

SECTION 03 38 00 - POST-TENSIONED CONCRETE

PART 1 GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Cast-in-place post-tensioned concrete framing members and slabs.
 - 2. Sheathing-covered tensioning tendons for unbonded system.
- B. Related Sections:
 - 1. Section 03 30 00 - Cast-In-Place Concrete

1.2 REFERENCES

- A. American Concrete Institute:
 - 1. ACI 117 - Standard Specifications for Tolerances for Concrete Construction and Materials.
 - 2. ACI 301 - Specifications for Structural Concrete.
 - 3. ACI 318 - Building Code Requirements for Structural Concrete.
 - 4. ACI 423.6 - Specification for Unbonded Single-Strand Tendons.
- B. ASTM International:
 - 1. ASTM A416/A416M - Standard Specification for Steel Strand, Uncoated Seven-Wire for Prestressed Concrete.
 - 2. ASTM A421/A421M - Standard Specification for Uncoated Stress-Relieved Steel Wire for Prestressed Concrete.
 - 3. ASTM A722/A722M - Standard Specification for Uncoated High-Strength Steel Bar for Prestressing Concrete.
 - 4. ASTM C109/C109M - Standard Test Method for Compressive Strength of Hydraulic Cement Mortars (Using 2-in. or (50-mm) Cube Specimens).
- C. American Welding Society:
 - 1. AWS B2.1 - Specification for Welding Procedure and Performance Qualification.
- D. Concrete Reinforcing Steel Institute:
 - 1. CRSI - CRSI Design Handbook.
- E. Post Tensioning Institute:
 - 1. PTI - Post-Tensioning Manual.
 - 2. PTI - Specification for Unbonded Single Strand Tendons.

1.3 SUBMITTALS

- A. Unless otherwise specified, submittals required in this section shall be submitted for review. Submittals shall be prepared and submitted in accordance with Division 1.
- B. General Contractor shall submit a Submittal Schedule to the engineer within 30 days after they have received the Owner's Notice to Proceed.
- C. All submittals shall be reviewed and returned to the Architect within 10 working days.
- D. Incomplete submittals will not be reviewed.
- E. Submittals not review by the General Contractor prior to submission the Engineer will not be reviewed. Include on the submittal a statement or stamp of approval by the Contractor, representing that the Contractor has seen and examined the submittal and that all requirements listed in sections Division 1 have been complied with.
- F. Engineer will review submittals a maximum of two review cycles as part of their normal services. If submittals are incomplete or otherwise unacceptable and re-submitted, General Contractor shall compensate Engineer for additional review cycles.
- G. Design calculations without the appropriate signature and seal indicated below will be rejected and returned without review.
- H. Hardcopy Submittals: Submit three prints. Prints will be reviewed by the Engineer, and then the Architect. One marked print will be returned to Contractor for printing and distribution. Multiple copies will not be marked by the Engineer.
- I. Electronic Submittals:
 - 1. Contractor shall include in the submittal schedule an indication of submittals that are intended to be submitted electronically. Upon receipt of the submittal schedule, the Engineer reserves the right to indicate submittals that will not be accepted electronically. Paper copies of such submittals shall be furnished as referenced in this specification.
 - 2. The Engineer reserves the right to require paper copies of submittals that are received electronically. Provide Engineer one (1) paper copies in addition to the electronic submittal. Paper copy will be retained and electronic copy will be returned. Review cycle for such submittals shall not commence until such time that the paper copies are received.

3. Electronic Submittals shall be submitted in Protected Document Format (PDF) compatible with Adobe Acrobat Professional version 7.0 or later. Electronic files shall not be broken into smaller individual files. File sizes too large to process email or within a file transfer protocol (FTP) site shall be provided on a CD.
 4. The submission of submittals electronically does not relieve the contractor of their responsibility to review the submittal prior to transmission to the Engineer. Electronic Submittals shall include contractor comments, and a statement and/or stamp of approval by Contractor, representing that the Contractor has seen and examined the submittal and that all requirements listed in this Section and Division 1 have been complied with. Electronic submittals without the Contractor's approval will be rejected and returned.
 5. The Engineer assumes no responsibility for the printed reproduction of submittals reviewed electronically, transmission errors or returned electronic submittals that become corrupted or are otherwise not accessible by the Contractor's or Subcontractor's computer hardware and/or software.
- J. Shop Drawings:
1. Indicate layout, tendon sizes, grouping, spacing, horizontal and vertical locations, placing sequence, supports and locations, tendon supports, accessories, clearances required for jack, and pressure plate stresses; signed and sealed by professional engineer licensed in the State of Maine.
 2. Review of the shop drawings will be made for the size and arrangement of reinforcement. Conformance of the Shop Drawings to the Contract Drawings remains the responsibility of the General Contractor. Engineer's review in no way relieves the General Contractor of this responsibility.
 3. Shop drawings will not be reviewed as partial submittals. A complete submittal shall be provided all items listed prior. Incomplete submittals will not be reviewed.
- K. Describe tensioning sequence, type of jack, pressure monitoring device, anchorage set, tendon elongation and tendon cut-off procedures.
- L. Post-Tensioning Design:
1. Calculations documenting the initial and final post-tensioning forces as indicated on the drawings shall be submitted for review. Calculations are to be prepared under the direct supervision of a Professional Engineer licensed in the State of Maine. Calculations shall be signed and sealed by a Professional Engineer licensed in the State of Maine.

2. Design shall be in accordance with the applicable provisions of the latest edition of the American Concrete Institute (ACI) Building Code Requirements for Structural Concrete, and the requirements of the Post Tensioning Institute (PTI) Post-Tensioning Manual.
3. Submit the following information in the calculation submittal:
 - a. Size and quantity of post-tensioning tendons and/or post-tensioning strands in each member
 - b. Jacking force for each member.
 - c. Estimation of initial and final losses for each member, to include the effects of elastic shortening, creep, shrinkage, relaxation of tendons, friction, and anchor seating loss.
 - d. Final, effective post-tensioning force after all losses have been considered.
 - e. Post-tension anchorage devices, couplers and miscellaneous hardware necessary for stressing.
 - f. Design of anchorage zone reinforcement.

M. Mix designs: Reference Section 03 30 00 for additional information.

N. Manufacturer's Certificate: Certify tendon strength characteristics meet or exceed specified requirements.

O. Certificate of jack calibration, identifying calibration method.

1.4 CLOSEOUT SUBMITTALS

A. Section 01 70 00 - Execution Requirements: Closeout procedures.

B. Project Record Documents: Record actual locations of tendons, stressing sequence and tension loads established, and measured elongation of tendons.

C. Operation and Maintenance Data: Procedures for submittals.

1.5 QUALITY ASSURANCE

A. Perform Work in accordance with all Local, State, and Federal Standards.

B. Refer to 03 30 00 for additional inspection and testing requirements.

1.6 QUALIFICATIONS

A. Design post-tensioned members under direct supervision of Licensed Professional Engineer experienced in design of this Work and licensed in State of Maine.

B. Installer: Company specializing in constructing the Work of this section with minimum three years of documented experience.

- C. Welder: Qualified within previous 12 months in accordance with AWS B2.1.

1.7 PRE-INSTALLATION MEETINGS

- A. Section 01 30 00 - Administrative Requirements: Pre-installation meeting.
- B. Convene minimum one week prior to commencing work of this section.
- C. Discuss tendon locations, sleeve locations, and cautions regarding cutting or core drilling.

1.8 ENVIRONMENTAL REQUIREMENTS

- A. Section 01 60 00 - Product Requirements.
- B. Minimum Ambient Temperature for Grouting and Grout During Cure: 40 degrees F
- C. Maximum Grout Temperature (While Curing Under Pressure): 90 degrees F.
- D. Cold Weather Placing: Refer to 03 30 00.
- E. Hot Weather Placing: Refer to 03 30 00.

1.9 COORDINATION

- A. Section 01 30 00 - Administrative Requirements: Coordination and project conditions.
- B. Coordinate the Work of framing components not post- tensioned but associated with the work of this Section.

PART 2 PRODUCTS

2.1 FORMWORK

A. Forms for Exposed Finish Concrete: Unless otherwise indicated, construct formwork for exposed concrete surfaces with plywood, metal, metal-framed plywood faced or other acceptable panel-type materials, to provide continuous, straight, smooth, exposed surfaces. Furnish in largest practicable sizes to minimize number of joints and to conform to joint system shown on drawings. Provide form material with sufficient thickness to withstand pressure of newly-placed concrete without bow or deflection.

1. Use plywood complying with U.S. Product Standard PS-1 "B-B (Concrete Form) Plywood", Class I, Exterior Grade or better, mill-oiled and edge-sealed, with piece bearing legible inspection trademark.

Form Coatings: Provide commercial formulation form-coating compounds that will not bond with, stain nor adversely affect concrete surfaces, and will not impair subsequent treatments of concrete surfaces

2.2 REINFORCEMENT

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

B. Welded Wire Fabric: ASTM A 185, welded steel wire fabric. Provide welded wire fabric in flat sheets.

C. Unbonded Tendon Strand: Factory assembled, [complying with PTI "Specification for Unbonded Single Strand Tendons,"] ASTM A416/A416M, Grade 270 stranded steel cable; full length without splices; ultimate tensile stress of 270 ksi, ½ inch or 0.6 inch diameter strand, greased and covered with polyethylene sheathing providing free movement of tendon within sheathing; complete with end anchorages.

1. Corrosion Protection: ACI 423.6.

D. Tendon Anchor: Type compatible with tendon and of strength not less than tendon.

E. Tendon Coupling: Type compatible with tendon and of strength equal to 125% greater than tendon after attachment to tendons.

F. Reinforcement: As specified and required based on tendon layout.

2.3 ACCESSORIES

A. Tie Wire: Minimum 16 gage annealed type

- B. Supports for Reinforcement: Provide supports for reinforcement including bolsters, chairs, spacers, and other devices for spacing, supporting and fastening reinforcing bars and welded wire fabric in place. Use plastic, wire bar type supports or concrete block supports complying with CRSI recommendations, unless otherwise specified. Wood, clay brick and other unspecified devices are not acceptable.
 - 1. For exposed-to-view concrete surfaces, where legs of supports are in contact with forms, provide supports with legs which are plastic protected (CRSI, Class I) or stainless steel protected (CRSI, Class 2).
- C. Anchorages: See Sections 03 30 00 and 05 12 00.
- D. Recessed Reglets: See Section 03 30 00.
- E. Touch-up Primer: Zinc rich, for galvanized items.

2.4 CONCRETE MATERIALS AND MIX DESIGN

- A. Concrete Materials: As specified in Section 03 30 00.
- B. Mix Design: As specified in Section 03 30 00.

2.5 SOURCE QUALITY CONTROL AND TESTS

- A. Section 01 40 00 - Quality Requirements: Testing, inspection and analysis requirements.
- B. Inspect and test stressing tendons before delivery to site for compliance with specified standards.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Section 01 30 00 - Administrative Requirements: Coordination and project conditions.
- B. Verify that site conditions are ready to receive Work and field measurements have been confirmed by the installer.

3.2 FORMWORK ERECTION

- A. Design, erect, support, brace and maintain formwork to support vertical and lateral loads that might be applied until such loads can be supported by concrete structure. Construct formwork so concrete members and structures are of correct size, shape, alignment, elevation and position.
- B. Design, construct, erect, maintain, and remove forms for cast-in-place concrete work in compliance with ACI 347.
- C. Design formwork to be readily removable without impact, shock or damage to cast-in-place concrete surfaces and adjacent materials.
- D. Construct forms to sizes, shapes, lines and dimensions shown, and to obtain accurate alignment, location, grades, level and plumb work in finished structures. Provide for openings, offsets, keyways, recesses, moldings, rustications, reglets, chamfers, blocking, screeds, bulkheads, anchorages and inserts, and other features required in work. Use selected materials to obtain required finishes. Solidly butt joints and provide backup at joints to prevent leakage of cement paste.
- E. Fabricate forms for easy removal without hammering or prying against concrete surfaces. Provide crush plates or wrecking plates where stripping may damage cast concrete surfaces. Provide top forms for inclined surfaces where slope is too steep to place concrete with bottom forms only. Kerf wood inserts for forming keyways, dovetail slots, reglets, recesses, and the like to prevent swelling and for easy removal.
- F. Provide temporary openings where interior area of formwork is inaccessible for clean out, for inspection before concrete placement and for placement of concrete. Securely brace temporary openings and set tightly to forms to prevent loss of concrete mortar. Locate temporary openings on forms at inconspicuous locations.
- G. Chamfer exposed corners and edges as indicated, using wood, metal, PVC or rubber chamfer strips fabricated to produce uniform smooth lines and tight edge joints.
- H. Form Ties: Factory-fabricated, adjustable-length, removable or snap-off metal form ties, designed to prevent form deflection, and to prevent spalling concrete surfaces upon removal.
- I. Unless otherwise indicated, provide ties for concrete surfaces to be exposed to view in the final condition so portion remaining within concrete after removal is 1" (minimum) inside concrete.
- J. Form ties shall not leave holes larger than 1" diameter in concrete surface. Repair holes left by form ties after removal of formwork.

- K. Provision for Other Trades: Provide openings in concrete formwork to accommodate work of other trades. Determine size and location of openings, recesses, and chases from trades providing such items. Accurately place and securely support items built into forms.
- L. Cleaning and Tightening: Thoroughly clean forms and adjacent surfaces to receive concrete. Remove chips, wood, sawdust, dirt or other debris just before concrete is placed. Retighten forms and bracing after concrete placement as required to eliminate mortar leaks and maintain proper alignment.
- M. Provide supports and working space for tensioning jacks.
- N. Provide permanent tendon location markers.
- O. Install anchorage [and connection] devices.
- P. Install reglets.

3.3 TENDON PLACEMENT

- A. Locate and position tendons. Protect from displacement. Protect from damage; replace if damaged.
- B. Install tendons to vertical elevation and horizontal positions indicated on shop drawings.
- C. Secure jack pressure plates in position perpendicular to line of stressing force.
- D. Maintain concrete cover around reinforcement as indicated on drawings and noted in ACI 318 & 362.
- E. Install other reinforcement as specified in Section 03 30 00.

3.4 INSTALLING CONCRETE

- A. Place concrete in accordance with Section 03 30 00.
- B. Verify tendons, anchors, seats, plates, and other items to be cast into concrete are placed and secure.
- C. Refer to Section 03 30 00 for curing requirements.
- D. Refer to Section 03 30 00 for concrete finishing requirements.

3.5 TENSIONING

- A. Begin tensioning operations after concrete has reached 4000 psi compressive strength and ambient temperature is above specified requirements. Confirm concrete strength with test cylinders prior to tensioning.
- B. Perform tensioning in steps as determined by installer. Measure prestressing force. Maintain jacking and tensioning records as work progresses.
- C. Jack against tendon pressure plate, not against concrete.
- D. Cut off excess tendon inside face of concrete. Apply touch-up primer to cut end.
- E. Repair/Replace members damaged during tensioning process. Conduct repairs as directed.

3.6 GROUTING

- A. Grout fill anchorage pockets.

3.7 REMOVAL OF FORMS

- A. See Section 03 30 00 for requirements for removal of forms.
- B. Remove forms, reshore, and brace concrete after concrete develops strength sufficient to carry its own weight, construction loads, and design loads.

3.8 REPAIR OF SURFACE DEFECTS

- A. Repair surface defects in accordance with Section 03 30 00.
- B. Request examination of concrete surfaces upon removal of forms.
- C. Modify/Replace concrete not conforming to required lines, detail, and elevations at the direction of the Engineer of Record.
- D. Modify/Replace concrete not properly placed, resulting in honeycombing or other defects at the direction of the Engineer of Record.

3.9 CONCRETE TOLERANCES

- A. Section 01400 - Quality Requirements: Tolerances.
- B. Conform to Section 03 30 00 for formwork construction tolerances.
- C. Conform to Section 03 30 00 for reinforcement construction tolerances.
- D. Conform to Section 03 30 00 for floor flatness tolerance requirements.

3.10 ERECTION TOLERANCES

- A. Section 01400 - Quality Requirements: Tolerances.
- B. Install reinforcement within the following tolerances for flexural members, walls, and compression members:

Reinforcement Depth	Depth Tolerance	Concrete Cover Tolerance
Greater than 8 inches	plus or minus 3/8 inch	minus 3/8 inch
Less than 8 inches	plus or minus 1/2 inch	minus 1/2 inch

- C. Maximum Variation from Indicated Position: 1/4 inch.
- D. Maximum Variation from Indicated Elevation: 1/4 inch.

3.11 FIELD QUALITY CONTROL

- A. Section 01400 - Quality Requirements: Field inspecting, testing, adjusting, and balancing.
- B. Concrete Inspections:
 - 1. Continuous Tensioning Inspection: Inspect for application of proper tension on tendons by measuring steel elongation and jacking force. Inspect anchor seating.
 - 2. Other Inspections: As specified in Section 03 30 00.
- C. Strength Test Samples:
 - 1. Concrete Sampling, Cylinder Molding, and Curing Procedures: As specified in Section 03 30 00.
 - 2. Grout Cube Molding, Curing, and Testing Procedures: ASTM C109/C109M.
 - 3. Sample concrete per Section 03 30 00.
 - 4. Make one additional cylinder during cold weather concreting, and field cure.
- D. Field Testing:
 - 1. Test Methods and Tests: As specified in Section 03 30 00.

END OF SECTION