

SECTION 03 41 00– STRUCTURAL PRECAST CONCRETE

PART 1 - 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 work of this section.

1.2 SCOPE OF WORK

- A. Provide labor, material and equipment to produce, deliver and erect double tees, beams, columns, wall panels, slabs, hollow-core planks, stair units and other members and materials necessary to complete the structure as described by the Drawings, General Notes and these Specifications.

1.3 QUALITY ASSURANCE

A. Applicable Standards:

1. American Concrete Institute (ACI):

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| 301 | Specifications for Structural Concrete for Buildings |
| 318 | Building Code Requirements for Reinforced Concrete |

2. Prestressed Concrete Institute (PCI)

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| MNL-116 | Manual for Quality Control for Plants and Production of Structural Precast Concrete Products |
| MNL-117 | Manual for Quality Control for Plants and Production of Architectural Precast Concrete Products |
| MNL-120 | PCI Design Handbook, Precast and Prestressed Concrete |
| MNL-135 | Tolerance Manual for Precast and Prestressed Concrete Construction |

3. Concrete Reinforcing Steel Institute (CRSI): Manual of Standard Practice.

4. American Welding Society (AWS):

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| D1.1 | Structural Welding Code-Steel |
| D1.4 | Structural Welding Code-Reinforcing Steel |

5. Local building code, with supplements.

B. Fabricator Qualifications:

1. The precast concrete producer shall not have less than 5 years experience in providing structural precast and/or precast prestressed concrete products and services normally associated with the industry.
2. The precast concrete producer shall be a participant in the PCI Plant Certification Program and, upon request, shall submit written evidence to show experience, qualifications and adequacy of plant capability and facilities for performance of

contract requirements. Compliance with this provision is subject to verification by the Architect and Engineer.

- C. Erector Qualifications: The precast concrete erector shall not have less than 2 years experience in the erection of precast structural concrete similar to the requirements of this project. Upon request, provide written evidence that equipment and personnel are adequate and qualified for performance of contract requirements.
- D. Welder and Welding Machine Operator Qualifications: All field and plant welders shall be certified in accordance with AWS D1.1 for the type of welding required.
- E. Plant Quality Control: Provide copies of plant quality control program describing procedures for the following:
 - 1. Verifying size and placement of reinforcing steel and prestressing strand.
 - 2. Verifying strength of concrete.
 - 3. Tensioning and de-tensioning operations.
 - 4. Verifying sizes and critical dimensions of members.
 - 5. Verifying position of plates, inserts and other embedded items.
 - 6. Verifying squareness of forms and positioning of blockouts.
 - 7. Final inspecting of products prior to shipment.

If units are produced at locations other than precast concrete production plants, maintain procedures and conditions for quality control that are equivalent to plant production.

- F. Professional Engineer: A professional engineer who is licensed to practice engineering in the state the project is located and who is experienced in providing engineering services of the kind indicated. Engineering services are defined as those performed for projects with precast concrete framing that are similar to that indicated for this Project in material, design, and extent.

1.4 DELIVERY, STORAGE AND HANDLING

- A. Store precast concrete units at manufacturer's plant or project site to prevent cracking, distortion, staining, or other physical damage, and so that markings are visible. Lift and support units at designated lift points. Do not use upper member of stacked tier as storage area for shorter member or heavy equipment. Deliver units to project site in such quantities and at such times to assure continuity of installation.

1.5 SUBMITTALS

- A. Certification and Test Reports: Submit manufacturer's specifications and instructions for manufactured materials and products. Include manufacturer's and plant's certifications and laboratory test reports for the following:
 - 1. PCI Plant Certification.
 - 2. Concrete mix designs, including sources of coarse, fine and lightweight aggregates as well as admixtures.

3. Prestressing strand mill certificates.
 4. Mill certificates for reinforcing bars and welded wire mesh.
 5. Mill certificates for high strength reinforcing bars.
 6. Structural steel mill certificates.
 7. Welder and welding operator certifications.
 8. Calibrations of prestressing jacks.
 9. Calibration of cylinder testing machine.
 10. Mill certificates for cement.
 11. Cylinder test reports on concrete for all precast units.
- B. Shop Drawings: Submit for review by the Architect and Engineer detailed shop drawings as follows:
1. Erection Drawings:
 - a. Column anchor bolt setting plan and plan of other miscellaneous items to be embedded in cast-in-place concrete for the attachment of precast concrete members.
 - b. Dimensioned building plans, elevations and sections showing identification of each precast member. Drawings submitted shall not be reproduces of the contract drawings.
 - c. Complete connection details showing size, type and grade of all plates, inserts and anchors. Show proper welding symbols in accordance with AWS D1.1.
 - d. Description of all loose and cast-in hardware, plates, inserts, etc.
 - e. Field installed anchor location drawings.
 - f. Erection sequence and handling requirements.
 - g. All dead, live and other applicable loads used in the design.
 2. Production Drawings for all precast members:
 - a. Member elevations and sections showing all dimensions.
 - b. Finishes.
 - c. Size, type, grade and location of all reinforcing steel including that required for handling and erection.
 - d. Prestress forces and number of strands.
 - e. Concrete strengths at release for prestressed members and 28 day design strength.
 - f. Size, type and location of all cast-in plates, inserts and other hardware.
 - g. Size, type and location of all expansion blockouts.
 - h. Size, type and location of all lifting and handling devices.
 - i. Estimated cambers at time of erection.
 - j. Estimated member weights.
 - k. Method of transportation.
 3. All shop drawings submitted shall be sealed by a professional engineer who is licensed in the state where the project is located.

C. Design Calculations:

1. Precast Unit Design: Provide for review by the Engineer complete design calculations for dead loads, live loads, lateral loads, and lifting and erection loads. Calculations shall show design for all connections at the member ends and to each adjoining member.
2. Details shown on the contract drawings shall be considered minimum requirements that shall be increased or modified as required for actual design forces. Refer to General Notes on the structural drawings for design loads.
3. Calculations shall be prepared by or under the direct supervision of a professional engineer. All members designed by computer shall have calculations that include documentation of the computer program identifying the method of solution, all input data and output for each unit. At least one unit shall be correspondingly designed by hand and submitted with the computer data for verification. All calculations shall be neat, well organized and bound. Partial, incomplete or unstamped calculations will be rejected.
4. Precast Erection Design: The Erector shall submit installation drawings and engineering calculations of the erection process stamped by a professional engineer licensed in the state where the project is located for Engineer review.
5. Design Modifications: Design modifications may be made as necessary to meet field conditions and to ensure proper fitting of the work, but only with the prior written approval of the Architect and Engineer for each occurrence. Provide complete design calculations and drawings for required or anticipated design modifications in accordance with these specifications.

D. Samples

1. Submit all samples of materials as requested by the Architect and specified herein in accordance with requirements of the Division 01, General Requirements and obtain written approval from the Architect before ordering materials.
2. Finish samples: Submit two 12"x12"x2" thick samples of concrete to indicate color, texture, and finish for approval.
3. Prepare two full-size samples of a structural precast concrete bay unit for Architect's inspection at production plant prior to start of installation work, and after Architect's review of finish samples. Acceptable full-size samples may be incorporated in job installation as follows.
 - a. One approved full-size unit shall be identified and installed in the project for the purpose of judging the installed units. One approved full-size unit shall be retained at the production plant for the precast producer to judge completed units prior to shipment. The full-size unit retained at the production plant may be the last unit incorporated into the project.
4. Submit samples of anchors, dowels, and bearing pads and all other materials requested by the Architect.

PART 2 - PRODUCTS

2.1 FORMWORK

- A. Provide forms and, where required, form facing materials of metal, plastic, wood, or other acceptable material that is non-reactive with concrete and will produce required finished surfaces. Rust-stained or excessively worn forms that would impair the quality of the finished surface are not acceptable. Comply with recommendations set forth in ACI 347, Guide to Formwork for Concrete.
- B. Accurately construct forms mortar-tight and of sufficient strength to withstand pressures due to concrete placing operations, temperature changes, and when prestressed, the pretensioning and detensioning operations. Maintain formwork to provide completed precast concrete units of shapes, lines, and dimensions indicated on the approved shop drawings within specified production tolerances.
- C. Unless forms for plant-produced prestressed concrete units are stripped prior to detensioning, design forms so that stresses are not induced from precast units due to deformation of concrete under prestress or to movement during detensioning.

2.2 REINFORCING MATERIALS

- A. Reinforcing Bars: ASTM A615, Grade 60. All reinforcing steel that requires welding shall conform to ASTM A 706.
- B. Galvanized Reinforcing Bars: ASTM A767, Class II (2.0 oz. Zinc P.S.F.).
- C. Epoxy Coated Reinforcing Bars: ASTM A775.
- D. Plain Steel Wire: ASTM A82.
- E. Welded Wire Fabric: ASTM A185.
- F. Deformed Steel Wire: ASTM A496.
- G. Welded Deformed Steel Wire Fabric: ASTM A497.
- H. Prestressing Tendons: ASTM A 416/A 416M, Grade 250 (Grade 1720) or Grade 270 (Grade 1860), uncoated, 7-wire, low-relaxation strand or ASTM A 886/A 886M, Grade 270 (Grade 1860), indented, 7-wire, low-relaxation strand (including supplement).
- I. Unbonded Post-tensioning Strand: ASTM A 416/A 416M with corrosion inhibitor conforming to ASTM D 1743, Grade 270 (Grade 1860), 7-wire, low-relaxation strand with polypropylene conduit sheath.
- J. Prestressing Bars: ASTM A722.
- K. Supports for Reinforcement:
 - 1. Provide supports for reinforcement including bolsters, chairs, spacers and other devices for spacing, supporting or fastening reinforcing, complying with CRSI recommendations.

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

2.3 CONCRETE MATERIALS

- A. Refer to the drawings for classes and strengths of concrete required.
- B. Portland Cement: ASTM C150, Type I or Type III, or as otherwise specified on the drawings. For concrete exposed to salt air or salt water, provide type II or type V cement.
 1. Concrete exposed to sulfates in soil or water
 - a. Exposure class S1: For areas designated on the drawings as exposure class S1, use ASTM C 150, Type II or ASTM C 1157, Type MS.
 - b. Exposure class S2: For areas designated on the drawings as exposure class S2, use ASTM C 150, Type V or ASTM C 1157, Type HS.
 - c. Alternate cement types for exposure classes and S2: ASTM C 150, Type I or III cement may be used for concrete exposed to exposure S1 or S2 if the tricalcium aluminate (C3A) content is less than 8 percent for S1 exposure or 5 percent for S2 exposure. ASTM C 150, Type I or III cement may be used for exposure to seawater if the tricalcium aluminate content does not exceed 10 percent and the w/cm ratio of the concrete mix does not exceed 0.40.
 - d. Exposure class S3: For areas designated on the drawings as exposure class S3, use ASTM C 150, Type V plus pozzolan or slag or ASTM C 1157, Type HS plus pozzolan or slag or ASTM C 595, Type IP (HS) or Type IS (HS). The amount of pozzolan or slag added or in a blended mix shall be such that has been determined by service record to improve sulfate resistance when used with Type V cement or the amount that when tested according to ASTM C 1012 meets the criteria of table 4.5.1 in ACI 318-08.
 - e.
 2. Use only one brand and type of cement throughout the project, unless otherwise acceptable to the Architect and Engineer.
- C. Supplemental Cementitious Material:
 1. Fly Ash: C 618, Class C or F.
 2. Metakaolin: ASTM C 618, Class N.
 3. Silica Fume: ASTM C 1240 with optional chemical and physical requirements.
 4. Slag Cement: ASTM C 989, Grade 100 or 120.
- D. Aggregates:
 1. Gravel or crushed stone: ASTM C33. Provide from a single source for exposed concrete.
 2. Lightweight aggregate: expanded shale or clay, ASTM C330.

Provide lightweight concrete with a dry unit weight of not less than 110 nor more than 116 pounds per cubic foot. Design the mix to produce strengths as

indicated on the drawings with a split cylinder strength factor $(f_{ct}/f'_c)^{0.5}$ of not less than 5.7 and a drying shrinkage limit of 0.03% at 28 days.

- E. Water: Comply with the requirements of ASTM C1602.
- F. Calcium Chloride; not permitted
- G. Air-Entraining Admixture: ASTM C260. Provide air entrainment as specified in Table 4.2.1. of ACI 318 in all concrete exposed to freezing and thawing. Interior steel troweled surfaces subjected to vehicular traffic shall not have more than 3% entrained air. Surfaces scheduled to receive hardeners shall not have more than 3% entrained air.

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

"Darex" or "Daravair" series; W. R. Grace & Co.
"MBAE90" or "Micro-Air"; BASF Admixtures, Inc
"Sika AER"; Sika Corporation
"Air Mix" or "AEA-92"; The Euclid Chemical Company, Inc.
"Eucon Air 30" or "Eucon Air 40", The Euclid Chemical Co., Inc.

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

- H. Water-Reducing Admixture: ASTM C494, Type A. See maximum permissible chloride ion content in concrete specified below.

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

"Pozzolith 322N" or "Polyheed 997"; BASF Admixtures, Inc.
"Plastocrete 161"; Sika Chemical Corp.
"Eucon WR-75 or WR-91"; The Euclid Chemical Company, Inc.
"WRDA ";series W.R. Grace & Co.
"Eucon NW" or "Eucon LW", The Euclid Chemical Company, Inc.

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

- I. Mid-Range Water-Reducing Admixture: ASTM C494, Type A and Type F. See maximum permissible chloride ion content in concrete specified below.

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

"Polyheed 997", BASF Admixtures, Inc.
"Eucon MR", The Euclid Chemical Company, Inc.
"Sikament HP", Sika Chemical Corp.
"Daracem" or "Mira " series, W.R. Grace & Co.
"Eucon X15" or "Eucon X20", The Euclid Chemical Company, Inc.

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

- J. High-Range Water-Reducing Admixture (Superplasticizer): ASTM C494, Type F or Type G. See maximum permissible chloride ion content in concrete specified below.

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

"ADVA" or "Daracem" Series; W.R. Grace & Co.
"Rheobuild 1000" or "Glenium 30/30"; BASF Admixtures, Inc.
"Sikament"; Sika Chemical Corp.
"Eucon 37/1037" or "Plastol" series; The Euclid Chemical Company, Inc.
"Euconl SP" or "Eucon RD", The Euclid Chemical Company, Inc.

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

- K. Water-Reducing, Accelerator Admixture (Non-Corrosive, Non-Chloride): ASTM C494, Type C or E. See maximum permissible chloride ion content in concrete specified below.

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

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

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

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

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

"Daratard" series, W.R. Grace & Co.
"Pozzolith 100XR" or "Pozzolith 300R"; BASF Admixtures, Inc.
"Plastiment"; Sika Chemical Co.
"Eucon Retarder", Series, The Euclid Chemical Company, Inc.

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

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

"Rheomac VMA" series, BASF Building Systems
"Eucon SL" or "Visctrol", The Euclid Chemical Co.
"VisoCrete" series, Sika Chemical Co.
"VMAR" series, W.R. Grace & Co.

2.4 CONNECTION MATERIALS

- A. Steel Plates: ASTM A36.
- B. Steel Shapes: ASTM A36.
- C. Carbon-Steel Bolts and Studs: ASTM A 307, Grade A or C, carbon-steel, hex-head bolts and studs; carbon-steel nuts, ASTM A 563; and flat, unhardened steel washers, ASTM F 844.
- D. Anchor Bolts: Non-headed type with tensile strength requirements conforming to [ASTM F1554 Grade 36] or [ASTM A 307], unless otherwise indicated. Provide regular hexagon nuts and carbon steel washers.
- E. Stainless-Steel Plate: ASTM A 666, Type 304, of grade suitable for application.
- F. Stainless-Steel Bolts and Studs: ASTM F 593, alloy 304 or 316, hex-head bolts and studs; stainless-steel nuts; and flat, stainless-steel washers.
 - 1. Lubricate threaded parts of stainless steel bolts with an anti-seize thread lubricant during assembly.
- G. Stainless-Steel Headed Studs: ASTM A 276, with minimum mechanical properties for studs as indicated under MNL-116, Table 3.2.3.
- H. Weldable Reinforcing Bars: ASTM A706.
- I. Headed Studs: ASTM A108, 60,000 psi minimum tensile strength.
- J. Deformed Bar Anchors: ASTM A496, 70,000 psi minimum yield strength.
- K. Prestressing Steel Bars: ASTM A722.
Approved Manufacturer: Dywidag Systems International, USA, Inc.
- L. Threaded Rods: ASTM A36.
- M. Welding Electrodes: Comply with AWS D1.1.
- N. Ductile Iron Inserts: ASTM A536.
Approved Manufacturers:
 - 1. Dayton/Richmond Concrete Accessories.
 - 2. Hohmann & Barnard, Inc.
- O. Ferrule Wing Inserts: Provide from the following products:
 - 1. "FX-19 Ferrule Wing Insert", Meadow Burke Products.
 - 2. "F-62, Flared Thin Slab Ferrule Insert", Dayton/Richmond Concrete Accessories.

- P. Corrosion Protection of Steel Units: All items shall be hot-dipped galvanized in accordance with ASTM A153. Zinc-rich coating for field repair shall be manufactured by Sherwin-Williams (Zinc-Clad 5 B69 A 45) or ZRC Cold Galvanizing Compound.

2.5 GROUT MATERIALS

- A. Non-Metallic Non-Shrink Grout: Premixed, non-corrosive, non-staining product containing Portland cement, silica sands, shrinkage compensating agents, and fluidity improving compounds. Conform to ASTM C1107. Provide the minimum strength as shown below as determined by grout cube test at 28 days.
- B. Attain 28 day compressive strength as determined by grout cube tests conforming to ASTM C109 adequate to transfer the design bearing stresses to the supporting concrete. Unless shown otherwise by the precaster's engineering calculations, the required minimum compressive strength shall be as follows:
1. 6,000 psi for supporting concrete up to 3,000 psi.
 2. 8,000 psi for supporting concrete between 3,000 psi and 4,000 psi.
 3. Unless noted otherwise on the drawings, grout strength on supporting concrete greater than 4000 psi shall be 8000 psi.
- C. Follow manufacturer's directions and recommendations for mixing and placing grout.
- D. Grout to be similar in color to that of surrounding concrete.
- E. Acceptable non-shrink grouts:
- "SonogROUT 10k" as manufactured by Sonneborn-ChemRex, Inc.
 - "CrySTEX" and "DuragROUT" as manufactured by L&M Construction Chemicals, Inc.
 - "Sure Grip High Performance Grout," and "1107 Advantage Grout" as manufactured by Dayton-Superior Corporation.
 - "Masterflow 713", and "Set Grout" as manufactured by Master Builders Technologies.
 - "Five Star Grout" as manufactured by U.S. Grout Corp.
 - "NS Grout" as manufactured by The Euclid Chemical Company.
 - "SikaGrout 212", as manufactured by Sika
- F. Sand Cement Grout: Provide sand cement grout for grouting all pockets and blockouts in precast members and in grouting prestressed ducts where specified on the drawings. Sand cement grout shall consist of Portland Cement (ASTM C 150 Type I or III), sand (ASTM C33), and water. Proportions by weight shall be one part cement, 2 1/4 to 2 1/2 parts sand, and the minimum amount of water required to obtain a workable mix. Minimum compressive strength shall be 3500 PSI at 28 days. Admixtures to accelerate the set or prevent freezing may be utilized, except the use of admixtures containing chlorides will not be permitted.

2.6 BEARING PADS

- A. Elastomeric Pads:
1. Unreinforced: 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 according to ASTM D 2240, minimum tensile strength 2250 psi (15.5 MPa) per ASTM D 412 and having a minimum thickness of 3/8" for tees, 1/2" for

beams and 1/4" for slabs, unless otherwise shown on the drawings. Pads greater than 1 1/4" in thickness shall be laminated with steel plates (min. 1/16" thick) molded into the material.

2. Random-Oriented, Fiber-Reinforced Elastomeric Pads: Preformed, randomly oriented synthetic fibers set in elastomer. Surface hardness of 70 to 90 Shore A durometer. Capable of supporting a compressive stress of 3000 psi (20.7 MPa) with no cracking, splitting or delaminating in the internal portions of the pad. Test one specimen for each 200 pads used in the Project.
 3. Cotton-Duck-Fabric-Reinforced Elastomeric Pads: Preformed, horizontally layered cotton-duck fabric bonded to an elastomer. Surface hardness of 80 to 100 Shore A durometer. Conforming to Division II, Section 18.10.2 of AASHTO Standard Specifications for Highway Bridges, or Military Specification, MIL-C-882E.
 4. Design: Design of bearing pads shall conform to the design recommendations in the PCI Design Handbook.
 5. Size pads so that both surfaces are in complete contact with the bearing pads. The design bearing pressure for unreinforced bearing pads shall not exceed 800 psi under total service load, and 500 psi under dead load, unless shown otherwise by approved manufacture's data.
 6. Provide beveled, plain elastomeric bearing pads between non-parallel load surfaces.
- B. High-Density Plastic: Multimonomer, nonleaching, plastic strip capable of supporting construction loads with no visible overall expansion.
- C. Tetrafluoroethylene (TFE) Slide Bearings:
1. Glass-filled virgin Teflon slide bearings as shown on the drawings and as manufactured by:
 - a. Con-Serv, Inc., Georgetown, SC
 - b. Seismic Energy Co., Athens, TX

Other manufacturers will be acceptable only with Engineer approval.

2.7 EPOXY MORTAR PATCH

- A. General Requirements: Two-component material suitable for use on dry or damp surface, complying with ASTM C881, for use in concrete repairs. The color of the patch shall match the surface color of the precast concrete unit.
- B. Products for Epoxy Mortar Patches:
- "Sikadur Lo-Mod LV"; Sika Chemical Corporation
 - "Duracrete", The Euclid Chemical Company
 - "Sure Level Epoxy (J-57)", Dayton-Superior
 - "Epofil", BASF Building Systems
 - "Pro-Poxy 2500", Unitex
 - "Rezi-Weld 1000", W. R. Meadows
 - "US Spec EPM 3000", US Mix Co.
 - "Duralcrete LV", The Euclid Chemical Company

"SpecPoxy Binder", SpecChem

2.8 GROUT DUCTS IN PRECAST WALL PANELS

- A. Ducts for prestressed bars shall be flexible metal conduit with a diameter at least 1/4" larger than the nominal diameter of the bar and a minimum wall thickness of 0.040" (20 gage). The metal conduit shall be capable of withstanding a crushing force of 600 pounds per lineal foot and shall be completely sealed against the leakage of grout.

2.9 INSULATED PANEL ACCESSORIES

- A. Expanded Polystyrene Board Insulation: Rigid, cellular polystyrene thermal insulation complying with ASTM C578 formed by expansion of polystyrene base resin.
- B. Extruded-Polystyrene Board Insulation: Rigid, cellular polystyrene thermal insulation complying with ASTM C 578 formed from polystyrene base resin by an extrusion process using HCFCs as blowing agents.
- C. Polyisocyanurate Board Insulation: Rigid, cellular polyisocyanurate thermal insulation complying with ASTM C 591 formed by using HCFCs as blowing agents.
- D. Wythe Connectors: Provide connectors manufactured to connect wythes of precast concrete panels of the following types:
 - 1. Glass-fiber
 - 2. Vinyl-ester polymer
 - 3. Polypropylen pin
 - 4. Stainless-steel pin
 - 5. Bent galvanized reinforcing bars
 - 6. Galvanized welded wire truss
 - 7. Galvanized bent wire
 - 8. Cylindrical metal sleeve anchor

PART 3 - EXECUTION

3.1 PRODUCTION

- A. General: Produce precast concrete units complying with manufacturing and testing procedures, quality control recommendations and dimensional tolerances of PCI MNL-116, MNL-117 and MNL-135, unless stricter requirements are specified herein or on the drawings.
- B. Proportioning and Design of Mixes:
 - 1. Prepare design mixes for each type of concrete required.

2. Design mixes may be prepared by an independent testing facility or by qualified precast manufacturing personnel, at precast manufacturer's option.
 3. Proportion mixes by either laboratory trial mixture or field experience methods, complying with ACI 301 and ACI 318, using materials to be employed on the project for each type of concrete required.
 4. Submit written reports to Architect/Engineer of proposed mix for each type of concrete at least 30 days prior to start of precast unit production. Do not begin concrete production until mixes and evaluations have been reviewed and approved by Architect and Engineer and Owner's testing laboratory.
 5. Mix design adjustments may be requested when characteristics of materials, job conditions, weather, test results, or other circumstances warrant. Laboratory test data for revised mix designs and strength results must be submitted to and accepted by Architect and Engineer and Owner's testing laboratory before using in the work.
 6. Limit use of fly ash to 25 percent replacement of portland cement by weight and slag cement to 50 percent of portland cement by weight; metakaolin and silica fume to 10 percent of portland cement by weight.
 7. Produce normal weight concrete consisting of specified portland cement, aggregates, admixtures and water to produce the following properties:
 - a. Compressive Strength at 28 days: 5,000 psi minimum at 28 days, or as required by design or as noted on the drawings.
 - b. Release Strength: The minimum release strength for prestressed units shall be 3500 psi.
 - c. Drying Shrinkage Limit: 0.03% at 28 days.
 8. Produce lightweight concrete consisting of specified portland cement, aggregates, admixtures and water to produce the following properties:
 - a. Compressive Strength: 5,000 psi minimum at 28 days, or as required by design or as noted on the drawings.
 - b. Split-Cylinder Tensile Strength: The split cylinder strength factor as determined by ASTM C496 ($F_{ct}/(f'_c)^{0.5}$) shall not be less than 5.7.
 - c. Air-dry density: Not less than 110 nor more than 116 pounds per cubic foot.
 - d. Release Strength: The minimum release strength of prestressed members shall be 3500 psi unless noted otherwise and permitted by design.
 - e. Drying Shrinkage Limit: 0.03% at 28 days.
- C. Admixtures:
1. Comply with ACI 212.2R.
 2. Use air-entraining admixture in concrete unless otherwise indicated.
 3. Use water-reducing admixtures in strict compliance with manufacturer's directions. Admixtures to increase cement dispersion, or provide increased workability for low-slump concrete, may be used subject to Architect and Engineer's approval.

4. Use amounts as recommended by admixture manufacturer for climatic conditions prevailing at time of placing. Adjust quantities of admixtures as required to maintain quality control.
- D. Embedded Items: Accurately position and secure cast-in anchorage devices. Locate anchorages where they do not affect position of reinforcement or placing of concrete. Do not relocate bearing plates or reinforcing steel in units unless approved in writing by the Architect and Engineer. Provide and coordinate the placement of embeds required for equipment or components hung from precast units.
- E. Reinforcement Installation:
1. Clean reinforcement of loose rust and mill scale, earth and other materials which reduce or destroy bond with concrete.
 2. Accurately position, support and secure reinforcement against displacement by formwork, construction, or concrete placement operations. Locate and support reinforcing by metal chairs, runners, bolsters, spacers and hangers, as specified by CRSI Manual of Standard Practice.
 3. Place reinforcement to obtain at least the minimum coverages for concrete protection as specified in the drawings. Arrange, space and securely tie bars and bar supports to hold reinforcement in position during concrete placement operations. Set wire ties so ends are directed into concrete, not toward exposed concrete surfaces.
- F. Tensioning: Pretensioning of tendons for prestressed concrete may be accomplished either by single strand tensioning method or multiple-strand tensioning method. Comply with PCI MNL-116 requirements.
- G. Concrete Placement: Place concrete in a continuous operation to prevent formation of seams or planes of weakness in precast units, complying with requirements of ACI 301. Thoroughly consolidate placed concrete by internal and/or external vibration without dislocation or damage to reinforcement and embedded items.
- H. Identification:
1. Provide permanent markings to identify pick-up points and orientation in the structure, complying with markings indicated on final shop drawings. Imprint date of casting on each precast unit on a surface which will not show in finished structure.
 2. Provide additional marking as required by local building codes or ordinances.
- I. Curing:
1. Cover all precast and precast/prestressed concrete members with tarpaulins or other suitable means immediately after casting.
 2. Curing by low-pressure steam, by steam vapor, by radiant heat and moisture, or other similar process may be employed to accelerate concrete hardening and to reduce curing time.
- J. Detensioning:

1. Delay detensioning of prestressed units until concrete has attained design release strength, as established by test cylinders.
2. If concrete has been heat-cured, perform detensioning while concrete is still warm and moist to avoid dimensional changes which may cause cracking or undesirable stresses in concrete.
3. Detensioning of prestressed tendons may be accomplished either by gradual release of tensioning jacks or by heat cutting tendons, using a sequence and pattern to prevent shock or unbalanced loading.

K. Finishes:

1. Commercial Structural Finishes
 - a. Commercial Grade: Remove large fins and protrusions and fill large holes. Rub or grind ragged edges. Faces are to be true, well-defined surfaces. Air holes, water marks, and color variations are acceptable. Allowable form joint offsets are limited to 3/16 in.
 - b. Standard Grade: Normal plant-run finish produced in forms that impart a smooth finish to concrete. Surface holes smaller than 1/2 inch caused by air bubbles, normal color variations, form joint marks, and minor chips and spalls are acceptable. Fill air holes greater than 1/4 inch in width that occur in high concentration (more than one per 2 in.²). Major or unsightly imperfections, honeycombs, or structural defects are not permitted. Allowable joint offset is limited to 1/8 inch.
 - c. Grade B Finish: Fill air pockets and holes larger than 1/4 inch in diameter with sand-cement paste matching color of adjacent surfaces. Fill air holes greater than 1/8 inch in width that occur in high concentration (more than one per 2 in.²). Grind smooth form offsets or fins larger than 1/8 inch. Repair surface blemishes due to holes or dents in forms. Discoloration is permitted at form joints.
 - d. Grade A Finish: Repair and/or fill all surface blemishes with the exception of air holes 1/16 inch in width or smaller and form marks where the surface deviation is less than 1/16 inch. Float-apply a neat cement-paste coating to exposed surfaces. Rub dried paste coat with burlap to remove loose particles. Discoloration is permitted at form joints. Grind smooth all form joints.
2. Commercial Architectural Finishes: Exposed faces shall be free of joint marks, grain, or other obvious defects. Corners, including false joints shall be uniform, straight and sharp. Finish exposed-face surfaces of structural precast concrete units to match approved mockups and as follows:
 - a. Smooth-Surface Finish: Provide surfaces free of excessive air voids, sand streaks, and honeycombs, with uniform color and texture.
 - b. Textured-Surface Finish: Impart by form liners to provide surfaces free of excessive air voids, streaks, and honeycombs, with uniform color and texture.
 - c. Bushhammer Finish: Use power or hand tools to remove matrix and fracture coarse aggregates.
 - d. Retarded Finish: Use chemical retarding agents applied to forms and washing and brushing procedures to expose aggregate and surrounding matrix surfaces after form removal.

- e. Abrasive-Blast Finish: Use abrasive grit, equipment, application techniques, and cleaning procedures to expose aggregate and surrounding matrix surfaces.
 - f. Acid-Etched Finish: Use acid and hot-water solution, equipment, application techniques, and cleaning procedures to expose aggregate and surrounding matrix surfaces. Protect hardware, connections and insulation from acid attack.
 - g. Honed Finish: Use continuous mechanical abrasion with fine grit, followed by filling and rubbing procedures.
 - h. Polished Finish: Use continuous mechanical abrasion with fine grit, followed by filling and rubbing procedures.
 - i. Sand-Embedment Finish: Use selected stones placed in a sand bed in bottom of form, with sand removed after curing.
- 3. Unformed Surface: Provide light broom finish to unformed surfaces unless otherwise indicated. Consolidate concrete, bring to proper level with a straightedge, and apply the finish as specified.
 - 4. Finish of Treads of Stair Units: For units cast top side up, provide a steel troweled finish followed by a light broom finish parallel to the length of the unit. For units cast top side down, provide a light sandblast on the tread area to produce a non-skid surface before delivery to the job site.
 - 5. Finish of Top Surface of Composite Members: Top surfaces of double tees, hollow-core plank or other precast members scheduled to receive a topping shall have a rough scratch finish with surface transversely scarified to provide ridges approximately 1/4" deep.
 - 6. Finish of Exposed Ends of Units: Strands shall be recessed 3/4" minimum and recess shall be filled with non-shrink, non-metallic grout. Sandblast ends to provide a proper surface for sealant adhesion.
 - 7. Holes: Cast in holes for openings in flanges larger than 10" in diameter or 10" square in accordance with final approved shop drawings. Other smaller holes will be field cut by trades requiring them, as acceptable to Engineer. Do not cut through stems of double tees, or through any prestressed members without Architect and Engineer approval.
- L. Joint Widths: Unless shown otherwise on the drawings, provide joint widths in accordance with MNL-135.

3.2 QUALITY ASSURANCE

- A. General: The Precast producer shall comply with noted standards and perform tests and inspections as described below to assure the specified quality in the final product.
- B. Production Tolerances:
 - 1. Provide production tolerances in accordance with PCI MNL-135.
 - 2. Precast units having dimensions not conforming to specified tolerances will be rejected if appearance or function of the structure is adversely affected. Repair, or remove and replace rejected units as required to comply with contract documents. The Architect and Engineer must approve all repairs.

- C. Concrete Strength Verification: Mold and test concrete cylinders as follows:
1. Cylinders for strength tests shall be molded and cured in accordance with ASTM C31 and tested in accordance with ASTM C39.
 2. Minimum of two (2) per bed for each pour to verify specified release strength.
 3. Minimum of two (2) per 50 cubic yards for each class of concrete to verify 28-day strength but not less than one set per day's operation.
 4. Lightweight Concrete: An additional two cylinders per 50 cubic yards for each class of concrete used to perform splitting-cylinder tensile tests at 28 days.
 5. Test cylinders shall be cured with and by the same methods as the members they represent.
- D. Acceptance Criteria of Concrete Strength: The compressive strength level of an individual class of concrete shall be considered satisfactory if both the following requirements are met:
1. The average of all sets of three consecutive strength tests equal or exceed the required f'c.
 2. No individual strength test falls below the required f'c by more than 500 psi.
 3. If criteria 1 above is not met but criteria 2 above has been, the Precast Producer shall immediately notify the Engineer by telephone or email and take immediate steps to increase the average of subsequent strength tests.
 4. If criteria 2 is not met, the Engineer shall be immediately notified by telephone or email and all units cast from the concrete that is represented by the low strength test shall be considered potentially deficient and subject to further tests or replacement.
- E. Acceptance of Units: Precast units will be considered potentially deficient requiring the unit to be either further tested or replaced if the manufacturing processes fail to comply with any of the requirements which may affect the strength of the precast units, including but not limited to the following conditions:
1. Failure to meet compressive strength tests requirements
 2. Failure to meet split cylinder strength requirements for lightweight concrete.
 3. Reinforcement, reinforcement placing, and pretensioning and detensioning of tendons of prestressed concrete not conforming to specified fabrication requirements.
 4. Visual evidence of cracks exceeding .02 inches wide, excessive negative camber, or deflection in excess of calculated anticipated amounts.
 5. Concrete curing and protection of precast units not as specified.
 6. Precast units damaged during storage, transportation, handling or erection.

- F. Investigation of Low Concrete Strength: When there is evidence that the strength of precast concrete units does not meet specification requirements, the Precast Manufacturer's testing service shall take cores from hardened concrete for compressive strength determination, complying with ASTM C 42 and as follows:
1. Take at least 3 representative cores from precast units of suspect strength from locations directed by the Architect and Engineer.
 2. Test cores in a saturated-surface-dry condition in accordance with ACI 318 if concrete will be wet during use of completed structure.
 3. Test cores in an air-dry condition in accordance with ACI 318 if concrete will be dry during use of completed structure.
 4. Strength of concrete for each series of cores will be considered satisfactory if their average compressive strength is at least 85% of 28-day design compressive strength and no individual test is less than 75% of the required $f'c$.
 5. Test results will be reported in writing on same day that tests are made, with copies to Owner, Architect, Engineer, and General Contractor. Include in test reports the project identification name and number, date, name of precast concrete manufacturer name of concrete testing service, identification letter, number and type of member or members represented by core tests, design compressive strength, compression breaking strength and type of break (corrected for length-diameter ratio), direction of applied load to core with respect to the horizontal plane of concrete as placed, and moisture condition of core at time of testing.
 6. Where core test results are satisfactory and precast units are acceptable for use in work, fill core holes solid with non-shrink patching mortar or epoxy based mortar as directed by Architect and Engineer and finish to match adjacent concrete surfaces.
- G. X-Rays: The Architect or Engineer may order x-rays taken of any member if there is sufficient doubt about the proper existence or location of reinforcing steel, embedded items, or strands.
- H. Load Tests: The Architect or Engineer may order a load test of the member in the plant or in the field if there is sufficient evidence to question the structural integrity of the member.
- I. Repair of Out-of-Tolerance Finishes: Defects exceeding the criteria established in the specified finish, provided the structural capacity is not impaired, shall be cause for repair by patching with a two-part epoxy mortar or rejection of the unit. Patching shall be done only when acceptable to Architect and Engineer. The patch shall match the color, texture and finish of the original unit. All concrete surface repairs except those for minor surface blemishes that are less than the specified minimum must be noted in quality control reports and submitted for Architect and Engineer review and approval for each occurrence prior to erection. Patches not conforming to these requirements may be a cause for rejection of the unit.
- J. Products Not Meeting Specifications: Precast units that do not conform to all specified requirements including strength, tolerances, both fabrication and erection, and finishes shall be rejected and replaced with units meeting all requirements of the Contract Documents, unless approval by the Architect and Engineer is obtained in writing for an authorized repair.

- K. Authorized Repairs: No structural or architectural repair shall be made to any precast unit either in the plant or in the field without written documented approval for each occurrence in the form of a letter or drawing from the Architect or Engineer. Unauthorized repair details shall not be allowed.

3.3 INSTALLATION

A. General:

1. Examine supporting structure and conditions under which precast concrete work is to be erected and provide written notification of conditions detrimental to proper and timely completion of work. Do not proceed with installation until unsatisfactory conditions have been corrected in a manner acceptable to Erector.
2. General Contractor shall monitor all phases of erection to ensure the work is in conformance with the contract documents.
3. Erect members by means of suitable lifting devices at points provided by the manufacturer.
4. Provide temporary shoring and bracing as required to ensure stability during erection. The erector shall brace unsymmetrical sections during erection and pouring of topping slabs to prevent rotation and instability regardless of whether it is specified on the erection drawings. The responsibility for bracing such members shall rest solely with the Erector.
5. Properly align, plumb and level precast units. Level out variations between adjacent members by shimming, loading or any other feasible method recommended by the manufacturer and acceptable to the Architect and Engineer.
6. Provide accurate placement and alignment of anchor bolts, plates or dowels in supporting structural elements.
7. Provide true, level bearing surfaces on all field placed foundations, bearing walls and other supporting members.
8. Bearing Pads: Install specified bearing pads as precast units are being erected and maintain in correct position until precast units are placed.

B. Erection Tolerances: Erection tolerances shall conform to PCI MNL-135

C. Field Welding:

1. Perform welding in compliance with AWS D1.1 and D1.4.
2. Protect units from damage by field welding operations and provide non-combustible shields as required.
3. Remove all lifting loops and touch-up paint all galvanized field welded connections as specified.
4. Repair damaged metal surfaces by cleaning and applying a coat of zinc-rich coating to galvanized surfaces and primer compatible with painted surfaces.

- D. Exposed surfaces of all plates embedded in concrete shall be painted with zinc-rich coating specified above after the field connection is complete.
- E. Grouting Joints: After precast units have been set and secured, grout at specified locations shown on the drawings and as follows:
 - 1. Provide non-shrink non-metallic grout under base plates, bearing plates, at all load-bearing joints, at all pockets and at all blockouts.
 - 2. Provide forms or other acceptable method to retain grout in place until sufficiently hard 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 48 hours after initial set. Promptly remove excess grout material and spillage from exposed surfaces before it hardens.
- F. Powder-Actuated Fasteners and Expansion Anchors: Do not use powder-actuated fasteners or expansion anchors in precast prestressed units except as submitted and approved on shop drawings or other submittal.
- G. Damage to Units During Installation: Damage to precast units sustained during installation resulting in spalls deeper than 1/4 inch and cracks exceeding .01 inch in width shall be immediately reported to the Architect and Engineer. Units thus damaged shall be subject to repair or replacement as directed by the Architect and Engineer. Repairs of spalls shall be done using a two-part epoxy mortar patch that shall match the color, texture, and finish of the original unit. Cracks shall be repaired using an epoxy injection process.

3.4 ACCEPTANCE

- A. Field Inspection: Acceptance of erected precast concrete will be made by the Architect and Engineer for general conformance with the plans and specifications.
- B. Defective Work: Precast concrete units which do not conform to specified requirements, including strength, tolerances, and finishes, shall be repaired or replaced with precast concrete units that meet requirements of this section as directed by the Architect and Engineer. The Contractor shall also be responsible for the cost to any other work affected by or resulting from corrections to precast concrete work.

3.5 QUALITY ASSURANCE TESTING AND INSPECTION DURING CONSTRUCTION

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

END OF SECTION 03 41 00