SECTION 03 3000- CAST-IN-PLACE CONCRETE

Revise this Section by deleting and inserting text to meet Project-specific requirements.

This Section uses the term "Architect" or “Engineer.” Change this term to match that used to identify the design professional as defined in the General and Supplementary Conditions.

Verify that Section titles referenced in this Section are correct for this Project's Specifications; Section titles may have changed.

Delete hidden text after this Section has been edited for the Project.

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-01 Specification sections, apply to work of this section.

B. The Contractor's attention is specifically directed, but not limited, to the following documents for additional requirements:

1. The current version of the *Uniform General Conditions for Construction Contracts*, State of Texas, available on the web site of the Texas Facilities Commission.
2. The University of Houston’s *Supplemental General Conditions and Special Conditions for Construction.*

1.2 DESCRIPTION OF WORK

A. Extent of concrete work is shown on drawings, including schedules, notes and details which show size and location of members and type of structural concrete to be cast in place. Furnish all labor, materials, services, equipment and hardware required in conjunction with or related to the forming, delivery and pouring of all cast-in-place concrete Work.

1.3 QUALIFICATIONS

A. The concrete supplier shall have a minimum of five years of experience in manufacturing ready-mixed concrete products complying with ASTM C 94 requirements for production facilities and equipment. The supplier must be certified according to the National Ready Mixed Concrete Association’s Certification of Ready Mixed Concrete Production Facilities.

B. The concrete contractor shall have a minimum of five years of experience with installation of concrete similar in material, design and extent to that indicated for this Project and whose work has resulted in construction with a record of successful –service performance.

C. Any testing laboratory retained by the Contractor or Subcontractor to run tests required by this specification but not performed by the Owner's testing laboratory shall meet the basic requirements of ASTM E 329.

1.4 QUALITY CONTROL

A. The Contractor is responsible for control of quality, including workmanship and materials furnished by his subcontractors and suppliers.

B. Codes and Standards: Comply with provisions of following codes, specifications and standards, except where more stringent requirements are shown or specified:

1. ACI 301 – "Specifications for Structural Concrete for Buildings".

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

3. ACI 318 – "Building Code Requirements for Reinforced Concrete".

4. ACI 311 – "Guide for Concrete Inspection."

5. ACI 347 – "Guide to Formwork for Concrete."

6. ACI 304 – "Guide for Measuring, Mixing, Transporting, and Placing Concrete."

7. Concrete Reinforcing Steel Institute (CRSI), "Manual of Standard Practice".

8. Steel Construction Manual, 14th edition, American Institute of Steel Construction

C. Document Conflict and Precedence: In case of conflict among Contract Documents and Contract Specifications, request clarification from the Architect/Engineer through "Request for Information" (RFI) process before proceeding with the Work. In case of a conflict between and/or among the structural drawings and specifications, the strictest interpretation shall govern, unless specified otherwise in writing by the Architect/Engineer.

D. Inspection and Testing of the Work: Materials and installed work may require testing and retesting, as directed by the governing building code, the Architect/Engineer, or the Owner at any time during progress of work.

1. The Contractor shall provide forty-eight (48) hours notification to the Owner's Testing Laboratory of construction operations including the project schedule to allow the Testing Laboratory to schedule inspections. Failure to sufficiently notify may result in additional costs incurred by the Testing Laboratory that may be back-charged to the Contractor by the Owner.

2. The Contractor shall cooperate with laboratory personnel and provide access to the work.

3. The Contractor shall make arrangements with and for the Owner's Testing Laboratory for off-site inspection of material stockpiles, concrete delivery vehicles, concrete material storage facilities, and concrete-batching facilities.

4. If required, the Contractor shall furnish casual labor, equipment, and facilities as required for sampling and testing by the laboratory and otherwise facilitate the required inspections and tests.

5. Inspection or testing by the Owner does not relieve the Contractor of his responsibility to perform the Work in accordance with the Contract Documents. Tests not specifically indicated to be done at the Owner's expense, including retesting of rejected materials and installed work, shall be done at the Contractor's expense. See Division 01 Section "Structural Testing Laboratory Services.

E. Acceptance Criteria for Concrete Strength: A strength test is defined as the average strength of at least two 6" x 12" cylinder breaks or at least three 4" x 8" cylinder breaks tested at the strength age indicated on the drawings for that class of concrete. The strength level of an individual class of concrete shall be considered satisfactory when both of the following requirements are met:

1. The average of all sets of three consecutive strength tests equal or exceed the required f'c.

2. No individual strength test falls below the required f'c by more than 0.1 f'c or 500 psi, whichever is greater.

F. Responsibility for Selection and use of concrete admixtures and chemical treatments: The Contractor shall be responsible for selecting admixtures and surface treatments that are compatible with the intended use of the concrete including all final surface treatments called for within this or other specifications or on the Contract Drawings. The Contractor is responsible for following the manufacturer's instructions for the use of their product including abiding by any limitations placed by the manufacturer on the use of any of its products.

G. Survey for Anchor Rods and Reinforcing Steel Dowels: The Contractor shall use a qualified and experienced filed engineer (construction surveyor), having a minimum of three years of experience as "lead" field engineer on projects of similar type, lay out the proper location of all embedded anchor rods, embedded connection plates for structural steel columns and beams, tension rods for structural precast, and correct location and elevation of concrete column dowels before they are encased in concrete.

H. Manufacturer Representative Presence:

1. Post-installed anchors: The manufacturer's representative for each post-installed anchor product (adhesive, expansion, undercut, screw, or insert anchor) shall be

present during the first day's installation of the product to observe whether the anchors are installed according to manufacturer's instructions.

2. Fiber-reinforced concrete: The manufacturer's representative for each fiber type shall be present during the first pour in which the fiber is used to observe whether the dosage rate and placing and finishing method is in accordance with the specifications and the manufacturer's instruction.

1.5 PREINSTALLATION CONFERENCES

A. Mix Design Conference: At least 30 days prior to submittal of concrete design mixes, the Contractor shall hold a meeting or telephone conference to review the detailed requirements for preparing the concrete mix designs. Participants shall include representatives from the Contractor, UH Facilities Project Inspector, Owner's Testing Laboratory, Concrete Supplier, Architect, and Engineer.

B. Pre-Concrete Conference:

1. At least 7 days prior to beginning concrete work, the Contractor shall conduct a meeting to review the proposed mix designs and to discuss required methods and procedures to produce concrete construction of the required quality. Also review requirements for submittals, status of coordinating work and availability of materials. Establish work progress schedule and procedures for materials inspection, testing and certifications. The contractor shall send a pre-concrete conference agenda to all attendees 7 days prior to the scheduled date of the conference.

2. The Contractor shall require responsible representatives of every party who is concerned with the concrete work to attend the conference, including but not limited to the following:

Contractor's Superintendent
Laboratory responsible for field quality control and batch plant quality control
Concrete Subcontractor
Ready-Mix Concrete Producer
Concrete Pumping Contractor
Fiber Reinforcement Representative
Owner's and Architect's/Engineer's Representative

3. Minutes of the meeting shall be recorded, typed and printed by the Contractor and distributed by him to all parties concerned within 5 days of the meeting. One copy of the minutes shall be transmitted to the following for information purposes:

Owner's Representative
UH Facilities Project Inspector

Architect
Engineer-of-Record

4. The Engineer shall be present at the conference. The Contractor shall notify the Engineer at least 7 days prior to the scheduled date of the conference.

1.6 ACTION SUBMITTALS

A. Product Data: Submit manufacturer's product data with application and installation instructions for proprietary materials and items, including admixtures, patching compounds, epoxies, grouts, waterstops, joint systems, fiber reinforcement, curing compounds, dry-shake finish materials, hardeners, sealers mechanical splices, hooked anchorage systems, dowel bar substitute systems, dowel bar sleeves, joint fillers, and others as requested by Architect/Engineer.

B. Samples: Submit samples of materials specified if requested by Architect/Engineer, including names, sources and descriptions.

C. Mix Designs: Submit mix designs as specified herein.

D. Material and Mill Certificates: Provide material and mill certificates as specified herein and in Division 01 Section "Structural Testing Laboratory Services. The Manufacturer and Contractor shall sign the material and mill certificates certifying that each material item complies with specified requirements. Provide certification from admixture manufacturers that chloride ion content complies with specified requirements.

E. Construction Joints: Submit drawing of proposed construction joint locations in concrete for slab on grade, mat foundations, structural floors, roofs and walls. Submit any additional or changed reinforcing that is required at construction joints that differs from that shown on the drawings.

F. Pour Sequence for Mat Foundation: Submit proposed pour sequence for mat foundations.

G. Industrial Slabs: Submit proposed pour sequence and procedure for protecting concrete during placement, finishing, and curing.

H. Minutes of preconstruction conference.

I. Surveys: Submit report certifying that all anchor rods and reinforcing dowels into columns above are in their proper location prior to placing of concrete.

Retain paragraph and associated subparagraphs below if Project is to be LEED v4 certified.

J. LEED Action Submittals (Projects authorized for LEED certification only)

1. Building Product Disclosure and Optimization - Sourcing of Raw Materials:

a. Leadership Extraction Practices

(1) Extended Producer Responsibility (EPR): Submit documentation indicating that manufacturers have a take back or recycling program for the product purchased.

(2) Recycled Content: For products having recycled content, indicate percentages by weight of post-consumer and pre-consumer recycled content.

(a) Include statement indicating costs for each product having recycled content.

b. Sourcing of Raw Materials: For products that are required to comply with requirements for regional materials, indicating location of material manufacturer and point of extraction, harvest, or recovery for each raw material.

(1) Include statement indicating distance to Project, cost for each regional material and the fraction by weight that is considered regional.

(2) Product Certificates: For materials manufactured within 100 miles of Project, indicating location of material manufacturer and point of extraction, harvest, or recovery for each raw material. Include distance to Project and cost for each raw material.

2. Indoor Environmental Quality, Low Emitting Materials: Building Products must be tested and compliant with the California Department of Public-Health (CDPH) Standard Method V1.1-2010, using the applicable exposure scenario.

a. For paints, and coatings, wet applied, include printed statement of VOC content, showing compliance with the applicable VOC limits of the California Air Resources Board (CARB) 2007, Suggested Control Measure for Architectural Coatings or the South Coast Air Quality Management District (SCAQMD) Rule 113-2011.

b. Adhesives and Sealants: For wet applied on site products, submit printed statement showing compliance with the applicable chemical content requirements of SCAQMD Rule 1168, effective July 1, 2005 and rule amendment date of January 7, 2005.

(1) Product Data: For installation adhesives, indicating VOC content.

c. Alternative tests for VOC include ASTM D 2369-10, ISO 11890, ASTM D 6886-03; or ISO 11890-2.

d. Methylene Chloride and perchloroethylene may not be added to paints, coating, adhesive or sealants.

e. Provide General Emissions Evaluation certificates for adhesives, sealants showing compliance with California Department of Public Health v1.1 emissions testing or equivalent.

3. Laboratory Test Reports: For installation adhesives indicating compliance with requirements for low-emitting materials

1.7 INFORMATIONAL SUBMITTALS

Retain paragraph and associated subparagraphs below if Project is to be LEED v4 certified.

A. LEED Informational Submittals:

1. Building Product Disclosure and Optimization - Sourcing of Raw Materials:

a. Raw Material Sources and Extraction Reporting: Submit Raw materials supplier corporate Sustainability Reports (CSRs); documenting responsible extraction; including extraction locations, long term ecologically responsible land use, commitment to reducing environmental harms from extraction and manufacturing processes, and a commitment to meeting applicable standards or programs that address responsible sourcing criteria.

(1) Submit manufacturers' self-declared reports.
(2) Submit third party verified corporate sustainability reports (CSR) using one of the following frameworks:

(a) Global Reporting Initiative (GRI) Sustainability Report
(b) Organization for Economic Co-operation and Development (OECD) Guidelines for Multinational Enterprises
(c) UN Global Compact
(d) ISO 26000
(e) USGBC approved program.

2. Building Product Disclosure and Optimization - Material Ingredients

a. Material Ingredient Optimization: Submit manufacturer's Environmental Product Declaration (EPD) or at least one of the following:

(1) GreenScreen V1.2 Benchmark: Third party report prepared by a licensed GreenScreen List Translator, or a full GreenScreen Assessment.
(2) Cradle to Cradle: Manufacturer's published literature for the product bearing the Cradle to Cradle logo.
(3) International Alternative Compliance Path - REACH Optimization
(4) Declare: Manufacturer's completed Product Declaration Form
(5) Other programs approved by USGBC

b. Product Manufacturer Supply Chain Optimization: Submit documentation from manufacturers for products that go beyond material ingredient optimization as follows:
(1) Are sourced from product manufacturers who engage in validated and robust safety, health, hazard, and risk programs which at a minimum document at least 99 percent (by weight) of the ingredients used to make the building product or building material, and

(2) Are sourced from product manufacturers with independent third party verification of their supply chain that at a minimum verifies:

(a) Processes are in place to communicate and transparently prioritize chemical ingredients along the supply chain according to available hazard, exposure and use information to identify those that require more detailed evaluation

(b) Processes are in place to identify, document, and communicate information on health, safety and environmental characteristics of chemical ingredients

(c) Processes are in place to implement measures to manage the health, safety and environmental hazard and risk of chemical ingredients

(d) Processes are in place to optimize health, safety and environmental impacts when designing and improving chemical ingredients

(e) Processes are in place to communicate, receive and evaluate chemical ingredient safety and stewardship information along the supply chain

(f) Safety and stewardship information about the chemical ingredients is publicly available from all points along the supply chain.

1.8 PROVISION FOR OTHER WORK

A. Provide for installation of inserts, hangers, metal ties, anchors, bolts, angle guards, dowels, thimbles, slots, nailing strips, blocking, grounds and other fastening devices required for attachment of work. Properly locate in cooperation with other trades and secure in position before concrete is poured. Do not install sleeves or block-outs in any concrete slabs, beams or columns except where shown on the drawings or upon written approval of the Architect/Engineer.

B. Protect adjacent finish materials against damage and spatter during concrete placement.

C. To maintain location accuracy, the General Contractor's field engineer shall furnish building control lines and elevation bench marks for the use of all trades.

PART 2 - PRODUCTS

2.1 CONCRETE MATERIALS

A. Refer to the drawings for classes and strengths of concrete required.

B. Hydraulic Cement:

1. Use ASTM C 150, Type I or Type III, or ASTM C 1157, Type GU or HE unless otherwise specified. Do not use Type III cement in slabs on grade unless approved in advance by the Engineer.

2. Concrete exposed to sulfates in soil or water

    a. Exposure class S1: For areas designated on the drawings as exposure class S1, use ASTM C 150, Type II or ASTM C 1157, Type MS.
    b. Exposure class S2: For areas designated on the drawings as exposure class S2, use ASTM C 150, Type V or ASTM C 1157, Type HS.
    c. Alternate cement types for exposure classes and S2: ASTM C 150, Type I or III cement may be used for concrete exposed to exposure S1 or S2 if the tricalcium aluminate (C3A) content is less than 8 percent for S1 exposure or 5 percent for S2 exposure ASTM C 150, Type I or III cement may be used for exposure to seawater if the tricalcium aluminate content does not exceed 10 percent and the w/cm ratio of the concrete mix does not exceed 0.40.
    d. Exposure class S3: For areas designated on the drawings as exposure class S3, use ASTM C 150, Type V plus pozzolan or slag or ASTM C 1157, Type HS plus pozzolan or slag or ASTM C 595, Type IP (HS) or Type IS (HS). The amount of pozzolan or slag added or in a blended mix shall be such that has been determined by service record to improve sulfate resistance when used with Type V cement or the amount that when tested according to ASTM C 1012 meets the criteria of table 4.5.1 in ACI 318-08.

3. Use one brand of cement, for each class of concrete, throughout the project, unless approved otherwise by the Architect/Engineer and the Owner's Testing Laboratory. Submit mill certificates certifying conformance to this specification for each brand and type of cement. Documentation of design mix strength history must match the cement brand used.

4. Testing of cement in lieu of mill certificate submittal will be required if:

    a. The cement has been in storage at the mixing site for over 30 days
    b. It is suspected by the Owner, Architect, Engineer or Owner's Testing Laboratory that the cement has been damaged in storage or in transit or is in any way defective.

C. Low-alkali cement: Cement that has the additional requirement that equivalent alkalis ($Na_2O + 0.658K_2O$) do not exceed 0.60% according to ASTM C 150-00, Table 2.

D. Expansive Cement: ASTM C 845, Type K.

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

F. Silica Fume: ASTM C 1240, Amorphous Silica.

G. Slag Cement: ASTM C 989, Grade 100 or 120 or ASTM C 595, Type IS or Type S.

H. Normal weight Aggregates: ASTM C 33, and as herein specified. Submit material certificates from aggregate supplier or test results from an independent testing Labratory certifying conformance to this specification for each source of aggregate.

1. For concrete identified on the drawings as exposed to exposure classes C1 and C2, submit certification that aggregate does not contain any deleterious materials that react with alkalis in the concrete mix to cause excessive expansion of the concrete for concrete that is exposed to wetting, has extended exposure to humid atmosphere, or is in contact with moist ground unless low-alkali cement is used.

I. Lightweight Aggregates: ASTM C 330. Submit material certificates from aggregate supplier or test results from an independent testing Labratory certifying conformance to this specification for each source of aggregate.

J. Water: Comply with the requirements of ASTM C 1602

K. Cementitious materials, aggregate, and water must be extracted or recovered as well as manufactured within 500 miles of the project site.

L. Air-Entraining Admixture: ASTM C 260.

Subject to compliance with requirements, provide one of the following products and manufacturers:

"Darex" or "Daravair" series; W. R. Grace & Co.
“MB-VR”, "MB-AE90" or "Micro-Air"; BASF Admixtures, Inc
"Sika AER"; Sika Corporation
"Air Mix" or "AEA-92"; the Euclid Chemical Company
“Eucon Air 30” or “Eucon Air 40”, the Euclid Chemical Company.

Submit manufacturer's certification that product conforms to the requirements specified and is compatible with all other admixtures to be used.

M. Water-Reducing Admixture: ASTM C 494, Type A. See maximum permissible chloride ion content in concrete specified below.

Subject to compliance with requirements, provide one of the following products and manufacturers:

"Pozzolith" series; BASF Construction Chemicals
"Plastocrete 161"; Sika Chemical Corp.
"Eucon WR-75 or WR-91"; the Euclid Chemical Company.
"WRDA "; series W.R. Grace & Co.
“Eucon NW” or “Eucon LW”, the Euclid Chemical Company

Submit manufacturer's certification that product conforms to the requirements specified and is compatible with all other admixtures to be used.

N. Mid-Range Water-Reducing Admixture: ASTM C 494, Type A and Type F. See maximum permissible chloride ion content in concrete specified below.

Subject to compliance with requirements, provide one of the following products and manufacturers:

"Polyheed" series, BASF Construction Chemicals
"Eucon MR", the Euclid Chemical Company
"Sikament HP", Sika Chemical Corp.
"Daracem" or "Mira" series, W.R. Grace & Co.
"Eucon X15" or "Eucon X20", the Euclid Chemical Company

Submit manufacturer's certification that product conforms to the requirements specified and is compatible with all other admixtures to be used.

O. High-Range Water-Reducing Admixture (superplasticizer): ASTM C 494, Type F or Type G. See maximum permissible chloride ion content in concrete specified below.

Subject to compliance with requirements, provide one of the following products and manufacturers:

"ADVA" or "Daracem" Series; W.R. Grace & Co.
"Rheobuild 1000" or "Glenium" series; BASF Construction Chemicals
"Sikament"; Sika Chemical Corp.
"Eucon 37/1037" or "Plastol" series; the Euclid Chemical Company
"Euconl SP" or "Eucon RD", the Euclid Chemical Company

Submit manufacturer's certification that product conforms to the requirements specified and is compatible with all other admixtures to be used.

P. Water-Reducing, Accelerator Admixture (Non-Corrosive, Non-Chloride): ASTM C 494, Type C or E. See maximum permissible chloride ion content in concrete specified below.

Subject to compliance with requirements, provide one of the following products and manufacturers:

"Polarset";"Gilco", "Lubricon NCA" or "DCI", W.R. Grace & Co.
"Pozzutec 20+"; BASF Construction Chemicals
"Accelguard 80/90"; "NCA", or "AcN", the Euclid Chemical Company
"Plastocrete 161FL", Sika Chemical Co.
"Eucon AcN", the Euclid Chemical Company

Submit manufacturer's certification that product conforms to the requirements specified and is compatible with all other admixtures to be used.

Q. Water-Reducing, Retarding Admixture: ASTM C 494, Type D. See maximum permissible chloride ion content in concrete specified below.

Subject to compliance with requirements, provide one of the following products and manufacturers:

"Daratard" series, W.R. Grace & Co.
"Pozzolith" series or "DELVO" series; BASF Construction Chemicals
"Plastiment"; Sika Chemical Co.
"Eucon Retarder", Series, the Euclid Chemical Company

Submit manufacturer's certification that product conforms to the requirements specified and is compatible with all other admixtures to be used.

R. Viscosity Modifying Admixture: Used to enhance plastic concrete properties such as workability, pumpability, and stability for "self-consolidating concrete".

"Rheomac VMA" series, BASF Construction Chemicals
"Eucon SL" or "Visctrol", the Euclid Chemical Company
"VisoCrete" series, Sika Chemical Co.
"VMAR" series, W.R. Grace & Co.

S. Shrinkage Reducing Admixture: An admixture that reduces drying shrinkage by reducing the capillary tension of pore water.

Subject to compliance with requirements, provide one of the following products and manufacturers:

For Air-Entrained Concrete:

"Eclipse Plus"'; Grace Construction Products
"Eucon SRA"; the Euclid Chemical Company

For Non Air-Entrained Concrete

"Eclipse Floor", Grace Construction Products
"Tetraguard AS20", BASF Construction Chemicals

T. Corrosion Inhibitor: 30% calcium nitrite

Products: Subject to compliance with requirements, provide the following at dosage rates per Engineer of Record from manufacturer's recommendation based on design life, application, clear cover and other products in concrete mix:

"Eucon CIA" or "Eucon BCN", the Euclid Chemical Company

"DCI" or “DCI-S”, W.R. Grace & Co.
"Rheocrete CNI", BASF Construction Chemicals
“Sika CNI”, Sika Chemical Co.

U. Corrosion Inhibitor: Amine-Ester type

Products: Subject to compliance with requirements, provide the following at dosage rates per manufacturer’s recommendation:

"Rheocrete 222+", BASF Construction Chemicals

V. Crystalline-forming Waterproofing Admixture: An powder admixture capable of producing concrete that is water tight under hydrostatic pressure up to 7 atmospheres when tested in accordance with Corps of Engineers test CRD-C48 and capable of sealing cracks up to 0.4mm.

Products: Subject to compliance with requirements, provide the following at dosage rates per manufacturer’s recommendation:

“Penetron Admix”, ICS/Penetron International/Ltd.
”Krystol Internal Membrane”, Kryton International, Inc.
“Xypex C series”, Xypex Chemical Corporation
“Rheomac 300D”, BASF Construction Chemicals

W. Calcium Chloride and Chloride Ion Content: Calcium chloride or admixtures containing more than 0.5% chloride ions by weight of the admixture are not permitted. For concrete exposed to sulfate exposure class S2 or S3 as noted on the drawings, admixtures must be completely free of chloride ions.

X. Certification: Written conformance to all the above mentioned requirements and the chloride ion content of the admixture as tested by an accredited laboratory will be required from the admixture manufacturer at the time of mix design review by the Engineer.

2.2 RELATED MATERIALS

A. Waterstops: Provide waterstops at all construction joints and other joints in all foundation walls below grade and where shown on the drawings. Size to suit joints. Provide flat, dumbbell type or center bulb type where shown on drawings.

1. ADCOR ES waterstops: W.R. Grace & Co.

2. Polyvinyl chloride (PVC) waterstops: Corps of Engineers CRD-C 572.

3. Preformed Plastic Waterstops: Federal Specifications SS-S-210A "Sealing Compound for Expansion Joints".

Manufacturers: Synko-Flex Products, Inc.

4. Bentonite Waterstop RX manufactured by American Volclay Products.

B. Vapor Retarder: Provide vapor retarder cover chosen from products specified below over prepared base material where indicated.

1. Plastic Vapor Retarder Provide a flexible preformed sheet membrane conforming to ASTM E 1745 with the following properties.

a. Class A material
b. Minimum of 15 mils thick
c. Maximum water vapor permeance rating of 0.01 Perms after mandatory conditioning as tested by ASTM E 96
d. Acceptable products include the following:

(1) Stego Industries, LLC Stego Wrap Vapor Barrier (15 mil)"
(2) EPRO “Ecoshield E-15”
(3) Reef Industries, Griffolyn Type-65

2. Tape for Plastic Vapor Retarders: High-density polyethylene tape with pressure sensitive adhesive having a minimum width of 4 inches having a maximum water vapor transmission rate of .3 perms.

C. Absorptive Cover: Burlap cloth made from jute or kenaf, weighing approximately 9 oz. per sq. yd., complying with AASHTO M 182, Class 2.

D. Moisture-Retaining Cover: One of the following, complying with ANSI/ASTM C 171:

1. Waterproof paper.

2. Polyethylene film.

3. Polyethylene-coated burlap.

4. Polyethylene-coated natural cellulose fabric such as “Aquacure” by Greenstreak Group, Inc.

5. Cover for Industrial Slab: Provide a low permeance moisture-retaining cover that allows a moisture loss of no more than 1 lb/sq. yd. in 72 h when tested in accordance with ATSM C 156 for industrial slabs. The material shall be non-staining with a tensile strength meeting ASTM D 882 and a minimum retention capacity of 6.5 g.

E. Slip-resistive Emery Aggregate or Aluminum Granule Finish: Provide fused aluminum-oxide granules, or crushed emery, as abrasive aggregate for slip-resistive finish. The emery aggregate shall contain not less than 50% aluminum oxide and not less than 20% ferric oxide. The aluminum aggregate material shall contain not less than 95% fused

aluminum-oxide granules. Use material that is factory-graded, packaged, rust-proof and non-glazing, and is unaffected by freezing, moisture and cleaning materials.

Subject to compliance with requirements, provide one of the following:

"Emery Tuff Non-Slip", Dayton-Superior
"Grip-It" or “Grip-It AO”, L&M Construction Chemicals, Inc
“Frictex NS”, Sonneborn-ChemRex

F. Colored, Mineral Aggregate, Dry Shake Surface Hardener: Packaged, dry, combination of materials, consisting of portland cement, graded quartz aggregate, coloring pigments (if required) and plasticizing admixtures. Use coloring pigments that are finely ground, non-fading mineral oxides, inter-ground with cement. Color, as selected by Architect, unless otherwise indicated.

Products: Subject to compliance with requirements, provide one of the following:

"Surflex"; the Euclid Chemical Company
"Quartz Plate"; L & M Const. Chemical Co.
“Lithochrome”, LM Scofield Construction Chemical Co.
"Mastercron"; BASF Building Systems
"Quartz-Tuff“, Dayton Superior
“US Spec Dense Top”, US Mix Co.

Submit manufacturer's certification that product conforms to the requirements specified.

G. Metallic Aggregate Hardener Finish: Packaged dry, combination of materials consisting of Portland Cement, specially processed and graded iron aggregate, coloring pigments (if required) and plasticizing admixtures. The hardener shall be formulated, processed and packaged under stringent quality control. Use coloring pigments that are finely ground, non-fading mineral oxides inter-ground with cement. Color as selected by Architect unless otherwise indicated.

"Euco-Plate HD"; the Euclid Chemical Company
"Masterplate 200"; BASF Building Systems
"Ferro Tuff," Dayton-Superior

H. Non-Oxidizing Metallic Floor Hardener: Packaged dry, combination of materials consisting of portland cement, non-rusting aggregate and plasticizing admixtures.

"Diamond Plate," the Euclid Chemical Company
"Lumiplate," BASF Building Systems

I. Liquid Membrane-Forming Curing and Curing and Sealing Compounds:

1. Water-Based Dissipating Resin Type Curing Compound: Curing Compound shall be a dissipating resin type, which chemically breaks down after approximately 4 weeks. Membrane forming compound shall meet ASTM C 309, Types 1 or 1D, Class B with VOC content less than 350 g/L.

   Products: Subject to compliance with requirements, provide one of the following:

   "Kurez DR Vox", the Euclid Chemical Company
   "L&M Cure R", L&M Construction Chemicals
   "Hydro Cure 309", Unitex
   "Sealtight 1100-Clear", W. R. Meadows
   "US Spec Maxcure Resin Clear", US Mix Co.

   Submit manufacturer's certification that product conforms to the requirements specified and is compatible with any covering or surface treatments to be applied. Submit any instructions that must be followed prior to any subsequent surface treatments and floor coverings.

2. High Solids, Water-Based Acrylic Curing and Sealing Compound with Moderate Yellowing Characteristics: Water-Based membrane-forming curing and sealing compound conforming to ASTM C 1315, Type 1, Class B, classified as low odor with a VOC content less than 350 g/L. Product shall provide a maximum moisture loss of 0.030 Kg/m^2 in 72 hours when applied at a coverage rate of 300 sf/gallon. Do not apply to surfaces that are to receive subsequent cementitious toppings, sealers, hardeners, ceramic tile, resilient flooring, vinyl-backed carpet, wood, or terrazzo, epoxy overlays or adhesives, or other coating or finishing products.

   Products: Subject to compliance with above requirements, provide one of the following products or equivalent products:

   "Safe Cure and Seal (J-19)"; Dayton Superior Corp.
   "Super Aqua-Cure VOX"; the Euclid Chemical Company
   "Dress & Seal, 30 WB"; L & M Construction Chemicals, Inc.
   "Masterkure 200W"; BASF Building Systems
   "Hydro 18", Unitex

   Submit manufacturer's certification that product conforms to the requirements specified and is compatible with any covering or surface treatments to be applied. Submit any instructions that must be followed prior to any subsequent surface treatments.

3. High Solids, Water-Based, Non-Yellowing Curing and Sealing Compound: Water based membrane-forming curing and sealing compound, acrylic type, complying with ASTM C 1315, Type 1, Class A classified as low odor with a VOC content less than 350 g/L. Do not apply to surfaces that are to receive subsequent cementitious toppings, sealers, hardeners, ceramic tile resilient flooring, vinyl-

backed carpet, wood, terrazzo, epoxy overlays or adhesives, or other coating or finishing products.

Products: Subject to compliance with requirements, provide one of the following:

"Super Diamond Clear Vox", the Euclid Chemical Company
"Lumiseal 30 WB", L&M Construction Chemicals
“Kure 1315”, BASF Building Systems
“Hydro Seal 30”, Unitex
“Vocomp 30”, W. R. Meadows
“US Spec Radiance UV-25”, US Mix Co.

Submit manufacturer's certification that product conforms to the requirements specified and is compatible with any covering or surface treatments to be applied. Submit any instructions that must be followed prior to any subsequent surface treatments.

J. Evaporation Control: Monomolecular film forming compound applied to exposed concrete slab surfaces for temporary protection from rapid moisture loss in hot weather conditions.

Products: Subject to compliance with requirements, provide one of the following:

"Eucobar"; the Euclid Chemical Company
"E-Con"; L & M Construction Chemical, Inc.
"Confilm"; BASF Building Systems
"Sure Film (J-74)", Dayton Superior
"SikaFilm", Sika Chemical Co.
“Pro-Film”, Unitex
“Sealtight Evapre”, W. R. Meadows
“US Spec Monofilm ER”, US Mix Co.

Submit manufacturer's certification that product conforms to the requirements specified and is compatible with all coverings and surface treatments to be applied. Submit any instructions that must be followed prior to any subsequent surface treatments.

K. Chemical Curing/Floor Hardener Compound: Sodium silicate based compound which reacts with concrete constituents to harden the surface, resulting in a surface having a maximum abrasion coefficient of 0.25 cm3/cm2 when tested in accordance with ASTM C 418.

Products: Subject to compliance with requirements, provide one of the following:

"Eucosil," the Euclid Chemical Company
"Sonosil," BASF Building Systems

"Day-Chem S.1-Cure (J-13), Dayton Superior
"Chem Hard;" L & M Construction Co.
“Uni Cure HD”, Unitex
“Med-Cure”, W. R. Meadows
“US Spec Permasil”, US Mix Co.

Submit manufacturer's certification that product conforms to the requirements specified and is compatible with all coverings and surface treatments to be applied. Submit any instructions that must be followed prior to any subsequent surface treatments.

L. Chemical Hardener: Colorless aqueous solution containing a blend of magnesium fluosilicate and zinc fluosilicate combined with a wetting agent, containing not less than 2 lbs. of fluosilicates per gal.

Products: Subject to compliance with requirements, provide one of the following:

"Surfhard"; the Euclid Chemical Company
"Lapidolith"; BASF Building Systems
"Day-Chem Hardener (J-15)," Dayton Superior
“Fluohard”, L & M Construction Chemical, Inc.
“Penalith”, W. R. Meadows

Submit manufacturer's certification that product conforms to the requirements specified and is compatible with all coverings or surface treatments to be received. Submit any instructions that must be followed prior to any subsequent surface treatments.

M. Liquid sealer/densifier: High performance, deeply penetrating concrete densifier that is an odorless, colorless, VOC-compliant, non-yellowing siliconate-based solution containing a minimum solids content of 20%, 50% of which is siliconate.

“Euco Diamond Hard”, the Euclid Chemical Company
”Seal Hard”, L & M Construction Chemical, Inc.
“Luqui-Hard”, W.R. Meadows

N. Water and Chloride Ion Repelling Penetrating Sealer: Clear, solvent based silane or siloxane penetrating sealer which reacts chemically with the concrete surface to function as a Chloride Ion screen with a minimum 90% factor when tested in accordance with NCHRP #244, Series II, 100% solids, and applied in accordance with the manufacturer's recommendation.

Products: Subject to compliance with requirements, provide one of the following:

a. “Hydrozo 100”, BASF Building Systems.
b. “Iso-flex 618-100 CRS”, Lymtal International, Inc.

c. "Protectosil Chem-Trete BSM-400", Evonik Industries

O. Water and Chloride Ion Repelling Penetrating Sealer: Clear, solvent free, silane penetrating sealer which reacts chemically with the concrete surface to function as a Chloride Ion screen with a minimum 83% factor when tested in accordance with NCHRP #244, Series II and applied in accordance with the manufacturer's recommendation.

Products: Subject to compliance with requirements, provide one of the following:

1. 40% solids:

   a. "Enviroseal 40" –BASF Building Systems
   b. "Iso-flex 618-40 WB", Lymtal International, Inc.

2. 100% solids:

   a. "Protectosil BH-N", Evonik Industries

P. Bonding Compound: Polyvinyl acetate or acrylic base, for use in cosmetic and/or nonstructural repairs.

Products: Subject to compliance with requirements, provide one of the following:

1. Acrylic or Styrene Butadiene:

   "Day-Chem Ad Bond (J-40)"; Dayton Superior
   "SBR Latex"; the Euclid Chemical Company
   "Daraweld C"; W. R. Grace
   "Acrylic Additive" BASF Building Systems
   "SikaLatex", Sika Chemical Co.
   "Intralok", W. R. Meadows
   "US Spec Acrylcoat", US Mix Co.
   "Akkro 7-T", the Euclid Chemical Company

2. Polyvinyl Acetate (Interior Use Only)

   "Tammseld"; the Euclid Chemical Company
   "Everweld"; L & M Construction Chemicals, Inc.
   "Superior Concrete Bonder (J-41)," Dayton Superior
   "US Spec Bondcoat", US Mix Co.

Q. Epoxy Products: Two component material suitable for use on dry or damp surface, complying with ASTM C 881.

1. Products for Crack Repair:

   "Sikadur 35 Hi Mod LV"; Sika Chemical Company – injection type
   "Sikadur 52", Sika Chemical Company – injection type

"Sikadur 55 SLV", Sika Chemical Company – gravity feed
"Eucopoxy Injection Resin," the Euclid Chemical Company
"Sure-Inject (J-56)," Dayton Superior
“Epofil SLV”, BASF Building Systems
“ETI-LV” or “ETI-GV”, Simpson Strong-Tie Co., Inc. – injection type
“Pro-Poxy 100 LV” or “Pro-Poxy 50”, Unitex
“Crackbond”, U.S. Anchor Corp.
“Rezi-Weld LV”, W. R. Meadows
“US Spec Maxibond” US Mix Co. – injection or gravity feed
“US Spec Eposeal LVS”, US Mix Co. – gravity feed
“Duralcrete LV”, the Euclid Chemical Company

2. Products for Epoxy Mortar Patches:

"Sikadur Lo-Mod LV"; Sika Chemical Corporation
""Duracrete”, the Euclid Chemical Company
"Sure Grip Epoxy Grout (J-54)," Dayton-Superior
“Epofil”, BASF Building Systems
“Pro-Poxy 2500”, Unitex
“Rezi-Weld 1000”, W. R. Meadows
“US Spec EPM 3000”, US Mix Co.
“Duralcrete LV”, the Euclid Chemical Company

3. Products for Epoxying steel plates to concrete: conform to ASTM C 881-90, Type IV, Grade 3, Class A, B, & C except gel times.

"Sikadur 31 Hi-Mod Gel"; Sika Corporation
"Sure Anchor I (J-S1)," Dayton Superior
"Epo Gel" or "Rapid Gel", BASF Building Systems
“Pro-Poxy 300”, Unitex
“US Spec Gelbond NS” US Mix Co.
“Duralcrete Gel”, the Euclid Chemical Company

4. Products for Adhesive Anchors or Reinforcing Steel in Normal weight Concrete: Product that conforms to ASTM C 881-02, Type IV, Grade 3, Class A, B, & C except gel times, and that is dispensed from a two-component cartridge system through a mixing nozzle that thoroughly mixes the two components as it is injected into the hole.

   a. ICC Approval: Only anchors evaluated by the ICC Evaluation Service, Inc. (ICC-ES) with a published, currently valid, Evaluation Report showing it as having passed Acceptance Criteria 308 shall be approved for use.
   b. Consult with the manufacturer for the minimum temperature of the concrete substrate allowed.

c. All anchors installed upwardly inclined require continuous inspection unless an exception to the continuous special inspection for upwardly inclined installation is noted on the drawings.

d. Normal weight Concrete:

"HIT-RE 500-SD", Hilti Fastening Systems (periodic inspection unless anchors are installed upwardly inclined)
"SET-XP" Adhesive", Simpson Strong-tie (periodic inspection unless higher factors are used in design requiring continuous inspection as noted on the drawings or anchors are installed upwardly inclined)
"PE 1000+", Powers Fasteners, Inc. (periodic inspection unless anchors are installed upwardly inclined)
HIT-HY 150 MAX-SD", Hilti Fastening Systems (periodic inspection unless anchors are installed upwardly inclined)

e. Lightweight Concrete:

No approved products

f. These products may not be used in concrete cast over corrugated deck.

g. Install only anchors identified on the drawings by manufacturer and product. Substitutions using products approved by this Specification may be permitted provided complete design calculations, as required by and in accordance with the proposed product's current and valid ICC Evaluation Service Report (ESR) and ACI 318 Appendix D, are signed and sealed by a professional engineer licensed in the state where the project is located and furnished to the Engineer for review and approval prior to commencement of work. The contractor shall request design criteria for all conditions where a product substitution is considered. Failure to obtain approval for an anchor substitution may result in the request by the Engineer to remove installed anchors and replace with the product specified on the drawings at the Contractor's expense.

R. Self-Leveling Mortars, Underlayment Compound: Free flowing, self-leveling, pumpable cementitious base compound. Follow manufacturer's instruction regarding the use of a bonding agent.

Products: Unless specified otherwise, provide one of the following:

"Sonoflow," BASF Building Systems
"Sikatop 111"; Sika Chemical Co.
"Flo-Top" or "Super Flo-Top"; the Euclid Chemical Company
"Levelayer I," Dayton Superior
"US Spec Self-leveling Underlayment" US Mix Co.

"Level Magic", the Euclid Chemical Company

S. Polymer Patching Mortar: Polymer and microsilica modified cementitious based compounds.

Products:

Horizontal Application

"Thin Top Supreme, Concrete Top Supreme," the Euclid Chemical Company
"Sikatop 121 or 122," Sika Chemical
"Emaco R310 CI," BASF Building Systems
"Sonopatch 100 or 200", BASF Building Systems
"US Spec H2 or NuTop" US Mix Co.
"Speed Crete PM", the Euclid Chemical Company

Upwardly Inclined Application

"Verticoat/Verticoat Supreme," the Euclid Chemical Company
"Sikatop 123," Sika Chemical
"Emaco R350 CI," BASF Building Systems
"Sonopatch 200", BASF Building Systems
"US Spec V/O Patch", US Mix Co.
"Speed Crete PM", the Euclid Chemical Company

T. High Strength Flowing Repair Mortar: For forming and pouring structural members, or large horizontal repairs, provide flowable one-part, high strength microsilica polymer modified repair mortar with 3/8" aggregate. The product shall achieve 9000 psi @ 28-days at a 9-inch slump.

Products:

"Road Patch", BASF Building Systems
"US Spec STR Mortar", US Mix Co.
"Eucocrete", the Euclid Chemical Company
"Form and Pour", the Euclid Chemical Company

U. Anti-Corrosive Epoxy/Cementitious Adhesive: Water-based epoxy/cementitious compound for adhesion and corrosion protection or reinforcing members (20 hour maximum open time).

Products:

"Duralprep A.C", the Euclid Chemical Company
"Armatec 110," Sika Chemical Co.
"Sonoprep Plus", BASF Building Systems

V. Expansion and Undercut Anchors in Concrete:

1. ICC Approval: Only anchors evaluated by the ICC Evaluation Service, Inc. (ICC-ES) with a published, currently valid, Evaluation Report showing it as having passed Acceptance Criteria 193 and approval for use in cracked concrete and resisting wind and seismic loads shall be approved for use.

2. Type: All expansion and undercut anchors in concrete shall be only wedge type expansion, sleeve-type expansion, or undercut type anchors.

3. Interior Use: All anchors, nuts and washers for use in interior conditioned environments free of potential moisture shall be manufactured from carbon steel zinc plated in accordance with Federal Specification QQ-Z-325C, Type II, Class 3.

4. Exterior or Exposed Use: All anchors, nuts and washers for use in exposed or potentially wet environments, or for attachment of exterior cladding materials shall be galvanized or stainless steel. Galvanized anchors, nuts and washers shall conform to ASTM A 153. Stainless steel anchors shall be manufactured from 300 series stainless steel and nuts and washers from 300 series or Type 18-8 stainless steel.

5. Nuts and Washers: Nuts and washers shall be furnished from the manufacturer and used with the anchors.

6. Acceptable Products and Manufacturers – Normal and Lightweight Concrete:

"Kwik Bolt TZ", Hilti Fastening Systems (periodic inspection)
"HDA Undercut Anchor" Hilti Fastening Systems (continuous inspection)
"HSL-3 Heavy Duty Sleeve Anchor", Hilti Fastening Systems (continuous inspection)
"Strong-Bolt Wedge Anchor", Simpson Strong-Tie, Co., Inc. (continuous inspection)
"Red Head Trubolt + Wedge Anchor", ITW Red Head (periodic inspection)
"DUC Undercut Anchor", USP Structural Connectors (continuous inspection)
"Power Stud + SD1", Powers Fasteners, Inc (periodic inspection)
"Power Stud + SD2", Powers Fasteners, Inc (periodic inspection)
"SRS TZ Carbon Steel Anchor", MKT Metall-Kunststoff-Technik (continuous inspection)

7. Acceptable Products and Manufacturers – Normal and Light Weight Concrete on Corrugated Deck:

"Kwik Bolt TZ", Hilti Fastening System (periodic inspection)

Strong-Bolt Wedge-Anchor", Simpson Strong-Tie, Co, Inc. (continuous inspection)
Power Stud + SD2", Powers Fasteners, Inc. (periodic inspection)

8. Install only anchors identified on the drawings by manufacturer and product. Substitutions using products approved by this Specification may be permitted provided complete design calculations, as required by and in accordance with the proposed product's current and valid ICC Evaluation Service Report (ESR) and ACI 318 Appendix D, are signed and sealed by a professional engineer licensed in the state where the project is located and furnished to the Engineer for review and approval prior to commencement of work. The contractor shall request design criteria for all conditions where a product substitution is considered. Failure to obtain approval for an anchor substitution may result in the request by the Engineer to remove installed anchors and replace with the product specified on the drawings at the Contractor's expense.

W. Screw and Insert Anchors in Concrete

1. Approvals: Only anchors evaluated by the ICC Evaluation Service, Inc. (ICC-ES) with a published, currently valid, Evaluation Report showing it as having passed Acceptance Criteria 193 and approved for use in cracked concrete and resisting wind and seismic loads shall be approved for use.

2. Interior Use: All screw anchors for use in interior conditioned environments free of potential moisture shall be manufactured from carbon steel zinc plated in accordance with Federal Specification QQ-Z-325C, Type II, Class 3.

3. Exterior or Exposed Use: All screw anchors for use in exposed or potentially wet environments, or for attachment of exterior cladding materials shall be galvanized or stainless steel. Galvanized anchors shall conform to ASTM A 153. Stainless steel anchors shall be manufactured from 300 series stainless steel.

4. Acceptable Products and Manufacturers – All Conditions:

"Titen HD", Simpson Strong-Tie Co., Inc (continuous inspection)
"Snake+Anchor" Powers Fasteners, Inc. (periodic inspection)
"Wedge-Bolt+", Powers Fasteners, Inc. (greater than ¼ in. diameter) (periodic inspection)

5. Install only anchors identified on the drawings by manufacturer and product. Substitutions using products approved by this Specification may be permitted provided complete design calculations, as required by and in accordance with the proposed product's current and valid ICC Evaluation Service Report (ESR) and ACI 318 Appendix D, are signed and sealed by a professional engineer licensed in the state of Texas and furnished to the Engineer for review and approval prior to commencement of work. The contractor shall request design criteria for all

conditions where a product substitution is considered. Failure to obtain approval for an anchor substitution may result in the request by the Engineer to remove installed anchors and replace with the product specified on the drawings at the Contractor's expense.

X. Threaded Rods Chemically Anchored in Concrete

1. Type: Threaded rods installed in holes using a chemical anchoring process shall have a 45º chiseled end on one end.

2. Interior and Exterior Application: Meet the requirements of ASTM A 153 galvanized steel, or F 593, Group 1 or 2, condition CW stainless steel.

Y. Anchor Rods:

1. All anchor rods shall conform to the ASTM designation and shall be of the yield strength as specified below as appropriate for the types and at the locations as specified on the drawings:

   a. ASTM F 1554, Grade 36 (1/4 inch to 4 inches in diameter).
   b. ASTM F 1554, Grade 55 (1/4 inch to 4 inches in diameter). (Also comply with Supplementary Requirement S1 of ASTM F 1554)
   c. ASTM F 1554, Grade 105 (1/4 inch to 3 inches in diameter.
   d. ASTM A 588 (corrosion resistant).
   e. ASTM A 354 Grade BD, 130 ksi (to 2 ½ inches in diameter).
   f. ASTM A 354 Grade BD, 115 ksi (greater than 2 ½ inches to 4 inches in diameter).
   g. ASTM A 354 Grade BC, 109 ksi (to 2 ½ inches in diameter).
   h. ASTM A 354 Grade BC, 99 ksi (greater than 2 ½ inches to 4 inches in diameter).

2. Anchor rods used with ASTM A 588 base plates shall be threaded round stock conforming to ASTM A 588, grade 50.

3. Anchor rods used with ASTM A 588 base plates shall be threaded round stock conforming to ASTM A 588, grade 50.

4. Anchor rods used with galvanized base plates shall be galvanized.

5. Nuts: All nuts with anchor rods shall be heavy hex head conforming to ASTM A 563.

6. Washers: Unless noted otherwise on the drawings, washer size and thickness for all anchor rods shall conform to Table 14-2 of AISC "Steel Construction Manual" with holes 1/16" greater than the anchor rod diameter. Washers shall conform to ASTM A 36 steel.

Z. Non-Shrink Grout:

1. Type: Grout for base plates, bearing plates and grouting under precast or tilt-up wall panels shall be a non-metallic, shrinkage resistant, premixed, non-corrosive, non-staining product containing Portland cement, silica sands, shrinkage compensating agents and fluidity improving compounds.

2. Specifications: Non-shrink grout shall conform to ASTM C 1107.

3. Compressive Strength: Provide the minimum strength as shown below as determined by grout cube tests at 28 days:

   a. 6,000 PSI for supporting concrete 3000 psi and less.
   b. 8,000 PSI for supporting concrete greater than 3000 psi and less than or equal to 4000 psi.
   c. Unless noted otherwise on the drawings, grout strength on supporting concrete greater than 4000 psi shall be 8000 psi.

4. Products: Acceptable non-shrink grouts are listed below:

   "Crystex"; L & M Construction Chemicals, Inc.
   "Masterflow 713 Plus"; BASF Building Systems
   "Set Grout," BASF Building Systems.
   "Five Star Grout"; U. S. Grout Corp.
   "Sonogrout 10K"; BASF Building Systems
   "NS Grout"; the Euclid Chemical Company
   "Sure-Grip High Performance Grout"; Dayton Superior Corp.
   "CG 200 PC", Hilti, Inc.
   “CG-86 Grout”, W. R. Meadows
   “US Spec GP Grout”, US Mix Co.

5. High Flow, Non-Metallic Grout: Use high-flow grout where high fluidity and/or increased placing time is required and for base plates that are larger than 10 square feet. The factory pre-mixed grout shall conform to ASTM C 1107, "Standard Specification for Packages Dry, Hydraulic-Cement Grout (Non-Shrink)." In addition, the grout manufacturer shall furnish test data from an independent laboratory indicating that the grout when placed at a fluid consistency shall achieve 95% bearing under a 18" x 36" base plate. Provide one of the following:

   "Hi-Flow Grout," the Euclid Chemical Company
   "Masterflow 928," BASF Building Systems.
   "14K Hy Flow," BASF Building Systems
   “588 Grout”, W. R. Meadows
   “US Spec MP Grout”, US Mix Co.

AA. Frictionless Bearing Pads:

1. Types:

   a. Frictionless bearing pads shall be a nominal 3/32" glass filled virgin Tetrafluoroethylene (TFE) conforming to ASTM D 4745 with a 10 gauge A36 steel backing plate factory bonded with a tested epoxy performed in a heated bonding process under a controlled pressure. Provide one sliding pad tack welded to the lower supporting surface and one tack welded to the upper surface. Unless detailed otherwise on the drawings, the upper element shall be larger than the lower element on all sides by the amount of the expansion joint width shown on the drawings.

   b. The lower frictionless bearing pads shall be a nominal 1/16" glass filled virgin Tetrafluoroethylene (TFE) conforming to ASTM D 4745 with a 10 gauge A36 steel backing plate factory bonded with a tested epoxy performed in a heated bonding process under a controlled pressure. The upper frictionless bearing pad shall be a 20 gauge stainless steel sheet (RMS<20) resistance welded to a 10 gauge A36 steel backing plate. The lower sliding pad shall be tack welded to the lower supporting surface and the upper pad tack welded to the upper surface. Unless detailed otherwise on the drawings, the upper element shall be larger than the lower element on all sides by the amount of the expansion joint width shown on the drawings.

2. Design: The pad size and design shall conform to 1998 AASHTO "LRFD Bridge Design Specifications," Section 14. Design bearing pressure under total service load shall not exceed the manufacturer's recommendation. If Neoprene is used the compressive load shall be limited to 800 psi.

3. Corrosion Resistance: Frictionless bearing pads for exterior or exposed usage shall be manufactured for use in an exposed climate of heat, cold, moisture, and ultraviolet rays. All backing steel in an exposed or open environment shall be shop painted with a zinc rich paint or field painted with "ZRC Cold Galvanizing Compound".

4. Acceptable Manufacturers: The following manufacturers are acceptable:

   a. Con-Serv, Inc., Georgetown, SC
   b. Seismic Energy Co., Athens, TX

Other manufacturers will be acceptable only with Engineer approval prior to bid.

BB. Steel Fibers: Provide deformed cold-drawn wire or modified cold-drawn steel fibers meeting the requirements of ASTM A 820, types I or V, and that are listed as an acceptable product for use in the D900 series of UL Fire Rating Assemblies. The fibers shall have a minimum tensile strength of 145,000 psi when tested in accordance with ASTM A 370. The fibers shall have a minimum aspect ratio of 48. Acceptable products include:

"Dramix RC-65/60-BN" (Type 1), "Dramix RL45/50BN" (Type I), Dramix ZL60/1.05" (Type 1), Bekaert Corp.
"Novocon 1050" (Type I), Novocon 1050 HE" (Type I), or "Novomesh 850" (Type I), Propex Concrete Systems, Corp.
"MasterFiber FF or FS" series, BASF Construction Chemicals

CC. Synthetic Micro Fiber Reinforcement: Collated, fibrillated, or monofilament polypropylene, cellulose, or multi-filament nylon fibers conforming to ASTM C 1116, Type III or Type IV.

Products:

"Fiberstrand", the Euclid Chemical Company
"Econo-Mono" or "Econo-Net"; Forta Corp.
"Fibermesh 300"; Propex Concrete Systems, Corp.
"Grace Microfibers" or "Grace Fibers", W.R. Grace & Co.
"Caprolan-RC", Honeywell Nylon Inc.
"Nycon RC", Nycon, Inc.
"UltraFiber 500", Buckeye Technologies, Inc.
"MasterFiber M or F" series, BASF Construction Chemicals

DD. Synthetic Macro Fiber Reinforcement: Monofilament polypropylene/polyethylene fibers conforming to ASTM C 1116, Type III having an aspect ratio between 50 and 90 and a minimum tensile strength of 90 ksi. The fiber lengths shall be between 1.5 and 2 inches long.

Products:

"Tuf-Strand S.F.", the Euclid Chemical Company
"Forta-Ferro", Forta Corp.
"Strux 90/40", W.R. Grace
"Fibermesh 650", Propex Concrete Systems, Corp.
"Synmix", Bekaert Corp.
"MasterFiber MAC" series, BASF Construction Chemicals

EE. Reglets: Where resilient or elastomeric sheet flashing or bituminous membranes are terminated in reglets, provide reglets of not less than 26 gage galvanized sheet steel. Fill reglet or cover face opening to prevent intrusion of concrete or debris.

FF. Carton Forms: Carton forms shall be manufactured using corrugated paper material with a moisture resistant exterior surface and specifically designed for foundation support. Carton forms shall be designed to support the wet weight of the concrete that is shown by the details to be poured on top of the form but not less than 600 psf. Refer to the Reinforced Concrete General Notes for the restriction on horizontal construction joints.

The forms shall be designed in such a way that the bottom of the form will collapse when acted upon by upward movement of the soil.

1. Form Configuration: Carton forms shall be of a vertical cellular configuration only, except as permitted by item 4 below, and shall be rectangular as shown on the details. The depth of the carton forms is shown on the details. Forms shall be manufactured to fit snugly against round piers and shall be baffled in such a way as to prevent concrete from flowing back into the form during the concrete pour. The Contractor shall use expandable foam to fill all gaps and holes between carton forms and at intersections with foundations.

2. Carton forms shall be kept dry and protected until concrete is poured. Wet, compressed, or deteriorated carton forms shall not be used. Do not wrap or cover carton forms with polyethylene sheets or permanent waterproof cover as that will prevent proper deterioration of the forms.

3. Technical data and brochures on carton forms shall be submitted for Engineer's review.

4. Other types of forms using different types of paper and different configurations will be accepted if it can be shown by independent tests that the form will properly function and will deteriorate due to moisture in an appropriate time frame.

5. For slab conditions, cover carton forms with a 1/4 inch masonite protection cover board to prevent puncture and other damage during construction.

6. Products: Subject to requirements, acceptable manufacturers include but are not limited to the following:

SureVoid Products, Inc., Englewood, CO

GG. Contraction and Construction Joint-Filler Material for Slabs-on-Grade: Provide a 2-component semi-rigid, 100% solids epoxy having a minimum shore A hardness of 80 when tested in accordance with ASTM D 2240 and an elongation below 25% when measured in accordance with ASTM D 638. Subject to compliance with requirements, provide one of the following:

"Euco 700", the Euclid Chemical Company
"Spec-Joint CJ"; Conspec Marketing and Manufacturing Co., Inc.
"Masterfill 300 I", BASF Building Systems
"MM-80", Metzger/McGuire Co.
"Rezi-Weld Flex", W. R. Meadows
"US Spec SR-50 EJF", US Mix Co.

HH. Bond breaker for Construction Joints in Slabs-on-Grade: A dissipating bond breaking compound containing no silicones, resins, or waxes, and that conforms to ASTM C 309. Subject to compliance with requirements, acceptable manufacturers include the following:

"Sure-Lift", Dayton Superior Corporation, Inc.
"Tilt-Eez", Conspec Marketing and Manufacturing Co., Inc.

II. Joint-Filler Strips for Isolation Joints in Slabs-on-Grade: ASTM D 1751, asphalt-saturated cellulosic fiber, or ASTM D 1752, cork or self-expanding cork. In post-tensioned slabs or shrinkage-compensated slabs, use compressible isolation-joint filler material that does not develop a stress greater than 25 psi at 50% strain when tested in accordance with ASTM D 1621 or D 3575.

JJ. Rigid-Cellular-Polystyrene Boards use as Fill under Topping Slabs or Slabs-on-Grade: Provide rigid, expanded (EPS) or extruded (XPS) cellular polystyrene boards that conform to ASTM D 6817 or ASTM C 578 with a minimum density of [Polystyrene Density] kg/m^3. Subject to compliance with requirements, acceptable manufacturers include the following:

"STYROFOAM Brand" Dow Chemical Company
"R-Control EPS Geofoam" - All grades, R-Control Building Systems
"EPS Geofoam", Carpenter Co.
"Knauf Geofoam", Knauf Polystyrene
"Insulfill", Premier Industries

2.3 PROPORTIONING AND DESIGN OF CONCRETE MIXES

A. The Contractor shall submit concrete mix designs and the Concrete Mix Design Submittal Form located at the end of this specification section for each class of concrete indicated on the structural drawings and in the Specifications for approval by the Engineer and Owner's Testing Laboratory at least 15 working days prior to the start of construction,. If required, the Contractor shall engage the services of an independent Testing Laboratory to assist in preparing the mix design. The Contractor shall not begin work with a particular mix until that mix design has been approved.

B. Mix Design Conference: See the PREINSTALLATION CONFERENCES Article of this specification.

C. The Contractor, acting in conjunction with his Concrete Supplier and his Testing Laboratory, shall submit in writing, with his mix designs, the method used to select mix proportions. Either of the following methods, as outlined in ACI 301, may be used.

1. Field Experience Method

2. Laboratory Trial Mixture Method

D. Required types of concrete and compressive strengths shall be as indicated on the Structural Drawings.

E. All mix designs shall state the following information:

1. Mix design number or code designation by which the Contractor shall order the concrete from the Supplier.

2. Structural slab or member for which the concrete is designed (i.e., columns, shear walls, footings, slab on grade, etc.).

3. Wet and dry unit weight.

4. 28 day compressive strength.

5. Aggregate type, source, size, gradation, fineness modulus.

6. Cement type and brand.

7. Fly ash or other pozzolan type and brand (if any).

8. Admixtures including air entrainment, water reducers, high-range water reducers, accelerators, and retarders.

9. Design Slump or Slump/Flow.

10. Proportions of each material used.

11. Water/cementitious ratio and maximum allowable water content.

12. Method by which the concrete is intended to be placed (bucket, chute, or pump).

13. Required average strength qualification calculations per ACI 301 4.2.3.3a and 4.2.3.3b. Submit separate qualification calculations for each production facility that will supply concrete to the project.

14. Documentation of Average strength (trial mix data or field test data) per ACI 301: When field test data is used to qualify average strength, submit separate documentation for each production facility that will supply concrete to the project.

15. Field test data submitted for qualification of average strength under ACI 301 shall include copies of the Concrete Testing Laboratory's reports from which the data was compiled.

16. All other information requested in the Concrete Mix Design Submittal Form located at the end of this specification section.

F. Low Alkali Concrete: For concrete identified on the drawings as exposed to exposure classes C1 and C2, the total alkali contribution from cementitious materials in the concrete mix shall not exceed 4.0 pounds per cubic yd of concrete unless the aggregate used is certified to contain no deleterious materials that react with alkalis in the concrete mix as defined in ASTM C 33. This requirement may be met by the use of low-alkali cement.

G. Supplementary Cementitious Materials: Fly ash and/or ground granulated blast-furnace slag replacement of Portland cement shall be within percentage replacement levels listed on the drawings unless noted otherwise. Every effort should be made to reduce the amount of cement to the minimum practical amount, and still achieve performance requirements contained in the Contract Documents.

1. Cement replacement shall not exceed a percentage level that has been shown by experience on other projects to exhibit satisfactory performance using materials from identical sources as proposed for this project. As an alternate, trial concrete batches can be performed to identify mix designs that maximize cement replacement while meeting strength requirements per ACI 318 Section 5.3 and finishability criteria.

2. The use of fly ash or slag in architecturally exposed structural concrete shall be coordinated with the Architect, Engineer of Record, and Contractor.

3. If fly ash is used, it must be at a minimum replacement percentage of 15%.

4. Overall replacement percentages with combined fly ash and slag shall not exceed the maximum identified with slag or be less than the minimum identified with fly ash for each type of element. In addition, the replacement percentage of fly ash within the combined mix shall not exceed the maximum identified with fly ash alone.

5. Replacement percentages exceeding the maximum may be permitted at the discretion of the Architect, Engineer of Record, and Contractor.

6. For concrete identified on the drawings as being subject to Exposure Class F3, the maximum amount of supplementary cementitious materials shall not exceed the limits noted in table 4.4.2 of ACI 318-08

7. Except for Mass Concrete, the Contractor may submit for approval a revised mix design with lower supplementary cementitious material percentages than herein specified should finishability or other issues arise due to changing weather conditions.

H. Aggregate: Comply with the following special requirements:

1. For exposed concrete, provide aggregates from a single source.

2. For exposed surfaces subject to Exposure Class C1 or C2, do not use aggregates containing spalling-causing deleterious substances.

3. For slabs and other designated concrete, combined aggregate gradation shall be 8% - 18% for large top size aggregates (1 1/2 in.) or 8% - 22% for smaller top size aggregates (1 in. or 3/4 in.) retained on each sieve below the top size and above the No. 100. Deviations from this gradation may be allowed upon the approval of the Engineer subject to the following limitations:

   a. The percent retained on two adjacent sieves shall be not less than 5%.
   b. The percent retained on three adjacent sieves shall be not less than 8%
   c. If the percent retained on two adjacent sieves is less than 8%, the total percent retained on either of those sieves and the adjacent outside sieve shall be not less than 13 %

I. Admixtures:

1. Admixtures to be used in concrete shall be subject to the approval of the Engineer and Owner's Testing Laboratory and shall be used for the purpose intended by the manufacturer to produce concrete to meet the specified requirements.

2. Quantities of admixtures to be used shall be in strict accordance with the manufacturer's instructions.

3. Air Content Requirements: For concrete subject to Exposure Class F1, F2 or F3 as noted on the drawings, use air-entrainment admixtures to provide concrete such that the air content at the point of delivery shall conform to the requirements of Table 4.4.1.of ACI 318-08 within plus or minus 1.5%. Required air content levels may be reduced by 1.0 percent for concrete strengths above 5000 psi.

   a. Interior steel troweled surfaces subjected to vehicular traffic shall not have more than 3% entrained air.
   b. Surfaces scheduled to receive hardeners shall not have more than 3% entrained air.
   c. Air-entraining admixtures are not permitted in industrial slabs.

4. Self-consolidating Concrete (SCC): Use where shown on the drawings. Proportion SCC mix with specified admixtures to produce a concrete having properties that allow it to flow freely into all spaces of the formwork, through tight openings under its own weight and is resistant to segregation during transport and placing. Flowable spread shall be between 20 to 30 inches and shall show no evidence of segregation, mortar halo, or aggregate pile, although some slight bleeding is acceptable. Workability, pumpability, finish, and setting time of the proposed mix design must be demonstrated by a successful trial placement onsite.

J. Lightweight Structural Concrete:

1. Comply with the requirements of ACI 211 and ACI 301.

2. Provide concrete with a dry unit weight of not more than 116 pounds per cubic foot and not less than 110 pounds per cubic foot. Design mix to produce strengths as indicated on the drawings with a split cylinder strength factor $(fct/(f'c)^{0.5})$ of not less than 5.7.

K. Adjustments of Concrete Mixes: Mix design adjustments may be requested by the Contractor when characteristics of materials, job conditions, weather, test results, or other circumstances warrant. Such mix design adjustments shall be provided at no additional cost to the Owner. Any adjustments in approved mix designs including changes in admixtures shall be submitted in writing with the specified Concrete Mix Design Submittal Form to the Engineer and Owner's Testing Laboratory for approval prior to field use.

L. Shrinkage: Concrete so identified on the drawings shall be proportioned for maximum allowable unit shrinkage as noted on the drawings, measured at 28 days after curing in lime water as determined by ASTM C 157 (using air storage). Submit results of test for each class of applicable concrete after every 500 CY placed.

M. Chloride Ion Content:

1. Unless noted otherwise, The maximum water soluble chloride ion concentration in hardened concrete measured at ages from 28 to 42 days contributed from all ingredients including water, aggregates, cementitious materials, and admixtures shall not exceed the limits specified in ACI 318-08 Table 4.3.1 depending on to which Corrosion Exposure Class (CO, C1 or C2) the concrete is subject as noted on the drawings. Water-soluble chloride ion tests shall conform to ASTM C 1218. One test shall be run for each class of concrete before the mix design submittal and each time a change is made to the mix design (such as change in aggregate type or source).

2. The chloride ion content in all concrete used for prestressed or post-tensioned concrete shall not exceed .06 percent by weight of cement.

3. The Concrete Supplier shall certify on the Mix Design Submittal Form that the chloride ion content in all concrete mix designs used on the project does not exceed the limits stated above.

2.4 CONCRETE MIXING

A. Ready-Mix Concrete: Comply with requirements of ANSI/ASTM C 94, "Ready Mixed Concrete" and Division 01 Section “Structural Testing Laboratory Services.

PART 3 - EXECUTION

3.1 SLUMP LIMIT

A. The slump, as measured in the field where concrete cylinders are taken, shall be within plus or minus 1 inch of the design slump noted on the Mix Design Submittal Form. Self-consolidating concrete shall have a slump/flow of plus or minus 2 inches of the design slump noted on the Mix Design Submittal Form. Water may be added to the concrete in the field only to the extent that the prescribed water/cementitious ratio noted in the Mix Design Submittal Form is not exceeded.

3.2 VAPOR RETARDER INSTALLATION

A. Install vapor retarder in accordance with ASTM E 1643 and manufacturer's instructions.

B. Lap all seams 6" and seal all joints in the field with the specified pressure sensitive tape. Heat-welded joints done in a shop prior to delivery is an acceptable method to minimize the number of field joints.

C. Seal all pipe penetrations through the vapor retarder with a boot made from the vapor retarder material and tape.

3.3 JOINTS IN CONCRETE

A. Construction Joints: Locate and install construction joints as indicated on the drawings or if not shown on drawings, located so as not to impair strength and appearance of the structure, as acceptable to Architect/Engineer.

1. Keyways: Provide continuous keyways with a depth of one tenth of the member thickness (1 1/2" minimum or as shown on the drawings) in construction joints only where shown on the drawings.

2. Joint Construction: Place construction joints in the center one third of suspended spans and grade beams and as shown on the drawings for slabs-on-grade and walls unless shown otherwise. Offset joints in girders a minimum distance of twice the beam width from a beam-girder intersection. Place joints perpendicular to main reinforcement. Continue reinforcement across construction joints unless otherwise shown on the drawings. Dowels that cross construction joints shall be supported during concreting operations so as to remain parallel with the slab or wall surface and at right angles to the joint. Submit all construction joint locations as a shop drawing submittal.

3. Waterstops: Provide waterstops in construction joints as indicated on the Architectural and Structural Drawings. Install waterstops to form continuous diaphragm in each joint. Make provisions to support and protect exposed waterstops during progress of work. Fabricate field joints in waterstops in accordance with manufacturer's printed instructions.

4. Isolation Joints in Slabs-on-Ground: Construct isolation joints (without dowels) in slabs-on-ground at points of contact between slabs on ground and vertical surfaces only where specifically detailed on the drawings. Install joint-filler strips at joints where indicated. Extend joint-filler strips full width and depth of joint, terminating flush with finished concrete surface, unless otherwise indicated on the drawings. Install joint-filler strips in lengths as long as practicable. Where more than one length is required, lace or clip sections together. Provide construction joints with dowels at all locations unless isolation joints are detailed.

5. Contraction joints in slabs-on-grade and unbonded topping slabs: Maximum joint spacing shall be 36 times the slab thickness or 20 feet, whichever is less and at a minimum on column lines unless otherwise noted on the drawings. Use one of the two following methods (sawed or formed) to create the joints. Do not use the formed joint in areas subject to vehicular traffic or in industrial slabs.

    a. Sawed Joints
        (1) Primary Method: Early-Entry, dry-cut method, by Soff-Cut International, Corona, CA (800) 776-3328. Finisher must have documented successful experience in the use of this method prior to this project. Install cuts within 1 to 4 hours, depending on air temperature, after final finish as soon as the concrete surface is firm enough to not be torn or damaged by the blade at each saw cut location. Use 1/8 inch thick blade, cutting 1 1/4" inch into the slab.
        (2) Optional Method (where Soff-Cut System method equipment is not available, subject to limitations): This method may not be used when there is no dowel passing through the contraction joint. Use a conventional saw to cut joints within 4 to 12 hours after finishing as soon as the concrete has hardened sufficiently to prevent aggregates from being dislodged by the saw. Complete cutting before shrinkage stresses become sufficient to produce cracking. Use 1/8 inch thick blade, cutting to a depth of 1/4 of the slab thickness but not less than 1 inch. Cut to a depth of 1/3 slab thickness for slabs reinforced with steel fibers.

    b. Formed Joints: Form contraction joints by inserting pre-molded plastic hardboard or fiberboard strip into fresh concrete until top surface of strip is flush with slab surface. The depth is to be 1/4 the slab thickness, but not less than 1 inch. Tool slab edges round on each side of insert. After concrete has cured, remove inserts and clean groove of loose debris.

    c. Joint Filler: Provide in both contraction and saw-cut construction joints when specified.
        (1) Remove dirt and debris from the joint by vacuuming immediately prior to filling the joint. Clean the joint of curing compounds and sealers.

(2) Filler material shall be applied to the joints when the building is under permanent temperature control, but no less than 90 days after slab construction.

(3) Follow the manufacturer's recommended procedure for installing filler material. The joint filler must be flush with the adjacent concrete. A concave profile on the top of the joint filler is unacceptable and will be grounds for removal and replacement.

d. The Contractor shall protect the joints from damage caused by wheeled traffic or other sources during construction until a joint-filler material (if specified) has been installed.

3.4 INSTALLATION OF EMBEDDED ITEMS

A. General: Set and build into work anchorage devices and other embedded items required for other work that is attached to, or supported by, cast-in-place concrete. Use setting drawings, diagrams, instructions and directions provided by suppliers of items to be attached thereto unless directed otherwise by these specifications. Install reglets to receive top edge of foundation sheet waterproofing where specified by the Architect, and to receive thru-wall flashings in outer face of concrete frame at exterior walls, where flashing is shown at lintels, relieving angles and other conditions.

B. Anchor Rods: Furnish anchor rods and other connectors required for securing structural steel to foundations and other in-place work as shown on the drawings. Furnish 1/8" minimum steel templates for presetting rods and other anchors to accurate locations as shown on the drawings in keeping with the tolerances noted in ACI 117 for embedded anchor rods. Steel template shall be clearly marked with the following information:

1. Grid line intersection where template is to be used.

2. Orientation of the plate relative to the building grid lines.

3. “Top of Template” elevation.

4. Anchor rod projection above top of template.

C. Edge Forms and Screed Strips for Slabs: Set edge forms or bulkheads and intermediate screed strips for slabs to obtain required elevations and contours in finished slab surface. Provide and secure units sufficiently strong to support types of screed strips by use of strike-off templates or accepted compacting type screeds.

D. Do not install sleeves and block-outs in concrete slabs, pier caps, footings or walls except where shown on the structural drawings or approved by the Architect and Engineer.

E. Securely fasten embedded plates, angles, anchor rods and other items to be built into the concrete to the formwork or hold in place with templates. Insertion of these items into concrete after casting is prohibited.

3.5 CONCRETE PLACEMENT

A. Pre-placement Inspection: Before placing concrete, inspect and complete formwork installation, reinforcing steel and items to be embedded or cast-in. Notify other crafts to permit installation of their work; cooperate with other trades in setting such work. Moisten wood forms immediately before placing concrete where form coatings are not used.

B. Coordinate the installation of joint materials and vapor retarders with placement of forms and reinforcing steel.

C. Comply with ACI 301 and as herein specified.

1. Concrete Temperature: The maximum acceptable concrete temperature at the truck discharge point shall be 95 °F.

2. Deposit concrete continuously or in layers of such thickness that no concrete will be placed on concrete which has hardened sufficiently to cause the formation of seams or planes of weakness. If a section cannot be placed continuously, provide construction joints as herein specified. Deposit concrete as nearly as practicable to its final location to avoid segregation. Spread concrete using short-handled, square-ended shovels, or come-alongs.

3. Placing Concrete in Forms: Deposit concrete in forms in horizontal layers not deeper than 24" and in a manner to avoid inclined construction joints. Where placement consists of several layers, place each layer while preceding layer is still plastic to avoid cold joints.

4. Consolidate placed concrete by mechanical vibrating equipment supplemented by hand-spading, rodding or tamping. Use internal vibrators of the largest size and power that can properly be used in the work as described in the table entitled “Range of characteristics, performance, and applications of internal vibrators” found in ACI 301.

5. Do not use vibrators to transport concrete inside forms. Insert and withdraw vibrators vertically at uniformly spaced locations not farther than visible effectiveness of machine. Place vibrators to rapidly penetrate placed layer and at least 6" into preceding layer. Do not insert vibrators into lower layers of concrete that have begun to set. At each insertion limit duration of vibration to time necessary to consolidate concrete and complete embedment of reinforcement and other embedded items without causing segregation of mix.

6. Placing Concrete Slabs: Deposit and consolidate concrete slabs in a continuous operation, within limits of construction joints, until the placing of a panel or section is completed. Place concrete for beams, girders, brackets, column capitals, haunches, and drop panels at the same time as concrete for slabs. Do not place concrete over columns and walls until concrete in columns and walls is no longer plastic and has been in place at least one hour.

7. Consolidate concrete during placing operations so that concrete is thoroughly worked around reinforcement and other embedded items and into corners of forms, eliminating air and stone pockets that may cause honeycombing, pitting, or planes of weakness.

8. Bring slab surfaces to correct level with straightedge and strikeoff. Use highway straightedges, bull floats or darbies to smooth surface free of humps or hollows before excess moisture or bleedwater appears on the surface. Do not disturb slab surfaces prior to beginning finishing operations.

9. Maintain reinforcing in proper position during concrete placement operations.

10. Placing Concrete by Pump: If concrete is placed by using a pump, the grout used for pump priming must not become a part of the completed structure unless an engineered grout design mix and grout location are approved in advance by the Engineer.

3.6 FINISH OF FORMED SURFACES

A. General: Formed surfaces shall have the finishes as described below and as shown on the drawings after formwork is removed and repairs made.

B. Matching Sample Finish: Finish on surfaces at locations noted on drawings shall match sample panel furnished to Contractor. Reproduce finish on a 100 square foot mock-up panel in a location designated by Architect/Engineer. Protect mock-up from damage for the duration of project. Approval of mock-up by Architect is required before proceeding with application of finish in project.

C. Definitions and Finish Requirements

1. Surface Finish 1.0 (SF-1.0):

   a. No formwork facing material is specified
   b. Patch voids larger than 1-1/2 in. wide or 1/2 in. deep
   c. Remove projections larger than 1.0 inch.
   d. Provide surface tolerance Class D as specified in ACI 117
   e. Tie holes need not be patched

2. Surface Finish 1.1 (SF-1.1):

a. No formwork facing material is specified
b. Patch voids larger than 1 in. wide or 1/2 in. deep
c. Remove projections larger than 1/2 inch.
d. Provide surface tolerance Class C as specified in ACI 117
e. Tie holes need not be patched

3. Surface Finish 2.0 (SF-2.0):

a. Provide specified formwork-facing material
b. Patch voids larger than 3/4 in. wide or 1/2 in. deep
c. Patch tie holes
d. Remove projections larger than 1/4 in.
e. Provide surface tolerance Class B as specified in ACI 117
f. Provide mock-up of concrete surface appearance.

4. Surface Finish 2.1 (SF-2.1):

a. Provide specified formwork-facing material
b. Patch voids larger than 3/4 in. wide or 1/2 in. deep
c. Patch tie holes
d. Remove projections larger than 1/4 in.
e. Provide surface tolerance Class B as specified in ACI 117
f. Provide specified rubbed finish after formwork removal
g. Provide mock-up of concrete surface appearance.

5. Surface Finish 2.2 (SF-2.2):

a. Provide specified formwork-facing material
b. Patch voids larger than 3/4 in. wide or 1/2 in. deep
c. Patch tie holes
d. Remove projections larger than 1/4 in.
e. Provide surface tolerance Class B as specified in ACI 117

6. Surface Finish 2.3 (SF-2.3):

a. No formwork-facing material is specified
b. Patch voids larger than 3/4 in. wide or 1/2 in. deep
c. Patch tie holes
d. Remove projections larger than 1/4 in.
e. Provide surface tolerance Class B as specified in ACI 117

7. Surface Finish 3.0 (SF-3.0):

a. Provide specified formwork facing material
b. Patch voids larger than 3/4 in. wide or 1/2 in. deep
c. Remove projections larger than 1/8 inch.

d. Patch tie holes
e. Provide surface tolerance Class A as specified in ACI 117
f. Provide mock-up of concrete surface appearance.

8. Surface Finish 3.1 (SF-3.1):

a. Provide specified formwork-facing material
b. Patch voids larger than 3/4 in. wide or 1/2 in. deep
c. Patch tie holes
d. Remove projections larger than 1/8 in.
e. Provide surface tolerance Class A as specified in ACI 117
f. Provide specified rubbed finish after formwork removal
g. Provide mock-up of concrete surface appearance.

9. Surface Finish 3.2 (SF-3.2):

a. Provide specified formwork-facing material
b. Patch voids larger than 3/4 in. wide or 1/2 in. deep
c. Patch tie holes
d. Remove projections larger than 1/8 in.
e. Provide surface tolerance Class A as specified in ACI 117

10. Surface Finish 3.3 (SF-3.3):

a. No formwork-facing material is specified
b. Patch voids larger than 3/4 in. wide or 1/2 in. deep
c. Patch tie holes
d. Remove projections larger than 1/8 in.
e. Provide surface tolerance Class A as specified in ACI 117

D. Standard Finish: Provide SF-1.0 on all concrete surfaces not exposed to view in the final condition unless otherwise specified.

E. Exposed Finishes: Provide SF-2.0 on all concrete surfaces exposed to view in final condition unless otherwise specified.

F. Rubbed Finishes: Remove forms as early as permitted by these specifications and perform any necessary repairs and patches.

1. Smooth Rubbed Finish: Provide smooth rubbed finish to scheduled or specified concrete surfaces which have received smooth-form finish treatment, not later than one day after form removal. Moisten concrete surfaces and rub with carborundum brick or other abrasive until a uniform color and texture is

produced. Do not apply cement grout other than that created by the rubbing process.

2. Grout Cleaned Finish: Provide grout cleaned finish to scheduled or specified concrete surfaces that have received smooth-form finish treatment.

   a. Combine one part portland cement to 1-1/2 parts sand meeting the requirements of ASTM C144 and C404 by volume, and 50:50 mixture of acrylic or styrene butadiene based bonding admixture and water to consistency of thick paint. Proprietary additives may be used at Contractor's option. Blend standard portland cement and white portland cement, amounts determined by trial patches, so that final color of dry grout will closely match adjacent surfaces.
   b. Thoroughly wet concrete surfaces and apply grout to coat surfaces and fill small holes. Remove excess grout by scraping and rubbing with clean burlap. Keep damp by fog spray for at least 36 hours after rubbing.

3. Cork-floated Finish: Provide cork-floated finish to scheduled or specified concrete surfaces that have received smooth-form finish treatment.

   a. Combine one part portland cement to one part sand meeting the requirement of ASTM C144 or C404, by volume and water and mix to a to consistency of thick paint. Apply stiff to a wet surface, compressing the grout into all voids.
   b. Produce the final finish with a cork float using a swirling motion.

G. Self-Consolidating Concrete Architectural Finish: Use self-consolidating concrete where shown on the plans to produce a smooth, uniform finish upon form removal with no patching, stoning, rubbing or other form of repair, except washing, permitted. The surface shall match the approved jobsite test panel.

H. Related Unformed Surfaces: At tops of walls, horizontal offsets and similar unformed surfaces occurring adjacent to formed surfaces, strike-off smooth and finish with a texture matching adjacent formed surfaces. Continue final surface treatment of formed surfaces uniformly across adjacent unformed surfaces, unless otherwise indicated.

3.7 MONOLITHIC SLAB FINISHES

Place, consolidate, strike off, and level concrete, eliminating high spots and low spots, before proceeding with any other finish operation. Do not add water to the surface of the concrete during finishing operation.

A. Scratch Finish: Apply scratch finish to monolithic slab surfaces that are to receive concrete floor topping or mortar setting beds for tile, portland cement terrazzo and other bonded applied cementitious finish flooring material, and as otherwise indicated. After placing slabs, plane surface to tolerance specified below. Slope surfaces uniformly to

drains where required. After leveling, roughen surface before final set, with stiff brushes, brooms or rakes.

B. Float Finish: Apply float finish to monolithic slab surfaces to receive trowel finish and other finishes as hereinafter specified, and slab surfaces which are to be covered with membrane or elastic waterproofing, membrane or elastic roofing, or sand-bed terrazzo, and as otherwise indicated. After screeding, consolidating and leveling concrete slabs, do not work surface until ready for floating. Begin floating, using a hand float, a bladed power float equipped with float shoes, or a powered disk float, when the bleed water sheen has disappeared and the concrete surface has stiffened sufficiently to permit the operation. Check and level surface plane to a tolerance as specified below. Cut down high spots and fill low spots. Uniformly slope surfaces to drains. Immediately after leveling, refloat surface to a uniform, smooth, granular texture.

C. Trowel Finish: Apply trowel finish to monolithic slab surfaces to be exposed-to-view, and slab surfaces to be covered with resilient flooring, carpet, ceramic or quarry tile, paint or other thin film finish coating system. After floating, begin first trowel finish operation by hand or power-driven trowel. Begin final troweling when surface produces a ringing sound as trowel is moved over surface. Consolidate concrete surface by final hand-troweling operation, free of trowel marks, uniform in texture and appearance, and with a level surface to a tolerance as specified below. Grind smooth surface defects which would telegraph through applied floor covering system.

D. Trowel and Fine Broom Finish: Where ceramic or quarry tile is to be installed with thin-set mortar, apply initial trowel finish as specified above, then immediately follow with slightly scarifying surface by fine brooming.

E. Slip-Resistive Broom Finish: Apply slip-resistive broom finish to garage floors and ramps less than 6% slope, exterior concrete platforms, steps and ramps and elsewhere as indicated. Immediately after float finishing, slightly roughen concrete surface by brooming with fiber bristle broom perpendicular to main traffic route. Coordinate required final finish with Architect before application.

F. Roller-Bug Finish: Provide a roller-bug finish with minimum ¼" amplitude to all ramps exceeding a 6% slope. Extend the finish as least 12 feet beyond the beginning and ending of the greater-than-6% ramp. The finish shall be imprinted on the concrete by the use of a roller-bug tamper.

G. Chemical-Hardener Finish: Apply chemical-hardener finish to interior concrete floors where indicated. Apply liquid chemical-hardener after complete curing and drying of the concrete surface. Apply proprietary chemical hardeners, in strict accordance with manufacturer's printed instructions.

After final coat of chemical-hardener solution is applied and dried, remove surplus hardener by scrubbing and mopping with water.

H. Liquid Sealer/Densifier Finish: Apply liquid sealer/densifier finish to exposed interior concrete floors where indicated. Apply liquid sealer/densifier after complete curing and drying of the concrete surface and in strict accordance with manufacturer's printed instructions.

I. Penetrating Sealer Finish: Apply a chloride-and-water-repelling-penetrating-sealer finish to surfaces as described below and where indicated on the drawings. Apply liquid penetrating sealer after complete curing and drying of the concrete surface. Apply proprietary sealers in strict accordance with manufacturer's printed instructions. The Contractor shall verify the compatibility of the sealer product with the paint used to stripe parking decks and coordinate the sequencing of the sealing and striping operations. Apply to the following surfaces:

1. Sloping and horizontal surfaces of parking garages

2. Top surfaces of exposed exterior balconies

J. Slip-Resistive Aggregate Finish: Apply slip-resistive aggregate finish to concrete stair treads, platforms, ramps and elsewhere as indicated on the Architect's or Structural Drawings.

After completion of float finishing, and before starting trowel finish, uniformly spread 25 lbs. of dampened slip-resistive aggregate per 100 sq. ft. of surface. Tamp aggregate flush with surface using a steel trowel, but do not force below surface. After broadcasting and tamping, apply trowel finishing as herein specified.

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

K. Colored, Mineral Aggregate Surface Hardener: Provide colored, mineral aggregate surface hardener to monolithic slab surface indicated.

Apply dry shake materials for colored wear-resistant finish at rate of not less than 100 lbs. per 100 sq. ft., unless greater amount is recommended by material manufacturer.

Cast a trial slab approximately 20 feet square to determine actual application rate, color and finish as acceptable to Architect/Engineer.

Immediately following first floating operation, uniformly distribute approximately 2/3 of required weight of dry shake material over concrete surface, and embed by means of power floating. Follow floating operation with second shake application, uniformly distributing remainder of dry shake material at right angles to first application, and embed by power floating.

After completion of broadcasting and floating, apply trowel finish as herein specified. Cure slab surface with curing compound recommended by dry shake hardener manufacturer. Apply curing compound immediately after final finishing.

L. Non-Oxidizing Metallic Floor Hardener: Slabs in areas noted on the drawings shall receive an application of the non-oxidizing, metallic floor hardener applied at the rate of 150 lbs. Per 100 sq. ft. Immediately following the first floating operation, uniformly distribute approximately 2/3 of the required weight of the hardener over the concrete surface by mechanical spreader and embedded by means of power floating. The hardener shall be floated in and the second application made. The surface shall be floated again to properly bond the hardener to the base concrete slab. The surface shall then be troweled at least twice to a smooth dense finish.

M. Metallic Aggregate Floor Hardener: Slabs in areas noted on the drawings shall receive an application of the metallic aggregate floor hardener applied at the rate of 150 lbs. Per 100 sq. ft. Immediately following the first floating operation, uniformly distribute approximately 2/3 of the required weight of the hardener over the concrete surface by mechanical spreader and embedded by means of power floating. The hardener shall be floated in and the second application made. The surface shall be floated again to properly bond the hardener to the base concrete slab. The surface shall then be troweled at least twice to a smooth dense finish.

N. Finish of Top of Spread Footings and/or Mat Foundations:

1. Top Surface below Finished Slab: The top of the footing or mat shall be screeded level and smooth with a flatness F-number, F_F15 (overall), F_F10 (minimum local) and a levelness F-number, F_L12 (overall), F_L10 (minimum local).

2. Top Surface as Finished Slab: The top surface of a footing or mat that is to serve as the finished slab in the building shall be leveled cured, and surface prepared as specified for the finished floor construction appropriate to the space usage as defined in the Architectural Drawings.

3.8 CONCRETE FINISH MEASUREMENT AND TOLERANCES

A. Testing Procedure: ASTM E 1155

B. Tolerance on Floor Elevations: Construction tolerance on absolute floor elevation from the specified elevation as shown on the drawings shall be as specified below, taken from ACI 117:

1. Slab-on-Grade Construction - $\pm$ 3/4".

2. Top surfaces of formed slabs measured prior to removal of supporting shores - $\pm$ 3/4".

3. Top surfaces of all other slabs - $\pm$ 3/4".

C. Random Traffic Floor Finish Tolerances:

1. Specified overall values for flatness (SOF_F) and levelness (SOF_L) shall conform to the values listed below for the floor surface classification noted for each slab category noted.

Floor Surface Classification	SOF_F	SOF_L
Conventional	20	15
Moderately Flat	25	20
Flat	35	25
Very Flat	45	35
Super Flat	60	40

2. Minimum local values for flatness (MLF_F) and levelness (MLF_L) shall equal 3/5 of the SOF_F and SOF_L values, respectively, unless noted otherwise. The MLF_F and MLF_L values shall apply to the minimum areas bounded by the column lines and half-column lines, or the minimum areas bounded by the construction and contraction joints, whichever are the smaller areas.

3. The SOF_L and MFL_L tolerance values shall apply only to level slabs-on-ground or to level, uncambered suspended slabs that are shored such that it cannot deflect from the time the floor is placed to the time it is measured.

4. Slabs specified to slope shall have a tolerance from the specified slope of 3/8" in 10 feet at any point.

D. Construction Requirements to Achieve Specified Floor Finish Tolerances:

1. Forms shall be properly leveled, in good condition and securely anchored including special attention to ends and transitions.

2. Bearing surfaces for straightedges such as form edges or previously poured slabs shall be kept clean of laitance, sand, gravel, or other foreign elements.

3. Screeds shall be maintained in good condition with true round rolling wheels and level cutting edges. The use of optical sighting equipment such as lasers is recommended for checking levelness and straightness. The Contractor shall promptly adjust or replace equipment when test results indicate substandard work.

4. Highway straightedges are recommended for use in lieu of bull-floats for all slab placement and finishing operations.

E. Contractor Responsibility for Concrete Floor Finish Requirements: Floor finish requirements shown below (flatness and levelness tolerances) are minimum requirements that apply unless stricter requirements are contained in instructions for

installation of applied floor products in which case the Contractor is responsible for attaining the values prescribed by the manufacturer of such products.

F. Concrete Floor Finish Tolerance for Slab-on-Grade Construction:

1. Concrete Placement: Concrete shall be placed and screeded to predetermined marks set to elevations prescribed on the drawings.

2. Finish Tolerances of Random Traffic Floor Surfaces:

   a. Slabs in nonpublic areas, mechanical rooms, surfaces to received raised computer flooring, surfaces to have thick-set tile or a topping, and parking structures: Conventional
   b. Carpeted Areas: Moderately Flat
   c. Industrial Slabs: Moderately Flat
   d. Exposed slabs in public spaces, slabs to receive thin-set flooring: Flat
   e. Ice or Roller rinks: Very Flat
   f. Movie or Television studios: Super Flat
   g. Gymnasium Floors Scheduled to Receive Wood Playing Floor: Very Flat

G. Concrete Floor Finish Tolerance for Shored, Cast-in-Place Suspended Slab Construction:

1. Concrete Placement: Formwork shall be set and securely braced so that soffits are positioned to allow scheduled concrete member sizes and thicknesses within tolerances specified in ACI 117. Concrete shall be placed and screeded to predetermined marks on the form surface conforming to elevations prescribed on the drawings.

2. Camber: Formwork camber, as indicated on the drawings, shall be set to provide a uniform, smooth soffit profile in each direction. Minimum slab thickness, as specified on the drawings, shall be maintained throughout the slab surface to a tolerance as specified in ACI 117. Tolerance on camber shall be $\pm$ 1/4". Levelness F-Number tolerances specified below does not apply to areas of the floor where camber or intentional slope is shown.

3. Finish Tolerances of Random Traffic Floor Surfaces:

   a. Slabs in nonpublic areas, mechanical rooms, surfaces to received raised computer flooring, surfaces to have thick-set tile or a topping, and parking structures: Conventional
   b. Carpeted Areas: Moderately Flat
   c. Exposed slabs in public spaces, slabs to receive thin-set flooring: Flat
   d. Movie or Television studios: Super Flat

4. Extra Concrete: The contractor shall include in his bid any additional concrete required to achieve the specified slab surface finish tolerance.

5. Concrete Placement at Column Bays Supported by unshored transfer girders: Concrete in floor areas supported by unshored transfer girders shall be placed and screeded to predetermined marks placed over the slab conforming to elevations as specified on the drawings. At least the minimum slab thickness, as specified on the drawings, shall be maintained throughout the slab surface. The Contractor shall conform to the F_F values specified above.

H. Concrete Floor Finish Tolerance - Unshored Metal Deck on Shored or Unshored Steel Beam or Open-Web Joist Floor Construction:

1. Concrete Placement: Concrete over metal deck shall be placed and screeded level and flat to the tolerance specified below, maintaining at least the minimum slab thickness at all locations as specified on the drawings. The Contractor shall increase the slab thickness as required to compensate for metal deck deflection, and in unshored beam construction, residual beam camber and beam deflection in order to achieve a level and flat floor within specified tolerances.

2. Finish Tolerance of Random Traffic Floor Surfaces:

   a. Slabs in nonpublic areas, mechanical rooms, surfaces to received raised computer flooring, surfaces to have thick-set tile or a topping, and parking structures: Conventional
   b. Carpeted Areas: Moderately Flat
   c. Exposed slabs in public spaces, slabs to receive thin-set flooring: Flat
   d. Movie or Television studios: Super Flat
   e. Eighty percent (80%) of the final floor surface shall fall within an envelope of 0.75" centered about the mean elevation of all the readings. (± 0.375 about mean). The mean elevation of all readings shall not deviate from the specified design grade by more than ± 0.375".

3. Extra Concrete: The contractor shall include in his bid any additional concrete required to achieve the specified slab surface finish tolerance and to compensate for metal deck deflection, beam camber and beam deflection.

4. Concrete Placement at Column Bays Supported on Transfer Girders or Trusses: Concrete in floor areas supported by transfer girders or trusses shall be placed and screeded to predetermined marks placed over the metal deck slab conforming to elevations as specified on the drawings. At least the minimum slab thickness, as specified on the drawings, shall be maintained throughout the slab surface. The Contractor shall conform to the F_F values specified above.

I. Remedial Measures for Slab Finish Construction Not Meeting Specified Tolerances:

1. Application of Remedial Measures. Remedial measures specified herein are required whenever either or both of the following occur:

a. The composite overall values of F_F or F_L of the entire floor installation measure less than specified values.
b. Any individual test section measures less than the specified absolute minimum F_F or F_L value.

2. Modification of Existing Surface:

a. If, in the opinion of the Architect/Engineer or Owner's Representative, all or any portion of the substandard work can be repaired without sacrifice to the appearance or serviceability of the area, then the Contractor shall immediately undertake the approved repair method.
b. The Contractor shall submit for review and approval a detailed work plan of the proposed repair showing areas to be repaired, method of repair and time to affect the repair.
c. Repair method(s), at the sole discretion of the Architect/Engineer or Owner's Representative, may include grinding (floor stoning), planing, re-topping with self-leveling underlayment compound or repair topping, or any combination of the above.
d. The Architect/Engineer or Owner's Representative maintains the right to require a test repair section using the approved method of repair for review and approval to demonstrate a satisfactory end product. If, in the opinion of the Architect/Engineer or Owner's Representative, the repair is not satisfactory an alternate method of repair shall be submitted or the defective area shall be replaced.
e. The judgment of the Architect/Engineer or Owner's Representative on the appropriateness of a repair method and its ability to achieve the desired end product shall be final.
f. All repair work shall be performed at no additional cost to the Owner and with no extension to the construction schedule.

3. Removal and Replacement:

a. If, in the opinion of the Architect/Engineer or Owner's Representative, all or any portion of the substandard work cannot be satisfactorily repaired without sacrifice to the appearance or serviceability of the area, then the Contractor shall immediately commence to remove and replace the defective work.
b. Replacement section boundaries shall be made to coincide with the test section boundaries as previously defined.
c. Sections requiring replacement shall be removed by saw-cutting along the section boundary lines to provide a neat clean joint between new replacement floor and existing floor.
d. The new section shall be reinforced the same as the removed section and doweled into the existing floor as required by the Engineer. No existing

removed reinforcing steel may be used. All reinforcing steel shall be new steel.

e. Replacement sections may be retested for compliance at the discretion of the Architect/Engineer or Owner's Representative.

f. The judgment of the Architect/Engineer or Owner's Representative on the need for replacement shall be final.

g. All replacement work shall be performed at no additional cost to the Owner and with no extension to the construction schedule.

3.9 CONCRETE CURING AND PROTECTION

A. General:

1. Protect freshly placed concrete from premature drying and excessive cold or hot temperatures. Maintain concrete with minimal moisture loss at a relatively constant temperature for the period necessary for hydration of the cement and hardening of concrete. Limit moisture loss to a maximum of 0.05 lb. /sq. ft – hr for concrete containing silica fume and 0.2 lb. /sq. ft. - hr for all other concrete before and during finishing operations.. If using an evaporation retarder, apply in accordance with manufacturer's instructions after screeding and bull floating, but before power floating and troweling.

2. Curing shall commence as soon as free water has disappeared from the concrete surface after placing and finishing. The curing period shall be 7 days for all concrete except high early strength concrete which shall be cured for 3 days minimum.

   Alternatively, curing times may be reduced if either of the following provisions is complied with:

   a. If tests are made of cylinders kept adjacent to the structure and cured by the same methods, curing measures may be terminated when the average compressive strength has reached 70% of the specified 28 day compressive strength.

   b. If the temperature of the concrete is maintained at a minimum of 50°F for the same length of time required for laboratory cured cylinders of the same concrete to reach 85% of the 28 day compressive strength, then curing may be terminated thereafter.

3. Curing shall be in accordance with ACI 301 procedures. Avoid rapid drying at the end of the curing period.

B. Curing Formed Surfaces: Where wooden forms are used, cure formed concrete surfaces, including undersides of beams, supported slabs and other similar surfaces by moist curing with forms in place for full curing period or until forms are removed. When forms are

removed, continue curing by one or a combination of the methods specified below, as applicable.

1. Columns and shearwalls that are not exposed to view: Moist cure in forms or by one or a combination of methods 1, 2, or 3 specified below. Use a high –solids, liquid membrane-forming curing and sealing compound conforming to ASTM C 1315, type I, Class A or B for method 3.

2. Columns and shearwalls that are exposed to view: Moist cure in forms or by one or a combination of methods 1, 2 or 3 specified below. Use a high-solids, non-yellowing, liquid membrane-forming curing and sealing compound conforming to ASTM C 1315, type 1, class A for method 3.

3. Sides and Soffits of Beams and Pan-Joist Ribs, Soffits of Slabs: Moist cure in forms or by one or a combination of methods 1, 2 or 3 specified below. Use a liquid membrane-forming dissipating resin curing compound conforming to ASTM C 309, type 1, class A or B for method 3.

4. Basement Walls, Sides of Exterior Retaining Walls: Moist cure in forms or by one or a combination of methods 1, 2 or 3 specified below. Use a liquid membrane-forming dissipating resin curing compound conforming to ASTM C 309, type 1, class A or B for method 3.

C. Curing Unformed Surfaces: Cure unformed surfaces, such as slabs, floor topping and other flat surfaces by one or a combination of the methods specified below, as applicable. The Contractor shall choose a curing method that is compatible with the requirements for subsequent material usage on the concrete surface.

1. Ramps and Horizontal Surfaces of Parking Areas, Exposed Exterior Balconies: Cure using only methods 1 or 2 as specified below.

2. Floors Directly Exposed to Vehicular or Foot Traffic not in Parking Areas and not otherwise receiving a chemical hardener or penetrating sealer finish: Apply two coats of a high-solids, water-based, non-yellowing, liquid membrane-forming curing and sealing compound conforming to ASTM C 1315, type 1, Class A in accordance with method 3 as specified below.

3. Floors in Non-Public spaces that are left exposed to view and not receiving sealers or hardeners, floors involved in under-floor air distribution systems: Apply one coat of a high-solids, water-based, non-yellowing, liquid membrane-forming curing and sealing compound conforming to ASTM C 1315, type 1, Class A or B in accordance with method 3 as specified below.

4. Floors that are to receive subsequent cementitious toppings, sealers, hardeners, ceramic tile, acrylic terrazzo, vinyl composition tile, sheet vinyl, linoleum, vinyl-backed carpet, rubber, athletic flooring, synthetic turf, wood, epoxy overlay or

adhesive, or other coating or finishing products: Cure using methods 2 or 3 as specified below. Use a water-based dissipating resin type curing compound conforming to ASTM C 309, type 1, class A or B for method 3.

5. Industrial Slabs: Cure using methods 1 or 2 as specified below for 7 days. The temperature of applied water shall be with 10° F of concrete surface temperature.

6. All Other Surfaces: Cure using methods 1, 2 or 3 as specified below. Use a water-based dissipating resin type curing compound conforming to ASTM C 309, type 1, class A or B for method 3.

D. Curing Methods:

1. Method 1 - Moisture Curing: Provide moisture curing by one of the following methods:

   a. Keep concrete surface continuously wet by covering with water.
   b. Continuous water-fog spray.
   c. Covering concrete surface with specified absorptive cover, thoroughly saturating cover with water and keeping continuously wet. Place absorptive cover to provide coverage of concrete surfaces and edges, with 4" lap over adjacent absorptive covers.

2. Method 2 - Moisture-Retaining Cover Curing: Provide moisture-retaining cover curing as follows:

   Cover concrete surfaces with moisture-retaining cover for curing concrete, placed in widest practicable width with sides and ends lapped at least 3" and sealed by waterproof tape or adhesive. Immediately repair any holes or tears during curing period using cover material and waterproof tape. Water may be added to concrete surface to prevent drying before the cover is installed, but the surface shall not be flooded with water if a non-absorptive cover is used.

3. Method 3 – Curing or Curing and Sealing Compound: Provide curing, curing/hardener, liquid membrane-forming curing, or curing and sealing compound as follows:

   Apply specified compound to concrete slabs as soon as final finishing operations are complete (within 2 hours and after surface water sheen has disappeared). Apply uniformly in continuous operation by power-spray or roller in accordance with manufacturer's directions. Do not allow to puddle. Recoat areas subjected to heavy rainfall within 3 hours after initial application. Maintain continuity of coating and repair damage during curing period. Apply second coat for sealing 2 to 3 hours after the first coat was applied.

Do not use membrane-forming curing and sealing compounds on surfaces which are to be covered with coating material applied directly to concrete, liquid floor hardener, waterproofing, dampproofing, membrane roofing, flooring (such as ceramic or quarry tile, glued-down carpet, vinyl composition tile, linoleum, sheet vinyl, rubber, athletic flooring, synthetic turf, or wood), paint or other coatings and finish materials. Dissipating resin type cures are acceptable in these locations.

3.10 HOT WEATHER CONCRETING

A. Definition:

1. Conditions warranting hot weather concreting practices are defined as any combination of high air temperature, low relative humidity and wind velocity tending to impair the quality of fresh or hardened concrete or otherwise result in abnormal properties. If conditions cause an evaporation rate of 0.2 lb. /sq. ft. /hr. as calculated by Figure 2.1.5 in ACI 305R-99, then precautions shall be taken to prevent plastic shrinkage cracks from occurring.

B. Specification: Follow hot weather concreting practices specified below when required to limit the concrete temperature at the truck discharge point to the stated maximum acceptable temperature.

C. Records: Under hot weather conditions, the Contractor shall keep records of outside air temperature, concrete temperature at truck discharge and general weather conditions.

D. Hot Weather Concreting Requirements: The following items, all or in part as required, shall be followed to limit the concrete temperature to the stated maximum acceptable temperature and to minimize the possibility of plastic shrinkage cracks from developing.

1. Design the concrete mixes specifically for hot weather conditions replacing some cement with fly ash or other pozzolan and using a water reducing retarding admixture (ASTM C 494 Type D).

2. Use the largest size and amount of coarse aggregate compatible with the job.

3. Use sunshades and/or windbreaks.

4. Delay construction of indoor slabs-on-grade until the walls and roof are constructed.

5. Cool and shade aggregate stockpiles.

6. Use ice as part of the mixing water or cool the water with liquid nitrogen.

7. Limit the number of revolutions at mixing speed to 125 maximum.

8. Reduce time between mixing and placing as much as possible.

9. Do not add water to ready-mixed concrete at the job site unless it is part of the amount required initially for the specified water-cement ratio and the specified slump.

10. Schedule concrete placement for early morning, late afternoon, or night.

11. Have all forms, equipment and workers ready to receive and handle concrete.

12. Maintain one standby vibrator for every three vibrators used.

13. Keep all equipment and material cool by spraying with water including exteriors of forms, reinforcing steel, subgrade, chutes, conveyors, pump lines, tremies, and buggies.

14. Protect slab concrete at all stages against undue evaporation by applying a fog spray or mist above the surface or applying a monomolecular film. Where high temperatures and/or placing conditions dictate, use water-reducing retarding admixture (Type D) in lieu of the water-reducing admixture (Type A) as directed by the Owner's Testing Laboratory.

15. Provide continuous curing, preferably with water, during the first 24 hours using wet burlap, cotton mats, continuous spray mist, or by applying a curing compound meeting ASTM C 1315. Continue curing for 3 days minimum.

16. Cover reinforcing steel with water soaked burlap so that steel temperature will not exceed ambient air temperature immediately before placement of concrete.

17. As soon as possible, loosen forms and run water down the inside. When forms are removed, provide a wet cover to newly exposed surfaces.

3.11 COLD WEATHER CONCRETING

A. Definition:

1. Concrete shall not be placed when the outside air temperature is 40°F or less unless cold weather concreting practices are followed as specified below.

2. Cold weather concreting practices should also be followed whenever the average daily air temperature is expected to be less than 40°F for more than three successive days. The average daily air temperature is the average of the highest and lowest temperature occurring during the period from midnight to midnight. The requirement for adhering to these cold-weather concreting practices may be terminated when the air temperature is above 50^{o} F for more than half of any 24 hour duration.

3. Cold-weather concreting practices invoked shall keep the temperature of the concrete immediately after placing within the following temperature ranges:

   a. 55° to 75° F for sections less than 12 in. in the least dimension
   b. 50° to 70° F for sections 12 to 36 in. in the least dimension
   c. 45° to 65° F for sections 36 to 72 in. in the least dimension
   d. 40° to 60° F for sections greater than 72 in. in the least dimension

4. Concrete Protection: Protect the concrete immediately after placing and during the defined protection period such that the concrete does not freeze nor fall below the temperature levels stated in the above paragraph. For concrete not loaded during construction the protection period shall be for a minimum of three days if cold-weather conditions persist. The time period may be reduced to a minimum of two days if Type III cement or an accelerating admixture is used or if an additional 100 pounds of cement per cubic yard is added to the concrete mix. Concrete fully loaded during construction shall be protected during cold weather conditions for whatever time period is required to obtain the required strength as determined by nondestructive strength tests (Windsor probe, Swiss Hammer Test) on the in-place concrete. Protect concrete surfaces from freezing for the first 24 hours even if cold-weather conditions do not officially exist due to high volatility in ambient temperatures.

5. Protection Deficiency: If the temperature requirements during any portion of the protection period are not met but the concrete surface did not freeze, the protection period shall be extended until twice the deficiency expressed in degree-hours is made up. Deficiency degree-hours are defined as the average deficiency in temperature below the required value times the number of hours the deficiency persisted. Make-up degree hours are the average increase in temperature above the minimum value times the hours required to make up twice the deficiency degree-hours. Contact the Architect/Engineer if the concrete surface was allowed to freeze during the protection period.

6. Protection Removal: As the protection is being removed the decrease in temperature measured at the surface of the concrete in a 24 hour period shall not exceed the following:

   a. 50° F for sections less than 12 in. in the least dimension
   b. 40° F for sections 12 to 36 in. in the least dimension
   c. 30° F for sections 36 to 72 in. in the least dimension
   d. 20° F for sections greater than 72 in. in the least dimension

7. The maximum concrete temperature heated by artificial means at point of placement shall not exceed 90°F.

B. Records: Under cold weather conditions, the Contractor shall keep records of outside air temperature, concrete temperature as placed and general weather conditions. The temperature record shall be taken no less than 2 times per 24 hour duration.

C. Cold Weather Concreting Requirements: The following items, all or in part as required, should be followed to assure acceptable concrete in cold weather conditions:

1. Design the concrete mix to obtain high early strength by using higher cement content, a high early strength cement (Type III), or a specified non-chloride accelerator (ASTM C 494 Type C or E).

2. Protect the concrete during curing period using insulating blankets, insulated forms, enclosures and/or heaters.

3. Concrete cured in heated enclosures shall have heaters vented to prevent exposure of concrete and workmen to noxious gases.

4. Frozen subgrade shall be thawed prior to concrete placement and snow and ice shall be removed from forms.

5. Temperature of embedments in concrete must be heated to above 32° F prior to placing concrete

6. Heat the mixing water and then blend hot and cold water to obtain concrete no more than 10°F above the required temperature.

7. Heat the aggregates by circulating steam in pipes placed in the storage bins for air temperatures consistently below 32°F. When either water or aggregate is heated to over 140°F combine them in the mixer first to obtain a maximum temperature of the mixture not to exceed 140°F in order to prevent flash set of the concrete.

8. Uniformly thaw aggregates far in advance of batching to prevent moisture variations in the stockpile.

9. Cover warmed stockpiles with tarps to retain heat.

10. Place air entraining admixture in the batch after the water temperature has been reduced by mixing with cooler solid materials.

11. Use wind screens to protect concrete from rapid cooling.

12. Place vertical pump lines inside the building, if possible, for concrete being pumped.

13. Maintain artificial heat as low as possible to reduce temperature stresses during cooling.

14. Avoid water curing of concrete except for parking garage structures. Apply the required curing compound to unformed surfaces as soon as possible to prevent drying of concrete from heated enclosures.

15. Delay form stripping as long as possible to help prevent drying from heated enclosures and to reduce damage to formed surfaces caused by premature stripping.

16. Provide triple thickness of insulating materials at corners and edges vulnerable to freezing.

17. Wrap protruding reinforcing bars with insulation to avoid heat drain from the warm concrete.

18. Gradually reduce the heat at the end of the heating period to reduce likelihood of thermal shock.

3.12 MISCELLANEOUS CONCRETE ITEMS

A. Filling-In: Fill-in holes and openings left in concrete structures for passage of work by other trades, unless otherwise shown or directed, after work of other trades is in place. Mix, place and cure concrete as herein specified, to blend with in-place construction. Provide other miscellaneous concrete filling shown or required to complete work.

B. Curbs: Provide monolithic finish to interior curbs by stripping forms while concrete is still green and 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 rods for machines and equipment to template at correct elevations, complying with certified diagrams or templates of manufacturer furnishing machines and equipment.

D. Grout base plates and foundations as indicated, using specified non-shrink, non-metallic grout. Use high-flow grout where high fluidity and/or increased placing time are required. This grout shall be used for all base plates larger than 10 square feet.

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

F. Installation of adhesive anchors using injectable epoxy or adhesive: A representative of the adhesive manufacturer shall be present for the first day that adhesive anchors are installed. After drilling the hole to the diameter and depth recommended by the manufacturer, clean the hole with a wire or nylon brush. Blow the dust out of the hole using compressed air with a nozzle that reaches to the bottom of the hole. When using adhesive from a new pack, the adhesive that is discharged from the mixing nozzle should

be a uniform gray color before any adhesive is installed in the hole. Fill the hole with adhesive starting from the very bottom of the hole until the hole is about 2/3 full. Do not leave an air pocket at the bottom of the hole. Insert the anchor rod or dowel by slowly twisting it into the hole.

3.13 CONCRETE SURFACE REPAIRS

A. Definition - Defective Areas:

1. Formed Surfaces: Concrete surfaces requiring repairs shall include all cracks in excess of 0.01" and any other defects that affect the durability or structural integrity of the concrete. Voids, including honeycombing and rock pockets, and tie holes shall be repaired as required by the specified Surface Finish.

2. Unformed Surfaces: Concrete surfaces requiring repair shall include all surface defects such as crazing, cracks in excess of 0.01" wide or cracks which penetrate to reinforcement or through the member, pop-outs, spalling and honeycombs.

B. Classification:

1. Structural Concrete Repair: Major defective areas in concrete members that are load carrying (such as shear walls, beams, joists and slabs), are highly stressed, and are vital to the structural integrity of the structure shall require structural repairs. Structural concrete repairs shall be made using a two-part epoxy bonder, epoxy mortar or specified polymer repair mortar. The Engineer shall determine the locations of required structural concrete repairs.

2. Cosmetic Concrete Repair: Defective areas in concrete members that are non-load carrying and minor defective areas in load carrying concrete members shall require cosmetic concrete repair when exposed to view and not covered up by architectural finishes. Cosmetic concrete repairs may be made using a polymer repair mortar and compatible bonding agent. The Architect/Engineer shall determine the locations of required cosmetic concrete repairs. Stains and other discolorations that cannot be removed by cleaning and are exposed to view will require cosmetic repair. Cosmetic concrete repair in exposed-to-view surfaces will require Architect's approval prior to patching operation.

3. Slab Repairs: High and low areas in concrete slabs shall be repaired by removing and replacing defective slab areas unless an alternate method, such as grinding and/or filling with self-leveling underlayment compound or repair mortar is approved by the Architect/Engineer. Repair of slab spalls and other surface defects shall be made using epoxy products as specified above and as determined by the Engineer. The high strength flowing repair mortar may be used for areas greater than 1 inch in depth.

3.14 QUALITY ASSURANCE TESTING AND INSPECTION DURING CONSTRUCTION

A. See Testing Laboratory Services section of these Specifications for concrete materials and cast-in-place concrete inspection and test requirements.

END OF SECTION 03 3000

Date: _____

Concrete Mix Design
Submittal Form (Note 1)

I. Project Information
A. Name of Project: _____ B. City, State: _____
C. General Contractor: _____
D. Concrete Supplier: _____
1. Address: _____
2. Name to Contact: _____ 3. Phone No.: _____ 4. Fax No.: _____

II. Concrete Mix Information
A. Concrete Mix Design Designation (Note 2): _____
B. Minimum Concrete Strength f'c: _____ psi at _____ days and C. Maximum w/c Ratio:_____
D. Concrete Type (check one) _____NW _____LW E. Required Wet Weight: _____pcf
F. Concrete Use (member type as specified in General Notes): _____
G. Required Air Content: _____%
H. Method of Concrete Placement for this Mix:
(check one) ____ Bucket ____ Pump ____ Chute ____ Tremie ____ Other (Specify) _____

III. Method of Concrete Mix Design Preparation: (Check One Method Below) (Note 3)
A. _____ Field Experience Method B. _____ Trial Mixture Method

IV. Concrete Production Facility Information
A. Production facility has field strength test records of specified class or within 1 ksi of class: ____ Yes ____ No
Answer B thru C only if answer to IV.A. is "yes". If answer to IV.A. is "no", go to V.B.:
B. Test Record Information: (Check either 1, 2, or 3 below)
1. _____ ≥ 30 consecutive tests 2. _____ Two groups of ≥ 30 tests 3. _____ 15 to 29 tests
C. Standard Deviation S(PSI):
1. Modification Factor (if B.3. checked only. Ref. Table 5.3.1.2 of ACI 318-02.) MF = _____
2. Standard Deviation S = _____ psi 3. MF x S (if B.3. checked only) = _____ psi

Note: Combined aggregate gradation for slabs and other designated concrete shall be 8% -18% for large top size aggregates (1 ½ in.) or 8%-22% for smaller top size aggregates (1 in. of ¾ in.) retained on each sieve below the top size and above the No. 100 sieve.

V. Required Average Compressive Strength f'cr (psi)
A. Calculation of f'cr from S (fill out only if IV.A. is "yes) (larger of 1 or 2 below controls)
1. f'cr = f'c + 1.34 x S = _____ psi 2. f'cr = f'c + 2.33 x S - 500 = _____ psi
B. Calculation of f'cr from ACI 318-02 Table 5.3.2.2: (fill out if IV.A. is "No")
1. f'cr = f'c + _____ psi = _____ psi

VI. Concrete Mix Design by Field Experience Method: (fill out below only if III.A. is checked)
Note: This method requires one or more mix designs with a 45 day minimum field record of at least ten consecutive test results using similar materials and conditions as the proposed mix design.
A. Available field record is based on how many mix designs? _____ (specify number)
B. Average strength of field record is _____ psi (must be ≥ f'cr in V.)

VII. Concrete Mix Design by Trial Mixture Method: (fill out below only if III.B. is checked)
Note: This method requires using at least three different trial mixes with varying W/C ratios or cement contents with a plot of average strength vs. W/C ratio or cement content. Submit scale graph of results.
A. Trial Mixes: (Note: All other ingredients as specified in VIII. below)

	Mix 1	Mix 2	Mix 3	Selected (interpolated) values
Cements (lbs.)	_____	_____	_____	_____
W/C Ratio	_____	_____	_____	_____
Compressive Strength (psi) at Specified Days	_____	_____	_____	_____

VIII. Proposed Mix Design

A. Sources of Materials:

1. Cement: Type: ____ Manufacturer _____Lo-Alkali? Y N Sp. Gr._____
2. Fly Ash: Type: ____ Manufacturer _____ Sp. Gr._____
3. Silica Fume: Manufacturer: _____ Type (check one): ___ Slurry ___ Powder
   Slurry: Specific Gravity _____ Water Content by Wt. _____% Silica by Wt. _____%
   Powder: Specific Gravity _____ Silica by Wt. _____%
4. Coarse Aggregate: Size: _____ Type: _____ Source: _____ Ovendry Sp. Gr. _____
   (Note 4) Ovendry Rodded Density: _____ PCF Absorption: _____% (moist. content at SSD cond.)
5. Lightweight Agg.:_____ Size: _____ Type: _____ Source: _____ Ovendry Sp. Gr.

   (Note 4) Ovendry Rodded Density: _____ PCF Absorption: ____% (moist. content at SSD cond.)
6. Fine Aggregate: Type: _____ Source: _____ Fineness Modulus: _____
   (Note 4) Ovendry Sp. Gr. _____ Absorption (moisture content at SSD condition): ____%
7. Air Entraining Agent (AEA): Manufacturer and Name: _____ ASTM No. _____

Note: Specify below all types and combinations of admixtures anticipated to be used for all anticipated weather conditions. Explain in (12) below.

8. Water Reducers (WR):
   a. (Plain) Manufacturer and Name: _____ ASTM No. _____
   b. (w/Accelerator) Manufacturer and Name: _____ ASTM No. _____
   c. (w/Retarder) Manufacturer and Name: _____ ASTM No. _____
9. Accelerators: Manufacturer and Name: _____ ASTM No. _____
10. Retarders: Manufacturer and Name: _____ ASTM No. _____
11. High Range Water Reducer (HRWR) (superplasticizers):
    a. (Plain) Manufacturer and Name: _____ ASTM No. _____
    b. (w/Retarder) Manufacturer and Name: _____ ASTM No. _____
12. Comments: _____

B. Mix Proportions: (Per Cubic Yard)

Item	Wt. (lbs.)	Absolute Vol. (Cu. Ft.)
1. Cement	_____	_____
2. Fly Ash	_____	_____
3. Silica Fume	_____	_____
4. Coarse Agg. (SSD Wt.)	_____	_____
5. Lightweight Agg. (SSD Wt.)	_____	_____
6. Fine Agg. (SSD Wt.)	_____	_____
7. AEA	_____ oz/100# cement	Added at: ___ Batch Plant ___ Site
8. a. WR (Plain)	_____ oz/100# cement	Added at: ___ Batch Plant ___ Site
b. WR (W/Acc.)	_____ oz/100# cement	Added at: ___ Batch Plant ___ Site
c. WR (W/Ret.)	_____ oz/100# cement	Added at: ___ Batch Plant ___ Site
9. Accelerator:	_____ oz/100# cement	Added at: ___ Batch Plant ___ Site
10. Retarder:	_____ oz/100# cement	Added at: ___ Batch Plant ___ Site
11. a. HRWR (Plain)	_____ oz/100# cement	Added at: ___ Batch Plant ___ Site
b. HRWR (w/Ret.)	_____ oz/100# cement	Added at: ___ Batch Plant ___ Site
12. Other: _____ (Specify Units)		
13. Water (including free water on aggregates)	_____ (lbs.)	_____ (cu. ft.) _____ (gal.)

C. Mix Design Characteristics: (Pozzolan = flyash and/or silica fume)

1. Water (including free water on aggregates)/(Cement + pozzolan): $W/C = \frac{(lbs.)}{(lbs.)} = $ _____
   (Not applicable for LW concrete)
2. Fine Aggregate/Total Aggregate = $\frac{(lbs.)}{(lbs.)} = $ _____ 3. Pozzolan/Pozzolan+Cement) = $\frac{(lbs.)}{(lbs.)} = $ _____
4. Concrete Density: a. Unit Wet Weight: _____ pcf b. Unit Dry Weight: _____ pcf
5. Air Content: _____%
6. Slump or Slump Flow a. Initial Slump (before adding WR or HRWR) _____ in.
   b. Final Slump or Flow (after adding WR or HRWR or SCC) _____ in.

D. Chloride Ion Content: The Concrete Supplier certifies that total chloride ion content of the concrete mix, as tested by ASTM C 1218 does not exceed the amounts specified in Table 4.4.1 of ACI 318.

E. Alkali Content: The Concrete Supplier certifies, if required by specification Section 03 3000, that the total alkali content contributed from cementitious materials does not exceed 4.0 lbs./cu. yd. of concrete or certifies that the aggregate contains no deleterious material that react with alkalis in the concrete mix.

F. Mix Water Purity: The Concrete Supplier certifies that the appropriate specified chemical concentration limits are not exceeded in the total volume of mix water.

Notes:

1. This form is required to be submitted to Engineer and Owner's Testing Laboratory for all concrete mixes on the job. When any mix ingredient changes during the course of the job, this submittal form shall be resubmitted for approval. All information must be filled in for approval of mix design. Submit all backup data for calculations.
2. The mix designation should be that used by the Contractor to order the concrete from the Supplier and as noted on the batch ticket.
3. Refer to ACI 318 for requirements of each concrete mix design preparation method.
4. Submit sieve analysis of fine and course aggregates. Include chart indicating combined aggregate retained on each sieve size.

X. Certification by Concrete Supplier

Signature: _____ Representing: _____ Date: _____