SECTION 03300 - CAST-IN-PLACE CONCRETE

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specification sections, apply to work of this section.

1.2 STANDARDS

The following Standards are listed in this specification:

ASTM A36	Specification for Carbon Structural Steel
ASTM A153	Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware
ASTM A185	Specification for Welded Steel Wire Fabric for Concrete Reinforcement
ASTM A193-B7	Specification for Alloy-Steel and Stainless Steel Bolting Materials for High Temperature Services
ASTM A307	Specification for Carbon Steel Bolts and Studs, 60000 psi Tensile Strength
ASTM A496	Specification for Deformed Steel Wire for Concrete Reinforcement
ASTM A576	Standard Specification for Steel Bars, Carbon, Hot-Wrought, Special Quality
ASTM A615	Standard Specification for Deformed and Plain Billet-Steel Bars for Concrete Reinforcement
ASTM A706	Specification for Low-Alloy Steel Deformed Bars for Concrete Reinforcement.
ASTM C33	Standard Specification for Concrete Aggregates
ASTM C39	Test Method for Compressive Strength of Cylindrical Concrete Specimens
ASTM C94	Specification for Ready Mixed Concrete
ASTM C150	Specification for Portland Cement
ASTM C171	Standard Specification for Sheet Materials for Curing Concrete
ASTM C192	Practice for Making and Curing Concrete Test Specimens in the Laboratory
ASTM C260	Specification for Air-Entraining Admixtures for Concrete
ASTM C309	Specification for Liquid Membrane-Forming Compounds for Curing Concrete
ASTM C330	Standard Specification for Lightweight Aggregates for Structural Concrete
ASTM C418	Test Method for Abrasion Resistance of Concrete by Sandblasting
ASTM C494	Standard Specification for Chemical Admixtures for Concrete
ASTM C618	Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use as a Mineral Admixture in Concrete”
ASTM C881	Specification for Epoxy-Resin-Base Bonding Systems for Concrete

ASTM C1116	Standard Specification for Fiber-Reinforced Concrete and Shotcrete
ASTM C1157	Standard Performance Specification for Hydraulic Cement
ASTM C1218	Test Method for Water-Soluble Chloride in Mortar and Concrete
ASTM C1315	Specification for Liquid Membrane-Forming Compounds Having Special Properties for Coring and Sealing Concrete
ASTM D2240	Test Method for Rubber Property – Durometer Hardness
ASTM D4397	Standard Specification for Polyethylene Sheeting for Construction, Industrial, and Agricultural Applications
ASTM E154	Test Methods for Water Vapor Retarders Used in Contact with Earth Under Concrete Slabs, on Wall, or as Ground Cover
ASTM E1155	Standard Test Method for Determining Floor Flatness and Levelness Using the F-Number System
ASTM E1745	Standard Specification for Plastic Water Vapor Retarders Used in Contact with Soil or Granular Fill under Concrete Slabs

1.3 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 concrete to be poured. Furnish all labor, materials, services, equipment and hardware required in conjunction with or related to the forming, delivery and pouring of all poured-in-place concrete work.

B. Concrete paving and walks are specified in Division 2.

1.4 QUALIFICATIONS

A. The concrete supplier shall have a minimum of two years experience in manufacturing ready-mixed concrete products complying with ASTM C94 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 two years 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.

1.5 QUALITY ASSURANCE

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

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

B. Document Conflict and Precedence: In case of conflict among documents, including architectural and structural drawings and specifications, notify the Architect/Engineer prior to submitting proposal. In case of conflict between and/or among the structural drawings and specifications, the strictest interpretation shall govern, unless specified otherwise in writing by the Architect/Engineer.

C. Inspection and Testing of the Work: Materials and installed work may require testing and retesting, as directed by the Architect/Engineer, at any time during progress of work. Allow free access to material stockpiles and facilities. 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 Testing Laboratory section of the Specifications.

Inspection or testing by the Owner does not relieve the Contractor of his responsibility to perform the Work in accordance with the Contract Documents.

D. Acceptance Criteria for Concrete Strength: The strength level of an individual class of concrete shall be considered satisfactory if both 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 500 psi.

A strength test shall be defined as the average strength of two cylinder breaks tested at the strength age indicated on the drawings for that class of concrete.

E. 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 structural or architectural 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.

F. Responsibility for Design of Formwork: The General Contractor is responsible for the design, construction, and safety of all formwork. The General Contractor shall employ a professional engineer who is licensed in the state where the project is located and is experienced in the design of formwork to design all formwork and formwork removal. Forms shall be designed to withstand all loads imposed while in place including wet weight of concrete, construction equipment, live loads, and lateral loads due to wind and wet concrete imbalance. The General Contractor is responsible for determining when forms and other temporary supports may be removed.

G. Survey for Anchor Rods: The Contractor shall use a qualified, licensed professional engineer/land surveyor to lay out the proper location of all embedded anchor rods for columns above before they are encased in concrete. The surveyed locations of such elements shall be submitted to the Architect/Engineer for record.

1.6 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, Owner's Testing Laboratory, Concrete Supplier, 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 the concrete design mix
   Laboratory responsible for field quality control
   Concrete Subcontractor
   Ready-Mix Concrete Producer
   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
   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.

1.7 SUBMITTALS

A. Shop Drawings: Submit shop drawings for all reinforcing steel and related accessories for the Engineer's approval. Shop drawings shall show arrangement and layout, bending and assembly diagrams, bar schedules, stirrup spacing, splicing and laps of bars and shall be prepared in accordance with CRSI Standards. Submit details for steel templates that are to be used when placing dowels for columns, plinths, or pilasters out of foundation elements or for placing anchor bolts for structural steel members.

B. 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, curing compounds, dry-shake finish materials, hardeners, sealers and others as requested by Architect/Engineer.

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

D. Mix Designs: Submit mix designs and the Concrete Mix Design Submittal Form located at the back of this specification section for each class of concrete that is to be provided for the project as specified herein. Submit the qualifying test data that supports each mix design as required herein.

E. Material and Mill Certificates: Provide material and mill certificates as specified herein and in the Testing Laboratory section of the Specifications. 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.

F. Design Calculations: Submit for record calculations of all concrete formwork and the shoring plan sealed by a registered engineer in the state where the project is located.

G. Formwork Drawings: Formwork Drawings, prepared under the supervision and sealed by a registered professional engineer in the state where the project is located, shall be submitted for Owners record and shall be reviewed by the Engineer for conformance to structural layout only. Such shop drawings shall indicate types of materials, sizes, lengths, connection details, design allowance for construction loads, anchors, form ties, braces, construction joints, reveals, camber, openings, formwork coatings and all other pertinent information.

H. International Conference of Building Official (ICBO) Technical Reports: Submit technical reports of approval from ICBO for mechanical splice and dowel bar substitute systems.

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

J. Minutes of preconstruction conference.

K. Surveys: Submit reports certifying that all anchor rods for columns above are in their proper location prior to placing of concrete.

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 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.

PART 2 - PRODUCTS

2.1 CONCRETE MATERIALS

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

A. Portland Cement: ASTM C 150, Type I or Type III, or ASTM C 1157, Type GU or HE unless otherwise approved by the Architect/Engineer. For concrete exposed to salt air or salt water, provide Type II or Type V cement.

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.

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

C. Normal Weight Aggregates: ASTM C33 and as herein specified.

D. Water: Clean, fresh, drinkable, free of oils, acids or organic matter harmful to concrete.

E. Air-Entraining Admixture: ASTM C260. Provide air entrainment as specified in Table 4.2.1.of ACI 318-99 in all concrete exposed to freezing and thawing. Interior steel troweled surfaces subjected to vehicular traffic shall not have more than 3% entrained air. Surfaces scheduled to receive hardeners shall not have more than 3% entrained air.

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

"Darex-AEA" or "Daravair"; W. R. Grace & Co.
"MBAE90" or "Micro-Air"; Master Builders
"Sika AER"; Sika Corporation
"Air Mix" or "AEA-92"; The Euclid Chemical Company, Inc.
“Boral Air 30” or “Boral Air 40”, Boral Material Technologies, Inc.

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

F. Water-Reducing Admixture: ASTM C494, 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 322N" or "Polyheed 997"; Master Builders
"Plastocrete 161"; Sika Chemical Corp.
"Eucon WR-75 or WR-91"; The Euclid Chemical Company, Inc.
"WRDA with Hycol"; W.R. Grace & Co.
“Boral NW” or “Boral LW”, Boral Material Technologies, Inc.

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

G. Mid-Range Water-Reducing Admixture: ASTM C494, 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 997”, Master Builders
“Eucon MR”, The Euclid Chemical Company, Inc.
“Sikament HP”, Sika Chemical Corp.
“Mira 70”, W.R. Grace & Co.
“Boral X15” or “Boral X20”, Boral Material Technologies, Inc.

H. High-Range Water-Reducing Admixture (Super Plasticizer): ASTM C494, 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"; W.R. Grace & Co.
"Rheobuild 1000" or "Rheobuild 3000FC"; Master Builders
"Sikament"; Sika Chemical Corp.
"Eucon 37 or Eucon 537"; The Euclid Chemical Company, Inc.
“Boral SP” or “Boral RD”, Boral Material Technologies, Inc.

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

I. Water-Reducing, Accelerator Admixture (Non-Corrosive, Non-Chloride): ASTM C494, 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"; W.R. Grace & Co.
"Pozzutec 20"; Master Builders
"Accelguard 80"; The Euclid Chemical Company, Inc.
“Plastocrete 161FL”, Sika Chemical Co.
“Boral AcN”, Boral Material Technologies, Inc.

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

J. 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-17"; W.R. Grace & Co.
"Pozzolith 100XR" or "Pozzolith 300R; Master Builders
"Plastiment"; Sika Chemical Co.
"Eucon Retarder 75"; The Euclid Chemical Company, Inc.
“Boral R-Series”, Boral Material Technologies, Inc.

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

K. Corrosion Inhibitor: 30% calcium nitrite

Products: Subject to compliance with requirements, provide the following at 8 gal/cy:

"Eucon CIA", The Euclid Chemical Co.
"DCI", W.R. Grace & Co.
"Rheocrete 222+" or "Rheocrete CNI", Master Builders
“Armatec 2000”, Sika Chemical Co.
“Boral BCN”, Boral Material Technologies, Inc.

L. Corrosion Inhibitor: Amine-Ester type

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

"Rheocrete 222+", Master Builders

M. Calcium Chloride and Chloride Ion Content:

1. Calcium chloride or admixtures containing more than 0.5% chloride ions by weight of the admixture are not permitted.
2. The maximum water-soluble chloride ion concentration in hardened concrete 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 318-99 Table 4.4.1. Water-soluble chloride ion tests shall conform to ASTM C1218.

   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 will not exceed limits stated above.

N. 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 REINFORCEMENT MATERIALS

A. Reinforcement:

1. Reinforcing Steel: All reinforcing steel shall conform to ASTM A615 Grade 60 unless noted otherwise on the drawings..
2. Weldable Reinforcing Steel: All reinforcing steel required to be welded shall conform to ASTM A 706.
3. Deformed Bar Anchors: Deformed Bar Anchors shall conform to ASTM A 496 with a minimum yield strength of 75,000 PSI. Standard ASTM A 615 Grade 60 or Grade 40 reinforcing bars may not be substituted for deformed bar anchors.
4. Plain Steel Welded Wire Fabric: Welded plain-steel wire fabric shall conform to ASTM A 185 with a yield strength of 65,000 PSI. Provide in flat sheets only.
5. Joint Dowel Bars: Smooth bars used to dowel across slab-on-grade construction joints shall conform to ASTM A615, Grade 40 or A36, plain-steel bars. Cut bars true to length with ends square and free of burrs.
6. Dowel Bar Sleeves: Plastic or gage metal (26 ga. min.) sleeves with an inside diameter of 1/16 inch greater than the dowel bar that it encases, that have the strength, durability, and design to provide free movement of the dowel relative to the concrete slab and that are specifically manufactured for this purpose.
7. Tie Wire: Tie wire shall be annealed steel tie wire, minimum 16 gauge. Provide only plastic coated or stainless steel tie wire in exposed concrete structures and all architectural concrete.

B. Supports for Reinforcement: Provide supports for reinforcement including bolsters, chairs, spacers and other devices for spacing, supporting and fastening reinforcing

bars and welded wire fabric in place. Use wire bar type or all plastic supports complying with CRSI recommendations.

1. Slabs-on-Grade: Use supports with sand plates or horizontal runners designed for use on ground.

2.3 SPLICES

A. Tension Splices: Concrete members with mechanical anchorage splices developing 125% of the yield strength in tension shall have vertical bars with shear cut, flame cut, or saw cut ends. The following are acceptable mechanical anchorage splices:

"Cadweld-Series C", Erico Products, Inc.
"Lenton Coupler", Erico Products, Inc.
"NMB Splice Sleeve", Splice Sleeve North America"
“Bar-Grip” and “ZAP Screwlok”, BarSplice Products, Inc.
“BarLock, S-Series and L-Series”, MBT Coupler System, Inc.
“Coupler Splice System”, Dayton/Richmond, Inc.
“US/MC-SAE Mechanical Coupler”, Dayton/Richmond, Inc.
"Dywidag Threadbar Coupler" Dywidag Systems International, USA, Inc. or other Engineer-approved product.

All splices shall be approved by the International Conference of Building Officials (ICBO) and shall have the ICBO Technical Report submitted for Engineer review.

B. Splice Type and Lap Lengths: Required splice type and lap lengths are defined on the drawings. Lap splice lengths for unscheduled bars not shown otherwise on the drawings shall be 48 bar diameters minimum.

C. Dowel Bar Replacement: All reinforcing steel bars shown on the drawings crossing concrete construction joint surfaces with inserts cast flush against the form and having dowels connected to the insert in a subsequent concrete pour shall conform to the following:

1. Splice connection at insert shall develop the full tensile capacity of the reinforcing steel.
2. The following are acceptable products:

"Lenton Form Saver", tapered thread dowel and insert, Erico Products, Inc.
"Dowel Bar Splicer", dowel bar substitution and rebar splice system (DB-SAE Splicer), Dayton/Richmond, Inc.
“B.P.I. Barsplicer System”, BarSplice Products, Inc. or other Engineer-approved product.

All splices shall be approved by the International Conference of Building Officials (ICBO) and shall have the ICBO Technical Report submitted for Engineer review.

D. Hooked Anchorage Replacement: Reinforcing bar terminations shall be manufactured out of ASTM A576 material and shall develop the full yield strength of the bar when installed at the manufacturer's recommended depth. The bar shall be connected to the terminating device in such a way as to develop 125% of the yield strength of the bar. The following are acceptable products:

"Lenton Terminator", Erico Products, Inc.
"Grip-Twist Rebar Terminations", BarSplice Products, Inc. or other Engineer-approved product.

All splices shall be approved by the International Conference of Building Officials (ICBO) and shall have the ICBO Technical Report submitted for Engineer review.

2.4 FORMWORK MATERIAL

A. Forms For Exposed Finish Concrete: Unless otherwise specified, formwork for exposed concrete surfaces shall consist of plywood, metal, metal-framed plywood, or other acceptable surface. Formwork shall provide a continuous straight and smooth surface conforming to the joint system as specified on the Architect's drawings. Form material shall have sufficient thickness to withstand pressure of concrete without bow or deflection. Plywood shall be exterior grade overlaid plywood complying with U.S. Product Standard PS-1 and as follows:

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

B. Forms for Unexposed Finish Concrete: Unless otherwise specified, formwork for unexposed concrete surfaces shall be constructed with plywood, lumber, metal or other acceptable material. Lumber shall be dressed on at least two edges and one side for tight fit.

C. Nails and Fasteners: Use only galvanized nails and fasteners for securing formwork in structures exposed to weather or unconditioned spaces such as garages, canopies and porte-cocheres.

D. Form Ties: Factory-fabricated, removable or snap-off metal or glass-fiber-reinforced plastic form ties designed to resist lateral pressure of fresh concrete on forms and to prevent spalling of concrete on removal. Refer to Architectural drawings for tie hole requirements.

1. Exposed Surfaces: Furnish units that will leave no corrodible metal closer than 1 inch to the plane of the exposed concrete surface. Furnish ties that, when removed, will leave holes not larger than 1 inch in diameter in concrete surface.
2. Damproofed Surfaces: Furnish ties with integral water-barrier plates to walls indicated to receive dampproofing or waterproofing.

3. Exposed to Weather or Unconditioned Space: Provide galvanized form ties in surfaces that will be exposed to weather or in an unconditioned space in the final structure.

E. Chamfer Strips: Provide wood, metal, PVC, or rubber strips, ¾ by ¾ inch, minimum.

2.5 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 centerbulb type.

1. Rubber waterstops: Corps of Engineers CRD-C 513.

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

Greenstreak
Progress Unlimited, Inc.
Westec Barrier Technologies; Div. of Western Textile Products, Inc.
Williams Products, Inc.

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

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

BoMetals, Inc.
Greenstreak
W. R. Meadows
Progress Unlimited, Inc.
Vinylex Corp.
Paul Murphy Plastics, Co.
Sternson Group
Tamms Industries Co.; Div. Of LaPorte Construction Chemicals of North America, Inc.
Westec Barrier Technologies; Div. Of Western Textile Products, Inc.

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. Moisture Retarder: Provide moisture retarder cover chosen from products specified below over prepared base material where indicated.

1. Plastic Moisture Retarder: Provide a flexible, preformed sheet membrane having a water-vapor permeance rate no greater than 0.04 perms when tested in accordance with ASTM E 154, section 7 and otherwise conforming to ASTM E 1745.

    a. Provide a Class C material and wherein the moisture barrier component is not less than 10 mils thick when the concrete is to be placed by pump or conveyor. Acceptable products include the following:

        "Stego Wrap Vapor Barrier (10 mil)", Stego Industries, LLC
        "Griffolyn T-85", Reef Industries
        "Rufco D16WB", Raven Industries

    b. Provide a Class B material and wherein the moisture barrier component is not less than 15 mils thick when the concrete is to be placed by truck or buggy. Acceptable products include the following:

        "Stego Wrap Vapor Barrier (15 mil)", Stego Industries, LLC

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.

E. Non-slip Aggregate Finish: Provide fused aluminum oxide granules, or crushed emery, as abrasive aggregate for non-slip finish with emery aggregate containing not less than 50% aluminum oxide and not less than 25% ferric oxide. 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 Non-Slip", Dayton-Superior

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, interground with cement. Color, as selected by Architect, unless otherwise indicated.

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

"Surflex"; Euclid Chemical Co.
"Quartz Plate"; L & M Const. Chemical Co.
"Mastercron"; Chem-Rex, Inc., MBT Protection and Repair Division
"Harcol", Sonneborn-Chem-Rex
"Quartz-Tuff", Dayton Superior

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

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

1. High Solids, Water-Based, Non-Yellowing Curing and Sealing Compound: Water based membrane-forming curing and sealing compound, acrylic type, complying with ASTM C1315, Type 1, Class A classified as low odor. Do not apply to surfaces that are to receive subsequent cementitious toppings, sealers, hardeners, ceramic tile or terrazzo or other coating or finishing products.

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

"Super Diamond Clear Vox", Euclid Chemical Company
"Lumiseal 30 WB", L&M Construction Chemicals
"Kure 1315", Sonneborn-ChemRex

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

H. 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"; Euclid Chemical Company
"E-Con"; L & M Construction Chemical, Inc.
"Confilm"; ChemRex, Inc., MBT Protection and Repair Division
"Sure Film (J-74)", Dayton Superior
"SikaFilm", Sika Chemical Co.

Submit manufacturer's certification that product conforms to the requirements specified and is compatible with all coverings and surface treatments to be applied.

I. 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"; Euclid Chemical Co.
   "Daraweld C"; W. R. Grace.
   "Acrylic Additive," Sonneborn Chem-Rex, Inc.
   "SikaLatex", Sika Chemical Co.

2. Polyvinyl Acetate (Interior Use Only)

   "Euco Weld"; Euclid Chemical Co.
   "Everweld"; L & M Construction Chemicals, Inc.
   "Superior Concrete Bonder (J-41)," Dayton Superior

J. Epoxy Products: Two component material suitable for use on dry or damp surface, complying with ASTM C 881, for use in all structural concrete repairs.

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," Euclid Chemical Company
   "Sure-Inject (J-56)," Dayton Superior
   “Epofil SLV”, Sonneborn-ChemRex

2. Products for Epoxy Mortar Patches:

   "Sikadur Lo-Mod LV"; Sika Chemical Corporation.
   "Euco 452 LV," Euclid Chemical Company
   "Sure Grip Epoxy Grout (J-54)," Dayton-Superior
   “Epofil”, Sonneborn-ChemRex

3. Allowable working loads for the single installations under static loading should not exceed 25% capacity or the allowable load of the anchor rod.
4. Ultimate load values in 2000, 4000, and 6000 psi stone aggregate concrete. Ultimate loads are indicated for the embedment shown in the Embedment in Concrete column. Performance values are based on the use of high strength threaded rod (ASTM A193 Gr. 87). The use of lower strength rods will result in lower ultimate tension and shear loads.**

5. Products for Epoxying Bolts or Reinforcing Steel into Concrete: Conform to ASTM C881-90, Type IV, Grade 3,Class A, B, & C except gel times.

   "Sikadur 31 Hi-Mod Gel"; Sika Corporation

"Euclid 452 Gel“,Euclid Chemical Company
"Sure Anchor I (J-S1)”, Dayton Superior
"Epo Gel" or "Rapid Gel”, Soneborn Chem-Rex
“HSE 2421 System”, Hilti Fastening Systems
“Epcon C6 System”, ITW Ramset/Red Head
"Power-Fast Injection Gel", Powers Rawl

6. Products for Epoxying Steel Plates to Concrete: Conform to ASTM C881-90, Type IV, Grade 3, Class A, B, & C except gel times.

"Sikadur 31 Hi-Mod Gel"; Sika Corporation
"Euclid 452 Gel," Euclid Chemical Company
"Sure Anchor I (J-S1)," Dayton Superior
"Epo Gel" or "Rapid Gel," Soneborn Chem-Rex

Substitutions may be considered provided complete technical information and job references are furnished to the Engineer for approval prior to commencement of work.

K. Self-Leveling Mortars, Underlayment Compound: Freeflowing, self-leveling, pumpable cementitious base compound.

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

"Sonoflow," Sonneborn Chem-Rex, Inc.
"Sikatop 111"; Sika Chemical Co.
"Flo-Top" or "Flo-Top 90"; Euclid Chemical Co.
"Levelayer I," Dayton Superior

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

Products:

Horizontal

"Thin Top Supreme, Concrete Top Supreme," Euclid Chemical
"Sikatop 121 or 122," Sika Chemical
"Emaco R310CI," ChemRex, Inc., MBT Protection and Repair Division
“Sonopatch 100 or 300”, Sonneborn-ChemRex

Vertical or Overhead

"Verticoat/Verticoat Supreme," Euclid Chemical
"Sikatop 123," Sika Chemical
"Emaco R320CI," ChemRex, Inc., MBT Protection and Repair Division
“Sonopatch 200”, Sonneborn-ChemRex

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

Products:

“Road Patch”, Sonneborn-ChemRex

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

Products:

"Corr-Bond," Euclid Chemical Co.
"Armatec 110," Sika Chemical Co.
“Sonoprep”, Sonneborn-ChemRex

O. Expansion Bolts in Concrete:

1. ICBO Approval: Only concrete anchors approved by the International Conference of Building Officials (ICBO) with a published Research Report shall be approved for use.
2. Type: All expansion bolts in concrete shall be only wedge type expansion or undercut bolts.
3. Interior Use: All expansion bolts, 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 expansion bolts, 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 bolts, nuts and washers shall conform to ASTM A 153. Stainless steel bolts 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 bolts.
6. Acceptable Products and Manufacturers:

   "Kwik-Bolt II" or HSL Heavy Duty Sleeve Anchor"; Hilti Fastening Systems.
   "Trubolt Wedge Anchors," ITW Ramset/Red Head
   "Power Stud," Powers-Rawl Fasteners, Inc.
   “Sleeve-All”, Simpson Strong-Tie Co., Inc.

   Other manufacturers will be acceptable only if approved by ICBO with an ICBO Research Report submitted for Engineer review.

P. Adhesive Bolts in Concrete- Sealed Capsule Type:

1. Type: Adhesive bolts in concrete shall consist of a specially prepared threaded steel rod meeting the requirements of ASTM A 307, A36, or A193-B7 and a sealed capsule containing a two part system of modified vinylester resin and hardener. Adhesive anchors containing polyester resin shall not be used.
2. Exterior Use: Adhesive bolts used in exterior, exposed, potentially wet environments and for attachment of exterior cladding materials shall have threaded rods manufactured from ASTM A 153 galvanized steel or 300 series stainless steel. Nuts and washers shall also be galvanized or stainless steel.
3. Nuts and Washers: Nuts and washers shall be furnished from the manufacturer and used with the bolts.
4. Products: Subject to compliance with requirements, provide one of the following:

   "HVA Adhesive System"; Hilti Fastening Systems.
   "Chem-Stud" or "Hammer-Capsule", Powers-Rawl Fastening, Inc.
   "Maxima 7" or "Impact", ITW Ramset/Red Head
   “VGC 50”, Simpson Strong-Tie Co., Inc.

   Other manufacturers will be acceptable only if approved by ICBO with an ICBO Research Report submitted for Engineer review.

Q. Adhesive Bolts in Concrete – Two-Part Injectable Type:

1. Type: Adhesive bolts in concrete shall consist of a threaded rod steel rod meeting the requirements of ASTM A307, A36 or A193-B7 and a two component adhesive system contained in side by side packs connected to a mixing nozzles which thoroughly mixes the components as it is injected into the hole.
2. Exterior Use: Adhesive bolts used in exterior, exposed, potentially wet environments and for attachment of exterior cladding materials shall have threaded rods manufactured from ASTM A 153 galvanized steel or 300 series stainless steel. Nuts and washers shall also be galvanized or stainless steel.
3. Nuts and Washers: Nuts and washers shall be furnished from the manufacturer and used with the bolts.
4. Products: Subject to compliance with requirements provide one of the following:

   “Epcon A7”, ITW Ramset/Red Head
   "HIT HY-150", Hilti Fastening Systems
   “Epoxy-Tie ET”, Simpson Strong-Tie Co., Inc.

R. Reglets: Where resilient or elastomeric sheet flashing or bituminous membrane 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.

S. Contraction Joint-Filler Material for Slabs-on-Grade: Provide a 2-component semi-rigid, 100% solids epoxy having a minimum shore A hardness of 75 when tested in accordance with ASTM D2240. Subject to compliance with requirements, provide one of the following:

"Euco 700", Euclid Chemical Co., Inc.
"Spec-Joint CJ"; Conspec Marketing and Manufacturing Co., Inc.
"Masterfill 300 I", ChemRex, Inc., MBT Protection and Repair Division

T. Bondbreaker for Construction Joints in Slabs-on-Grade: A dissipating bondbreaking compound containing no silicones, resins, or waxes, and that conforms to ASTM C309. Subject to compliance with requirements, acceptable manufacturers include the following:

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

2.6 PROPORTIONING AND DESIGN OF CONCRETE MIXES

The Contractor shall submit for approval by the Engineer and Owner's Testing Laboratory, at least 15 working days prior to the start of construction, 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. The Contractor shall not begin work with a particular mix until that mix design has been approved.

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, Owner's Testing Laboratory, Concrete Supplier, and Engineer.

B. 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 318, may be used.

1. Field Experience Method
2. Laboratory Trial Mixture Method

When field experience methods are used to select concrete proportions, establish proportions as specified in ACI 301 and ACI 211. When Laboratory trial batches are used to select concrete proportions, the procedure as outlined in ACI 318 shall be followed. Prepare test specimens in accordance with ASTM C192 and conduct strength tests in accordance with ASTM C39. Proportioning without field experience or trial mixtures is not permitted.

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

D. 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 member for which the concrete is designed (i.e. columns, shear walls, footings, 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, accelerators, and retarders
9. Design Slump
10. Proportions of each material used
11. Water cement 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 318 5.3.1 and 5.3.2. 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 318 5.3.3. 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 318 5.3.1, 5.3.2 and 5.3.3 shall include copies of the Concrete Testing Agency'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.

E. Concrete Suppliers Record of Quality Control: The concrete supplier's past record of quality control shall be used in the design of the concrete mixes to determine the amount by which the average concrete strength fcr should exceed the specified strength f'c as outlined in ACI 318. If a suitable record of test results is not available, the average strength must exceed the design strength by the amount as specified in ACI 318. After sufficient data becomes available from the job, the statistical methods of ACI 214 may be used to reduce the amount by which the average strength must exceed f'c as outlined in ACI 318.

F. Fly Ash: Fly ash replacement of cement shall not exceed 25% (one part fly ash max. to three parts cement) by weight.

G. Aggregate: Provide aggregates from a single source for exposed concrete. For exterior exposed surfaces, do not use fine or coarse aggregates containing spalling-

causing deleterious substances. Combined aggregate gradation for slabs and other designated concrete 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.

H. Admixtures:

1. Admixtures to be used in concrete shall be subject to the approval of the Engineer and Owner's Testing Laboratory.
2. Quantities of admixtures to be used shall be in strict accordance with the manufacturers instructions.

I. 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.

J. Chloride Ion Content: A written submittal shall be made with each mix design proposed for use on the project that the chloride ion content from all ingredients including admixtures will not exceed the limits specified in this section of the Specifications.

2.7 CONCRETE MIXES

A. Ready-Mix Concrete: Comply with requirements of ANSI/ASTM C 94, "Ready Mixed Concrete" and Testing Laboratory section of the specifications.

PART 3 - EXECUTION

3.1 FABRICATION AND CONSTRUCTION OF FORMWORK

A. Design, erect, support, brace and maintain formwork, according to ACI 301, to support vertical, lateral, static, and dynamic construction loads that might be applied until the concrete structure can support such loads.

B. Construct formwork so concrete members and structures are of correct size, shape, alignment, elevation and position. Maintain formwork construction tolerances complying with ACI 117.

C. Construct forms to sizes, shapes, lines and dimensions shown, and to obtain accurate alignment, location, grades, level and plumb work in finished structures. Provide for openings, offsets, sinkages, keyways, recesses, moldings, rustications, reglets, chamfers, blocking, screeds, bulkheads, anchorages and inserts and other

features required in work. Use selected materials to obtain required finishes. Solidly butt joints and provide back-up at joints to prevent leakage of cement paste.

D. Construct forms so as to limit the offset between adjacent pieces of formwork facing material in accordance with the following classifications as defined in ACI 117. The offset limits shall apply to both abrupt and gradual variations in the surface.

1. Class A, 1/8 inch, for surfaces prominently exposed to public view in the completed structure
2. Class B, ¼ inch, for surfaces scheduled to receive plaster, stucco, or wainscoting.
3. Class C, ½ inch, for all other surfaces.

E. Fabricate forms for easy removal without hammering or prying against concrete surfaces. Provide crush plates or wrecking plates where stripping may damage cast concrete surfaces. Provide top forms for inclined surfaces steeper than 1.5 horizontal to 1 vertical. Kerf wood inserts for forming keyways, reglets, recesses, and the like, to prevent swelling and for easy removal.

F. Set edge forms, bulkheads, and intermediate screed strips for slabs to achieve required elevations and slopes in finished concrete surfaces. Provide and secure units to support screed strips; use strike-off templates or compacting-type screeds.

G. Provide temporary openings where interior area of formwork is inaccessible for cleanout, for inspection before concrete placement, and for placement of concrete. Securely brace temporary openings and patch forms to prevent loss of concrete mortar. Locate temporary openings on forms at inconspicuous locations.

H. Chamfer exposed corners and edges as indicated, using specified chamfer strips fabricated to produce uniform smooth lines and tight edge joints.

I. Form Ties: Unless otherwise indicated, provide ties so portion remaining within concrete after removal is 1 1/2" inside concrete and will not leave holes larger than 1" diameter in concrete surface. Refer to Architectural drawings for tie hole requirements.

J. Provisions for Other Trades: Provide openings in concrete formwork to accommodate work of other trades. Determine size and location of openings, recesses and chases from trades providing such items. Accurately place and securely support items built into forms.

3.2 CLEANING AND TIGHTENING

Thoroughly clean forms and adjacent surfaces to receive concrete. Remove chips, wood, sawdust, dirt, and all other debris just prior to concrete placement. Retighten forms and bracing prior to concrete placement as required to prevent mortar leaks and maintain proper alignment.

3.3 CLEANING AND RE-USE OF FORMS

Forms reused in the work shall be repaired and cleaned. Split, frayed, delaminated, or otherwise damaged facing material will not be acceptable for exposed surfaces. Forms intended for successive concrete placement shall have surfaces cleaned, fins and laitance removed, and joints tightened to avoid surface offsets. New form coating compound shall be applied to reused forms. Thin form-coating compounds only with thinning agent of type, and in amount, and under conditions of form-coating compound manufacturer's directions. Do not allow excess form-coating material to accumulate in forms or to come into contact with in-place concrete surfaces against which fresh concrete will be placed. Apply in compliance with manufacturer's instructions. Coat steel forms with a non-staining, rust-preventative form oil or otherwise protect against rusting. Rust-stained steel formwork is not acceptable.

3.4 TOLERANCES

Unless specified otherwise, all tolerances for concrete formwork shall conform to ACI Standard 117, "Standard Tolerances for Concrete Construction and Materials". Before concrete placement the Contractor shall check lines and levels of erected formwork and make any corrections and adjustments as required to ensure proper size and location of concrete members and stability of forming systems. During concrete placement the Contractor shall check formwork and supports to ensure that forms have not displaced and that completed work will be within specified tolerances.

3.5 REMOVAL OF FORMS AND SUPPORTS

A. Records of Weather Conditions: The General Contractor shall be responsible for keeping records of weather conditions to be used in the decision on when to remove forms.

B. Formwork Not Supporting Concrete: Formwork not supporting concrete such as sides of walls and similar parts of the structure, may be removed after cumulatively (not necessarily consecutively) curing at not less than 50°F for 12 hours after placing concrete, provided the concrete is sufficiently hard so as not to be damaged by form removal operations and provided curing and protection operations are maintained. If ambient air temperatures remain below 50°F, if retarding agents are used, or if Type II and Type V portland cement is used, then this specified minimum period should be increased as required to safely remove the forms without damage to the concrete. Where such forms also support formwork for slab or beam soffits, the removal times of the latter shall govern.

3.6 FABRICATION AND DELIVERY OF REINFORCEMENT

A. Bending and Forming: Fabricate bars of indicated sizes and accurately form to shapes and lengths indicated and required, by methods not injurious to materials. Do not heat reinforcement for bending. Bars with kinks or bends not scheduled will be rejected.

B. Marking and Shipping: Bundle reinforcement and tag with suitable identification to facilitate sorting and placing. Transport and store at site so as not to damage material. Keep sufficient supply of tested, approved and proper reinforcement at the site to avoid delays. Maintain reinforcing bars free of mud, dirt, grease, or other coating.

3.7 PLACING REINFORCEMENT

A. Comply with Concrete Reinforcing Steel Institute's recommended practice for "Placing Reinforcing Bars", for details and methods of reinforcement placement and supports and as herein specified.

B. Before placing and again before concrete is placed, clean reinforcement of loose rust and mill scale, earth, ice and other materials which reduce or destroy bond with concrete.

C. Accurately position, support and secure reinforcement against displacement by formwork, construction, or concrete placement operations. Locate and support reinforcing by metal chairs, runners, bolsters, spacers and hangers, as required. Exercise particular care to maintain proper distance and clearance between parallel bars and between bars and forms. Provide metal spreaders and spacers to hold steel in position. Support steel at proper height upon approved chairs.

D. Place reinforcement to obtain at least minimum coverages for concrete protection. Arrange, space and securely tie bars and bar supports to hold reinforcement in position during concrete placement operations. Set wire ties so ends are directed into concrete, not toward exposed concrete surfaces.

E. Support of Spread Footing Reinforcing Steel

1. Bottom Steel: Support bottom reinforcing mat on slab bolsters designed for soil supported slabs that provide the specified clearance to the bars. Spacing between supports shall not exceed 4'-0" centers each way.
2. Top Steel: Support top reinforcing on steel angle frames braced in both directions or on special standee support bars. Spacing between supports shall not exceed 4'-0" centers each way. The depth of the supports shall provide the specified clearance from the bars to the top of the concrete. The design of the support steel shall be the responsibility of the Contractor.

   The design of the support steel shall be the responsibility of the Contractor.

F. Install welded wire fabric in as long lengths as practicable. Lap adjoining pieces at least one full mesh plus two inches and lace splices with wire. Offset end laps in adjacent widths to prevent continuous laps in either direction. Welded wire fabric shall be furnished and placed in flat sheets only.

G. Coordinate with other trades and expedite materials and labor to avoid omissions and delay.

H. Install waterproof membrane or moisture barrier as specified prior to placing steel for concrete slabs-on-grade.

I. Extend reinforcement continuous through construction joints unless otherwise shown on the drawings or, if approved on the shop drawings, provide dowels of sufficient length to develop the full tension or compression strength of the bar as applicable.

J. Slab-on-Grade Joint Dowel Bars: Support slab-on-grade joint dowel bars independently of support for slab reinforcement on soil supported slab bolsters or specially manufactured cradles such that dowel bar remains parallel to slab surface and at right angles to joint during concreting operations. Lightly coat the exposed end of the dowel with a paraffin-base lubricant, asphalt emulsion, form oil, or grease or use a dowel bar sleeve specifically manufactured for the purpose of preventing a bond between the dowel and the concrete.

K. Provide and place additional reinforcing steel at all sleeves and openings in beams, slabs and walls as specified on the drawings. Where sleeves or openings not shown on the drawings interrupt the reinforcement, consult with Engineer for instructions for placing and splicing of bars. Provide required additional reinforcing steel at no additional cost to the Owner.

3.8 REINFORCING STEEL SPACING AND COVERAGE

A. Reinforcing Steel Coverage: Reinforcing steel coverage should conform to the requirements specified below. Cover specified shall be considered minimums that may require increasing where reinforcing steel intersects for different member types. Cover in structural members not specified below shall conform to the requirements of ACI 318-99 Section 7.7 unless specified otherwise on the drawings.

1. Foundation Members

a.	Foundation Retaining Walls	- 2" both faces
b.	Sump Walls, Pit Walls	- 2" both faces
c.	Spread Footings, Combined Footings	- 3" bottom and sides, 2" top
d.	Interior Slab on Grade	- 1" top cover for one layer of steel - 1" top cover, 3" bottom cover for two layers of steel
e.	Exterior Slab on Grade	- 2" top cover for one layer of steel - 2" top cover, 3" bottom cover for two layers of steel

B. Reinforcing Steel Spacing: Comply with the requirements of ACI 318-99, Section 7.6.

3.9 SPLICING REINFORCING STEEL

A. Provide splice type (tension lap splice, compression lap splice, compression end bearing splice, or mechanical anchorage tension splice) as indicated on the drawings.

Splice reinforcing bars only at locations shown on the structural drawings and approved shop drawings. Unauthorized or unscheduled splices not approved by the Engineer in writing will not be accepted.

B. All lap splices in reinforcing steel shall be contact lap splices unless detailed otherwise on the drawings.

C. Maintain proper cover between reinforcing bars at splices.

D. Lap unscheduled reinforcing bars not otherwise specified a minimum of 48 bar diameters at splices. Lap welded wire fabric a minimum of one full wire mesh plus two inches.

3.10 WELDING REINFORCING STEEL

A. Welding reinforcing steel is permitted only where specifically shown on the drawings. All welding shall conform to AWS D1.4 "Structural Welding Code - Reinforcing Steel". Only weldable reinforcing steel conforming to ASTM A706 or deformed bar anchors conforming to ASTM A496 shall be permitted. ASTM A615 bars may not be welded for structural use.

B. Scheduled or detailed reinforcing steel shall not be tack welded for any reason.

3.11 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. Water may be added to the concrete in the field only to the extent that the prescribed water-cement ratio noted in the Mix Design Submittal Form is not exceeded.

3.12 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 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 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. Provide construction joints with dowels at all locations unless isolation joints are detailed.
5. Contraction (Control) Joints in Slabs-on-Ground: 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.

    a. Sawed Joints
        i. 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 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.
        ii. Optional Method (where Soff-Cut System method equipment is not available): 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.
    b. Formed Joints: Form contraction joints by inserting premolded 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
        i. Remove dirt and debris from the joint by vacuuming immediately prior to filling joint. Clean the joint of curing compounds and sealers.
        ii. 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.

iii. Strictly following the manufacturer's recommended procedure for installing filler material.

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.

3.13 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. 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. 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.

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

D. Securely fasten embedded plates, angles, anchor bolts 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.

3.14 CONCRETE PLACEMENT

A. Preplacement 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 moisture barriers with placement of forms and reinforcing steel.

C. Comply with ACI 301 and as herein specified.

1. 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.

2. 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.
3. Consolidate placed concrete by mechanical vibrating equipment supplemented by hand-spading, rodding or tamping. Use equipment and procedures for consolidation of concrete in accordance with ACI 309 recommended practices.
4. 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.
5. 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.
6. Consolidate concrete during placing operations so that concrete is thoroughly worked around reinforcement and other embedded items and into corners.
7. 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.
8. Maintain reinforcing in proper position during concrete placement operations.
9. 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.

3.15 FINISH OF FORMED SURFACES

A. Rough Form Finish: Provide rough form finish for formed concrete surfaces not exposed-to-view in the finish work unless otherwise indicated. This is the concrete surface having texture imparted by form facing material used, with tie holes and defective areas repaired and patched and fins and other projections exceeding 1/4" in height rubbed down or chipped off.

B. Smooth Form Finish: Provide smooth form finish for formed concrete surfaces exposed-to-view, or that are to be covered with a coating material applied directly to concrete, or a covering material applied directly to concrete, such as waterproofing, dampproofing, painting, veneer plaster or other similar system or to a surface that is to receive a smooth rubbed finish or grout cleaned finish. This is as-cast concrete surface obtained with selected form facing material, arranged orderly and symmetrically with a minimum of seams. Repair and patch defective areas with fins or other projections exceeding 1/8 inch in height removed and smoothed.

C. 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.

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

1. Combine one part portland cement to 1-1/2 parts fine sand 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.
2. 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.

E. 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.

3.16 MONOLITHIC SLAB FINISHES

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

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 float blades or float shoes only, when surface water has disappeared or when concrete has stiffened sufficiently to permit operation of power-driven floats, or both. Consolidate surface with power-driven floats, or by hand-floating if area is small or inaccessible to power units. 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 trowel finish as specified above, then immediately follow with slightly scarifying surface by fine brooming.

E. Non-Slip Broom Finish: Apply non-slip broom finish to 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. Non-slip Aggregate Finish: Apply non-slip 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 non-slip 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 non-slip aggregate.

G. 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.

H. 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, FF15 (overall), FF10 (minimum local) and a levelness F-number, FL12 (overall), FL10 (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.

3.17 CONCRETE FINISH MEASUREMENT AND TOLERANCES

A. Definitions:

1. Flatness - a measure of a concrete surfaces curvature or deviation from a planar surface. Concrete surfaces that are not flat are wavy or bumpy.
2. Levelness - A measure of a concrete surfaces tilt or inclination from a horizontal plane. Concrete surfaces that are not level are sloped or tilted.
3. FF Flatness F-Number - The flatness F-Number FF measures floor curvature or flatness and for any floor section or overall floor area is defined as follows:

$$F_F = \frac{4.57}{(3 \times Sq) + \bar{q}}$$

Where $\bar{q}$ is the mean value and Sq the standard deviation of all floor q readings. A q reading is defined as the difference in slope between three successive points along any test measurement line on the floor surface that are twelve inches apart.

4. FL Levelness F-Number - The levelness F-Number FL measures floor inclination from a horizontal plane and for any floor section or overall area is defined as follows:

$$F_L = \frac{12.5}{(3 \times Sz) + \bar{z}}$$

Where $\bar{z}$ is the mean value and Sz the standard deviation of all floor z readings. A z reading is defined as the difference in elevation between two successive points along any test measurement line on the floor surface that are 10 feet (120") apart.

Measurement of F_L is not applicable for floors that are intentionally inclined or cambered, for elevated structural floors that can deflect from the time the floor is poured to the time it is measured, and for unshored form surfaces.

B. Measurement Standard: All floors should be measured for flatness and levelness according to ASTM E 1155 "Standard Test Method for Determining Floor Flatness and Levelness Using the F-Number System".

C. Time Period for Measurement and Reporting: Measurement of the finished concrete surface profile for any test section shall be made when requested by the Owner's Representative at his option. All measurements shall be made by the Owner's Testing Laboratory or designated party within 24 hours after completion of finishing operations. For structural elevated floors measurement shall also be made prior to removal of forms and shores. The Contractor shall be notified immediately after the measurements of any section are complete and a written report of the floor measurement results shall be submitted within 72 hours after finishing operations are complete. The Contractor shall take immediate action to correct any work that is outside specified tolerances as outlined later in this section.

D. Measuring Equipment: The concrete surface profile shall be measured using equipment manufactured for the purpose such as a Dipstick Floor Profiler as manufactured by the Edward W. Face Company in Norfolk, Virginia, F-Meters manufactured by Allen Face & Company in Norfolk, Virginia, optical, or laser means or other method specified in ASTM E 1155.

E. Two-Tiered Measurement Standard: Each floor test section and the overall floor area shall conform to the two-tiered measurement standard as specified herein.

1. Minimum Local Value (MLV). The minimum local FF/FL values represent the absolute minimum surface profile that will be acceptable in any one floor test section.
2. Specified Overall Value (SOV). The specified overall FF/FL values represent the minimum values acceptable for all combined floor test sections representing the overall floor.

SOV and MLV FF/FL values are specified later in this section for each portion of the structure.

F. Floor Test Sections: For purposes of this specification a floor test section is defined as the smaller of the following areas:

1. The area bounded by column and/or wall lines.
2. The area bounded by construction and/or control joint lines.
3. Any combination of column lines and/or control joint lines.

Test sample measurement lines within each test section shall be multidirectional along two orthogonal lines as defined by ASTM E 1155.

The precise layout of each test section shall be determined by the Owner's testing agency and shall be submitted for Architect/Engineer review and approval.

G. 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 - + 3/4"
2. Top surfaces of formed slabs measured prior to removal of supporting shores - + 3/4".
3. Top surfaces of all other slabs - + 3/4"

The tolerance on relative elevation difference between points on the floor shall be defined by the FL Levelness F-Number as prescribed below.

H. 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 bullfloats for all slab placement and finishing operations.

I. 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.

J. 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. Tolerance:

a. Slabs in nonpublic areas, mechanical rooms, surfaces to received raised computer flooring, surfaces to have thick-set tile or a topping:
Specified Overall Value - F_F20/F_L15
Minimum Local Value - F_F15/F_L10
b. Carpeted Areas:

Specified Overall Value - F_F25/F_L20
Minimum Local Value - F_F17/F_L15

c. Exposed slabs in public spaces, slabs to receive thin-set flooring:
Specified Overall Value - FF35/FL25
Minimum Local Value - F_F24/F_L17

K. 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, beam deflection in excess of actual beam camber in order to achieve a level and flat floor within specified tolerances.

2. Tolerance:

a. Slabs in nonpublic areas, mechanical rooms, surfaces to received raised computer flooring, surfaces to have thick-set tile or a topping:
Specified Overall Value - FF20
Minimum Local Value - FF15

b. Carpeted Areas:
Specified Overall Value - FF25
Minimum Local Value - FF17

c. Exposed slabs in public spaces, slabs to receive thin-set flooring:
Specified Overall Value - FF30
Minimum Local Value - FF24

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".

Slabs specified to slope shall have a tolerance from the specified slope of 3/8" in 10 feet at any point as required by ACI 117.

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, and for beam deflection in excess of actual beam camber.

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.

L. 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 FF or FL of the entire floor installation measure less than specified values.
   b. Any individual test section measures less than the specified absolute minimum FF or FL 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 effect the repair.
   c. Repair method(s), at the sole discretion of the Architect/Engineer or Owner's Representative, may include grinding (floor stoning), planing, retopping 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 sawcutting 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.

3.18 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. In hot, dry and windy weather protect concrete from rapid moisture loss exceeding 0.2 lb./sq. ft. x hr before and during finishing operations with an evaporation control material. 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. 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 C309, 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. Floors Directly Exposed to Vehicular or Foot Traffic not in Parking Areas: Apply two coats of a high-solids, liquid membrane-forming curing and sealing compound conforming to ASTM C1315, type 1, Class A in accordance with method 3 as specified below.
2. Floors that are to receive subsequent cementitious toppings, sealers, hardeners, ceramic tile or terrazzo or other coating or finishing products: Cure using methods 1, 2 or 3 as specified below. Use a water-based dissipating resin type curing compound conforming to ASTM C309, type 1, class A or B for method 3.
3. 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 C309, 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-Cover Curing: Provide moisture-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.

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

   Apply specified curing and sealing 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, glue down carpet), paint or other coatings and finish materials., Dissipating resin type cures are acceptable in these locations.

3.19 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.
2. The maximum acceptable concrete temperature at the truck discharge point shall be 95°F.

B. Specification: Hot weather concreting practices specified below shall be followed, all or in part as required, to limit the concrete temperature at the truck discharge point to 95°F or lower.

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 95°F or lower 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.

3.20 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 following conditions exist for more than three successive days:

   a. the average daily air temperature is less than 40°F, and
   b. the air temperature is not greater than 50°F for more than one half of any 24 hour period.

   The average daily air temperature is the average of the highest and lowest temperature occurring during the period from midnight to midnight.

3. The temperature of concrete mixed and delivered to the job site shall conform to the following requirements:

Air Temperature	Min. Concrete Temperature
Above 30°F	60°F
0°F to 30°F	65°F
Below 0°F	70°F

4. The minimum temperature of concrete during placement and curing shall be 55°F.
5. 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.

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 suitable for cold weather. Use air entrainment (where not prohibited) and obtain high early strength by using a 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. Concrete shall be protected and cured at 50°F for seven days minimum if normal concrete (Type I cement) is used and for three days minimum if high early strength concrete (concrete with Type III cement, 100 pounds cement added per cubic yard concrete, or a non-chloride accelerator added).
6. Concrete not loaded during construction shall be protected a minimum of 3 days for normal concrete and 2 days for high early strength concrete to obtain safe form stripping strength. Concrete fully loaded during construction shall be protected 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.
7. Heat the mixing water and then blend hot and cold water to obtain concrete no more than 10°F above the required temperature.
8. 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.

9. Uniformly thaw aggregates far in advance of batching to prevent moisture variations in the stockpile.
10. Cover warmed stockpiles with tarps to retain heat.
11. Place air entraining admixture in the batch after the water temperature has been reduced by mixing with cooler solid materials.
12. Use wind screens to protect concrete from rapid cooling.
13. Place vertical pump lines inside the building, if possible, for concrete being pumped.
14. Maintain artificial heat as low as possible to reduce temperature stresses during cooling.
15. 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.
16. 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.
17. Provide triple thickness of insulating materials at corners and edges vulnerable to freezing.
18. Wrap protruding reinforcing bars with insulation to avoid heat drain from the warm concrete.
19. Gradually reduce the heat at the end of the heating period to reduce likelihood of thermal shock.

3.21 SHRINKAGE AND TEMPERATURE REINFORCEMENT

Provide shrinkage and temperature reinforcement (as required by ACI 318) at right angles to main top and bottom bars for all structural slabs unless detailed otherwise on the drawings.

3.22 PLACEMENT OF WELDED WIRE FABRIC

Wherever welded wire fabric is specified as reinforcement in slabs, it shall be continuous and properly lapped one full wire spacing plus 2" across the entire concrete surface and not interrupted by beam or girders.

3.23 PLACEMENT OF COLUMN DOWELS AND ANCHOR BOLTS

Dowels for columns, plinths, and pilasters and anchor bolts shall be accurately set using 1/8" thick steel templates.

3.24 REINFORCEMENT IN COMPOSITE METAL DECK SLAB

A. Minimum Reinforcement: Composite metal deck slabs shall be reinforced as indicated on the drawings. All slabs, whether scheduled or not, shall be reinforced at a minimum with either welded wire fabric or reinforcing bars as shown in the table below:

Concrete Above Deck	Reinf. Area (sq. in./ft.)	WWF	Bars
3 1/2"	0.029	6 x 6 – W2.0 x W2.0	#3 @ 18 E. W.
4 1/2"	0.040	6 x 6 – W2.0 x W2.0	#3 @ 18 E. W.
5"	0.045	6 x 6 – W2.9 x W2.9	#3 @ 18 E. W.
6"	0.054	6 x 6 – W2.9 x W2.9	#3 @ 18 E. W.

B. Extra Reinforcement Over Girders:

Provide

1. #3 at 12" on center x 3'-0" long tied to (2)-#5 continuous cross bars chaired at 48" centers to provide 3/4" top cover to reinforcement.

C. Placement of Slab Reinforcement:

1. Minimum (Temperature) Welded Wire Fabric Reinforcement: Provide 3/4" clear cover from the top of the slab to welded wire fabric reinforcement. Support welded wire fabric on #4 supports bars parallel to the deck flutes at 48” on center that are supported by high chairs at 48” on center. High chairs shall be manufactured specifically for metal deck (CRSI Type HCM).

3.25 REINFORCEMENT AROUND OPENINGS IN COMPOSITE METAL DECK SLABS

For all openings in metal deck not framed with structural steel and greater than 10" in width in either direction, provide 1 - #5 x opening width plus 4'-0" in a direction perpendicular to deck ribs at each side of opening with bars bearing on top of ribs and 2 - #5 x deck span plus 1'-0" past nearest support beam at each side of opening chaired 3/4" up from bottom of nearest deck rib running beside the opening from support to support.

3.26 REINFORCEMENT IN TOPPING SLABS

Provide welded smooth wire fabric minimum 6 x 6 W1.4 x W1.4 in all topping slabs unless specified otherwise on the drawings.

3.27 REINFORCEMENT IN HOUSEKEEPING PADS

Provide welded smooth wire fabric 6 x 6 W2.9 x W2.9 minimum in all housekeeping pads supporting mechanical equipment unless detailed otherwise on the drawings.

3.28 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 bolts for machines and equipment to template at correct elevations, complying with certified diagrams or templates of manufacturer furnishing machines and equipment.

D. 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.

E. Installation of Adhesive Anchors Using Injectable Epoxy or Adhesive: A representative of the adhesive manufacturer shall be present for the first three holes that are drilled and filled with adhesive. 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.

3.29 CONCRETE SURFACE REPAIRS

A. Definition - Defective Areas:

1. Formed Surfaces: Concrete surfaces requiring repairs shall include all honeycombs, rock pockets and voids exceeding 1/4" in any dimension, holes left by tie rods or bolts, cracks in excess of 0.01" and any other defects that affect the durability or structural integrity of the concrete.
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, popouts, 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. Location of structural concrete repairs shall be determined by the Engineer.

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 location of cosmetic concrete repair required shall be determined by the Architect/Engineer. 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.

3.30 QUALITY CONTROL TESTING DURING CONSTRUCTION

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

3.31 INVESTIGATION OF LOW CONCRETE STRENGTH TEST RESULTS

A. Contractor Responsibility for Low Strength Concrete

1. If the average of any three consecutive strength tests falls below the required f'c for a class of concrete but no individual strength test is more than 500 psi below f'c, the Contractor shall immediately notify the Engineer by telephone or e-mail and take immediate steps to increase the average of subsequent strength tests.
2. If any individual strength test falls more than 500 psi below the required f'c, the Contractor shall immediately notify the Engineer by telephone or e-mail and take immediate steps to assure that the load-carrying capacity of the structure is not jeopardized.

B. Additional Field Tests to Confirm Low Concrete Strengths

1. The cost of all investigations of low-strength concrete shall be borne by the Contractor.
2. Non-Destructive Tests: If any individual strength test falls more than 500 psi below the required f'c, the Engineer may request that non-destructive tests such as Swiss Hammer, Windsor Probe, or other appropriate methods be

performed on the concrete in question. See the Testing Laboratory Services section of the Specifications for additional details.

3. Core Tests: If the likelihood of low-strength concrete is confirmed and it has been determined that the load-carrying capacity of the structure is significantly reduced as a result, the Engineer may request that core tests be taken from the area in question. There shall be a minimum of three cores taken for each strength test more than 500 psi below the required f'c. See the Testing Laboratory Services Section of the Specifications for additional details
4. Acceptance Criteria for Core Test: Concrete in an area represented by core tests shall be considered adequate if the average of three cores is equal to at least 85% of the required f'c and no single core is less than 75% of the required f'c. If approved by the Engineer, locations of erratic core strengths may be retested to check testing accuracy.
5. Load Test: If the concrete strength is not considered adequate based on core tests and the structural adequacy remains in doubt, the Engineer may order a load test as specified in ACI 318 be conducted for the questionable portion of the structure.
6. Strengthening of the Structure or Demolition: If the structural adequacy of the affected portion of the structure remains in doubt following the load test, the Engineer may order the structure to be strengthened by an appropriate means or demolished and rebuilt at the Contractor's expense.

END OF SECTION 03300

SECTION 03331 - CAST-IN-PLACE ARCHITECTURAL CONCRETE

PART 1 - GENERAL

1.1 SUMMARY

A. This Section specifies cast-in-place architectural concrete, including formwork, reinforcement accessories, concrete materials, concrete mix design, placement procedures, and finishes.

1. Location: All exposed cast-in-place concrete.

1.2 DEFINITION

A. Cast-in-Place Architectural Concrete: Concrete that is exposed to view on surfaces of the completed structure or building and that requires special concrete materials, formwork, placement, or finishes to obtain specified architectural appearance.

B. Design Reference Sample: Sample designated by Architect in the Contract Documents that reflects acceptable surface quality and appearance of cast-in-place architectural concrete.

1.3 SUBMITTALS

A. Material Safety Data (MSD): MSD Sheets are required for all materials with detailed information on content, product safety, and potentially harmful characteristics. MSD Sheets shall be submitted by Contractor to the Architect for review prior to delivery or use of such materials on the project site. Product approval will depend, in part, upon meeting the environmental requirements of this specification, based upon MSD information submitted to the Architect for review.

B. Product Data: For each type of manufactured material and product indicated.

C. Design Mixes: For each concrete mix. Include alternate mix designs when characteristics of materials, Project conditions, weather, test results, or other circumstances warrant adjustments.

D. Shop Drawings: Show formwork construction including form-facing joints, rustications, construction and contraction joints, form joint-sealant details, form tie location and patterns, inserts and embedments, cutouts, cleanout panels, and other items that visually affect cast-in-place architectural concrete.

E. Samples: For each of the following materials:

1. Form-release agent.
2. Form ties.
3. Cement.
4. Chamfers and rustications.
5. Curing compound.

F. Samples for Verification: Architectural concrete samples, cast vertically, approximately 18 by 18 by 2 inches, of finishes, colors, and textures to match the design reference sample. Include Sample sets showing the full range of variations expected in these characteristics.

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

H. Material Certificates: Signed by manufacturers certifying that each of the following materials complies with requirements:

1. Cementitious materials and aggregates.
2. Admixtures.
3. Curing compounds.

I. Placement Schedule: Submit concrete placement schedule before start of architectural concrete placement operations. Include location of all joints including construction joints.

J. Preinstallation Conference: Minutes of preinstallation conference.

1.4 QUALITY ASSURANCE

A. Installer Qualifications: An experienced cast-in-place architectural concrete contractor who has specialized in installing cast-in-place architectural 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 in-service performance.

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

1. Manufacturer must be certified according to the National Ready Mixed Concrete Association's "Certification of Ready Mixed Concrete Production Facilities."

C. Testing Agency Qualifications: An independent testing agency, acceptable to authorities having jurisdiction, qualified according to ASTM C 1077 and ASTM E 329 to conduct the testing indicated, as documented according to ASTM E 548.

1. Personnel conducting field tests shall be qualified as ACI Concrete Field Testing Technician, Grade 1, according to ACI CP-1 or an equivalent certification program recognized by ASTM C 1077.

D. Source Limitations for Cast-in-Place Architectural Concrete: Obtain each color, size, type, and variety of concrete material and concrete mix from one manufacturer with resources to provide cast-in-place architectural concrete of consistent quality in appearance and physical properties.

E. ACI Standards: Comply with ACI 303.1, "Specification for Cast-in-Place Architectural Concrete"; ACI 301, "Specification for Structural Concrete"; and ACI 117, "Specifications for Tolerances for Concrete Construction and Materials," unless more stringent provisions are indicated.

F. Mockups: Before casting architectural concrete, build mockups to verify selections made under sample Submittals and to demonstrate aesthetic effects and qualities of materials and execution. Build mockups to comply with the following requirements, using materials indicated for the completed Work:

1. Build mockups in the location and of the size indicated or, if not indicated, as directed by Architect.
2. Notify Architect seven days in advance of dates and times when mockups will be constructed.
3. Demonstrate curing, cleaning, and protecting of cast-in-place architectural concrete, finishes, and contraction joints, as applicable.
4. In presence of Architect, damage part of the exposed surface of cast-in-place architectural concrete for each finish, color, and texture required, and demonstrate materials and techniques proposed for repairs to match adjacent undamaged surfaces.
5. Obtain Architect's approval of mockups before casting architectural concrete.
6. Maintain mockups during construction in an undisturbed condition as a standard for judging the completed Work.
7. Demolish and remove mockups when directed.
8. Approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

G. Preinstallation Conference: Conduct conference at Project site to comply with requirements in Division 1 Section "Project Meetings."

PART 2 - PRODUCTS

1.5 FORM-FACING MATERIALS

A. General: Comply with Division 3 Section "Cast-in-Place Concrete" for formwork and other form-facing material requirements.

B. Form-Facing Panels for As-Cast Finishes: Steel, glass-fiber-reinforced plastic, or other approved nonabsorptive panel materials that will provide continuous, true, and smooth architectural concrete surfaces. Furnish in largest practicable sizes to minimize number of joints.

C. Chamfer Strips: Metal, rigid plastic, elastomeric rubber, or dressed wood, 3/4 by 3/4 inch, minimum; nonstaining.

D. Form Joint Tape: Compressible foam tape, pressure sensitive, AAMA 810.1, minimum 1/4 inch thick.

E. Form Joint Sealant: Elastomeric sealant complying with ASTM C 920, Type M or S, Grade NS, that adheres to form joint substrates.

F. Sealer: Penetrating, clear, polyurethane wood form sealer formulated to reduce absorption of bleed water and prevent migration from wood of set-retarding chemicals.

G. Form-Release Agent: Commercially formulated form-release agent that will not bond with, stain, or adversely affect architectural concrete surfaces and will not impair subsequent treatments of those surfaces.

1. Formulate form-release agent with rust inhibitor for steel form-facing materials.

H. Surface Retarder: Chemical liquid set retarder, for application on form-facing materials, capable of temporarily delaying final hardening of newly placed concrete surface to depth of reveal specified.

I. Form Ties: Factory-fabricated, removable ties designed to resist lateral pressure of fresh concrete on forms and to prevent spalling of concrete on removal.

1. Furnish ties with tapered tie cone spreaders that, when removed, will leave holes 1 inch in diameter on concrete surface.

1.6 REINFORCEMENT ACCESSORIES

A. General: Comply with Division 3 Section "Cast-in-Place Concrete" for steel reinforcement and other requirements for reinforcement accessories.

B. Bar Supports: Bolsters, chairs, spacers, and other devices for spacing, supporting, and fastening reinforcing bars and welded wire fabric in place. Where legs of wire bar supports contact forms, use all-plastic bar supports.

1.7 CONCRETE MATERIALS

A. General: Refer to Division 3, Cast-In-Place Concrete section for concrete materials and mix designs.

B. Water: Potable, complying with ASTM C 94 except free of wash water from mixer washout operations.

1.8 CURING MATERIALS

A. Clear, Waterborne, Liquid Membrane-Forming Curing Compound: ASTM C 309, Type 1, Class B.

PART 3 - EXECUTION

1.9 FORMWORK

A. General: Comply with Division 3 Section "Cast-in-Place Concrete" for formwork, embedded items, and shoring and reshoring.

B. In addition to ACI 303.1 limits on form-facing panel deflection, limit concrete surface irregularities, designated by ACI 347R as abrupt or gradual, as follows:

1. Class A, 1/8 inch.

C. Fabricate forms for easy removal without hammering or prying against concrete surfaces. Provide crush or wrecking plates where stripping may damage cast-in-place surfaces. Provide top forms for inclined surfaces steeper than 1.5 horizontal to 1 vertical. Kerf wood rustications, keyways, reglets, recesses, and the like, for easy removal.

1. Do not use rust-stained, steel, form-facing material.

D. Provide temporary openings for cleanouts and inspection ports where interior area of formwork is inaccessible. Close openings with panels tightly fitted to forms and securely braced to prevent loss of concrete mortar. Locate temporary openings in forms at inconspicuous locations.

E. Form openings, chases, offsets, sinkages, keyways, reglets, blocking, screeds, and bulkheads required in the Work. Determine sizes and locations from trades providing such items.

F. Clean forms and adjacent surfaces to receive concrete. Remove chips, wood, sawdust, dirt, and other debris just before placing concrete.

G. Seal form joints and penetrations at form ties with form joint tape or form joint sealant to prevent mortar leaks.

H. Retighten forms and bracing before placing concrete, as required, to prevent mortar leaks and maintain proper alignment.

I. Coat contact surfaces of forms with form-release agent, according to manufacturer's written instructions, before placing reinforcement.

1.10 REINFORCEMENT AND INSERTS

A. General: Comply with Division 3 Section "Cast-in-Place Concrete" for fabricating and installing steel reinforcement.

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

1.11 REMOVING AND REUSING FORMS

A. Formwork, for sides of beams, walls, columns, and similar parts of the Work, that does not support weight of concrete may be removed after cumulatively curing at not less than 50 deg F for 24 hours after placing concrete, provided concrete is hard enough to not be damaged by form-removal operations and provided curing and protection operations are maintained.

1. Schedule form removal to maintain surface appearance that matches approved mockups.

B. Leave formwork, for beam soffits, joists, slabs, and other structural elements, that supports weight of concrete in place until concrete has achieved 28-day design compressive strength. Remove forms only if shores have been arranged to permit removal of forms without loosening or disturbing shores.

C. Clean and repair surfaces of forms to be reused in the Work. Do not use split, frayed, delaminated, or otherwise damaged form-facing material. Apply new form-release agent.

D. When forms are reused, clean surfaces, remove fins and laitance, and tighten to close joints. Align and secure joints to avoid offsets. Do not use patched forms for architectural concrete surfaces.

1.12 JOINTS

A. Construction Joints: Install construction joints true to line with faces perpendicular to surface plane of cast-in-place architectural concrete so strength and appearance of concrete are not impaired, at locations indicated or as approved by Architect.

1. Place joints perpendicular to main reinforcement. Continue reinforcement across construction joints, unless otherwise indicated.
2. Use bulkhead forms with keys of plywood, wood, or expanded galvanized steel sheet, unless otherwise indicated. Embed keys at least 1-1/2 inches into concrete. Align construction joint within rustications attached to form-facing material.
3. Locate joints for beams, slabs, joists, and girders in the middle third of spans. Offset joints in girders a minimum distance of twice the beam width from a beam-girder intersection.
4. Locate horizontal joints in walls and columns at underside of floors, slabs, beams, and girders and at the top of footings or floor slabs.
5. Space vertical joints in walls as indicated. Locate joints beside piers integral with walls, near corners, and in concealed locations where possible.
6. Use bonding agent at locations where fresh concrete is placed against hardened or partially hardened concrete surfaces.

B. Contraction Joints: Form weakened-plane contraction joints true to line with faces perpendicular to surface plane of cast-in-place architectural concrete so strength and appearance of concrete are not impaired, at locations indicated or as approved by Architect.

1.13 CONCRETE PLACEMENT

A. Before placing concrete, verify that installation of formwork, reinforcement, and embedded items is complete and that required inspections have been performed.

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

C. Deposit concrete continuously between construction joints. Deposit concrete to avoid segregation.

D. Deposit concrete in forms in horizontal layers no deeper than 24 inches and in a manner to avoid inclined construction joints. Place each layer while preceding layer is still plastic, to avoid cold joints.

1. Consolidate placed concrete with mechanical vibrating equipment. Use equipment and procedures for consolidating concrete recommended by ACI 309R.

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

E. Cold-Weather Placement: Comply with ACI 306.1 and as follows. Protect concrete work from physical damage or reduced strength that could be caused by frost, freezing actions, or low temperatures.

1. When air temperature has fallen to or is expected to fall below 40 deg F, uniformly heat water and aggregates before mixing to obtain a concrete mixture temperature of not less than 50 degrees F and not more than 80 degrees F at point of placement.
2. Do not use frozen materials or materials containing ice or snow. Do not place concrete on frozen subgrade or on subgrade containing frozen materials.
3. Do not use calcium chloride, salt, or other materials containing antifreeze agents or chemical accelerators, unless otherwise indicated and approved in concrete mix designs.

F. Hot-Weather Placement: Place concrete according to recommendations in ACI 305R and as follows, when hot-weather conditions exist:

1. Cool ingredients before mixing to maintain concrete temperature below 90 degrees F at time of placement. Chilled mixing water or chopped ice may be used to control temperature, provided water equivalent of ice is calculated to total amount of mixing water. Using liquid nitrogen to cool concrete is Contractor's option.
2. Cover steel reinforcement with water-soaked burlap so steel temperature will not exceed ambient air temperature immediately before embedding in concrete.
3. Fog-spray forms, steel reinforcement, and subgrade just before placing concrete. Keep subgrade moisture uniform without standing water, soft spots, or dry areas.

1.14 FINISHES

A. Smooth-Formed Finish with Light Sandblast: As-cast concrete texture imparted by form-facing material, arranged in an orderly and symmetrical manner with a minimum of seams. Repair and patch tie holes and defective areas. Remove fins and other projections exceeding 1/8 inch in height. Do not apply rubbed finish to smooth-formed finish.

1. Apply light sandblast finish to formed surfaces to match Architect’s sample.

B. Related Unformed Surfaces: At tops of walls, horizontal offsets, and similar unformed surfaces adjacent to formed surfaces, strike off smooth and finish with a texture matching adjacent formed surfaces.

1. Continue final surface treatment of formed surfaces uniformly across adjacent unformed surfaces, unless otherwise indicated.

C. Maintain uniformity of special finishes over construction joints, unless otherwise indicated.

1.15 CONCRETE CURING

A. Protect freshly placed concrete from premature drying and excessive cold or hot temperatures according to ACI 301.

B. Begin curing immediately after removing forms from concrete. Cure by one or a combination of the following methods that will not mottle, discolor, or stain concrete:

1. Moisture Curing: Keep exposed surfaces of cast-in-place architectural concrete continuously moist for not less than seven days with the following materials:

a. Water.
b. Continuous water-fog spray.
c. Absorptive cover, water saturated and kept continuously wet. Cover concrete surfaces and edges with 12-inch lap over adjacent absorptive covers.

2. Curing Compound: Mist concrete surfaces with water. Apply curing compound uniformly in continuous operation by power spray or roller according to manufacturer's written instructions. Recoat areas subjected to heavy rainfall within three hours after initial application. Maintain continuity of coating and repair damage during curing period.

1.16 FIELD QUALITY CONTROL

A. General: Comply with Division 3 Section "Cast-in-Place Concrete" for field quality-control requirements.

1.17 REPAIRS, PROTECTION, AND CLEANING

A. Repair and cure damaged finished surfaces of cast-in-place architectural concrete when approved by Architect. Match repairs to color, texture, and uniformity of surrounding surfaces and to repairs on approved mockups.

1. Remove and replace cast-in-place architectural concrete that cannot be repaired and cured to Architect's approval.

B. Protect corners, edges, and surfaces of cast-in-place architectural concrete from damage; use guards and barricades.

C. Protect cast-in-place architectural concrete from staining, laitance, and contamination during remainder of construction period.

D. Clean cast-in-place architectural concrete surfaces after finish treatment to remove stains, markings, dust, and debris.

E. Wash and rinse surfaces according to concrete finish applicator's written recommendations. Protect other Work from staining or damage due to cleaning operations.

1. Do not use cleaning materials or processes that could change the appearance of cast-in-place architectural concrete finishes.

END OF SECTION 03331

SECTION 03450 - PLANT-PRECAST ARCHITECTURAL CONCRETE

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes the following:

1. Precast architectural concrete units.

1.2 PERFORMANCE REQUIREMENTS

A. Structural Performance: Provide precast architectural concrete units and connections capable of withstanding design loads within limits and under conditions indicated.

1.3 SUBMITTALS

A. Material Safety Data (MSD): MSD Sheets are required for all materials with detailed information on content, product safety, and potentially harmful characteristics. MSD Sheets shall be submitted by Contractor to the Architect for review prior to delivery or use of such materials on the project site. Product approval will depend, in part, upon meeting the environmental requirements of this specification, based upon MSD information submitted to the Architect for review.

B. Product Data: For each type of product indicated.

C. Design Mixes: For each concrete mix.

D. Shop Drawings: Detail fabrication and installation of precast architectural concrete units. Indicate member locations, plans, elevations, dimensions, shapes, cross sections, limits of finish, and types of reinforcement, including special reinforcement.

1. Comprehensive engineering analysis signed and sealed by a professional engineer registered and licensed in the State of Florida and responsible for its preparation.

E. Samples: Six samples of finish, color, and texture indicated; approximately 12 by 12 by 2 inches.

F. Qualification Data: For firms and persons specified in "Quality Assurance" Article to demonstrate their capabilities and experience. Include lists of completed projects with project names and addresses, names and addresses of architects and owners, and other information specified.

G. Material Certificates: Signed by manufacturers certifying that each of the following items complies with requirements:

1. Concrete materials.
2. Reinforcing materials and prestressing tendons.
3. Admixtures.
4. Water-absorption test reports.

1.4 QUALITY ASSURANCE

A. Installer Qualifications: An experienced installer who has completed precast architectural concrete work similar in material, design, and extent to that indicated for this Project and whose work has resulted in construction with a record of successful in-service performance.

B. Fabricator Qualifications: A firm that complies with the following requirements and is experienced in manufacturing precast architectural concrete units similar to those indicated for this Project and with a record of successful in-service performance.

1. Professional Engineer Qualifications: A professional engineer registered in the state of Florida and who is experienced in providing engineering services of the kind indicated. Engineering services are defined as those performed for installations of precast architectural concrete that are similar to those indicated for this Project in material, design, and extent.

a. Engineer shall assume responsibility for engineering precast architectural concrete units to comply with performance requirements. This responsibility includes preparation of Shop Drawings and comprehensive engineering analysis by a qualified professional engineer.

2. Participates in PCI's Plant Certification program and is designated a PCI-certified plant for Group A, Category A1--Architectural Cladding and Load Bearing Units or in APA's Plant Certification Program for Production of Architectural Precast Concrete Products and is designated an APA-certified plant.
3. Has sufficient production capacity to produce required units without delaying the Work.
4. Is registered with and approved by authorities having jurisdiction.

C. Testing Agency Qualifications: An independent testing agency, acceptable to authorities having jurisdiction, qualified according to ASTM C 1077 and ASTM E 329 to conduct the testing indicated, as documented according to ASTM E 548.

D. Design Standards: Comply with ACI 318 and the design recommendations of PCI MNL 120, "PCI Design Handbook--Precast and Prestressed Concrete."

E. Quality-Control Standard: For manufacturing procedures and testing requirements, quality-control recommendations, and dimensional tolerances for types of units required, comply with PCI MNL 117, "Manual for Quality Control for Plants and Production of Architectural Precast Concrete Products."

F. Preinstallation Conference: Conduct conference at Project site to comply with requirements of Division 1.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Deliver precast architectural concrete units to Project site in such quantities and at such times to ensure continuity of installation. Store units at Project site to prevent cracking, distorting, warping, staining, or other physical damage, and so markings are visible.

B. Lift and support units only at designated lifting and supporting points as shown on Shop Drawings.

1.6 SEQUENCING

A. Furnish anchorage items to be embedded in or attached to other construction without delaying the Work. Provide setting diagrams, templates, instructions, and directions, as required, for installation.

PART 2 - PRODUCTS

1.7 REINFORCING MATERIALS

A. Reinforcing Bars: ASTM A 615/A 615M, Grade 60, deformed.

B. Supports: Manufacturer's bolsters, chairs, spacers, and other devices for spacing, supporting, and fastening reinforcing bars and welded wire fabric in place according to CRSI's "Manual of Standard Practice," PCI MNL 117.

1.8 CONCRETE MATERIALS

A. Portland Cement: ASTM C 150, Type I or Type III, white, of same type, brand, and source.

B. Normal-Weight Aggregates: Except as modified by PCI MNL 117, ASTM C 33, with coarse aggregates complying with Class 5S.

C. Coloring Admixture: ASTM C 979, synthetic mineral-oxide pigments or colored water-reducing admixtures, temperature stable, nonfading, and alkali resistant.

D. Water: Potable; free from deleterious material that may affect color stability, setting, or strength of concrete and complying with chemical limits of PCI MNL 117.

E. Admixtures: Types recommended by the precast manufacturer for installation indicated.

1.9 BEARING PADS

A. Provide bearing pads for precast architectural concrete units as follows:

1. Elastomeric Pads: AASHTO M 251, plain, vulcanized, 100 percent polychloroprene (neoprene) elastomer, molded to size or cut from a molded sheet, 50 to 70 Shore A durometer, minimum tensile strength 2250 psi per ASTM D 412.
2. High-Density Plastic: Multimonomer, nonleaching, plastic strip.

1.10 CONCRETE MIXES

A. Normal-Weight Concrete Mixes: Proportion mixes by either laboratory trial batch or field test data methods according to ACI 211.1, with materials to be used on Project, to provide normal-weight concrete with the following properties:

1. Compressive Strength (28 Days): 5000 psi.
2. Maximum Water-Cementitious Materials Ratio: 0.45.

B. Prepare design mixes for each type of concrete required.

1. Limit use of fly ash and silica fume to not exceed, in aggregate, 25 percent of portland cement by weight.

C. Design mixes may be prepared by a qualified independent testing agency or by qualified precast plant personnel at precast architectural concrete fabricator's option.

D. Limit water-soluble chloride ions to the maximum percentage by weight of cement permitted by ACI 318.

E. Water Absorption: 12 to 14 percent by volume, tested according to PCI MNL 117.

F. Add air-entraining admixture at manufacturer's prescribed rate to result in concrete at point of placement having an air content complying with PCI MNL 117.

1.11 FABRICATION

A. Cast-in Anchors, Inserts, Plates, Angles, and Other Anchorage Hardware: Fabricate anchorage hardware with sufficient anchorage and embedment to comply with design requirements. Accurately position for attachment of loose hardware, and secure in

place during precasting operations. Locate anchorage hardware where it does not affect position of main reinforcement or concrete placement.

B. Furnish loose steel plates, clip angles, seat angles, anchors, dowels, cramps, hangers, and other hardware shapes for securing precast architectural concrete units to supporting and adjacent construction.

C. Reinforcement: Comply with recommendations in CRSI's "Manual of Standard Practice" and PCI MNL 117 for fabricating, placing, and supporting reinforcement.

1. Clean reinforcement of loose rust and mill scale, earth, and other materials that reduce or destroy the bond with concrete.
2. Accurately position, support, and secure reinforcement against displacement during concrete-placement and consolidation operations. Completely conceal support devices to prevent exposure on finished surfaces.
3. Place reinforcement to maintain at least 3/4-inch minimum coverage. Arrange, space, and securely tie bars and bar supports to hold reinforcement in position while placing concrete. Direct wire tie ends away from finished, exposed concrete surfaces.

D. Reinforce precast architectural concrete units to resist handling, transportation, and erection stresses.

E. Mix concrete according to PCI MNL 117 and requirements in this Section. After concrete batching, no additional water may be added.

F. Place concrete in a continuous operation to prevent seams or planes of weakness from forming in precast concrete units. Comply with requirements in PCI MNL 117 for measuring, mixing, transporting, and placing concrete.

G. Thoroughly consolidate placed concrete by internal and external vibration without dislocating or damaging reinforcement and built-in items. Use equipment and procedures complying with PCI MNL 117.

H. Comply with ACI 306.1 procedures for cold-weather concrete placement.

I. Comply with ACI 305R recommendations for hot-weather concrete placement.

J. Identify pickup points of precast architectural concrete units and orientation in structure with permanent markings, complying with markings indicated on Shop Drawings. Imprint or permanently mark casting date on each precast architectural concrete unit on a surface that will not show in finished structure.

K. Cure concrete, according to requirements in PCI MNL 117, by moisture retention without heat or by accelerated heat curing using low-pressure live steam or radiant heat and moisture.

L. Discard precast architectural concrete units that are warped, cracked, broken, spalled, stained, or otherwise defective unless repairs are approved by Architect.

1.12 FABRICATION TOLERANCES

A. Fabricate precast architectural concrete units straight and true to size and shape with exposed edges and corners precise and true so each finished panel complies with PCI MNL 117 product tolerances as well as position tolerances for cast-in items.

1.13 FINISHES

A. Finish: Match Architect's sample.

1. Finish exposed top and bottom surfaces of precast architectural concrete units to match face-surface finish.

1.14 SOURCE QUALITY CONTROL

A. Quality-Control Testing: Test and inspect precast concrete according to PCI MNL 117 requirements.

B. Defective Work: Precast architectural concrete units that do not comply with requirements, including strength, manufacturing tolerances, and finishes, are unacceptable. Replace with precast concrete units that comply with requirements.

PART 3 - EXECUTION

1.15 EXAMINATION

A. Examine substrates and conditions for compliance with requirements for installation tolerances, true and level bearing surfaces, and other conditions affecting performance. Proceed with installation only after unsatisfactory conditions have been corrected.

B. Do not install precast concrete units until supporting concrete has attained minimum design compressive strength.

1.16 INSTALLATION

A. Install clips, hangers, and other accessories required for connecting precast architectural concrete units to supporting members and backup materials.

B. Install precast architectural concrete. Provide temporary supports and bracing as required to maintain position, stability, and alignment as units are being permanently connected.

1. Install bearing pads as precast concrete units are being erected.
2. Maintain horizontal and vertical joint alignment and uniform joint width as erection progresses.

3. Remove projecting hoisting devices and use sand-cement grout to fill voids within recessed hoisting devices flush with surface of concrete.

C. Anchor precast architectural concrete units in position by bolting, welding, grouting, or as otherwise indicated. Remove temporary shims, wedges, and spacers as soon as possible after anchoring and grouting are completed.

1.17 ERECTION TOLERANCES

A. Install precast architectural concrete units level, plumb, square, true, and in alignment without exceeding the noncumulative erection tolerances of PCI MNL 117, Appendix I.

1.18 REPAIRS

A. Repair exposed exterior surfaces of precast architectural concrete units to match color, texture, and uniformity of surrounding precast architectural concrete if permitted by Architect.

B. Remove and replace damaged precast architectural concrete units if repairs do not comply with requirements.

1.19 CLEANING

A. Clean exposed surfaces of precast concrete units after erection to remove weld marks, other markings, dirt, and stains.

1. Wash and rinse according to precast concrete fabricator's written recommendations. Protect other work from staining or damage due to cleaning operations.
2. Do not use cleaning materials or processes that could change the appearance of exposed concrete finishes.

END OF SECTION 03450

SECTION 03520 - LIGHTWEIGHT CONCRETE ROOF INSULATION

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes cast-in-place lightweight insulating concrete for roof decks.

1.2 DEFINITIONS

A. Lightweight Concrete Roof Insulation: Low-density concrete, with an oven-dry unit weight not exceeding 50 lb/cu. ft., placed with or without embedded rigid insulation, and classified as follows:

1. Cellular Lightweight Concrete: Low-density concrete made with portland cement, water, and air-producing foaming agents.

1.3 SUBMITTALS

A. Material Safety Data (MSD): MSD Sheets are required for all materials with detailed information on content, product safety, and potentially harmful characteristics. MSD Sheets shall be submitted by Contractor to the Architect for review prior to delivery or use of such materials on the project site. Product approval will depend, in part, upon meeting the environmental requirements of this specification, based upon MSD information submitted to the Architect for review.

B. Product Data: For each type of product specified. Include mixing and application instructions for each type of lightweight insulating concrete.

1. Include lightweight insulating concrete design designations of a qualified testing and inspecting agency evidencing compliance with requirements.

C. Shop Drawings: Include plans, sections, and details showing roof slopes, insulation thickness, roof penetrations, roof perimeter terminations and curbs, control and expansion joints, and roof drains.

D. Design Mixes: For each lightweight insulating concrete mix, including as-cast unit weight, oven-dry unit weight, and compressive strength.

E. Material Test Reports: From a qualified independent testing agency evidencing compliance with requirements of the following based on comprehensive testing of current materials:

1. Thermal insulation value per ASTM C 177
2. Mix design compressive strength per ASTM C 495

3. Mix design wet and dry density range per ASTM C 495
4. Expanded polystyrene (EPS) density per ASTM C 578

F. Material Certificates: In lieu of agency test reports, when permitted by Architect, signed by lightweight insulating concrete manufacturer certifying that each material item complies with requirements.

G. Research Reports or Evaluation Reports: Reports of the model code organization acceptable to authorities having jurisdiction that evidence lightweight insulating concrete's compliance with building code in effect for Project.

1. Submit a sample copy of the warranty covering the proposed lightweight insulating concrete system.

1.4 QUALITY ASSURANCE

A. Installer Qualifications: Engage an certified, experienced Installer who has completed lightweight insulating concrete work similar in material, design, and extent to that indicated for this Project and who is acceptable to and certified by the manufacturer of primary materials.

B. Testing Agency Qualifications: To qualify for approval, an independent testing agency must demonstrate to Architect's satisfaction, based on evaluation of agency-submitted criteria conforming to ASTM C 1077 and ASTM E 329, that it has the experience and capability to satisfactorily conduct the testing indicated without delaying the Work.

C. Fire-Test-Response Characteristics: Where indicated, provide lightweight insulating concrete identical to that tested for fire resistance per ASTM E 119 by a testing and inspecting agency acceptable to authorities having jurisdiction.

1. Fire-Resistance Ratings: As indicated by design designations in UL "Fire Resistance Directory" or in the listing of another testing and inspecting agency acceptable to authorities having jurisdiction.

D. FM Listing: Provide lightweight insulating concrete evaluated by Factory Mutual as part of a roof assembly and listed in FM Research Corp.'s "Approval Guide" for Class 1 fire rating and Class 1-90 windstorm ratings.

E. Provide lightweight aggregates containing no detectable asbestos as determined by the method specified in EPA's 40 CFR Part 763, Subpart F, Appendix A, Section 1, "Polarized Light Microscopy."

1.5 DELIVERY, STORAGE, AND HANDLING

A. Deliver materials in manufacturer's original undamaged packages or acceptable bulk containers.

B. Store packaged materials to protect them from elements or physical damage.

C. Do not use cement that shows indications of moisture damage, caking, or other deterioration.

1.6 PROJECT CONDITIONS

A. General: Comply with manufacturer’s instructions and recommendations.

1.7 ROOF SYSTEM GUARANTEE

A. Roof System Guarantee: Upon successful completion of the project, and after all post installation procedures have been completed, furnish the Owner with the roofing system manufacturer’s fifteen (15) year warranty. The insulation system warranty shall include the composite roof deck system consisting of lightweight concrete roof insulation system. All repair or replacement costs covered under the guarantee shall be borne by the insulation system manufacturer. The guarantee shall be a term type, without deductibles or limitations on coverage amount, and be issued at no additional cost to the Owner. Specific items covered during the term of the insulation system warranty include:

1. The actual resistance to heat flow through the roof insulation will be at least 80% of the design thermal resistance, provided that the roofing membrane is free of leaks.
2. The roof insulation will remain in a re-roofable condition should the roof membrane require replacement (excluding damage caused by fastener pullout during removal of the old membrane.)
3. The Insulating Concrete Warranty will not limit, by geographic location, the owners rights for claims, actions, and/or proceedings.
4. The roof insulation material will not cause structural damage to the building as a result of expansion from thermal or chemical action.

B. Refer to Specification Section 07540, Thermoplastic Membrane Roofing for roof system guarantee requirements, which affect this Section.

PART 2 - PRODUCTS

1.8 LIGHTWEIGHT INSULATING CONCRETE ROOFING SYSTEM

A. Manufacturers: Subject to compliance with requirements, provide products manufactured by one of the following:

1. Cellular Lightweight Concrete:

a. Celcore Inc.
b. Elastizell Corporation of America.
c. Siplast Inc.

1.9 MATERIALS

A. Portland Cement: ASTM C 150, Type I, Type II, or Type III.

B. Insulation: Expanded polystyrene insulation board having a nominal density of one pound per cubic foot defined as Type 1 by ASTM C 578 and containing approximately 3% open area. The insulation shall carry the Factory Mutual approval label and the Underwriters Laboratories Classified label.

C. Foaming Agent: ASTM C 869 and ASTM C 796.

D. Water: Clean, potable and free of deleterious amounts of acid, alkali, and organic mateials.

E. Metal Deck: Refer to the Structural Drawings.

1.10 CELLULAR LIGHTWEIGHT CONCRETE

A. General: Design mix to produce lightweight concrete roof insulation with the following minimum physical properties using the minimum amount of water necessary to produce a workable mix.

1. Wet Density: 34 to 48 lb/cu. ft. at point of placement, when tested according to ASTM C 138.
2. Dry Density: 26 to 32 lb/cu. ft., when tested according to ASTM C 495.
3. Compressive Strength: Minimum 200 psi, when tested according to ASTM C 495.

PART 3 - EXECUTION

1.11 EXAMINATION

A. General: Comply with materials manufacturer’s instructions and recommendations regarding surface preparation, cleaning or other corrective measures to insure surfaces to receive lightweight insulating concrete are acceptable to the installer.

1. Do not begin placement of materials until surfaces are acceptable to the installer.

1.12 MIXING AND PLACING

A. General: Install lightweight insulating concrete materials according to manufacturer's recommendations. Mix and place lightweight insulating concrete according to manufacturer's instructions, using equipment and procedures to avoid segregation of mix and loss of air content.

1. Install the Lightweight Insulation System to provide for an average/minimum thermal value of R-19.
2. Install the Lightweight Insulation System to provide for a minimum positive roof slope of 1/4 inch per foot. See the structural drawings for slope provided by the roof framing system.
3. Avoid roof-top traffic over the roof insulation system until one can walk over the surface without creating surface damage.

1.13 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified independent testing agency, acceptable to Architect, to take samples and conduct tests to evaluate lightweight insulating concrete. Do not use same testing service that provided initial mix designs.

1. Take samples according to ASTM C 172, except as modified by ASTM C 495.
2. Determine as-cast unit weight during each hour of placement, according to ASTM C 138.
3. Determine compressive strength and oven-dry unit weight according to ASTM C 495. Make a set of at least 6 molds for each day's placement, but not less than 1 set of molds for each 5000 sq. ft. of roof area.

B. Report test results to Architect and lightweight insulating concrete producer within 24 hours of completion of each test.

C. Additional Tests: Make additional tests when test results indicate as-cast unit weight, compressive strength, oven-dry unit weight, or other requirements have not been met.

1. Retest in-place lightweight insulating concrete according to ASTM C 513 for compressive strength and oven-dry unit weight.

1.14 DEFECTIVE WORK

A. Refinish, or remove and replace, lightweight insulating concrete surfaces that are excessively scaled or too rough to receive roofing, according to current published requirements of roofing manufacturer.

B. Remove and replace lightweight insulating concrete that fails to meet compressive strength and oven-dry unit weight requirements.

END OF SECTION 03520