

Section 03301

CONCRETE

PART 1 - GENERAL

1-1. SCOPE. This section covers all cast-in-place concrete, including reinforcing steel, forms, finishing, curing, and appurtenant work. All concrete shall be air-entrained.

1-2. GENERAL. All cast-in-place concrete shall be accurately formed and properly placed and finished as indicated on the drawings and as specified herein.

1-3. SUBMITTALS.

1-3.01. Drawings and Data. All submittals of drawings; manufacturers' certificates of compliance, recommendations, and test data; reports; catalog data sheets; and other data shall be in accordance with the submittals section, unless otherwise specified herein.

Reports and certifications on proposed materials and mix proportions for each concrete mix design shall be submitted for review within 30 days after the preconstruction conference and prior to conducting the laboratory trial batches for each mix design.

Bar lists and drawings for the fabrication and placing of reinforcement shall be submitted for review and shall have sufficient plans, elevations, and sections to adequately detail and label all reinforcement. The bar lists and drawings shall also include a reference to the structure in which the reinforcement will be installed and to the project drawing showing the reinforcement.

1-3.02. Manufacturer's Certificate of Compliance. A manufacturer's certificate of compliance, which includes the name of the project and, when requested, copies of independent test results confirming compliance with specified requirements, shall be submitted to the Engineer for the following materials:

Cement.

Admixtures.

Fly ash.

Slag Cement.

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Membrane curing compound and floor sealer.

1-4. STORAGE AND HANDLING. Cement and fly ash shall be stored in suitable moistureproof enclosures. Cement and fly ash which has become caked or lumpy shall not be used.

Aggregates shall be stored so that segregation and the inclusion of foreign materials are prevented. The bottom 6 inches of aggregate piles in contact with the ground shall not be used.

Reinforcing steel shall be carefully handled and shall be stored on supports that will prevent the steel from touching the ground.

PART 2 - PRODUCTS

2-1. LIMITING REQUIREMENTS. Unless otherwise specified, concrete shall be controlled within the following limiting requirements.

2-1.01. Cement Content. The quantity of Portland cement in the concrete shall be not less than that indicated in the following table:

Quantity of Cement (lb/yd ³)			
Coarse Aggregate Size from No. 4 Sieve to			
3/8 in.	1/2 in.	3/4 in.	1 in.
600	580	560	535

2-1.02. Maximum Water-Cementitious Ratio. The maximum water-cementitious ratio shall be 0.42 on a weight basis. If fly ash or slag cement is used, the combined mass of cement plus fly ash shall be used to determine the water-cementitious materials ratio.

2-1.03. Cementitious Material Content Limits. At the option of the Contractor, fly ash may be substituted for up to 25 percent of the portland cement, but not less than 15 percent, on the basis of 1.0 lbs of fly ash added for each lb of cement reduction.

Contractor may substitute slag cement for portland cement for up to 50 percent of the portland cement, but not less than 25 percent, on the basis of 1.0 lbs of slag cement added for each lb of cement reduction.

Mixtures using slag cement in combination with fly ash will not be acceptable.

2-1.04. Coarse Aggregate. The maximum nominal coarse aggregate size shall be not larger than 1 inch.

2-1.05. Slump. Concrete slump shall be kept as low as possible consistent with proper handling and thorough compaction. Unless otherwise authorized by the Engineer, slump of concrete without a superplasticizer shall not exceed 4 inches. Slump of concrete with a superplasticizer, or a midrange water reducer, shall not exceed 8 inches.

2-1.06. Total Air Content. The total volumetric air content of concrete after placement shall be 6 percent, ± 1 percent.

2-1.07. Admixtures. The admixture content, batching method, and time of introduction to the mix shall be in accordance with the manufacturer's recommendations. A water-reducing admixture and an air-entraining admixture shall be included in all concrete. A midrange water reducer or a superplasticizer may be used at the Contractor's option. No calcium chloride or admixture containing chloride from sources other than impurities in admixture ingredients will be acceptable.

2-1.10. Strength. The minimum acceptable compressive strengths, as determined by ASTM C39 with 6 inch diameter by 12 inch cylinders, shall be:

Age	Minimum Compressive Strength
7 days	3,375 psi
28 days	5,200 psi

2-1.11. Shrinkage Limits. Based on the modified ASTM C157 test procedures as specified herein, the shrinkage limits of concrete shall be the average drying shrinkage of each set of three test specimens cast in the laboratory from a trial batch as measured at the 21 days drying age, and shall not exceed 0.036% for laboratory specimens.

The average drying shrinkage of each set of test specimens cast in the field from concrete delivered to the site, and sampled at the end of the delivery truck chute, as measured at the 21 days drying age shall not exceed 0.048% for field specimens.

2-1.12. Water-Soluble Chloride. Maximum water-soluble chloride ion concentrations in hardened concrete at an age of 28 days shall not exceed 0.10% as a percentage of mass cement.

2-2. MATERIALS.

Cement	ASTM C150, Type II, low alkali.
Fly Ash	ASTM C618, Class F, except loss on ignition shall not exceed 4 percent.
Slag Cement (GGBFS)	ASTMC989, Grade 100 or 120.
Fine Aggregate	Clean natural sand, ASTM C33. Artificial or manufactured sand will not be acceptable.
Coarse Aggregate	Non-reactive crushed rock, washed gravel, or other inert granular material conforming to ASTM C33, class 4S, except that clay and shale particles shall not exceed 1 percent.
Water	Potable.
Admixtures	
Water-Reducing	ASTM C494, Type A or D.
Air-Entraining	ASTM C260.
Superplasticizing	ASTM C494, Type F or G.
Shrinkage Reducing	Grace "Eclipse Plus" or BASF (Master Builders) "Tetraguard AS20".
Reinforcing Steel	
Bars	ASTM A615, Grade 60, deformed.

Welded Wire Fabric

ASTM A185 or A497.

Bar Supports

CRSI Class 1, plastic protected;
or Class 2, stainless steel
protected.

Mechanical Connector
(Couplers or Form Savers)

Classified Type 2 per ACI 318-02
or per UBC-97. Use only where
indicated on the drawings.

Water Stops

Metal, at Construction Joints

Uncoated carbon steel, 12 gage,
size as indicated on the
drawings.

PVC, at Construction Joints

Extruded, virgin, elastomeric,
polyvinyl chloride (PVC), white
(no pigment), flat, ribbed,
3/8 inch thick. Reclaimed
material will not be acceptable.
Provide hog rings or grommets
spaced at 12 inches on center
entire length.

For Concrete Sections Less
than 12 Inches in Thickness

6 inches wide, 3/8 inch thick;
Greenstreak "679" or Vinylex
"R6-38".

For Concrete Sections
12 Inches or More in
Thickness

9 inches wide, 3/8 inch thick;
Greenstreak "646" or Vinylex
"R9-38".

Forms

Plywood Product

Standard PS1, waterproof,
resin-bonded, exterior type,
Douglas fir.

Lumber

Straight, uniform width and
thickness, and free from knots,
offsets, holes, dents, and other
surface defects.

Form Coating	Nonstaining and nontoxic after 30 days, VOC-compliant; Burke "Form Release (WB)", L&M Chemical "E Z Strip", Nox-Crete "Form Coating", or Symons "Thrift Kote WB".
Pre-Cure Finishing Aid	Burke "Finishing Aid Concentrate", Euclid "Eucbar", L&M Chemical "E-Con", Master Builders "Confilm", or Sika "Sikafilm".
Polyethylene Film	Product Standard PS17 or ASTM D4397, 6 mils or thicker.
Vapor Barrier and Seam Tape	Polyolefin geomembrane, Stego Wrap, 15 mils Vapor Barrier. Stego Wrap Red polyethelene tape.
Membrane Curing Compound and Floor Sealer	ASTM C1315, Type I, Class A, maximum VOC 5.8 lb/gal, minimum 25 percent solids, acrylic, nonyellowing, unit moisture loss 0.40 kg/m ² maximum in 72 hours.
VOC – EPA	

2-3. PRELIMINARY REVIEW. The source and quality of concrete materials and the concrete proportions proposed for the work shall be submitted to the Engineer for review before concrete is placed.

2-4. FORMS. Forms shall be designed to produce hardened concrete having the shape, lines, and dimensions indicated on the drawings. Forms shall be substantial and sufficiently tight to prevent leakage of mortar and shall be maintained in proper position and accurate alignment.

Forms for pavement, curbs, or gutters shall be made of steel and shall be supported on thoroughly compacted earth. The top face of pavement forms shall not vary from a true plane more than 1/4 inch in 10 feet.

Forms shall be thoroughly cleaned and oiled before concrete is placed.

Where concrete is placed against gravel or crushed rock which does not contain at least 25 percent material passing a No. 4 sieve, such surfaces shall be covered with polyethylene film to protect the concrete from loss of water. Joints in the film shall be lapped at least 4 inches.

2-4.01. Form Ties. Form ties shall be of the removable end, permanently embedded body type, and shall have sufficient strength and rigidity to support and maintain the form in proper position and alignment without the use of auxiliary spreaders.

Form ties for liquid-containing walls shall be provided with waterstop washers located on the permanently embedded portions of the ties at the approximate center of the wall. Permanently embedded portions of form ties without threaded ends shall be constructed so that the removable ends are readily broken off without damage to the concrete. Through-wall tapered removable ties will not be acceptable.

2-4.02. Edges and Corners. Chamfer strips shall be placed in forms to bevel all salient edges and corners, except the top edges of walls and slabs which are to be tooled and edges which are to be buried. Unless otherwise noted, bevels shall be 3/4 inch wide.

2-4.03. Form Removal. Forms shall not be removed or disturbed until the concrete has attained sufficient strength to safely support all dead, live, and construction loads. Care shall be taken in form removal to avoid surface gouging, corner or edge breakage, and other damage to the concrete.

2-5. REINFORCEMENT. Reinforcement shall be accurately formed and positioned and shall be maintained in proper position while the concrete is being placed and compacted. Unless otherwise indicated on the drawings, the details of fabrication shall conform to ACI 315 and 318. In case of conflict, ACI 318 shall govern. Reinforcement shall be free from dirt, loose rust, scale, and contaminants. Mechanical connections shall be used only as indicated on the drawings.

2-6. BATCHING AND MIXING. Concrete shall conform to ASTM C94 and shall be furnished by an acceptable ready-mixed concrete supplier.

2-6.01. Consistency. The consistency of concrete shall be suitable for the placement conditions. Aggregates shall float uniformly throughout the mass, and the concrete shall flow sluggishly when vibrated or spaded. The slump shall be kept uniform.

2-6.02. Delivery Tickets. A delivery ticket shall be prepared for each load of ready-mixed concrete and a copy of the ticket shall be handed to the Engineer by the truck operator at the time of delivery. Tickets shall indicate the name and location of the concrete supplier, the project name, the mix identification, the quantity of concrete delivered, the quantity of each material in the batch, the outdoor temperature in the shade, the time at which the cement was added, and the numerical sequence of the delivery.

PART 3 - EXECUTION

3-1. PLACEMENT. The Contractor shall inform the Engineer at least 24 hours in advance of the times and places at which he intends to place concrete.

Methods of conveying concrete to the point of final deposit and of placing shall prevent segregation or loss of ingredients. During and immediately after placement, concrete shall be thoroughly compacted and worked around all reinforcement and embedments and into the corners of the forms. Concrete shall be compacted by immersion-type vibrators, vibrating screeds, or other suitable mechanical compaction equipment. The use of "jitterbug" tampers to compact concrete flatwork will not be permitted.

3-1.01. Cold Weather Concreting. Except as modified herein, cold weather concreting shall comply with ACI 306R. The temperature of concrete at the time of delivery shall not be less than 40°F.

When placed, heated concrete shall not be warmer than 80°F. When freezing temperatures may be expected during the curing period, the concrete shall be maintained at a temperature of at least 50°F for five days or 70°F for three days, after placement. Concrete and adjacent form surfaces shall be kept continuously moist. Sudden cooling of concrete shall not be permitted.

3-2. WATER STOPS. Each water stop shall be continuous throughout the length of the joint in which it is installed. Water stops shall be clean, free from coatings, and shall be maintained in proper position until surrounding concrete has been deposited and compacted.

Junctions between adjacent sections of metal water stops shall be lapped 5 inches and securely bolted, screwed, or spot welded together.

Junctions between adjacent sections of elastomeric (PVC) water stops shall be spliced in strict conformity with the recommendations of the manufacturer.

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Directional changes and intersections shall be factory fabricated by the water stop manufacturer prior to delivery to the site of the work. Field splices will be acceptable only in straight sections.

3-3. **FINISHING.** Recesses from form ties shall be filled flush with mortar. Fins and other surface projections shall be removed from all formed surfaces, except exterior surfaces that will be in contact with earth backfill.

Unless otherwise specified, unformed surfaces shall be screeded and given an initial float finish as soon as the concrete has stiffened sufficiently for proper working. Any piece of coarse aggregate which is disturbed by the float or which causes a surface irregularity shall be removed and replaced with mortar. Initial floating shall produce a surface of uniform texture and appearance, with no unnecessary working of the surface.

Initial floating shall be followed by a second floating at the time of initial set. The second floating shall produce a finish of uniform texture and color and the completed finish for unformed surfaces unless indicated otherwise.

Tie holes in formed surfaces shall be cleaned, wetted, and filled with patching mortar. The patches shall be finished flush and cured and shall match the texture and color of the adjacent concrete.

3-3.01. **Troweling.** Interior floor surfaces which will be exposed after construction is completed; exposed top surfaces of equipment bases and interior curbs; and other surfaces designated on the drawings shall be steel trowel finished. Troweling shall be performed after the second floating when the surface has hardened sufficiently to prevent an excess of fines being drawn to the surface. Troweling shall produce a dense, smooth, uniform surface free from blemishes and trowel marks.

3-3.02. **Application of Pre-Cure Finishing Aid.** Concrete flatwork subject to rapid evaporation due to hot weather, drying winds, and sunlight may be protected with a pre-cure finishing aid. The finishing aid shall form a monomolecular film on the surface of fresh, plastic concrete to retard evaporation.

Immediately following screeding, pre-cure finishing aid shall be sprayed over the entire surface of fresh, plastic concrete flatwork at a rate of not less than 200 square feet per gallon, in accordance with the manufacturer's recommendations. The spray equipment shall have sufficient capacity to continuously spray finishing aid at approximately 40 psi with a suitable nozzle as recommended by the manufacturer.

The sprayable solution shall be prepared as recommended by the manufacturer.

Under severe drying conditions, additional applications of finishing aid may be required following each floating or troweling, except the last finishing operation.

3-4. CURING. Concrete shall be protected from loss of moisture by water saturation or by membrane curing for at least 7 days after placement; however, when concrete is also being protected from low temperatures, the period of curing by saturation shall be 1 day less than the duration of the low temperature protection.

Water saturation shall be used on concrete which will be covered later with mortar or additional concrete. Water saturation or membrane curing compound may be used on all other concrete surfaces.

Water saturation of concrete surfaces shall begin as soon as possible after initial set. Unformed surfaces shall be covered with polyethylene film, tarpaulins, or sand to retain the water. Water shall be applied as often as necessary to keep the concrete saturated for the entire curing period. Acceptable methods of water curing are described in ACI 308.

Membrane curing compound shall be sprayed at a coverage rate of not more than 300 square feet per gallon. Unformed surfaces shall be covered with curing compound within 30 minutes after final finishing. If forms are removed before the end of the specified curing period, curing compound shall be immediately applied to the formed surfaces. Curing compound shall be suitably protected against abrasion during the curing period.

Concrete shall be protected against freezing for at least 8 days after placement.

3-5. REPAIRING DEFECTIVE CONCRETE. Defects in concrete surfaces shall be repaired to the satisfaction of the Engineer. All concrete which is honeycombed or otherwise defective shall be cut out and removed to sound concrete, with edges cut square to avoid feathering.

Concrete repair work shall conform to Article 5.3.7 of ACI 301 and shall be performed in a manner that will not interfere with thorough curing of surrounding concrete. Repair work shall be adequately cured.

3-6. FIELD CONTROL TESTING.

3-6.01. Air Content. An air content test shall be made on concrete from each batch of concrete from which concrete compression test cylinders are made.

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The Contractor shall provide all equipment and supplies necessary for the testing. Air content shall be determined in accordance with ASTM C231.

3-6.02. Slump. A slump test shall be made on concrete from each batch of concrete from which concrete compression test cylinders are made. Slump shall be determined in accordance with ASTM C143.

3-6.03. Test Cylinders. Compression test specimens shall be made, cured, stored, and delivered to the laboratory in accordance with ASTM C31 and C39. Compressive strength tests will be evaluated in accordance with ACI 318 and as specified herein.

One set of 6 inch diameter by 12 inch concrete test cylinders shall be cast for each concrete pour. A set of test cylinders shall consist of four cylinders, two to be broken and to have compressive strengths averaged at 7 days, and two to be broken and to have compressive strengths averaged at 28 days. All concrete required for testing shall be furnished by, and at the expense of, the Contractor.

The cured cylinders shall be tested by an independent testing laboratory at the expense of the Owner.

3-6.04. Water-Soluble Chloride Ion. Water-soluble chloride ion testing shall be performed once for each 1,000 cubic yards of concrete in accordance with ASTM C1218.

3-6.05. Shrinkage Tests. Concrete shrinkage tests shall be performed once for each 1,000 cubic yards of concrete with controlled shrinkage that is placed and shall be made on concrete from a batch of concrete from which concrete compression test cylinders are made. Shrinkage testing shall be conducted as specified for the preliminary trial mixes.

End of Section

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Section 03600

GROUT

PART 1 - GENERAL

1-1. SCOPE. This section covers procurement and installation of grout. Unless otherwise specified, only nonshrink grout shall be furnished.

Epoxy grouting of anchor bolts, threaded rod anchors, and reinforcing bars is covered in the anchorage in concrete and masonry section. Grouting of masonry is covered in the building masonry section.

1-2. SUBMITTALS. A letter of certification indicating the types of grout to be supplied and the intended use of each type shall be submitted in accordance with the submittals section.

1-3. DELIVERY, STORAGE, AND HANDLING. Materials shall be handled, transported, and delivered in a manner which will prevent damage of any kind. Materials shall be protected from moisture.

PART 2 - PRODUCTS

2-1. MATERIALS.

Nonshrink Grout

ASTM C1107.

Water

Clean and free from deleterious substances.

2-2. NONSHRINK GROUT. Nonshrink grout shall be furnished factory premixed so that only water is added at the jobsite.

PART 3 - EXECUTION

3-1. PREPARATION. The concrete foundation to receive nonshrink grout shall be saturated with water for at least 12 hours preceding grouting unless additional time is required by the grout manufacturer.

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3-2. INSTALLATION.

3-2.01. Mixing. Grout shall be mixed in a mechanical mixer. No more water shall be used than is necessary to produce a flowable grout.

3-2.02. Placement. Unless otherwise specified or indicated on the drawings, grout under baseplates shall be 1-1/2 inches thick. Grout shall be placed in strict accordance with the directions of the manufacturer so that all spaces and cavities below the baseplates are completely filled without voids. Forms shall be provided where structural components of baseplates will not confine the grout.

3-2.03. Edge Finishing. In all locations where the edge of the grout will be exposed to view, the grout shall be finished smooth after it has reached its initial set. Except where shown to be finished on a slope, the edges of grout shall be cut off flush at the baseplate.

3-2.04. Curing. Nonshrink grout shall be protected against rapid loss of moisture by covering with wet cloths or polyethylene sheets. After edge finishing is completed, the grout shall be wet cured for at least 3 days and then an acceptable membrane curing compound shall be applied.

End of Section

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