

## **DIVISION III - CONCRETE**

## SECTION 03119 INSULATING CONCRETE FORMING

### PART 1 GENERAL

#### 1.01 SUMMARY

- A. Section Includes:
  - 1. Comply with the requirements for Division 1.
  - 2. Furnish all labor, materials, tools and equipment to perform the complete erection/ installation of the Insulating Concrete Form System (ICF), installation of reinforcing steel, placement of concrete within formwork, and final cleanup.
  - 3. Adequate bracing and false work shall be provided by the Installing Contractor to comply with all applicable Codes.
  
- B. Products Supplied But Not Installed Under This Section:
  - 1. *EPS* compatible modified bituminous sheet waterproofing membrane.
  - 2. *EPS* compatible parge coat.
  
- C. Products Installed But Not Supplied Under This Section:
  - 1. Sleeves
  - 2. Inserts
  - 3. Anchors
  - 4. Bolts
  - 5. Reinforcing Steel
  - 6. Window & Door Opening Bucks
  - 7. Concrete
  
- D. Related Requirements:
  - 1. Section 032000- Concrete Reinforcing
  - 2. Section 03300- Cast-In-Place Concrete
  - 3. Section 034000- Precast Concrete
  - 4. Section 040000- Masonry
  - 5. Section 050000- Metals
  - 6. Section 060000- Wood & Plastics
  - 7. Section 071300- Sheet Waterproofing
  - 8. Section 072400- Exterior Insulation and Finish Systems
  - 9. Section 074600- Siding
  - 10. Section 080000- Openings
  - 11. Sections 092200  
through 092500- Supports for Plaster and Gypsum Board, Gypsum Plastering,  
Portland Cement Plastering, Other Plastering
  - 12. Sections 0 7000  
through 098000- Wall Finishes/Acoustical Treatment

#### 1.02 PRICE AND PAYMENT PROCEDURES

- A. Alternates:

1. **Materials** shall be only as specified in Paragraphs 2.02 & 2.03 as per Manufacturer specified in Paragraph 2.01. No alternate materials shall be accepted for this Section.

### 1.03 REFERENCES

#### A. Abbreviations and Acronyms:

1. *EPS*- Acronym for "Expanded Polystyrene" when referencing the insulating foam component of the Insulating Concrete Form System.
2. *ICF*- Acronym for "Insulating (or Insulated) Concrete Form"

#### B. Definitions:

1. *Form Alignment System*- a form alignment & scaffold system designed exclusively for use with Insulating Concrete Forms.
2. *Trained Installer*- An installation contractor, who has received instructional training in the installation of the specified Insulating Concrete Form System and is capable of providing written verification of his designation as such by the specified manufacturer of the system being installed.
3. *Technical Associate*- A technical representative, usually a staff member of a Distribution Firm, who has received instructional training in the installation of Insulating Concrete Form system and is in the capacity of supervising an installation crew on site.
4. *Window or Door Opening Buck*- a pre-manufactured or site constructed frame assembly consisting of wood or plastic material (or combination thereof) used to frame a rough opening within the forming system that will retain concrete around the opening. The frame can also provide for subsequent anchorage of doors and windows within the wall assembly.

#### C. Reference Standards:

1. American Concrete Institute (ACI)
  - a. ACI 318 Building Code Requirements for Structural Concrete and Commentary
2. American Society for Testing and Materials (ASTM)
  - a. ASTM C165: Standard Test Method for Measuring Compressive Properties of Thermal Insulations
  - b. ASTM C177: Standard Test Method for Steady-State Heat Flux Measurements and Thermal Transmission Properties by Means of the Guarded-Hot-Plate Apparatus
  - c. ASTM C203: Standard Test Methods for Breaking Load and Flexural Properties of Block-Type Thermal Insulation
  - d. ASTM C272: Standard Test Method for Water Absorption of Core Materials for Structural Sandwich Constructions
  - e. ASTM C303: Standard Test Method for Dimensions and Density of Preformed Block and Board-Type Thermal Insulation
  - f. ASTM C518: Standard Test Method for Steady-State Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus
  - g. ASTM C578: Standard Specification for Rigid, Cellular Polystyrene Thermal Insulation
  - h. ASTM D1621: Standard Test Method for Compressive Properties Of Rigid Cellular Plastics
  - i. ASTM D1622: Standard Test Method for Apparent Density of Rigid Cellular Plastics

- j. ASTM D2126: Standard Test Method for Response of Rigid Cellular Plastics to Thermal and Humid Aging
  - k. ASTM D2863: Standard Test Method for Measuring the Minimum Oxygen Concentration to Support Candle-Like Combustion of Plastics (Oxygen Index)
  - l. ASTM E84: Standard Test Method for Surface Burning Characteristics of Building Materials
  - m. ASTM E90 Standard Test Method for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions and Elements
  - n. ASTM E96: Standard Test Methods for Water Vapor Transmission of Materials
  - o. ASTM E336: Standard Test Method for Measurement of Airborne Sound Attenuation between Rooms in Buildings.
  - p. ASTM E2634: Standard Specification for Flat Wall Insulating Concrete Form (ICF) Systems
3. International Code Council Evaluation Service (ICC-ES)
    - a. AC12: Acceptance Criteria for Foam Plastic Insulation
    - b. AC15: Concrete Floor, Roof and Wall Systems and Concrete Masonry Wall Systems
    - c. AC 353: Stay-in-place, Foam Plastic Insulating Concrete Form (ICF) Systems for Solid Concrete
  4. National Fire Protection Association (NFPA)
    - a. NFPA 259: Standard Test Method for Potential Heat of Building Materials
    - b. NFPA 268: Standard Test Method for Determining Ignitability of Exterior Wall Assemblies Using a Radiant Heat Energy Source
    - NFPA 285: Standard Fire Test Method for Evaluation of Fire Propagation Characteristics of Exterior Non-Load-Bearing Wall Assemblies Containing Combustible Components
    - c. NFPA 286: Standard Methods of Fire Tests for Evaluating Contribution of Wall and Ceiling Interior Finish to Room Fire Growth
  5. Southwest Research Institute (SwRI)
    - a. SwRI 99-02: Crawl Space Insulation Evaluation Protocol
  6. Underwriters Laboratories Inc. (UL)
    - a. UL 263: Fire Tests of Building Construction and Materials

#### 1.04 ADMINISTRATIVE REQUIREMENTS

- A. Pre-installation Meetings:
  1. Ensure those materials listed under Sub-Sections 2.01 through 2.03 are provided to *Trained Installer* prior to commencement of work under this Section.
  2. *Trained Installer* for this section shall provide list of known special requirements for interface of materials provided in this section as such may pertain to co-ordination with mechanical, electrical, plumbing, interior and exterior finish sub trades prior to commencement of work.

#### 1.05 SUBMITTALS

- A. Bid Submission Documents:

1. Contractor shall submit with bid proposal for this section written confirmation of:
    - a. Name of ICF Product forming the basis for the material cost of the bid.
    - b. Name of ICF Product forming the basis for the labor cost of the bid.  
If two different ICF products are involved in above, contractor shall specify BOTH material AND Labor bids associated with each material.
  2. Contractor shall submit with bid proposal for this section, written verification of credentials of the subcontractor responsible for the form system installation (*trained installer*) designated to be installing the ICF product as follows:
    - a. That the installing contractor is either:
      - 1) An experienced ICF Contractor (*trained installer*) with minimum 3 years experience in commercial ICF construction or;
      - 2) A qualified masonry or traditional concrete forming contractor with minimum 5 years experience in commercial construction applications.
    - b. That the installing contractor has demonstrated experience on supervising commercial construction projects of with gross floor areas of 50,000 ft<sup>2</sup> or greater. (Submit project name(s)/ location(s)).
- B. Test and Evaluation Reports:
1. *Technical Associate* for form system shall submit on request, relevant laboratory tests or data that validate product compliance with performance criteria specified prior to commencement of work under this Section (See Section 2.03 B Regulatory Requirements).
  2. Submit copy of valid product evaluation report, demonstrating compliance with this specification and applicable codes for site condition. (See Section 2.03 B Regulatory Requirements).
- C. Manufacturers' Instructions:
1. Submit copy of manufacturer's product installation manual
- D. *Form Alignment System* Engineering:
1. For wall heights above 12 feet (3.6m) of unsupported wall height, the contractor shall provide scaffold engineering for support of the *Form Alignment System* or shall ensure this engineering is included by the engineer of record for support of the form system and the *Form Alignment System* assemblies during construction.

#### 1.06 CLOSEOUT SUBMITTALS

- A. Warranty Documentation:
1. Product warranty documentation specified under Section 1.11 shall be supplied to contractor (for subsequent provision to building owner) upon completion of building construction.

#### 1.07 MAINTENANCE MATERIAL SUBMITTALS

- A. Maintenance:
1. *Trained Installer* shall supply to contractor (for subsequent provision to building owner) copy of pertinent documentation as relates to instruction on post repair, renovation, modification or service work with respect to the form system once occupancy commences.

#### 1.08 QUALITY ASSURANCE

A. Qualification- Installers / Applicators / Erectors:

1. Contractor shall engage the services of a *Trained Installer* or *Technical Associate* for the duration of the work under this Section who has been trained in procedures pertaining to the correct installation of the specified form system (*Trained installer* may already be the designated ICF Installing Contractor if providing credentials as such).
2. *Trained Installer/Technical Associate* shall furnish proof of training documentation to Contractor prior to commencement of work under this Section.

B. Mock-ups:

1. If required, construct sample wall mock-up panel to include full wall system and details, located where directed by Consultant. Panel may form part of finished work if approved by Consultant.

## 1.09 DELIVERY, STORAGE, AND HANDLING

A. Delivery and Acceptance Requirements:

1. *Trained Installer/Technical Associate* to meet with Contractor prior to material delivery on site to co-ordinate provision of access, storage area, and protection of insulating concrete form product and spatial requirements for *Form Alignment System* placement steel storage & forming.
2. Deliver products in original factory packaging, bearing identification of product, manufacturer and batch/lot number.
3. *Trained Installer* shall furnish product packaging labels to contractor as required to maintain traceability of product for duration of contract.
4. Bulk of form shipment shall be delivered as pre-assembled units and folded flat to maximize shipping space. Only form panels and insert webs as may be required for floor interfaces or specialized construction on site are to be shipped unassembled but in labeled packages for traceability

B. Storage and Handling Requirements:

1. Handle and store products in location to prevent damaging and soiling.
2. Maintain form materials and accessories in original packaging (or provide similar protection to unpackaged form materials -should on-site storage prior to installation extend beyond 3 months).
3. Form units and related form installation materials and equipment to be stored flat until time of use.

## 1.10 SITE CONDITIONS

A. Ambient Conditions:

1. Use appropriate measures for protection and supplementary heating when required to ensure proper curing conditions in accordance with manufacturer's recommendations if installation is carried out during periods of weather where temperatures are below minimum specified by governing Building Code for concrete and masonry.

## 1.11 WARRANTY

A. Manufacturer Warranty:

1. *Technical Associate* shall supply of written copy of specific warranties of the product.

## PART 2 PRODUCTS

## 2.01 MANUFACTURERS

### A. Manufacturer List:

1. Provide insulating concrete form system materials from one of the following Manufacturers assuring that system selected complies in all respects with performance requirements of Section 2.03.
  - a. Nudura corporation.
  - b. Logix.

### B. Substitution Limitations:

1. Forming System shall carry an active listing/classification for fire resistance rating of the completed wall assembly as endorsed by Underwriters Laboratories® UL per testing to the ANSI/UL-263 Standard.
2. Form System supplied shall provide full height webs fastening strips in contact throughout height of the wall assembly at 8-inches (203 mm) o/c placement within system to assure minimum settlement during concrete placement and maximum sleeve insertion diameter possible between webs.
3. Form system shall provide dovetail flutes to both sides of its interior cavity to enable structural bonding of concrete to foam once concrete is cured.

## 2.02 INSULATING CONCRETE FORMING SYSTEM (ICF)

- A. Where project scope permits, form units shall be supplied through an authorized distributor of the Manufacturer listed for the bid. The distributor shall be capable of providing product on site within 24 hours notice.
- B. The Manufacturer's authorized distributor shall have available local to the region, technical sales staff that can be contacted or even contracted (under separate contract) as may be required to provide timely on site problem resolution as installation or product supply issues may arise.
- C. Where local distribution cannot service to the requirements of the contract scope and product is to be supplied directly by the manufacturer, the manufacturer shall provide on-site technical assistance as specified under Clause D of this section.
- D. Where product is supplied direct, technical assistance supplied by the manufacturer shall include the provision of a technical consultant direct from or contracted by the manufacturer for first week of contract that form product is to be erected on the site to coordinate form system installation, crew organization and set-up. During installation, (as agreed to with terms of contractor), the manufacturer's technical consultant shall provide periodic site visits (as may required under separate contract) at key stages of form installation, to assure continued product installation quality.

## 2.03 DESCRIPTION

### A. General:

1. Insulating concrete form system shall consist of two (2) flame resistant panels of expanded polystyrene (EPS) connected by either high-density polypropylene hinged pin foldable webs or EPS embedded polystyrene fastening strips interconnected with slide in format - high density polypropylene web connectors. EPS foam panels shall feature continuous vertical dove tail grooves on interior panel surfaces to provide

integral surface bonding to concrete core once filled and concrete is cured. Dove tail grooves shall also facilitate structural linkage with end cap forms placed into the form cavity where required as part of the overall architectural design layout.

2. All web fastening strips to run full height of form and be fitted top and bottom with reversible fitting, "triple-tooth" interlocking mechanisms to enable positive vertical interlocking of forms with each other. Wall system webs to provide minimum 1 ½" (38mm) wide fastening strips at 8-inches (203mm) on center approx 5/8-inch (15.9 mm) below insulation face to facilitate finish fastening of both interior and exterior finishes.
3. Insulating concrete form system shall be capable of forming ALL of following concrete core thicknesses: 4, 6, 8, 10 or 12-inches wall sections (as required for various locations throughout project scope with standard form line-up) (See form dimensions summary Attachments Table A at end of Section).
4. Insulating concrete form system shall provide a minimum insulation panel thickness of 2 5/8-inches (66.7mm) throughout ALL forms and panels forming the form system product inventory (with exception of variance required for brick ledge and tapered top forms).
5. All form units of wall forming system shall be capable of being shipped to site in folded condition to minimize shipping cost and site storage space requirement and be capable of being deployed to installation ready condition by simply unfolding the unit in a single pull motion or pull motion combined with insertion of a single web (at corner condition).
6. Standards, corner forms and stand alone panels of form system shall provide fully reversible interlocks along top and bottom edges to assure minimum product waste on site. EPS foam panels shall be molded with 1-inch wide by ½-inch high/deep alternating male/female reversible projection/socket interlocks positioned in pairs along both top and bottom edges of all panels.
7. Wall system shall be capable of providing horizontal and vertical lock positioning of steel within form cavity to conform to all reinforcing requirements of ACI 318.

B. Regulatory Requirements:

1. Form system manufacturer shall provide on request, written documentation verifying active compliance to ICC-ES Acceptance Criteria AC-353 "Stay-in-place, Foam Plastic Insulating Concrete Form (ICF) Systems for Solid Concrete", with valid listing in the report verifying qualification of form system for use in Types I through V construction as qualified under the governing Building Code for this project and additional compliances as outlined in Section 2.03.1.B.3 (below).
2. As alternate to above, Form system manufacturer shall provide IAS Accredited 3<sup>rd</sup> Party Certification confirming compliance to ASTM E 2634 – "Standard Specification for Flat Wall Insulating Concrete Forms" and verification that the system meets all testing and documentation requirements for use in Types I through V construction as qualified under the governing Building Code for this project as well as additional compliances as outlined in Section 2.03.1.B.3 (below)
3. Documentation as provided per Section 2.03.1.B.1 or 2 above: shall verify compliance to the following regulatory documents and standards:
  - a) Form system structural, and general performance assessment of properties of EPS foam and polypropylene materials assessment in accordance with the following standards:
    1. ASTM C578: Standard Specification for Rigid, Cellular Polystyrene Thermal Insulation (which includes results for);

- a. ASTM C165: Standard Test Method for Measuring Compressive Properties of Thermal Insulation
  - b. ASTM C177: Standard Test Method for Steady-State Heat Flux Measurements and Thermal Transmission Properties by Means of the Guarded-Hot-Plate Apparatus
  - c. ASTM C203: Standard Test Methods for Breaking Load and Flexural Properties of Block-Type Thermal Insulation
  - d. ASTM C272: Standard Test Method for Water Absorption of Core Materials for Structural Sandwich Constructions
  - e. ASTM C303: Standard Test Method for Dimensions and Density of Preformed Block and Board-Type Thermal Insulation
  - f. ASTM C518: Standard Test Method for Steady-State Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus
  - g. ASTM D1621: Standard Test Method for Compressive Properties Of Rigid Cellular Plastics
  - h. ASTM D1622: Standard Test Method for Apparent Density of Rigid Cellular Plastics
  - i. ASTM D2126: Standard Test Method for Response of Rigid Cellular Plastics to Thermal and Humid Aging
  - j. ASTM D2863: Standard Test Method for Measuring the Minimum Oxygen Concentration to Support Candle-Like Combustion of Plastics (Oxygen Index)
  - k. ASTM E96: Standard Test Methods for Water Vapor Transmission of Materials
- b) Finish attachment testing in accordance with:
    - 1. ASTM D1761: Standard Test Methods for Mechanical Fasteners in Wood (Modified for Polypropylene Web assessment)
  - c) Surface Burning, Flash Ignition and Self Ignition Temperature Characteristics assessment of both plastic web and EPS form materials in accordance with:
    - 1. ASTM D635: Standard Test Method for Rate of Burning and/or Extent and of Burning of Plastics in a Horizontal Position
    - 2. ASTM E84: Standard Test Method for Surface Burning Characteristics of Building Materials
    - 3. ASTM D1929: Standard Test Method for Determining Ignition Temperature of Plastics
  - d) Verification of performance and compliance of finishes for provision thermal barrier protection to foam plastic.
    - 1. NFPA 286: Standard Methods of Fire Tests for Evaluating Contribution of Wall and Ceiling Interior Finish to Room Fire Growth or...
  - e) Crawl Space Installation Evaluation in accordance with:
    - 1. SwRI 99-02: Crawl Space Insulation Evaluation Protocol
  - f) Fire Resistance Rated Construction assessment in accordance with:
    - 1. UL 263: Fire Tests of Building Construction and Materials (See also Sections 2.01 and 2.04.A. 4 through 9)

- g) Non-Combustible Construction assessment (i.e. approved non-combustible material finish requirement documentation) in accordance with:
  - 1. NFPA 259: Standard Test Method for Potential Heat of Building Materials
  - 2. NFPA 268: Standard Test Method for Determining Ignitability of Exterior Wall Assemblies Using a Radiant Heat Energy Source.
- h) Assessment of non-combustible finishes verifying exterior protection of foam plastic insulation in accordance with one of the following standards:
  - 1. NFPA 285: Standard Fire Test Method for Evaluation of Fire Propagation Characteristics of Exterior Non-Load-Bearing Wall Assemblies Containing Combustible Components.
- i) Additional Testing and engineering documentation to verify qualification of EPS foam panels as a Vapor Retarder in conjunction with testing to:
  - 1. ASTM E-96 Standard Test Methods for Water Vapor Transmission of Materials
- j) Testing and engineering documentation to verify qualification of fully assembled wall system as an air barrier element in accordance with:
  - 1. ASTM E1677 Standard Specification for an Air Retarder (AR) Material or System for Low-Rise Framed Building Walls
- k) Testing and engineering documentation to verify qualification of the form system as meets the minimum STC performance requirements of 50 in accordance with:
  - 1. ASTM E 90: Standard Test Method for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions and Elements, or;
  - 2. ASTM E 336: Standard Test Method for Measurement of Airborne Sound Attenuation between Rooms in Buildings.

C. Sustainability Characteristics:

- 1. When required by Architect/Engineer, *Technical Associate* for the form system shall provide, written documentation verifying product recycle content and manufacturing location compliances with respect to USGBC/LEED® document submissions.

## 2.04 PERFORMANCE / DESIGN CRITERIA

A. Capacities:

- 1. Selected system in conjunction with concrete and designated exterior and interior finishes shall provide minimum insulation level of R 23.59 (hr.ft<sup>2</sup>.F/Btu) or (RSI 4.158 (m<sup>2</sup>.K/W) -U Factor 0.2405 W/m<sup>2</sup>.K) across full line of form unit cavity widths.
- 2. EPS foam panels forming part of wall system shall provide maximum vapor permeation rate of 0.78 Perm-inch.(36 ng/Pa.s.m<sup>2</sup>) based on 2 5/8-inches (66.7 mm) singles thickness of foam on interior surface of concrete core.
- 3. Finished wall assembly formed by system shall provide minimum sound transmission class (STC) sound attenuation performance as follows:
  - a) 6-inch core form and above
    - 1) STC 50 (with regular 1/2-inch gypsum board both sides)
- 4. Finished insulating concrete form wall assembly shall be capable of providing fire resistance ratings as listed in this section. Manufacturers of the specified wall assembly number (BXUV.U930) shall be actively listed and classified with Underwriters Laboratories Inc. Listings shall be verifiable under Certifications Directory of UL at:

5. Fire resistance ratings shall be established by testing in full accordance with ANSI/UL 263 – LATEST edition when installed as per the listed classification (BXUV.U930)
  - a) 6-inch core form and above - 4 hour fire resistance rating
6. Per BXUV.U930 Note 2- Wall reinforcement shall consist of minimum No. 5 Bar 60 ksi yield strength installed at 12-inches o/c vertically and 18-inches o/c horizontally.
7. Per BXUV.U930 Note 3- Concrete shall be minimum 4000 psi compressive strength at 28 days and shall be a minimum density of 145 lbs +/- 5lbs /ft<sup>3</sup>.
8. Per BXUV.U930 Note 4- Finished wall assembly shall provide above noted fire resistance ratings using unclassified or classified ½-inch gypsum board finish (interior surface only for exterior walls and both sides for interior demising walls).
9. When reinforced per BXUV.U930 Note 2, 6-inch load bearing wall must demonstrate being able to be loaded to a minimum axially applied load of 40,000 lbs/lf for full 4-hour burn duration under above test conditions.

## 2.05 MATERIALS

### A. Insulating Concrete Forming:

1. Provide Insulating Concrete Forming as listed in Appendix A as may be required for proper execution of the work.

### B. Concrete:

1. Concrete supplied under Section 060300 shall be of strength as indicated on the drawings (measured at 28 days). Recommended maximum aggregate size to be ½-inch aggregate for 4 & 6-inch cavity forms and, ¾-inch aggregate for 8-inch cavity forms and higher.
2. Recommended concrete slump is 4 to 6-inches +/-.
3. Where required by engineer of record, recommended slump specification shall be attained through addition of super plasticizer/mid-range water reducing agents to achieve design mix strength and concrete flow-ability.

### C. Reinforcing Steel:

1. Reinforcing steel shall be as specified in Section 032100 and shall be supplied under that Section for placement by the Form System's *Trained Installer*.

### D. Waterproofing:

1. Where specified, waterproofing shall be self-adhesive modified bituminous sheet waterproofing membrane as supplied by concrete form system manufacturer specific to the form system specified under this section. Material to be supplied under this Section & installed as specified under Section 07 13 52 (Modified Bituminous Sheet Waterproofing).
2. Waterproofing material shall be *EPS* foam compatible.

### E. Parging:

1. Where called for on drawings, parging (acrylic stucco type) shall be as recommended and supplied by Concrete Form Manufacturer under this section and installed as specified under Section 092400 (Portland Cement Plaster).
2. Alternate EIFS supplied and installed under Section 07 24 00 (Exterior Insulation and Finish System).

## 2.06 ACCESSORIES

### *Form Alignment System*

1. The *Trained Installer* shall furnish and utilize the Wall Access and *Form Alignment System* (as supplied by the Manufacturer or approved equivalent) to facilitate construction of the wall assembly, and to provide adjustment for ensuring plumbness and straightness of the wall system during construction, just prior to concrete placement and immediately after concrete placement while form system is still adjustable to final finished position.
2. *Form Alignment System* shall be OSHA compliant. *Technical Associate* shall supply engineering documentation pertaining to the "base" *Form Alignment System* components to verify compliance upon request.
3. As specified under Section 1.05 Submittals, for wall heights above 12-feet (3.6 m), the contractor shall provide scaffold engineering for *Form Alignment System* support or shall ensure this engineering is included by the engineer of record for support of the form system during construction.

## PART 3 EXECUTION

### 3.01 INSTALLERS

#### A. Installer List:

- 1.

#### B. Substitution Limitations:

1. Per Section 1.05 Submittals – Bid Submittal requirements, the installing contractor for this section shall be:
  - a) An experienced ICF Contractor (*trained installer*) with minimum 3 years experience in commercial ICF construction or;
  - b) A qualified masonry or traditional concrete forming contractor with minimum 5 years experience in commercial construction applications.
  - c) A qualified master carpenter with minimum 5 years experience in commercial construction applications.
2. Per Section 1.05 Submittals – Bid Submittal requirements, the installing contractor shall have demonstrated experience on supervising commercial construction projects of with gross floor areas of 50,000 ft<sup>2</sup> or greater. (Submit project name(s)/ location(s)).

### 3.02 EXAMINATION

#### A. Verification of Conditions:

1. Inspect all areas included in Part 1 Section 1.01 Summary to establish extent of work and verify site access conditions.
2. Verify that site conditions are as set out in Part 1- Section 1.10 Site Conditions.

#### B. Evaluation and Assessment:

1. Examine footings installed under Section 03 30 53 are within +/-1/4-inch of level and that steps footing increments are 18-inches in height.
2. Where partial or half course is intended for starting course elevation, ensure step footing increment is equal to cut form unit less 1/2-inch.
3. When specified, ensure reinforcing steel dowels are in place at specified centers along footing lengths.

4. Ensure reinforcement steel dowels have OSHA compliant protection installed until formwork is erected above dowel level.

### 3.03 PREPARATION

#### A. Surface Preparation:

1. Clean all debris from top of footings prior to commencement of insulating concrete form system installation.
2. Sequence installation of concrete formwork with related work specified in other sections to ensure that wall assemblies, including window and door accessories, trim, service penetrations, transition changes, and mechanical service are protected against damage from effects of weather, corrosion, and adjacent construction activity.

### 3.04 ERECTION / INSTALLATION / APPLICATION

#### A. Installation Procedures:

1. Installation of forms to be in strict accordance with manufacturer's product installation manual as supplied in evidence to contractor under Part 1 Section 1.05 of this Section.
2. The *trained installer* shall ensure all manufacturer's procedures for the following work are employed on site (as outlined in the manufacturer's product Installation manual) Additional to all required procedures being followed, the trained Installer shall specifically assure cross checks with respect to layout, leveling and vertical alignment are executed as noted below in each section:
  - a) First Course Placement – perform cross checks for accuracy of plan layout to survey pins, marks or grid lines as set by the contractor.
  - b) Horizontal Reinforcement Placement – assure reinforcement diameter, grade and positioning is accurate to engineering specifications on structural drawings and installed in correct axis of wall for each course placed.
  - c) Successive Course Placement – assure system is accurately leveled subsequent to 2<sup>nd</sup> course placement.
  - d) Door & Window Opening Construction – when specified, assure bucks have been prepared for anchorage with concrete and/or fitted with mesh attachments as may be required for subsequent exterior finishes such as acrylic stuccos or similar architectural coatings for non-combustible construction. *Trained Installer* shall also assure all top, bottom and stirrup steel fittings are installed per engineering specifications.
  - e) *Form Alignment System* Installation – assure *Form Alignment System* is regularly checked for crew safety, anchorage to form system as specified, vertical alignment checks at both pre-placement of concrete as well.
  - f) Vertical Reinforcement Placement- assure reinforcement diameter, grade and positioning is accurate to engineering specifications on structural drawings and installed in correct axis of wall, prior to placement of concrete.
  - g) Pre-Concrete Placement Inspection- trained installer shall assure string lines are place at top of all pours and wall system aligned for placement, cross check and assure that all required service penetration sleeves, embed plates, anchor bolts, fittings, beam pocket preparations, as specified on drawings are in place prior to commencement of concrete placement.
  - h) Concrete Placement- trained installer shall assure concrete tickets retained for contractor records and that slump, strength and aggregate size are as specified per Section 2.04 of this Section. *Trained installer* to assure truck delivery timed for rate of placement and that placement does rate not exceed ACI recommended practices. *Trained installer* shall also assure that concrete during lift placement is

mechanically and internally vibrated per ACI Standards to assure full monolithic concrete placement for all areas of formwork.

- i) *Form Alignment System* and Scaffold Access Assembly, adjustment & removal. *Trained installer* shall assure entire wall lengths aligned to vertical plumb by string line and screeded to horizontal level as required for finished wall height prior to concrete set. Subsequent to initial concrete cure, contractor shall assure that scaffold access and *Form Alignment System* remains in place until removal is directed accordingly by engineer of record for the project.

**B. Interface with Other Work:**

1. Service penetrations (electrical service conduits, water service pipes, air supply and exhaust ducts etc.) shall be installed at the required locations as indicated by the appropriate trade.
2. Service penetrations exceeding 16" x 16" in area shall be reinforced per engineer specifications
3. Prior to concrete placement, install service penetration sleeves (supplied by others) at designated locations to create voids for service placement at later date.
4. Instructions for exterior finish application to be reviewed with each trade. Contractor shall contact *Trained Installer* for specific instructions where sub trade has insufficient information or specialty requirements not addressed in specification specific to ICF applications.

**3.05 CLEANING**

**A. Waste Management**

1. Clean up and properly dispose of all debris remaining on job site related to the installation of the insulated concrete forms.

**3.06 PROTECTION**

- A. Assure final finishes are installed over form product or provide temporary coverage of installation to reduce EPS foam surface exposure to ultra violet light should final finish application be delayed longer than 18 months after form product installation.
- B. Consult with exterior finish contractor concerning exposure of EPS to ultraviolet light to ensure proper finish to ICF walls.

**ATTACHMENTS**

**(A) SUMMARY OF SPECIFIED FORM UNIT THICKNESSES AND DIMENSIONS**

Product	Feature	4" (100mm)		6" (150mm)		8" (200mm)		10" (250mm)		12" (300mm)	
		inches	mm	inches	mm	inches	mm	inches	mm	inches	mm
Standard Form Unit	Length	96	2438	96	2438	96	2438	96	2438	96	2438
	Width	9 1/4	235	11 1/4	286	13 1/4	337	15 1/4	387	17 1/4	438
	Height	18	457	18	457	18	457	18	457	18	457
	EPS Thickness	2 5/8	67	2 5/8	67	2 5/8	67	2 5/8	67	2 5/8	67
90 Degree Form	Length (a) (Ing)	31 5/8	803	31 5/8	803	33 5/8	854	35 5/8	905	37 5/8	956
	Length (b)	15 5/8	397	15 5/8	397	17 5/8	448	19 5/8	498	21 5/8	549

Unit	(sht)										
		Width	9 1/4	235	11 1/4	286	13 1/4	337	15 1/4	387	17 1/4
	Height	18	457	18	457	18	455	18	455	18	455
45 Degree Form Unit	Length (a) (In)	26 1/2	673	26 1/2	673	26 1/2	673	28 1/2	724	30 1/2	775
	Length (b) (sht)	10 1/2	267	10 1/2	267	10 1/2	267	12 1/2	318	14 1/2	368
	Width	9 1/4	235	11 1/4	286	13 1/4	337	15 1/4	387	17 1/4	438
	Height	18	457	18	457	18	457	18	457	18	457
	Length	48	1219	48	1219	48	1219	48	1219	48	1219
One & Two Sided Tapered Top Form Units*	Width	9 1/4	235	11 1/4	286	13 1/4	337	15 1/4	387	17 1/4	438
	Height	18	457	18	457	18	457	18	457	18	457
	EPS Thickness	2 5/8	67	2 5/8	67	2 5/8	67	2 5/8	67	2 5/8	67
	Length	48	1219	48	1219	48	1219	48	1219	48	1219
Molded Brick Ledge*	Width	9 1/4	235	11 1/4	286	13 1/4	337	15 1/4	387	17 1/4	438
	Height	18	457	18	457	18	457	18	457	18	457
	Length	48	1219	48	1219	48	1219	48	1219	48	1219
T-Form Units (main and T-wall core thickness matching)	Lg. T Mn. Lgth	18	457	20	508	22	559	24	610	26	660
	Sh. T Mn. Lgth	50	1270	52	1321	54	1372	56	1422	58	1473
	Height	18	457	18	457	18	457	18	457	18	457
	EPS Thickness	2 5/8	67	2 5/8	67	2 5/8	67	2 5/8	67	2 5/8	67
Molded Brick Ledge & Tapered Top Unit	Length	48	1219	48	1219	48	1219	48	1219	48	1219
	Width	9 1/4	235	11 1/4	286	13 1/4	337	15 1/4	387	17 1/4	438
	Height	18	457	18	457	18	457	18	457	18	457
Brick Ledge Extension	Length	32	813	32	813	32	813	32	813	32	813
	Width	4 1/2	114	4 1/2	114	4 1/2	114	4 1/2	114	4 1/2	114
	Height	13 1/2	343	13 1/2	343	13 1/2	343	13 1/2	343	13 1/2	343
End Cap	Width	4 1/4	108	6 1/4	159	8 1/4	210	10 1/4	260	12 1/4	311
	Height	18	457	18	457	18	457	18	457	18	457
	EPS Thickness	2 5/8	67	2 5/8	67	2 5/8	67	2 5/8	67	2 5/8	67
	Fast. Strip Op.	YES		YES		YES		YES		YES	
Height Adjuster	Length	32	813	32	813	32	813	32	813	32	813
	Height	3	76	3	76	3	76	3	76	3	76
	Fast. Strip Op.	YES		YES		YES		YES		YES	

\* These form units sold in 96-inch (2438 mm) lengths in some regions of the USA

END OF SECTION

## SECTION 03300 - CAST-IN-PLACE CONCRETE

### GENERAL

#### 1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

#### 1.2 SUMMARY

- A. This Section specifies cast-in place concrete, including formwork, reinforcement, concrete materials, mixture design, placement procedures, and finishes, for the following:
  - 1. Footings.
  - 2. Foundation walls.
  - 3. Slabs-on-grade.
  - 4. Floor Slab.
  - 5. Building walls.
- B. Related Sections include the following:
  - 1. Division 03 Section "Architectural Concrete" for general building applications of specially finished formed concrete.
  - 2. Division 31 Section "Earth Moving" for drainage fill under slabs-on-grade.
  - 3. Division 32 Section "Concrete Paving" for concrete pavement and walks.
  - 4. Division 32 Section "Decorative Concrete Paving" for decorative concrete pavement and walks.

#### 1.3 DEFINITIONS

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

#### 1.4 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Design Mixtures: For each concrete mixture. Submit alternate design mixtures when characteristics of materials, Project conditions, weather, test results, or other circumstances warrant adjustments.

- C. Steel Reinforcement Shop Drawings: Placing drawings that detail fabrication, bending, and placement. Include bar sizes, lengths, material, grade, bar schedules, stirrup spacing, bent bar diagrams, bar arrangement, splices and laps, mechanical connections, tie spacing, hoop spacing, and supports for concrete reinforcement.
  - 1. Shoring and Reshoring: Indicate proposed schedule and sequence of stripping formwork, shoring removal, and installing and removing reshoring.
- D. Samples: For waterstops vapor retarder.
- E. Welding certificates.
- F. Qualification Data: For Installer.
  - 1. Aggregates.
- G. Material Certificates: For each of the following, signed by manufacturers:
  - 1. Cementitious materials.
  - 2. Admixtures.
  - 3. Form materials and form-release agents.
  - 4. Steel reinforcement and accessories.
  - 5. Fiber reinforcement.
  - 6. Waterstops.
  - 7. Curing compounds.
  - 8. Floor and slab treatments.
  - 9. Bonding agents.
  - 10. Adhesives.
  - 11. Vapor retarders.
  - 12. Joint-filler strips.
  - 13. Repair materials.
- H. Floor surface flatness and levelness measurements to determine compliance with specified tolerances.
- I. Field quality-control test reports.
- J. Minutes of preinstallation conference.

#### 1.5 QUALITY ASSURANCE

- A. Installer Qualifications: A qualified installer who employs on Project personnel qualified as ACI-certified Flatwork Technician and Finisher and a supervisor who is an ACI-certified Concrete Flatwork Technician.
- B. Manufacturer Qualifications: A firm experienced in manufacturing ready-mixed concrete products and that complies with ASTM C 94 requirements for production facilities and equipment.

1. Manufacturer certified according to NRMCA's "Certification of Ready Mixed Concrete Production Facilities."
- C. Testing Agency Qualifications: An independent agency, acceptable to authorities having jurisdiction, qualified according to ASTM C 1077 and ASTM E 329 for testing indicated, as documented according to ASTM E 548.
1. Personnel conducting field tests shall be qualified as ACI Concrete Field Testing Technician, Grade 1, according to ACI CP-01 or an equivalent certification program.
  2. Personnel performing laboratory tests shall be ACI-certified Concrete Strength Testing Technician and Concrete Laboratory Testing Technician - Grade I. Testing Agency laboratory supervisor shall be an ACI-certified Concrete Laboratory Testing Technician - Grade II.
- D. Source Limitations: Obtain each type or class of cementitious material of the same brand from the same manufacturer's plant, obtain aggregate from one source, and obtain admixtures through one source from a single manufacturer.
- E. Welding: Qualify procedures and personnel according to AWS D1.4, "Structural Welding Code--Reinforcing Steel."
- F. ACI Publications: Comply with the following unless modified by requirements in the Contract Documents:
1. ACI 301, "Specification for Structural Concrete," Sections 1 through 5.
  2. ACI 117, "Specifications for Tolerances for Concrete Construction and Materials."
- G. Concrete Testing Service: Engage a qualified independent testing agency to perform material evaluation tests and to design concrete mixtures.
- H. Preinstallation Conference: Conduct conference at Project site to comply with requirements in Division 01 Section "Project Management and Coordination."
1. Before submitting design mixtures, review concrete design mixture and examine procedures for ensuring quality of concrete materials. Require representatives of each entity directly concerned with cast-in-place concrete to attend, including the following:
    - a. Contractor's superintendent.
    - b. Independent testing agency responsible for concrete design mixtures.
    - c. Ready-mix concrete manufacturer.
    - d. Concrete subcontractor.

## 1.6 DELIVERY, STORAGE, AND HANDLING

- A. Steel Reinforcement: Deliver, store, and handle steel reinforcement to prevent bending and damage.

- B. Waterstops: Store waterstops under cover to protect from moisture, sunlight, dirt, oil, and other contaminants.

## PART 2 - PRODUCTS

### 2.1 MANUFACTURERS

- A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:
  - 1. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, products specified.
  - 2. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, manufacturers specified.

### 2.2 FORM-FACING MATERIALS

- A. Smooth-Formed Finished Concrete: Form-facing panels that will provide continuous, true, and smooth concrete surfaces. Furnish in largest practicable sizes to minimize number of joints.
  - 1. Plywood, metal, or other approved panel materials.
- B. Form-Release Agent: Commercially formulated form-release agent that will not bond with, stain, or adversely affect concrete surfaces and will not impair subsequent treatments of concrete surfaces.
  - 1. Formulate form-release agent with rust inhibitor for steel form-facing materials.
- C. Form Ties: Factory-fabricated, removable or snap-off metal or glass-fiber-reinforced plastic form ties designed to resist lateral pressure of fresh concrete on forms and to prevent spalling of concrete on removal.
  - 1. Furnish units that will leave no corrodible metal closer than 3/4 inch to the plane of exposed concrete surface.

### 2.3 STEEL REINFORCEMENT

- A. Recycled Content of Steel Products: Provide products with an average recycled content of steel products so postconsumer recycled content plus one-half of preconsumer recycled content is not less than 25 percent.
- B. Reinforcing Bars: ASTM A 615, Grade 60, deformed.
- C. Plain-Steel Wire: ASTM A 82.

- D. Deformed-Steel Wire: ASTM A 496.
- E. Plain-Steel Welded Wire Reinforcement: ASTM A 185, plain, fabricated from as-drawn steel wire into flat sheets.

## 2.4 REINFORCEMENT ACCESSORIES

- A. Joint Dowel Bars: ASTM A 615, Grade 60, plain-steel bars, cut bars true to length with ends square and free of burrs.
- B. Bar Supports: Bolsters, chairs, spacers, and other devices for spacing, supporting, and fastening reinforcing bars and welded wire reinforcement in place. Manufacture bar supports from steel wire, plastic, or precast concrete according to CRSI's "Manual of Standard Practice," of greater compressive strength than concrete and as follows:

## 2.5 CONCRETE MATERIALS

- A. Cementitious Material: Use the following cementitious materials, of the same type, brand, and source, throughout Project:
  - 1. Portland Cement: ASTM C 150, Type I/II, gray. Supplement with the following:
    - a. Fly Ash: ASTM C 618, Class C.
  - B. Silica Fume: In all water holding area ASTM C 1240, amorphous silica.
  - C. Normal-Weight Aggregates: ASTM C 33, Class 3M coarse aggregate or better, graded. Provide aggregates from a single source with documented service record data of at least 10 years' satisfactory service in similar applications and service conditions using similar aggregates and cementitious materials.
    - 1. Maximum Coarse-Aggregate Size: 1-1/2 inch nominal.
    - 2. Fine Aggregate: Free of materials with deleterious reactivity to alkali in cement.
- D. Water: ASTM C 94 and potable.

## 2.6 ADMIXTURES

- A. Air-Entraining Admixture: ASTM C 260.
- B. Chemical Admixtures: Provide admixtures certified by manufacturer to be compatible with other admixtures and that will 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. Plasticizing and Retarding Admixture: ASTM C 1017, Type II.
- C. Set-Accelerating Corrosion-Inhibiting Admixture: Commercially formulated, anodic inhibitor or mixed cathodic and anodic inhibitor; capable of forming a protective barrier and minimizing chloride reactions with steel reinforcement in concrete and complying with ASTM C 494, Type C.
1. Available Products:
    - a. Boral Material Technologies, Inc.; Boral BCN.
    - b. Euclid Chemical Company (The); Eucon CIA.
    - c. Grace Construction Products, W. R. Grace & Co.; DCI.
    - d. Master Builders, Inc.; Rheocrete CNI.
    - e. Sika Corporation; Sika CNI.

## 2.7 FIBER REINFORCEMENT

- A. Synthetic Fiber: Option for specific area only to be proposed by the contactor and approved by E.R. fibrillated polypropylene fibers engineered and designed for use in concrete pavement, complying with ASTM C 1116, Type III, 1/2 to 1-1/2 inches long.
1. Products:
    - a. Fibrillated Fibers:
      - 1) Axim Concrete Technologies; Fibrasol F.
      - 2) Euclid Chemical Company (The); Fiberstrand F.
      - 3) FORTA Corporation; Forta.
      - 4) Grace Construction Products, W. R. Grace & Co.; Grace Fibers.
      - 5) SI Concrete Systems; Fibermesh.
- B. Self-Expanding Rubber Strip Waterstops: Manufactured rectangular or trapezoidal strip, bentonite-free hydrophilic polymer modified chloroprene rubber, for adhesive bonding to concrete, 3/8 by 3/4 inch.
1. Available Products:
    - a. Deneef Construction Chemicals; Swellseal.
    - b. Greenstreak; Hydrotite.
    - c. Mitsubishi International Corporation; Adeka Ultra Seal.
    - d. Progress Unlimited, Inc.; Superstop.

## 2.8 VAPOR RETARDERS

- A. Plastic Vapor Retarder: ASTM E 1745, Class C, or polyethylene sheet, ASTM D 4397, not less than 10 mils thick. Include manufacturer's recommended adhesive or pressure-sensitive joint tape.
  - 1. Available Products:
    - a. Fortifiber Corporation; Moistop Plus.
    - b. Raven Industries Inc.; Dura Skrim 10.
    - c. Reef Industries, Inc.; Griffolyn Type- 85.
    - d. Stego Industries, LLC; Stego Wrap, 10 mils.
- B. Granular Fill: Clean mixture of crushed stone or crushed or uncrushed gravel; ASTM D 448, Size 57, with 100 percent passing a 1-1/2-inch sieve and 0 to 5 percent passing a No. 8 sieve.

## 2.9 FLOOR AND SLAB TREATMENTS

- A. Penetrating Liquid Floor Treatment: Clear, chemically reactive, waterborne solution of inorganic silicate or silicate materials and proprietary components; odorless; colorless; that penetrates, hardens, and densifies concrete surfaces.
  - 1. Available Products:
    - a. Burke by Edoco; Titan Hard.
    - b. ChemMasters; Chemisil Plus.
    - c. ChemTec International; ChemTec One.
    - d. Conspec Marketing & Manufacturing Co., Inc., a Dayton Superior Company; Intraseal.
    - e. Curecrete Distribution Inc.; Ashford Formula.
    - f. Dayton Superior Corporation; Day-Chem Sure Hard.
    - g. Euclid Chemical Company (The); Euco Diamond Hard.
    - h. Kaufman Products, Inc.; SureHard.
    - i. L&M Construction Chemicals, Inc.; Seal Hard.
    - j. Meadows, W. R., Inc.; Liqui-Hard.
    - k. Metalcrete Industries; Floorsaver.
    - l. Nox-Crete Products Group, Kinsman Corporation; Duranox.
    - m. Symons Corporation, a Dayton Superior Company; Buff Hard.
    - n. US Mix Products Company; US Spec Industraseal.
    - o. Vexcon Chemicals, Inc.; Vexcon StarSeal PS.

## 2.10 CURING MATERIALS

- A. Clear, Waterborne, Membrane-Forming Curing Compound: ASTM C 309, Type 1, Class B, 18 to 25 percent solids, nondissipating, certified by curing compound manufacturer to not interfere with bonding of floor covering.

1. Available Products:

- a. Burke by Edoco; Spartan Cote WB II 20 Percent.
- b. ChemMasters; Safe-Cure Clear.
- c. Conspec Marketing & Manufacturing Co., Inc., a Dayton Superior Company; High Seal.
- d. Dayton Superior Corporation; Safe Cure and Seal (J-19).
- e. Euclid Chemical Company (The); Diamond Clear VOX.
- f. Kaufman Products, Inc.; SureCure Emulsion.
- g. Lambert Corporation; Glazecote Sealer-20.
- h. L&M Construction Chemicals, Inc.; Dress & Seal WB.
- i. MBT Protection and Repair, Div. of ChemRex; MasterKure-N-Seal VOC.
- j. Meadows, W. R., Inc.; Vocomp-20.
- k. Metalcrete Industries; Metcure 0800.
- l. Nox-Crete Products Group, Kinsman Corporation; Cure & Seal 200E.
- m. Sonneborn, Div. of ChemRex; Kure-N-Seal.
- n. Symons Corporation, a Dayton Superior Company; Cure & Seal 18 Percent E.
- o. Tamms Industries, Inc.; Clearseal WB STD.
- p. Unitex; Hydro Seal 18.
- q. US Mix Products Company; US Spec Radiance UV-25
- r. Vexcon Chemicals, Inc.; Starseal 0800.

2.11 RELATED MATERIALS

- A. Expansion- and Isolation-Joint-Filler Strips: ASTM D 1751, asphalt-saturated cellulosic fiber or ASTM D 1752, cork.
- B. Bonding Agent: ASTM C 1059, Type II, non-redispersible, acrylic emulsion or styrene butadiene.
- C. Epoxy Bonding Adhesive: ASTM C 881, two-component epoxy resin, capable of humid curing and bonding to damp surfaces, of class suitable for application temperature and of grade to suit requirements, and as follows:
  1. Types IV and V, load bearing, for bonding hardened or freshly mixed concrete to hardened concrete.
- D. Dovetail Anchor Slots: Hot-dip galvanized steel sheet, not less than 0.0336 inch thick, with bent tab anchors. Temporarily fill or cover face opening of slots to prevent intrusion of concrete or debris.

2.12 REPAIR MATERIALS

- A. Repair Underlayment: Cement-based, polymer-modified, self-leveling product that can be applied in thicknesses from 1/8 inch and that can be feathered at edges to match adjacent floor elevations.

1. Cement Binder: ASTM C 150, portland cement or hydraulic or blended hydraulic cement as defined in ASTM C 219.
  2. Primer: Product of underlayment manufacturer recommended for substrate, conditions, and application.
  3. Aggregate: Well-graded, washed gravel, 1/8 to 1/4 inch or coarse sand as recommended by underlayment manufacturer.
  4. Compressive Strength: Not less than 5000 psi at 28 days when tested according to ASTM C 109.
- B. Repair Overlayment: Cement-based, polymer-modified, self-leveling product that can be applied in thicknesses from 1/8 inch and that can be feathered at edges to match adjacent floor elevations.
1. Cement Binder: ASTM C 150, portland cement or hydraulic or blended hydraulic cement as defined in ASTM C 219.
  2. Primer: Product of topping manufacturer recommended for substrate, conditions, and application.
  3. Aggregate: Well-graded, washed gravel, 1/8 to 1/4 inch or coarse sand as recommended by topping manufacturer.
  4. Compressive Strength: Not less than 5000 psi at 28 days when tested according to ASTM C 109.

## 2.13 CONCRETE MIXTURES, GENERAL

- A. Prepare design mixtures for each type and strength of concrete, proportioned on the 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 mixture designs based on laboratory trial mixtures.
- B. Cementitious Materials: Limit percentage, by weight, of cementitious materials other than portland cement in concrete as follows:
1. Fly Ash: 25 percent.
  2. Silica Fume: 10 percent.
- C. Limit water-soluble, chloride-ion content in hardened concrete to 0.06 percent by weight of cement.
- D. Admixtures: Use admixtures according to manufacturer's written instructions.
1. Use plasticizing admixture in concrete, as required, for placement and workability.

## 2.14 CONCRETE MIXTURES FOR BUILDING ELEMENTS

- A. Footings: Proportion normal-weight concrete mixture as follows:

1. Minimum Compressive Strength: 4000 psi at 28 days.
2. Maximum Water-Cementitious Materials Ratio: 0.40.
3. Slump Limit: 4 inches for concrete with verified slump of 2 to 4 inches before adding high-range water-reducing admixture or plasticizing admixture, plus or minus 1 inch.
4. Air Content: 5-1/2 percent, plus or minus 1.5 percent at point of delivery for 1-1/2-inch nominal maximum aggregate size.

B. Foundation Walls: Proportion normal-weight concrete mixture as follows:

1. Minimum Compressive Strength: 4000 psi at 28 days.
2. Maximum Water-Cementitious Materials Ratio: 0.40.
3. Slump Limit: 4 inches for concrete with verified slump of 2 to 4 inches before adding high-range water-reducing admixture or plasticizing admixture, plus or minus 1 inch.
4. Air Content: 5-1/2 percent, plus or minus 1.5 percent at point of delivery for 1-1/2-inch nominal maximum aggregate size.

C. Slabs-on-Grade& Floor Slab: Proportion normal-weight concrete mixture as follows:

1. Minimum Compressive Strength: 4000 psi at 28 days.
2. Minimum Cementitious Materials Content: 540 lb/cu. yd..
3. Slump Limit: 4 inches, plus or minus 1 inch.
4. Air Content: Do not allow air content of troweled finished floors to exceed 3 percent.
5. Synthetic Fiber: Option Only if approved by E.R Uniformly disperse in concrete mixture at manufacturer's recommended rate, but not less than 4.5 lb/cu. yd.

## 2.15 FABRICATING REINFORCEMENT

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

## 2.16 CONCRETE MIXING

- A. Ready-Mixed Concrete: Measure, batch, mix, and deliver concrete according to ASTM C 94 and ASTM C 1116, and furnish batch ticket information.
1. 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

### 3.1 FORMWORK

- A. Design, erect, shore, brace, and maintain formwork, according to ACI 301, to support vertical, lateral, static, and dynamic loads, and construction loads that might be applied, until structure can support such loads.
- B. Construct formwork so concrete members and structures are of size, shape, alignment, elevation, and position indicated, within tolerance limits of ACI 117.
- C. Limit concrete surface irregularities, designated by ACI 347R as abrupt or gradual, as follows:
  - 1. Class A, 1/8 inch for smooth-formed finished surfaces.
- D. Construct forms tight enough to prevent loss of concrete mortar.
- E. Fabricate forms for easy removal without hammering or prying against concrete surfaces. Provide crush or wrecking plates where stripping may damage cast concrete surfaces. Provide top forms for inclined surfaces steeper than 1.5 horizontal to 1 vertical.
  - 1. Install keyways, reglets, recesses, and the like, for easy removal.
  - 2. Do not use rust-stained steel form-facing material.
- F. Set edge forms, bulkheads, and intermediate screed strips for slabs to achieve required elevations and slopes in finished concrete surfaces. Provide and secure units to support screed strips; use strike-off templates or compacting-type screeds.
- G. Provide temporary openings for cleanouts and inspection ports where interior area of formwork is inaccessible. Close openings with panels tightly fitted to forms and securely braced to prevent loss of concrete mortar. Locate temporary openings in forms at inconspicuous locations.
- H. Form openings, chases, offsets, sinkages, keyways, reglets, blocking, screeds, and bulkheads required in the Work. Determine sizes and locations from trades providing such items.
- I. Clean forms and adjacent surfaces to receive concrete. Remove chips, wood, sawdust, dirt, and other debris just before placing concrete.
- J. Retighten forms and bracing before placing concrete, as required, to prevent mortar leaks and maintain proper alignment.
- K. Coat contact surfaces of forms with form-release agent, according to manufacturer's written instructions, before placing reinforcement.

### 3.2 EMBEDDED ITEMS

- A. Place and secure anchorage devices and other embedded items required for adjoining work that is attached to or supported by cast-in-place concrete. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
  - 1. Install anchor rods, accurately located, to elevations required and complying with tolerances in Section 7.5 of AISC's "Code of Standard Practice for Steel Buildings and Bridges."
  - 2. Install dovetail anchor slots in concrete structures as indicated.

### 3.3 REMOVING AND REUSING FORMS

- A. General: Formwork for sides of beams, walls, columns, and similar parts of the Work that does not support weight of concrete may be removed after cumulatively curing at not less than 50 deg F for 72 hours after placing concrete, if concrete is hard enough to not be damaged by form-removal operations and curing and protection operations are maintained.
- B. Clean and repair surfaces of forms to be reused in the Work. Split, frayed, delaminated, or otherwise damaged form-facing material will not be acceptable for exposed surfaces. Apply new form-release agent.
- C. When forms are reused, clean surfaces, remove fins and laitance, and tighten to close joints. Align and secure joints to avoid offsets. Do not use patched forms for exposed concrete surfaces unless approved by Architect.

### 3.4 VAPOR RETARDERS

- A. Plastic Vapor Retarders: Place, protect, and repair vapor retarders according to ASTM E 1643 and manufacturer's written instructions.
  - 1. Lap joints 6 inches and seal with manufacturer's recommended tape.

### 3.5 STEEL REINFORCEMENT

- A. General: Comply with CRSI's "Manual of Standard Practice" for placing reinforcement.
  - 1. Do not cut or puncture vapor retarder. Repair damage and reseal vapor retarder before placing concrete.
- B. Clean reinforcement of loose rust and mill scale, earth, ice, and other foreign materials that would reduce bond to concrete.
- C. Accurately position, support, and secure reinforcement against displacement. Locate and support reinforcement with bar supports to maintain minimum concrete cover. Do not tack weld crossing reinforcing bars.

1. Weld reinforcing bars according to AWS D1.4, where indicated.
- D. Set wire ties with ends directed into concrete, not toward exposed concrete surfaces.
- E. Install welded wire reinforcement in longest practicable lengths on bar supports spaced to minimize sagging. Lap edges and ends of adjoining sheets at least one mesh spacing. Offset laps of adjoining sheet widths to prevent continuous laps in either direction. Lace overlaps with wire.

### 3.6 JOINTS

- A. General: Construct joints true to line with faces perpendicular to surface plane of concrete.
- B. Construction Joints: Install so strength and appearance of concrete are not impaired, at locations indicated or as approved by Architect.
- C. Contraction Joints in Slabs-on-Grade: Form weakened-plane contraction joints, sectioning concrete into areas as indicated. Construct contraction joints for a depth equal to at least one-fourth of concrete thickness as follows:
  1. Sawed Joints: Form contraction joints with power saws equipped with shatterproof abrasive or diamond-rimmed blades. Cut 1/8-inch- wide joints into concrete when cutting action will not tear, abrade, or otherwise damage surface and before concrete develops random contraction cracks.

### 3.7 WATERSTOPS

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

### 3.8 CONCRETE PLACEMENT

- A. Before placing concrete, verify that installation of formwork, reinforcement, and embedded items is complete and that required inspections have been performed.
- B. Do not add water to concrete during delivery, at Project site, or during placement unless approved by Architect.
- C. Before test sampling and placing concrete, water may be added at Project site, subject to limitations of ACI 301.
  1. Do not add water to concrete after adding high-range water-reducing admixtures to mixture.

- D. Deposit concrete continuously in one layer or in horizontal layers of such thickness that no new concrete will be placed on concrete that has hardened enough to cause seams or planes of weakness. If a section cannot be placed continuously, provide construction joints as indicated. Deposit concrete to avoid segregation.
1. Deposit concrete in horizontal layers of depth to not exceed formwork design pressures and in a manner to avoid inclined construction joints.
  2. Consolidate placed concrete with mechanical vibrating equipment according to ACI 301.
  3. Do not use vibrators to transport concrete inside forms. Insert and withdraw vibrators vertically at uniformly spaced locations to rapidly penetrate placed layer and at least 6 inches into preceding layer. Do not insert vibrators into lower layers of concrete that have begun to lose plasticity. At each insertion, limit duration of vibration to time necessary to consolidate concrete and complete embedment of reinforcement and other embedded items without causing mixture constituents to segregate.
- E. Deposit and consolidate concrete for floors and slabs in a continuous operation, within limits of construction joints, until placement of a panel or section is complete.
1. Consolidate concrete during placement operations so concrete is thoroughly worked around reinforcement and other embedded items and into corners.
  2. Maintain reinforcement in position on chairs during concrete placement.
  3. Screed slab surfaces with a straightedge and strike off to correct elevations.
  4. Slope surfaces uniformly to drains where required.
  5. Begin initial floating using bull floats or darbies to form a uniform and open-textured surface plane, before excess bleedwater appears on the surface. Do not further disturb slab surfaces before starting finishing operations.
- F. Cold-Weather Placement: Comply with ACI 306.1 and as follows. Protect concrete work from physical damage or reduced strength that could be caused by frost, freezing actions, or low temperatures.
1. When average high and low temperature is expected to fall below 40 deg F for three successive days, maintain delivered concrete mixture temperature within the temperature range required by ACI 301.
  2. Do not use frozen materials or materials containing ice or snow. Do not place concrete on frozen subgrade or on subgrade containing frozen materials.
  3. Do not use calcium chloride, salt, or other materials containing antifreeze agents or chemical accelerators unless otherwise specified and approved in mixture designs.
- G. Hot-Weather Placement: Comply with ACI 301 and as follows:
1. Maintain concrete temperature below 90 deg F at time of placement. Chilled mixing water or chopped ice may be used to control temperature, provided water equivalent of ice is calculated to total amount of mixing water. Using liquid nitrogen to cool concrete is Contractor's option.
  2. Fog-spray forms, steel reinforcement, and subgrade just before placing concrete. Keep subgrade uniformly moist without standing water, soft spots, or dry areas.

### 3.9 FINISHING FORMED SURFACES

- A. Rough-Formed Finish: As-cast concrete texture imparted by form-facing material with tie holes and defects repaired and patched. Remove fins and other projections that exceed specified limits on formed-surface irregularities.
  - 1. Apply to concrete surfaces not exposed to public view.
- B. Smooth-Formed Finish: As-cast concrete texture imparted by form-facing material, arranged in an orderly and symmetrical manner with a minimum of seams. Repair and patch tie holes and defects. Remove fins and other projections that exceed specified limits on formed-surface irregularities.
  - 1. Apply to concrete surfaces exposed to public view.
- C. Related Unformed Surfaces: At tops of walls, horizontal offsets, and similar unformed surfaces adjacent to formed surfaces, strike off smooth and finish with a texture matching adjacent formed surfaces. Continue final surface treatment of formed surfaces uniformly across adjacent unformed surfaces, unless otherwise indicated.

### 3.10 FINISHING FLOORS AND SLABS

- A. General: Comply with ACI 302.1R recommendations for screeding, restraightening, and finishing operations for concrete surfaces. Do not wet concrete surfaces.
- B. Scratch Finish: While still plastic, texture concrete surface that has been screeded and bull-floated or darbied. Use stiff brushes, brooms, or rakes to produce a profile amplitude of 1/4 inch in 1 direction.
  - 1. Apply scratch finish to surfaces as indicated and to receive mortar setting beds for bonded cementitious floor finishes .
- C. Float Finish: Consolidate surface with power-driven floats or by hand floating if area is small or inaccessible to power driven floats. Restraighten, cut down high spots, and fill low spots. Repeat float passes and restraightening until surface is left with a uniform, smooth, granular texture.
  - 1. Apply float finish to surfaces indicated to receive trowel.
- D. Trowel Finish: After applying float finish, apply first troweling and consolidate concrete by hand or power-driven trowel. Continue troweling passes and restraighten until surface is free of trowel marks and uniform in texture and appearance. Grind smooth any surface defects that would telegraph through applied coatings or floor coverings.
  - 1. Apply a trowel finish to surfaces as indicated to be covered with resilient flooring, carpet, and ceramic or quarry tile set over a cleavage membrane, paint, or another thin-film-finish coating system.
  - 2. Finish surfaces to the following tolerances, according to ASTM E 1155, for a randomly trafficked floor surface:

- a. Specified overall values of flatness, F(F) 35; and of levelness, F(L) 25; with minimum local values of flatness, F(F) 24; and of levelness, F(L) 17; for slabs-on-grade and floor slab.
  3. Finish and measure surface so gap at any point between concrete surface and an unlevelled, freestanding, 10-foot- long straightedge resting on 2 high spots and placed anywhere on the surface does not exceed 1/8 inch.
- E. Broom Finish: Apply a broom finish to exterior concrete platforms, steps, and ramps, and elsewhere as indicated.
1. Immediately after float finishing, slightly roughen trafficked surface by brooming with fiber-bristle broom perpendicular to main traffic route. Coordinate required final finish with Architect before application.

### 3.11 MISCELLANEOUS CONCRETE ITEMS

- A. Filling In: Fill in holes and openings left in concrete structures, unless otherwise indicated, after work of other trades is in place. Mix, place, and cure concrete, as specified, to blend with in-place construction. Provide other miscellaneous concrete filling indicated or required to complete the Work.
- B. Curbs: Provide monolithic finish to interior curbs by stripping forms while concrete is still green and by steel-troweling surfaces to a hard, dense finish with corners, intersections, and terminations slightly rounded.
- C. Equipment Bases and Foundations: Provide machine and equipment bases and foundations as shown on Drawings. Set anchor bolts for machines and equipment at correct elevations, complying with diagrams or templates from manufacturer furnishing machines and equipment.
- D. Steel Pan Stairs: Provide concrete fill for steel pan stair treads, landings, and associated items. Cast-in inserts and accessories as shown on Drawings. Screed, tamp, and trowel-finish concrete surfaces.

### 3.12 CONCRETE PROTECTING AND CURING

- A. General: Protect freshly placed concrete from premature drying and excessive cold or hot temperatures. Comply with ACI 306.1 for cold-weather protection and ACI 301 for hot-weather protection during curing.
- B. Evaporation Retarder: Apply evaporation retarder to unformed concrete surfaces if hot, dry, or windy conditions cause moisture loss approaching 0.2 lb/sq. ft. x h before and during finishing operations. Apply according to manufacturer's written instructions after placing, screeding, and bull floating or darbying concrete, but before float finishing.
- C. Formed Surfaces: Cure formed concrete surfaces, including underside of beams, supported slabs, and other similar surfaces. If forms remain during curing period,

moist cure after loosening forms. If removing forms before end of curing period, continue curing for the remainder of the curing period.

- D. Unformed Surfaces: Begin curing immediately after finishing concrete. Cure unformed surfaces, including floors and slabs, concrete floor toppings, and other surfaces.
- E. Cure concrete according to ACI 308.1, by one or a combination of the following methods:
  - a. Absorptive cover, water saturated, and kept continuously wet. Cover concrete surfaces and edges with 12-inch lap over adjacent absorptive covers.
  - 2. Curing Compound: Apply uniformly in continuous operation by power spray or roller according to manufacturer's written instructions. Recoat areas subjected to heavy rainfall within three hours after initial application. Maintain continuity of coating and repair damage during curing period.
    - a. After curing period has elapsed, remove curing compound without damaging concrete surfaces by method recommended by curing compound manufacturer unless manufacturer certifies curing compound will not interfere with bonding of floor covering used on Project.

### 3.13 LIQUID FLOOR TREATMENTS

- A. Penetrating Liquid Floor Treatment: Prepare, apply, and finish penetrating liquid floor treatment according to manufacturer's written instructions.
  - 1. Remove curing compounds, sealers, oil, dirt, laitance, and other contaminants and complete surface repairs.
  - 2. Do not apply to concrete that is less than three days' old.
  - 3. Apply liquid until surface is saturated, scrubbing into surface until a gel forms; rewet; and repeat brooming or scrubbing. Rinse with water; remove excess material until surface is dry. Apply a second coat in a similar manner if surface is rough or porous.
- B. Sealing Coat: Uniformly apply a continuous sealing coat of curing and sealing compound to hardened concrete by power spray or roller according to manufacturer's written instructions.

### 3.14 JOINT FILLING

- A. Prepare, clean, and install joint filler according to manufacturer's written instructions.
  - 1. Defer joint filling until concrete has aged at least one month. Do not fill joints until construction traffic has permanently ceased.

### 3.15 CONCRETE SURFACE REPAIRS

- A. Defective Concrete: Repair and patch defective areas when approved by Architect. Remove and replace concrete that cannot be repaired and patched to Architect's approval.
- B. Patching Mortar: Mix dry-pack patching mortar, consisting of one part portland cement to two and one-half parts fine aggregate passing a No. 16 sieve, using only enough water for handling and placing.
- C. Repairing Formed Surfaces: Surface defects include color and texture irregularities, cracks, spalls, air bubbles, honeycombs, rock pockets, fins and other projections on the surface, and stains and other discolorations that cannot be removed by cleaning.
  - 1. Immediately after form removal, cut out honeycombs, rock pockets, and voids more than 1/4 inch in any dimension in solid concrete, but not less than 1 inch in depth. Make edges of cuts perpendicular to concrete surface. Clean, dampen with water, and brush-coat holes and voids with bonding agent. Fill and compact with patching mortar before bonding agent has dried. Fill form-tie voids with patching mortar or cone plugs secured in place with bonding agent.
  - 2. Repair defects on surfaces exposed to view by blending white portland cement and standard portland cement so that, when dry, patching mortar will match surrounding color. Patch a test area at inconspicuous locations to verify mixture and color match before proceeding with patching. Compact mortar in place and strike off slightly higher than surrounding surface.
  - 3. Repair defects on concealed formed surfaces that affect concrete's durability and structural performance as determined by Architect.
- D. Repairing Unformed Surfaces: Test unformed surfaces, such as floors and slabs, for finish and verify surface tolerances specified for each surface. Correct low and high areas. Test surfaces sloped to drain for trueness of slope and smoothness; use a sloped template.
  - 1. Repair finished surfaces containing defects. Surface defects include spalls, popouts, honeycombs, rock pockets, crazing and cracks in excess of 0.01 inch wide or that penetrate to reinforcement or completely through unreinforced sections regardless of width, and other objectionable conditions.
  - 2. After concrete has cured at least 14 days, correct high areas by grinding.
  - 3. Correct localized low areas during or immediately after completing surface finishing operations by cutting out low areas and replacing with patching mortar. Finish repaired areas to blend into adjacent concrete.
  - 4. Correct other low areas scheduled to remain exposed with a repair topping. Cut out low areas to ensure a minimum repair topping depth of 1/4 inch to match adjacent floor elevations. Prepare, mix, and apply repair topping and primer according to manufacturer's written instructions to produce a smooth, uniform, plane, and level surface.
  - 5. Repair defective areas, except random cracks and single holes 1/4 inch or less in diameter, by cutting out and replacing with fresh concrete. Remove defective areas with clean, square cuts and expose steel reinforcement with at least a 3/4-inch clearance all around. Dampen concrete surfaces in contact with patching

concrete and apply bonding agent. Mix patching concrete of same materials and mixture as original concrete except without coarse aggregate. Place, compact, and finish to blend with adjacent finished concrete. Cure in same manner as adjacent concrete.

6. Repair random cracks and single holes 1 inch or less in diameter with patching mortar. Groove top of cracks and cut out holes to sound concrete and clean off dust, dirt, and loose particles. Dampen cleaned concrete surfaces and apply bonding agent. Place patching mortar before bonding agent has dried. Compact patching mortar and finish to match adjacent concrete. Keep patched area continuously moist for at least 72 hours.

E. Perform structural repairs of concrete, subject to E.R approval, using epoxy adhesive and patching mortar.

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

### 3.16 FIELD QUALITY CONTROL

A. Testing and Inspecting: Owner will engage a qualified testing and inspecting agency to perform field tests and inspections and prepare test reports.

B. Inspections:

1. Steel reinforcement placement.
2. Steel reinforcement welding.
3. Headed bolts and studs.
4. Verification of use of required design mixture.
5. Concrete placement, including conveying and depositing.
6. Curing procedures and maintenance of curing temperature.
7. Verification of concrete strength before removal of shores and forms from beams and slabs.

C. Concrete Tests: Testing of composite samples of fresh concrete obtained according to ASTM C 172 shall be performed according to the following requirements:

1. Testing Frequency: Obtain one composite sample for each day's pour of each concrete mixture exceeding 5 cu. yd., but less than 25 cu. yd., plus one set for each additional 50 cu. yd. or fraction thereof.
2. Slump: ASTM C 143; one test at point of placement for each composite sample, but not less than one test for each day's pour of each concrete mixture. Perform additional tests when concrete consistency appears to change.
3. Air Content: ASTM C 231, pressure method, for normal-weight concrete; ASTM C 173, volumetric method, for structural lightweight concrete; one test for each composite sample, but not less than one test for each day's pour of each concrete mixture.

4. Concrete Temperature: ASTM C 1064; one test hourly when air temperature is 40 deg F and below and when 80 deg F and above, and one test for each composite sample.
  5. Unit Weight: ASTM C 567, fresh unit weight of structural lightweight concrete; one test for each composite sample, but not less than one test for each day's pour of each concrete mixture.
  6. Compression Test Specimens: ASTM C 31.
    - a. Cast and laboratory cure two sets of two standard cylinder specimens for each composite sample.
    - b. Cast and field cure two sets of two standard cylinder specimens for each composite sample.
  7. Compressive-Strength Tests: ASTM C 39;
    - a. Test one set of two field-cured specimens at 7 days and one set of two labored specimens at 28 days.
  8. When strength of field-cured cylinders is less than 95 percent of companion laboratory-cured cylinders, Contractor shall evaluate operations and provide corrective procedures for protecting and curing in-place concrete.
  9. Strength of each concrete mixture will be satisfactory if every average of any three consecutive compressive-strength tests equals or exceeds specified minimum 28 days compressive strength and no compressive-strength test value falls below specified compressive strength.
  10. Test results shall be reported in writing to Architect, concrete manufacturer, and Contractor within 48 hours of testing. Reports of compressive-strength tests shall contain Project identification name and number, date of concrete placement, name of concrete testing and inspecting agency, location of concrete batch in Work, design compressive strength at 28 days, concrete mixture proportions and materials, compressive breaking strength, and type of break for both 7- and 28-day tests.
  11. Additional Tests: Testing and inspecting agency shall make additional tests of concrete when test results indicate that slump, air entrainment, compressive strengths, or other requirements have not been met, as directed by Architect. Testing and inspecting agency may conduct tests to determine adequacy of concrete by cored cylinders complying with ASTM C 42 or by other methods as directed by Architect.
  12. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.
  13. Correct deficiencies in the Work that test reports and inspections indicate dos not comply with the Contract Documents.
- D. Measure floor and slab flatness and levelness according to ASTM E 1155 within 24 hours of finishing.

END OF SECTION 033000

## SECTION 03371 - GROUT

### PART 1 - GENERAL

- A. The general provision of the Contract, including General and Supplementary Conditions and Requirements, apply to the work specified in this section.

### PART 2 - RELATED WORK SPECIFIED ELSEWHERE

- A. Structural steel base plates, anchoring devices and leveling shims: Section 5A.

### PART 3 - DELIVERY AND STORAGE

- A. Prevent damage to or contamination of non-shrink grouting materials during delivery, handling and storage.
- B. Store all non-shrink grouting materials in undamaged condition with seals and labels intact as packaged by the manufacturer.
- C. Non-shrink grout - SonogROUT - Sonneborn - Contech by Sonneborn Building Products Division or approved equal to be used under bearing plates or for grouting rebar dowels into existing walls.

### PART 4 - MATERIALS

- A. Non-shrink grout conforming to the following requirements:
  - 1. Manufactured under rigid quality control specifically for grout used in transferring heavy loads.
  - 2. Contain metallic and non-metallic aggregates especially graded to minimize bleeding.
  - 3. Contain metallic aggregate that is ductile and capable of withstanding impact without fracturing.
  - 4. Have an initial setting time of approximately one hour at 70 degrees F.
  - 5. Produce no settlement or drying shrinkage at 3 days or thereafter.
  - 6. Have higher strength at all ages than plain cement grout of the same flowability.
  - 7. Resist attack by oil and water and have lower absorption than plain cement grout of the same flowability.
- B. Portland Cement: ASTM C 150-72, Type 1.
- C. Sand: ASTM C 33-71a, Fine Aggregate.
- D. Pea Gravel: ASTM C 33-71a. Coarse aggregate, graded so that at least 90 percent passes 3/8-inch sieve and 90 percent is retained by a number 4 sieve.

## **PART 5 - MIXES**

- A. For less than 2-inch clearance, or where size or shape of space makes grouting difficult, grout mix shall consist of grout material and water.
- B. For greater than 2-inch clearances where coarse aggregate will not obstruct free passage of the grout, extend grout by adding 50 pounds of pea gravel per 100 pounds of grout material.
- C. Use the minimum amount of water necessary to produce a flowable grout without causing either segregation or bleeding.
- D. Portland cement mortar for raked-out edges of non-shrink grout: 1 part Portland cement, 2 parts sand and 0.50 parts water by weight.

## **PART 6 - MIXING**

- A. Mix non-shrink grouting materials and water in a mechanical mixer for no less than 3 minutes.
- B. Mix grout as close to the work areas as possible and transport the mixture quickly and in a manner that does not permit segregation of materials.
- C. After the grout has been mixed, do not add more water for any reason.

## **PART 7 - PROCEDURES**

- A. Installation methods and procedures shall be approved by the Engineer's representative before work is begun.

## **PART 8 - SURFACE PREPARATION**

- A. Remove all defective concrete, laitance, dirt, oil, grease, and other foreign material from concrete surfaces by bush-hammering, chipping, or other similar means, until a sound, clean concrete surface is achieved.
- B. Lightly roughen the concrete, but not enough to interfere with the proper placement of grout.
- C. Cover concrete area with waterproof membrane until ready to grout.
- D. Remove foreign materials from all steel surfaces in contact with grout.
- E. Align, level, and maintain final positioning of all components to be grouted.
- F. Take special precautions during extreme weather conditions according to the manufacturer's written instructions.

- G. Immediately before grouting, remove waterproof membranes and clean any contaminated surfaces.
- H. Saturate all concrete surfaces with clean water; remove excess water and leave none standing.

#### **PART 9 - PLACING**

- A. Place non-shrink grouting material quickly and continuously by the most practical means permissible; pouring, pumping, or under gravity pressure.
- B. Do not use either pneumatic-pressure or dry packing methods without written permission of the Architect.
- C. Apply grout from one side only to avoid entrapping air.
- D. Final installation shall be thoroughly compacted and free from air pockets.
- E. Do not vibrate the placed grout mixture, or allow it to be placed if the area is being vibrated by nearby equipment.
- F. Do not remove leveling shims for at least 48 hours after grout has been placed.
- G. After shims have been removed, fill voids with plain cement-sand grout.
- H. After the non-shrink grout has reached initial set, rake out all exposed edges approximately 1-inch into the grouted area and point with portland cement mortar.

#### **PART 10 - CURING**

- A. Cure grout for 3 days after placing by keeping wet and covering with curing paper or by another approved method.

End of Section

## SECTION 03410 – STRUCTURAL PRECAST CONCRETE – PLANT CAST

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

#### 1.2 SUMMARY

- A. This Section includes structural precast concrete units, plant cast, including the following:
  - 1. Hollow-core slab units.
  - 2. Steel header members.
  - 3. Steel connection plates and brackets.
  - 4. Grouting and anchor bolting and welding.
- B. Related Sections: The following sections contain requirements that relate to this section:
  - 1. Division 3 Section “Cast-In-Place Concrete” for composite topping slabs and reinforcing steel.
  - 2. Division 5 Section “Structural Steel” for shop-welded shear connectors, welding requirements, and miscellaneous steel anchors.

#### 1.3 PERFORMANCE REQUIREMENTS

- A. Structural Performance: Engineer, fabricate, and install structural precast concrete units to withstand design loadings indicated on structural drawing.
  - 1. The design of precast –prestressed hollow core slabs shall be in accordance with the latest recommendations of the PCI and ACI building code requirements.
  - 2. Manufacturer shall use contract drawing information indicating depth, loading and deflection requirement of member to design precast-prestressed hollow core slabs. Where the topping is to provide composite action, the topping slab weight is not included in the superimposed dead load.
  - 3. Concentrated loads, resulting from crane rail or other special cases, are shown with diagrammatic sketches of the member, showing the placement and magnitude of the concentrated load. Precast manufacturer shall attend prefabrication meeting in order to coordinate all loading, embed and penetration requirements.
  - 4. Design steel headers where required. Design shall comply with AISC specifications.
- B. Engineering Responsibility: Engage a fabricator who uses a qualified professional engineer to prepare design calculations, fire-resistance calculations, shop drawings, and other structural data.
- C. Prefabrication Coordination Conference: Conduct coordination conference at the Architects Office to comply with the requirements in Division 01 Section “Project

Management and Coordination". Required attendees include the Architect, Construction Manager, Structural Engineer, Steel Fabricator, Structural Precast Concrete Fabricator and Crane Rail supplier and installer.

#### 1.4 SUBMITTALS

- A. General: Submit each item in this Article according to the Conditions of the Contract and Division 1 Specification Sections.
- B. Product data and instructions for manufactured materials and products.
  - 1. Certification by paint and curing compound manufacturers that products supplied comply with local regulations controlling use of volatile organic compounds (VOCs).
- C. Shop drawings detailing fabrication and installation of precast concrete units. Indicate member dimensions and cross-sections; locations, sizes, and types of reinforcement, including special reinforcement; estimated camber; and lifting devices necessary for handling and erection.
  - 1. Include an erection plan indicating layout and dimensions, and identifying each precast concrete unit corresponding to sequence and procedure of installation. Indicate welded connections by AWS standard symbols. Detail loose, cast-in, and field hardware, inserts, connections, and joints, including accessories and construction at openings in precast units.
  - 2. Indicate locations and details of anchorage devices that are to be embedded in other construction. Furnish templates, if required, for accurate placement.
  - 3. Shop drawings shall be signed and sealed by the qualified professional engineer, registered in the State of Kentucky, responsible for their preparation.
  - 4. To the extent structural precast unit design considerations are indicated as fabricator's responsibility, include structural analysis data signed and sealed by the qualified professional engineer, registered in the State of Kentucky, responsible for their preparation. The calculations will be reviewed for design intent only. Engineering and detailing shall be solely the responsibility of the manufacturer and the professional engineer responsible for their preparation.
- D. Design mixes for each concrete mix. Submit revised mix proportions when characteristics of materials, project conditions, weather, test results, or other circumstances warrant adjustments.
- E. Material test reports from a qualified independent testing agency evidencing compliance with requirements of the following based on comprehensive testing of current materials:
  - 1. Concrete materials.
  - 2. Reinforcing materials.
  - 3. Prestressing strands.
  - 4. Admixtures.
  - 5. Bearing pads.
- F. Material certificates in lieu of agency test reports, when permitted by Architect, signed by fabricator certifying that each material item complies with requirements.

## 1.5 QUALITY ASSURANCE

- A. Installer Qualifications: Engage an experienced Installer who has completed structural precast concrete work similar in material, design, and extent to that indicated for this Project and with a record of successful in-service performance.
- B. Fabricator Qualifications: Firm experienced in producing structural precast concrete units similar to those indicated for this Project and with a record of successful in-service performance as well as sufficient production capacity to produce required units without delaying the Work.
  - 1. Fabricator must participate in the Precast/Prestressed Concrete Institute's (PCI) Plant Certification Program and be designated a PCI Certified Plant.
  - 2. Refer also to Section 01415 for special inspection and testing requirements and inspection of fabricators related to this work.
- C. Professional Engineer Qualifications: A professional engineer who is legally authorized to practice in the State of Kentucky and who is experienced in providing engineering services of the kind indicated that have resulted in the installation and successful in-service performance of precast concrete units similar to this Project in material, design, and extent.
- D. Testing Agency: Engage an independent testing agency to perform shop inspections and tests and to provide test reports. Manufacturer shall provide testing agency with access to places where structural precast concrete units are being fabricated so inspection and testing can be accomplished. Correction of deficiencies and additional testing to determine compliance of corrected work will be performed at Contractor's expense. To qualify for acceptance, an independent testing agency must demonstrate to Architect's satisfaction, based on evaluation of agency-submitted criteria conforming to ATM C 1077 and ASTM E 329, that it has the experience and capability to satisfactorily conduct the testing indicated without delaying the Work.
  - 1. Refer also to Section 01415 for special inspection of fabricators requirements related to this work.
- E. PCI Design Standard: Comply with recommendations of PCI MNL-120 "PCI Design Handbook—Precast and Prestressed Concrete" applicable to types of structural precast concrete units indicated.
- F. PCI Quality-Control Standard: Comply with requirements of PCI MNL-116 "Manual for Quality Control for Plants and Production of Precast and Prestressed Concrete Products," including manufacturing and testing procedures, quality-control recommendations, and camber and dimensional tolerances for types of units required.
- G. ACI Publications: Comply with the following ACI publications applicable to types of structural precast concrete units indicated:
  - 1. ACI 301 "Specifications for Structural Concrete for Buildings."
  - 2. ACI 318 "Building Code Requirements for Reinforced Concrete."
  - 3. ACI 315 "Manual of Standard Practice for Detailing Reinforced Concrete Structures."
  - 4. ACI 525 "Minimum Requirements for Thin-Section Precast Concrete Construction."

- H. Welding Standards: Comply with applicable provisions of the following American Welding Society publications:
  - 1. AWS D1.1 “Structural Welding Code – Steel.”
  - 2. AWS D1.4 “Structural Welding Code – Reinforcing Steel.”
  - 3. AWS D12.1 “Recommended Practices for Welding Reinforcing Steel, Metal Inserts, and Connections in Reinforced Concrete Construction.”
- I. Fire- Test-Response Characteristics: Provide structural precast concrete units that comply with the following requirements:
  - 1. Fire-response tests are performed by a qualified testing and inspecting agency. A qualified testing and inspecting agency includes UL or another agency that is acceptable to authorities having jurisdiction and performs testing and follow-up services.
  - 2. Fire-resistance-rated assemblies indicated are identical in materials and construction to those tested for fire resistance per ASTM E 119.
  - 3. Fire-resistance-rated assemblies are indicated by design designations listed in the UL “Fire Resistance Directory” or in the listings of another qualified testing and inspecting agency.

## 1.6 DELIVERY, STORAGE, AND HANDLING

- A. Deliver precast concrete units to Project site in such quantities and at such times to ensure continuity of installation. Store units at Project site to prevent cracking, distorting, warping, staining, or other physical damage, and so that markings are visible.
- B. Lift and support units only at designated lifting or supporting points as shown on final shop drawings.
- C. Deliver anchorage items that are to be embedded in other construction before starting such work. Provide setting diagrams, templates, instructions, and directions, as required, for installation.
- D. Provide temporary lateral support during erection to prevent bowing and warping. Blocking and supports shall be clean, non-staining, and shall not prevent uniform curing of exposed surfaces.

## PART 2 - PRODUCTS

### 2.1 REINFORCING MATERIALS

- A. Reinforcing Bars: ASTM A 615, Grade 60, deformed.
- B. Steel-Welded Wire Fabric: ASTM A 185, welded steel wire fabric in sheets.
- C. Supports for Reinforcement: Bolsters, chairs, spacers and other devices for spacing, supporting and fastening reinforcing bars and welded wire fabric in place. Use supports complying with CRS I recommendations.

1. For exposed-to-view concrete surfaces, where legs of supports are in contact with forms, provide supports with legs that are protected with plastic (CRSI, Class 1) or stainless steel (CRSI, Class 2).

## 2.2 PRESTRESSING TENDONS

- A. Prestressing Strand: ASTM A 416, Grade 250 or 270, uncoated, 7-wire, stress-relieved.

## 2.3 CONCRETE MATERIALS

- A. Portland Cement: ASTM C 150, Type I or Type III.
  1. Use only one brand and type of cement throughout Project, unless otherwise acceptable to Architect.
- B. Fly Ash: ASTM C 618, Class C or F.
- C. Normal-Weight Aggregates: ASTM C 33, Class 5S. Provide aggregates from a single source.
  1. For exposed exterior surfaces, do not use fine or coarse aggregates that contain substances that cause spalling or surface discoloration due to oxidation.
- D. Water: Potable.
- E. Admixtures, General: Provide admixtures for concrete that contain not more than 0.05 percent chloride ions.
- F. Air-Entraining Admixture: ASTM C 260, certified by manufacturer to be compatible with other required admixtures.
- G. Water-Reducing Admixture: ASTM C 494, Type A.
- H. High-Range, Water-Reducing Admixture: ASTM C 494, Type F or Type G.
- I. Water-Reducing, Accelerating Admixture: ASTM C 494, Type E.
- J. Water-Reducing, Retarding Admixture: ASTM C 494, Type D.
- K. Corrosion Inhibitor: ASTM C 494, Type C.

## 2.4 CONNECTION MATERIALS AND FINISHES

- A. Steel Shapes and Plates: ASTM A 36.
- B. Bolts and Studs: ASTM A 307, Grade A; carbon-steel, hex-head bolts and studs; carbon-steel nuts; and flat, unhardened steel washers.
- C. High-Strength Bolts and Nuts: ASTM A 325, Type 1, heavy hex steel structural bolts, heavy hex carbon-steel nuts, and hardened carbon-steel washers.

- D. Welded Headed Studs: AWS D1.1, Type B headed studs, cold-finished carbon-steel bars.
- E. Deformed-Steel Wire Bar Anchors: ASTM A 496.
- F. Welding Electrodes: Comply with AWS standards.
- G. Accessories: Provide clips, hangers, shims, and other accessories required to install precast concrete units.
- H. Hot-Dip Galvanized Finish: For exterior steel items and items indicated for galvanizing, apply zinc coating by the hot-dip process, complying with the following requirements:
  - 1. ASTM A 123 for galvanizing rolled, pressed, and forged shapes, plates, bars, and strips.
  - 2. ASTM A 153 for galvanizing iron and steel hardware.
- I. Galvanizing Repair Paint: High-zinc-dust-content paint with dry film containing not less than 93 percent zinc dust by weight, and complying with DOD-P-21035A or SSPC-Paint 20.
- J. Shop-Primed Finish: Prepare surfaces of interior steel items, except those with galvanized finish or those surfaces to be embedded in concrete, according to requirements of SSPC-SP 3 and shop-apply primer according to SSPC-PA 1.
  - 1. Primer: Fast-curing, lead- and chromate-free, VOC-conforming, universal modified-alkyd primer with good resistance to normal atmospheric corrosion, complying with performance requirements of FS TT-P-664.

## 2.5 BEARING PADS

- A. Provide bearing pads for precast concrete units as follows:
  - 1. Elastomeric Pads: AASHTO M 251, plain, vulcanized, 100 percent polychloroprene (neoprene) elastomer, molded to size or cut from a molded sheet, 50 to 70 shore A durometer, minimum tensile strength 2250 psi per ASTM D 412.
  - 2. Random, Fiber-Reinforced Elastomeric Pads: Preformed, randomly oriented synthetic fibers set in elastomer. Surface hardness of 70 to 90 shore A durometer.
  - 3. Frictionless Pads: Tetrafluoroethylene (TFE), glass-fiber-reinforced, bonded to mild-steel plate, and of type required in-service stress.

## 2.6 GROUT MATERIALS

- A. Nonmetallic, Nonshrink Grout: Premixed, nonmetallic, noncorrosive, nonstaining grout containing selected silica sands, portland cement, shrinkage-compensating agents, plasticizing and water-reducing agents, complying with ASTM C 1107, with fluid consistency and a 30-minute working time.

## 2.7 CURING MATERIALS

- A. Clear, Solvent-Borne, Liquid, Membrane-Forming Curing Compound: ASTM C 309, Type I, Class A, wax free. Moisture loss not more than 0.55 kg/sq. meter when applied at 200 sq.ft./gal.

## 2.8 CONCRETE MIXES

- A. Prepare design mixes for each type and strength of concrete by either laboratory trial batch or field experience methods as specified in ACI 301. For the trial batch method, use an independent testing agency acceptable to Architect or qualified precast manufacturing plant personnel for preparing and reporting proposed mix designs. Trial batch and field experience tests shall have been performed within 12 months of submittal date.
  - 1. Limit use of fly ash less than or equal to 25 percent of cement content by weight.
- B. Normal-Weight Concrete: Provide normal-weight concrete with the following properties:
  - 1. Compressive Strength (28 Day): 5000 psi
  - 2. Maximum Water-Cementitious Materials Ratio at Point of Placement: 0.40.
- C. Use air-entraining admixture in exterior exposed concrete unless otherwise indicated. Add air-entraining admixture at manufacturer's prescribed rate to result in concrete at point of placement having total air content with a tolerance of plus or minus 1-1/2 percent within the following limits:
  - 1. Other concrete not exposed to freezing, thawing, or hydraulic pressure, or to receive a surface hardener: 2 to 4 percent air.
- D. Other Admixtures: Use water-reducing, high-range water-reducing, water-reducing and accelerating, or water-reducing and retarding admixtures, as required, according to manufacturer's directions.
- E. Concrete-Mix Adjustments: Concrete-mix design adjustments may be requested by precaster when characteristics of materials, project conditions, weather, test results, or other circumstances warrant as accepted by Architect. Laboratory test data for revised mix design and strength results must be submitted to and accepted by Architect before using in the work.

## 2.9 FABRICATION

- A. Formwork: Accurately construct forms, mortar tight, of sufficient strength to withstand pressures due to concrete placing operations, temperature changes, and for pretensioning and detensioning operations. Maintain formwork to provide completed precast concrete units of shapes, lines, and dimensions indicated, within fabrication tolerances specified in PCI MNL-116.
  - 1. Coat surfaces of forms with bond-breaking compound before reinforcement is placed. Provide commercial-formula, form-coating compounds that will not bond with, stain, or adversely affect concrete surfaces and that will not impair subsequent treatments of concrete surfaces requiring bond or adhesion. Apply in compliance with manufacturer's instructions.

2. Unless forms for precast, prestressed concrete units are stripped prior to detensioning, design forms so that stresses are not induced in precast units due to deformation of concrete under prestress or movement during detensioning.
- B. Built-In Anchorages: Accurately position built-in anchorage devices and secure to formwork. Locate anchorages where they do not affect the position of the main reinforcement or placing of concrete. Do not relocate bearing plates in units, unless acceptable to Architect.
- C. Cast-in openings larger than 12 inches in diameter or 12 inches square according to final shop drawings. Other smaller holes may be field cut by trades requiring them, as acceptable to Architect. Trades field cutting holes shall locate holes so as to not cut prestressing tendons.
- D. Reinforcement: Comply with the recommendations of CRSI's "Manual of Standard Practice" for fabricating, placing, and supporting reinforcement.
1. Clean reinforcement of loose rust and mill scale, earth, and other materials that reduce or destroy the bond with concrete.
  2. Accurately position, support, and secure reinforcement against displacement by formwork, construction, or concrete placement operations. Locate and support reinforcement by metal chairs, runners, bolsters, spacers and hangers, as required.
  3. Place reinforcement to obtain at least the minimum coverages for concrete protection. Arrange, space, and securely tie bars and bar supports to hold reinforcement in position while placing concrete. Set wire ties so ends are directed into concrete, not toward exposed concrete surfaces.
  4. Install welded wire fabric in lengths as long as practical. Lap adjoining pieces at least one full mesh and lace splices with wire. Offset laps of adjoining widths to prevent continuous laps in either direction.
- E. Pretensioning: Pretension tendons for precast, prestressed concrete either by single-strand tensioning method or multiple-strand tensioning method. Comply with PCI MNL-116 requirements.
- F. Concrete Mixing: Comply with requirements and with ASTM C 94. Following concrete batching, no additional water may be added.
- G. Concrete Placement: Place concrete in a continuous operation to prevent seams or planes of weakness from forming in precast units. Comply with requirements of ACI 304R for measuring, mixing, transporting, and placing concrete.
1. Thoroughly consolidate placed concrete by internal and external vibration without dislocating or damaging reinforcement and built-in items. Use equipment and procedures complying with ACI 309R.
  2. Comply with ACI 306R procedures for cold-weather concrete placement.
  3. Comply with ACI 305R procedures for hot-weather concrete placement.
- H. Identify pickup points of precast concrete units and orientation in structure with permanent markings, complying with markings indicated on final shop drawings. Imprint casting date on each precast unit on a surface that will not show in the finished structure.

- I. Cure concrete according to the requirements of PCI MNL-116 by moisture retention without heat or by accelerated heat curing, using low-pressure live steam or radiant heat and moisture.
- J. Delay detensioning prestressed concrete units until concrete has attained at least 70 percent of its compressive strength as established by test cylinders cured under the same conditions as the concrete.
  - 1. If concrete has been heat cured, detension while concrete is still warm and moist to avoid dimensional changes that may cause cracking or undesirable stresses.
  - 2. Detension pretensioned tendons either by gradually releasing tensioning jacks or by heat-cutting tendons, using a sequence and pattern to prevent shock or unbalanced loading.
- K. Finish formed surfaces of precast concrete as indicated for each type of unit as follows:
  - 1. Grade B Finish: Fill air pockets and holes greater than 1/4 inch (6 mm) in diameter with sand-cement paste matching color of adjacent surfaces. Grind smooth form offsets or fins greater than 1/8 inch (3 mm).
- L. Finish unformed surfaces by trowel, unless otherwise indicated. Consolidate concrete, bring to proper level with straightedge, float, and trowel to a smooth, uniform finish.

## 2.10 HOLLOW-CORE SLAB UNITS

- A. Provide precast, prestressed concrete units with open, hollow cores running the full length of the slab units.
- B. Provide solid, monolithic, precast concrete slab units where shown on drawings. Design and fabricate solid units to dimensions and details indicated as required for hollow-core slab units.
- C. Furnish units free of voids or honeycombs.
- D. Reinforce units to resist transportation and erection stresses.
- E. Include cast-in weld plates where required.
- F. Coordinate with other trades for installation of cast-in items.
- G. Provide headers of cast-in-place concrete or structural steel shapes for openings larger than one slab width according to hollow-core slab unit fabricator's recommendations.
- H. Maximum camber between each hollow-core slab shall not exceed 1/2 inch.

## 2.11 SOURCE QUALITY CONTROL

- A. Quality-Control Testing: Test and inspect precast concrete according to PCI MNL-116 requirements.
- B. Strength of precast concrete units will be considered potentially deficient when precast concrete units fail to comply with requirements, including the following:

1. Fail to meet compressive-strength test requirements.
  2. Reinforcement and pretensioning and detensioning tendons of prestressed concrete do not conform to fabrication requirements.
  3. Concrete curing and protection of precast units against extremes in temperature fail to meet requirements.
  4. Precast units are damaged during handling and erecting.
- C. Testing: When there is evidence that the strength of precast concrete units may be deficient or may not meet requirements, the Owner will employ an independent testing agency to obtain, prepare, and test cores drilled from hardened concrete to determine compressive strength according to ASTM C 42.
1. A minimum of 3 representative cores will be taken from precast concrete units of suspect strength, from locations directed by Architect.
  2. Cores will be tested in an air-dry condition per ACI 301 when precast concrete units will be dry under service conditions.
  3. Strength of concrete for each series of 3 cores will be considered satisfactory if the average compressive strength is at least 85 percent of the 28-day design compressive strength and no core compressive strength is less than 75 percent of the 28-day design compressive strength.
  4. Test results will be made in writing on the same day that tests are made, with copies to Architect, Contractor, and precast fabricator. Test reports will include the Project identification name and number, date, name of precast concrete fabricator, name of concrete testing agency; identification letter, name, and type of precast concrete unit or units represented by core tests; design compressive strength, compressive strength at break and type of break, corrected for length-diameter ratio, and direction of applied load to core with respect to horizontal plane of concrete as placed.
- D. Patching: Where core test results are satisfactory and precast concrete units meet requirements, solidly fill core holes with patching mortar and finish to match adjacent concrete surfaces.
- E. Dimensional Tolerances: Units having dimensions smaller or greater than required and not meeting tolerance limits may be subject to additional testing.
1. Precast units having dimensions greater than required will be rejected if the appearance or function of the structure is adversely affected or if larger dimensions interfere with other construction. Repair or remove and replace rejected units, as required, to meet construction conditions.
- F. Defective Work: Precast concrete units that do not conform to requirements, including strength, manufacturing tolerances, and finishes, are unacceptable. Replace with precast concrete units that meet requirements.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Examine substrates and conditions for compliance with requirements, including installation tolerances, true and level bearing surfaces, and other conditions affecting performance of precast concrete units. Do not proceed with installation until unsatisfactory conditions have been corrected.

### 3.2 INSTALLATION

- A. Members shall bear the minimum length called for on contract or shop drawings. If no bearing length is specified, 3-1/2 inches shall be considered the minimum.
- B. Set vertical units dry, without grout, attaining joint dimension with lead or plastic spacers. Grout pack base of unit.
- C. Bearing Pads: Install bearing pads as precast concrete units are being erected. Set pads on true, level, and uniform bearing surfaces and maintain in correct position until precast units are placed. Concrete masonry units supporting precast concrete units shall be solid or grout filled to 8" minimum depth below bearing.
- D. Welding: Perform welding in compliance with AWS D1.1 and AWS D1.4, with qualified welders.
  - 1. Protect precast concrete units and bearing pads from damage by field welding or cutting operations and provide noncombustible shields as required.
  - 2. Repair damaged metal surfaces by cleaning and repriming damaged painted surfaces.
- E. Fasteners: Do not use drilled or powder-actuated fasteners for attaching accessory items to precast, prestressed units, unless otherwise acceptable to Architect.
- F. Erection Tolerances: Install precast units level, plumb, square, and true, without exceeding the recommended erection tolerances of PCI MNL-127 "Recommended Practice for Erection of Precast Concrete."
- G. Shore and brace precast concrete units to maintain location, stability, and alignment until permanent connections are installed.
- H. Remove lifting hooks if necessary.
- I. Grouting Connections and Joints: After precast concrete units have been placed and secured, grout open spaces at keyways, connections, and joints with non shrink high strength grout.
  - 1. Provide forms or other acceptable method to retain grout in place until hard enough to support itself. Pack spaces with stiff grout material, tamping until voids are completely filled. Place grout to finish smooth, plumb, and level with adjacent concrete surfaces. Keep grouted joints damp for not less than 24 hours after initial set. Promptly remove grout material from exposed surfaces before it hardens.
  - 2. Level differential elevation of adjoining horizontal members with grout to maximum slope of 1:12.

### 3.3 CLEANING

- A. Clean exposed surfaces of precast concrete units after erection to remove weld marks, other markings, dirt, and stains.
  - 1. Wash and rinse according to precast concrete fabricator's recommendations. Protect other work from staining or damage due to cleaning operations.

2. Do not use cleaning materials or processes that could change the appearance of exposed concrete finishes.

END OF SECTION 034100