SECTION 03431
PRECAST AND PRESTRESSED CONCRETE

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Precast and prestressed concrete.

B. Related Sections include but are not necessarily limited to:
   1. Division 0 - Bidding Requirements, Contract Forms, and Conditions of the Contract.
   2. Division 1 - General Requirements.
   3. Section 03002 - Concrete.
   4. Section 03200 – Concrete Reinforcement.
   5. Section 09900 - Painting.

1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. American Association of State Highway and Transportation Officials (AASHTO):
      a. Standard Specification for Highway Bridges.
   2. American Concrete Institute (ACI):
      a. 211.2, Standard Practice for Selecting Proportions for Structural Lightweight Concrete.
      b. 318, Building Code Requirements for Structural Concrete.
   3. ASTM International (ASTM):
      a. A36, Standard Specification for Carbon Structural Steel.
      b. A108, Standard Specification for Steel Bars, Carbon, Cold Finished, Standard Quality.
      c. A416, Standard Specification for Steel Strand, Uncoated Seven-Wire for Prestressed Concrete.
      d. A496, Standard Specification for Steel Wire, Deformed, for Concrete Reinforcement.
      e. C33, Standard Specification for Concrete Aggregates.
      f. C150, Standard Specification for Portland Cement.
      g. C330, Standard Specification for Lightweight Aggregates for Structural Concrete.
      h. E329, Standard Specifications for Agencies Engaged in the Testing and/or Inspection of Materials Used in Construction.
   4. American Welding Society (AWS):
      a. A5.1, Specification for Carbon Steel Electrodes for Shielded Metal Arc Welding.
      b. A5.5, Specification for Low-Alloy Steel Electrodes for Shielded Metal Arc Welding.

c. D1.1, Structural Welding Code - Steel.
d. D1.4, Structural Welding Code - Reinforcing Steel.

5. Occupational Safety and Health Administration (OSHA).
6. Prestressed Concrete Institute (PCI):
   a. MNL-116, Manual for Quality Control for Plants and Production of Precast Prestressed Concrete Products.
   b. PCI Design Handbook Precast and Prestressed Concrete.
7. Building code:
   a. International Code Conference (ICC):
      1) International Building Code and associated standards, 2003 Edition

B. Qualifications:
   1. Provide precast and prestressed concrete units produced by an active member of Prestressed Concrete Institute (PCI).
   2. Provide units manufactured by plant which has regularly and continuously engaged in manufacture of units of same type as those required for a minimum of 3 years.
   3. Assure manufacturer's testing facilities meet requirements of ASTM E329.
   4. Welding operators and processes to be qualified in accordance with:
      a. AWS D1.1 for welding steel shapes and plates.
      b. AWS D1.4 for welding reinforcing bars.
   5. Welding operators to have passed qualification tests for type of welding required during the previous 12 months prior to commencement of welding.

1.3 SUBMITTALS

A. Shop Drawings:
   1. See Section 01340 for requirements for the mechanics and administration of the submittal process.
   2. Product technical data including:
      a. Acknowledgement that products submitted meet requirements of standards referenced.
      b. Manufacturer's installation instructions.
      c. Sizes, types and manufacturer of neoprene bearing pads.
      d. Hardware to be utilized to support suspended appurtenances.
   3. Shop Drawings and erection plans for precast units, their connections and supports showing:
      a. Member size and location.
      b. Size, configuration, location and quantity of reinforcing bars and prestressing strands.
      c. Initial prestress forces.
      d. Size and location of openings verified by Contractor.
      e. Size, number, and locations of embedded metal items and connections.
      f. Required concrete strengths.
      g. Identification of each unit using same standard marking numbers as used to mark actual units.

4. Calculations for members and connections designed by fabricator. Calculations to be sealed by a professional Structural Engineer registered in the State in which the Project is constructed. Perform calculations using the dead load of the members plus the superimposed uniform and concentrated loads shown on the Drawings and indicated in this Specification Section. Indicate the following:
   a. Design for maximum moment, maximum shear and maximum torsion.
   b. Final top and bottom flexural stresses resulting from the stresses due to maximum moment and prestress force.
   c. Ultimate moment capacity.
   d. Final top and bottom flexural stresses, ultimate moment capacity, and ultimate shear capacity, if affected, for members with reduced cross sections due to openings or penetrations.
   e. When required on Drawings, a check for no tension in top and bottom of members due to prestress force and member dead load plus superimposed loads indicated on Drawings and in this Specification Section.
   f. Column design for maximum axial load and maximum moment.
5. Submit test results, when so required on Drawings, showing that embedded connection items will adequately support the indicated loads. Connection items to have an ultimate load capacity of at least two times the required indicated load.
6. Concrete mix design(s) including submittal information defined in Section 03002.
7. Copies of source quality control tests.
8. Certification of manufacturer's testing facility qualifications.

PART 2 PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
   1. Headed studs and deformed bar anchors:
      a. Nelson Stud Welding Div., TRW, Inc.
      b. KSM Division, Omark Industries.

2.2 MATERIALS

A. Embedded Steel Plates and Shapes: ASTM A36.

B. Bearing Pads:
   1. Neoprene.
   2. Section 18, Division 2 of the AASHTO Standard Specification for Highway Bridges.
   3. 60 durometer strength.

C. Cement:

1. Comply with ASTM C150, Type I or III.
2. Type II cement to be used in the following precast units:
   a. Precast weir troughs.

D. Aggregates for Normal Weight Concrete:
1. ASTM C33 with coarse aggregate meeting the gradation for size 67 as stated in ASTM C33.
2. Provide aggregates approved for bridge construction by the State Highway Department in the state where the precast units are fabricated or in the state where the Project is located.
3. All fine aggregate to be natural not manufactured.

E. Aggregates for Lightweight Concrete:
1. ASTM C330 with 3/4 IN maximum size coarse aggregate.
2. All fine aggregate to be natural not manufactured.

F. Water:
1. Potable, clean.
2. Free of oils, acids, and organic matter.

G. Maximum total chloride ion content contributed from all ingredients of concrete including water, aggregates, cement and admixtures measured as a weight percent of cement to not exceed 0.06 for prestressed concrete and 0.10 for all other precast concrete.

H. Prestressing Strands:
1. Either 250K or 270K high tensile strength uncoated seven wire strand.
2. Manufacture and test strands in accordance with ASTM A416.

I. Reinforcing Steel and Welded Wire Fabric: See Section 03002.

J. Headed Studs:
1. ASTM A108.
2. Minimum yield strength: 50,000 psi.
3. Minimum tensile strength: 60,000 psi.

K. Deformed Bar Anchors:
1. ASTM A496.
2. Minimum tensile strength: 80,000 psi.
3. Minimum yield strength: 70,000 psi.

L. Electrodes:
1. E70 series conforming to AWS A5.1 or AWS A5.5 for welding steel shapes and plates.
2. E90 series conforming to AWS A5.5 for welding rebar.

M. Concrete sand cement grout in keyways between hollow core slabs. See Section 03002.

2.3 MIXES

A. See Section 03002.

B. Maximum water cement ratio for lightweight concrete to be determined in accordance with recommendations of ACI 211.2 to provide required 28-day compressive strength and maximum slump of 3 IN.

C. Do not begin fabrication of units until concrete mix design(s) have been approved by Engineer.

2.4 DESIGN

A. General Design Requirements:
   1. Design units and connections in strict accordance with ACI 318 and the PCI Design Handbook Precast and Prestressed Concrete.
   2. Design units for spans, dead load of members, dead and live loads indicated on the Drawings with concentrated loads placed in their actual locations. Verify weights and locations of concentrated loads.
   3. Design units taking into account reduced cross section at openings and penetrations.
   4. Provide all reinforcing in units as indicated. Where not indicated, design and provide all reinforcing and prestressing strands subject to approval of Engineer.
   5. Due to presence of corrosive atmosphere, design prestressed members where indicated on Drawings for no tension in top and bottom of members resulting from loads indicated on Drawings and in this Specification Section.
   6. Design double tee flanges to carry all dead and live loads to be placed thereon. Do not place concentrated equipment loads on flanges but support the loads on the double tee legs.

B. Specific Design Requirements:

2.5 FABRICATION

A. Do not fabricate units until Shop Drawings have been approved by Engineer and returned to Contractor and support locations have been field verified by Contractor.

B. Manufacture, quality, dimensional and erection tolerances of all units to be in accordance with both PCI MNL-116 and PCI Design Handbook Precast and Prestressed Concrete.

C. Cast all members in smooth rigid forms which will provide straight, true members of uniform thickness and uniform color and finish.

D. Use sand cement grout mixture to fill all air pockets and voids, and to repair chipped edges.

E. Finish all repairs smooth and to match adjacent surface texture and color.

F. Where units are to receive concrete topping, provide units having heavy broom finish on top surface for bond.
   1. Provide roughness of top surface to provide bond with topping and design for horizontal shear at topping and unit interface in accordance with requirements of Paragraph 17.5 of ACI 318.

2. Make all other surfaces smooth.

G. Incorporate embedded plates, angles, and flange welding strips into members at time of manufacture. Provide embedded items as shown on the Drawings unless prior approval is received from Engineer to do otherwise.
   1. Provide flange welding strips as indicated on Drawings.
   2. Provide welding strips on all flange edges of all double tee units.
   3. Space strips as shown on Drawings.
   4. Cast lifting handles into units at or near support points. Remove lifting handles after units are erected.

H. Cast openings larger than 6 IN SQ or 6 IN DIA in units at time of manufacture. Make smaller openings by neat cutting or neat drilling by trades requiring them. Coordinate sizes and locations of all openings before fabrication of units.

I. Make provisions for support of suspended ceilings, lighting fixtures, ducts, piping, conduits and other suspended work.
   1. When drilled expansion bolts or powder-driven fasteners are approved for use, coordinate prestress strand location with prestress concrete member supplier so that drilled expansion bolts or powder-driven fasteners do not hit or are drilled or driven into prestress strands.
   2. Install powder-driven fasteners by means of a low velocity powder-actuated tool complying with requirements of OSHA.
      a. Assure that the load to be supported by each in place drilled expansion bolt or powder-driven fastener does not exceed the maximum allowable load recommended by the bolt or fastener manufacturer for the concrete strength encountered and for the type, size and embedment length of expansion bolt or driven fastener installed.

J. Automatically weld headed studs and deformed bar anchors to members to provide full penetration weld between studs, bar anchors and members they are attached to.

K. Weld steel shapes and plates per AWS D1.1 and reinforcing steel per AWS D1.4.

L. Minimum concrete compressive strength at time of strand release: 3500 psi.

M. Mark each unit as indicated on the erection plans. Place mark on non-exposed-to-view surface.

N. Coat or finish ends of exposed prestressing strands to prevent rusting.

O. Fabricate the following types of precast and prestressed units (all units to be made with normal weight concrete unless noted otherwise on Drawings):
   1. Prestressed double tees of sizes indicated on Drawings. Weight of double tees, based on an 8 FT-0 IN wide section, not to exceed following:

DEPTH	NORMAL WEIGHT CONCRETE	LIGHTWEIGHT CONCRETE
12 IN	37 psf	29 psf
16 IN	42 psf	33 psf
24 IN	55 psf	40 psf
32 IN	75 psf	60 psf

2. Prestressed hollow core slabs of sizes indicated. Weight of hollow core slabs not to exceed the following:

DEPTH	NORMAL WEIGHT CONCRETE	LIGHTWEIGHT CONCRETE
6 IN	50 psf	40 psf
8 IN	70 psf	55 psf
10 IN	80 psf	65 psf
12 IN	105 psf	80 psf

3. Precast weir troughs and lintels as shown on Drawings.
4. Precast concrete beams and columns as shown on Drawings:
   a. Reinforce as indicated. If reinforcement is not indicated, design and provide reinforcement as required to support maximum torsion, shear, moment and axial loads.
   b. See Paragraph 2.4B of this Section for specific design requirements.
   c. Provide beam and column connections as indicated on Drawings and as required to support all loads subject to Engineer's approval.

2.6 SOURCE QUALITY CONTROL

A. During production of precast concrete units, conduct strength tests of concrete placed in units as required in Specification Section 03002 for concrete placed during fabrication. Results of strength tests to be sent immediately to Engineer, Contractor and Owner. Test reports to indicate units they represent.

B. When approved by Engineer, strength tests may be made by precast manufacturer after he has submitted certification that his testing facilities meet the requirements of ASTM E329.

PART 3 EXECUTION

3.1 PREPARATION

A. Verify acceptability and location of supports to receive units. Check bearing surfaces to determine that they are level and uniform.

B. Verify compressive strengths of concrete and masonry supports. Do not start erection of units until supports have reached their 28-day required compressive strengths.

3.2 ERECTION

A. Sequence erection to provide a balance of loads across beams and columns.

B. Give consideration to possible lack of stability or capacity of partially completed frame or structure.

C. Contractor to be responsible for guying, shoring, and bracing of frame, walls and individual members as necessary to resist forces due to wind, erection, or any other source that may occur before structure is completed.

D. Use only erection equipment adequate for placing units at lines and elevations indicated on Drawings. Do not damage units or existing construction during erection. Erect units using lifting handles cast into the units.

E. Place each leg of all double tees on a 3/8 IN thick neoprene pad held 1 IN back from edge of support. Pad dimensions equal to length of bearing -1 IN x bearing width +2 IN.

F. Place hollow core slabs on continuous 1/4 IN thick neoprene bearing pad so that width equals bearing length -1 IN.

G. Provide a 1/2 IN thick neoprene bearing pad on the top of all precast concrete columns. Pad to cover entire top surface of column except hold pad back 1 IN from face of column all around.

H. Weir Trough:
   1. Anchor weir troughs to supports as indicated on Drawings.
   2. Provide continuous 3/8 IN thick neoprene pad under troughs at support.
   3. Hold back pads 1 IN from edge of support.

I. After erection, verify that there is no direct contact between bottom of units and supporting members. Where direct contact occurs, install additional layers of bearing material to raise units off supports.

J. Lintels:
   1. Length of lintel bearing on supports to be as indicated on Drawings. If not indicated, minimum length of lintel bearing to be 8 IN.
   2. When indicated on Drawings, fill masonry cells under lintel bearing with masonry grout and reinforce cells if so indicated.
   3. Provide minimum 3/8 IN thick full bed joint of masonry mortar between underside of lintel and top surface of grouted masonry for complete lintel bearing length.
   4. Where masonry cells are not required to be grouted under lintel bearing, provide minimum 3/8 IN thick face shell mortar bed joint between bottom of lintel and top of masonry block for complete lintel bearing length.
   5. See Drawing details for required felt paper under lintel bearing at masonry control joints.

K. Weld steel shapes and plates per AWS D1.1 and reinforcing steel per AWS D1.4.

L. Fill all keyways between hollow core slabs with concrete sand cement grout. See Section 03002.

M. After all precast units are erected and all precast unit connections have been made, coat all exposed surfaces of the connections with the same prime and finish paint as required on the adjacent precast concrete units. See Section 09900.

3.3 FIELD QUALITY CONTROL

A. Causes for rejection of units include, but are not necessarily limited to the following:
   1. Cracked units.
   2. Chipped, broken, or spalled edges.
   3. Units not within allowable casting tolerances.
   4. Voids or air pockets which, in opinion of Engineer, are too numerous or too large.
   5. Non-uniform finish or appearance.
   6. Low concrete strength.
   7. Improperly placed embedded items and/or openings.
   8. Exposed wire mesh, reinforcing or prestressing strands.

END OF SECTION