TG 03300 v08.08
Summary of Changes:

(1) Revised table and paragraph 3.06.C for reinforcing bar and welded wire fabric sizes and support spacing to state that the information shown is for guidance only and that the specifier will be responsible for determining the appropriate reinforcement sizes and support spacing.

(2) Revised paragraph 3.18.B to state that the five (5) year guarantee period against floor sealant bond failure due to vapor emission and alkalinity levels should be provided by the manufacturer in lieu of the Contractor.

Cast-in-Place Concrete TECHNICAL GUIDE — TG 03300

1. COORDINATION ISSUES: Verify contractor's quality control provisions for testing and payment methods.

1.1. Confirm that civil drawings and specifications coordinate with architectural and structural for concrete slab fiber secondary reinforcing requirements.

1.2 Coordinate joint locations with structural and civil.

1.3 Coordinate types, descriptions, and locations.

2. DESIGN ISSUES:

2.1 Design the project using the soft metric system for reinforcing and indicate both the standard and soft metric sizes in a specification table or on drawings.

2.2 Consider using Fiber reinforced concrete in the design. Fiber technologies has significantly advanced and its use is encouraged.

2.3 Design joint locations to minimize cracking.

3. DRAWING NOTES:

3.1 Structural Drawings: Code design load requirements shall be included in Structural Notes.

3.2 Locate control/contraction joints in accordance with ACI 302.1.

3.3 Show all joint locations.

3.4. Detail all joints

3.5 Construction Tolerances for Slopes on Accessible Routes:

3.5.1 Include the following drawing note:
"Design slopes for accessible parking spaces, access aisles and accessible routes are less the maximum slopes allowed by the applicable Accessibility regulations. Slopes installed in excess of the regulation maximum will be considered defective work, and shall be corrected."

3.5.2 Include on the same drawing a list of the Accessibility regulation maximum slopes for accessible parking spaces, access aisles, and accessible routes.

4. STANDARD DRAWINGS: (Not Used)

5. SPECIFICATION NOTES:

5.1 Fiber Reinforcement: shall be added to ready-mixed concrete wherever the material is to be used for sidewalks and other exterior slabs on grade. Wire matt or bar reinforcement in driveways, including flares and aprons, is still considered primary reinforcement by the DOT and County requirements. Under normal condition, add to the ready-mix at the plant in the quantity recommended by the manufacturer. If job conditions warrant, fiber reinforcement may by added at the jobsite providing that fibers are evenly distributed in the mix.

5.2 Vapor Retarders: Carefully check submittals for meeting the requirements of paragraph 2.08. The minimum requirements for ASTM E1745, Class A retarders include Tensile Strength of 45 lbf/in., and Puncture Resistance of 2200 g. The minimum requirements for Class B retarders include Tensile Strength of 30 lbf/in., and Puncture Resistance of 1700 g.

6. GUIDE SPECIFICATION:

6.1 Section 03300 Cast-in-Place Concrete

SPECIFIER'S NOTE: Blue colored texts are Notes to the Specifier and should be completely deleted from the final text. Where [red colored text in brackets] is shown in this specification section, insert wording, numbers, etc. as appropriate and delete brackets. Where <Red colored text in brackets> is shown, choice is indicated. Make the appropriate choice and delete the brackets. Maintain footer notation in italics with the current version used (e.g. TG 03300 v08.~~02~~08). Verify that section titles cross referenced in this Section correspond to this Project's specifications; Section titles may have changed.

Do not include the Project Name (etc.) line in the footer. Use the following format for the specification footer.

TG 03300 v0~~7.09~~8.08 Cast-in-Place Concrete
DAGS Job No. [00-00-0000] 03300 - 2

End Footer Sample

SECTION 03300 - CAST-IN-PLACE CONCRETE

Part 1 - GENERAL

SPECIFIER NOTES: List in paragraph 1.01.B below only products and construction that might be listed in this Section but are specified elsewhere.

1.01 SUMMARY

A. Section includes cast-in-place concrete, including formwork, reinforcement, concrete materials, mix design, placement procedures, and finishes.

B. Related Sections include the following:

1. Division 1 Section “Concrete Moisture Vapor Emission and Alkalinity Testing” for moisture vapor emission and alkalinity testing of concrete slabs to receive finish flooring.

2. Division 2 Section “Earthwork” for drainage fill under slabs-on-grade.

3. Division 2 Section “Basaltic Termite Barrier.”

4. Division 2 Section “Cement Concrete Pavement” for concrete pavement and walks.

5. Division 3 Section “Concrete Toppings” for metallic and nonmetallic concrete floor toppings.

6. Division 9 Section “Resilient Tile Floor” for resilient flooring and accessories, including floor leveling and patching compounds and testing for moisture and alkalinity.

7. Division 9 Section “Carpet” for testing for moisture and alkalinity.

8. Division 9 Section “Painting” testing for moisture and alkalinity.

1.02 DEFINITIONS

A. Cementitious Materials: Portland cement alone or in combination with one or more of blended hydraulic cement, fly ash and other pozzolans, ground granulated blast-furnace slag, and silica fume.

SPECIFIER NOTES: As a UBC requirement, provide subparagraph 1.03.A.1 for facilities located in seismic Zones 3 & 4.

1.03 SUBMITTALS

A. Product Data:
1. Reinforcing steel - Certified mill test results or laboratory test results. Indicate bar size, yield strength, ultimate tensile strength, elongation and bend test. Provide chemical composition for rebars that are to be welded.

B. Design Mixes: For each concrete mix. Include alternate mix designs when characteristics of materials, project conditions, weather, test results, or other circumstances warrant adjustments.
1. Indicate amounts of mix water to be withheld for later addition at Project site.

SPECIFIER NOTES: Delete paragraph 1.03.C below if reinforcement shop drawings are not required.

C. Steel Reinforcement Shop Drawings: Details of fabrication, bending, and placement, prepared according to ACI 315, “Details and Detailing of Concrete Reinforcement.” Include material, grade, bar schedules, stirrup spacing, bent bar diagrams, arrangement,

and supports of concrete reinforcement. Include special reinforcement required for openings through concrete structures.

SPECIFIER NOTES: Only include paragraph1.03.D in special conditions where formwork shop drawings are required. Confirm with Project Coordinators. If shop drawings are required, confirm the requirements in paragraph 1.04 A. "Professional Engineer Qualifications" in "Quality Assurance" Article.
SPECIFIER'S NOTE: Delete subparagraph 1.03.D.1 below if no shoring and reshoring are required.

D. Formwork Shop Drawings: Prepared by or under the supervision of a qualified licensed professional engineer detailing fabrication, assembly, and support of formwork. Design and engineering of formwork are Contractor's responsibility.
   1. Shoring and Reshoring: Indicate proposed schedule and sequence of stripping formwork, shoring removal, reshoring, and final removal of shoring.

SPECIFIER NOTES: Retain subparagraph1.03.E below if procedures for welder certification are retained in "Quality Assurance" Article.

E. Welding Certificates: Copies of certificates for welding procedures and personnel.

SPECIFIER NOTES: Use either paragraph 1.03.G or 1.03.F Delete test reports paragraph if not required.

F. Material Test Reports: From a qualified testing agency indicating and interpreting test results for compliance with the requirements indicated, based on comprehensive testing of current materials.

SPECIFIER NOTES: Delete material certificates paragraph if using "Material Test Reports" paragraph above. Retain and edit subparagraphs 1.03.G.1 thru 12 when using paragraphs 1.03.F or 1.03.G.

G. Material Certificates: Signed by manufacturers certifying that each of the following items complies with requirements:
   1. Form materials and form-release agents.
   2. Steel reinforcement and reinforcement accessories.
   3. Fiber reinforcement.
   4. Waterstops.
   5. Curing materials.
   6. Floor and slab treatments.
   7. Bonding agents.
   8. Adhesives.
   9. Vapor retarders.
   10. Epoxy joint filler.
   11. Joint-filler strips.
   12. Repair materials.

SPECIFIER'S NOTE: Delete paragraph 1.03.H if no pre-installation conference is scheduled.

H. Minutes of pre-installation conference.

SPECIFIER'S NOTE: Delete paragraph 1.04 A. if Contractor is not required to engage the services of a qualified professional engineer in "Submittals" Article.
SPECIFIER'S NOTE: DAGS Standard is to have contractor provide the testing. Retain paragraph 1.04.C if Contractor or manufacturer selects testing agency for mix design, material test reports, or field quality control. Retain subparagraph 1.04.C.1 below, required by ACI 301 and ASTM C 31/C 31M, if emphasis is needed. ASTM C 1077 notes relevant field or laboratory technician certification by ACI, NRMCA, PCA, or National Institute for Certification in Engineering Technologies may demonstrate evidence of competence.

1.04 QUALITY ASSURANCE

A. Professional Engineer Qualifications: A professional engineer who is legally qualified to practice in jurisdiction where Project is located and who is experienced in providing engineering services of the kind indicated. Engineering services are defined as those performed for formwork and shoring and reshoring installations that are similar to those indicated for this Project in material, design, and extent.

B. Manufacturer Qualifications: A firm experienced in manufacturing ready-mixed concrete products complying with ASTM C 94 requirements for production facilities and equipment.

C. Testing Agency Qualifications: An independent testing agency, acceptable to authorities having jurisdiction, qualified according to ASTM C 1077 and ASTM E 329 to conduct the testing indicated, as documented according to ASTM E 548.
   1. Personnel conducting field tests shall be qualified as ACI Concrete Field Testing Technician, Grade 1, according to ACI CP-1 or an equivalent certification program.

D. Source Limitations: Obtain each type or class of cementitious material of the same brand from the same manufacturer's plant, each aggregate from one source, and each admixture from the same manufacturer.

SPECIFIER'S NOTE: Delete paragraph below if no welding. Retain "Welding Certificates" Paragraph in "Submittals" Article if below is retained. AWS states that welding qualifications remain in effect indefinitely unless welding personnel have not welded for more than six months or there is a specific reason to question their ability.

E. Welding: Qualify procedures and personnel according to AWS D1.4, "Structural Welding Code--Reinforcing Steel."

F. ACI Publications: Comply with the following, unless more stringent provisions are indicated and maintain a copy at the field office.
   1. ACI 301, "Specification for Structural Concrete."

   2. ACI 117, "Specifications for Tolerances for Concrete Construction and Materials."

   3. ACI 347R "Guide to Formwork for Concrete"

SPECIFIER'S NOTE: Delete paragraph 1.04.G and subparagraphs below if not required. If retaining, indicate location, concrete type, and other details of mockups on Drawings or by inserts. Revise wording if only one mockup is required. Revise size of mockups in subparagraph 1.04.G.1 below if required. In subparagraph 1.04.G.6, choose to delete mockup or to retain mockups as part of the building rather than separately.

G. Mockups: Cast concrete slabs-on-grade mockup to demonstrate typical joints, surface finish, texture, tolerances, and standard of workmanship.
   1. Build mockups approximately 200 sq. ft. in the location indicated or, if not indicated, as directed by Engineer.

   2. Notify Contracting Officer seven days in advance of dates and times when mockups will be constructed.

3. Obtain Contracting Officer's approval of mockups before starting construction.

4. If Contracting Officer determines that mockups do not meet requirements, demolish and remove them from the site and cast another until the mockup is approved.

5. Maintain mockups during construction in an undisturbed condition as a standard for judging the completed Work.

6. Demolish and remove mockups when directed.

7. Approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

SPECIFIER'S NOTE: Delete paragraph 1.04.H if concrete work is not extensive or complex enough to justify a pre-installation conference. As a guide, provide pre-installation conference when project uses in excess of 300 c.y. of concrete or for buildings greater than 10,000 s.f. Confirm with Project Coordinator. If retaining paragraph coordinate with Division 1 Sections. Retain subparagraph 1.04.H.1 if warranted by complexity of mix design and quality control of materials.

H. Pre-installation Conference: Unless waived by the Contracting Officer, conduct conference at Project site to comply with requirements in Division 1 Section 01310 PROJECT MANAGEMENT AND COORDINATION.
   1. Before submitting design mixes, review concrete mix design and examine procedures for ensuring quality of concrete materials. Require representatives of each entity directly concerned with cast-in-place concrete to attend along with the Contracting Officer, including the following:
      a. Contractor's superintendent.

      b. Ready-mix concrete producer.

      c. Concrete subcontractor.

   2. Agenda to include review of joint locations

SPECIFIER'S NOTE: Insert agenda items not listed in Division 1 Section "Project Management and Coordination" under subparagraph 1.04.H.2

SPECIFIER'S NOTE: Delete both subparagraphs 1.05.A.1 and 1.05.A.2 below if coated steel reinforcement is not required. Delete subparagraph 1.05.A.2 if epoxy-coated steel reinforcement is not required.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Deliver, store, and handle steel reinforcement to prevent bending and damage.
   1. Avoid damaging coatings on steel reinforcement.

   2. Repair damaged epoxy coatings on steel reinforcement according to ASTM D 3963/D 3963M.

PART 2 - PRODUCTS

SPECIFIER'S NOTE: Retain subparagraph 2.01.A.1, revising if necessary, if generic specification is sufficient. Retain subparagraph 2.01.A.2 if plywood selection is required. If Finish overlaid birch plywood is required, add to subparagraph below and delete DOC PS 1 and other four choices of plywood.
SPECIFIER'S NOTE: Select one of four subparagraphs 2.01.A.2.a thru 2.01.A.2.d below or revise to suit Project. First imparts glossy finish, second imparts matte finish, and third and fourth impart coarser-textured finish depending on face-ply characteristics

2.01 FORM-FACING MATERIALS

A. Smooth-Formed Finished Concrete: Comply with ACI 347R. Provide new or good finish form-facing panels that will provide continuous, true, and smooth concrete surfaces. Furnish in largest practicable sizes to minimize number of joints.
   1. Plywood, metal, or other ACI 347R approved panel materials.

   2. Exterior-grade plywood panels, suitable for concrete forms, complying with DOC PS 1, and as follows:
      a. High-density overlay, Class 1, or better.

      b. Medium-density overlay, Class 1, or better, mill-release agent treated and edge sealed.

      c. Structural 1, B-B, or better, mill oiled and edge sealed.

      d. B-B (Concrete Form), Class 1, or better, mill oiled and edge sealed.

B. 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.

SPECIFIER'S NOTE: Forms in paragraph 2.01.D leave joint impressions in spiral or straight lines. Limit types of forms if a particular pattern of joint is required. Different release treatments of forms also affect appearance of as-cast surfaces.

C. Forms for Cylindrical Columns, Pedestals, and Supports: Metal, glass-fiber-reinforced plastic, paper, or fiber tubes that will produce surfaces with gradual or abrupt irregularities not exceeding specified formwork surface class. Provide units with sufficient wall thickness to resist plastic concrete loads without detrimental deformation.

D. Pan-Type Forms: Glass-fiber-reinforced plastic or formed steel, stiffened to resist plastic concrete loads without detrimental deformation.

SPECIFIER'S NOTE: Retain paragraph 2.01.E for void forms, sometimes called "carton forms," if required for expansive soils or block outs.

E. Void Forms: Biodegradable paper surface, treated for moisture resistance, structurally sufficient to support weight of plastic concrete and other superimposed loads.

SPECIFIER'S NOTE: Modify or delete paragraph 2.01.F for chamfer strips requirements.

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

G. Form-Release Agent: Commercially formulated form-release agent that will not bond with, stain, or adversely affect concrete surfaces and will not impair subsequent treatments of concrete surfaces. Form oils or waxes shall not be used for concrete surfaces intended to be painted.
   1. Formulate form-release agent with rust inhibitor for steel form-facing materials.

SPECIFIER'S NOTE: Delete or revise subparagraphs 2.01.H.1 thru 2.01.H.3 below to suit Project. For marine or extreme exposure conditions, use fiberglass form ties. Should the designer choose a hole size less than 1 ½ inches, modify subparagraph2.01.I.2.

H. 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 inch]*** to the plane of the exposed concrete surface.

   2. Furnish ties that, when removed, will leave holes not larger than ***[1 ½ inches]*** in diameter in concrete surface.

3. Furnish ties with integral water-barrier plates to walls indicated to receive dampproofing or waterproofing.

SPECIFIER'S NOTE: Delete or revise paragraphs 2.02.A thru 2.02.O and subparagraphs to suit steel reinforcement requirements. Indicate grades on the drawings if other than grade 60 is used. Provide a reference table as part of the structural general notes.

2.02 STEEL REINFORCEMENT

A. Reinforcing Bars: ASTM A 615/A 615M, Grade 60, deformed, unless otherwise noted on the drawings.

B. Plain-Steel Wire: ASTM A 82, as drawn ***[or, if applicable, select Plain-Steel Wire: ASTM A 82, galvanized.]***

SPECIFIER'S NOTE: Do not use rolled wire fabric; use sheet.

C. Plain-Steel Welded Wire Fabric: ASTM A 185, fabricated from as-drawn steel wire into flat sheets.

SPECIFIER'S NOTE: Retain paragraph 2.02.D for reinforcement that is welded or if added ductility is sought.

D. Low-Alloy-Steel Reinforcing Bars: ASTM A 706/A 706M, deformed.

SPECIFIER'S NOTE: Edit and retain paragraphs 2.02.E thru 2.02.L below if conditions or project requires specialized reinforcement.
SPECIFIER'S NOTE: For paragraph 2.02.E, select type of reinforcement to be galvanized from subparagraphs 2.02.E.1or 2 below. Select weight of zinc coating from either subparagraph 2.02.E.3 or 4 below. Class I has at least 50 percent more weight of zinc than Class II.

E. Galvanized Reinforcing Bars: ASTM A 767/A 767M, hot-dip galvanized after fabrication and bending, of reinforcement type and zinc coating as follows:
   1. Steel Reinforcement: ASTM A 615/A 615M, Grade 60, deformed.
   2. Steel Reinforcement: ASTM A 706/A 706M , deformed.
   3. Zinc Coating: Class I.
   4. Zinc Coating: Class II.

SPECIFIER'S NOTE: If epoxy-coated reinforcement is required, select either first paragraph 2.02.F for bars coated before fabrication or second paragraph 2.02.F for bars coated after fabrication and should not be field bent or re-bent. Select type of reinforcement from either subparagraphs 2.02.F.1 or 2 .

F. Epoxy-Coated Reinforcing Bars: ASTM A 775/A 775M, and as follows:
   1. Steel Reinforcement: ASTM A 615/A 615M, Grade 60, deformed.
   2. Steel Reinforcement: ASTM A 706/A 706M, deformed.

OR

F. Epoxy-Coated Fabricated Reinforcing Bars: ASTM A 934/A 934M, and as follows:
   1. Steel Reinforcement: ASTM A 615/A 615M, Grade 60, deformed.
   2. Steel Reinforcement: ASTM A 706/A 706M, deformed.

SPECIFIER'S NOTE: Select type of reinforcement from subparagraphs 2.02.G.1 or 2.

G. Steel Bar Mats: ASTM A 184/A 184M, assembled with clips.
   1. Steel Reinforcement: ASTM A 615/A 615M, Grade 60, deformed.
   2. Steel Reinforcement: ASTM A 706/A 706M, deformed.

H. Deformed-Steel Wire: ASTM A 496.

SPECIFIER'S NOTE: Select either plain steel or deformed steel.

I. Epoxy-Coated Wire: ASTM A 884/A 884M, Class A coated, **<plain-steel><deformed-steel>** wire.

J. Galvanized Plain-Steel Welded Wire Fabric: ASTM A 185, fabricated from galvanized steel wire into flat sheets.

K. Deformed-Steel Welded Wire Fabric: ASTM A 497, flat sheet.

SPECIFIER'S NOTE: Select either plain steel or deformed steel.

L. Epoxy-Coated Welded Wire Fabric: ASTM A 884/A 884M, Class A, **<plain-steel><deformed-steel>**.

End Paragraphs E thru L

SPECIFIER'S NOTE: Use only concrete chairs with sand plate pedestals to support reinforcing to prevent puncturing vapor retarder. Use subparagraph 2.03.A.1 as standard. Delete or revise subparagraphs 2.03.A.2 and 2.03.A.3 below if required for Project.

2.03 REINFORCEMENT ACCESSORIES

A. Bar Supports: Bolsters, chairs, spacers, and other devices for spacing, supporting, and fastening reinforcing bars and welded wire fabric in place that will not puncture the vapor retarder. Use plastic straps or brightly colored tie wires to secure reinforcing. Manufacture bar supports according to CRSI's "Manual of Standard Practice" from steel wire, plastic, or precast concrete or fiber-reinforced concrete 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 or CRSI Class 2 stainless-steel bar supports. Refer to paragraph 3.06 for chair support spacing.

2. For epoxy-coated reinforcement, use epoxy-coated or other dielectric-polymer-coated wire bar supports.

3. For zinc-coated reinforcement, use galvanized wire or dielectric-polymer-coated wire bar supports.

SPECIFIER'S NOTE: Add other products for dowels or dowel sleeves if required. These include circular and rectangular plastic dowel sleeves, square dowels, and plastic-surfaced or reinforced-paper-covered dowels. Use paragraph 2.03.B as standard. Delete or revise subparagraphs 2.03.C thru 2.03.E below if required for Project.

B. Joint Dowel Bars: Plain-steel bars, ASTM A 615/A 615M, Grade 60. Cut bars true to length with ends square and free of burrs.

C. Epoxy-Coated Joint Dowel Bars: ASTM A 775/A 775M; with ASTM A 615/A 615M, Grade 60, plain-steel bars.

D. Epoxy Repair Coating: Liquid, two-part, epoxy repair coating; compatible with epoxy coating on reinforcement and complying with ASTM A 775/A 755M.

E. Zinc Repair Material: ASTM A 780, zinc-based solder, paint containing zinc dust, or sprayed zinc.

End Paragraphs C thru E

SPECIFIER'S NOTE: Add mechanical splices and connections for steel reinforcement here if required.

SPECIFIER'S NOTE: Delete portland cement if only blended hydraulic cement is required. If supplementary cementing materials are required, usually retain portland cement with either fly ash or slag from subparagraphs below and allow Contractor option of using blended hydraulic cements. Portland Cement Type II is generally used by all local

manufacturers. If climatic (e.g. waterfront or high sulfate) conditions require, use only Portland Cement Type II.

2.04 CONCRETE MATERIALS

A. Portland Cement: ASTM C 150, **<Type I><Type II>**.

SPECIFIER'S NOTE: Unless conditions warrant, Contractor should be able to chose supplementary cement materials and blended hydraulic cement to satisfy project conditions. from subparagraphs below, if permitted. Blending fly ash or slag with portland cement is done at ready-mix plant. Each type of blended hydraulic cement may be further qualified by adding suffixes (MS) for moderate sulfate resistance, (A) for air entrainment, and (MH) for moderate heat of hydration.

SPECIFIER'S NOTE: Blended Hydraulic Cement and Ground Granulated Blast-Furnace Slag are not normally inventoried in Hawaii.

B. Pozzolans

1. Fly Ash: ASTM C 618, Class C or F.

2. Blended Hydraulic Cement: ASTM C595M.

3. Ground Granulated Blast-Furnace Slag: ASTM C 989, Grade 100 or 120.

C. Blended Hydraulic Cement: ASTM C 595M; Type IS - portland blast-furnace slag cement, Type IP - portland/pozzolan cement, Type I (PM) - pozzolan-modified portland cement, or Type I (SM) - slag-modified portland cement.

SPECIFIER'S NOTE: Silica fume in paragraph 2.05.D below is most often used in high-strength concrete and in special applications such as bridge decks to enhance durability by lowering permeability of concrete.

D. Silica Fume: ASTM C 1240, amorphous silica.

SPECIFIER'S NOTE: ASTM C 33 limits deleterious substances in coarse aggregate depending on climate severity and in-service location of concrete. Show top size of aggregate(s) and its location(s) to be used on the project. Use moderate weathering conditions subparagraph 2.04.E.1 as standard conditions, unless severe conditions are present. Edit to suit. ASTM C 33 default classes for Severe and Moderate weathering regions are repeated. Revise subparagraphs, respectively, to either 4M or 5M (exposed architectural concrete) or 4S or 5S (frequent wetting) if required. Higher numbers are for greater concrete exposure.

SPECIFIER'S NOTE: Select coarse-aggregate size from one of the three subparagraphs 2.04.E. 2, 3 or 4 below. If using different aggregate sizes for concrete, indicate location of each on Drawings. Standard aggregate size is either #57 or #67. (Reference: CCPI Aggregate nomenclature).

E. Normal-Weight Aggregate: ASTM C 33, uniformly graded, and as follows:

1. Class: Moderate weathering region, but not less than 3M. **[or use severe weathering region, but not less than 3S]**

2. Aggregate Size: 1-1/2 inches (38 mm).

3. Aggregate Size: No. 57 (1 inch to No. 4).

4. Aggregate Size: No. 67 (3/4 inch to No. 4).

SPECIFIER'S NOTE: Select lightweight coarse-aggregate size from one of the three subparagraphs 2.04.F. 1, 2 or 3 below. If using different aggregate sizes for concrete, indicate location of each on Drawings.

F. Lightweight Aggregate: ASTM C 33.

1. Aggregate Size: No. 67 (3/4 inch to No. 4).
2. Aggregate Size: 1/2 inch to No. 8.

3. Aggregate Size: No. 8 (3/8 inch to No. 8).

G. Size of Coarse Aggregate: Except when otherwise specified or permitted, maximum size of coarse aggregate shall not exceed three-fourths of the minimum clear spacing between reinforcing bars (or bundled bars), one-fifth of the narrowest dimension between the sides of forms, or one-third of the thickness of slabs or toppings.

H. Water: Potable and complying with ASTM C 94 or non potable meeting ASTM C-94 Acceptance Criteria for Questionable Water Supply. Use only potable water for job site mixing.

SPECIFIER'S NOTE: Allow contractor choice of selecting admixtures, unless restricting admixtures are required by job conditions. Select chemical admixtures from paragraphs 2.05.B thru 2.05.F below.

2.05 ADMIXTURES

A. General: Admixtures certified by manufacturer to contain not more than 0.1 percent water-soluble chloride ions by mass of cementitious material and to be compatible with other admixtures and cementitious materials. Do not use admixtures containing calcium chloride.

B. Air-Entraining Admixture: ASTM C 260.

C. Water-Reducing Admixture: ASTM C 494, Type A.

D. High-Range, Water-Reducing Admixture: ASTM C 494, Type F.

E. Water-Reducing and Accelerating Admixture: ASTM C 494, Type E.

F. Water-Reducing and Retarding Admixture: ASTM C 494, Type D.

SPECIFIER'S NOTE: Use Corrosion-Inhibiting Admixture only in special conditions and delete paragraph 2.05.G if not required. Select products because there are no product standards and Manufacturers offer formulations that act differently. Confirm listed products are available through local suppliers.

G. Corrosion-Inhibiting Admixture: Commercially formulated, anodic inhibitor or mixed cathodic and anodic inhibitor; capable of forming a protective barrier and minimizing chloride reactions with steel reinforcement in concrete.

1. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, the following:

2. Products: Subject to compliance with requirements, provide one of the following:
   a. DCI or DCI-S; W. R. Grace & Co., Construction Products Div.

   b. Rheocrete CNI or Rheocrete 222+; Master Builders, Inc.

   c. FerroGard-901; Sika Corporation.
   d. Eucon-CIA; Euclid Chemical corporation.

End Paragraph 2.05.G

SPECIFIER'S NOTES: Delete Article 2.06 if not required.
Select type of steel fiber from three subparagraphs 2.06.A.1 thru 2.06.A.3 below. Revise length of fiber and insert other dimensions if required. Type 1 steel wire fibers include "Dramix" by Bekaert and "Zorex" by Novocon. Type 2 cut steel sheet fibers include "Fibercon" by Fibercon International.

Synthetic fibers shall be used in all exterior concrete slabs on grade for secondary reinforcement. Show locations on drawings. Retain either paragraph 2.06.B or paragraph

2.06.C or delete both if not required. Revise if adding polyester or nylon fiber. Manufacturers claim fibrillated polypropylene fibers, applied in sufficient quantity and length, improve some hardened concrete properties. Fibrillated or monofilament fibers, applied in reduced quantity, help decrease plastic shrinkage effects. Note : Not all slab finishes will produce acceptable results.

2.06 FIBER REINFORCEMENT A. Carbon-Steel Fiber: ASTM A 820, deformed, minimum ***[2.4 inches (60 mm)]*** long, and of diameter or effective diameter indicated.

1. Fiber: Type 1, cold-drawn wire.

2. Fiber: Type 2, cut sheet.

3. Fiber: Type 1, cold-drawn wire, or Type 2, cut sheet.

B. Synthetic Fiber: Fibrillated or monofilament polypropylene fibers engineered and designed for use in concrete, complying with ASTM C 1116, Type III, ***[1/2 to 1-1/2 inches]*** long.

SPECIFIER'S NOTE: The listed products and manufacturer are available through local suppliers and are included for reference. Contractors' submittals are to be checked for compliance.

Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, the following:

1. ***Carbon-Steel Fibers:***
   a. ***Dramix; Bekaert Corporation***
   b. ***Fibercon; Fibercon International***
   c. ***Zorex; Novocon International Inc.***
2. ***Fibrillated Fibers:***
   a. ***Fibermesh; Fibermesh, Div. of Synthetic Industries***
   b. ***Forta; Forta Corporation***
   c. ***Grace Fibers; W. R. Grace & Co., Construction Products Div.***
3. ***Monofilament Fibers:***
   a. ***Fiberstrand 100; Euclid Chemical Co.***
   b. ***Fibermix Stealth; Fibermesh, Div. of Synthetic Industries***
   c. ***Forta Mono; Forta Corporation***
   d. ***Grace MicroFiber; W. R. Grace & Co., Construction Products Div.***

SPECIFIER'S NOTE: Select type of waterstops either paragraph 2.07.A or 2.07.B or 2.07.C to be used on project. Delete this Article 2.06 if waterstops are not required.

2.07 WATERSTOPS

A. Flexible Rubber Waterstops: CE CRD-C 513, for embedding in concrete to prevent passage of fluids through joints. Factory fabricate corners, intersections, and directional changes.

B. Flexible PVC Waterstops: CE CRD-C 572, for embedding in concrete to prevent passage of fluids through joints. Factory fabricate corners, intersections, and directional changes.

SPECIFIER'S NOTE: The listed products and manufacturer are available through local suppliers and are included for reference. Contractors' submittals are to be checked for compliance.

Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, the following:

1. ***Rubber Waterstops:***
   a. ***Greenstreak.***
   b. ***Williams Products, Inc.***
2. ***PVC Waterstops:***
   a. ***Greenstreak.***

b. Meadows: W. R. Meadows, Inc.
c. Tamms Industries Co.; Div. of LaPorte Construction Chemicals North America, Inc.

C. Self-Expanding Strip Waterstops: Manufactured rectangular or trapezoidal strip, sodium bentonite or other hydrophylic material for adhesive bonding to concrete.

SPECIFIER'S NOTE: The listed products and manufacturer are available through local suppliers and are included for reference. Contractors' submittals are to be checked for compliance. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, the following:
1. *Volclay Waterstop-RX; Colloid Environmental Technologies Co.*
2. *Conseal CS-231; Concrete Sealants Inc.*
3. *Swellseal Joint; De Neef Construction Chemicals (U.S.) Inc.*
4. *Hydrotite; Greenstreak.*
5. *Mirastop; Mirafi Moisture Protection, Div. of Royal Ten Cate (USA), Inc.*

SPECIFIER'S NOTE: A vapor retarder is required under all interior slabs-on-grade. ASTM E 1745 establishes permeance levels, tensile strength and puncture resistance values for Classes A and B. Class A has the highest tensile and puncture strength requirements. The permeance requirements listed in the two paragraphs below exceed the minimum requirements of ASTM E 1745.
1. *Select Class B as standard.*
2. *Specify class A only where project conditions such as heavy slab reinforcement or a subgrade with sharp cobbles or exposed stone may damage a thinner vapor retarder.*

SPECIFIER'S NOTE: The listed products are available through local suppliers and are included for reference. Contractors' submittals are to be checked for compliance. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, the following:
1. *Griffolyn Type-85 by Reef Industries Inc.*
2. *Stego Wrap (15 mil) Vapor Barrier by Stego Industries.*
3. *Sealtight Vapormat 10 Mil by W.R. Meadows.*

2.08 VAPOR RETARDERS

A. Vapor Retarder: ASTM E 1745, Class B except as modified in Subparagraph 1. below, nylon or polyester-cord-reinforced three-ply high-density polyethylene sheet, or one ply extruded polyolefin sheet; 10 mil minimum thickness. Compliance to ASTM standards shall be confirmed by an independent testing agency.
   1. Permeance Rating: ASTM E96, ASTM E154 not exceeding 0.035 grains/ft^2/hr

SPECIFIER'S NOTE: The listed products are available through local suppliers and are included for reference. Contractors' submittals are to be checked for compliance. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, the following:
1. *Griffolyn Type 105 by Reef Industries Inc.*
2. *Griffolyn Type 65G by Reef Industries Inc.*
3. *Sealtight Vapormat 15 mil by W.R. Meadows.*
4. *Premolded Membrane Vapor Seal with Plasmatic Core by W.R. Meadows.*

B. Vapor Retarder: ASTM E 1745, Class A except as modified in Subpargraph 1. below, nylon- or polyester-cord-reinforced three-ply high-density polyethylene sheet or one-ply extruded polyolefin sheet; 15 mil minimum thickness. Compliance to ASTM standards shall be confirmed by an independent testing agency.
   1. Permeance Rating: ASTM E96, ASTM E154 not exceeding 0.03 grains/ft^2/hr.

SPECIFIER'S NOTE: Retain paragraph 2.09.B or paragraph 2.09.C and subparagraphs if nonmetallic dry-shake floor hardeners are required. Select 2.09.B if unpigmented hardener is required; select 2.09.C if pigmented hardener is required. Verify suitability

with manufacturer if air content of concrete exceeds 3 percent. Retain one subparagraph in 2.09.C. If retaining second, indicate colors in a separate schedule.

2.09 FLOOR AND SLAB TREATMENTS

A. Slip-Resistive Aggregate Finish: Factory-graded, packaged, rustproof, nonglazing, abrasive aggregate of silicon carbide, or fused aluminum-oxide granules or crushed emery with emery aggregate containing not less than 50 percent aluminum oxide and not less than 25 percent ferric oxide; unaffected by moisture, and cleaning materials.

B. Unpigmented Mineral Dry-Shake Floor Hardener: Factory-packaged dry combination of portland cement, graded quartz aggregate, and plasticizing admixture.

C. Pigmented Mineral Dry-Shake Floor Hardener: Factory-packaged dry combination of portland cement, graded quartz aggregate, coloring pigments, and plasticizing admixture. Use coloring pigments that are finely ground, nonfading mineral oxides interground with cement.

1. Colors: Match Project's samples.

2. Colors: As indicated by referencing manufacturer's designations.

3. Colors: As selected by DAGS from manufacturer's full range for these characteristics.

SPECIFIER'S NOTE: Penetrating liquid floor treatment paragraph 2.09.D is commonly applied to harden and densify floors of warehouses and distribution facilities, imparting a satin sheen to finished floor. While formulations vary, manufacturers claim these nonfluosilicate liquids improve abrasion and chemical resistance and dustproof concrete surface. If approved by manufacturer, these products may be installed over mineral dry-shake floor hardeners. Delete paragraph if not used.

D. Penetrating Liquid Floor Treatment: Chemically reactive, waterborne solutions of inorganic silicate or siliconate or polymerized polyester polymer or other materials and proprietary components; odorless; colorless; that penetrates, hardens, waterproofs or densifies concrete surfaces.

SPECIFIER'S NOTE: The listed products and manufacturer are available through local suppliers and are included for reference. Contractors' submittals are to be checked for compliance.

Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, the following:

1. Unpigmented Mineral Dry-Shake Floor Hardener:
- ***a. Non-Metallic Floor Hardener; Burke Group, LLC (The)***
- ***b. Concolor; ChemMasters***
- ***c. Quartz Tuff; Dayton Superior Corporation***
- ***d. Surflex; Euclid Chemical Co.***
- ***e. Maximent; Master Builders, Inc.***
- ***f. Hard Top; Richmond Screw Anchor Co.***
- ***g. Lithochrome Color Hardener; L. M. Scofield Co.***
- ***h. Harcol; Sonneborn, Div. of ChemRex, Inc.***
- ***i. Hard Top; Symons Corporation***

2. Pigmented Mineral Dry-Shake Floor Hardener:
- ***a. Non-Metallic Floor Hardener; Burke Group, LLC (The)***
- ***b. Concolor; ChemMasters***
- ***c. Quartz Tuff; Dayton Superior Corporation***
- ***d. Surflex; Euclid Chemical Co.***
- ***e. Maximent; Master Builders, Inc.***
- ***f. Lithochrome Color Hardener; L. M. Scofield Co.***
- ***g. Harcol; Sonneborn, Div. of ChemRex, Inc.***

3. Penetrating Liquid Floor Treatment:

a. Titan Hard; Burke Group, LLC (The)
b. Chemisil Plus; ChemMasters.
c. Day-Chem Sure Hard; Dayton Superior Corporation.
d. Euco Diamond Hard; Euclid Chemical Co.
e. StableCrete Plus; Conselcor.

SPECIFIER'S NOTE: Use evaporation retarder in paragraph 2.10.A below as it temporarily reduces moisture loss from concrete surfaces awaiting finishing in hot, dry, and windy conditions. Evaporation retarders are not curing compounds. Select curing aids and materials from remaining paragraphs below, retaining optional materials if applicable.

2.10 CURING MATERIALS AND EVAPORATION RETARDERS

A. Evaporation Retarder: Waterborne, monomolecular film forming, manufactured for application to fresh concrete.

B. Absorptive Cover: AASHTO M 182, Class 2, burlap cloth made from jute or kenaf, weighing approximately ***[9 oz./sq. yd.]*** dry.

C. Moisture-Retaining Cover: ASTM C 171, polyethylene film or white burlap-polyethylene sheet.

D. Water: Potable.

SPECIFIER'S NOTE: Paragraph 2.10.E is a clear, solvent-borne, membrane-forming curing compound. Delete if waterborne, low-VOC-emission compounds are required. Non-dissipating type products have generally been listed. Check finish flooring manufacturer's requirements.

E. Clear, Solvent-Borne, Membrane-Forming Curing Compound: ASTM C 309, Type 1, Class B.

SPECIFIER'S NOTE: Curing compounds in paragraph 2.10.F have a solids content of about 15 percent. If requiring a curing compound to have a solids content of 18 percent or more, add the phrase "**18 to 22 percent solids**." This solid content comfortably exceeds moisture retention requirements of ASTM C 309, and will partially seal the concrete. Check finish flooring manufacturer's requirements.

F. Clear, Waterborne, Membrane-Forming Curing Compound: ASTM C 309, Type 1, Class B, ***[18 to 22 percent solids]***.

SPECIFIER'S NOTE: Paragraph 2.10.G is a clear, non-yellowing, solvent-borne, membrane-forming curing and sealing compound meeting recently developed ASTM C 1315 requirements. Retain if curing compound with sealing properties is required.

G. Clear, Solvent-Borne, Membrane-Forming Curing and Sealing Compound: ASTM C 1315, Type 1, Class A.

SPECIFIER'S NOTE: Paragraph 2.10.H is a clear, non-yellowing, waterborne, membrane-forming curing and sealing compound meeting recently developed ASTM C 1315 requirements. Retain if lower-VOC emissions and a curing compound with sealing properties are required. Verify curing compounds meet maximum emission limits of authorities having jurisdiction.

H. Clear, Waterborne, Membrane-Forming Curing and Sealing Compound: ASTM C 1315, Type 1, Class A.

SPECIFIER'S NOTE: The listed products and manufacturer are available through local suppliers and are included for reference. Contractors' submittals are to be checked for compliance.

Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, the following:

1. Evaporation Retarder:
a. Finishing Aid Concentrate; Burke Group, LLC (The)

b. Spray-Film; ChemMasters
c. Sure Film; Dayton Superior Corporation
d. Eucobar; Euclid Chemical Co.
e. Confilm; Master Builders, Inc.
f. Rich Film; Richmond Screw Anchor Co.
g. SikaFilm; Sika Corporation
h. Finishing Aid; Symons Corporation

2. Clear, Solvent-Borne, Membrane-Forming Curing Compound:
a. Spartan-Cote; Burke Group, LLC (The)
b. Spray-Cure & Seal 15; ChemMasters
c. Day-Chem Cure and Seal; Dayton Superior Corporation
d. Diamond Clear; Euclid Chemical Co.
e. Nitocure S; Fosroc
f. CS-309; W. R. Meadows, Inc.
g. Rich Seal 14 percent UV; Richmond Screw Anchor Co.
h. Kure-N-Seal; Sonneborn, Div. of ChemRex, Inc
i. Cure & Seal 14 percent; Symons Corporation
j. Clear Seal 150; Tamms Industries Co., Div. of LaPorte Construction Chemicals of North America, Inc.
k. Acrylic Cure; Unitex

3. Clear, Waterborne, Membrane-Forming Curing Compound:
a. Klear Kote WB II Regular; Burke Chemicals.
b. Safe-Cure & Seal 20; ChemMasters.
c. Safe Cure and Seal; Dayton Superior Corporation.
d. Aqua Cure VOX; Euclid Chemical Co.
e. Vocomp-20; W. R. Meadows, Inc.
f. Rich Seal 14 percent E; Richmond Screw Anchor Co.
g. Kure-N-Seal WB; Sonneborn, Div. of ChemRex, Inc.
h. Cure & Seal 14 percent E; Symons Corporation.
i. Seal Cure WB 150; Tamms Industries Co., Div. of LaPorte Construction Chemicals of North America, Inc.
j. Hydro Seal; Unitex

4. Clear, Waterborne, Membrane-Forming Curing Compound, 18 to 22 Percent Solids:
a. Klear Kote WB II 20 percent; Burke Chemicals
b. Safe-Cure & Seal 20; ChemMasters
c. Diamond Clear VOX; Euclid Chemical Co.
d. Vocomp-20; W. R. Meadows, Inc.
e. Rich Seal 18 percent E; Richmond Screw Anchor Co.
f. Kure-N-Seal W; Sonneborn, Div. of ChemRex, Inc.
g. Cure & Seal 18 percent E; Symons Corporation
h. Seal Cure WB STD; Tamms Industries Co., Div. of LaPorte Construction Chemicals of North America, Inc.
i. Hydro Seal 800; Unitex

5. Clear, Solvent-Borne, Membrane-Forming Curing and Sealing Compound:
a. Spray-Cure & Seal Plus; ChemMasters
b. CS-309/30; W. R. Meadows, Inc.
c. Rich Seal 31 percent UV; Richmond Screw Anchor Co.
d. Cure & Seal 31 percent UV; Symons Corporation

6. Clear, Waterborne, Membrane-Forming Curing and Sealing Compound:
a. Klear-Kote Cure-Sealer-Hardener, 30 percent solids; Burke Group, LLC
b. Polyseal WB; ChemMasters
c. Vocomp-30; W. R. Meadows, Inc.

SPECIFIER'S NOTE: Select one of three paragraphs 2.11.A below. Joint-filler strips are used in floor isolation joints.

2.11 RELATED MATERIALS

A. Joint-Filler Strips: ASTM D 1751, asphalt-saturated cellulosic fiber.

OR

A. Joint-Filler Strips: ASTM D 1752, cork or self-expanding cork.

OR

A. Joint-Filler Strips: ASTM D 1751, asphalt-saturated cellulosic fiber, or ASTM D 1752, cork or self-expanding cork.

SPECIFIER'S NOTE: Retain paragraph 2.11.B if semirigid joint filler is required to fill joints and support edges of trafficked contraction and construction joints.

B. Epoxy Joint Filler: Two-component, semirigid, 100 percent solids, epoxy resin with a Shore A hardness of 80 per ASTM D 2240.

SPECIFIER'S NOTE: Bonding agent in paragraph2.11.C may be used directly from container or as an admixture in cement or sand-cement slurries and rubbing grout.

C. Bonding Agent: ASTM C 1059, Type II, non-redispersible, acrylic emulsion or styrene butadiene.

SPECIFIER'S NOTE: Select type of epoxy, based on use, from 2.11.D subparagraphs 1 thru 3 below.

D. Epoxy-Bonding Adhesive: ASTM C 881, two-component epoxy resin, capable of humid curing and bonding to damp surfaces, of class and grade to suit requirements, and as follows:
   1. Type II, non-load bearing, for bonding freshly mixed concrete to hardened concrete.
   2. Types I and II, non-load bearing, for bonding hardened or freshly mixed concrete to hardened concrete.
   3. Types IV and V, load bearing, for bonding hardened or freshly mixed concrete to hardened concrete.

SPECIFIER'S NOTE: Retain paragraph 2.11.E For cement wash finish.

E. Cementitious Coatings: Cement based polymer modified concrete finishing materials. Available Products subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, the following:
   1. ProFinish by Bonded Materials
   2. Polycoat by Tremcrete Systems Incorporated
   3. Durus by Durus High Tech Cement
   4. MBT RS-1150 by Master Builders Technologies.

F. Sleeves:
   1. Schedule 40 pipe, galvanized per ASTM A53.
   2. Schedule 40 PVC Pipe.

SPECIFIER'S NOTE: Delete paragraphs 2.11.G and H if not required. Coordinate sizes and locations on Drawings.

G. Reglets: Fabricate reglets of not less than (0.0217-inch) thick galvanized steel sheet. Temporarily fill or cover face opening of reglet to prevent intrusion of concrete or debris.

H. Dovetail Anchor Slots: Hot-dip galvanized steel sheet, not less than (0.0336 inch) thick, with bent tab anchors. Temporarily fill or cover face opening of slots to prevent intrusion of concrete or debris.

SPECIFIER'S NOTE: Retain paragraph 2.12.A and subparagraphs 2.12.A.1 thru 4 below as a repair material for areas beneath floor finishes. Do not use gypsum based leveling or patching materials.

2.12 REPAIR MATERIALS

A. Repair Underlayment: Cement-based, polymer-modified, self-leveling product that can be applied in thicknesses from 1/8 inch and that can be feathered at edges to match adjacent floor elevations. Products shall contain no added gypsum.

1. Cement Binder: ASTM C 150, portland cement or hydraulic or blended hydraulic cement as defined in ASTM C 219.

2. Primer: Product of underlayment manufacturer recommended for substrate, conditions, and application.

3. Aggregate: Well-graded, washed gravel, 1/8 to 1/4 inch or coarse sand as recommended by underlayment manufacturer.

4. Compressive Strength: Not less than 4000 psi (27.6 MPa) at 28 days when tested according to ASTM C 109/C 109M.

SPECIFIER'S NOTE: The listed products and manufacturer are available through local suppliers and are included for reference. Contractors' submittals are to be checked for compliance.

Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, the following:

1. Typical self-leveling floor toppings or overlayment products. include:

a. Levelayer III" by Dayton Superior

b. Levelex HS" by L&M Construction

c. Certi-Vex SLU TC" by Vexcon.

Similar products that exceed 5000 psi include:

d. Mastertop 112 Topping" by Master Builders

e. Quikrete Self-Leveling Floor Resurfacer Fast-Set by Quikcrete.

SPECIFIER'S NOTE: Retain paragraph and subparagraphs below as a repair material for areas not receiving floor finishes.

B. Repair Topping: Traffic-bearing, cement-based, polymer-modified, self-leveling product that can be applied in thicknesses from 1/4 inch. Products shall contain no added gypsum.

1. Cement Binder: ASTM C 150, portland cement or hydraulic or blended hydraulic cement as defined in ASTM C 219.

2. Primer: Product of topping manufacturer recommended for substrate, conditions, and application.

3. Aggregate: Well-graded, washed gravel, 1/8 to 1/4 inch or coarse sand as recommended by topping manufacturer.

4. Compressive Strength: Not less than 5500 psi (39 MPa) at 28 days when tested according to ASTM C 109/C 109M.

SPECIFIER'S NOTE: Paragraphs 2.13.B thru 2.13.F are examples of portions of structures often needing different concrete mixes. Revise locations, adding others if more concrete mixes are required. Unless SPECIFIER has a reason to select slump limits, allow Contractor the choice to select the slump limits based on jobsite conditions. Unless SPECIFIER has a reason to select water-cementitious materials ratio different than those noted in paragraphs 2.13.L, M and N, use the standards. If durability is a concern use W/C ratio and Fc to define the mix. Refer to ACI 318 Chapter 4.

2.13 CONCRETE MIXES

A. Prepare design mixes for each type and strength of concrete determined by either laboratory trial mix or field test data bases, as follows:
   1. Proportion normal-weight concrete according to ACI 211.1 and ACI 301.

   2. Proportion lightweight structural concrete according to ACI 211.2 and ACI 301.

SPECIFIER'S NOTE: Unless required for project requirements use: Class 4000 for slabs on grade; Class 3000 for all non prestressed structural slabs, beams, piers, columns, stairs, walls footings and equipment pads above ground; Class 2500 for sidewalks, equipment pads on grade and other uses not identified. Use Class 3000 for electrical handholds and boxes; class 2500 for duct encasements. Use Class 3000 for drainage, sewer and plumbing systems; manholes, catch basins, valve boxes and other appurtenance; and Class 2500 for thrust blocks and trench encasements.

B. Footings and Foundation Walls: Proportion normal-weight concrete mix as follows:
   1. Compressive Strength (28 Days): ***[3000 psi]***.

SPECIFIER'S NOTE: Revise to suit Project.

C. Slab-on-Grade: Proportion normal-weight concrete mix as follows:
   1. Compressive Strength (28 Days): ***[4000 psi]***.

SPECIFIER'S NOTE: Delete paragraph 2.13.D and subparagraphs below if lightweight structural concrete is used. Suspended slabs include formed concrete, composite or noncomposite concrete on metal deck, and concrete topping on structural precast concrete. If Project has more than one type of suspended slab with different properties, indicate location of each on Drawings. Revise to suit Project.

D. Suspended Slabs: Proportion normal-weight concrete mix as follows:
   1. Compressive Strength (28 Days): ***[3000 psi]***.

SPECIFIER'S NOTE: Delete paragraph 2.13.E and subparagraphs below if no lightweight structural concrete. Revise locations if necessary. Coordinate requirements with lightweight aggregate supplier, structural engineer and, if applicable, UL design limits. Select compressive strength from subparagraph 2.13.E.1 or revise to suit Project. Edit subparagraph 2.13.2 thru 8 below or revise values or unit weight terminology. "Calculated equilibrium unit weight" is the basis preferred by Expanded Shale Clay and Slate Institute rather than "maximum air dry unit weight" included in ACI 301 for measuring unit weight.

E. Suspended Slabs: Proportion lightweight structural concrete mix as follows:
   1. Compressive Strength (28 Days): **< _____ psi>**.

   2. Calculated Equilibrium Unit Weight: **<_____ *lb/cu. ft.>*** plus or minus ***[3 lb/cu. ft.]*** as determined by ASTM C 567.

SPECIFIER'S NOTE: Revise to suit Project.

F. Building Frame Members: Proportion normal-weight concrete mix as follows:
   1. Compressive Strength (28 Days): ***[3000 psi]***.

G. Electrical Handholes and Boxes; Drainage Sewer and Plumbing systems; Manholes, Catchbasins, Valve Boxes and other appurtenances:
   1. Compressive Strength (28 Days): ***[3000 psi]***.

H. Electrical Ducts, Conduit Encasements; Sidewalks, Equipment pads on grade; Thrust Blocks and Trench Encasements:
   1. Compressive Strength (28 Days): ***[2500 psi]***.

I. Slab Vapor Emissions Rates: At the time of finished flooring installation , vapor emissions shall not exceed a maximum of 5 lbs. per 1000 square feet per 24 hours or the maximum emission established by the flooring manufacturer whichever is less. If the vapor

emission rate exceeds the limit specified, take measures specified in Paragraph 3.18 to reduce the emissions to an acceptable level without delaying the project.

SPECIFIER'S NOTE: Usually retain either paragraph2.13.J or paragraph and applicable subparagraphs 2.13.K.1 thru 7 below or retain both paragraphs 2.13.J & K and indicate exposure conditions of concrete if required. Neither ACI 301 nor ACI 318 (ACI 318M) limits amount of cementitious material that can replace portland cement unless concrete is exposed to deicing chemicals. Percentages in subparagraphs 2.13.K.1 thru 4 below repeat ACI 301 limits for concrete exposed to deicing chemicals. Delete subparagraphs 2.13.K.5 thru 6 below if no silica fume is permitted. Limits of silica fume alone or in combination with other cementitious materials below are based on ACI 318 (ACI 318M). Revise to suit Project.

J. Cementitious Materials: For concrete exposed to deicers, limit percentage, by weight, of cementitious materials other than portland cement according to ACI 301 requirements.

K. Cementitious Materials: Limit percentage, by weight, of cementitious materials other than portland cement in concrete as follows:
   1. Fly Ash: 25 percent.
   2. Combined Fly Ash and Pozzolan: 25 percent.
   3. Ground Granulated Blast-Furnace Slag: 50 percent.
   4. Combined Fly Ash or Pozzolan and Ground Granulated Blast-Furnace Slag: 50 percent portland cement minimum, with fly ash or pozzolan not exceeding 25 percent.
   5. Silica Fume: 10 percent.
   6. Combined Fly Ash, Pozzolans, and Silica Fume: 35 percent with fly ash or pozzolans not exceeding 25 percent and silica fume not exceeding 10 percent.
   7. Combined Fly Ash or Pozzolans, Ground Granulated Blast-Furnace Slag, and Silica Fume: 50 percent portland cement minimum, with fly ash or pozzolans not exceeding 25 percent and silica fume not exceeding 10 percent.

SPECIFIER'S NOTE: For concrete subject to special exposure conditions or where durability is a concern, select one or more water-cementitious materials ratios from three paragraphs 2.13.L thru 2.13.N below. For normal conditions include paragraph 2.13.L. Indicate portions of structure affected by each requirement, here or on Drawings. A water cement ratio of 0.40 to 0.45 is recommended by ASTM F710-98 Standard Practice for Preparing Concrete Floors to Receive Moisture Sensitive Resilient Flooring, and a maximum ratio of 0.45 is recommended by CCPI .

L. Maximum Water-Cementitious Materials Ratio: **<0.40>** to **<0.45>** for concrete required to have low permeability, interior slabs with vapor sensitive floor coverings.

M. Maximum Water-Cementitious Materials Ratio: 0.45 for concrete exposed to deicers or subject to freezing and thawing while moist.

N. Maximum Water-Cementitious Materials Ratio: 0.40 for corrosion protection of steel reinforcement in concrete exposed to chlorides from deicing chemicals, salt, saltwater, brackish water, seawater, or spray from these sources.

SPECIFIER'S NOTE: For concrete subject to sulfate exposure, select water-cementitious materials ratios from paragraphs 2.13.O and 2.13.P. Indicate portions of structure affected by each requirement, here or on Drawings. If same concrete is also subject to special

exposure conditions, select the more restrictive requirement from paragraphs 2.13.N or 2.13.P.

O. Maximum Water-Cementitious Materials Ratio: 0.50 for concrete subject to moderate sulfate exposure.

P. Maximum Water-Cementitious Materials Ratio: 0.45 for concrete subject to severe or very severe sulfate exposure.

SPECIFIER'S NOTE: Air content in paragraph 2.13.Q is maximum recommended by ACI 302.1R.

Q. Do not add air entrainment to concrete of trowel-finished interior floors and suspended slabs. Do not allow entrapped air content to exceed 3 percent.

SPECIFIER'S NOTE: Retain paragraph 2.13.R or delete if classifying portions of the structure that will be exposed to chlorides, exposed to dampness, or dry or protected from moisture. Percentage below, from ACI 301, Article 4.2.2.6, is the most restrictive for non-prestressed reinforced concrete and eliminates the need to designate concrete exposure. ACI 301 and ACI 318 (ACI 318M) express this percentage by weight of cement, not cementitious material.

R. Limit water-soluble, chloride-ion content in hardened concrete per ACI 318 Chapter 4 for corrosion protection of reinforcing steel.

SPECIFIER'S NOTE: Select paragraph 2.13.S for steel-fiber reinforcement or paragraph 2.13.T. for synthetic fiber. Synthetic fibers shall be used in all exterior concrete slabs on grade. Indicate location, on Drawings, where concrete will use steel or synthetic fibers.

S. Steel-Fiber Reinforcement: Add to concrete mix, according to manufacturer's written instructions.

T. Synthetic Fiber: Uniformly disperse in concrete mix at manufacturer's recommended rate.
   1. Use synthetic fiber reinforcement for exterior concrete sidewalks on grade and in other areas identified in the contract documents.

SPECIFIER'S NOTE: Delete or revise subparagraphs 2.13.U.1 thru 2.13.U.4 to suit Project. If using subparagraph 2.13.U.4, add locations and dosage of corrosion-inhibiting admixture.

U. Admixtures: Use admixtures according to manufacturer's written instructions.
   1. Use water-reducing admixture or high-range water-reducing admixture (superplasticizer) 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, concrete for heavy-use industrial slabs and parking structure slabs, concrete required to be watertight, and concrete with a water-cementitious materials ratio below 0.50.

   4. Use corrosion-inhibiting admixture in concrete mixes where indicated.

2.14 FABRICATING REINFORCEMENT

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

SPECIFIER'S NOTE: Delete Project-site mixing paragraph 2.15.B if not permitted. ACI 301 applies measuring, batching, and mixing requirements from ASTM C 94 to Project-site mixing. ASTM C 1116 applies to mixing with steel or synthetic fibers.

2.15 CONCRETE MIXING

A. Ready-Mixed Concrete: Measure, batch, mix, and deliver concrete according to ASTM C 94, and ASTM C 1116 and furnish batch ticket information. Batch ticket information shall include design mix reference, water that can be added at the jobsite, and admixtures. For transit mixing, complete not less than 70 revolutions of the drum at the manufacturer's rated mixing speed. Discharge concrete into its final position within 90 minutes after introduction of batch water to the cement. If a retarder admixture is used, the discharge time limit of 90 minutes may be increased by the time specified for retardation by the admixture manufacturer or the concrete supplier. Mix concrete a minimum of one minute at mixing speed immediately prior to discharge.

B. Project-Site Mixing: Measure, batch, and mix concrete materials according to ASTM C 94. Mix concrete materials in appropriate drum-type batch machine mixer.
   1. For mixer capacity of 1 cu. yd.0.76 cu. m or less, continue mixing at least one and one-half minutes, but not more than five minutes after all ingredients are in mixer, before any part of batch is released.

   2. For mixer capacity larger than 1 cu. yd.0.76 cu. m, increase mixing time by 15 seconds for each additional 1 cu. yd.0.76 cu. m.

   3. Provide batch ticket for each batch discharged and used in the Work, indicating Project identification name and number, date, mix type, mix time, quantity, and amount of water added. Record approximate location of concrete placement in structure.

   4. Hand mixed concrete will not be allowed, except to make up shortages for fence post footing, thresholds, curbs and gutters, thrust block and utility trench encasements.

PART 3 - EXECUTION

3.01 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 concrete 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.

SPECIFIER'S NOTE: Select surface classes, usually two or more, from subparagraphs 3.01.C.1 thru 4 below. Indicate where each class applies. Classes are taken from ACI 347R. Form-Facing Materials: Several options for form-facing panels are presented in the Section Text, although the specifier may be more interested in limiting materials for smooth-formed finishes. Usually, few restrictions are placed on materials for rough-formed finishes.

ACI 347R recommends tolerances and surface irregularities in the completed concrete work. Tolerances recommended by ACI 347R, and mandated by ACI 301, follow ACI 117 limits. Accordingly, this Section references ACI 117 for tolerances. For surface irregularities, ACI 117 recognizes four surface classes from ACI 347R but expects the design professional to designate where each applies. Without other instructions in the Contract Documents, ACI 301 sets Class C as the default.

Surface irregularities are designated by ACI 347R as either "gradual" or "abrupt." Offsets and fins at formed joints are considered abrupt irregularities. Warping and planar variations are considered gradual irregularities, measured with a 60-inch- long straightedge for plane surfaces or a template for curved surfaces. The four surface classes defined in ACI 347R, with their suggested uses, are as follows:

Class A: For surfaces prominently exposed to public view, where appearance is especially important. Class A permits gradual or abrupt irregularities of 1/8 inch.

Class B: For coarse-textured surfaces to receive plaster, stucco, or wainscoting. Class B permits gradual or abrupt irregularities of 1/4 inch.

Class C: For permanently exposed surfaces without additional finish. Class C permits gradual or abrupt irregularities of 1/2 inch.

Class D: For surfaces, usually permanently concealed, where roughness is not objectionable. Class D permits gradual or abrupt irregularities of 1 inch.

C. Limit concrete surface irregularities, designated by ACI 347R as abrupt or gradual, as follows:
   1. Class A, 1/8 inch.
   2. Class B, 1/4 inch.
   3. Class C, 1/2 inch1.
   4. Class D, 1 inch.

D. Construct forms 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. Kerf wood inserts for forming keyways, reglets, recesses, and the like, for easy removal.
   1. 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. Maintain the integrity of the vapor retarder membrane.

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.

SPECIFIER'S NOTE: Choose either to chamfer or not to chamfer corners and edges in paragraph 3.01.H. ACI 301 default requires chamfers.

H. <Chamfer><Do not chamfer> exterior corners and edges of permanently exposed concrete.

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.

SPECIFIER'S NOTE: Specify embedded items and anchorage devices for other work attached to or supported by cast-in-place concrete. Add specific requirements for installing embedded items, if any, that are part of the Work. Select applicable subparagraphs 3.02.A.2 & 3 below and add others if required. Revise to suit Project.

3.02 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.
   1. Install anchor bolts, accurately located, to elevations required.

   2. Install reglets to receive top edge of foundation sheet waterproofing and to receive through-wall flashings in outer face of concrete frame at exterior walls, where flashing is shown at lintels, shelf angles, and other conditions.

   3. Install dovetail anchor slots in concrete structures as indicated.

   4. Install inserts, hangers, metal ties, nailing strips, blocking, grounds and other fastening devices needed for attachment of other work.

B. Locate electrical or mechanical conduits and fittings so that the strength of the concrete member is not impaired. "Conduits" include pipes, ducts, and electrical conduits. Unless required otherwise on the Drawings, conform to the following:
   1. Concrete Columns: Do not embed conduits if displacing more than 4% of the cross-sectional area of the column. Conduits shall not be larger in outside diameter than 1/3 the least dimension of the column.

   2. Concrete Walls: Do not embed conduits larger than one inch (nominal pipe size) diameter vertically. Place conduits in the middle of the wall and space a minimum of 10 times their outside diameter. Do not embed conduits horizontally in wall lengthwise. Provide sleeve for conduits passing through walls.

   3. Concrete Beams: Do not embed conduits larger than 1-1/2 inches outside diameter vertically in any beam. Place conduits in the middle third of the beam depth and space a minimum of 10 times their outside diameter. Do not embed conduits horizontally in beam lengthwise. Provide sleeve for conduits passing through beams.

   4. Suspended Concrete Slabs and Toppings: Do not embed conduits larger than 1 inch outside diameter s in concrete slab or topping. Conduits shall be spaced a minimum of 10 times their outside diameter. Avoid conduit crossings. Provide sleeve for conduits passing through slabs.

   5. Concrete Slabs on Grade: Do not embedded conduits within the thickness of any concrete slab on grade. Place conduits in the subgrade below the concrete slabs, but not within the thickness of the basaltic termite barrier.

C. Obtain DAGS Representative's approval to install conduit or pipe penetrations that may unduly impair the strength of the structural member (for example, multiple pipe penetrations near the face of a column).

SPECIFIER'S NOTE: Revise removal time in paragraph below if required. Period of 24 hours is halved to 12 hours in ACI 347R. Commentary in ACI 318 (ACI 318M) recognizes 12 hours for concrete using regular portland cement but advises that this period may be insufficient for concrete using Type II and Type V portland cements or ASTM C 595M cements, concrete with retarding admixtures, and concrete using ice during mixing.

3.03 REMOVING AND REUSING FORMS

A. General: Formwork, for sides of beams, walls, columns, and similar parts of the Work, that does not support weight of concrete may be removed after cumulatively curing at not less than 50 deg F(10 deg C) for 24 hours after placing concrete provided concrete is hard enough to not be damaged by form-removal operations and provided curing and protection operations are maintained. The 24 hour period may be reduced to 12 hours in compliance with ACI 347R with prior approval from the Contracting Officer.

SPECIFIER'S NOTE: Retain or revise one of four subparagraphs 3.03.B.1 thru 4 below. Paragraph 3.03.B.2 is default in ACI 301, and paragraph 3.03.B.1 is ACI 347R recommendation. Insert alternative provisions in subparagraph3.02.B.3 below for nondestructive testing and for evaluating concrete strength included in ACI 301, if permitted.

B. Leave formwork, for beam soffits, joists, slabs, and other structural elements, that supports weight of concrete in place until concrete has achieved the following:
   1. At least 70 percent of 28-day design compressive strength (minimum requirement).

   2. 28-day design compressive strength.

   3. Determine compressive strength of in-place concrete by testing representative field or laboratory-cured test specimens according to ACI 301.

   4. Remove forms only if shores have been arranged to permit removal of forms without loosening or disturbing shores.

C. 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.

D. 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 Contracting Officer.

SPECIFIER'S NOTE: Review this Article with Structural Engineer and revise if required. Revise paragraph below if setting more detailed requirements such as a minimum number of floors. Require Contractor to submit structural calculations and shoring plans if project warrants. Do not specify the number of floors to be shored/reshored as this requirement is the Contractor's responsibility. Specifying a MINIMUM NUMBER of floors to be shored or reshored may be acceptable.

3.04 SHORES AND RESHORES

A. Comply with ACI 318, ACI 318M, ACI 301, and recommendations in ACI 347R for design, installation, and removal of shoring and reshoring.

B. In multistory construction, extend shoring or reshoring over a sufficient number of stories to distribute loads in such a manner that no floor or member will be excessively loaded or will induce tensile stress in concrete members without sufficient steel reinforcement.

C. Plan sequence of removal of shores and reshore to avoid damage to concrete. Locate and provide adequate reshoring to support construction without excessive stress or deflection.

3.05 VAPOR RETARDERS

A. Vapor Retarder: Place, protect, and repair vapor-retarder sheets according to ASTM E 1643 "Standard Practice for Installation of Water Vapor Retarders" and manufacturer's written instructions. The more stringent shall apply.
   1. Use the greatest widths and lengths practical to minimize lap joints. Seal laps joints and edges with tape or materials compatible with the vapor retarder. Remove and

replace torn, punctured, or damaged vapor barrier materials, except when minor repairs or patches are allowed by manufacturer's instructions.

2. Do not cut or puncture vapor retarder. No penetrations of the vapor barrier allowed except for reinforcing steel and permanent utilities. Seal all penetrations including pipes and reinforcing. Repair damage and reseal vapor retarder before placing concrete.

3. Do not leave the vapor retarder exposed to ultraviolet radiation for more than a few days prior to the concrete pour. Remove standing water from the vapor retarder prior top concrete pour.

3.06 STEEL REINFORCEMENT

A. General: Comply with CRSI's "Manual of Standard Practice" for placing reinforcement.

B. Clean reinforcement of loose rust and mill scale, earth, ice, and other foreign materials.

SPECIFIER'S NOTE: Delete subparagraph 3.06.C .1 below if welding is not permitted or required*. Table shown below for spacing of supports for reinforcing bars and welded wire fabric (WWF) is for general guidance only and shows limited combination of reinforcement sizes and corresponding distance between supports. Specifier is responsible for providing the proper reinforcement sizes and corresponding maximum distance between supports to suit the Project.*

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.

1. Shop or field-weld reinforcement according to AWS D1.4, where indicated.

2. Support slab reinforcing bars and welded wire fabric (WWF) as follows:

BAR SIZE	MAXIMUM DISTANCE BETWEEN SUPPORTS
#3	2 feet
#4	3 feet
#5	4 feet
#3 at 15" E.W.	4'-6" o.c. each way
WIRE FABRIC SHEETS	MAXIMUM DISTANCE BETWEEN SUPPORTS
~~12 x 12~~ 6 x 6 - W2.9/w2.9	2'-0" o.c. each way
~~12 x 12~~ 6 x 6 - W6/W6	~~3'-4~~ 3'-0" o.c. each way

D. Set wire ties with ends directed into concrete, not toward exposed concrete surfaces.

E. Install welded wire fabric in longest practicable lengths on bar supports spaced to minimize sagging. Lap edges and ends of adjoining sheets at least one mesh spacing. Offset laps of adjoining sheet widths to prevent continuous laps in either direction. Lace overlaps with wire.

SPECIFIER'S NOTE: Retain paragraph 3.06.F if using epoxy-coated reinforcement. Retain paragraph 3.06.G if using zinc-coated reinforcement.

F. Epoxy-Coated Reinforcement: Use epoxy-coated steel wire ties to fasten epoxy-coated reinforcement. Repair cut and damaged epoxy coatings with epoxy repair coating according to ASTM D 3963/D 3963M.

G. Zinc-Coated Reinforcement: Use galvanized steel wire ties to fasten zinc-coated reinforcement. Repair cut and damaged zinc coatings with zinc repair material.

SPECIFIER'S NOTE: Coordinate joint types, description, and location with Drawings. Joints types are consolidated in this Article for consistency rather than for strict sequence of installation. Revise criteria for locating construction joints, in paragraphs below, to suit Project.

3.07 JOINTS

A. General: Construct joints true to line with faces perpendicular to surface plane of concrete.

SPECIFIER'S NOTE: Keyed joints are used in walls and floors and between walls and slabs or footings. Design keyed joints as required. Note that ACI 302.1R recommends limiting keyed joints to lightly trafficked floors. Insert spacing of construction joints in subparagraph3.07.B.3 below or on plan to suit Project. Select subparagraph 3.07.B.4 or 3.07.B.5, or delete both if a bonding material is not required.

B. Construction Joints: Install so strength and appearance of concrete are not impaired, at locations indicated or as approved by Contracting Officer.

1. Place joints perpendicular to main reinforcement. Continue reinforcement across construction joints, unless otherwise indicated. Do not continue reinforcement through sides of strip placements of floors and slabs.

2. Locate horizontal joints in walls and columns at underside of floors, slabs, beams, and girders and at the top of footings or floor slabs.

3. Space vertical joints in walls as indicated. Locate joints beside piers integral with walls, near corners, and in concealed locations where possible.

4. Use a bonding agent at locations where fresh concrete is placed against hardened or partially hardened concrete surfaces.

5. Use epoxy-bonding adhesive at locations where fresh concrete is placed against hardened or partially hardened concrete surfaces.

SPECIFIER'S NOTE: Insert spacing of contraction joints here or on Drawings if required. Contraction-joint spacings vary with slab thickness, aggregate size, and slump based on PCA's recommendations. Select type of joint-forming method required or retain both subparagraphs 3.07.C.1 and 2 below as Contractor's option. Add spacing of joints if not indicated on Drawings. Delete subparagraph 3.07.C.2 below if saw cutting is not permitted. Description below does not distinguish conventional wet- and dry-cut saws from early entry dry-cut saws. Timing is critical to sawed joints. "Soft-cut" early entry dry-cut saws have been used within one to two hours of finishing concrete and is preferred. Conventional saw cutting must be delayed to leave concrete undamaged, usually 4 to 12 hours, but not so long that uncontrolled cracking occurs.

C. Contraction Joints in Slabs-on-Grade: Form weakened-plane contraction joints, sectioning concrete into areas as indicated. Construct contraction joints for a depth equal to at least one-fourth of concrete thickness, as follows:

1. Grooved Joints: Form contraction joints after initial floating by grooving and finishing each edge of joint to a radius of ***[1/8 inch]***. Repeat grooving of contraction joints after applying surface finishes. Eliminate groover tool marks on concrete surfaces.

2. Sawed Joints: Form contraction joints with power saws equipped with shatterproof abrasive or diamond-rimmed blades. Cut ***[1/8 inch]*** wide joints into concrete when

cutting action will not tear, abrade, or otherwise damage surface and before concrete develops random contraction cracks.

SPECIFIER'S NOTE: Select subparagraph 3.07.D.1 or 3.07.D.2 or, if both are required, indicate location of each on Drawings.

D. Isolation Joints in Slabs-on-Grade: After removing formwork, install joint-filler strips at slab junctions with vertical surfaces, such as column pedestals, foundation walls, grade beams, and other locations, as indicated.
   1. Extend joint-filler strips full width and depth of joint, terminating flush with finished concrete surface, unless otherwise indicated.

   2. Terminate full-width joint-filler strips not less than 1/2 inch or more than 1 inch below finished concrete surface where joint sealants, specified in Division 7 Section "Joint Sealants," are indicated.

   3. Install joint-filler strips in lengths as long as practicable. Where more than one length is required, lace or clip sections together.

SPECIFIER'S NOTE: Delete paragraph 3.07.E if no dowel joints are required; revise if limiting Contractor's choice of dowel joint installation.

E. Dowel Joints: Install dowel sleeves and dowels or dowel bar and support assemblies at joints where indicated.
   1. Use dowel sleeves or lubricate or asphalt-coat one-half of dowel length to prevent concrete bonding to one side of joint.

SPECIFIER'S NOTE: Retain paragraphs 3.08.A and 3.08.B if waterstops are required.

3.08 WATERSTOPS

A. Flexible Waterstops: Install in construction joints as indicated to form a continuous diaphragm. Install in longest lengths practicable. Support and protect exposed waterstops during progress of Work. Field-fabricate joints in waterstops according to manufacturer's written instructions.

B. Self-Expanding Strip Waterstops: Install in construction joints and at other locations indicated, according to manufacturer's written instructions, bonding or mechanically fastening and firmly pressing into place. Install in longest lengths practicable.

SPECIFIER'S NOTE: Retain either paragraph 3.09.B depending on allowing water to be added at jobsite. Unless justified by project conditions allow adding water as standard. ACI 301 allows water to be added to concrete mix on-site, up to amount allowed in design mix. Incorporate supplementary requirements when concrete is to be placed below water table or underwater. Refer to Chapter 8, ACI 304 "Guide to Measuring, Mixing, Transporting and Placing Concrete". Provide additional paragraphs and clarification details to clarify conditions when high strength concrete (compression members) is used with low strength concrete (flexural members).

SPECIFIER'S NOTE: Delete subparagraph 3.09.B.1 below if high-range water-reducing admixtures are not permitted.

3.09 CONCRETE PLACEMENT

A. Before placing concrete, verify that installation of formwork, reinforcement, and embedded items is complete and that required inspections have been performed. Provide one day notification to DAGS Representative for each scheduled pour.

B. Do not add water to concrete during delivery, at Project site, or during placement, unless approved by DAGS Representative.

OR

B. Before placing concrete, water may be added at Project site, subject to limitations of ACI 301. Up to two gallons of water per cubic yard of concrete may be added at the jobsite provided the approved design mix accommodates the additional water.

1. Do not add water to concrete after adding high-range water-reducing admixtures to mix.

C. Convey concrete from mixer to the place of final deposit rapidly by methods that prevent segregation or loss of ingredients and will insure the required quality of concrete. Use conveying equipment, conveyors, hoppers, baffles, chutes, pumps that are sized and designed to prevent cold joints from occurring and prevent segregation in discharged concrete. Clean conveying equipment before each placement.

D. Deposit concrete continuously or in 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 specified. Deposit concrete to avoid segregation.

SPECIFIER'S NOTE: If required, insert a height limitation, for dropping concrete in forms. The standard is 12 feet.

E. Deposit concrete in forms in horizontal layers with proper consolidation into previous layers and in a manner to avoid inclined construction joints. Place each layer while preceding layer is still plastic, to avoid cold joints. For high wall pours (above 12 feet), Contractor must show its experience and demonstrate its proficiency before DAGS will permit pours in excess of 12 feet.
   1. Consolidate placed concrete with mechanical vibrating equipment. Use equipment and procedures for consolidating concrete recommended by ACI 309R.

   2. Do not use vibrators to transport concrete inside forms. Insert and withdraw vibrators vertically at uniformly spaced locations no farther than the visible effectiveness of the vibrator. Place vibrators to rapidly penetrate placed layer and at least 6 inches into preceding layer. Do not insert vibrators into lower layers of concrete that have begun to lose plasticity. At each insertion, limit duration of vibration to time necessary to consolidate concrete and complete embedment of reinforcement and other embedded items without causing mix constituents to segregate.

   3. Make construction joints only where located on Drawings unless otherwise approved by DAGS. Plan pours to continuously place concrete from one construction joint to another.

F. 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, free of humps or hollows, before excess moisture or bleed-water appears on the surface. Do not further disturb slab surfaces before starting finishing operations.

SPECIFIER'S NOTE: Unless cold-weather placement or hot-weather placement criteria are required, delete the respective paragraph and subparagraphs 3.09.G Cold-Weather Placement or paragraph and subparagraphs 3.09.H Hot-Weather Placement. Normal weather conditions are covered in the preceding paragraphs 3.09.A thru 3.09.F.

G. 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 air temperature has fallen to or is expected to fall below 40 deg F, uniformly heat water and aggregates before mixing to obtain a concrete mixture temperature of not less than 50 deg F and not more than 80 deg F at point of placement.

   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 mix designs.

H. Hot-Weather Placement: Place concrete according to recommendations in ACI 305R and as follows, when hot-weather conditions exist:
   1. Cool ingredients before mixing to maintain concrete temperature below 90 deg F at time of placement. Chilled mixing water or chopped ice may be used to control temperature, provided water equivalent of ice is calculated to total amount of mixing water. Using liquid nitrogen to cool concrete is Contractor's option.

   2. Cover steel reinforcement with water-soaked burlap so steel temperature will not exceed ambient air temperature immediately before embedding in concrete.

   3. Fog-spray forms, steel reinforcement, and subgrade just before placing concrete. Keep subgrade moisture uniform without standing water, soft spots, or dry areas.

SPECIFIER'S NOTE: Modify these requirements if job condition require. Synthetic fiber reinforcement provides only secondary reinforcement. Provide primary steel reinforcement where exterior slabs will be used for other than pedestrian traffic. or where poor soils conditions exist. Detail slab design and show locations of joints.

3.10 CONCRETE SLABS ON GRADE

A. For interior areas, unless specified elsewhere, place concrete floor slabs directly over vapor retarder overlain atop basaltic termite barrier (or granular fill-capillary barrier if BTB is not used in the Project) and reinforce slabs with grade 60, No. 10 (#3) steel bars at 15" O.C. each way.
   1. Place floor slabs in alternate panels, long strip pattern, and following construction or contraction joints. "Keyed Kold Joint" may be used in lieu of placement in alternate panels in areas where floor covering is specified provided all shrinkage cracks are sealed prior to installation of floor covering.

   2. Provide a bond-break filler strip, between concrete slab and abutting vertical surfaces and as detailed.

B. For exterior areas, unless specified elsewhere, place concrete floor slabs directly over granular fil ***[or compacted fill]*** and reinforce slabs with synthetic fibers. Provide isolation and contraction joints where detailed and, at intersections, corners and at abutments. Place contraction joints not more than 40 feet apart, unless detailed otherwise.
   1. Finish concrete true to grade, section and cross slope for sloped or crowned walks at 1.5% (1% minimum and 2% maximum). Round edges to 1/8" radius except saw-cut joints. Finish steps in connection with walks with same finish as walks.

SPECIFIER'S NOTE: Coordinate finishes selected from paragraphs 3.11.A thru 3.11.C below with finish schedule or indicate location of each on Drawings.

3.11 FINISHING FORMED SURFACES

A. Rough-Formed Finish: As-cast concrete texture imparted by form-facing material with tie holes and defective areas repaired and patched. Remove fins and other projections exceeding ACI 347R limits for class of surface specified.

SPECIFIER'S NOTE: Revise locations of subparagraphs 3.11.B.1 and 2 below to suit Project. Delete subparagraph 3.11.B.2 if a rubbed finish is required.

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 defective areas. Remove fins and other projections exceeding ***[1/8 inch]*** in height.
   1. Apply to concrete surfaces exposed to public view or to be covered with a coating or covering material applied directly to concrete, such as waterproofing, dampproofing, veneer plaster, or painting.

   2. Do not apply rubbed finish to smooth-formed finish.

SPECIFIER'S NOTE: Select one rubbed finish from subparagraphs 3.11.C.1 thru 3.11.C.4 below if required.

C. Rubbed Finish: Apply the following to smooth-formed finished concrete:
   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.

   2. Grout-Cleaned Finish (Burlap): Wet concrete surfaces and apply grout of a consistency of thick paint to coat surfaces and fill small holes. Mix one part portland cement to one and one-half parts fine sand with a 1:1 mixture of bonding admixture and water. Add white portland cement in amounts determined by trial patches so color of dry grout will match adjacent surfaces. Scrub grout into voids and remove excess grout. When grout whitens, rub surface with clean burlap and keep surface damp for at least 36 hours.

   3. Cork-Floated Finish: Wet concrete surfaces and apply a stiff grout. Mix one part portland cement and one part fine sand with a 1:1 mixture of bonding agent and water. Add white portland cement in amounts determined by trial patches so color of dry grout will match adjacent surfaces. Compress grout into voids by grinding surface. In a swirling motion, finish surface with a cork float.

   4. Cementitious Coating (Cement Wash): Prepare, apply and cure the coating per manufacturer's requirements. Apply in 1/16-inch thick coats not to exceed 1/8-inch.
      a. Cementitious coatings are finished coatings and not to be used as patching or repair materials. Cement-sand-water mix are not cementitious coatings as defined under paragraph 2.11.E. Under no circumstances will products containing gypsum plaster be allowed as a cementitious coating.

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.

SPECIFIER'S NOTE: Select types of slab finishes required. Consultant shall obtain the referenced ACI standards. Revise locations of finish in subparagraphs below to suit Project.

3.12 FINISHING FLOORS AND SLABS

A. General: Comply with recommendations in ACI 302.1R for screeding, restraightening, and finishing operations for concrete surfaces. Do not wet concrete surfaces.

B. Scratch Finish: While still plastic, texture concrete surface that has been screeded and bull-floated or darbied. Use stiff brushes, brooms, or rakes.

1. Apply scratch finish to surfaces indicated and to surfaces to receive concrete floor topping or mortar setting beds for ceramic or quarry tile, portland cement terrazzo, and other bonded cementitious floor finishes.

C. Float Finish: Consolidate surface with power-driven floats or by hand floating if area is small or inaccessible to power driven floats. Restraighten, cut down high spots, and fill low spots. Repeat float passes and restraightening until surface is left with a uniform, smooth, granular texture.
   1. Apply float finish to surfaces indicated, to surfaces to receive trowel finish, and to floor and slab surfaces to be covered with fluid-applied or sheet waterproofing, built-up or membrane roofing, or sand-bed terrazzo.

SPECIFIER'S NOTE: Revise surface plane tolerances to suit Project. Select floor flatness values and levelness values required for Project or revise values to suit type of floor. ACI 302.1R suggests subparagraph 3.12.D.2.a values below be used for carpeted slabs; subparagraphs 3.12.D.2.b & c, for thin floor coverings; and subparagraph 3.12.D.2.d, for very flat floors for high-speed forklifts, air pallets, and ice and roller rinks. Retain subparagraph 3.12.D.3 for straightedge method if deleting F-number system. Based on project size and requirements, Consultant shall determine appropriate method to use. The F- number system is preferred for slabs exceeding 1000 square feet.

SPECIFIER'S NOTE: For critical floors (FF50), Consultant must consider locating all floor penetrations. On suspended slabs, floor flatness is achievable but floor levelness may not be achievable because of camber requirements. Note locations on drawings where floor flatness and levelness does not apply.

D. Trowel Finish: After applying float finish, apply first trowel finish and consolidate concrete by hand or power-driven trowel. Continue troweling passes and restraighten until surface is free of trowel marks and uniform in texture and appearance. Grind smooth any surface defects that would telegraph through applied coatings or floor coverings.
   1. Apply a trowel finish to surfaces indicated and to floor and slab surfaces exposed to view or to be covered with resilient flooring, carpet, ceramic or quarry tile set over a cleavage membrane, paint, or another thin film-finish coating system.

   2. Finish surfaces to the following tolerances, measured within 24 hours according to ASTM E 1155/E 1155M for a randomly trafficked floor surface:
      a. Specified overall values of flatness, F(F) 25; and levelness, F(L) 20; with minimum local values of flatness, F(F) 17; and levelness, F(L) 15.

      b. Specified overall values of flatness, F(F) 35; and levelness, F(L) 25; with minimum local values of flatness, F(F) 24; and levelness, F(L) 17; for slabs-on-grade.

      c. Specified overall values of flatness, F(F) 30; and levelness, F(L) 20; with minimum local values of flatness, F(F) 24; and levelness, F(L) 15; for suspended slabs.

      d. Specified overall values of flatness, F(F) 45; and levelness, F(L) 35; with minimum local values of flatness, F(F) 30; and levelness, F(L) 24.

SPECIFIER'S NOTE: In subparagraph 3.12.D.3.a, select 1/4" as the normal default.

   3. Finish and measure surface so gap at any point between concrete surface and an unleveled freestanding 10-foot-long straightedge, resting on two high spots and placed anywhere on the surface, does not exceed the following:
      a. **<1/4 inch><3/16 inch><1/8 inch>**.

SPECIFIER'S NOTE: Delete paragraphs 3.12.E thru 3.12.G below if not applicable. Paragraphs 3.12.F and G are generally used on exterior concrete steps and platforms, ramps, and other surfaces subject to light foot traffic.

E. Trowel and Fine-Broom Finish: Apply a partial trowel finish, stopping after second troweling, to surfaces indicated and to surfaces where ceramic or quarry tile is to be installed by either thickset or thin-set method. Immediately after second troweling, and when concrete is still plastic, slightly scarify surface with a fine broom.

F. Broom Finish: Apply a broom finish to exterior concrete platforms, steps, and ramps, and elsewhere as indicated.
   1. Immediately after float finishing, slightly roughen trafficked surface by brooming with fiber-bristle broom perpendicular to main traffic route. Coordinate required final finish with Contracting Officer before application.

G. Swirled Finish: Apply a swirl finish to exterior concrete platforms, steps, and ramps, and elsewhere as indicated. Immediately after second troweling, and when concrete is still plastic, work the surface with a float in semi-circular or fan-like motion.

SPECIFIER'S NOTE: Delete paragraph 3.12.H and subparagraphs if not applicable. Generally used on interior and exterior concrete treads, platforms, and ramps subject to moderate foot traffic. Revise float finish in subparagraph 3.12.H.2 to trowel finish if required.

H. Slip-Resistive Aggregate Finish: Before final floating, apply slip-resistive aggregate finish where indicated and to concrete stair treads, platforms, and ramps. Apply according to manufacturer's written instructions and as follows:
   1. Uniformly spread ***[25 lb/100 sq. ft.]*** of dampened slip-resistive aggregate over surface in one or two applications. Tamp aggregate flush with surface, but do not force below surface.

   2. After broadcasting and tamping, apply float finish.

   3. After curing, lightly work surface with a steel wire brush or an abrasive stone, and water to expose slip-resistive aggregate.

SPECIFIER'S NOTE: Retain paragraphs 3.12.I and 3.12.J if mineral dry-shake hardener finish, either pigmented, or unpigmented, is required. Consult manufacturer's instructions and revise rate of application if required. Rate in subparagraph 3.12.I.1 below is usually recommended for light traffic. For color finish use rate recommended for heavy traffic. Because color finish is not generally uniform, ensure users are aware of expected final results. Color staining is also available to blend or mix different colors for unique finishes. Coordinate selection of curing compounds for compatibility with dry-shake materials and revise lists in Part 2 accordingly, as required.

I. Unpigmented Mineral Dry-Shake Floor Hardener Finish: After initial floating, apply mineral dry-shake materials to surfaces according to manufacturer's written instructions and as follows:

   1. Uniformly apply mineral dry-shake materials at a rate of ***[100 lb/100 sq. ft.]***, unless greater amount is recommended by manufacturer.

   2. Uniformly distribute approximately two-thirds of mineral dry-shake materials over surface by hand or with mechanical spreader, and embed by power floating. Follow power floating with a second mineral dry-shake application, uniformly distributing remainder of material, and embed by power floating.

   3. After final floating, apply a trowel finish. Cure concrete with curing compound recommended by dry-shake material manufacturer and apply immediately after final finishing.

J. Color Finish (Pigmented Mineral Dry-Shake Floor Hardener): Prior to color application, manufacturer's representative shall instruct finisher on application and curing requirements of Color Floor Hardener and be present during application. After initial floating, apply mineral dry-shake materials to surfaces according to manufacturer's written instructions and as follows:
   1. Uniformly apply mineral dry-shake materials at a rate of ***[100 lb/100 sq. ft.]***, unless greater amount is recommended by manufacturer. Do not cast material into standing water.

   2. Uniformly distribute approximately two-thirds of mineral dry-shake materials over surface by hand or with mechanical spreader, and embed by power floating. Follow power floating with a second mineral dry-shake application at right angles to first application, uniformly distributing remainder of material, and embed by power floating.

   3. After final floating, apply a trowel finish. Take care not to over trowel and "burn" the surface. Cure concrete with curing compound recommended by dry-shake material manufacturer and apply immediately after final finishing.

SPECIFIER'S NOTE: Paragraphs 3.13.A thru 3.13.F are examples of various items that may be included in a project. Add, revise, or delete to suit Project.

3.13 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 Work.

B. Curbs: Provide monolithic finish to interior curbs by stripping forms while concrete is still green and by steel-troweling surfaces to a hard, dense finish with corners, intersections, and terminations slightly rounded.

C. Equipment Bases and Foundations: Provide machine and equipment bases and foundations as shown on Drawings. Set anchor bolts for machines and equipment at correct elevations, complying with diagrams or templates of manufacturer furnishing machines and equipment.

D. Steel Pan Stairs: Provide concrete fill for steel pan stair treads, landings, and associated items. Cast-in inserts and accessories as shown on Drawings. Screed, tamp, and trowel-finish concrete surfaces.

E. Electrical Work: Use 3/4" maximum size of aggregates for duct encasement. Unless detailed otherwise, encase underground ducts or conduits as follows:
   1. Provide 3 inches minimum concrete cover around ducts or conduits. Use spacers to place and hold ducts. Provide 18 inches minimum earth cover over top of concrete encasement unless otherwise detailed.

   2. For future connections, provide a one foot section of ducts or conduits to extend beyond concrete encasement and terminate with a coupling or end cap.

F. Concrete for Drainage, Sewer and Plumbing Systems:
   1. Do not use calcareous coarse aggregates in sewerage structures or components.

   2. Unless specified elsewhere, construct sewer manholes in accordance with the latest adopted/amended edition of Section 23 SEWER MANHOLES of the "STANDARD SPECIFICATIONS FOR PUBLIC WORKS CONSTRUCTION".

SPECIFIER'S NOTE: If evaporation rate in paragraph below is exceeded, ACI 305R states that plastic shrinkage cracking is probable. See manufacturer' literature or ACI 305R for estimated moisture-loss chart relating relative humidity, air and concrete temperature, and wind velocity to rate of evaporation.

3.14 CONCRETE PROTECTION 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 with recommendations in ACI 305R for hot-weather protection during curing.

B. Evaporation Retarder: Apply evaporation retarder to unformed concrete surfaces 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 by one or a combination of the curing methods listed in paragraph 3.14.D.

SPECIFIER'S NOTE: Select curing method(s) from subparagraphs 3.14.D.1 thru 3.14.D.4 below. Delete options or restrict use of curing method(s) to specific locations or types of surfaces if required. Retain at least three subparagraphs below as Contractor's options, unless not suited for Project. Curing and sealing compound in subparagraph 3.14.D.4 below is usually for floors and slabs and may act as a permanent surface finish. Coordinate with finish flooring manufacturer's requirements.

D. Unformed Surfaces: Begin curing immediately after finishing concrete. Cure unformed surfaces, including floors and slabs, concrete floor toppings, and other surfaces, 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-inch 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 inches, 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. Moist cure or use moisture-retaining covers to cure concrete surfaces to receive floor coverings.

   b. Moist 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 recommends for use with floor coverings.

3. Curing Compound: Apply uniformly in continuous operation by 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.

4. Curing and Sealing Compound: Apply uniformly to floors and slabs indicated in a continuous operation by spray or roller according to manufacturer's written instructions. Recoat areas subjected to heavy rainfall within three hours after initial

application where recommended by the manufacturer. Repeat process 24 hours later and apply a second coat. Maintain continuity of coating and repair damage during curing period.

SPECIFIER'S NOTE: Delete Article 3.15 if treatments are not required. Some manufacturers state that their floor treatment also functions as a curing aid. If used as a cure, delete minimum age of concrete noted in subparagraph 3.15.A.2 below and revise application method to follow manufacturer's written instructions. Coordinate with "Concrete Protection and Curing" Article. Revise minimum concrete curing period below to 14 or 28 days if preferred or more if recommended. Usually delete paragraph 3.15.B below if two coats of curing and sealing compound have already been applied during curing stage. Sealing coat may be used as turnover coat, independent of means of curing, to improve appearance of an exposed concrete floor at end of Project.

3.15 LIQUID FLOOR TREATMENTS

A. Penetrating Liquid Floor Treatment: Prepare, apply, and finish penetrating liquid floor treatment according to manufacturer's written instructions.
   1. Remove curing compounds, sealers, oil, dirt, laitance, and other contaminants and complete surface repairs.

   2. Do not apply to concrete that is less than ***[7] [14] [28]*** days old.

   3. Apply liquid until surface is saturated, scrubbing into surface until a gel forms; re-wet; and repeat brooming or scrubbing. Rinse with water; remove excess material until surface is dry. Apply a second coat in a similar manner if surface is rough or porous.

B. Sealing Coat: Uniformly apply a continuous sealing coat of curing and sealing compound to hardened concrete by spray or roller according to manufacturer's written instructions.

SPECIFIER'S NOTE: Delete this Article 3.16 if no joint filling is required. ACI 302.1R recommends joint filling be deferred as long as possible in concrete floors. Typically, up to 30 percent of concrete shrinkage takes place in first month, with 80 to 90 percent during first 12 months. Revise period below if too short or too long. Joints must be filled before industrial floors can be placed in service.

3.16 JOINT FILLING

A. Prepare, clean, and install joint filler according to manufacturer's written instructions. Defer joint filling as long as possible. Do not fill joints until construction traffic has permanently ceased.

B. Remove dirt, debris, saw cuttings, curing compounds, and sealers from joints; leave contact faces of joint clean and dry.

C. Install semirigid epoxy joint filler full depth in saw-cut joints and at ***least [2 inches]*** deep in formed joints. Overfill joint and trim joint filler flush with top of joint after hardening.

SPECIFIER'S NOTE: This Article 3.17 provides basic applications for repairing concrete surfaces. Revise or delete to suit Project. Insert provision for testing repair technique on a mockup or surface to be concealed later, before repairing surfaces.

3.17 CONCRETE SURFACE REPAIRS

A. Defective Concrete: Repair and patch defective areas. Remove and replace concrete that cannot be repaired and patched to DAGS Representative'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(1.2-mm) sieve, using only enough water for handling and placing.

C. Repairing Formed Surfaces: Surface defects include color and texture irregularities, cracks, spalls, air bubbles, honeycombs, rock pockets, fins and other projections on the surface, and stains and other discolorations that cannot be removed by cleaning.
   1. Immediately after form removal, cut out honeycombs, rock pockets, and voids more than [1/2 inch] in any dimension in solid concrete but not less than [1 inch] 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 surfaces exposed to view by blending white portland cement and standard portland cement so that, when dry, patching mortar will match surrounding color. Patch a test area at inconspicuous locations to verify mixture and color match before proceeding with patching. Compact mortar in place and strike off slightly higher than surrounding surface.

   3. Repair defects on concealed formed surfaces that affect concrete's durability and structural performance as determined by DAGS Representative.

SPECIFIER'S NOTE: Delete subparagraph3.17.D.4 and 3.17.D.5, or retain both if applicable. Subparagraph 3.17.D.4 uses an underlayment; and subparagraph 3.17.D.5, a topping.

D. Repairing Unformed Surfaces: Test unformed surfaces, such as floors and slabs, for finish and verify surface tolerances specified for each surface. Correct low and high areas. Test surfaces sloped to drain for trueness of slope and smoothness; use a sloped template.
   1. Repair finished surfaces containing defects. Surface defects include spalls, popouts, honeycombs, rock pockets, crazing and cracks in excess of 0.01 inch wide or that penetrate to reinforcement or completely through unreinforced sections regardless of width, and other objectionable conditions.

   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. Correct other low areas scheduled to receive floor coverings with a repair underlayment. Prepare, mix, and apply repair underlayment and primer according to manufacturer's written instructions to produce a smooth, uniform, plane, and level surface. Feather edges to match adjacent floor elevations.

   5. Correct other low areas scheduled to remain exposed with a repair topping. Cut out low areas to ensure a minimum repair topping depth of [1/4-inch] to match adjacent floor elevations. Prepare, mix, and apply repair topping and primer according to manufacturer's written instructions to produce a smooth, uniform, plane, and level surface.

   6. Repair defective areas, except random cracks and single holes [1-inch] or less in diameter, by cutting out and replacing with fresh concrete. Remove defective areas with clean, square cuts and expose steel reinforcement with at least [3/4-inch] clearance all around. Dampen concrete surfaces in contact with patching concrete and apply bonding agent. Mix patching concrete of same materials and mix as original concrete except without coarse aggregate. Place, compact, and finish to blend with adjacent finished concrete. Cure in same manner as adjacent concrete.

   7. Repair random cracks and single holes [1-inch] or less in diameter with patching mortar. Groove top of cracks and cut out holes to sound concrete and clean off dust,

dirt, and loose particles. Dampen cleaned concrete surfaces and apply bonding agent. Place patching mortar before bonding agent has dried. Compact patching mortar and finish to match adjacent concrete. Keep patched area continuously moist for at least 72 hours.

E. Perform structural repairs of concrete, subject to DAGS Representative's approval, using epoxy adhesive and patching mortar.

F. Repair materials and installation not specified above may be used, subject to DAGS Representative's approval.

SPECIFIER'S NOTE: Modify Article 3.18 for short time frame projects that cannot accommodate adequate drying time. For short time frame projects, consider using a floor sealant system to insure vapor emission levels for moisture sensitive flooring materials are met.

3.18 DRYING CONCRETE SLABS TO LIMIT MOISTURE VAPOR EMISSIONS AND ALKALINITY

A. For concrete slabs (on grade or suspended) receiving floor finish susceptible to vapor emissions, protect, dry or seal concrete slabs to meet the required vapor emission level(s) of the intended floor finish systems. If choosing to use a floor sealing system, furnish submittals for approval.

1. Once slab drying has started, protect it from getting wet prior to floor finish installation. Test floor for moisture and alkalinity in accordance with Section 01450, Quality Requirements.

2. Test floor for vapor emission at locations and quantities recommended by the test kit manufacturer. Test pH levels of Concrete.

3. If the concrete slab does not meet the vapor emission or alkalinity level(s), use other means such as mechanical drying or floor sealing system(s) (penetrants, coatings, or membranes) to achieve the required levels.

4. If the concrete floor slab does not meet the required alkalinity level, neutralize, cure, dry or seal concrete to bring the concrete to an acceptable alkalinity level.

5. Be aware that no additional time or costs will be granted to meet the required vapor emission levels or alkalinity levels of the concrete surfaces.

B. Floor Vapor Emission Control System:

1. Acceptable products: Subject to compliance with requirements, products that may be incorporated into the Work include the following. Other products must be specifically approved by DAGS for use in this project.
   a. Floor Seal by Floor Seal Technology, Inc.

   b. Vectr-R System by Sinak Corporation.

   ~~C~~c. Cutdown by Dependable Floor Products

2. Install per manufacturer's requirements to achieve a guaranteed vapor emission rate that meets the finished flooring recommended rates. Treatment shall not provide detrimental conditions to the concrete slab or floor covering materials. Make sure flooring adhesives are compatible with the treatment materials.

3. Installer shall provide proof of installer's certification by the treatment manufacturer.

4. Guarantee

a. Manufacture's Guarantee: Warrant against bond failure with concrete and failure of the system due to vapor emission and alkalinity levels. Guarantee Period: Five (5) years.

b. Project Guarantee: Replace original finished flooring materials and vapor emission control system due to failure of the vapor emission control system to control vapor emission and prevent unacceptable alkalinity levels. Provide extended warranty that is covered by a separate material and installation bond or by the manufacturer's product liability insurance policy specifically covering the work on this Project. DAGS shall have final approval of accepting the bond or manufacturer's insurance policy.

~~c. Guarantee Period: Five (5) years.~~

SPECIFIER'S NOTE: Revise field quality-control testing below to suit Project or delete if not required for small projects. Retain paragraph 3.19.A if Contractor engages testing agency otherwise retain second paragraph 3.19.A if State engages testing agency. Contractor providing the testing agency is the normal condition. Coordinate with QUALITY REQUIREMENTS SECTION.

3.19 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified independent testing and inspecting agency to sample materials, perform tests, and submit test reports during concrete placement according to requirements specified in this Article.

OR

A. Testing Agency: State will engage a qualified independent testing and inspecting agency to sample materials, perform tests, and submit test reports during concrete placement. Sampling and testing for quality control may include those specified in this Article.

SPECIFIER'S NOTE: Retain first subparagraph 3.19.B.1 for more frequent testing than provided by second subparagraph 3.19.B.1 which is the testing frequency required to comply with ACI 301.
Delete unit weight test subparagraph 3.19.B.5 below if not using structural lightweight concrete.
Revise number of laboratory- or field-cured test specimens in subparagraph 3.19.B.6 below if required.
Field-cured specimens in subparagraph 3.19.B.7 below may be required to verify adequacy of curing and protection of concrete or to verify strength for removal of shoring and reshoring in multistory construction. Coordinate number of compression test specimens in subparagraph 3.19.B.7 and associated subparagraph 3.19.B.6. Revise age at testing or delete if not required. Limit field testing to concrete in designated structural elements if not required throughout Project.

B. Testing Services: 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 composite sample for each day's pour of each concrete mix exceeding [5 cu. yd.] (4 cu. m), but less than [25 cu. yd.] (19 cu. m), plus one set for each additional [50 cu. yd.] (38 cu. m) or fraction thereof.

OR

1. Testing Frequency: Obtain at least one composite sample for each [100 cu. yd.] (76 cu. m) or fraction thereof of each concrete mix placed each day.
   a. When frequency of testing will provide fewer than five compressive strength tests for each concrete mix, 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; one test at point of placement for each composite sample, but not less than one test for each day's pour of each concrete mix. Perform additional tests when concrete consistency appears to change.

3. Air Content: ASTM C 231, pressure method, for normal-weight concrete; ASTM C 173, volumetric method, for structural lightweight concrete; one test for each composite sample, but not less than one test for each day's pour of each concrete mix.
4. Concrete Temperature: ASTM C 1064; one test hourly when air temperature is 40 deg F4.4 deg C and below and when 80 deg F (27 degC) and above, and one test for each composite sample.

5. Unit Weight: ASTM C 567, fresh unit weight of structural lightweight concrete; one test for each composite sample, but not less than one test for each day's pour of each concrete mix.

6. Compression Test Specimens: ASTM C 31/C 31M; cast and laboratory cure one set of four standard cylinder specimens for each composite sample.
   a. Cast and field cure one set of four standard cylinder specimens for each composite sample.

7. Compressive-Strength Tests: ASTM C 39; test two laboratory-cured specimens at 7 days and two at 28 days.
   a. Test two field-cured specimens at 7 days and two at 28 days.

   b. A compressive-strength test shall be the average compressive strength from two specimens obtained from same composite sample and tested at age indicated.

SPECIFIER'S NOTE: Delete paragraph below if field-cured specimens are not required.

C. When strength of field-cured cylinders is less than 85 percent of companion laboratory-cured cylinders, Contractor shall evaluate operations and provide corrective procedures for protecting and curing in-place concrete.

D. Strength of each concrete mix 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 psi3.4 MPa.

E. Test results shall be reported in writing to DAGS Representative, 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 mix proportions and materials, compressive breaking strength, and type of break for both 7-and 28-day tests.

F. Nondestructive Testing: Impact hammer, sonoscope, or other nondestructive device may be permitted by DAGS Representative but will not be used as sole basis for approval or rejection of concrete.

G. Moisture Vapor Emission Test: Standard test method meeting ASTM F-1869.

H. Alkalinity (pH Level) Testing: Standard test required for floor slabs and all wall and ceiling surfaces to receive painted finishes. Testing of concrete to receive paint finish may be conducted under Painting Section.

I. 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 DAGS Representative. Testing and inspecting agency may conduct tests to determine adequacy of concrete by cored

cylinders complying with ASTM C 42 or by other methods as directed by DAGS Representative.

END OF SECTION