Florida Department of Transportation

RON DESANTIS
GOVERNOR

605 Suwannee Street
Tallahassee, FL 32399-0450

JARED W. PERDUE, P.E.
SECRETARY

November 2, 2023

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

Re: State Specifications Office
Section: 462
Proposed Specification: **4620702 Post-Tensioning.**
Associated with Proposed Specification: **9600202 Post-Tensioning Components.**

Dear Mr. Nguyen:

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

The changes are proposed by Ben Goldsberry to clarify language related to required anchorage cap positioning. This revision is associated with revision 9600202.

Please review and transmit your comments, if any, within two weeks (10 business days). Comments should be sent via email daniel.strickland@dot.state.fl.us.

If you have any questions relating to this specification change, please call me at (850) 414-4130.

Sincerely,

Signature on File

Daniel Strickland, P.E.
State Specifications Engineer

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

POST-TENSIONING.
(REV 4-19-23)

SUBARTICLE 462-7.2 is deleted and the following substituted:

462-7.2 System Installation:

Accurately and securely fasten all PT anchorages, ducts, inlet and outlet pipes, miscellaneous hardware, reinforcing bars, and other embedded items at locations shown in the Contract Documents or on approved shop or working drawings or as otherwise approved by the Engineer in writing.

If the anchorage caps will be fastened to the anchorage bearing plates, install the anchorages such that the top and bottom holes of the anchorage cap will form a vertical axis oriented 90 degrees from horizontal as required by 462-7.3.3.2.

462-7.2.1 Ducts:

1. Construct tendon ducts using the minimum number of splices as practical.

2. Accurately position and align ducts at locations shown in the Contract Documents, or according to approved shop or working drawings, or as approved in writing by the Engineer.

3. Securely fasten all internal ducts at regular intervals not exceeding 30 inches for steel pipes, 24 inches for round plastic ducts, and 12 inches for flat ducts to prevent movement, displacement, or damage from concrete placement and consolidation operations.

4. Show method and spacing of duct supports on appropriate shop drawings.

5. Ensure external tendon ducts are straight between connections to internal ducts at anchorages, diaphragms, and deviation saddles and are supported at intermediate locations according to the Contract Documents including approved shop drawings.

6. Ensure all alignments, including curves and straight portions, are smooth and continuous with no lips, kinks, or dents. This also applies to curves in pre-bent steel pipe.

7. Check and repair all ducts in accordance with 462-7.5 as necessary before placing any concrete.

8. Ensure ducts at end connections to anchorages, splices, inlets, outlets, drains, and all other duct openings are sealed at all times after installing ducts and until tendon installation is complete.

9. Provide an absolute seal of anchorage and duct termination locations per the approved system drawings.

10. Use of tape, caulking, epoxy or other sealants is not permitted to make connections or sealing for any reason.

11. Use heat welding techniques, in accordance with duct manufacturer's instructions, to make splices between sections of smooth plastic duct or make connection with electrofusion duct coupler as shown on the approved PT system shop drawings.

12. When connecting steel pipe to plastic pipe with a boot, use a 3/8 inches wide power seated band and clamps in accordance with 960-2.2 on each end of a duct boot to seal against filler leakage. Install band per manufacturer's instructions.

13. Ducts for prestressing used exclusively for temporary erection where PT will be removed from structure are not required to be coupled across segment joints.

14. Briefly open low point drains to allow for drainage of any water that may be present within the duct.

462-7.2.1.1 Installation Tolerances:

1. Ensure final position of PT ducts is within the tolerances in the following table:

Table 462-1
Duct Installation Tolerances

Type	Vertical Position (inches)	Horizontal Position (inches)
Horizontal tendons in slabs or in slab regions of larger members	±1/4	±1/2
Longitudinal draped superstructure tendons in webs: Tendon over supports or in middle third of span	±1/4	±1/4
Tendon in middle half of web depth	±1/2	±1/4
Longitudinal, generally horizontal, superstructure tendons usually in top or bottom of member	±1/4	±1/4
Horizontal tendons in substructures and foundations	±1/2	±1/2
Vertical tendons in web	Longitudinal Position ±1	Transverse Position ±1/4
Vertical tendons in pier shafts	±1/2	±1/4
All other cases	±1/4	±1/4

2. Ensure entrance and exit angles of tendon paths at anchorages, duct joints, and/or at faces of concrete are within plus or minus 3 degrees of desired angle measured in any direction.

3. Accomplish any deviations in alignment with smooth unkinked transitions.

4. Locate anchorages within plus or minus 1/4 inch of desired position laterally and plus or minus 1 inch along tendon except that minimum cover requirements must be maintained.

5. Position local zone anchorage confinement reinforcement in the form of spirals, multiple U-shaped bars, or links centered around duct and anchorage (±1/4 inch tolerance) and starting within 1/2 inch of the back of the main anchorage plate.

6. If conflicts exist between reinforcement and a PT duct/anchorage and other non-local zone reinforcement, the position of duct prevails. Adjust the non-local zone reinforcement with the Engineer's written approval.

462-7.2.2 Splices and Joints:

1. All splices, joints, couplings, connections (inlet and outlet), and valves are part of approved PT system.

2. Fabricate all duct splices to prevent duct kinks during concrete placement.

3. Use mandrels as needed to maintain duct alignment and shape.

462-7.2.3 Inlets, Outlets, Drains and Ports:

1. Place filler inlets, outlets, drains and ports at locations shown in the Contract Documents including approved shop drawings.

2. Equip all filler inlets, outlets, drains and ports with approved positive shut-off devices (e.g., valves).

3. At a minimum, place filler inlets, outlets or ports in the following positions and those shown in Standard Plans, Index 462-001:

a. Top of tendon anchorage;

b. Top and bottom of anchorage cap;

c. At high points of duct profile when vertical distance between highest and lowest point is more than 2 feet;

d. At major change in duct cross section; and,

e. At other locations required by the Engineer.

4. For all tendons other than grouted top slab transverse tendons in box girders, place drains at the geometric low points of all duct profiles, or as close as is practical to the geometric low points of all duct profiles, except where an inlet, outlet or anchorage that can serve as a drain is located at a low point. Locate drains, and inlets and outlets serving as drains, at the bottom of the duct cross section. Do not locate drains within the limits of diabolos.

5. Extend filler and drain tubes a sufficient distance out of concrete member to allow for proper closing of valves.

6. Direct inlets, outlets, drains and ports exiting on vertical or predominantly vertical surfaces of box and I-girders toward the inside face of exterior I-girders or toward the interior of box girders.

462-7.2.4 Tendons:

1. Store the PT tendon in such a way that it remains completely dry and free of moisture prior to installation within the duct.

2. Do not exceed 14 calendar days between first installation of PT strand within duct and completion of the stressing and filler injection operation.

3. Do not exceed 21 calendar days between the first installation of PT bars within duct and completion of the stressing and filler injection operations.

4. With written approval of the Engineer, the maximum number of calendars days allowed between the first installation of the PT tendon within the duct and completion of the stressing and filler injection operations is 30 for PT strand and 45 for PT bars by monitoring and continuously maintaining the relative humidity of air within the duct below 40%. Use a closed dehumidification system or other means approved by the Engineer. The dehumidification system must be installed and operational within 24 hours of first installation of the PT tendon within the duct and remain operational until just prior to filler injection.

5. The use of temporary corrosion inhibitor powder is not permitted as a method to increase the allowed number of calendar days between the first installation of the PT tendon within the duct and completion of the stressing and filler injection operations.

6. Any light surface corrosion forming during the period of time described in (1), (2), (3) or (4) of this Article will not be cause for rejection of the PT tendon.

7. Failure to inject filler into duct within the number of calendar days specified, will result in stoppage of work, except when waived by the Engineer in writing.

8. Just prior to PT tendon installation, briefly open low point drains to allow for drainage of any water that may be present within the duct. Close all low point drains and ports except the inlet and outlet ports at the anchorage caps. Blow oil-free dry compressed air meeting ASTM D4285 through one of the anchorage cap ports until the relative humidity measured at the inlet and outlet ends are less than 40% and continuing blowing for an additional 30 minutes. Stop blowing, wait a minimum of 15 minutes, and take humidity measurements at the inlet and outlet ends of blowing. Further blowing is not required if both humidity readings are less than 40%. If the humidity readings are 40% or greater, then repeat the process of blowing and waiting for 15 minutes until the humidity measurements at the inlet and outlet end of blowing are less than 40%. Take humidity measurements of air within the duct at the inlet end and outlet end of blowing using separate humidity meters. Use humidity meters approved by the Engineer.

9. Provide visual confirmation that the duct is free of water, moisture, and debris at the anchorages and low points of the tendon profile before installing the PT tendon within the duct.

10. Flushing of filler is not permitted without written approval of the Engineer and is only permitted as defined in this Article.

11. For grouted operations, vacuum injection is required to repair all voids and blockages as subject to provisions of 462-8.3.2. For flexible filler operations, use the repair procedure described in the approved Wax Injection Operations Plan.

12. For tendon ducts subjected to contamination with chlorides (e.g., uncapped ducts that have been subjected to salt spray), flush duct with potable water containing slack lime (i.e., calcium hydroxide) or quicklime (i.e., calcium oxide) in the amount of 0.17 pounds per gallon.

a. Test for presence of chlorides and oils in discharged water before placing tendon.

b. If chloride levels in flush water outflow exceed 300 ppm, continue to flush duct until chloride level in flush water outflow is below 250 ppm.

c. After the chloride level of flush water is below 250 ppm, open low point drains to allow for drainage of flush water within the duct. Perform the blowing process described in (8) of this Article. Provide visual confirmation that the duct is free of water and moisture for its entire length before installing the PT tendon within the duct.

13. Push or pull strands and wires through ducts to make up a tendon using methods that will not snag on any lips or joints in ducts.

14. Round off end of strands and wires that are pushed or fit advancing end with smooth protective cap.

15. Do not intentionally rotate strands or wires by any mechanical means during installation of PT strand into duct.

16. For superstructure tendons, provide sufficient strand and wire length beyond dead end anchorages to allow for second end stressing as needed for reconciliation of jacking force versus measured elongation.

17. Alternatively, tendons may be pulled through duct using a special steel wire sock or other device attached to advancing end. Strands may be brazed together for pulling as long as one foot of strand from the brazed end is removed by cutting after installation. Do not electric arc weld strand ends together for this purpose.

18. Cut tendons in accordance with 462-7.3.2.7.

19. Strand installation aids (i.e. wire/nylon ties around strand bundle, strand spacers, etc.) must be removed prior to stressing

20. Do not install permanent tendons before completion of testing as required by this Section or the Contract Documents. The only two exceptions are:

a. Tendon to be tested by "Theoretical Elongation Verification" may be installed for test; and,

b. Transverse tendons may be pre-installed in precast segmental boxes prior to concrete casting such that they meet 462-8.3.1.

SUBARTICLE 462-7.3.2 is deleted and the following substituted:

462-7.3.2 Stressing Tendons:

1. Tension all PT steel so PT force is not less than that required by the Contract Documents or as otherwise approved by the Engineer in writing.

2. Do not use monostrand jacks to stress straight tendons with five or more strands or wires, or for curved tendons with two or more strands or wires.

3. 4-strand curved top slab transverse tendons in box girders are permitted to use a monostrand jack.

4. Use of curved stressing noses or chairs is not permitted.

5. If the anchorage caps will be fastened to the wedge plates, maintain the position of both the stressing end and dead end wedge plates throughout the jacking process such that the top and bottom holes of the anchorage cap will form a vertical axis oriented 90 degrees from horizontal as required by 462-7.3.3.2.

462-7.3.2.1 Jacking Maximum Stress:

Maximum temporary stress (i.e., jacking stress) in PT steel must not exceed 80% and 75% of Guaranteed Ultimate Tensile Strength (GUTS) for PT strands and bars, respectively. The maximum temporary jacking stress must not exceed 50% of GUTS for PT bars that will be reused.

462-7.3.2.2 Initial and Permanent Stresses:

1. PT steel must be anchored at initial stresses resulting in long term retention of permanent stresses or forces of no less than those shown in the Contract Documents.

2. Unless otherwise approved by the Engineer in writing, initial stress after anchor set must not exceed 70% of GUTS at anchorages and 74% of GUTS at all other locations between anchorages.

3. Permanent stress and permanent force are stress and force remaining in PT steel after all losses, including long term creep and shrinkage of concrete, elastic shortening of concrete, relaxation of steel, losses in PT steel from sequence of stressing, friction, and unintended wobble of ducts, anchor set, friction in anchorages, and all other losses particular to the specific PT system.

462-7.3.2.3 Stressing Sequence:

1. Permanent PT tendons must be stressed from both ends, except as noted in the Contract Documents.

2. Required force may be applied at one end and subsequently at other end or simultaneously at both ends.

462-7.3.2.4 Elongation:

1. Ensure forces being applied to tendon and resulting elongation of tendon can be measured at all times.

2. Measure elongations to nearest 1/16 inch.

3. For required tendon force, observed elongation must agree within 7% of theoretical elongation or entire operation must be halted, checked, and source of error determined and remedied to satisfaction of the Engineer before proceeding.

4. Do not overstress tendon to achieve theoretical elongation.

5. If agreement between observed and theoretical elongations at the required force falls outside acceptable tolerances, additional tests may be required, at the Engineer's discretion and without additional compensation to the Contractor, for Tendon Modulus of Elasticity and/or In Place Wobble and Friction Test, or Lift-Off Test.

462-7.3.2.5 Friction:

1. Provide actual expected friction and wobble coefficients and anchor set in the shop drawings; submit calculations and show a typical tendon force diagram on shop drawings based upon expected actual coefficients and values for the PT system to be used.

2. Graphite may be used as a lubricant when friction must be reduced, subject to written approval of the Engineer.

462-7.3.2.6 Tendon Wire Failure:

1. Multi-strand PT tendons with wires which fail by breaking or slipping during stressing may be accepted provided these conditions are met:

a. Completed structure has a final PT force of at least 98% of original total design PT force;

b. PT force across a mating joint is at least 98% of PT force required by the Contract Documents for that mating joint for that stage of construction for precast or cast-in-place segmental construction. This 98% minimum PT force requirement applies to segmental construction, or any similar construction, that has members post-tensioned together across a common joint face at any stage of construction; and,

c. Any single tendon must have no more than a 5% reduction in cross-sectional area of PT steel due to wire failure.

2. When conditions permit the Contractor to propose acceptable alternative means of restoring PT force lost due to wire failure, any of the above conditions may be waived at discretion of and with approval of the Engineer in writing.

462-7.3.2.7 Cutting of PT Steel:

1. Cut PT steel using an abrasive saw or plasma torch within 3/4 inches to 1-1/2 inches away from the anchorage.

2. Flame cutting of PT steel is not permitted.

3. Do not cut tendon to final length prior to acceptance.

462-7.3.2.8 Post-Tensioning Operations Record:

1. Keep a record of these PT operations for each tendon installed:

a. Project name, Financial Project ID (FPID);

b. Contractor and/or subcontractor;

c. Tendon location, size, and type;

d. Date tendon was first installed in duct;

e. Reel number for strands and wires and heat number for bars;

f. Tendon cross-sectional area;

g. Modulus of elasticity;
h. Date stressed;
i. Jack and Gauge numbers per tendon end;
j. Required jacking force;
k. Gauge pressures at the pump and at the inlet;
l. Elongations (theoretical and actual);
m. Anchor sets (anticipated and actual);
n. Stressing sequence (i.e., sequential order of tendon stressing by number);
o. Stressing mode (single-end, dual-end, simultaneous);
p. Witnesses to stressing operations (Contractor and Inspector);
q. Any other relevant information.

2. Submit to the Engineer a complete set of stressing operation records within five days of completed tendon installation.

SUBARTICLE 462-7.3.3.2 is deleted and the following substituted:

462-7.3.3.2 Anchorage:

1. Install the anchorage cap such that the top and bottom holes form a vertical axis oriented 90 degrees from horizontal.

~~1~~2. Provide the following at anchorages as shown on Standard Plans, Index 462-002:

a. Temporary drain holes at the bottom of open top blockouts.

b. Temporary weatherproof plugs for upwardly oriented access or vent holes.

~~2~~3. Cap all filler inlets/outlets with plugs meeting the requirements of Section 960.

~~3~~4. Construct anchorage pour-backs and place elastomeric coatings at anchorages as indicated in the Contract Documents and as shown on Standard Plans, Index 462-002 within seven days of completing filler injection operations (see 462-7.4 for filler injection operations). For anchorages which require acrylic aliphatic polyurethane top coating, apply the acrylic aliphatic polyurethane top coating after the elastomeric coating has fully cured. See Standard Plans Index 462-002 and the Contract Documents for details on anchorages which require acrylic aliphatic polyurethane top coating. Construct anchorage pour-backs using reinforced concrete, magnesium ammonium phosphate concrete, or a Type Q epoxy grout meeting the requirements of Section 926.

a. Remove all laitance, grease, curing compounds, surface treatments, coatings, and oils by grit blasting or water blasting. Flush surface with water and blow dry. Surfaces must be clean, sound, and without any standing water. Test substrate at all pour-back locations using ACI 503 and develop a minimum of 175 psi tension (e.g., pull-off value). Testing frequency may be reduced, as determined by the Engineer, after the Contractor has demonstrated an ability to prepare substrate surfaces for bonding as indicated by the result of the ACI 503 test.

b. Mix and apply epoxy grout and magnesium ammonium phosphate concrete in accordance with the manufacturer's current standard technical guidelines. Construct all pour-backs in leak proof forms creating neat lines. Epoxy grout may require pumping for proper installation. Construct forms to maintain a liquid head to ensure intimate contact with concrete surface. Use vents as needed to provide for escape of air to ensure complete filling of forms.

45. Coat exposed surfaces of pour-backs and anchorage caps as shown on Standard Plans, Index 462-002 with an elastomeric coating system meeting the requirements of Section 975 and having a thickness of 30 mils to 45 mils. Apply the acrylic aliphatic polyurethane top coating to a dry film thickness of 5 to 6 mils. Ensure concrete, anchorage caps, or other substrates are structurally sound, clean, and dry. Concrete must be a minimum of 28 days old. Remove all laitance, grease, curing compounds, surface treatments, coatings, and oils by grit blasting or water blasting using a minimum 3,000 psi nozzle pressure. Blow surface with compressed air to remove dust or water. Apply the elastomeric coating within 90 days of filler injection. Apply the acrylic aliphatic polyurethane top coat and the manufacturer's approved primer over the elastomeric coating before applying Class 5 coating, if required.

56. Prior to application of elastomeric coating, construct a 2 foot x 4 foot concrete test block with a similar surface texture to surfaces to be coated. Coat a vertical face with chosen elastomeric coating system. Determine number of coats required to achieve the specified thickness without runs and drips. Mix and apply elastomeric coating as per manufacturer's current standard technical specifications. Spray application is preferred; roller application is permitted. Have coating manufacturer representative on site to supervise and comment on application of elastomeric coating onto test block. Apply coating using approved and experienced personnel with a minimum of three years experience applying similar polyurethane systems. Submit credentials of these persons to the Engineer for review and consideration for approval.

POST-TENSIONING.
(REV 4-19-23)

SUBARTICLE 462-7.2 is deleted and the following substituted:

462-7.2 System Installation:

Accurately and securely fasten all PT anchorages, ducts, inlet and outlet pipes, miscellaneous hardware, reinforcing bars, and other embedded items at locations shown in the Contract Documents or on approved shop or working drawings or as otherwise approved by the Engineer in writing.

If the anchorage caps will be fastened to the anchorage bearing plates, install the anchorages such that the top and bottom holes of the anchorage cap will form a vertical axis oriented 90 degrees from horizontal as required by 462-7.3.3.2.

462-7.2.1 Ducts:

1. Construct tendon ducts using the minimum number of splices as practical.

2. Accurately position and align ducts at locations shown in the Contract Documents, or according to approved shop or working drawings, or as approved in writing by the Engineer.

3. Securely fasten all internal ducts at regular intervals not exceeding 30 inches for steel pipes, 24 inches for round plastic ducts, and 12 inches for flat ducts to prevent movement, displacement, or damage from concrete placement and consolidation operations.

4. Show method and spacing of duct supports on appropriate shop drawings.

5. Ensure external tendon ducts are straight between connections to internal ducts at anchorages, diaphragms, and deviation saddles and are supported at intermediate locations according to the Contract Documents including approved shop drawings.

6. Ensure all alignments, including curves and straight portions, are smooth and continuous with no lips, kinks, or dents. This also applies to curves in pre-bent steel pipe.

7. Check and repair all ducts in accordance with 462-7.5 as necessary before placing any concrete.

8. Ensure ducts at end connections to anchorages, splices, inlets, outlets, drains, and all other duct openings are sealed at all times after installing ducts and until tendon installation is complete.

9. Provide an absolute seal of anchorage and duct termination locations per the approved system drawings.

10. Use of tape, caulking, epoxy or other sealants is not permitted to make connections or sealing for any reason.

11. Use heat welding techniques, in accordance with duct manufacturer’s instructions, to make splices between sections of smooth plastic duct or make connection with electrofusion duct coupler as shown on the approved PT system shop drawings.

12. When connecting steel pipe to plastic pipe with a boot, use a 3/8 inches wide power seated band and clamps in accordance with 960-2.2 on each end of a duct boot to seal against filler leakage. Install band per manufacturer’s instructions.

13. Ducts for prestressing used exclusively for temporary erection where PT will be removed from structure are not required to be coupled across segment joints.

14. Briefly open low point drains to allow for drainage of any water that may be present within the duct.

462-7.2.1.1 Installation Tolerances:

1. Ensure final position of PT ducts is within the tolerances in the following table:

Table 462-1
Duct Installation Tolerances

Type	Vertical Position (inches)	Horizontal Position (inches)
Horizontal tendons in slabs or in slab regions of larger members	±1/4	±1/2
Longitudinal draped superstructure tendons in webs: Tendon over supports or in middle third of span	±1/4	±1/4
Tendon in middle half of web depth	±1/2	±1/4
Longitudinal, generally horizontal, superstructure tendons usually in top or bottom of member	±1/4	±1/4
Horizontal tendons in substructures and foundations	±1/2	±1/2
Vertical tendons in web	Longitudinal Position ±1	Transverse Position ±1/4
Vertical tendons in pier shafts	±1/2	±1/4
All other cases	±1/4	±1/4

2. Ensure entrance and exit angles of tendon paths at anchorages, duct joints, and/or at faces of concrete are within plus or minus 3 degrees of desired angle measured in any direction.

3. Accomplish any deviations in alignment with smooth unkinked transitions.

4. Locate anchorages within plus or minus 1/4 inch of desired position laterally and plus or minus 1 inch along tendon except that minimum cover requirements must be maintained.

5. Position local zone anchorage confinement reinforcement in the form of spirals, multiple U-shaped bars, or links centered around duct and anchorage (±1/4 inch tolerance) and starting within 1/2 inch of the back of the main anchorage plate.

6. If conflicts exist between reinforcement and a PT duct/anchorage and other non-local zone reinforcement, the position of duct prevails. Adjust the non-local zone reinforcement with the Engineer's written approval.

462-7.2.2 Splices and Joints:

1. All splices, joints, couplings, connections (inlet and outlet), and valves are part of approved PT system.

2. Fabricate all duct splices to prevent duct kinks during concrete placement.

3. Use mandrels as needed to maintain duct alignment and shape.

462-7.2.3 Inlets, Outlets, Drains and Ports:

1. Place filler inlets, outlets, drains and ports at locations shown in the Contract Documents including approved shop drawings.

2. Equip all filler inlets, outlets, drains and ports with approved positive shut-off devices (e.g., valves).

3. At a minimum, place filler inlets, outlets or ports in the following positions and those shown in Standard Plans, Index 462-001:

a. Top of tendon anchorage;

b. Top and bottom of anchorage cap;

c. At high points of duct profile when vertical distance between highest and lowest point is more than 2 feet;

d. At major change in duct cross section; and,

e. At other locations required by the Engineer.

4. For all tendons other than grouted top slab transverse tendons in box girders, place drains at the geometric low points of all duct profiles, or as close as is practical to the geometric low points of all duct profiles, except where an inlet, outlet or anchorage that can serve as a drain is located at a low point. Locate drains, and inlets and outlets serving as drains, at the bottom of the duct cross section. Do not locate drains within the limits of diabolos.

5. Extend filler and drain tubes a sufficient distance out of concrete member to allow for proper closing of valves.

6. Direct inlets, outlets, drains and ports exiting on vertical or predominantly vertical surfaces of box and I-girders toward the inside face of exterior I-girders or toward the interior of box girders.

462-7.2.4 Tendons:

1. Store the PT tendon in such a way that it remains completely dry and free of moisture prior to installation within the duct.

2. Do not exceed 14 calendar days between first installation of PT strand within duct and completion of the stressing and filler injection operation.

3. Do not exceed 21 calendar days between the first installation of PT bars within duct and completion of the stressing and filler injection operations.

4. With written approval of the Engineer, the maximum number of calendars days allowed between the first installation of the PT tendon within the duct and completion of the stressing and filler injection operations is 30 for PT strand and 45 for PT bars by monitoring and continuously maintaining the relative humidity of air within the duct below 40%. Use a closed dehumidification system or other means approved by the Engineer. The dehumidification system must be installed and operational within 24 hours of first installation of the PT tendon within the duct and remain operational until just prior to filler injection.

5. The use of temporary corrosion inhibitor powder is not permitted as a method to increase the allowed number of calendar days between the first installation of the PT tendon within the duct and completion of the stressing and filler injection operations.

6. Any light surface corrosion forming during the period of time described in (1), (2), (3) or (4) of this Article will not be cause for rejection of the PT tendon.

7. Failure to inject filler into duct within the number of calendar days specified, will result in stoppage of work, except when waived by the Engineer in writing.

8. Just prior to PT tendon installation, briefly open low point drains to allow for drainage of any water that may be present within the duct. Close all low point drains and ports except the inlet and outlet ports at the anchorage caps. Blow oil-free dry compressed

air meeting ASTM D4285 through one of the anchorage cap ports until the relative humidity measured at the inlet and outlet ends are less than 40% and continuing blowing for an additional 30 minutes. Stop blowing, wait a minimum of 15 minutes, and take humidity measurements at the inlet and outlet ends of blowing. Further blowing is not required if both humidity readings are less than 40%. If the humidity readings are 40% or greater, then repeat the process of blowing and waiting for 15 minutes until the humidity measurements at the inlet and outlet end of blowing are less than 40%. Take humidity measurements of air within the duct at the inlet end and outlet end of blowing using separate humidity meters. Use humidity meters approved by the Engineer.

9. Provide visual confirmation that the duct is free of water, moisture, and debris at the anchorages and low points of the tendon profile before installing the PT tendon within the duct.

10. Flushing of filler is not permitted without written approval of the Engineer and is only permitted as defined in this Article.

11. For grouted operations, vacuum injection is required to repair all voids and blockages as subject to provisions of 462-8.3.2. For flexible filler operations, use the repair procedure described in the approved Wax Injection Operations Plan.

12. For tendon ducts subjected to contamination with chlorides (e.g., uncapped ducts that have been subjected to salt spray), flush duct with potable water containing slack lime (i.e., calcium hydroxide) or quicklime (i.e., calcium oxide) in the amount of 0.17 pounds per gallon.

a. Test for presence of chlorides and oils in discharged water before placing tendon.

b. If chloride levels in flush water outflow exceed 300 ppm, continue to flush duct until chloride level in flush water outflow is below 250 ppm.

c. After the chloride level of flush water is below 250 ppm, open low point drains to allow for drainage of flush water within the duct. Perform the blowing process described in (8) of this Article. Provide visual confirmation that the duct is free of water and moisture for its entire length before installing the PT tendon within the duct.

13. Push or pull strands and wires through ducts to make up a tendon using methods that will not snag on any lips or joints in ducts.

14. Round off end of strands and wires that are pushed or fit advancing end with smooth protective cap.

15. Do not intentionally rotate strands or wires by any mechanical means during installation of PT strand into duct.

16. For superstructure tendons, provide sufficient strand and wire length beyond dead end anchorages to allow for second end stressing as needed for reconciliation of jacking force versus measured elongation.

17. Alternatively, tendons may be pulled through duct using a special steel wire sock or other device attached to advancing end. Strands may be brazed together for pulling as long as one foot of strand from the brazed end is removed by cutting after installation. Do not electric arc weld strand ends together for this purpose.

18. Cut tendons in accordance with 462-7.3.2.7.

19. Strand installation aids (i.e. wire/nylon ties around strand bundle, strand spacers, etc.) must be removed prior to stressing

20. Do not install permanent tendons before completion of testing as required by this Section or the Contract Documents. The only two exceptions are:

a. Tendon to be tested by "Theoretical Elongation Verification" may be installed for test; and,

b. Transverse tendons may be pre-installed in precast segmental boxes prior to concrete casting such that they meet 462-8.3.1.

SUBARTICLE 462-7.3.2 is deleted and the following substituted:

462-7.3.2 Stressing Tendons:

1. Tension all PT steel so PT force is not less than that required by the Contract Documents or as otherwise approved by the Engineer in writing.

2. Do not use monostrand jacks to stress straight tendons with five or more strands or wires, or for curved tendons with two or more strands or wires.

3. 4-strand curved top slab transverse tendons in box girders are permitted to use a monostrand jack.

4. Use of curved stressing noses or chairs is not permitted.

5. If the anchorage caps will be fastened to the wedge plates, maintain the position of both the stressing end and dead end wedge plates throughout the jacking process such that the top and bottom holes of the anchorage cap will form a vertical axis oriented 90 degrees from horizontal as required by 462-7.3.3.2.

462-7.3.2.1 Jacking Maximum Stress:

Maximum temporary stress (i.e., jacking stress) in PT steel must not exceed 80% and 75% of Guaranteed Ultimate Tensile Strength (GUTS) for PT strands and bars, respectively. The maximum temporary jacking stress must not exceed 50% of GUTS for PT bars that will be reused.

462-7.3.2.2 Initial and Permanent Stresses:

1. PT steel must be anchored at initial stresses resulting in long term retention of permanent stresses or forces of no less than those shown in the Contract Documents.

2. Unless otherwise approved by the Engineer in writing, initial stress after anchor set must not exceed 70% of GUTS at anchorages and 74% of GUTS at all other locations between anchorages.

3. Permanent stress and permanent force are stress and force remaining in PT steel after all losses, including long term creep and shrinkage of concrete, elastic shortening of concrete, relaxation of steel, losses in PT steel from sequence of stressing, friction, and unintended wobble of ducts, anchor set, friction in anchorages, and all other losses particular to the specific PT system.

462-7.3.2.3 Stressing Sequence:

1. Permanent PT tendons must be stressed from both ends, except as noted in the Contract Documents.

2. Required force may be applied at one end and subsequently at other end or simultaneously at both ends.

462-7.3.2.4 Elongation:

1. Ensure forces being applied to tendon and resulting elongation of tendon can be measured at all times.

2. Measure elongations to nearest 1/16 inch.

3. For required tendon force, observed elongation must agree within 7% of theoretical elongation or entire operation must be halted, checked, and source of error determined and remedied to satisfaction of the Engineer before proceeding.

4. Do not overstress tendon to achieve theoretical elongation.

5. If agreement between observed and theoretical elongations at the required force falls outside acceptable tolerances, additional tests may be required, at the Engineer's discretion and without additional compensation to the Contractor, for Tendon Modulus of Elasticity and/or In Place Wobble and Friction Test, or Lift-Off Test.

462-7.3.2.5 Friction:

1. Provide actual expected friction and wobble coefficients and anchor set in the shop drawings; submit calculations and show a typical tendon force diagram on shop drawings based upon expected actual coefficients and values for the PT system to be used.

2. Graphite may be used as a lubricant when friction must be reduced, subject to written approval of the Engineer.

462-7.3.2.6 Tendon Wire Failure:

1. Multi-strand PT tendons with wires which fail by breaking or slipping during stressing may be accepted provided these conditions are met:

a. Completed structure has a final PT force of at least 98% of original total design PT force;

b. PT force across a mating joint is at least 98% of PT force required by the Contract Documents for that mating joint for that stage of construction for precast or cast-in-place segmental construction. This 98% minimum PT force requirement applies to segmental construction, or any similar construction, that has members post-tensioned together across a common joint face at any stage of construction; and,

c. Any single tendon must have no more than a 5% reduction in cross-sectional area of PT steel due to wire failure.

2. When conditions permit the Contractor to propose acceptable alternative means of restoring PT force lost due to wire failure, any of the above conditions may be waived at discretion of and with approval of the Engineer in writing.

462-7.3.2.7 Cutting of PT Steel:

1. Cut PT steel using an abrasive saw or plasma torch within 3/4 inches to 1-1/2 inches away from the anchorage.

2. Flame cutting of PT steel is not permitted.

3. Do not cut tendon to final length prior to acceptance.

462-7.3.2.8 Post-Tensioning Operations Record:

1. Keep a record of these PT operations for each tendon installed:

a. Project name, Financial Project ID (FPID);

b. Contractor and/or subcontractor;

c. Tendon location, size, and type;

d. Date tendon was first installed in duct;

e. Reel number for strands and wires and heat number for bars;

f. Tendon cross-sectional area;

g. Modulus of elasticity;

h. Date stressed;

i. Jack and Gauge numbers per tendon end;
j. Required jacking force;
k. Gauge pressures at the pump and at the inlet;
l. Elongations (theoretical and actual);
m. Anchor sets (anticipated and actual);
n. Stressing sequence (i.e., sequential order of tendon stressing by number);
o. Stressing mode (single-end, dual-end, simultaneous);
p. Witnesses to stressing operations (Contractor and Inspector);
q. Any other relevant information.

2. Submit to the Engineer a complete set of stressing operation records within five days of completed tendon installation.

SUBARTICLE 462-7.3.3.2 is deleted and the following substituted:

462-7.3.3.2 Anchorage:

1. Install the anchorage cap such that the top and bottom holes form a vertical axis oriented 90 degrees from horizontal.

2. Provide the following at anchorages as shown on Standard Plans, Index 462-002:

a. Temporary drain holes at the bottom of open top blockouts.

b. Temporary weatherproof plugs for upwardly oriented access or vent holes.

3. Cap all filler inlets/outlets with plugs meeting the requirements of Section 960.

4. Construct anchorage pour-backs and place elastomeric coatings at anchorages as indicated in the Contract Documents and as shown on Standard Plans, Index 462-002 within seven days of completing filler injection operations (see 462-7.4 for filler injection operations). For anchorages which require acrylic aliphatic polyurethane top coating, apply the acrylic aliphatic polyurethane top coating after the elastomeric coating has fully cured. See Standard Plans Index 462-002 and the Contract Documents for details on anchorages which require acrylic aliphatic polyurethane top coating. Construct anchorage pour-backs using reinforced concrete, magnesium ammonium phosphate concrete, or a Type Q epoxy grout meeting the requirements of Section 926.

a. Remove all laitance, grease, curing compounds, surface treatments, coatings, and oils by grit blasting or water blasting. Flush surface with water and blow dry. Surfaces must be clean, sound, and without any standing water. Test substrate at all pour-back locations using ACI 503 and develop a minimum of 175 psi tension (e.g., pull-off value). Testing frequency may be reduced, as determined by the Engineer, after the Contractor has demonstrated an ability to prepare substrate surfaces for bonding as indicated by the result of the ACI 503 test.

b. Mix and apply epoxy grout and magnesium ammonium phosphate concrete in accordance with the manufacturer’s current standard technical guidelines. Construct all pour-backs in leak proof forms creating neat lines. Epoxy grout may require

pumping for proper installation. Construct forms to maintain a liquid head to ensure intimate contact with concrete surface. Use vents as needed to provide for escape of air to ensure complete filling of forms.

5. Coat exposed surfaces of pour-backs and anchorage caps as shown on Standard Plans, Index 462-002 with an elastomeric coating system meeting the requirements of Section 975 and having a thickness of 30 mils to 45 mils. Apply the acrylic aliphatic polyurethane top coating to a dry film thickness of 5 to 6 mils. Ensure concrete, anchorage caps, or other substrates are structurally sound, clean, and dry. Concrete must be a minimum of 28 days old. Remove all laitance, grease, curing compounds, surface treatments, coatings, and oils by grit blasting or water blasting using a minimum 3,000 psi nozzle pressure. Blow surface with compressed air to remove dust or water. Apply the elastomeric coating within 90 days of filler injection. Apply the acrylic aliphatic polyurethane top coat and the manufacturer's approved primer over the elastomeric coating before applying Class 5 coating, if required.

6. Prior to application of elastomeric coating, construct a 2 foot x 4 foot concrete test block with a similar surface texture to surfaces to be coated. Coat a vertical face with chosen elastomeric coating system. Determine number of coats required to achieve the specified thickness without runs and drips. Mix and apply elastomeric coating as per manufacturer's current standard technical specifications. Spray application is preferred; roller application is permitted. Have coating manufacturer representative on site to supervise and comment on application of elastomeric coating onto test block. Apply coating using approved and experienced personnel with a minimum of three years experience applying similar polyurethane systems. Submit credentials of these persons to the Engineer for review and consideration for approval.