PART 1 GENERAL

1.1 SUMMARY

A. Provide labor, materials, necessary equipment and services to complete the post-tensioned concrete work, as indicated on the drawings and as specified.

B. Provide additional materials required for post-tensioned cast-in place concrete not otherwise specified and perform job site post-tensioning operations necessary to complete the work as shown and specified.

C. Related Sections:
   1. 03200 - Concrete Reinforcement.
   2. 03300 - Cast-In-Place Concrete.

1.2 REFERENCES

A. American Society for Testing and Materials (ASTM), latest edition:
   1. A416  Specification for Steel Strand, Uncoated Seven-Wire for Prestressed Concrete

1.3 QUALITY ASSURANCE

A. Codes and Standards: Comply with provisions of the latest edition of the following codes, specifications and standards, except where more stringent requirements are shown or specified:

   1. ACI 318-95 Building Code Requirements for Reinforced Concrete.
   2. ACI 318R-95 Commentary on Building Code for Reinforced Concrete.
   3. PCI "Losses" PCI Committee on Prestress Losses, "Recommendations for Estimating Prestress Losses", Prestressed Concrete Institute, Volume 20, No.4, July/August 1975, pp. 43-75.
   4. All applicable codes, specifications, and standards referenced in Sections 03200 and 03300.

B. Specialty Firm Qualifications: Firms with at least 5 years successful experience including projects of similar or larger scope and complexity.

C. Foreman Qualifications: Person with not less than 3 years field experience in foreman's capacity on projects of similar or larger scope and complexity.
1.4 DEFINITIONS

A. Post-tensioning: Any method of prestressing where the tendon is tensioned after the concrete has reached a specified strength.

B. Tendon: Refers to any single post-tensioning unit used to apply prestress force to the concrete member whether composed of one or more elements.

C. Unbonded Tendons: Refers to ungrouted tendons that are shop-coated and encased in slippage sheathing to prevent bond, to retard corrosion, and to reduce friction.

1.5 EXPERIENCE AND QUALIFICATIONS

A. Employ and pay for services of a specialty subcontractor to perform prestressing work.

B. Require specialty subcontractor to perform the following:

1. Before start of work, meet with Contractor to establish complete sequence and schedule of concrete placement and post-tensioning work. Indicate construction joints, stressing points, intermediate stressing points, and dead end locations. Contractor may submit alternate plan of joints, stressing points, etc. for approval.

2. Review Contract Documents for items at variance with Contractor's established procedures. Submit variance to the Board for review not less than 10 days before bids are received. Variances not submitted before such date shall be resolved to satisfaction of A/E at no additional cost to the Board.

3. Compute losses and provide final prestress forces indicated using materials and methods complying with Contract Documents, ACI 318, and PCI "Losses".

4. Provide a trained, skilled, experienced, full-time representative, approved by the A/E to be present during work to insure installation and prestressing operations are conducted in compliance with Contract Documents and ACI 318.

C. When approved by A/E, Contractor may provide services of his superintendent who is trained, skilled, and has not less than 5 years prestressing experience. In the event use of Contractor's superintendent is approved, specialty subcontractor shall:

1. Provide services of his representative to instruct Contractor's personnel in correct methods of installation, use, and operation of post-tensioning equipment.

2. Be present during first 3 concrete placements and post-tensioning operations.

3. Make monthly inspections throughout construction period to insure that post-tensioning operations and tendon placement are according to ACI 318 and Contract Documents.

4. Determine stressing equipment is used correctly and safely.

1.6 SUBMITTALS

A. Shop Drawings: Sepias of other photographic reproductions of the structural drawings are not allowed as a base for the shop drawings and shall be cause for resubmittal. Submit the following to A/E for fabrication and placement.

1. Dimensioned tendon layout locating tendons in horizontal plane.

2. Tendon profile locating centerline of prestress force at maximum 4 foot intervals with respect to bottom of post-tensioned element. Show chairs, chair heights, location of support steel, and other information regarding tendon support methods.
3. End anchorage details.
4. Jacking forces, initial and anchorage.
5. Required elongations.
6. Clearance requirements for stressing equipment.

B. Anchorages: Submit dynamic test data, for anchorages to verify fatigue properties are adequate to sustain maximum number and stress variations of loads anticipated during entire service life.

C. Losses: Submit calculations showing assumed losses for prestressing materials according to PCI "Losses".

D. Deviations: Should proposed materials and methods deviate from those shown on drawings or specifications, submit calculations analyzing the materials and methods proposed.

E. Changes: Do not incorporate proposed changes into the fabrication and placement details unless approved in writing. Do not make changes in details after approval.

F. Mill Tests: Submit certified mill test results and typical stress strain curves.

G. Calibration: Submit certified calibration test curves and results for stressing system.

H. Qualification Data: Submit data verifying qualification of specialty firm and foremen including references.

I. Standards: Submit letter stating that specialty firm has in their possession and will have on the jobsite copies of referenced standards and that management and foreman are knowledgeable about provisions that relate to this project.

J. Measurement of Elongations: Submit narrative and details showing means of measuring elongations, tolerances for measurement, and name of independent firm to measure or verify elongations.

1.7 INSTRUCTION

A. Have the post tensioning supplier give the Contractor's personnel instruction in placing the tendons and use of stressing equipment. Supplier shall supervise the post-tensioning work.

PART 2 PRODUCTS

2.1 POST-TENSIONING TENDONS AND ACCESSORIES

A. Strand: Uncoated, seven-wire stress-relieved steel strand meeting requirements of ASTM A416, Grade 270, Low-Relaxation.

B. Tendon Coating: Fabricated coated tendons shall be shop coated with coating compound to prevent bond, reduce friction and resist corrosion. The tendon shall be encased in slippage sheathing to further assure prevention of bond and maintain the element in proper diameter.
1. Tendon coating compound: Tendon wire shall be completely shop coated with a non-volatile, low friction mineral oil base grease with a rust preventing additive. This coating material shall have a relatively uniform viscosity under temperature ranges of -200 to 1200 degree F.

C. Slippage Sheathing: Plastic, heavy paper, felt, or other material, except aluminum, and the following:

   1. Capable of maintaining the group of wires tightly bundled
   2. Containing the wire coating compound during shipment, placing, and concreting.
   3. Preventing admission of concrete and mortar during concreting operations.

D. Anchorages and Couplers: Hardware shall meet the minimum requirements set forth in ACI 318, Chapter 18.

PART 3 EXECUTION

3.1 FORMWORK

A. Comply with applicable provisions of Section 03100, Concrete Formwork and as specified.

B. Design formwork for any additional loads induced during stressing by shifting load from one part of the formwork to another.

C. Secure stressing assemblies at tendon terminals to the formwork designed to maintain tendon in a fixed position during concreting.

D. Do not remove forms until stressing operation is complete and elongations are approved.

3.2 HANDLING and PLACING OF TENDONS

A. Have the complete tendons shipped coiled or bundled and fastened on shipping racks to protect tendons from damage during transit and storage at the job site. Protect from excessive corrosion and keep free of deleterious substances before placing.

B. Place supports for tendons to insure their remaining in proper position during the placing of the concrete. Unless otherwise indicated, supports for tendons shall be located at 4'-0" maximum centers. Vertical tendon dimensions shall vary not more than 1/8" in slabs and 1/4" in beams from the dimensions shown on the drawings.

C. Tendons shall be placed with a parabolic profile unless otherwise shown on the drawings. Dimensions shown on the drawings are the control points for the parabolic profile, dimensioned from bottom of slab or beam to center of prestress force.

D. In no case shall the minimum clear coverage for tendons be less than 1-1/2" for beam or girders, and 3/4" for slabs, and shall be according to ACI.

E. Cut back slippage sheathing at stressing ends of tendon before concrete in place to ensure correct installation of anchoring device.
F. Do not nick, bend, or damage in any way the tendons, coupler hardware, and anchorages during heading or prestressing of tendons. Repair tears, holes, and other damages in the slippage sheathing by re-wrapping before concreting begins.

G. If required, and where approved, couple the prestressing tendons to develop continuity with a strength equal to at least 95 percent of the specified tensile strength of the tendons. The coupler shall be detailed to transfer the post-tensioning force through the coupler without creating bending moments in the tendon. Coupler hardware shall be clean and free of deleterious substances.

H. Construct anchorages to develop 95 percent of the specified tensile strength of the tendons, both individually and as a group, without slippage, distortion or other changes that will allow loss of stress. The anchorage shall be detailed to transfer the post-tensioning force to the concrete without creating bending moments in the tendon. Anchorage hardware shall be clean and free of deleterious substances.

3.3 OBSERVATION

A. Do not begin concreting of prestressed members until placement of tendons and conventional reinforcement has been observed and approved by the A/E.

B. PLACING OF CONCRETE

C. Place concrete in such a manner as to ensure alignment of post-tensioning tendons and conventional reinforcement remains unchanged.

D. Provide uniform compaction of concrete, especially around anchorages.

3.4 STRESSING EQUIPMENT

A. Provide the necessary stressing equipment with certified calibration within 3 months of first use and at maximum 3 month intervals.

B. In order to insure proper calibration is maintained, exercise care in handling of stressing equipment.

3.5 PRESTRESSING

A. Concrete Strength: Do not begin tensioning operation until test of field cured concrete cylinders indicate the concrete in the members has attained a compressive strength of not less than 75 percent of the 28 days strength, or as otherwise shown on the drawings. Contractor shall arrange for and pay for testing field cured cylinders to verify strength for stressing as specified under concrete work.

B. Stressing Schedule: Concrete mix designs shall be proportioned and construction schedule established so the stressing operation occurs not longer than 80 hours after concrete placement.

C. Stressing Operation: After tests indicate the concrete has reached sufficient strength, stress the tendons by means of hydraulic jacks equipped with calibrated pressure gages with an accuracy of 1 percent of the scale range to allow the stress in the prestressing steel to be computed at any time. Notify the A/E 48 hours before any stressing operation takes place.
1. Minimum anchorage strength and age of post-tensioned concrete member shall be 3,000 psi and 40 hours old, unless otherwise approved by the A/E.
2. Conduct the stressing operation as recommended by the manufacturer of the prestressing materials, in the presence of the A/E and in compliance with approved shop drawings.
3. Keep records of the elongation and of the tension applied to each tendon and submit to the A/E promptly upon the completion of the post-tensioning of each member. At the time of stressing the first member of each type, check the stresses in the individual tendons to establish a post-tensioning procedure to insure uniform results.
4. Anchoring: Anchor the prestressing steel at an initial or "Transfer Stress" that will result in the retention of working forces or stresses of not less than those shown on the drawings as the final prestress force after losses. In no case shall the steel be anchored at stresses above 94 percent of the specified yield strength of the tendon.

D. Elongation Reports: Independent testing laboratory or inspector accepted by the A/E shall oversee elongation measurements and report each in compliance with established procedures.

E. Cutting of Tendon Tails: Do not begin cutting of stressed tendon tails until receipt of written approval of elongation reports by A/E.

3.6 TREATMENT OF ANCHORAGES

A. Upon completion of the stressing operation:
   1. Coat stressing assemblies with an approved rust preventive material.
   2. Apply epoxy bonding agent as specified in Section 03010, Concrete Work.
   3. Fill pockets for stressing terminals with grout as follows:
      a. Interior exposure in service: Cement grout.
      b. Exterior exposure in service: Non-shrink, non-metallic grout.
      c. Match color and texture of adjacent concrete where exposed to view in completed structure.

B. Whenever the grouted pocket is to be left exposed, smooth and rub the grout to match adjoining surfaces.

3.7 PATCHING

A. Thoroughly clean holes left by tie rods, strand hold-down devices, or other temporary inserts. Repair same as required for anchorages.

B. Members with honeycomb in areas of such depth as to expose tendons will be examined by A/E for structural adequacy. Where impairment of structural adequacy is apparent, the member or work will be rejected.

C. When honeycomb areas are to be repaired, remove loose material and cut back area until the coarse aggregate will break under chipping. Saturate the area, allow to approach a condition of surface dryness. Then apply a thin coat of epoxy adhesive bonding agent as specified in Section 03300, Cast-In-Place Concrete and repair with non-metallic, non-shrink grout and cure as required. The method to be used shall meet the approval of the A/E.

END OF SECTION