Florida Department of Transportation

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January 14, 2016

Khoa Nguyen
Director, Office of Technical Services
Federal Highway Administration
3500 Financial Plaza, Suite 400
Tallahassee, Florida 32312

Re: State Specifications Office
Section **450**
Proposed Specification: **4500100 Precast Prestressed Concrete Construction.**

Dear Mr. Nguyen:

We are submitting, for your approval, two copies of the above referenced Supplemental Specification.

The changes are proposed by Charles Boyd of the State Structures Design Office to incorporate specification language for stainless steel and FRP reinforcing and prestressing strand into the Standard Specifications.

Please review and transmit your comments, if any, within two weeks. Comments should be sent via email to daniel.scheer@dot.state.fl.us.

If you have any questions relating to this specification change, please call me at 414-4130.

Sincerely,

Signature on file

Daniel Scheer, P.E.
State Specifications Engineer

DS/ot
Attachment
cc: Florida Transportation Builders' Assoc.
State Construction Engineer

PRECAST PRESTRESSED CONCRETE CONSTRUCTION.
(REV 11-*1*6-15)

ARTICLE 450-1 is deleted and the following substituted:

450-1 Description.

Fabricate, store, transport and erect precast/prestressed concrete members prestressed by the pretensioning method. Pretensioned precast prestressed concrete products are products prestressed by the pretensioning method. In this method, steel *or Fiber Reinforced Polymer (FRP)* components are stressed and anchored; the concrete for the product is then cast and cured, and finally the stress in the steel *or FRP* components is released from the anchorages to the concrete through bond, after the concrete has attained its specified release strength.

A precast prestressed concrete plant, hereinafter called plant, is an independent operating facility capable of performing all the operations necessary to fabricate precast/prestressed concrete products.

Obtain precast/prestressed products from a plant that is currently on the Department's Production Facility Listing. Producers seeking inclusion on the list shall meet the requirements of Section 105.

When the plant's Quality Control Program is suspended, accept responsibility of either obtaining precast/prestressed products from a precast/prestressed concrete plant with an accepted Quality Control Program, or await re-approval of the Producer Quality Control Program. The Engineer will not allow changes in Contract Time or completion dates as a result of the concrete plant's Quality Control Program suspension. Accept responsibility for all delay costs or other costs associated with the plant's Quality Control Program suspension.

SUBARTICLE 450-2.1 is deleted and the following substituted:

450-2.1 General: Develop a Producer Quality Control Program as specified in Section 105.

Meet the requirements of the accepted Quality Control Program, Contract Documents, and Precast/Prestressed Concrete Institute (PCI) Manual for Quality Control for plants and production of structural precast concrete products. The requirements of the Contract Documents will govern, when there is a discrepancy between the PCI Manual and the Contract Documents.

Accept responsibility for performing daily Quality Control (QC) inspections of all phases of work ensuring all materials and workmanship incorporated into the product meet the requirements of the Contract Documents. Also, maintain a daily activity report detailing the results of the daily Quality Control Program activities. Ensure these daily reports and minutes of the weekly meetings with the Engineer and the plant's production personnel are maintained at the plant. During the weekly meetings, discuss the results of the QC inspections.

Inspect the product for conformance with the product dimension tolerances shown in Appendix B of PCI Manual MNL-116 (Manual for Quality Control for Plants and Production of Structural Precast Concrete Products), except as modified herein. Apply the tolerances with respect to the theoretical positions and dimensions shown in the Plans. Apply the same tolerances for U-Beams as those specified for I-girders, excluding sweep tolerance, when

inspecting the product for conformance with dimension tolerances. For Florida U-Beam diaphragms, the tolerance for the thickness of the intermediate and end diaphragms is plus 1 inch and minus 1/2 inch, and the location of intermediate diaphragms, relative to design plan positions, is plus or minus 3 inches. The tolerance of the thickness of end diaphragms shall be plus 3 inches and minus 1/2 inch.

Limit sweep to 1/2 inch for U-Beams and Inverted-T Beams. The maximum allowable sweep for I Beams is 1/8 inch per 10 foot length, but not to exceed 1.5 inch. The maximum allowable sweep for piling is 1/8 inch per 10 feet, but not to exceed 1.0 inch.

The tolerance for beam strand sheathing is plus or minus 2 inches.

Ensure the tolerance on all miscellaneous shaping including, but not limited to, chamfers, miters, bevels, keys, tapers, radii, holes, inserts, and block outs is within plus or minus 1/8 inch of the control dimension of the shape.

The tolerances represent the total allowable tolerance that will be accepted in the finished product. Do not apply tolerances shown for the overall dimensions of a member to violate the tolerances shown for positions of reinforcing and prestressing steel *or FRP*. Apply the tolerances during and after the fabrication of prestressed products. Do not reduce the concrete cover for reinforcing steel, *FRP reinforcing,* prestressing steel*, FRP prestressing strands,* or any other metallic objects specified in the Plans more than 1/4 inch. Do not reduce the concrete cover for reinforcing steel, *FRP reinforcing,* prestressing steel*, FRP prestressing strands,* or any other metallic *or plastic* objects when the cover specified in the Plans is minimum cover.

Ensure the QC inspector is present during concrete placements and performs inspection during all fabrication of precast prestressed concrete products, including the inspection of the operations before, during and after the placement of concrete.

Ensure the Plant QC Manager, or the QC inspectors under their direction, examine all precast prestressed concrete products within five working days of detensioning to ensure their dimensions conform to the specified tolerances and to determine if there are any deficiencies. This process control shall be listed on the Producer Quality Control Plan (QC Plan).

SUBARTICLE 450-2.4 is deleted and following substituted:

450-2.4 Documentation: Ensure that a system of records is maintained in each plant which will provide all information regarding the certification and testing of prestressing steel, *FRP prestressing strands,* reinforcing steel, *FRP reinforcing,* concrete materials and concrete, curing materials, embedded items, tensioning, concrete proportioning, pre-placement, placement, post-placement inspections, curing, and disposition of products. Include in the record keeping the deficiencies found as a result of the inspection and testing. Keep certified test reports for all materials incorporated into the production of precast prestressed concrete products.

Ensure that the printout or manual record of the tensioning operations is maintained and reflects the identification of the bed, type of fabricated products, the complete Financial Project Identification Number, jack identification number, date prestressing strands were stressed, temperature at the time of stressing, and signature of the qualified tensioning machine operator.

Ensure the proposed method and format for documenting required information is included in the Producer QC Plan.

Maintain records until all the precast prestressed products for a project have been fabricated then submit all the records to the Engineer. Ensure records are available at all times for the Engineer's inspection.

SUBARTICLE 450-3.1 is deleted and the following substituted:

450-3.1 General: Meet the following requirements:

Concrete .....Section 346
Steel Strands*.....Section 933
CFRP Strands .....Section 933*
Steel *Prestressing* Bars .....Section 933
Steel Accessories .....Section 933
Steel Spirals .....Section 931
Reinforcing Steel and Metal Welded Wire
Reinforcement~~**~~..... Sections 415 and 931
FRP Reinforcing ..... Sections 415 and 931
*FRP Spirals**.....Section 932*
Embedded Duct~~ Enclosure~~s .....Section ~~462~~*960*
Membrane Curing compounds***.....Section 925
Epoxy Resin Compounds.....Section 926
Burlap.....Section 925
Curing Blanket 400-16
Penetrant sealer*** .....Section 413
Methacrylate .....Section 413
Epoxy Injection of Cracks .....Section 411

* Do not use strands from more than one source in any individual prestressed element, with the exception of the partially tensioned strands (dormant strands).

** ~~The steel spirals for reinforcing in concrete piling may be manufactured from stock meeting the requirements of any grade of reinforcing steel, as shown in ASTM A615 for steel bars, or ASTM A1064 for steel wire.~~*The FRP spirals cannot be used in combination with steel prestressing strand.*

*** Use membrane curing compounds and sealers that are compatible with coating or other materials that are applied to concrete surface.

Use inserts in accordance with the recommendations of the manufacturers and within their certified capacities and application qualifications. Do not use aluminum inserts.

Use draped strand devices of sufficient rigidity having adequate support to retain the position of the strand unchanged under the induced load. Do not allow the devices to induce friction to the tendons such that the required jacking force and elongation cannot be attained.

SUBARTICLE 450-4.2 is deleted and the following substituted:

450-4.2 Reinforcing ~~Steel~~, Welded Wire Reinforcement and Prestressing Steel for Pretensioning:

450-4.2.1 General: Identify all reinforcing steel, welded wire reinforcement and prestressing ~~steel~~ *strand* for pretensioning by LOTs. A LOT of reinforcing steel or welded wire

is a shipment of material from the same manufacturer and heat. A LOT of prestressing steel is a shipment of material of the same size, production grade and heat from the same manufacturer. *A LOT of FRP reinforcing bars or prestressing strands is a shipment of material of the same size, fiber lot and resin batch from the same manufacturer.*

Acceptance of reinforcing ~~steel~~*bars*, welded wire reinforcement and prestressing steel for pretensioning is based on manufacturer's certification and the Department's verification tests. The sampling for verification testing will be performed by the Department at each precast plant, on at least two LOTs per year, additional samples may be taken at the manufacturing source of reinforcing *bar*~~steel~~, welded wire reinforcement and prestressing strands.

When products contain the material that has failed to meet the requirements of 450-3, reject the unused material of the failed LOT. The Engineer may require the evaluation of the products, which contain the failed material, in accordance with 450-14.

450-4.2.2 *Steel* Reinforcing ~~Steel~~ and Welded Wire Reinforcement: Obtain and maintain for each LOT a certified mill analysis, physical property test report and the manufacturer's assigned LOT number with the heat of the material represented. Verify that the report represents the steel received and that the steel meets the Contract Documents requirements. Reject all unidentified reinforcing steel or welded wire reinforcement received at the plant or job site.

Provide the manufacturer's certified mill analysis and three 7 foot long, randomly selected samples from the designated LOT of reinforcing steel and three randomly selected samples from the designated LOT of welded wire reinforcement when requested by Engineer. Ensure each sample of welded wire reinforcement covers an area of four intersections of transverse and longitudinal bars. Ensure the transverse wires of each piece of welded wire reinforcement extend approximately 6 inches to both sides.

450-4.2.3 FRP Reinforcing: *~~For material acceptance criteria on a project reference~~Meet the requirements of 932-3.*

450-4.2.~~3~~ *4 Steel* Prestressing *Strand*~~Steel~~ for Pretensioning: Obtain and maintain for each LOT of material received, the manufacturer's assigned LOT number, certified test values for specified material properties together with a representative load-elongation curve and the modulus of elasticity value based upon strand nominal area. Provide and support by records maintained by the strand manufacturer, production tolerances applied in selection of the reported strand modulus. Verify that documents provided represent the shipment received and meets the Contract Documents requirements.

Reject all unidentified prestressing steel received at the plant or job site.

Provide the manufacturer's certified mill analysis and three 5 foot long randomly selected samples from the designated LOT of material when requested by the Engineer.

450-4.2.5 FRP Prestressing Strand for Pretensioning: *~~For material acceptance criteria on a project reference~~Meet the requirements of 933-5.2.2.*

450-4.2.~~4~~ *6* Strand Chucks and Splice Chucks: Obtain and maintain certified test results certifying that the material meets the requirements of 450-3.

450-4.2.~~5~~ *7* Steel Accessories: Use only steel accessories meeting the requirements of 450-3.

450-4.2.~~6~~ *8* Ducts: Obtain and maintain certified test results certifying that the material meets the requirements of 450-3.

ARTICLE 450-5 is deleted and the following substituted:

450-5 Shop Drawings.

Submit shop drawings for all pretensioned prestressed concrete products containing FRP bars or strands. Submit shop drawings *for all other pretensioned prestressed concrete products* when the Contract Documents do not contain all the detailed information necessary to fabricate and erect the pretensioned prestressed concrete product. Ensure the submitted shop drawings meet the requirements of 5-1 and any additional Contract Document requirements.

Shop drawings are not required to depict supplemental reinforcing steel used to facilitate fabrication of products.

In lieu of shop drawings, furnish one copy of the following to the Engineer:

1. A copy of the Framing Plan with product designations for all superstructure components.
2. Strand detensioning schedule.
3. Tensioning and elongation calculations.
4. Details of supplemental steel that remains as part of the finished product.
5. Drawings, details and spacing for embedded items associated with fall protection systems used on beams.
6. When proposing to use materials and/or methods that differ from the requirements of the Contract Documents, submit full plan details and Specifications for the alternate materials and methods. Ensure the alternate materials and methods meet the following requirements:
   a. The provisions of the Contract Documents.
   b. The AASHTO LRFD Bridge Design Specifications, edition with interims as referenced in Plans.
   c. The recommendations of the material manufacturer.
   d. Any materials change proposed by the Contractor and approved by the Engineer.
   e. Net compressive stress in the concrete due to prestressing acting alone, after all losses, is not less than that provided by the stranding shown in the Plans.
   f. Ultimate strength of the structure with the proposed changes is not less than the ultimate strength of the original design.
   g. The provisions of the Departments Structures Design Guidelines.

SUBARTICLE 450-6.1 is deleted and the following substituted:

450-6.1 General: Use metal side and bottom forms, unless otherwise specified in the Contract Documents. For members with special shapes such as corner sheet piles, wood forms are permitted. Slab units and sheet piles may be cast on concrete surfaces meeting the profile dimensional tolerances of 450-6.3. Apply release agents in accordance with the manufacturer's recommendations. Liquid membrane curing compounds may be used to prevent bonding of slab products and sheet piles to the existing concrete surface, when applied in two or more coating. Ensure the last application of liquid membrane is applied immediately before placement of the slab or sheet pile.

For all beam members, use side forms designed to be removed without damaging the top flange of the beam. Remove the forms horizontally away from the beam by a method that prevents any contact of the form with the top flange after release of the form. Do not subject the top flange to any vertical force at any time. Include the form details and method of removal in the Producer QC Plan.

For all Florida-I Beams, use forms that do not have more than two horizontal joints.

Use void forms of a type for which service adequacy has been demonstrated, having sufficient strength to provide stability during handling and placing and to withstand hydrostatic pressures and other forces imposed upon them during concrete placement. Use form material that is neutral with respect to the generation of products harmful to the physical and structural properties of the concrete. Ensure that the presence of the form materials does not cause any detrimental effect to the concrete or other materials within the member. Positively vent all voids to the outside of the member. For end headers and inside forms, other materials capable of resisting the pressure from concrete are permitted*, except that end headers used with CFRP strands must be either timber headers or steel headers with rubber grommets to protect the CFRP strands from damage*.

Use end headers so designed that they can be placed and maintained in correct position between the side forms. Hold the headers in place with devices capable of being removed or loosened after the concrete has attained its initial set allowing free form expansion during curing methods that involve heat. Use end headers with openings conforming to the prestressing ~~steel~~ *strand* pattern to permit passage of the prestressing ~~steel~~*strand*. Locate the openings accurately within 1/8 inch of planned location of prestressing ~~steel~~ *strand* elements.

Construct circular openings for strands a maximum of 1/4 inch larger than the nominal strand diameter. Construct square or rectangular openings a maximum of 1/4 inch larger, horizontally and vertically, than the nominal strand diameter. Ensure that all headers are mortar tight.

ARTICLE 450-7 is deleted and the following substituted:

450-7 Protection and Placement of Prestressing ~~Steel~~*Strand*.

450-7.1 Protection of Prestressing ~~Steel~~*Strand*: Maintain and store prestressing steel above the ground surface on platforms, skids, or other supports, to prevent contamination from below, and protect them from mechanical injury. Do not use any packaging or wrapping material that retains moisture at the bottom of the reel. Clean contaminated prestressing ~~steel~~ *strand* before use or otherwise reject it. Handle prestressing ~~steel~~ *strand* carefully to prevent nicks or kinks. ~~and d~~*D*o not expose ~~it~~ *steel prestressing strand* to temperatures greater than 200ºF at any time. *Do not expose CRFP prestressing strand to temperatures greater than 120°F at any time.* Do not use arc welding equipment, including welding electrode lines, within 2 feet of prestressing *strand*~~steel~~. Do not perform any welding on forms that have been set in place after the prestressing *strand*~~steel~~ is placed in the bed. Reject prestressing *strand*~~steel~~ that has sustained any physical damage at any time.

450-7.2 Placing Prestressing *Strand*~~Steel~~: Use care during placement of prestressing *strand*~~steel~~ to avoid physical damage and contamination. Reject damaged strands. Do not use prestressing steel containing nicks, kinks, or former chuck grip marks. Do not use ~~steel~~

prestressing strand showing evidence of scale formation or which has become pitted. Remove and replace any damaged prestressing *strand*~~steel~~ in the bed.

450-7.3 Cleanliness of Prestressing *Strand*~~Steel~~: Inspect the prestressing *strand*~~steel~~ for any evidence of contamination. Use *strand*~~steel~~ that is free of deleterious materials such as grease, oil, wax, dirt, paint (except that used for marking identification) or other similar contaminants. Remove any contaminants detected from the *strand*~~steel~~ before proceeding with fabrication activities. Rust on prestressing steel that can be removed by light rubbing is acceptable. Streaks or spots which may remain after rust removal are acceptable if no pitting is present.

450-7.4 Debonded Strands: Extend the tubular debonding material (sheathing) through the header for debonded prestressing *strand*~~steel~~. Tie and tape the debonding material at the terminus located at the inside of the member. Seal openings between strand and sheathing for debonded strands with 100% silicone sealant within seven calendar days of detensioning. The sealing of openings between strand and sheathing is not required for beams with ends not be encased in permanent concrete diaphragms per 450-11.5 and strand protection per 450-11.6. Use sheathing that is tubular non-slit, high-density plastic with a minimum wall thickness of 0.025 inch, and an inside diameter exceeding the maximum outside diameter of the pretensioning strand by 0.025 inch to 0.14 inch, which does not react with concrete, coating, ~~or~~ steel*, or FRP* and prevents the intrusion of water or cement paste during concrete placement.

Do not use strands debonded over the full length of a product.

SUBARTICLE 450-8.2.1 is deleted and the following substituted:

450-8.2.1 General: The tensioning operations consist of the application of the final force or load which is the force required by the Plans and with the adjustments for abutment rotation, bed shortening, anchorage header movement, live end seating, dead end seating, splice chuck seating, friction in the jacking system and any other elements as applicable for the type of bed and anchorage being used. Also, adjust the force required by the Plans when the temperature differential between the ambient temperature at time of stressing and the expected concrete temperature at time of placement is greater than 25ºF. Increase the force at the rate of 1% for each 10ºF increment that the ambient temperature at time of stressing is below the expected concrete temperature at time of placing. Decrease the force at the rate of 1% for each 10ºF that the ambient temperature at time of stressing is above the expected concrete temperature at the time of placing. Do not allow the stress in the *steel* prestressing ~~steel~~ *strand* to exceed 80% of the specified tensile strength of the strand, after seating. *Do not allow the stress in the CFRP prestressing strand to exceed 65% of the specified tensile strength of the strand, after seating.* During each tensioning operation, for the verification of the live and dead end seating, check the seating of at least 4 strands or a minimum of 10% of the total number of strands, whichever is greater. Maintain a printed or manual record of the tensioning operation.

Compensation for temperature differential and abutment rotation are not required for self-stressing beds. However, adjust the final load for the effects of bed shortening due to the load from all the strands.

If the placement of concrete is delayed for more than seven calendar days after the completion of the stressing operation, check and adjust the final strand load as necessary before placement of concrete and maintain a printed or manual record of the stressing operation.

Accomplish tensioning by either single strand tensioning or multiple strand tensioning, and ensure that it is symmetrical about the vertical axis of the product. Tensioning methods, in general, consist of tensioning to the required loads indicated by the jacking system, or tensioning to the required load while monitoring the elongation of the prestressing *strand*~~steel~~.

SUBARTICLE 450-8.2.2 is deleted and the following substituted:

450-8.2.2 Single Straight Strand Tensioning: Apply an initial force of 5% to 25% of the final force to eliminate slack in the system. When single straight strand tensioning is used, tension the prestressing *strand*~~steel~~ until the required final force is attained. Measure and record the force and elongation.

SUBARTICLE 450-8.2.5 is deleted and the following substituted:

450-8.2.5 Wire Breakage:

450-8.2.5.1 Steel Prestressing Strand: Limit wire breakage to 2% of the total area of the strands in any product and verify that breakage is not indicative of a more extensive distress condition, otherwise reject all stranding. Replace individual strands with more than one wire failure.

450-8.2.5.2 FRP Prestressing Strand: *Replace individual strands with any wire failure.*

SUBARTICLE 450-8.2.6 is deleted and the following substituted:

450-8.2.6 Position of Prestressing ~~Steel~~*Strand*: Position prestressing *strand*~~steel~~ as shown in the Plans within the tolerances allowed in 450-2.1. Fix the required vertical and horizontal position of each prestressing strand at the ends of each product and at intervals within each product not exceeding 30 feet. Use the method of fixing the prestressing *strand*~~steel~~ shown in the Producer QC Plan. When blocks are to be used for supporting prestressing *strand*~~steel,~~ use those cast from concrete of the same mix design as used in the prestressed product. Stagger the location of blocks with an offset of 12 inches or greater and do not stack them.

ARTICLE 450-9 is deleted and replaced with the following:

450-9 Placement of Reinforcing ~~Steel~~ *Bars* and Other Embedded Materials.

450-9.1 Reinforcing *Bars* ~~Steel~~*and Supports*: Tie and/or support in position all reinforcing steel in each product with other reinforcing ~~steel~~ *bars* in a manner that will accurately position the ~~steel~~ *reinforcing bars* throughout the fabrication process. Use types of ties and methods of tying recommended by the CRSI, including lacing. Do not tie reinforcing ~~steel~~ *bars* to debonded prestressing ~~steel~~ *strands* within the limits of the sheathing material.

Tie or lace beam stirrup bars at a minimum of three points. Tie reinforcing ~~steel~~*bars*, other than stirrup bars in beam ends, as a minimum, at every other intersection. Either

tie or lace spiral*s* ~~wire~~ in piling at all four corners in the 1 inch pitch area, at the top corners and bottom center in the 3 inch pitch area, and at the top corners in the center area. Tie the bottom center in the pile center area as necessary to maintain concrete cover. Bend all tie*s* ~~wires~~ away from the form surface to provide maximum concrete cover.

When shown in the Plans, weld reinforcing steel in accordance with the requirements of AWS Structural Welding Code D 1.4. Do not weld in the prestressing bed.

450-9.2 Other Embedded Materials:

450-9.2.1 Inserts and Lifting Devices:

450-9.2.1.1 Placement: Locate inserts and lifting devices in accordance with the tolerances listed in 450-2.1. *Use only non-metallic inserts and lifting devices with CFRP reinforced piling.*

450-9.2.1.2 Corrosion Protection: Provide corrosion protection for embedded metal lifting devices that would remain exposed after construction.

After lifting operations using recessed metal*lic or non-metallic* lifting devices are complete, backfill block-outs with a Type F epoxy compound meeting the requirements of Section 926 for a minimum distance of 2 inches beyond the perimeter of the metal device as measured parallel to the exposed concrete surface. If the block-out extends less than 2 inches beyond the perimeter of the metal device, extend the epoxy compound beyond the block-out along the concrete surface. If Type 304 or 316 stainless steel lifting devices are used, non-shrink grout meeting the requirements of Section 934 may be used to backfill the block-out within its limits.

After lifting operations using flush or protruding metal*lic or non-metallic* lifting devices are complete, cut the lifting devices back to a minimum depth of 1 inch below the concrete surface and patch with a Type F epoxy compound meeting the requirements of Section 926. For all square prestressed piling, concrete sheet piling and concrete poles, cut and patch lifting devices before transporting from the casting yard.

450-9.2.2 Placement of Bearing Assemblies: Set bearing assemblies designed to transmit reaction forces to the concrete in the position shown in the Plans. Place bearing plate assemblies or shoes which are to be cast in a product within appropriate tolerances as provided in 450-2.1. Check the assemblies for position after stripping from the forms.

SUBARTICLE 450-10.1.2 is deleted and replaced with the following:

450-10.1.2 Hot Weather Concreting: Meet the requirements of Section 346 for temperature requirements and special measures for mixing concrete in hot weather.

Apply fog mist spray of water to prestressing strands, *steel* reinforcing ~~steel~~ *, FRP reinforcing,* and steel forms just before placing the concrete when the hot weather concreting special measures are in effect and the temperature of steel forms or reinforcing steel is greater than 120ºF.

SUBARTICLE 450-10.2 is deleted and the following substituted:

450-10.2 Protection of Concrete from Weather: Have protection materials available before the concrete placement begins to cover the products in the event of rain during the placement of concrete. Protection materials may be tarps, curing blankets, or other impervious

material that will not puncture when placed over protruding reinforcing ~~steel~~ and/or form elements. Include the method and materials for protection in the Producer QC Plan.

SUBARTICLE 450-10.3.1 is deleted and the following substituted:

450-10.3.1 General: Check forms, reinforcing ~~steel~~*bars*, prestressing *strand*~~steel~~, vent pipes, anchorages and other embedded items for compliance with the Contract Documents before placing concrete. Place concrete in accordance with 400-7, except as modified herein.

For concrete operations conducted at night, provide enough lighting to allow visual inspection of the interior of the forms during the complete concrete placement operation.

Convey concrete by the use of buckets, conveyors, pumps, troughs, or other equipment specifically designed for concrete conveyance, provided the placement method consistently produces quality concrete with no segregation or separation of the mix. Locate the concrete conveyance equipment within 12 inches of the top of the forms or surface of the concrete to minimize the free fall of the concrete.

Multiple placements may be used within a bedline, provided compliance with 450-11.1 is maintained.

SUBARTICLE 450-10.4 is deleted and the following substituted:

450-10.4 Vibration of Concrete: Except for self-consolidating concrete, consolidate concrete *in steel reinforced piling* by internal or external vibration, or combination of these methods. *For CFRP strand reinforced piling, use self-consolidating concrete without the use of vibration. If further consolidation is needed, manual rodding is permitted.*

Design external form vibrators for the specific use. Design forms used in conjunction with external vibration and build them to effectively transmit vibration to the concrete mass. Mount and operate form vibrators in compliance with the vibrator manufacturer's written recommendations, a copy of which must be on file at the prestressed concrete plant. Secure vibrators to the form mounts by positive locking devices so that maximum vibration is transmitted into the form. Modify or replace external form vibrator systems that are demonstrated to be ineffective. Operate vibrators at each mount location for the time necessary for complete concrete consolidation. Do not allow progressive points of vibration to exceed twice the visually effective radius of vibration. Keep forms equipped with external vibrators clean, and free of any buildup of hardened concrete.

Ensure internal vibrators are available before concrete placement is started. Use an internal vibrator with a head of such size that proper vibration of the concrete will be secured without causing movement of the prestressing ~~steel~~ *strand* or reinforcing ~~steel~~*bars*. The vibrating frequency range must be 8,000 to 15,000 impulses per minute. Have at least one standby vibrator available on-site. Insert the vibrator in the concrete at points spaced to ensure uniform vibration of the entire mass of the concrete. Do not allow points of insertions to be further apart than the radius over which the vibrator is visibly effective. Allow the vibrator to sink into the concrete by its own weight and allow it to penetrate into the underlying layers sufficiently so that the two layers are thoroughly consolidated together. After the concrete is thoroughly consolidated, slowly withdraw the vibrator to avoid formation of holes.

Revise the existing placement and consolidation procedure to improve the consolidation of the concrete, if the existing placement and consolidation procedure have produced unacceptable surface defects such as honeycombing, aggregate or mortar pockets, and excessive air bubbles.

SUBARTICLE 450-10.7.1 is deleted and the following substituted:

450-10.7.1 General: Use low-pressure steam curing, radiant heat curing or continuous moisture and heat curing. *Do not use low-pressure steam ~~curing~~ or radiant heat curing with CFRP piling.* If accelerated curing is completed before the curing period has elapsed, continue curing for the remaining part of the curing period in accordance with one of the curing methods above.

If accelerated curing is used, furnish and use temperature recording devices that will provide accurate, continuous, and permanent records of the time and temperature relationship of the enclosure and concrete throughout the entire curing period. Place the temperature recording sensors at a minimum of two locations, spaced approximately at or near the third point of bed length, to measure the temperatures of the enclosure and concrete. Initially calibrate recording thermometers and recalibrate them at least annually in accordance with manufacturer's recommendations. Place the sensors at the center of gravity of the bottom flanges for beams. Place the sensors at the center of gravity of the cross sections normal to pile length for solid piles, and at the midpoint of the wall thickness of the pile for voided piles.

When the ambient air temperature is equal to or higher than 50ºF, start the accelerated curing by supplying or retaining moisture and the application of the heat, following the initial set period of concrete. Determine the initial set time in accordance with ASTM C403. During the application of heat, do not allow the temperature rise in the concrete product to exceed 36ºF per hour. The maximum curing temperature of the enclosure or concrete must not exceed 150ºF. Maintain the maximum curing temperature uniform throughout the enclosure, with variation of not more than 20ºF from the maximum peak temperature until concrete reaches the required release strength. Allow the concrete element to cool gradually at the maximum cooling rate of 50ºF per hour and continue the cooling at this rate until the concrete temperature is 40ºF or less above the ambient temperature outside the curing enclosure.

When the ambient air temperature is below 50ºF cure the concrete in two stages. Start the accelerated curing of the first stage during the preset period by applying heat to increase the temperature of concrete at the maximum rate of 10ºF per hour. The total temperature gain of concrete during the initial set period cannot exceed 40ºF higher than the placement temperature, or 104ºF, whichever is less. Upon obtaining the initial set, continue curing as stated above for ambient temperature of 50ºF or higher. To prevent moisture loss on exposed surfaces during the preheating period, cover products as soon as possible after casting or keep the exposed surfaces wet by fog spray or wet blankets. Use enclosures for heat curing that allow free circulation of heat about the product and that are constructed to contain the heat with a minimum moisture loss. The use of tarpaulins or similar flexible covers may be used provided they are kept in good repair and secured in such a manner to prevent the loss of heat and moisture. Use enclosures that cover the entire bed from stressing abutment to stressing abutment, including all exposed stranding.

SUBARTICLE 450-11.3 is deleted and the following substituted:

450-11.3 Single Strand Detensioning: Detension the strand by using a low-oxygen flame in accordance with a pattern and schedule provided in the approved shop drawings, or Producer QC Plan, or described in 450-5. Heat with a low-oxygen flame played along the strand for a minimum of 5 inches. Heat strands in such a manner that the failure of the first wire in each strand will occur after the torch has been applied for a minimum of five seconds. Release strands in all prestressed products simultaneously and symmetrically about the vertical axis at both ends of the bed and at all intermediate points between products to minimize sliding of products. As an alternate, strands in piles, sheet piles, slabs and AASHTO Type II girders may be released simultaneously and symmetrically about the vertical axis at both ends of the bed until all the strands are released, then proceeding in order to intermediate points nearest the bed ends, or to the single remaining point at the center and release strands at these points in the same manner until all strands are released. *For CFRP strands coupled with steel strands, detension the steel strands first using the flame cutting process described above. At intermediate locations where CFRP strands are continuous between adjacent precast components, flame or shear cutting of the strands is not allowed.*

SUBARTICLE 450-11.5 is deleted and the following substituted:

450-11.5 Cutting Strands and Bars: Upon completion of the detensioning operation, cut *steel* strands to required length, using an oxygen flame or mechanical cutting device. Do not use electric arc welders to cut bars or *steel* strands. *Upon completion of the detensioning operation, cut* ~~*For*~~ *CFRP strands to the required length using a mechanical cutting device.* ~~,~~*Do not use flame or shear cutting* ~~*is not permitted*~~*to cut CFRP strands.*

450-11.5.1 Beams: For beam ends that will be permanently encased in concrete diaphragms, cut strands to 2.5 inches plus or minus 0.5 inch beyond the end of the product or as specified in the Plans. For beams with ends that will not be encased in permanent concrete diaphragms, mechanically cut strands a minimum of 1/8 inch below the concrete surface.

450-11.5.2 Piles: Mechanically cut strands flush with the concrete surface. For top (head) of fender piles and pile ends not embedded under final conditions, burn the strands a minimum of 1 inch below the concrete surface and clearly mark the pile to identify the top (head) end.

450-11.5.3 Poles: Mechanically cut strands to a minimum of 1/8 inch below the concrete surface.

SUBARTICLE 450-13.6 is deleted and the following substituted:

450-13.6 Removal and Restoration of Unsound Concrete: Carefully cut the area of unsound concrete to be repaired back perpendicular to (or slightly undercut from) the surface and to the depth of sound concrete or to a minimum depth of 1 inch, whichever is deeper. When reinforcing ~~steel~~*bars*, prestressing strand, inserts or weldments are exposed, remove the concrete from around the items to provide a 1 inch clearance all around. Coat the prepared surface with an approved epoxy bonding agent applied in accordance with the manufacturer's recommendations and then filled with an approved high-strength, non-metallic, non-shrink grout mixed and applied

in accordance with the manufacturer's recommendations. Firmly consolidate the grout mix in the area to be repaired. Restore surfaces and edges to the original dimensions and shape of the product.

ARTICLE 450-18 is deleted and the following substituted:

450-18 Basis of Payment.

Price and payment will be full compensation for all work and materials specified in this Section, including ~~steel~~ reinforcement, pretensioning ~~steel~~*strand*, embedded ducts, hardware, inserts and other materials as required, to fabricate, transport and place the product into its permanent position in the structure.

Payment for the items will be made under the following:

Item No. 450- 1-	Prestressed Beams - per foot.
Item No. 450- 2	Prestressed Beams: Florida-I Beams – per foot.
Item No. 450- 3-	Prestressed Slab Units - per foot.
Item No. 450- 4-	Prestressed Beam U-beams - per foot.
Item No. 450- 88-	Prestressed Slab Units Transversely Post-Tensioned - square foot.

PRECAST PRESTRESSED CONCRETE CONSTRUCTION.
(REV 11-16-15)

ARTICLE 450-1 is deleted and the following substituted:

450-1 Description.

Fabricate, store, transport and erect precast/prestressed concrete members prestressed by the pretensioning method. Pretensioned precast prestressed concrete products are products prestressed by the pretensioning method. In this method, steel or Fiber Reinforced Polymer (FRP) components are stressed and anchored; the concrete for the product is then cast and cured, and finally the stress in the steel or FRP components is released from the anchorages to the concrete through bond, after the concrete has attained its specified release strength.

A precast prestressed concrete plant, hereinafter called plant, is an independent operating facility capable of performing all the operations necessary to fabricate precast/prestressed concrete products.

Obtain precast/prestressed products from a plant that is currently on the Department's Production Facility Listing. Producers seeking inclusion on the list shall meet the requirements of Section 105.

When the plant's Quality Control Program is suspended, accept responsibility of either obtaining precast/prestressed products from a precast/prestressed concrete plant with an accepted Quality Control Program, or await re-approval of the Producer Quality Control Program. The Engineer will not allow changes in Contract Time or completion dates as a result of the concrete plant's Quality Control Program suspension. Accept responsibility for all delay costs or other costs associated with the plant's Quality Control Program suspension.

SUBARTICLE 450-2.1 is deleted and the following substituted:

450-2.1 General: Develop a Producer Quality Control Program as specified in Section 105.

Meet the requirements of the accepted Quality Control Program, Contract Documents, and Precast/Prestressed Concrete Institute (PCI) Manual for Quality Control for plants and production of structural precast concrete products. The requirements of the Contract Documents will govern, when there is a discrepancy between the PCI Manual and the Contract Documents.

Accept responsibility for performing daily Quality Control (QC) inspections of all phases of work ensuring all materials and workmanship incorporated into the product meet the requirements of the Contract Documents. Also, maintain a daily activity report detailing the results of the daily Quality Control Program activities. Ensure these daily reports and minutes of the weekly meetings with the Engineer and the plant's production personnel are maintained at the plant. During the weekly meetings, discuss the results of the QC inspections.

Inspect the product for conformance with the product dimension tolerances shown in Appendix B of PCI Manual MNL-116 (Manual for Quality Control for Plants and Production of Structural Precast Concrete Products), except as modified herein. Apply the tolerances with respect to the theoretical positions and dimensions shown in the Plans. Apply the same tolerances for U-Beams as those specified for I-girders, excluding sweep tolerance, when

inspecting the product for conformance with dimension tolerances. For Florida U-Beam diaphragms, the tolerance for the thickness of the intermediate and end diaphragms is plus 1 inch and minus 1/2 inch, and the location of intermediate diaphragms, relative to design plan positions, is plus or minus 3 inches. The tolerance of the thickness of end diaphragms shall be plus 3 inches and minus 1/2 inch.

Limit sweep to 1/2 inch for U-Beams and Inverted-T Beams. The maximum allowable sweep for I Beams is 1/8 inch per 10 foot length, but not to exceed 1.5 inch. The maximum allowable sweep for piling is 1/8 inch per 10 feet, but not to exceed 1.0 inch.

The tolerance for beam strand sheathing is plus or minus 2 inches.

Ensure the tolerance on all miscellaneous shaping including, but not limited to, chamfers, miters, bevels, keys, tapers, radii, holes, inserts, and block outs is within plus or minus 1/8 inch of the control dimension of the shape.

The tolerances represent the total allowable tolerance that will be accepted in the finished product. Do not apply tolerances shown for the overall dimensions of a member to violate the tolerances shown for positions of reinforcing and prestressing steel or FRP. Apply the tolerances during and after the fabrication of prestressed products. Do not reduce the concrete cover for reinforcing steel, FRP reinforcing, prestressing steel, FRP prestressing strands, or any other metallic objects specified in the Plans more than 1/4 inch. Do not reduce the concrete cover for reinforcing steel, FRP reinforcing, prestressing steel, FRP prestressing strands, or any other metallic or plastic objects when the cover specified in the Plans is minimum cover.

Ensure the QC inspector is present during concrete placements and performs inspection during all fabrication of precast prestressed concrete products, including the inspection of the operations before, during and after the placement of concrete.

Ensure the Plant QC Manager, or the QC inspectors under their direction, examine all precast prestressed concrete products within five working days of detensioning to ensure their dimensions conform to the specified tolerances and to determine if there are any deficiencies. This process control shall be listed on the Producer Quality Control Plan (QC Plan).

SUBARTICLE 450-2.4 is deleted and following substituted:

450-2.4 Documentation: Ensure that a system of records is maintained in each plant which will provide all information regarding the certification and testing of prestressing steel, FRP prestressing strands, reinforcing steel, FRP reinforcing, concrete materials and concrete, curing materials, embedded items, tensioning, concrete proportioning, pre-placement, placement, post-placement inspections, curing, and disposition of products. Include in the record keeping the deficiencies found as a result of the inspection and testing. Keep certified test reports for all materials incorporated into the production of precast prestressed concrete products.

Ensure that the printout or manual record of the tensioning operations is maintained and reflects the identification of the bed, type of fabricated products, the complete Financial Project Identification Number, jack identification number, date prestressing strands were stressed, temperature at the time of stressing, and signature of the qualified tensioning machine operator.

Ensure the proposed method and format for documenting required information is included in the Producer QC Plan.

Maintain records until all the precast prestressed products for a project have been fabricated then submit all the records to the Engineer. Ensure records are available at all times for the Engineer's inspection.

SUBARTICLE 450-3.1 is deleted and the following substituted:

450-3.1 General: Meet the following requirements:

Concrete .....Section 346
Steel Strands*.....Section 933
CFRP Strands*.....Section 933
Steel Prestressing Bars.....Section 933
Steel Accessories .....Section 933
Steel Spirals .....Section 931
Reinforcing Steel and Metal Welded Wire
Reinforcement..... Sections 415 and 931
FRP Reinforcing ..... Sections 415 and 931
FRP Spirals** .....Section 932
Embedded Ducts .....Section 960
Membrane Curing compounds***.....Section 925
Epoxy Resin Compounds.....Section 926
Burlap.....Section 925
Curing Blanket 400-16
Penetrant sealer*** .....Section 413
Methacrylate .....Section 413
Epoxy Injection of Cracks .....Section 411

* Do not use strands from more than one source in any individual prestressed element, with the exception of the partially tensioned strands (dormant strands).

** The FRP spirals cannot be used in combination with steel prestressing strand.

*** Use membrane curing compounds and sealers that are compatible with coating or other materials that are applied to concrete surface.

Use inserts in accordance with the recommendations of the manufacturers and within their certified capacities and application qualifications. Do not use aluminum inserts.

Use draped strand devices of sufficient rigidity having adequate support to retain the position of the strand unchanged under the induced load. Do not allow the devices to induce friction to the tendons such that the required jacking force and elongation cannot be attained.

SUBARTICLE 450-4.2 is deleted and the following substituted:

450-4.2 Reinforcing, Welded Wire Reinforcement and Prestressing Steel for Pretensioning:

450-4.2.1 General: Identify all reinforcing steel, welded wire reinforcement and prestressing strand for pretensioning by LOTs. A LOT of reinforcing steel or welded wire is a shipment of material from the same manufacturer and heat. A LOT of prestressing steel is a shipment of material of the same size, production grade and heat from the same manufacturer. A

LOT of FRP reinforcing bars or prestressing strands is a shipment of material of the same size, fiber lot and resin batch from the same manufacturer.

Acceptance of reinforcing bars, welded wire reinforcement and prestressing steel for pretensioning is based on manufacturer's certification and the Department's verification tests. The sampling for verification testing will be performed by the Department at each precast plant, on at least two LOTs per year, additional samples may be taken at the manufacturing source of reinforcing bar, welded wire reinforcement and prestressing strands.

When products contain the material that has failed to meet the requirements of 450-3, reject the unused material of the failed LOT. The Engineer may require the evaluation of the products, which contain the failed material, in accordance with 450-14.

450-4.2.2 Steel Reinforcing and Welded Wire Reinforcement: Obtain and maintain for each LOT a certified mill analysis, physical property test report and the manufacturer's assigned LOT number with the heat of the material represented. Verify that the report represents the steel received and that the steel meets the Contract Documents requirements. Reject all unidentified reinforcing steel or welded wire reinforcement received at the plant or job site.

Provide the manufacturer's certified mill analysis and three 7 foot long, randomly selected samples from the designated LOT of reinforcing steel and three randomly selected samples from the designated LOT of welded wire reinforcement when requested by Engineer. Ensure each sample of welded wire reinforcement covers an area of four intersections of transverse and longitudinal bars. Ensure the transverse wires of each piece of welded wire reinforcement extend approximately 6 inches to both sides.

450-4.2.3 FRP Reinforcing: Meet the requirements of 932-3.

450-4.2.4 Steel Prestressing Strandfor Pretensioning: Obtain and maintain for each LOT of material received, the manufacturer's assigned LOT number, certified test values for specified material properties together with a representative load-elongation curve and the modulus of elasticity value based upon strand nominal area. Provide and support by records maintained by the strand manufacturer, production tolerances applied in selection of the reported strand modulus. Verify that documents provided represent the shipment received and meets the Contract Documents requirements.

Reject all unidentified prestressing steel received at the plant or job site.

Provide the manufacturer's certified mill analysis and three 5 foot long randomly selected samples from the designated LOT of material when requested by the Engineer.

450-4.2.5 FRP Prestressing Strand for Pretensioning: Meet the requirements of 933-5.2.2.

450-4.2.6 Strand Chucks and Splice Chucks: Obtain and maintain certified test results certifying that the material meets the requirements of 450-3.

450-4.2.7 Steel Accessories: Use only steel accessories meeting the requirements of 450-3.

450-4.2.8 Ducts: Obtain and maintain certified test results certifying that the material meets the requirements of 450-3.

ARTICLE 450-5 is deleted and the following substituted:

450-5 Shop Drawings.

Submit shop drawings for all pretensioned prestressed concrete products containing FRP bars or strands. Submit shop drawings for all other pretensioned prestressed concrete products when the Contract Documents do not contain all the detailed information necessary to fabricate and erect the pretensioned prestressed concrete product. Ensure the submitted shop drawings meet the requirements of 5-1 and any additional Contract Document requirements.

Shop drawings are not required to depict supplemental reinforcing steel used to facilitate fabrication of products.

In lieu of shop drawings, furnish one copy of the following to the Engineer:

1. A copy of the Framing Plan with product designations for all superstructure components.
2. Strand detensioning schedule.
3. Tensioning and elongation calculations.
4. Details of supplemental steel that remains as part of the finished product.
5. Drawings, details and spacing for embedded items associated with fall protection systems used on beams.
6. When proposing to use materials and/or methods that differ from the requirements of the Contract Documents, submit full plan details and Specifications for the alternate materials and methods. Ensure the alternate materials and methods meet the following requirements:
   a. The provisions of the Contract Documents.
   b. The AASHTO LRFD Bridge Design Specifications, edition with interims as referenced in Plans.
   c. The recommendations of the material manufacturer.
   d. Any materials change proposed by the Contractor and approved by the Engineer.
   e. Net compressive stress in the concrete due to prestressing acting alone, after all losses, is not less than that provided by the stranding shown in the Plans.
   f. Ultimate strength of the structure with the proposed changes is not less than the ultimate strength of the original design.
   g. The provisions of the Departments Structures Design Guidelines.

SUBARTICLE 450-6.1 is deleted and the following substituted:

450-6.1 General: Use metal side and bottom forms, unless otherwise specified in the Contract Documents. For members with special shapes such as corner sheet piles, wood forms are permitted. Slab units and sheet piles may be cast on concrete surfaces meeting the profile dimensional tolerances of 450-6.3. Apply release agents in accordance with the manufacturer’s recommendations. Liquid membrane curing compounds may be used to prevent bonding of slab products and sheet piles to the existing concrete surface, when applied in two or more coating. Ensure the last application of liquid membrane is applied immediately before placement of the slab or sheet pile.

For all beam members, use side forms designed to be removed without damaging the top flange of the beam. Remove the forms horizontally away from the beam by a method that

prevents any contact of the form with the top flange after release of the form. Do not subject the top flange to any vertical force at any time. Include the form details and method of removal in the Producer QC Plan.

For all Florida-I Beams, use forms that do not have more than two horizontal joints.

Use void forms of a type for which service adequacy has been demonstrated, having sufficient strength to provide stability during handling and placing and to withstand hydrostatic pressures and other forces imposed upon them during concrete placement. Use form material that is neutral with respect to the generation of products harmful to the physical and structural properties of the concrete. Ensure that the presence of the form materials does not cause any detrimental effect to the concrete or other materials within the member. Positively vent all voids to the outside of the member. For end headers and inside forms, other materials capable of resisting the pressure from concrete are permitted, except that end headers used with CFRP strands must be either timber headers or steel headers with rubber grommets to protect the CFRP strands from damage.

Use end headers so designed that they can be placed and maintained in correct position between the side forms. Hold the headers in place with devices capable of being removed or loosened after the concrete has attained its initial set allowing free form expansion during curing methods that involve heat. Use end headers with openings conforming to the prestressing strand pattern to permit passage of the prestressing strand. Locate the openings accurately within 1/8 inch of planned location of prestressing strand elements.

Construct circular openings for strands a maximum of 1/4 inch larger than the nominal strand diameter. Construct square or rectangular openings a maximum of 1/4 inch larger, horizontally and vertically, than the nominal strand diameter. Ensure that all headers are mortar tight.

ARTICLE 450-7 is deleted and the following substituted:

450-7 Protection and Placement of Prestressing Strand.

450-7.1 Protection of Prestressing Strand: Maintain and store prestressing steel above the ground surface on platforms, skids, or other supports, to prevent contamination from below, and protect them from mechanical injury. Do not use any packaging or wrapping material that retains moisture at the bottom of the reel. Clean contaminated prestressing strand before use or otherwise reject it. Handle prestressing strand carefully to prevent nicks or kinks. Do not expose steel prestressing strand to temperatures greater than 200ºF at any time. Do not expose CRFP prestressing strand to temperatures greater than 120°F at any time. Do not use arc welding equipment, including welding electrode lines, within 2 feet of prestressing strand. Do not perform any welding on forms that have been set in place after the prestressing strand is placed in the bed. Reject prestressing strand that has sustained any physical damage at any time.

450-7.2 Placing Prestressing Strand: Use care during placement of prestressing strand to avoid physical damage and contamination. Reject damaged strands. Do not use prestressing steel containing nicks, kinks, or former chuck grip marks. Do not use prestressing strand showing evidence of scale formation or which has become pitted. Remove and replace any damaged prestressing strand in the bed.

450-7.3 Cleanliness of Prestressing Strand: Inspect the prestressing strand for any evidence of contamination. Use strand that is free of deleterious materials such as grease, oil,

wax, dirt, paint (except that used for marking identification) or other similar contaminants. Remove any contaminants detected from the strand before proceeding with fabrication activities. Rust on prestressing steel that can be removed by light rubbing is acceptable. Streaks or spots which may remain after rust removal are acceptable if no pitting is present.

450-7.4 Debonded Strands: Extend the tubular debonding material (sheathing) through the header for debonded prestressing strand. Tie and tape the debonding material at the terminus located at the inside of the member. Seal openings between strand and sheathing for debonded strands with 100% silicone sealant within seven calendar days of detensioning. The sealing of openings between strand and sheathing is not required for beams with ends not be encased in permanent concrete diaphragms per 450-11.5 and strand protection per 450-11.6. Use sheathing that is tubular non-slit, high-density plastic with a minimum wall thickness of 0.025 inch, and an inside diameter exceeding the maximum outside diameter of the pretensioning strand by 0.025 inch to 0.14 inch, which does not react with concrete, coating, steel, or FRP and prevents the intrusion of water or cement paste during concrete placement.

Do not use strands debonded over the full length of a product.

SUBARTICLE 450-8.2.1 is deleted and the following substituted:

450-8.2.1 General: The tensioning operations consist of the application of the final force or load which is the force required by the Plans and with the adjustments for abutment rotation, bed shortening, anchorage header movement, live end seating, dead end seating, splice chuck seating, friction in the jacking system and any other elements as applicable for the type of bed and anchorage being used. Also, adjust the force required by the Plans when the temperature differential between the ambient temperature at time of stressing and the expected concrete temperature at time of placement is greater than 25ºF. Increase the force at the rate of 1% for each 10ºF increment that the ambient temperature at time of stressing is below the expected concrete temperature at time of placing. Decrease the force at the rate of 1% for each 10ºF that the ambient temperature at time of stressing is above the expected concrete temperature at the time of placing. Do not allow the stress in the steel prestressing strand to exceed 80% of the specified tensile strength of the strand, after seating. Do not allow the stress in the CFRP prestressing strand to exceed 65% of the specified tensile strength of the strand, after seating. During each tensioning operation, for the verification of the live and dead end seating, check the seating of at least 4 strands or a minimum of 10% of the total number of strands, whichever is greater. Maintain a printed or manual record of the tensioning operation.

Compensation for temperature differential and abutment rotation are not required for self-stressing beds. However, adjust the final load for the effects of bed shortening due to the load from all the strands.

If the placement of concrete is delayed for more than seven calendar days after the completion of the stressing operation, check and adjust the final strand load as necessary before placement of concrete and maintain a printed or manual record of the stressing operation.

Accomplish tensioning by either single strand tensioning or multiple strand tensioning, and ensure that it is symmetrical about the vertical axis of the product. Tensioning methods, in general, consist of tensioning to the required loads indicated by the jacking system, or tensioning to the required load while monitoring the elongation of the prestressing strand.

SUBARTICLE 450-8.2.2 is deleted and the following substituted:

450-8.2.2 Single Straight Strand Tensioning: Apply an initial force of 5% to 25% of the final force to eliminate slack in the system. When single straight strand tensioning is used, tension the prestressing strand until the required final force is attained. Measure and record the force and elongation.

SUBARTICLE 450-8.2.5 is deleted and the following substituted:

450-8.2.5 Wire Breakage:

450-8.2.5.1 Steel Prestressing Strand: Limit wire breakage to 2% of the total area of the strands in any product and verify that breakage is not indicative of a more extensive distress condition, otherwise reject all stranding. Replace individual strands with more than one wire failure.

450-8.2.5.2 FRP Prestressing Strand: Replace individual strands with any wire failure.

SUBARTICLE 450-8.2.6 is deleted and the following substituted:

450-8.2.6 Position of Prestressing Strand: Position prestressing strand as shown in the Plans within the tolerances allowed in 450-2.1. Fix the required vertical and horizontal position of each prestressing strand at the ends of each product and at intervals within each product not exceeding 30 feet. Use the method of fixing the prestressing strand shown in the Producer QC Plan. When blocks are to be used for supporting prestressing strand use those cast from concrete of the same mix design as used in the prestressed product. Stagger the location of blocks with an offset of 12 inches or greater and do not stack them.

ARTICLE 450-9 is deleted and replaced with the following:

450-9 Placement of Reinforcing Bars and Other Embedded Materials.

450-9.1 Reinforcing Bars and Supports: Tie and/or support in position all reinforcing steel in each product with other reinforcing bars in a manner that will accurately position the reinforcing bars throughout the fabrication process. Use types of ties and methods of tying recommended by the CRSI, including lacing. Do not tie reinforcing bars to debonded prestressing strands within the limits of the sheathing material.

Tie or lace beam stirrup bars at a minimum of three points. Tie reinforcing bars, other than stirrup bars in beam ends, as a minimum, at every other intersection. Either tie or lace spirals in piling at all four corners in the 1 inch pitch area, at the top corners and bottom center in the 3 inch pitch area, and at the top corners in the center area. Tie the bottom center in the pile center area as necessary to maintain concrete cover. Bend all ties away from the form surface to provide maximum concrete cover.

When shown in the Plans, weld reinforcing steel in accordance with the requirements of AWS Structural Welding Code D 1.4. Do not weld in the prestressing bed.

450-9.2 Other Embedded Materials:

450-9.2.1 Inserts and Lifting Devices:

450-9.2.1.1 Placement: Locate inserts and lifting devices in accordance with the tolerances listed in 450-2.1. Use only non-metallic inserts and lifting devices with CFRP reinforced piling.

450-9.2.1.2 Corrosion Protection: Provide corrosion protection for embedded metal lifting devices that would remain exposed after construction.

After lifting operations using recessed metallic or non-metallic lifting devices are complete, backfill block-outs with a Type F epoxy compound meeting the requirements of Section 926 for a minimum distance of 2 inches beyond the perimeter of the metal device as measured parallel to the exposed concrete surface. If the block-out extends less than 2 inches beyond the perimeter of the metal device, extend the epoxy compound beyond the block-out along the concrete surface. If Type 304 or 316 stainless steel lifting devices are used, non-shrink grout meeting the requirements of Section 934 may be used to backfill the block-out within its limits.

After lifting operations using flush or protruding metallic or non-metallic lifting devices are complete, cut the lifting devices back to a minimum depth of 1 inch below the concrete surface and patch with a Type F epoxy compound meeting the requirements of Section 926. For all square prestressed piling, concrete sheet piling and concrete poles, cut and patch lifting devices before transporting from the casting yard.

450-9.2.2 Placement of Bearing Assemblies: Set bearing assemblies designed to transmit reaction forces to the concrete in the position shown in the Plans. Place bearing plate assemblies or shoes which are to be cast in a product within appropriate tolerances as provided in 450-2.1. Check the assemblies for position after stripping from the forms.

SUBARTICLE 450-10.1.2 is deleted and replaced with the following:

450-10.1.2 Hot Weather Concreting: Meet the requirements of Section 346 for temperature requirements and special measures for mixing concrete in hot weather.

Apply fog mist spray of water to prestressing strands, steel reinforcing , FRP reinforcing, and steel forms just before placing the concrete when the hot weather concreting special measures are in effect and the temperature of steel forms or reinforcing steel is greater than 120ºF.

SUBARTICLE 450-10.2 is deleted and the following substituted:

450-10.2 Protection of Concrete from Weather: Have protection materials available before the concrete placement begins to cover the products in the event of rain during the placement of concrete. Protection materials may be tarps, curing blankets, or other impervious material that will not puncture when placed over protruding reinforcing and/or form elements. Include the method and materials for protection in the Producer QC Plan.

SUBARTICLE 450-10.3.1 is deleted and the following substituted:

450-10.3.1 General: Check forms, reinforcing bars, prestressing strand, vent pipes, anchorages and other embedded items for compliance with the Contract Documents before placing concrete. Place concrete in accordance with 400-7, except as modified herein.

For concrete operations conducted at night, provide enough lighting to allow visual inspection of the interior of the forms during the complete concrete placement operation.

Convey concrete by the use of buckets, conveyors, pumps, troughs, or other equipment specifically designed for concrete conveyance, provided the placement method consistently produces quality concrete with no segregation or separation of the mix. Locate the concrete conveyance equipment within 12 inches of the top of the forms or surface of the concrete to minimize the free fall of the concrete.

Multiple placements may be used within a bedline, provided compliance with 450-11.1 is maintained.

SUBARTICLE 450-10.4 is deleted and the following substituted:

450-10.4 Vibration of Concrete: Except for self-consolidating concrete, consolidate concrete in steel reinforced piling by internal or external vibration, or combination of these methods. For CFRP strand reinforced piling, use self-consolidating concrete without the use of vibration. If further consolidation is needed, manual rodding is permitted.

Design external form vibrators for the specific use. Design forms used in conjunction with external vibration and build them to effectively transmit vibration to the concrete mass. Mount and operate form vibrators in compliance with the vibrator manufacturer’s written recommendations, a copy of which must be on file at the prestressed concrete plant. Secure vibrators to the form mounts by positive locking devices so that maximum vibration is transmitted into the form. Modify or replace external form vibrator systems that are demonstrated to be ineffective. Operate vibrators at each mount location for the time necessary for complete concrete consolidation. Do not allow progressive points of vibration to exceed twice the visually effective radius of vibration. Keep forms equipped with external vibrators clean, and free of any buildup of hardened concrete.

Ensure internal vibrators are available before concrete placement is started. Use an internal vibrator with a head of such size that proper vibration of the concrete will be secured without causing movement of the prestressing strand or reinforcing bars. The vibrating frequency range must be 8,000 to 15,000 impulses per minute. Have at least one standby vibrator available on-site. Insert the vibrator in the concrete at points spaced to ensure uniform vibration of the entire mass of the concrete. Do not allow points of insertions to be further apart than the radius over which the vibrator is visibly effective. Allow the vibrator to sink into the concrete by its own weight and allow it to penetrate into the underlying layers sufficiently so that the two layers are thoroughly consolidated together. After the concrete is thoroughly consolidated, slowly withdraw the vibrator to avoid formation of holes.

Revise the existing placement and consolidation procedure to improve the consolidation of the concrete, if the existing placement and consolidation procedure have produced unacceptable surface defects such as honeycombing, aggregate or mortar pockets, and excessive air bubbles.

SUBARTICLE 450-10.7.1 is deleted and the following substituted:

450-10.7.1 General: Use low-pressure steam curing, radiant heat curing or continuous moisture and heat curing. Do not use low-pressure steam or radiant heat curing with CFRP piling. If accelerated curing is completed before the curing period has elapsed, continue curing for the remaining part of the curing period in accordance with one of the curing methods above.

If accelerated curing is used, furnish and use temperature recording devices that will provide accurate, continuous, and permanent records of the time and temperature relationship of the enclosure and concrete throughout the entire curing period. Place the temperature recording sensors at a minimum of two locations, spaced approximately at or near the third point of bed length, to measure the temperatures of the enclosure and concrete. Initially calibrate recording thermometers and recalibrate them at least annually in accordance with manufacturer's recommendations. Place the sensors at the center of gravity of the bottom flanges for beams. Place the sensors at the center of gravity of the cross sections normal to pile length for solid piles, and at the midpoint of the wall thickness of the pile for voided piles.

When the ambient air temperature is equal to or higher than 50ºF, start the accelerated curing by supplying or retaining moisture and the application of the heat, following the initial set period of concrete. Determine the initial set time in accordance with ASTM C403. During the application of heat, do not allow the temperature rise in the concrete product to exceed 36ºF per hour. The maximum curing temperature of the enclosure or concrete must not exceed 150ºF. Maintain the maximum curing temperature uniform throughout the enclosure, with variation of not more than 20ºF from the maximum peak temperature until concrete reaches the required release strength. Allow the concrete element to cool gradually at the maximum cooling rate of 50ºF per hour and continue the cooling at this rate until the concrete temperature is 40ºF or less above the ambient temperature outside the curing enclosure.

When the ambient air temperature is below 50ºF cure the concrete in two stages. Start the accelerated curing of the first stage during the preset period by applying heat to increase the temperature of concrete at the maximum rate of 10ºF per hour. The total temperature gain of concrete during the initial set period cannot exceed 40ºF higher than the placement temperature, or 104ºF, whichever is less. Upon obtaining the initial set, continue curing as stated above for ambient temperature of 50ºF or higher. To prevent moisture loss on exposed surfaces during the preheating period, cover products as soon as possible after casting or keep the exposed surfaces wet by fog spray or wet blankets. Use enclosures for heat curing that allow free circulation of heat about the product and that are constructed to contain the heat with a minimum moisture loss. The use of tarpaulins or similar flexible covers may be used provided they are kept in good repair and secured in such a manner to prevent the loss of heat and moisture. Use enclosures that cover the entire bed from stressing abutment to stressing abutment, including all exposed stranding.

SUBARTICLE 450-11.3 is deleted and the following substituted:

450-11.3 Single Strand Detensioning: Detension the strand by using a low-oxygen flame in accordance with a pattern and schedule provided in the approved shop drawings, or

Producer QC Plan, or described in 450-5. Heat with a low-oxygen flame played along the strand for a minimum of 5 inches. Heat strands in such a manner that the failure of the first wire in each strand will occur after the torch has been applied for a minimum of five seconds. Release strands in all prestressed products simultaneously and symmetrically about the vertical axis at both ends of the bed and at all intermediate points between products to minimize sliding of products. As an alternate, strands in piles, sheet piles, slabs and AASHTO Type II girders may be released simultaneously and symmetrically about the vertical axis at both ends of the bed until all the strands are released, then proceeding in order to intermediate points nearest the bed ends, or to the single remaining point at the center and release strands at these points in the same manner until all strands are released. For CFRP strands coupled with steel strands, detension the steel strands first using the flame cutting process described above. At intermediate locations where CFRP strands are continuous between adjacent precast components, flame or shear cutting of the strands is not allowed.

SUBARTICLE 450-11.5 is deleted and the following substituted:

450-11.5 Cutting Strands and Bars: Upon completion of the detensioning operation, cut steel strands to required length, using an oxygen flame or mechanical cutting device. Do not use electric arc welders to cut bars or steel strands. Upon completion of the detensioning operation, cut CFRP strands to the required length using a mechanical cutting device. Do not use flame or shear cutting to cut CFRP strands.

450-11.5.1 Beams: For beam ends that will be permanently encased in concrete diaphragms, cut strands to 2.5 inches plus or minus 0.5 inch beyond the end of the product or as specified in the Plans. For beams with ends that will not be encased in permanent concrete diaphragms, mechanically cut strands a minimum of 1/8 inch below the concrete surface.

450-11.5.2 Piles: Mechanically cut strands flush with the concrete surface. For top (head) of fender piles and pile ends not embedded under final conditions, burn the strands a minimum of 1 inch below the concrete surface and clearly mark the pile to identify the top (head) end.

450-11.5.3 Poles: Mechanically cut strands to a minimum of 1/8 inch below the concrete surface.

SUBARTICLE 450-13.6 is deleted and the following substituted:

450-13.6 Removal and Restoration of Unsound Concrete: Carefully cut the area of unsound concrete to be repaired back perpendicular to (or slightly undercut from) the surface and to the depth of sound concrete or to a minimum depth of 1 inch, whichever is deeper. When reinforcing bars, prestressing strand, inserts or weldments are exposed, remove the concrete from around the items to provide a 1 inch clearance all around. Coat the prepared surface with an approved epoxy bonding agent applied in accordance with the manufacturer’s recommendations and then filled with an approved high-strength, non-metallic, non-shrink grout mixed and applied in accordance with the manufacturer’s recommendations. Firmly consolidate the grout mix in the area to be repaired. Restore surfaces and edges to the original dimensions and shape of the product.

ARTICLE 450-18 is deleted and the following substituted:

450-18 Basis of Payment.

Price and payment will be full compensation for all work and materials specified in this Section, including reinforcement, pretensioning strand, embedded ducts, hardware, inserts and other materials as required, to fabricate, transport and place the product into its permanent position in the structure.

Payment for the items will be made under the following:

Item No. 450- 1-	Prestressed Beams - per foot.
Item No. 450- 2	Prestressed Beams: Florida-I Beams – per foot.
Item No. 450- 3-	Prestressed Slab Units - per foot.
Item No. 450- 4-	Prestressed Beam U-beams - per foot.
Item No. 450- 88-	Prestressed Slab Units Transversely Post-Tensioned - square foot.