

SECTION 03 0505
UNDERSLAB VAPOR BARRIER

PART 1 GENERAL

1.01 REFERENCE STANDARDS

- A. ASTM E1643 - Standard Practice for Selection, Design, Installation and Inspection of Water Vapor Retarders Used in Contact with Earth or Granular Fill Under Concrete Slabs.
- B. ASTM E1745 - Standard Specification for Plastic Water Vapor Retarders Used in Contact with Soil or Granular Fill under Concrete Slabs.

1.02 SUBMITTALS

- A. See Section 01 3000 - Administrative Requirements, for submittal procedures.
- B. Product Data: Submit manufacturers' data on manufactured products.
- C. Samples: Submit samples of underslab vapor barrier to be used.
- D. Manufacturer's Installation Instructions: Indicate installation procedures and interface required with adjacent construction.

PART 2 PRODUCTS

2.01 MATERIALS

- A. Underslab Vapor Barrier:
 - 1. Water Vapor Permeance: Not more than 0.010 perms, maximum.
 - 2. Thickness: 15 mils.
 - 3. Basis of Design:
 - a. Stego Industries LLC; Pango Wrap Termite/Vapor Barrier (15-mil)
www.stegoindustries.com.
- B. Accessory Products: Vapor barrier manufacturer's recommended tape, adhesive, mastic, etc., for sealing seams and penetrations in vapor barrier.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that surface over which vapor barrier is to be installed is complete and ready before proceeding with installation of vapor barrier.

3.02 INSTALLATION

- A. Install vapor barrier in accordance with manufacturer's instructions and ASTM E1643.
- B. Install vapor barrier under interior slabs on grade; lap sheet over footings and seal to foundation walls.
- C. Lap joints minimum 6 inches.
- D. Seal joints, seams and penetrations watertight with manufacturer's recommended products and follow manufacturer's written instructions.
- E. No penetration of vapor barrier is allowed except for reinforcing steel and permanent utilities.
- F. Repair damaged vapor retarder before covering with other materials.

END OF SECTION

SECTION 03 1000
CONCRETE FORMING AND ACCESSORIES

PART 1 GENERAL

1.01 RELATED DOCUMENTS:

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

1.02 WORK INCLUDED:

- A. Formwork for cast-in-place concrete, with shoring, bracing, and anchorage.
- B. Openings for other affected work.
- C. Form accessories.
- D. Stripping forms.

1.03 WORK INSTALLED BUT FURNISHED UNDER OTHER SECTIONS:

- A. Section 05 50 00 - Miscellaneous Metals: Metal fabrications attached to formwork.
- B. Division 23 - Mechanical: Mechanical items attached to formwork.
- C. Division 26 - Electrical: Electrical items attached to formwork.

1.04 RELATED WORK:

- A. Section 03 20 00 - Concrete Reinforcement.
- B. Section 03 30 00 - Cast-In-Place Concrete.

1.05 REFERENCES:

- A. ACI 301 - Specifications for Structural Concrete for Buildings.
- B. ACI 318 - Building Code Requirements for Reinforced Concrete
- C. ACI 347 - Recommended Practice for Concrete Formwork.
- D. PS 1 - Construction and Industrial Plywood.

1.06 SYSTEM DESCRIPTION:

Design, engineer, and construct formwork, shoring, and bracing to meet design requirements, so that resultant concrete conforms to required shapes, lines and dimensions.

1.07 QUALITY ASSURANCE:

Construct and erect concrete formwork in accordance with ACI 301 and 347.

1.08 SUBMITTALS:

- A. Submit product data under provisions of Section 01 30 00.
- B. Product Data: Provide data on void form materials and installation requirements.

1.09 DELIVERY, STORAGE, AND HANDLING:

- A. Deliver, store and handle materials under provisions of Section 01 60 00.
- B. Deliver form materials in manufacturer's packaging with installation instructions.
- C. Store off ground in ventilated and protected area to prevent deterioration from moisture or damage.
- D. Remove packaging from void forms.

PART 2 PRODUCTS

2.01 DESIGN OF FORMWORK:

- A. Design, erect, support, brace and maintain formwork so that it will safely support all vertical and lateral loads that might be applied until such loads can be supported by the concrete structure.

Carry vertical and material loads to the ground by the formwork system and by the in-place construction that has attained adequate strength for that purpose. Construct formwork so that concrete members and structures are of the correct size, shape, alignment, elevation and position.

- B. Design forms to include assumed values of live load, dead load, weight of moving equipment operated on formwork, concrete mix, height of concrete drop, vibrator frequency, ambient temperature, foundation pressures, stresses, lateral stability, and other factors pertinent to safety of structure during construction.
- C. Provide temporary openings in wall forms, column forms and at other locations necessary to permit inspection and facilitate clean-out.
- D. Design formwork to be readily removable without impact, shock or damage to the cast-in-place concrete surfaces and adjacent materials.
- E. Provide formwork sufficiently tight to prevent leakage of cement paste during concrete placement. Solidly butt all joints and provide backup material at joints as may be required to prevent leakage and fins.

2.02 FORM MATERIALS:

- A. Forms for Exposed Finish Concrete:
 - 1. Unless otherwise shown or specified, construct all formwork for exposed concrete surfaces with plywood, metal, metal-framed plywood-faced or other panel type materials acceptable to the Architect, to provide continuous, straight smooth exposed surfaces. Furnish in the largest practicable sizes to minimize number of joints. Provide form material with sufficient thickness to withstand the pressure of newly placed concrete without bow or deflection.
 - 2. Unless otherwise shown or specified, use plywood complying with U.S. Product Standards PS-1, "B-B (Concrete Form) Plywood" Class I, Exterior Grade or better, mill-oiled and edge sealed, with each piece bearing the legible trademark of an approved inspection agency.
- B. Forms for Unexposed Finish Concrete:
 - 1. Form concrete surfaces which will be unexposed in the finished structure with plywood, boards, metal or other acceptable material. Provide lumber that is dressed on at least two edges and one side for a tight fit.
 - 2. Unless otherwise shown or specified, use either 6 inch or 8 inch boards, nominal one inch thick, or plywood as specified for exposed concrete, at Contractor's option.

2.03 FORMWORK ACCESSORIES:

- A. Form Ties: Removable or snap-off metal of adjustable length; 1-1/2 inch break back dimension; free of defects that will leave holes no larger than one inch diameter in concrete surface.
- B. Form Release Agent: Colorless mineral oil which will not stain concrete, or absorb moisture, or impair natural bonding or color characteristics of coating intended for use on concrete.
- C. Fillets for Chamfered Corners: Wood, metal, PVC, or rubber, to form the required corner of edge shapes as shown, 3/4" x 3/4" inch size, maximum possible lengths.
- D. Dovetail Anchor Slots: Minimum 24 gage thick galvanized steel; foam or fiber filled; release tape sealed slots; bent tab anchors; securable to concrete formwork; manufactured by AA Wire Products Company, Dur-O-Wall, or Heckmann Building Products.
- E. Nails, spikes, Lag Bolts, Through Bolts, Anchorage: Sized as required; of strength and character to maintain formwork in place while placing concrete.
- F. Void forms (carton forms): Moisture-resistant treated paper faces, biodegradable, structurally sufficient to support weight of concrete mix until initial set.

PART 3 EXECUTION

3.01 FORM CONSTRUCTION:

A. General:

1. Construct form complying with ACI 347, to the exact sizes, shapes, lines and dimensions shown, and as required to obtain accurate alignment, location, grades level and plumb work in the finished structures. Provide for openings, offsets, sinkages, keyways, recesses, moldings, rustications, reglets, chamfers, blocking, screeds, bulkheads, anchorages and inserts, and other features required on the work. Use selected materials to obtain the required finishes.
2. Fabricate forms for easy removal without hammering or prying against the concrete surfaces. Provide crush plates or wrecking plates where stripping may damage cast concrete surfaces. Provide top forms for inclined surfaces where the slope is too steep to place concrete with bottom forms only. Kerf wood inserts for forming keyways, reglets, recessed, and the like, to prevent swelling and assure ease of removal.
3. 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 set tightly to forms to prevent the loss of concrete mortar. Locate temporary openings on forms in an inconspicuous location as possible consistent with the requirements of the work.
4. Chamfer exposed external corners and edges where shown, using chamfer strips accurately fabricated to produce uniform smooth lines and tight edge joints.
5. Carefully form intersecting planes to provide true, clean-cut corners, with edge grain of plywood not exposed as form for concrete.
6. Provide all openings in form to accommodate other work, including mechanical and electrical work. Accurately place and securely support all items required to be built into forms.

B. Forms for Exposed Concrete:

1. Drill forms to suit ties used and to prevent leakage of concrete mortar around tie holes. Do not splinter forms by driving ties through improperly prepared holes.
2. Do not use metal cover plates for patching holes or defects in forms.
3. Provide sharp, clean corners at intersecting planes, without visible edges or offsets. Back joints with extra studs or girts to maintain true, square intersections.
4. Use extra studs, walers and bracing as required to prevent bowing of forms between studs and to avoid bowed appearance in concrete. Do not use narrow strips of form material which will produce bow.
5. Assemble forms so they may be readily removed without damage to exposed concrete surfaces.
6. Form molding shapes, recesses and projections with smooth-finish materials, and install in forms with sealed joints to prevent displacement.

C. Form Ties:

1. Provide factory-fabricated, adjustable-length, removable or snap-off metal form ties, designed to prevent form deflection, and to prevent spalling concrete surfaces upon removal.
2. Unless otherwise shown, provide ties so that the portion remaining within the concrete after removal of the exterior parts is at least 1-1/2 inches inside from the concrete surface. Unless otherwise shown, provide form ties which will not leave a hole larger than one inch in diameter in the concrete surface.
3. Form ties fabricated on the project site and wire ties are not acceptable.

D. Corner Treatment:

1. Form exposed corners of beams to produce square, smooth solid, unbroken lines, except as otherwise shown. "Exposed": concrete, is defined as concrete exposed to view in the finished structure, whether painted or unpainted.
 2. Where chamfered corners are indicated, form chamfers with 3/4" x 3/4" strips, unless otherwise shown, accurately formed and surfaced to produce uniformly straight lines and tight edge joints. Extend terminal edges to required limit and miter chamfer strips at changes in directions.
 3. Unexposed corners may be formed either square or chamfered.
- E. Control Joints: Locate where shown or directed. See Section 03 30 00, Cast-in-Place Concrete for treatment of control and construction joints, including wood screeds, metal keyways and sawcuts.
- F. Provisions for Other Trades: Provide openings in concrete formwork to accommodate work of other trades. Size and location of openings, recesses and chases are the responsibility of the trade requiring such items. Accurately place and securely support items.
- G. Cleanouts, Cleaning and Tightening: Provide temporary openings in forms as required to facilitate cleaning and inspection. Thoroughly clean forms and adjacent surfaces to receive concrete. Remove chips, wood, sawdust, dirt or other debris just before concrete is to be placed. Retighten forms immediately after concrete placement as required to eliminate mortar leaks.

3.02 EARTH CUTS:

Both faces of all grade beams shall be formed. Earth formed faces are not allowed.

3.03 TOLERANCES FOR FORMWORK CONSTRUCTION:

Construct formwork to provide completed concrete surfaces complying with the tolerances specified in ACI 301, after removal of forms and prior to patching and finishing of cast-in-place formed surfaces.

3.04 PREPARATION OF FORM SURFACES:

- A. Coat the contact surfaces of forms with a form-coating compound before reinforcement is placed. Provide commercial formulation form-coating compounds that will not bond with, stain, nor adversely affect concrete surfaces, and will not impair subsequent treatment of concrete surfaces requiring bond or adhesion, nor impede the wetting of surfaces to be cured with water or curing compounds. Apply in compliance with the manufacturer's instructions.
- B. Coat steel forms with a non-staining, rust-preventative form oil or otherwise protect against rusting. Rust-stained steel formwork is not acceptable.

3.05 REMOVAL OF FORMS:

- A. General: Formwork not supporting the weight of concrete, such as sides of beams, walls, columns, and similar parts of the work, may be removed 24 hours after placing the concrete, provided the concrete is sufficiently hard to not be damaged by the form removal operations, and provided that curing and protection operations are maintained.

3.06 RE-USE OF FORMS:

- A. Clean and repair the surfaces of forms that are to be re-used in the work, except that split, frayed, delaminated or otherwise damaged form facing material will not be acceptable. Apply new form coating compound material to all concrete contact form surfaces as specified for new formwork.
- B. When forms are extended for successive concrete placement, thoroughly clean surfaces, remove fins and laitance, and tighten forms to close all joints. Align and secure all joints to avoid offsets. Do not use "patched" forms for exposed concrete surfaces, except as acceptable to the Architect.

END OF SECTION

SECTION 03 2000
CONCRETE REINFORCING

PART 1 GENERAL

1.01 RELATED DOCUMENTS

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

1.02 WORK INCLUDED

- A. Reinforcing steel bars for cast-in place concrete.
- B. Support chairs, bolsters, bar supports, spacers, ties, and other accessories for supporting reinforcement.

1.03 RELATED WORK

- A. Section 03 10 00 - Concrete Formwork.
- B. Section 03 30 00 - Cast-In-Place Concrete.

1.04 SUBMITTALS

- A. Submit shop drawings under provisions of Section 01 30 00.
- B. Indicate fabrication, bending, and placement of concrete reinforcement. Comply with the ACI 315 "Manual of Standard Practice for Detailing Reinforced Concrete Structures." show bar schedules, stirrup spacing, diagrams of bent bars, arrangements and assemblies, as required for the fabrication and placement of concrete reinforcement.
- C. Submit mill test certificates of supplied concrete reinforcing, indicating physical and chemical analysis under provisions of Section 01 30 00.

1.05 QUALITY ASSURANCE

- A. Comply with the requirements for the following codes and standards, except as herein modified:
 - 1. American Concrete Institute, ACI 318 "Manual of Standard Practice for Detailing Reinforced Concrete Structures", and "Building Code Requirements for Reinforced Concrete."
 - 2. Concrete Reinforcing Steel Institute, "Manual of Standard Practice."
 - 3. Specifications for Structural Concrete for Buildings, ACI 301.
 - 4. ACI SP-66 - American Concrete Institute - Detailing Manual.
 - 5. ASTM A615 - Deformed and Plain Billet Steel Bars for Concrete Reinforcement.

1.06 DELIVERY, HANDLING AND STORAGE

- A. Deliver reinforcement to the project site bundled, tagged and marked. Use metal tags indicating bar size, lengths, and other information corresponding to markings shown on placement diagrams.
- B. Store concrete reinforcement materials and at the site to prevent damage an accumulation of dirt or excessive rust.

PART 2 PRODUCTS

2.01 MATERIALS

- A. Reinforcing Bars: ASTM A 615, deformed bars, uncoated finish.
 - 1. Provide Grade 60 for all reinforcing.
- B. Dowels: ASTM A 615, Grade 60, uncoated finish.
- C. Supports for Reinforcement: Bolsters, chairs, spacers and other devices for spacing, supporting and fastening reinforcement in place.
 - 1. Use wire bar type supports complying with CRSI recommendations, unless otherwise

indicated. Do not use wood, brick and other unacceptable materials.

2. For slabs on grade, use supports with sand plates or horizontal runners.
3. For exposed-to-view concrete surfaces, where legs of supports are in contact with forms, provide supports with either hot-dip galvanized or plastic protected or stainless steel protected legs, at Contractor's option.

D. Tie Wire: Minimum 16 gage annealed wire.

2.02 FABRICATION

- A. General: Fabricate reinforcing bars to conform to required shapes and dimensions, with fabrication tolerances complying with CRSI "Manual of Standard Practice." In case of fabricating errors, do not rebend or straighten reinforcement in a manner that will injure or weaken the material.
- B. Unacceptable Materials: Reinforcement with any of the following defects will not be permitted in the work:
 1. Bar lengths, depths and bends exceeding specified fabrication tolerances.
 2. Bends or kinks not indicated on drawings or final shop drawings.
 3. Bars with reduced cross-section due to excessive rusting or other cause.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Comply with the specified codes and standards, and Concrete Reinforcing Steel Institute ACI 318 recommended practice for "Placing Reinforcing Bars," for details and methods of reinforcement placement and supports, and as herein specified.
- B. Clean reinforcement to remove loose rust and mill scale, earth, ice, and other materials which reduce or destroy bond with concrete.
- C. Position, support and secure reinforcement against displacement by formwork, construction, or concrete placement operation. Locate and support reinforcing by metal chairs, runners, bolster, spacers and hangers, as required.
- D. Place reinforcement to obtain the minimum coverage for concrete protection. Arrange, space, and securely tie bars and bar supports together with 16 gage wire to hold reinforcement accurately in position during concrete placement operations. Set wire ties so that twisted ends are directed away from exposed concrete surfaces.
- E. Provide sufficient numbers of supports and of strength to carry reinforcement. Do not place reinforcing bars more than two inches beyond the 1st leg of any continuous bar support. Do not use supports as bases for runways for concrete conveying equipment and similar construction loads.
- F. Splices: Provide standard reinforcement splices by lapping ends, placing bars in contact, and tightly wire tying. Comply with requirements of ACI 318 for minimum lap of spliced bars. In slabs and beams reinforcing steel shall not be spliced at points of maximum stress unless otherwise indicated.

END OF SECTION

SECTION 03 3000
CAST-IN-PLACE CONCRETE

PART 1 GENERAL

1.01 RELATED DOCUMENTS

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

1.02 WORK INCLUDED

- A. Cast-in-place normal weight concrete consisting of Portland Cement, fine aggregate, coarse aggregate, water, admixtures; designed, proportioned, mixed, placed, finished and cured complete with joints, void boxes and embedded items as herein specified or required.

1.03 RELATED WORK

- A. Section 01 41 00 - Testing Laboratory Services.
- B. Section 31 63 29 – Drilled Piers.
- C. Section 03 10 00 - Concrete Formwork.
- D. Section 03 20 00 - Concrete Reinforcement.
- E. Section 07 90 05 – Caulking and Sealants.

1.04 SUBMITTALS

- A. Submit product data and Laboratory test reports under provisions of Section 01 30 00.
- B. Copies of manufacturer's specifications with application and installation instructions for proprietary materials and items, including admixtures, bonding agents, patching compounds, joint systems, non-shrink grout, vapor barrier, and floor finish materials.
- C. Copies of laboratory test reports for concrete materials and mix design test as specified.

1.05 REFERENCES

- A. ACI 211.1- Selecting Proportions for Normal and Heavyweight Concrete.
- B. ACI 301 - Specifications for Structural Concrete for Buildings.
- C. ACI 302 - Guide for Concrete Floor and Slab Construction.
- D. ACI 304 - Recommended Practice for Measuring, Mixing, and Placing Concrete.
- E. ACI 305R - Hot Weather Concreting.
- F. ACI 306R - Cold Weather Concreting.
- G. ACI 308 - Standard Practice for Curing Concrete.
- H. ACI 318 - Building Code Requirement for Reinforced Concrete.
- I. ASTM C33 - Concrete Aggregates.
- J. ASTM C94 - Ready-Mixed Concrete.
- K. ASTM C150 - Portland Cement.
- L. ASTM C260 - Air Entraining Admixtures for Concrete.
- M. ASTM C494 - Chemical Admixtures for Concrete.

1.06 QUALITY ASSURANCE

- A. Perform work in accordance with ACI 301.
- B. Where provisions of the above codes and standards are in conflict with the building code in force for this project, the building code shall govern.

- C. Contractor shall employ an independent Testing Laboratory, identified as Contractor's Testing Laboratory, to prepare concrete mix designs.
- D. Refer to Section 01 41 00 for testing by Owner's Testing Agency. Materials and installed work may require testing and retesting as directed by the Architect, at any time during progress of the work. Allow for access to material stockpiles and facilities at all times.
- E. Correct concrete work that does not conform to specified requirements, including strength, tolerances, finishes and color. Correct deficient strength as directed by the Architect.
- F. Acquire cement and aggregate from same source for all work.

1.07 TOLERANCES

- A. Maximum Variation of Surface Flatness for Exposed Concrete Floors: 1/8 inch in 10 feet.
- B. Maximum Variation of Surface Flatness Under Seamless Resilient Flooring: 1/8 inch in 10 feet.
- C. Maximum Variation of Surface Flatness Under Carpeting: 1/8 inch in 10 feet.
- D. In areas with floor drains, maintain floor elevation at walls. Pitch surfaces uniformly to drains at 1:50 minimal or greater if indicated on drawings.

PART 2 PRODUCTS

2.01 MATERIALS FOR CONCRETE

- A. Cements: ASTM C150, Type I, Gray.
- B. Admixtures: Use in compliance with the manufacturer's printed directions.
 - 1. Air-Entraining Admixtures: Comply with requirements of ASTM C260; Darex AEA, W. R. Grace; Sika Aer, Sika corp.; MB-VR or MB-AE, Master Builders.
 - 2. Water Reducing Admixture for Normal Use: comply with the requirements of ASTM C494, Type A, and contain no set-acceleration, or set retarding compounds, chlorides, fluorides, or nitrates; Pozzolith 344, Master Builders; Eucon WR-75, Euclid chemical Co.; Plastocrete 160, Sika Chemical Corp.; Chemtard, Chem-Mast Corp.
 - 3. Do not use calcium chloride in concrete. Do not use fly ash in concrete with exposed surfaces.
- C. Aggregates:
 - 1. For concrete of normal weight:
 - a. Coarse: ASTM C33, crushed stone.
 - b. Fine: ASTM C33.
 - 2. In proportioning, fine and coarse aggregates shall be regarded as separate ingredients. Each size of coarse aggregate, as well as combination of sizes when two or more are used, shall conform to the appropriate grading requirements of applicable ASTM specifications. Maximum sizes of aggregates shall be determined by proportioning requirements.
 - 3. Provide aggregates of each type from one source to ensure uniformity of color, size and shape.
 - 4. Maximum size of coarse aggregate: The nominal maximum size of the aggregate shall not be more than one-fifth of the narrowest dimension between sides of forms, one-third of the depth of slabs, nor three-fourths of the minimum clear spacing between reinforcing bars.
- D. Water: Clean, fresh, free from oil, acid, organic matter or other deleterious substances.

2.02 BONDING MATERIALS

- A. Concrete Bonding Agent: Provide an aqueous phase, film forming, freeze-thaw resistant compound suitable for brush or spray application complying with Mil-B-19235; Daraweld C, W. R. Grace; Weldcrete, Larsen Products Corp.; Euoweld, Euclid chemical; Vinl-Hesive, Nox-Crete Chemicals, Inc.

- B. Epoxy-Resin Bonding Agent: Provide a 2-component, mineral-filled, epoxy-sulfide polymer complying with FS MMM-G-650, Type I or Type II, grade A; Epoxite Grout, W.R. Grace; Sikastix, Sika Chemical Corp.; Epoxy Binder #38, Nox-Crete Chemicals, Inc.

2.03 JOINT MATERIALS

- A. Joint Fillers: Resilient, non-bituminous, Type I, semi-rigid, conforming to ASTM D1752.
- B. Control Joint Former: Plastic or galvanized; Armor Stresslock; Progress Unlimited Crack, Inducer.
- C. PVC Waterstops
 - 1. Polyvinyl chloride of the dumbbell type or centerbulb type, ribbed or deformed to prevent movement and shall have expandable center section. Waterstops shall comply with CE (Corps of Engineers) CRD-C572.
 - a. Manufacturers: Subject to compliance with requirements, provide products of one of the following:

AFCO Products	The Burke Co.
W. R. Meadows, Inc.	Progress Unlimited
Greenstreet Plastic Products	Vinylex Corp.
- D. Swellable Strip Waterstops: Earth Shield "TYPE 23" (or approved better); strips composed of butyl rubber and mastic; 3/8 inch (9.5 mm) by 3/4 inch (19 mm) by 25 foot (7.62 meter) roll.
 - 1. Properties:
 - a. Specific gravity — ASTM D71: 1.35
 - b. Hydrocarbon content — ASTM D4: 47%
 - c. Volatile matter — ASTM D6: 1%
 - d. Penetration cone in accordance with ASTM D217 at 77 degrees F (25 degrees C): 40 mm
 - e. Service temperature range: -30 to 180 degrees F (-34 to 82 degrees C)

2.04 FLOOR FINISH MATERIALS

- A. Liquid Chemical Floor Hardener Sealer (Sealed Concrete): Provide a colorless aqueous solution containing a blend of magnesium silicate and zinc silicate combined with a wetting agent, containing not less than 2 lbs of silicates per gallon; Harnolith, A.C. Horn/W.R. Grace; Saniseal 50, Master Builders Co.; Lithoplate, Protex Industries; Lapidolith, Sonenborn building Products; RIW Flintox Liquid, Toch Bros.; Harbeton, Nox-Crete Chemical, Inc. Provide slightly textured surface for slip resistance. Apply minimum of 3 coats at proportions recommended by manufacturer to achieve a complete seal. Provide in field mock up sample for approval in a non-conspicuous area such as storage closet or Janitor closet.

2.05 CONCRETE CURING MATERIALS

- A. Water: Clean and potable.
- B. Absorptive Cover: Burlap cloth made from jute or kenaf, weighing approximately 9 oz per sq yd and complying with AASHTO M 182, Class 3, or cotton mats complying with ASTM C440.
- C. Moisture-Retaining Cover: Waterproof paper, complying with ASTM C171, Type 1 or Type 2; Polyethylene sheeting, complying with AASHTO M 171; Polyethylene-coated burlap.
- D. Curing Compound: Liquid type membrane-forming curing compound complying with ASTM C309; use Type 1, clear with fugitive dye, for interior and exterior surfaces to receive applied finishes; Clear Seal, A.C. Horn/W.R. Grace; Sealkure, Toch Bros.; Kure-N-Seal, Sonneborn Building Products; Abco Cure & Seal, Nox-Crete Chemicals, Inc.

2.06 ACCESSORIES

- A. Vapor Barrier: 15 mil. Stego wrap, vapor permeability not more than 0.01 perms (ASTM E1745 test), resistant to decay in accordance with (ASTM E154). 15 mil Viper Vaporcheck II and Sealtight Perminator 15 mil are acceptable products.
- B. Void Boxes: Fiberboard per Section 03 10 00.

2.07 GROUTING MATERIALS

- A. Interior:
Non-Shrink grout, pre-mixed, factory-packaged, ferrous aggregate mortar grouting compound complying with CE (Corps of Engineers) CRD-C588, Type M; Embeco, Master Builders Co.; Ferrolith G, Sonneborn; Irontex, Toch Bros.
- B. Exterior:
Non-shrink grout, pre-mixed factory-packed, non-corrosive, metallic grout complying with CRD-C621; Ferrolith G-NC, Sonneborn-Contech.

2.08 PROPORTIONING AND DESIGN OF MIXES

- A. Contractor's Testing Laboratory shall proportion mixes by either laboratory trial batch or field experience methods, using materials to be employed on the project for each class of concrete required, complying with ACI 301 for normal weight concrete and structural lightweight concrete and other requirements specified herein. Submit written reports of each proposed mix prior to start of work. Do not begin concrete production until mixes have been reviewed by the Architect.
- B. Location, type, and minimum 28 day compressive strength of concrete shall be as follows:
Refer to General Notes.
- C. Slump Limits: Proportion and design mixes to result in concrete slump at point of placement as follows: Refer to General Notes
- D. The maximum allowable water to cement ratio shall not exceed 0.58, except water cement ratio for concrete subject to exterior exposure shall not exceed 0.5. Include all free water in the aggregate in all water-cement ratio computations.
- E. Use admixtures in mixes as specified below in amounts as recommended by the manufacturer for climatic conditions prevailing at time of placement. Adjust quantities and types of admixtures as required to maintain quality control.
 - 1. Use air entraining admixture in all concrete exposed to weather elements as manufacturer's prescribed rate to result in concrete at point of placement having an air content within following limits:
 - 5% for maximum 1-1/2" aggregate
 - 6% for maximum 1" aggregate
 - 6% for maximum 3/4" aggregate
 - 7% for maximum 1/2" aggregate
 - 2. Use air entraining admixture in concrete not exposed to weather in the amount recommended by manufacturer to improve workability, but the total air content of concrete shall not exceed 4 percent.
 - 3. Use water reducing admixture in all concrete except in piers and pavement and driveways. Its use is optional in piers.
- F. The criteria specified herein as maximum or minimums, and shall not be construed to pre-determine fixed quantities of materials in the mix design, or to preclude change of an accepted mix design at any time. Mix design adjustments may be requested by the Contractor when characteristics of materials, weather, test results, or other circumstances warrant; but such

adjustments shall be at no extra cost to the Owner, Laboratory test data for revised mix designs and strength results must be submitted to and accepted by the Architect before use in the work.

2.09 JOINTS AND EMBEDDED ITEMS

- A. Construction Joints:
 - 1. Locate and install construction joints, which are shown on the drawings, so as not to impair the strength of the structure, as acceptable to the Architect.
 - 2. At each construction joint in slabs form a troweled control joint 1/8 inch wide.
- B. Control Joints:
 - 1. Joint shall be located as shown on the drawings.
 - 2. Joint forms shall be placed while concrete is still plastic.
 - 3. Joint forms shall extend 1/4 of the slab thickness.
- C. Joint Sealant: All joints shall be filled with sealant in accordance with Section 07 92 00.
- D. Placing Embedded Items:
 - 1. Set and build into the 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 the items to be attached thereto.
 - 2. Set edge forms or bulkheads and intermediate screed strips for slabs to obtain the required elevations and contours in the finished slab surface. Provide and secure units sufficiently strong to support the types of screeds required. Align the concrete surfaces to the elevation of the screed strip by the use of strike-off templates or accepted compacting type screeds.
- E. Mechanical and electrical inserts, shall be installed.
- F. Embedded items shall be positioned accurately and supported against displacement. Voids in sleeves, inserts, and anchor slots shall be filled temporarily with readily removable material to prevent the entry of concrete into the voids.

2.10 MIXING OF CONCRETE

- A. Ready-Mixed Concrete: Comply with requirements of ASTM C94, and as herein specified. Proposed changes in mixing procedures, other than herein specified, shall be accepted by the Architect before implementation.
- B. During hot weather, or under conditions contributing to rapid setting of concrete, a shorter mixing time than specified in ASTM C94 may be required.
 - 1. When the air temperature is between 85 degrees F and 90 degrees F, reduce the mixing and delivery time from 1-1/2 hours to 75 minutes, and when the air temperature is above 90 degrees F, reduce the mixing and delivery time to 60 minutes.
- C. Certification: Furnish duplicate delivery tickets with each load of concrete delivered to the site. In addition to the requirements of ASTM C94, provide the following information on delivery tickets: Type and brand of cement, cement content per cu yd of concrete, maximum size of aggregate, amount and brand name of each admixture, total water content expressed as water/cement ratio.
- D. Weather Conditions:
 - 1. When air temperature has fallen to or is expected to fall below 45 degrees F, comply with recommendation of ACI 306 and as herein specified. Uniformly heat all water and aggregates before mixing as required 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. When hot weather conditions exist, comply with recommendations of ACI 305 and as herein specified. Cool ingredients before mixing to maintain concrete temperature at time of placement below 90 degrees F. Mixing water may be chilled, or chopped ice may be used to

control the concrete temperature provided the water equivalent of the ice is calculated to the total amount of mixing water.

PART 3 EXECUTION

3.01 CONCRETE PLACEMENT

- A. Pre-Placement Inspection: Before placing concrete, inspect and complete the formwork installation, reinforcing steel, and items to be embedded or cast in. Notify other crafts involved in ample time to permit the installation of their work, cooperate with other trades in setting such work, as required. Thoroughly wet wood forms immediately before placing concrete, as required where form coatings are not used.
- B. Conveying:
 - 1. Handle concrete from point of delivery and transfer to the concrete conveying equipment and to the locations of final deposit as rapidly as practicable by methods which will prevent segregation and loss of mix materials.
 - 2. Provide mechanical equipment of such size and design for conveying concrete to ensure a continuous flow of concrete at the delivery end. Provide runways for wheeled concrete conveying equipment from the concrete delivery point to the locations of final deposit. Keep interior surfaces of conveying equipment, including chutes, free of hardened concrete, debris, water, snow, ice, and other deleterious materials.
- C. General: 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 within the section. 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.
- D. Placing Concrete in Forms:
 - 1. Deposit concrete in forms in horizontal layers not deeper than 18 inches 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.
 - 2. Consolidate all concrete placed in forms by mechanical vibrating equipment supplemented by hand-spading, rodding or tamping. Use equipment and procedures for consolidation of concrete in accordance with ACI recommended practices.
 - 3. Do not use vibrators to transport concrete inside the forms. Insert and withdraw vibrators vertically at uniformly spaced locations not farther than the visible effectiveness of the machine. Do not insert vibrators into lower layers of concrete that have begun to set. At each insertion, limit the duration of vibration to the time necessary to consolidate the concrete and complete embedment of reinforcement and other embedded items without causing segregation of the mix.
- E. Placing Concrete Slabs:
 - 1. Deposit and consolidate concrete slabs in a continuous operation, within the limits of construction operation, within the limits of construction joints, until the placing of a panel or section is completed.
 - 2. Consolidate concrete during placing operations so that concrete is thoroughly worked around reinforcement and other embedded items and into corners.
 - 3. Bring slab surfaces to the correct level with a straight edge and strike off. Use bull floats or darbies to smooth surface, free of humps or hollows. Do not disturb slab surfaces prior to beginning finishing operations.
 - 4. Maintain reinforcing in the proper position during concrete placement operations.
- F. Hot Weather Placing:

1. When hot weather conditions exist that would seriously impair the quality and strength of concrete, place concrete in compliance with ACI 305 and as herein specified.
2. Cooling ingredients before mixing to maintain concrete temperature at time of placement below 90 degrees F. Mixing water may be chilled, or chopped ice may be used to control temperature provided water equivalent of ice is calculated to total amount of mixing water.
3. Cover reinforcing steel with water-soaked burlap if it becomes too hot, so that the steel temperature will not exceed the ambient air temperature immediately before embedment in concrete.
4. Fog spray forms, reinforcing steel and subgrade just before concrete is placed.
5. Do not use retarding admixtures.

G. Bonding:

1. Roughen surfaces of set concrete at all joints, except where bonding is obtained by use of a concrete bonding agent, and clean surfaces of laitance, coatings, loose particles, and foreign matter. Roughen surfaces in a manner to expose bonded aggregate uniformly and to not leave laitance, loose particles of aggregate, or damaged concrete at the surface.
2. Prepare for bonding of fresh concrete to new concrete that has been set but that is not fully cured, as follows:
 - a. At joints between walls or columns and beams or slabs they support, and elsewhere unless otherwise specified herein, dampen, but do not saturate, the roughened and cleaned surface of set concrete immediately before placing fresh concrete.
 - b. At joints in exposed work; at vertical joints in walls; at joints in beams and other structural members; dampen, but do not saturate, the roughened and cleaned surface of set concrete and apply a liberal coating of neat cement grout.
 - c. Use neat cement grout consisting of equal parts of Portland Cement and fine aggregate by weight and not more than 6 gallons of water per sack of cement. Apply with a stiff broom or brush to a minimum thickness of 1/16 inch. Deposit fresh concrete before cement grout has attained its initial set.
 - d. In lieu of neat cement grout, bonding grout may be a commercial concrete bonding agent. Apply to cleaned concrete surfaces in accordance with the printed instructions of the bonding material manufacturer.
3. Prepare for bonding of fresh concrete to fully-cured hardened concrete by using epoxy-resin bonding agent, as follows:
 - a. Mix the epoxy-resin adhesive binder in the proportions recommended by the manufacturer, carefully following directions for safety of personnel.
 - b. Before depositing fresh concrete, thoroughly roughen and clean hardened concrete surfaces and coat with epoxy-resin grout not less than 1/16 inch thick. Place fresh concrete while the epoxy-resin material is still tacky, without removing the in-place grout coat, and as directed by the epoxy-resin manufacturer.

3.02 CONCRETE SURFACE REPAIRS

A. Patching Defective Areas:

1. General: Repair and patch defective areas with cement mortar immediately after removal of forms, when acceptable to Architect.
2. Cut out honeycomb, rock pockets, voids over 1/4 inch diameter, and holes left by tie rods and bolts, down to solid concrete but, in no case, to a depth of less than one inch. Make edges of cuts perpendicular to the concrete surface. Thoroughly clean, dampen with water, and

brushcoat the area to be patched with neat cement grout. Proprietary patching compounds may be used when acceptable to the Architect.

3. For exposed to view surfaces, blend white Portland Cement and standard Portland Cement so that, when dry, the patching mortar will match the color of the surrounding concrete. Provide test areas at inconspicuous location to verify mixture and color match before proceeding with patching. Compact mortar in place and strike off slightly higher than the surrounding surface.

B. Repair of Formed Surfaces:

1. Repair exposed-to-view formed concrete surfaces, where possible, that contain defects which adversely affect the appearance of the finish. Remove and replace the concrete having defective surfaces if the defects cannot be repaired to the satisfaction of the Architect. Surface defects, as such, include color and texture irregularities, cracks, spalls, air bubbles, honeycomb, rock pockets, and holes left by the rods and bolts; fins and other projections on the surface; and stains and other discolorations that cannot be removed by cleaning.
2. Repair concealed formed concrete surfaces, where possible, that contain defects which adversely affect the durability of the concrete. If defects cannot be repaired, remove and replace the concrete having defective surfaces. Surface defects, as such, include cracks in excess of 0.01 inch wide, cracks of any width and other surface deficiencies which penetrate to the reinforcement or completely through non-reinforced sections, honeycomb, rock pockets, holes left by tie rods and bolts, and spalls except minor breakage at corners.

C. Repair of Unformed Surfaces:

1. Test unformed surfaces, such as monolithic slabs, for smoothness and to verify surface plane to the tolerances specified for each surface and finish. Correct low and high areas as herein specified.

Test unformed surfaces sloped to drain for trueness of slope, in addition to smoothness, using a template having the required slope. Correct low and high areas as herein specified.

2. Repair finished unformed surfaces that contain defects which adversely affect the durability of concrete. Surface defects, as such, include crazing, cracks in excess of 0.01 inch wide or which penetrate to reinforcement or completely through non-reinforced sections regardless of width, spalling, popouts, honeycomb, rock pockets, and other objectionable conditions.
3. Correct high areas in unformed surfaces by grinding, after the concrete has cured at least 14 days.
4. Correct low areas in unformed surfaces during, or immediately after completion of surface finishing operations by cutting out the low areas and replacing with fresh concrete. Finish repaired areas to blend into adjacent concrete. Proprietary patching compounds may be used when acceptable to the Architect.
5. Repair defective areas, except random cracks and single holes not exceeding one inch diameter, but cutting out and replacing with fresh concrete. Remove defective areas to sound concrete with clean, square cuts, and expose reinforcing steel with at least 3/4 inch clearance all around. Dampen concrete surfaces in contact with patching concrete, and brush with a neat cement grout coating or concrete bonding agent. Mix patching concrete of the same materials to provide concrete of the same type of class as original concrete. Place, compact and finish to blend with adjacent finished concrete. Cure in the same manner as adjacent concrete.
6. Repair isolated random cracks and single holes not over one inch diameter by the dry-pack method. Groove the top of cracks, and cut out holes to sound concrete and clean of dust, dirt and loose particles. Dampen cleaned concrete surfaces and apply bonding compound. Brush with a neat cement grout coating. Mix dry-pack, consisting of one part Portland Cement to 2-1/2 parts fine aggregate passing No. 16 mesh sieve, using only enough water as required for handling and placing. Place dry-pack after bonding compound has dried. Compact dry-pack

mixture in place and finish to match adjacent concrete. Keep patched areas continuously moist for not less than 72 hours.

7. Repair methods not specified above may be used, subject to the acceptance of the Architect.

3.03 FINISHING OF FORMED SURFACES

A. Rough Form Finish:

1. Provide rough form finish to concrete formed surfaces not exposed to view in the finish work or by other construction, unless otherwise indicated.
2. Standard rough form finish to concrete surface having the texture imparted by the form facing material used, with tie holes and defective areas repaired and patched, and fins and other projections exceeding 1/4 inch in height rubbed down or chipped off.

B. Smooth Form Finish:

1. Provide smooth form finish for all concrete formed surfaces that are to be exposed-to-view, or that are to be covered with a coating material applied directly to the concrete or a covering material bonded to the concrete such as waterproofing, dampproofing, painting, or other similar system.
2. Smooth form finish shall be the as-cast concrete surface as obtained with the form facing material, with defective areas repaired and patched, and all fins and other projections on the surface completely removed and smoothed.

- #### **C. 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 the adjacent formed surfaces. Continue the final surface treatment of formed surfaces uniformly across the adjacent unformed surfaces, unless otherwise indicated.

3.04 MONOLITHIC SLAB FINISHES

A. Scratch Finish:

1. Apply scratch finish to monolithic slab surfaces that are to receive mortar setting bed for tile.
2. After placing slabs, plane surface so that depressions between high spots do not exceed 1/4" under a 10' straightedge. Slope surfaces uniformly to drain where required. After leveling, roughen surface before final set, with stiff brushes, broom or rakes.

B. Floated Finish:

1. Apply floated finish to monolithic slab surfaces that are to receive trowel finish and other finishes as hereinafter specified.
2. After screeding, consolidating, and leveling concrete slabs, do not work surface until ready for floating. Begin floating when surface water has disappeared or when concrete has stiffened sufficiently to permit operation of power-driven floats. Consolidate surface with power-driven floats, or by hand-floating if area is small or inaccessible to power units. Check and level the surface plane to a tolerance not exceeding 1/4 inch in 10 feet when tested with a 10 foot straightedge placed on the surface at not less than two different angles. Cut down high spots and fill all low spots. Uniformly slope surfaces to drains. Immediately after leveling, refloat surface to a uniform, smooth, granular texture.

C. Trowel Finish:

1. Apply trowel finish to monolithic slab surfaces that are to be exposed to view, and slab surfaces to be covered with resilient flooring, carpet, tile and other floor finishes.
2. After floating, begin the first trowel finish operation using a power-driven trowel. Begin final troweling when the surface produces a ringing sound as the 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 plane tolerance not exceeding 3/16" x 10' when

tested with a 10 foot straightedge. Grind smooth surface defects which would telegraph through applied floor covering system.

D. Non-Slip Broom Finish:

1. Apply non-slip broom finish to exterior concrete platform, steps, and elsewhere as indicated.
2. Immediately after trowel finishing, slightly roughen concrete surface by brooming with fiber bristly broom perpendicular to the main traffic route. Coordinate required final finish with the Architect before application.

E. Polished Finish:

1. Consult with the architect regarding the finish required for polished concrete surfaces.
2. 30 days minimum prior to slab placement, prepare a 4'x4' sample slab with a polished finish for the Architect's approval.

3.05 CONCRETE CURING AND PROTECTION

A. General:

1. Protect freshly placed concrete from premature drying and excessive cold or hot temperature.
2. Start curing as soon as free water has disappeared from concrete surface after placing and finishing. Weather permitting, keep continuously moist for not less than 7 days.
3. Freshly placed concrete shall be maintained in a moist condition for at least 7 days after placing. Each day the forms are left in place and kept wet enough to prevent the opening of joints in the forms and the drying out of the concrete will counted as one day of curing.

B. Preservation of Moisture: Perform curing of concrete by moisture curing, by moisture-retaining cover curing, by membrane curing, and by combinations thereof, as herein specified.

1. Provide moisture curing by any of the following methods:
 - a. Keeping the surface of the concrete continuously wet by covering with water.
 - b. Continuous water-fog spray.
 - c. Covering concrete surface with the specified absorptive cover, thoroughly saturating cover with water, and keeping continuously wet. Place absorptive cover to provide coverage of concrete surfaces and edges, with maximum 4 inch lap over adjacent absorptive covers.
2. 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 inches and sealed by waterproof tape or adhesive. Immediately repair any holes or tears during the curing period using cover material and waterproof tape.
3. Provide membrane curing as follows:
 - a. Apply the specified membrane forming and curing compound to damp concrete surfaces as soon as the water film has disappeared. Apply uniformly in a two-coat continuous operation by power spray equipment in accordance with the manufacturer's directions. Re-coat areas which are subjected to heavy rainfall within 3 hours after initial application. Maintain the continuity of the coating and repair damage to the coat during the entire curing period.
 - b. Do not use membrane curing compounds on slabs on grade or on surfaces which are to be covered with a coating material applied directly to the concrete or with a covering material bonded to the concrete, such as other concrete, liquid floor hardener, waterproofing, dampproofing, membrane roofing, flooring, and other coatings and finish materials.
 - c. Do not use membrane curing compound at any areas to receive stain concrete finish.

C. Curing Formed Surfaces: Cure formed concrete surfaces, including the undersides of beams, and other similar surfaces by moist curing with the forms in place for the full curing period until forms

are removed. If forms are removed, continue curing by any of the methods specified above, as applicable.

D. Curing Unformed Surfaces:

1. Initially cured unformed surfaces, such as slabs, and other flat surfaces by moist curing.
2. Final cure unformed surfaces, unless otherwise specified, by any of the methods specified above, as applicable.
3. Final cure concrete surfaces to receive liquid floor hardener or finish flooring by use of moisture-retaining cover, unless otherwise directed.

E. Temperature of Concrete During Curing:

1. When the atmospheric temperature is 40 degrees F and below, maintain the concrete temperature at not less than 55 degrees F continuously throughout the curing period. When necessary, make arrangements before concrete placing for heating, covering insulation or housing as required to maintain the specified temperature and moisture conditions continuously or the concrete curing period. Provide cold weather protections complying with the requirements of ACI 306.
2. When the atmospheric temperature is 80 degrees F and above, or during other climatic conditions which will cause too rapid drying of the concrete, make arrangements before the start of concrete placing for the installation of wind breaks or shading, and for fog spraying, wet sprinkling, or moisture-retaining covering. Protect the concrete continuously for the concrete curing period. Provide hot weather protections complying with the requirements of ACI 305.
3. Maintain concrete temperature as uniformly as possible, and protect from rapid atmospheric temperature changes. Avoid temperature changes in concrete which exceed 5 degrees F in any one hour and 50 degrees F in any 24-hour period.
4. Protection from Mechanical Injury: During the curing period, protect concrete from damaging mechanical disturbances including load stresses, heavy shock, excessive vibration, and from damage caused by rain or flowing water. Protect all finished concrete surfaces from damage by subsequent operations.

3.06 MISCELLANEOUS CONCRETE ITEMS

- A. Filling-In: Fill-in holes and openings left in concrete structures for the passage of work by other trades, unless otherwise shown or directed, after the work of other trades is in place. Mix, place and cure concrete as herein specified, to blend with in-place construction. Provide all other miscellaneous concrete filling shown or required to complete the work.
- B. Vapor Barrier Under Slabs-On-Fill: Refer to structural notes for exact placement of vapor barrier under slabs-on-fill.

3.07 EVALUATION AND ACCEPTANCE OF CONCRETE

- A. Evaluation of Quality Control Tests: The concrete quality control testing as hereinbefore specified will be evaluated by the following criteria.
 1. Do not use concrete delivered to the final point of placement which has a slump or total air content outside the values specified.
 2. Compressive strength tests will be considered satisfactory if the average of any group of three consecutive compressive strength tests which may be selected, is in each instance equal to or greater than the 28-day design compressive strength of the type or class of concrete; and no individual strength test result falls below 90 percent of the specified 28-day compressive strength.

3. If the compressive strength tests fail to meet the minimum requirements specified, the concrete represented by such tests will be considered deficient in strength and subject to additional testing as herein specified.
- B. Strength of Concrete Structures: The strength of the concrete structure-in-place will be considered potentially deficient if it fails to comply with any of the requirements which control the strength of structure.
 - C. Testing Concrete Structure for Strength: When there is evidence that the strength of the concrete structure in-place does not meet specification requirements, the concrete testing service shall take cores drilled from hardened concrete for compressive strength determination, complying with ASTM C 42.
 1. Strength of concrete for each series of cores will be considered satisfactory if their average compressive strength is at least 90 percent of the 28-day design compressive strength and if no single core is less than 75 percent of specified 28-day compressive strength.
 - E. Fill core holes solid with patching mortar, and finish to match adjacent concrete surfaces.
 - F. Exterior Dog runs and areas indicated in the Documents, shall have sealed concrete

END OF SECTION

SECTION 03 3300
ARCHITECTURAL CONCRETE

PART 1 - GENERAL

1.01 SUMMARY

- A. Section includes cast-in-place architectural concrete, including form facings, reinforcement and accessories, concrete materials, concrete mixture design, placement procedures, and finishes.

1.02 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at Project site.

1.03 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Design Mixtures: For each concrete mixture.
- C. Formwork Shop Drawings.
- D. Placement schedule.
- E. Samples: For each of the following materials:
 - 1. Form-facing panels.
 - 2. Form ties.
 - 3. Exposed aggregates.
 - 4. Coarse- and fine-aggregate gradations.
 - 5. Chamfers and rustications.

1.04 INFORMATIONAL SUBMITTALS

- A. Material certificates.
- B. Material test reports.

1.05 QUALITY ASSURANCE

- A. Field Sample Panels: After approval of verification sample and before casting architectural concrete, produce field sample panels to demonstrate the approved range of selections made under Sample submittals. Produce a minimum of three sets of full-scale panels, cast vertically, approximately 48 by 48 by 6 inches minimum, to demonstrate the expected range of finish, color, and texture variations.
- B. Mockups: Before casting architectural concrete, build mockups to verify selections made under Sample submittals and to demonstrate typical joints, surface finish, texture, tolerances, and standard of workmanship. Build mockups to comply with the following requirements, using materials indicated for the completed Work:

1.06 PRECONSTRUCTION TESTING

- A. Preconstruction Testing Service: Engage a qualified testing agency to perform preconstruction testing on concrete mixtures.

1.07 FIELD CONDITIONS

- A. Cold-Weather Placement: Comply with ACI 306.1.
- B. Hot-Weather Placement: Comply with ACI 301.

PART 2 - PRODUCTS

2.01 CONCRETE, GENERAL

- A. ACI Publications: Comply with the following unless modified by requirements in the Contract Documents:
 - 1. ACI 301.
 - 2. ACI 303.1.

2.02 FORM-FACING MATERIALS

- A. General: Comply with Section 033000 "Cast-in-Place Concrete" for formwork and other form-facing material requirements.
- B. Form-Facing Panels for As-Cast Finishes: Steel- and glass-fiber-reinforced plastic, or other approved nonabsorptive panel materials that provide continuous, true, and smooth architectural concrete surfaces. Furnish in largest practicable sizes to minimize number of joints.
- C. Rustication Strips: Metal or rigid plastic, or with sides beveled and back kerfed; nonstaining; in longest practicable lengths.
- D. Chamfer Strips: Metal, rigid plastic, elastomeric rubber, or dressed wood, 3/4 by 3/4 inch, minimum; nonstaining; in longest practicable lengths.
- E. Form Joint Tape: Compressible foam tape; pressure sensitive; AAMA 800; minimum 1/4 inch thick.
- F. Form Ties: Factory-fabricated, removable ties designed to resist lateral pressure of fresh concrete on forms and to prevent spalling of concrete on removal.

2.03 STEEL REINFORCEMENT AND ACCESSORIES

- A. General: Comply with Section 033000 "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; manufactured according to CRSI's "Manual of Standard Practice."
 - 1. Where legs of wire bar supports contact forms, use gray, all-plastic or CRSI Class 1, gray, plastic-protected bar supports.

2.04 CONCRETE MATERIALS

- A. Source Limitations: Obtain each type or class of cementitious material of the same brand from the same manufacturer's plant, obtain aggregate from single source, and obtain admixtures from single source from single manufacturer.
- B. Cementitious Materials:
 - 1. Portland Cement: ASTM C 150, Type I/II gray.
 - 2. Fly Ash: ASTM C 618.
 - 3. Silica Fume: ASTM C 1240 amorphous silica.
- C. Normal-Weight Aggregates: Use normal weight coarse aggregates that conform to ASTM C 33, Class 5S or Class 5M coarse aggregate.
 - 1. Maximum Coarse-Aggregate Size: 3/4 inch.
- D. Normal-Weight Fine Aggregate: ASTM C 33, manufactured or natural sand, from same source for entire Project.
- E. Air-Entraining Admixture: ASTM C 260.
- F. Chemical Admixtures: Certified by manufacturer to be compatible with other admixtures and that does not contribute water-soluble chloride ions exceeding those permitted in hardened concrete. Do not use calcium chloride or admixtures containing calcium chloride.
 - 1. Water-Reducing Admixture: ASTM C 494, Type A.
 - 2. Retarding Admixture: ASTM C 494, Type B.
 - 3. Water-Reducing and Retarding Admixture: ASTM C 494, Type D.
 - 4. High-Range, Water-Reducing Admixture: ASTM C 494, Type F.
 - 5. High-Range, Water-Reducing and Retarding Admixture: ASTM C 494, Type G.
 - 6. Plasticizing and Retarding Admixture: ASTM C 1017, Type II.

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

2.05 CURING MATERIALS

- A. Absorptive Cover: AASHTO M 182, Class 2, burlap cloth made from jute or kenaf, weighing approximately 9 oz./sq. yd. when dry.
- B. Moisture-Retaining Cover: ASTM C 171, polyethylene film or white burlap-polyethylene sheet.
- C. Waterborne, Membrane-Forming Curing Compound: ASTM C 309, Type 1, Class B.
 - 1. For integrally colored concrete, curing compound shall be approved by color pigment manufacturer.
 - 2. For concrete indicated to be sealed, curing compound shall be compatible with sealer.

2.06 CONCRETE MIXTURES

- A. Prepare design mixtures for each type and strength of cast-in-place architectural concrete proportioned on basis of laboratory trial mixture or field test data, or both, according to ACI 301.
 - 1. Use a qualified independent testing agency for preparing and reporting proposed design mixtures based on laboratory trial mixtures.
- B. Cementitious Materials: For cast-in-place architectural concrete exposed to deicers, limit percentage, by weight, of cementitious materials other than portland cement according to ACI 301 requirements. Use fly ash, pozzolan, slag cement, and silica fume as needed to reduce the total amount of portland cement, which would otherwise be used, by not less than 40 percent.
- C. Color Pigment: Add color pigment to concrete mixture according to manufacturer's written instructions and to result in hardened concrete color consistent with approved mockup.
- D. Concrete Mixtures:
 - 1. Compressive Strength (28 Days): Refer to General Notes.
 - 2. Maximum W/C Ratio: Refer to General Notes.
 - 3. Slump Limit: Refer to General Notes.
 - 4. Air Content: Refer to General Notes.

2.07 CONCRETE MIXING

- A. Ready-Mixed Architectural Concrete: Measure, batch, mix, and deliver concrete according to ASTM C 94/C 94M and furnish batch ticket information.
 - 1. Clean equipment used to mix and deliver cast-in-place architectural concrete to prevent contamination from other concrete.
 - 2. When air temperature is between 85 and 90 deg F, reduce mixing and delivery time from 1-1/2 hours to 75 minutes; when air temperature is above 90 deg F, reduce mixing and delivery time to 60 minutes.

PART 3 - EXECUTION

3.01 FORMWORK INSTALLATION

- A. General: Comply with Section 033000 "Cast-in-Place Concrete" for formwork, embedded items, and shoring and reshoring.
- B. Limit deflection of form-facing panels to not exceed ACI 303.1 requirements.
- C. In addition to ACI 303.1 limits on form-facing panel deflection, limit cast-in-place architectural concrete surface irregularities, designated by ACI 347 as abrupt or gradual, as follows:
 - 1. Class B, 1/4 inch.
- D. Construct forms to result in cast-in-place architectural concrete that complies with ACI 117 (ASI 117M).
- E. Chamfer exterior corners and edges of cast-in-place architectural concrete.

- F. Clean forms and adjacent surfaces to receive concrete. Remove chips, wood, sawdust, dirt, and other debris just before placing concrete.
- G. Retighten forms and bracing before placing concrete, as required, to prevent mortar leaks and maintain proper alignment.

3.02 REINFORCEMENT AND INSERT INSTALLATION

- A. General: Comply with Section 033000 "Cast-in-Place Concrete" for fabricating and installing steel reinforcement. Securely fasten steel reinforcement and wire ties against shifting during concrete placement.
- B. Set wire ties with ends directed into concrete, not toward exposed concrete surfaces.

3.03 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 if concrete is hard enough to not be damaged by form-removal operations and curing and protection operations are maintained.
 - 1. Cut off and grind glass-fiber-reinforced plastic form ties flush with surface of concrete.
- B. 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 cast-in-place architectural concrete surfaces.

3.04 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.
- 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.

3.05 CONCRETE PLACEMENT

- A. Do not add water to concrete during delivery, at Project site, or during placement.
- B. Deposit concrete continuously between construction joints. Deposit concrete to avoid segregation.

3.06 FINISHES, GENERAL

- A. Architectural Concrete Finish: Match Architect's design reference sample, identified and described as indicated, to satisfaction of Architect.
- 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.

3.07 CONCRETE CURING

- A. Begin curing cast-in-place architectural concrete immediately after removing forms from concrete. Cure according to ACI 308.1, by one or a combination of the following methods that will not mottle, discolor, or stain concrete:
 - 1. Moisture curing.
 - 2. Moisture-retaining-cover curing.
 - 3. Curing compound.

3.08 FIELD QUALITY CONTROL

- A. General: Comply with field quality-control requirements in Section 033000 "Cast-in-Place Concrete."

3.09 REPAIR, 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.

END OF SECTION

**SECTION 03 3511
CONCRETE FLOOR FINISHES**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Surface treatments for concrete floors and slabs.

1.02 ADMINISTRATIVE REQUIREMENTS

- A. Coordinate the work with concrete floor placement and concrete floor curing.

1.03 SUBMITTALS

- A. See Section 01 3000 - Administrative Requirements, for submittal procedures.
- B. Product Data: Manufacturer's published data on each finishing product, including information on compatibility of different products and limitations.
- C. Maintenance Data: Provide data on maintenance and renewal of applied finishes.

1.04 MOCK-UP

- A. For coatings, construct mock-up area under conditions similar to those that will exist during application, with coatings applied.
- B. Mock-Up Size: 10 feet square.
- C. Locate where determined in the field by Owner and Architect.
- D. Mock-up may remain as part of the work.

1.05 DELIVERY, STORAGE, AND HANDLING

- A. Deliver materials in manufacturer's sealed packaging, including application instructions.

1.06 FIELD CONDITIONS

- A. Maintain ambient temperature of 50 degrees F minimum.

PART 2 PRODUCTS

2.01 CONCRETE FLOOR FINISH APPLICATIONS

- A. Unless otherwise indicated, all concrete floors are to be finished using Densifier / Hardner, Penetrating Sealers, Stain & Polish.
- B. Liquid Densifier/Hardener:
 - 1. Use at following locations: As required for specific finishes.
- C. Concrete Stain:
 - 1. Use at following locations: As indicated on the contract drawings.
- D. Penetrating Clear Sealer:
 - 1. Use at following locations: As indicated on the contract drawings.
- E. High Gloss Clear Sealer:
- F. Polished Finish:
 - 1. Use at following locations: As indicated on the contract drawings.

2.02 DENSIFIERS AND HARDENERS

- A. Liquid Densifier/Hardener: Penetrating chemical compound that reacts with concrete, filling the pores and dustproofing; for application to concrete after set.
 - 1. Products:
 - a. Bomanite Stabilizer Pro: Proprietary water based liquid hardener based on Lithium Silicate with Silane additives containing no VOC's applied at three points of the installation process formulated to chemically harden and improve the density of concrete .

- b. Bomanite Stain Guard: Proprietary water based liquid hardener with additional stain resistant properties based on Lithium Silicate and Methacrylate additives containing <50 g/l VOC applied as the final step of the installation process formulated to chem.
- c. Substitutions: See Section 01 6000 - Product Requirements.

2.03 COATINGS

- A. Concrete Stain or Dye: Translucent, penetrating compound for interior or exterior use; must be finished with a topical sealer.
 - 1. Composition: Stain product compatible with Bomanite polishing process.
 - 2. Number of Coats: As required.
 - 3. Primary Color: TBD from stain manufacturer's full range of colors, _____.
 - 4. Application:
 - a. Primary Color: As required.
- B. Penetrating Sealer: Transparent, non-yellowing, water-based coating.
 - 1. Composition: _____.
 - 2. Products:
 - a. Ashford Formula - www.ashfordformula.com.

2.04 POLISHED CONCRETE SYSTEM

- A. Polished Concrete System: Materials, equipment, and procedures designed and furnished by a single manufacturer to produce dense polished concrete of the specified sheen.
 - 1. Acceptable Systems:
 - a. VitraFlor by Bomanite—Exposure of aggregate: Concrete to be ground to a full sand exposure with minimal top size aggregate exposure (minimum starting grit of 150 metal bond) and polished to 3,000 grit..

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that floor surfaces are acceptable to receive the work of this section.
- B. Verify that flaws in concrete have been patched and joints filled with methods and materials suitable for further finishes.

3.02 GENERAL

- A. Apply materials in accordance with manufacturer's instructions.

3.03 COATING APPLICATION

- A. Verify that surface is free of previous coatings, sealers, curing compounds, water repellents, laitance, efflorescence, fats, oils, grease, wax, soluble salts, residues from cleaning agents, and other impediments to adhesion.
- B. Protect adjacent non-coated areas from drips, overflow, and overspray; immediately remove excess material.
- C. Apply coatings in accordance with manufacturer's instructions, matching approved mock-ups for color, special effects, sealing and workmanship.

3.04 CONCRETE POLISHING

- A. Execute using materials, equipment, and procedures specified by manufacturer, using manufacturer approved installer.
 - 1. Final Polished Sheen: Semigloss finish; other sheens are included as comparison to illustrate required sheen; final sheen is before addition of any sealer or coating, regardless of whether that is also specified or not.
 - 2. Semi-Gloss Finish: Reflecting overhead and side images from 35 to 45 feet away.

END OF SECTION

SECTION 03 4113

PRECAST CONCRETE HOLLOW-CORE PLANKS

PART 1 GENERAL

1.01 DESCRIPTION OF WORK

- A. Work Included: Furnish and install all precast concrete hollow core slabs, bearing pads and other items necessary to complete the work shown on Drawings and as specified herein, including all necessary prestressing and mild steel reinforcement and grouting hollow core slab joints. Perform all required tests and inspections.
- B. Related Work Specified Elsewhere:
 - 1. Testing laboratory services: Section 01 41 00
 - 2. Concrete reinforcement: Section 03 20 00
 - 3. Cast-in-place concrete: Section 03 30 00

1.02 SUBMITTALS

- A. Concrete Mix Design: Submit to Architect and Owner's testing laboratory copies of proposed mix designs, prepared in accordance with ACI 301, Chapter 4. Each proposed mix design shall be accompanied by a complete standard deviation analysis based on at least 30 consecutive strength tests or by 3 laboratory trial mixtures with confirmation tests.
- B. Shop Drawings: Manufacturer shall submit shop drawings to Architect for review prior to fabrication, showing complete information for manufacture and installation of precast concrete units. Indicate setting plan, member dimensions, camber, cross-sections; location, size, and type of reinforcement; openings; and special reinforcement and lifting devices necessary for handling and erection. Each unit shall be identified by a standard mark to be listed in a schedule on manufacturer's erection plan and placed legibly on each piece at the time of manufacture. Show location and details of anchorage devices, if any, to be embedded in other construction and furnish templates, if required, for placement. Show sequence and method of installation. Shop drawings shall be prepared under supervision of, and sealed by, a Licensed Professional Engineer, licensed in the State of Texas.
- C. Calculations: Manufacturer shall submit to Architect 3 copies of complete design calculations, prepared and sealed by a Licensed Professional Engineer, licensed in the State of Texas, for all units. Calculations shall indicate assumed loading, material strengths, stresses, size and location of reinforcement, cambers and deflections. Design precast units to support live and dead loads shown of Drawings, in addition to handling and erection stresses, In compliance with applicable codes and governing authorities. Shop drawings submitted without corresponding calculations will be returned as an incomplete submittal. Manufacturer's standard load tables, if submitted, shall be sealed by a Professional Engineer licensed in the State of Texas. Calculations will be retained for Architect's record, and will not be approved or returned.

1.03 QUALIFICATIONS

- A. Fabricator Qualifications: A minimum of 5 years successful experience in the fabrication of precast concrete units similar to units required for this project. Fabricator must have sufficient production capacity to produce required units without causing delay in work. Fabricator shall be an active member of Precast Concrete Institute and participate in its Plant Certification Program. Precast units shall be Hollow Core Concrete Planks, depth as noted on the Plans and Details.
- B. Erector Qualifications: Erector shall have a minimum of 5 years successful experience in erection of precast concrete units similar to units required for this project.

1.04 CODES AND STANDARDS

- A. Latest adopted edition of all standards referenced in this Section shall apply, unless noted otherwise. In case of conflict between Contract Documents and Building Code, the more stringent shall govern.
- B. Codes and Standards: Comply with provisions of the following codes, Specifications and standards, except as otherwise indicated:
 - 1. ACI 301, "Specifications for Structural Concrete for Buildings."
 - 2. ACI 311, "Recommended Practice for Concrete Inspection."
 - 3. ACI 315, "Manual of Standard Practice for Detailing Reinforced Concrete Structures."
 - 4. ACI 318, "Building Code Requirements for Reinforced Concrete."
 - 5. ACI 304. "Recommended Practice for Measuring, Mixing, Transporting, and Placing Concrete."
 - 6. Concrete Reinforcing Steel Institute, "Manual of Standard Practice."
 - 7. PCI MNL-116, "Manual for Quality Control for Plants and Production of Precast Prestressed Concrete Products."

1.05 PROPORTIONING AND DESIGN OF MIXES

- A. Proportion mixes and submit appropriate mix designs. Show record of compressive tests, in accordance with requirements of Section 03 30 00.

1.06 TESTING AND LABORATORY CONTROL BY MANUFACTURER

- A. Cylinder Test: Conduct a compressive strength test in accordance with ASTM C 31 and C 39. One set of cylinders shall be taken from each line cast in any one day, but not less than 1 such test for each 100 cubic yards poured. Compressive strength test shall consist of 5 specimen cylinders taken from concrete near point of deposit and cured under plant conditions. Test 2 cylinders at 7 days, 2 cylinders at 28 days, and retain 1 cylinder for further testing as may be required.
- B. Slump Test: Slump shall conform to limits shown on approved mix designs.
- C. Air Content: Determine, where applicable, for each set of compressive cylinders in accordance with ASTM C 173.
- D. Aggregate Testing: Make periodic sampling and testing of stockpiled aggregates to assure quality, uniformity, and conformance to Specifications.
- E. Concrete Temperature: Determine each time a set of compression cylinders is made and hourly when air temperature is 40⁰ F. and below or 90⁰ F. and above.
- F. Inspection: Perform plant inspections of formwork and reinforcement placement prior to casting each member. Inspect all members after casting for conformance with contract documents and shop drawings.
- G. Load Test: When there is evidence that strength of precast concrete units does not meet Specification requirements, the manufacturer shall replace units of suspect strength or, if acceptable to Architect, load test units in accordance with requirements of ACI 318, Chapter 20. Load tests shall be performed at manufacturer's plant.

1.07 TESTING AND INSPECTION BY OWNER'S TESTING LABORATORY

- A. Refer to Section 01 41 00.

1.08 DESIGN

- A. Precast concrete manufacturer shall design members in accordance with criteria given in the Construction Documents.

1.09 SUBSTITUTIONS

- A. Drawings and Specifications are based on standard or modified precast concrete units, as established by PCI. Units of a size or configuration other than shown on Drawings may, if approved in writing by Architect prior to bid date, be submitted for consideration. Cost of any and

all changes, as may be required on the project by acceptance of a substitute precast unit, shall be paid by Contractor. This also applies to cost of any required structural design changes as well as changes in labor and materials.

PART 2 PRODUCTS

2.01 CONCRETE MATERIALS

- A. Concrete mix for hollow core slabs shall obtain a minimum 28 day compressive strength of 5000 psi.
- B. Portland Cement: Non-staining, Type I or III, Portland Cement, conforming to ASTM C 150. Use only 1 brand of cement throughout work for each type of unit.
- C. Lightweight Coarse Aggregate: Expanded shale or other materials conforming to ASTM C 330, if applicable.
- D. Fine Aggregate: Clean, sharp, manufactured river sand conforming to ASTM C 33, washed and screened free of loam, clay, or other deleterious substances.
- E. Water: Clean, fresh, free from oil, acid, organic matter, or other deleterious substances.
- F. Admixtures: Produced by established, reputable manufacturers and used in strict compliance with manufacturer's recommendations. Do not use admixtures which have not been incorporated and tested in accepted mixes, unless otherwise authorized in writing by Architect.
 - 1. Cement-dispersing, Water-reducing Admixture: Conforming to ASTM C 494, Type A, free of set-accelerating or set-retarding compounds, chlorides, fluorides, or nitrates.
 - 2. Air-entraining Admixture: Conforming to ASTM C 260, In sufficient quantity to assure controlled entrainment of air in concrete, as specified or indicated on Drawings.
 - 3. Calcium Chloride: Do not use calcium chloride or admixtures containing calcium chloride in concrete mix.

2.02 REINFORCEMENT

- A. Deformed Bars: Conform to ASTM A 615, Grade 60.
- B. Strand: Uncoated, 7 wire, 3/8" to 1/2" diameter, low-relaxation, 250 or 270 ksi strand, conforming to ASTM A 416 or A 416A. Strand supplier shall certify, in writing to precast plant that all strand meets or exceeds ACI requirements regarding bond and development as evidence by laboratory tests.

2.03 GROUT

- A. Sand/Cement Grout: A mixture of 1 part Type I Portland Cement and 3 parts clean natural sand, conforming to ASTM C 33.

2.04 FORM MATERIALS

- A. Standard extrusion casting beds of dimensions shown on Drawings and in such repair as to produce acceptable surfaces.

2.05 CURING COMPOUND

- A. Conforming to ASTM C 309, with a water retention capacity not exceeding a loss of 0.055 gm/cm² when used at a coverage of 250 square feet per gallon and tested in accordance with ASTM C 156. Curing compound, if used, shall be conclusively demonstrated not to inhibit bonding qualities of toppings, paint, or other subsequent coating and shall be approved by Architect prior to use.

2.06 BEARING PADS

- A. Bearing pads shall be continuous, 1/8" thick, 3" wide KOROLATH.

2.07 ACCESSORIES

- A. Clips, hangers, and other accessories as required for proper installation of precast units and for support of subsequent construction.

PART 3 EXECUTION

3.01 MANUFACTURING REQUIREMENTS

- A. Concrete Properties: Concrete strength, density and other properties shall be shown on approved mix design.
- B. Admixtures: Use water-reducing admixtures, in strict compliance with manufacturer's directions. Admixtures to increase cement dispersion or provide increased workability for low –slump concrete, may be used at Contractor's option (subject to Architect's approval). When admixtures are used, a reduction in specified minimum cement content of concrete mixes will not be permitted. Use amounts of admixtures as recommended by admixtures manufacturer for climatic conditions prevailing at time of placing. Adjust quantities of admixtures as required to maintain quality control.
- C. Casting: Hollow core slab units shall be machine extruded, maintaining required dimensions within specified tolerances.
- D. Cold Weather Placing:
 - 1. Protect concrete work from physical damage or reduced strength which could be caused by frost, freezing action, or low temperatures in compliance with ACI 306 and as herein specified.
 - 2. When air temperature has fallen or is expected to fall below 40⁰ F., uniformly heat all water and aggregates before mixing as required to obtain a concrete mixture temperature of not less than 50⁰ F. and not more than 80⁰ F.
 - 3. Do not use frozen materials or materials containing ice or snow.
 - 4. Do not use calcium chloride, salt, or other materials containing antifreeze agents or chemical accelerators, unless otherwise accepted in writing by Architect.
- E. Hot Weather Placing:
 - 1. When hot weather conditions exist that would seriously impair quality and strength of concrete, place concrete in compliance with ACI 305 and as herein specified.
 - 2. Cool ingredients before mixing to maintain concrete temperature, at time of placement, below 90 degrees F. Mixing water may be chilled, or chopped ice may be used to control concrete temperature provided water equivalent of the ice is calculated as part of total amount of mixing water.
 - 3. Do not use retarding admixtures without written acceptance of Architect.
- F. Finishing: Comply with Division III, of PCI MNL-116. Formed surfaces shall have standard plant finish. Small surface holes caused by air bubbles, normal form joint marks, and minor chips and spalls will be tolerated, but no major or unsightly imperfections, honeycomb, or structural defects will be permitted.
- G. Curing and Detensioning:
 - 1. All precast units shall be moist cured until concrete has reached its design release strength as established by test cylinders.
 - 2. Steam or pressure curing may be used to accelerate period of curing. Entire top surfaces shall be exposed to fully saturated humidity. Recording thermometers shall be located at approximately 50-0" intervals along pretensioning beds to maintain a continuous record of intervals along pretensioning beds to maintain a continuous record of curing temperature, which shall not exceed 190⁰ F.
 - 3. Total initial prestressing force shall be maintained between anchorages until concrete has reached an average compressive strength equal to calculated release strength, as determined by compressive cylinder tests made for each continuous pour. After required strength has been attained tension in the strands shall be gradually released to concrete and the strands cut off using a sequence and pattern to prevent shock or unbalanced loading.
- H. Strength Deficiencies: Strength of precast concrete units will be considered potentially deficient if manufacturing processes fail to comply with any of the requirements which may affect strength of precast units, including the following conditions:
 - 1. Failure to meet compressive strength test requirements.

2. Reinforcement, pretensioning, and detensioning of tendons of prestressed concrete not conforming to specified fabrication requirements.
 3. Concrete curing and protection of precast units against extremes in temperature, not as specified.
- I. Preparation for Other Trades: Do any cutting, notching, forming, and drilling of precast items required for installation of work of other trades (as shown on approved shop drawings).
- J. Fabrication Tolerances:
1. Dimensional tolerances shall be as outlined in Division VI, of the PCI MNL-116. Differential camber between adjacent units shall not exceed $\frac{1}{2}$ " regardless of whether they are the same or different designs. Units which do not comply shall be repositioned or replaced. Shimming at bearings shall be done only when approved by Architect. In the event of a conflict between Specifications and PCI MNL-116, Specifications shall govern.
 2. Precast units having any dimension smaller or greater than required and outside specified tolerance limits, will be rejected if appearance or function of structure is impaired or if adjacent construction is adversely affected. Repair or remove and replace rejected units as required to meet construction conditions.

3.02 INSTALLATION

- A. Delivery, Storage, and Handling:
1. Deliver precast concrete units to project site in such quantities and at such times as will assure continuity of installation. Store units at site to ensure against cracking, distortion, staining, or other physical damage and so that markings are visible. Lift and support units at designated lift points only.
 2. Deliver anchorage items which are to be embedded in other construction before start of such work.
 3. Provide setting diagrams, templates, instructions, and directions as required for installation.
- B. Job Conditions: Before start of erection operations examine all parts of supporting structure and conditions under which precast concrete work is to be erected. Make note of conditions detrimental to proper and timely completion of work. Do not proceed with installation until unsatisfactory conditions have been corrected in an acceptable manner. Verify dimensions of supporting structures at project site and adjust final shop drawings to reflect actual field dimensions.
- C. Erection:
1. Elements shall be erected by competent tradesmen and accurately set in positions assigned to them on approved Installation and/or erection Drawings and securely anchored in final position. All joints shall conform to approved drawings.
 2. Erection procedures shall be determined by Contractor and shall represent the safest procedures, methods, and sequences possible, consistent with Drawings and Specifications.
 3. Do not install units until concrete has reached its 28 day design strength.
 4. Install bearing pads, where indicated, as precast units are being erected. Set pads on level, uniform bearing surfaces and maintain in correct position until precast units are placed. Hold pads back 1" from face of ledge, unless otherwise shown.
 5. Grout all joints between units parallel to their length, with 3500 psi and/cement grout. Mix grout so finish is level with top surface of precast units. Tape or form underside of joints as required to contain grout and prevent seepage over adjacent surfaces or other construction. Strike off flush on top. Remove and dispose of excess grout.
 6. Shores or leveling devices for adjusting camber between adjacent units shall not be removed before grout key has cured 24 hours. Do not place construction loads on units until grout key has cured 24 hours.

7. Perform cutting and fitting of precast units as required for passage of other projecting or adjacent work, but only as approved by manufacturer. Provide straight and clean cuts without breaking or spalling edges. Before cutting, all openings shall be approved by Architect. Do not cut any reinforcing steel, unless acceptable to precast unit manufacturer and Architect. Reinforce edges of cut openings where required to maintain structural integrity of precast units.
 8. Holes for mechanical openings shall be cut with a saw or core drilled, by experienced tradesmen, only in locations shown on approved shop drawings or as otherwise approved by Architect. Do not cut or damage prestressing strands.
 9. Locate units on supporting construction to provide a minimum end bearing length of 2" on bearing pad, except as otherwise shown on Drawings.
 10. Accessories: Install clips, hangers, and other accessories required for erection of precast units to support members and back-up materials.
- D. Conduct Inspections, perform testing, and make repairs or replace unsatisfactory precast units as required.
 - E. Damaged Material: Any cracked or broken items shall not be set, but shall be replaced with satisfactory work. Patching of minor defects, by skilled tradesmen, will be permitted but covering large defects or those which affect appearance or structural integrity of the member, will not be permitted. If approved by Architect, cracks shall be repaired by pressure-injecting epoxy grout.
 - F. Protection: Take proper precautions to prevent work of other trades over which, or against which, precast concrete work occurs.
 - G. Erection Tolerances: Install precast units within tolerance limits recommended in PCI Design Handbook, Sixth Edition, Section 8.3.
 - H. Scaffolding: Furnish scaffolding required for the installation of precast concrete items. Make same available to other trades required to execute work in conjunction with precast work. Scaffolding shall be constructed and erected in a safe and substantial manner, conforming to all governing ordinances.

END OF SECTION

SECTION 03 4713
TILT-UP PRECAST CONCRETE

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Tilt-up, site cast concrete wall panels, load bearing, erected from mold to final position.
- B. Supports, devices, load bearing supports, and attachments.
- C. Calking of joints.
- D. Grouting under panels.
- E. The Project Architect/Engineer has not been retained to design the wall panels or the floor slab to resist the stresses caused by erection of the wall panels, nor to determine the means and methods to be used for erection and bracing until permanent bracing is in place.
- F. It shall be the Contractor's responsibility to erect the panel in a manner that will be both safe for personnel and property, and to brace and otherwise protect the panels against wind and other forces that may occur during construction and until connections to the permanent structural system are completed.
- G. It shall be the Contractor's responsibility to erect that a suitable slab has been prepared to provide for the level of finish that has been established within this specification.
- H. It shall be the Contractor's responsibility to coordinate the slab finishing including saw cutting of all joints with the panel forming to minimize the impact to the architectural finish of the panels.

1.02 RELATED SECTIONS

- A. Section 051200 - Structural Steel: Placement of anchorage welding to building structure components.
- B. Section 033000 - Cast-In-Place Concrete: Placement of panel base bearing plates in concrete top of foundation.
- C. Section 032000 - Reinforcing Steel: Reinforcing Steel and Welding Requirements.
- D. Section 055000 - Miscellaneous Metals.
- E. Section 033000 - Cast-In-Place Concrete: Foundation bearing support.

1.03 REFERENCES

- A. ASTM A123 - Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel.
- B. ASTM A184/A18M - Specification for Fabricated Deformed Steel Bar Mats for Concrete Reinforcement.
- C. ASTM A185 - Specification for Steel Welded Wire Fabric, Plain, for Concrete Reinforcement.
- D. ASTM A496 - Standard Specification for Steel Wire, Deformed, for Concrete Reinforcement.
- E. ASTM A497 - Specification for Steel Welded Wire Deformed Fabric for Concrete Reinforcement.
- F. ASTM C39 - Test Method for Compressive Strength of Cylindrical Concrete Specimens.
- G. ASTM C330 - Specification for Lightweight Aggregates for Structural Concrete.
- H. ACI 301 - Specification for Structural Concrete.
- I. ACI 315 - Standard for Details and Detailing Concrete Reinforcement.
- J. CRSI Manual of Standard practice.
- K. CRSI Specifications for Placing Reinforcement.
- L. ANSI/ACI 301 - Specifications For Structural Concrete for Buildings.
- M. ANSI/ACI 318 - Building Code Requirements for Reinforced Concrete.
- N. ANSI/ASTM A36 - Structural Steel.

- O. ANSI/ASTM A307 - Carbon Steel Externally Threaded Standard Fasteners.
- P. ANSI/ASTM C31 - Making and Curing Concrete Test Specimens in the Field.
- Q. ANSI/ASTM C143 - Test for Slump of Portland Cement Concrete.
- R. ANSI/ASTM C150 - Portland Cement.
- S. ANSI/ASTM C260 - Air-Entraining Admixtures for Concrete.
- T. ANSI/AWS D1.1 - Structural Welding Code.
- U. ASTM A615 - Deformed and Plain Billet-Steel Bars for Concrete Reinforcement.
- V. ASTM C33 - Concrete Aggregates.
- W. PCI - Manual for Structural Design of Architectural Precast Concrete.
- X. PCI MNL-116 - Manual for Quality Control for Plants and Production of Precast and Prestressed Concrete Products.
- Y. PCI MNL-120 - Design Handbook - Precast and Prestressed Concrete.
- Z. PCI MNL-123 - Manual on Design of Connections for Precast Prestressed Concrete.

1.04 SUBMITTALS

- A. Material Submittals:
 - 1. Sample of Interior and/or Exterior Surface Treatment.
 - 2. Manufacturer's literature for bondbreakers.
 - 3. Mix design for structural grout for panel support.
- B. Submit under provisions of Section 013300.
- C. Shop Drawings: Indicate layout, tilt-up unit locations, configuration, unit identification marks, reinforcement, connection details, support items, dimensions, openings, and relationship to adjacent components.
- D. Mix Design: Submit proposed mix design under provisions of Section 013300 before starting work.

1.05 QUALITY ASSURANCE

- A. Perform Work in accordance with PCI MNL-116, PCI MNL-123, PCI MNL120, ANSI/ACI 318.
- B. Welding: ANSI/AWS D1.1.
- C. Regulatory Requirements: Comply with applicable codes and regulations of governmental agencies having jurisdiction. Where those requirements conflict with this Specification, comply with the more stringent provisions.
- D. Job Mock-up Panel for Architectural Finishes
 - 1. Prepare minimum 4 feet by 8 feet panel using forming system and construction methods to be used on project. Prepare one panel for each level of finish shown on the drawings.
 - 2. Incorporate edge and reveal conditions as detailed on the project drawings.
 - 3. Painted and Textured Concrete Finishes.
 - 4. Sandblast or Colored Concrete Finishes.
 - a. Utilize full range size and colors in aggregate.
 - b. Utilize full range of color in grout.
 - c. If sand blasting is specified, it shall match degree specified.
 - 5. Architectural Liner or Cast-In Brick Finishes
 - a. Utilize full range of color sampling for brick specified.
 - b. If liners are to be used, sample shall consist of section showing integration of both horizontal and vertical liner joints.
 - 6. Maintain approved mock-up for comparison with finish work.

7. Dispose of mock-up when project is completed or when project is directed by Project Architect/Engineer.
8. Cast mock-up over slab joint or column joint if actual panels will be affected by these conditions.

1.06 QUALIFICATIONS

- A. Precast Fabricator and Erectors: Qualified in accordance with PCI MNL-116.
- B. Welder: Qualified within previous 12 months in accordance with ANSI/AWS D1.1 and ANSI/AWS D1.4.

1.07 HANDLING

- A. Protect and handle products under provisions of Section 016000.
- B. Handle tilt-up units to position, consistent with their shape and design. Lift and support only from support points.
- C. Lifting or Handling Equipment: Capable of maintaining units during manufacture, erection, and in position for fastening.
- D. Blocking and Lateral Support During Erection: Clean and non-staining, without causing harm to exposed surfaces. Provide temporary lateral support to prevent bowing and warping.
- E. Protect units from staining, chipping, or spalling.

1.08 FIELD MEASUREMENTS

- A. Verify that field measurements are as indicated on shop Drawings.

PART 2 – PART PRODUCTS

2.01 MANUFACTURED ITEMS

- A. Lifting hardware, inserts, braces, and related embedded and attached items shall be manufactured specifically for site cast tilt-up construction.

2.02 PANEL MATERIALS

- A. Forms:
 1. Forms shall contain blockouts required to provide openings detailed on Drawings. Coordinate all openings with other trades.
 2. Panel boundary forms shall be rigidly constructed and well braced steel or wood forms, straight and with precise corners. Design to withstand stresses resulting from the casting process. Consideration should be given to exposed formed surfaces. All forming surfaces shall be smooth and clean prior to pouring of concrete.
 3. Panels may be stacked for ease of casting, in forms as specified above.
 4. When panels are stack cast, maintain a continuous sound and smooth surface with forming and plaster at all openings.
 5. Bondbreaker must be compatible with curing compound and other finishes, including paint, and floor finish.
- B. Reveal Materials: All materials used for creating reveals or relief in the exterior face of the panel must be adequate strength to withstand construction traffic/loads without damage.

2.03 CONCRETE MATERIALS

- A. Cement: ANSI/ASTM C150, Portland Type I - Normal gray color.
- B. Concrete Materials: ASTM C33 water and sand and ASTM C330 for lightweight aggregate concrete.
- C. Mixing water shall be free of any acid, alkali, oil or organic material that may interfere with the setting of the cement.
- D. Admixtures shall be approved by Project Architect/Engineer.
- E. All concrete shall be produced and delivered in accordance with ASTM C94.

- F. Reinforcing Steel: ASTM A615, deformed steel bars plain finish, strength and size as shown on drawings.
- G. Air Entrainment Admixture: ANSI/ASTM C260.
- H. Surface Finish Aggregate: As indicated on Architectural Drawings.
- I. Grout: Non-shrink, minimum 10,000 psi, 28 day strength.
- J. Lifting hardware, inserts, braces, and related embedded and attached items shall be manufactured specifically for site cast tilt-up construction.

2.04 CONCRETE CURING MATERIALS

- A. Liquid Membrane-Forming Curing Compound:
 - 1. It is preferred that the curing compound/bondbreaker be the same product or compatible, and that only one manufacturer's product is used.

2.05 SEALANT AND CAULKING MATERIALS

- A. Sealants: In accordance with Section 07920 - Sealants and Caulking.

2.06 BONDBREAKER

- A. Liquid Dissipating Membrane-Forming Curing Compound.
 - 1. The bondbreaking material shall also be a dissipating membrane forming material complying with ASTM C 309-98a, Type I and I D, Class B.
 - 2. The bondbreaking compound shall be applied with adequate time to dry prior to placement of reinforcing steel.
 - 3. The bondbreaking compound shall dry in 30-minutes or less at 100°F to reduce panel clean up.
 - 4. Material must be compatible with curing material.
 - 5. The bondbreaker used must be compatible with any coating specified for interior or exterior concrete panels and slab.
 - 6. Provide chemical agent to remove bondbreaker to allow veneer to be able to adhere to panels.
- B. Refer to manufacturer's instructions as to proper procedures for post applying a liquid floor hardener or sealant to areas where bondbreaker is present.

2.07 STEEL REINFORCEMENT

- A. Welded wire reinforcement shall conform to ASTM A185 or A497 based on type and location and shall be of the style shown on the project drawings. Welded wire reinforcement shall be supplied in flat sheets.

2.08 MISCELLANEOUS METALS

- A. Conform to requirements of Section 055000 - Metal Fabrications.
- B. Provide all inserts, dowels, and other items to be cast in panels, including items required for erection and bracing.
- C. Steel that will be exposed to the exterior or damp environments in finished panels shall be plastic-tipped, hot-dipped galvanized or protected by other means to prevent corrosion or oxidation of the metal after fabrication in accordance with ASTM A123.
 - 1. Selection of plastic-tipped treatments: Ensure that the plastic will not create stress concentrations within the thin sections of concrete when located near a surface from differential thermal expansion and contraction ultimately resulting in local shear failure of the concrete surface producing surface blemishes.

2.09 SUPPORT DEVICES

- A. Connecting and Support Devices: ANSI/ASTM A36 steel.
- B. Primer: None.

2.10 ACCESSORIES

- A. Bearing Pads: High density plastic or Steel, smooth both sides as shown on drawings.
- B. Form Liner Materials
 - 1. Vac-u-form thermoformed rigid polymer alloy sheets as required by Contractor for quantity of panels.
 - 2. Form liners for Textured Finish Concrete: Flute rib pattern 14331.
 - 3. Liners to accommodate form pressures to a maximum 1000 psf. Comply with manufacturer's recommendations for support of large or deep patterns which may deform under pressure.
 - 4. Provide Vac-u-form Release agent or equal.

2.11 MIX

- A. Concrete: Refer to General Notes.

2.12 FINISH - SUPPORT DEVICES

- A. Clean surfaces of rust, scale, grease, and foreign matter.
- B. Prime paint in one coat, except surfaces in direct contact with concrete or requiring field welding.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Verify site conditions under provisions of Section 010390.
- B. Verify that building structure, anchors, devices, and openings are ready to receive work of this Section.

3.02 PREPARATION

- A. Provide for erection procedures and induced loads during erection. Maintain temporary bracing in place until final support is provided.
- B. Provide necessary hoisting equipment.
- C. Casting Slab Preparation:
 - 1. Casting slab shall be cured. Saw cuts, cracks, joints or defects in the casting bed shall be filled so as to minimize transfer of the joint line to the panel face.
 - 2. Waste slabs, if used, shall be of sufficient thickness and strength so as not to crack with the weight of the panels.
 - 3. Contractor shall be responsible for compatibility of curing agents, sealants, and releasing agents utilized in the Work. If panels are to be stacked, the troweled surface shall be considered the casting bed and shall be treated as the same.
 - 4. Isolation pockets shall be formed in such a manner as to minimize the transfer of the pocket to the finished appearance of the panel.
- D. Bondbreaker to be applied in accordance with manufacturer's printed instruction for the applicable condition.
- E. After placing reinforcing steel for panels, check casting slab surfaces for continuity of film. Touch-up or recoat worn or damaged areas, taking care to prevent application of coating on reinforcing steel and inserts.
- F. Coordinate installation of inserts and anchorages required to be set into concrete slabs prior to casting of panels.
- G. Where reveals are specified in panels, assure that forming strips are straight and securely fastened to prevent movement or floating during placing operations and that alignment between adjacent panels is correct. Reveal tolerances shall comply with the provisions of Section (3.7) of this document.

3.03 SITE FABRICATION

- A. Fabrication procedure to conform to PCI MNL-116.
- B. Maintain environmental records and quality control program during production of tilt-up units. Make records available upon request.
- C. Use rigid molds, constructed to maintain tilt-up unit uniform in shape, size and finish.
- D. Maintain consistent quality during manufacture.
- E. Fabricate connecting devices, plates, angles, inserts, bolts, and accessories. Fabricate to permit initial placement and final attachment.
- F. Embed reinforcing steel, anchors, inserts plates, angles, and other cast-in items as indicated on Drawings.
- G. Locate hoisting devices to permit removal after erection.
- H. Cure units to develop concrete quality, and to minimize appearance blemishes such as non-uniformity, staining, or surface cracking.
- I. Minor patching is acceptable, providing structural adequacy and appearance of units is not impaired.

3.04 PLACING CONCRETE

- A. Concrete shall be thoroughly worked around reinforcement, around the embedded items, and into corners of the forms.
- B. Cold joints shall not be permitted in an individual site cast tilt-up panel.

3.05 CURING AND PROTECTIONS

- A. Protect freshly placed concrete from premature drying and excessive cold or hot temperatures, and maintain without drying at a relatively constant temperature for the period of time necessary for hydration of the cement and proper hardening of the concrete.
- B. Apply liquid membrane curing compound in accordance with manufacturer's recommendations.
- C. Underlying panels in a stack cast arrangement shall be cured in the same manner as casting beds.

3.06 FINISH - TILT-UP UNITS

- A. Finish Type A: Ensure exposed-to-view finish surfaces of tilt-up units are uniform in color and appearance.

3.07 SITE FABRICATION TOLERANCES

- A. Conform to PCI MNL-117.

3.08 QUALITY CONTROL AND TESTS

- A. Provide testing and analysis of concrete mix under provisions of Section 014000.
- B. Take one set of 3 concrete test cylinders for every 50 cu yard or less of concrete placed in accordance with ANSI/ASTM C31. Take one set minimum for each day pour.
- C. Take one slump tests for every set of test cylinders in accordance with ANSI/ASTM C143

3.09 ERECTION

- A. Erect units without damage to shape or finish. Replace or repair damaged panels.
- B. Erect members level and plumb within allowable tolerances.
- C. Align and maintain uniform horizontal and vertical joints, as erection progresses.
- D. When members require adjustment beyond design or tolerance criteria, discontinue affected work; advise Architect/Engineer.
- E. Fasten and weld units in place. Perform welding, including tack welds, in accordance with ANSI/AWS D1.1.
- F. Touch-up field welds and scratched or damaged surfaces.

- G. Set vertical units dry, without grout, attaining joint dimension with lead or plastic spacers. Grout pack base of unit.
- H. Exposed Joint Dimension: ½ inch.
- I. Minimum strength of panels at time of erection shall be in accordance with the lifting design.
- J. Use erection equipment that will prevent damage to existing construction, permanent floor slabs and panels. Damage to Work shall be repaired or replaced at the Contractor's expense and in a manner acceptable to the Project Architect/Engineer prior to painting or coating.
- K. Panels not attached to the building frame at the time of erection shall be braced in position using a bracing system designed to resist wind and other loads that may reasonably be determined until all structural connections have been made. There shall be a minimum of two braces per panel. Design of bracing shall be the responsibility of the Contractor. Panel bracing connection shall be maintained daily by Contractor to assure tightness.
- L. Temporary panel bracing shall not be removed until roof diaphragm is completely welded and installed.

3.10 ERECTION TOLERANCES

- A. Maximum Variation from Plane of Location: 1/4 inch in 10 feet and 3/8 inch in 100 feet, non-cumulative.
- B. Maximum Offset from True Alignment Between Two Connecting Units: 1/4 inch.
- C. Joint Tolerance: Plus or minus 1/4 inch.
- D. Casting Tolerances
 - 1. Height and Width of Basic Panel

Up to 20 feet	1/4
20 feet to 30 feet	5/16
Each additional 10-foot increment in excess of 30 feet	1/8
 - 2. Thickness 3/16
 The tolerance listed is for the average variation of panel thickness through any horizontal or vertical cross-section of the panel.
 - 3. Skew of panel or opening. The tolerance listed is the measured difference in length of the two diagonals.

Per 6 feet of dimension	1/8
Maximum difference	1/2
 - 4. Openings cast into panel

Size of opening	1/4
Location of Centerline of opening	1/4
 - 5. Location/Placement of embedded items

Inserts, bolts, pipe sleeves	3/8
Lifting and bracing inserts	1/2
Weld plate embeds (lateral placement)	1
Weld plate embeds (Tipping & Flushness)	1/4
 - 6. Deviation of concrete reinforcing steel cover 3/8
 Erection Tolerances
 - 7. Joint width variation. The tolerance listed is measured between panels at the exterior face of the panels at the joint.

For panels up to 20 feet tall	1/4
For each 10 foot increment in excess of 20 foot tall	1/4

8. Joint taper - The tolerance listed is the measured difference in joint width indicating the panel edges are not parallel.
- | | |
|--|-----|
| Maximum for entire length | 3/8 |
| For panels up to 20 feet tall | 1/4 |
| For each 10 foot increment in excess of 20 foot tall | 1/8 |
9. Panel alignment.
- | | |
|---|-----|
| Alignment of horizontal and vertical joints | 1/4 |
| Offset in exterior face of adjacent panels | 1/4 |

3.11 ADJUSTING

- A. Adjust work under provisions of Section 017300.
- B. Adjust units so that joint dimensions are within tolerances.

3.12 PROTECTION

- A. Protect units from damage.
- B. Provide non-combustible shields during welding operations.

3.13 PANEL FINISH

- A. Exposed surfaces of panels shall be finished as indicated on the project drawings. This shall include both the front and back of the panels as well as any exposed edges as defined below.
- B. Visible surfaces of the panels, when in place shall be free from surface defects for as defined below for a Grade A finish.
 - 1. Grade A - Architectural: Project designed for the circulation of people within a distance of 10 feet to 25 feet.
 - a. All panel surfaces will be free of all voids, holes, pockets and other surface deformations greater than 1/8 inch.
 - b. Surfaces of panels must not project reinforcing patterns, floor joints or other projections or voids from the casting surface.
 - c. Cracks are not permissible in excess of 1/32 inch.
 - d. All surface repairs must be performed in such a way as to prevent the projection of repair strokes through the intended finish.
 - e. All holes shall be filled with patching material to present a smooth surface ready for painting unless the deigned finish is to result in exposed aggregates whereby the patching material shall match the intended color and texture.
 - f. Reveals must be maintained in their designed positions. Deviation from any horizontal or vertical line shall not exceed 1/8 inch over 10 feet.

3.14 DEFICIENT COMPRESSIVE STRENGTH

- A. Panel damage that occurs during erection, cracks readily visible per the requirements specified in Section 03470.3.6.2, permanent bowing occurring from erection, and spalls, shall be repaired or replaced to the satisfaction of the Project Architect/Engineer, appropriate to the type and location on the building.

END OF SECTION