EXPECTED IMPLEMENTATION JULY 2022

DRAFT

POST-TENSIONING SYSTEMS
(REV 12-1-21) (FA 1-19-22) (7-22)

ARTICLE 960-1 is deleted and the following substituted:

960-1 Description.

This Section covers all post-tensioning (PT) systems and components remaining in a completed structure, including temporary erection PT left in-place and permanent PT for design capacity.

The submittal for approval of PT systems must use materials and components meeting the requirements of this Section and Section 462. Submit PT system shop drawings to the Engineer for review and acceptance in accordance with Section 5. The PT system shop drawings must include component drawings, system drawings, and test reports. The acceptance of a PT system for use on the project is based on the exact major components, as defined in 960-2, that were used in system testing and that are shown on the approved PT system shop drawings.

ARTICLE 960-2 is deleted and the following substituted:

960-2 Component Standards.

All PT system components must be materials compatible with the filler material and installation process used to encapsulate the tendons. The component materials must not chemically degrade during the service life of the structure. The service life of the structure is 75-years unless specified otherwise in the Contract Documents.

The following are major components and must be marked with the manufacturer's name, trademark, model number, and size corresponding to catalog designation: anchorages, bearing plates, trumpets, caps, duct couplers, connections, "O"-rings, heat shrink tubing, duct, and local zone reinforcement. Any of these items that cannot be marked must be contained in packaging or appropriately tagged with the necessary information.

The following are examples of common off-the-shelf accessories and need not be stamped: bolts, washers, inlets, outlets, drains, ports, valves, plugs, nipples, hose adapters, and grease.

Substitution, modification, or deletion of any major component of the PT system, excluding local zone reinforcement, after system testing and approval by the Engineer is not permitted.

Provide only PT systems utilizing tendons completely encapsulated in grout or flexible filler filled anchorages and ducts. Do not use systems transferring prestress force by bonding prestress steel strand directly to concrete. Embedded anchorages for bars are permitted. Strand or strand-tendon couplers are not permitted.

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SUBARTICLE 960-2.2.1.5 is deleted and the following substituted:

960-2.2.1.5 Connections, Fittings, and Tolerance:

1. Devices or methods for all duct connections (e.g., splices, joints, couplers, connection to anchorages), shall produce smooth interior alignment with no lips or kinks.

2. Use of tape, caulking, epoxy, or other sealants is not permitted to join or repair duct, to make connections, or for any other purpose.

3. Use a reducer when adjacent sections of duct are directly connected to each other and the outside diameters vary more than plus or minus 0.08 inch.

4. Provide all connections that are external to the concrete with a minimum pressure rating of 150 psi.

5. Use heat shrink sleeves and circular sleeve couplers made from high-density polyethylene or polypropylene material, or duct couplers made from high-density polyethylene or polypropylene material with O-rings or seals to make connections between sections of corrugated plastic duct or between corrugated plastic duct and trumpets.

6. Use heat shrink sleeves and circular sleeve couplers made from high-density polyethylene or polypropylene material to make connections between corrugated plastic duct and steel pipe.

7. Use heat shrink sleeves with or without circular sleeve couplers made from high-density polyethylene or polypropylene material to make connections between corrugated plastic duct and anchorages with integral trumpets.

8. Use heat welding techniques, electrofusion duct couplers, or elastomer sleeves and stainless steel band clamps to make connections between sections of smooth plastic duct.

9. Use elastomer sleeves and stainless steel band clamps to make connections between smooth plastic duct and steel pipe.

10. Use welding or elastomer sleeves and stainless steel band clamps to make connections between sections of steel pipe that are external to the concrete.

11. Use welding, elastomer sleeves and stainless steel band clamps or heat shrink sleeves and circular sleeve couplers made from high-density polyethylene or polypropylene material to make connections between steel pipe and trumpets that are internal to the concrete.

12. Use elastomer sleeves with a minimum wall thickness of 3/8 inches and reinforced with a minimum of four ply polyester reinforcement. Use a 3/8 inch wide stainless steel power seated band and clamps on each end of the elastomer sleeves to secure the sleeves to plastic ducts or steel pipes. Seat the bands with a 120 pound force prior to clamping them in place.

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SUBARTICLE 960-2.2.2.2 is deleted and the following substituted:

960-2.2.2.2 Inlets, Outlets, Drains, Ports, Valves, and Plugs:

1. Provide permanent inlets, outlets, drains, ports, valves, and threaded plugs made of nylon, high-density polyethylene or polypropylene materials, or stainless steel.

2. For unbonded post-tensioning systems using flexible filler, provide permanent inlets, outlets and drains made from steel. Provide temporary inlets, outlets, drains and valves made from brass or steel.

3. All inlets, outlets, drains and ports shall have pressure rated mechanical shut-off valves or plugs. Mechanical shut-off valves must be 1/4 turn ball valves.

4. Inlets, outlets, drains, ports, valves, and plugs shall have a minimum pressure rating of 150 psi.

5. Inlets, outlets and ports shall have a minimum inside diameter of 3/4 inches for strand and 3/8 inches for single bar tendons and four-strand ducts.

6. Drains shall have a minimum inside diameter of 3/8 inches. Locate drains, and inlets and outlets serving as drains, at the bottom of the duct cross section.

7. Specifically designate temporary items, not part of the permanent structure, on the PT system shop drawings.

SUBARTICLE 960-2.3 is deleted and the following substituted:

960-2.3 Steel Reinforcing:

960-2.3.1 Mild:

1. Reinforcing steel shall conform to Section 415 and Section 462.
2. Test typical local zone reinforcement for compliance with AASHTO LRFD Bridge Design Specifications and AASHTO LRFD Bridge Construction Specifications, as applicable. Include reinforcement details in the PT system shop drawings submitted for approval.

ARTICLE 960-3 is deleted and the following substituted:

960-3 System Approval Requirements.

960-3.1 Independent Testing: Use independent laboratories meeting the credentials described in this Section to perform all testing, other than field testing, and to submit certified test reports for materials and components. Certification may be performed by a qualified independent laboratory outside of the United States, only if the facility is pre-approved by the State Materials Office.

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Conform all testing procedures used for materials or components to applicable American Society of Testing and Materials (ASTM) and International Federation of Structural Concrete (fib) Specifications or as modified in this Section.

960-3.1.1 Material Laboratory: Test plastic components in a certified independent laboratory accredited through the laboratory accreditation program of the Geosynthetic Accreditation Institute (GAI),the American Association for Laboratory Accreditation (A2LA) or qualified by an ISO 17025 accreditation agency using personnel with documented experience running the required test methods.

960-3.1.2 Component and System Laboratory: Test individual components and the PT system as a whole witnessed by and/or performed in a certified independent laboratory audited by the AASHTO Materials Reference Laboratory (AMRL), or with an AASHTO R18 Accreditation as set forth by the AASHTO Highway Subcommittee on Materials or qualified by an ISO 17025 accreditation agency using personnel with documented experience running the required test methods.

960-3.1.3 System Testing: In lieu of performing PT system tests witnessed by and/or performed in a certified independent laboratory, the PT system tests may be performed at the project site and witnessed by the Engineer.

960-3.2 Testing Requirements:

960-3.2.1 Component and System Tests: Corrugated duct, smooth duct and all associated components that are used for both internal and external PT systems, e.g. couplers, anchorages, inlets, outlets, drains, ports, valves, plugs, etc., shall meet the requirements of fib Technical Report Bulletin 75 titled, Polymer-Duct Systems for Internal Bonded Post-Tensioning, Performance Level 2 (PL2), with modifications as shown in Table 960-6.

Table 960-6
Required Component and System Tests

Reference to fib Bulletin 75			Required Tests for each PT System Type(1)		
Procedures	Appendix	Test Description	Internal PT System with Grout	Internal PT System with Flexible Filler	External PT System with Flexible Filler
Component Assessment	A.1	Dimensional requirement	Yes	No	No
	A.2	Stiffness of duct	Yes(2)	No	No
	A.3	Longitudinal load resistance	Yes	Yes	Yes
	A.4	Lateral load resistance	Yes	No	No
	A.5	Flexibility of duct system	Yes	Yes	No
	A.6	Leak tightness of duct system	Yes	Yes	No
	A.7	Concrete pressure on duct	Yes(3)	No	No
	A.8	Wear resistance of duct	Yes	No	No
	A.9	Wear resistance of duct under sustained load	Yes	No	No
	A.10	Bond behavior of duct	Yes	No	No
	A.11	Precast segmental duct coupler system	Yes(4)	Yes(4)	No
	A.12	Fracture resistance of duct	No	No	No
System Assessment	B.1	Leak tightness of anchorage-duct assembly	Yes(5)	Yes(5)	Yes(5)
	B.2	EIT performance of duct system	No	No	No
	B.3	EIT performance of anchorage-duct assembly	No	No	No
	B.4	Full scale duct system assembly	Yes(5)(6)	Yes(5)(6)	Yes(5)(6)
	B.5	Leak tightness of assembled duct system	Yes(5)(6)	Yes(5)(6)	No

(1) Yes = Test is required; No = Test is not required.
(2) Do not preload strand into duct prior to testing.
(3) Identify duct as meeting Performance Class I or II criteria.
(4) Use an epoxy compound meeting the requirements of Section 926, Type AB.
(5) Perform tests on the largest assembly and the smallest assembly for each family of PT systems. A family of PT systems is defined a group of PT strand/bar assemblies of various sizes using common anchorage devices and design.
(6) For each test, use a PT system assembly consisting of at least one of each component and connection type required to install a tendon from anchorage cap to anchorage cap. For bar tendon systems, use between 15 and 50 feet of duct with a straight profile.

960-3.2.2 Filler Containment Assembly Pressure Test: In addition to the other testing specified in this Section, test all filler containment assemblies, i.e., anchorages, anchorage caps, inlets, outlets, drains, ports, valves, plugs, etc., for all system sizes as follows:

1. Assemble the anchorage and anchorage cap with all required filler injection attachments.

2. Seal the opening in the anchorage where the duct/trumpet connects.

3. Condition the assembly by maintaining a pressure of 150 psi in the system for three hours.

4. After conditioning, lock off the air supply to the assembly.

5. After lock off, the assembly must sustain 150 psi internal pressure for five minutes with no more than 15 psi, or 10%, reduction in pressure.

This test may be combined with the External Duct Systems Pressure Test for external PT systems.

960-3.2.3 External PT Systems Pressure Test: In addition to the other testing specified in this Section, test all sizes of external PT systems as follows:

1. Prepare a system assembly consisting of at least one of each component and connection type required to install a tendon from anchorage cap to anchorage cap using between 15 and 50 feet of duct with a straight profile.

2. Condition the assembly by maintaining a pressure of 100 psi in the system for three hours.

3. After conditioning, lock off the air supply to the assembly.

4. After lock off, the assembly must sustain 100 psi internal pressure for five minutes with no more than 10 psi reduction in pressure.

960-3.2.4 Vacuum Test for Internal and External PT Systems with Flexible Filler: In addition to the other testing specified in this Section, test all sizes of internal PT systems with flexible filler and all external PT as follows:

1. Prepare a system assembly consisting of at least one of each component and connection type required to install a tendon from anchorage cap to anchorage cap using between 15 and 50 feet of duct Do not cast any component into concrete.

2. Condition the assembly by maintaining a 90% vacuum in it for 1 hour.

3. After conditioning, lock off the air supply to the assembly.

4. After lock off, the assembly must sustain a 90% vacuum for 5 minutes with no more than a 10% loss of vacuum.

960-3.3 Standard Tendon Sizes: Develop and test PT systems for the sizes and types shown in the Contract Documents.

960-3.4 System Modifications: Contact the Engineer for direction before changing any materials or components of a PT system that has been approved by the Engineer for use on the project. Repeat all appropriate material, component, and entire system tests if the manufacturer and/or model of any major component, as defined in 960-2, is modified or replaced, excluding local zone reinforcement.

960-3.5 Component Samples: Furnish all required material samples to laboratories for testing and to the Department as requested, at no cost to the Department.

960-3.6 Calculations, Shop Drawings, Test Reports, and Certification: Show fully detailed shop drawings of all component configurations, connections, anchorages, inlets, outlets, drains, high point inspection port details, anchorage inspection details, permanent anchorage caps, application limits of the PT system, and installation procedures of components. On the first page of each PT system shop drawing set, provide

a list of all system components in tabular format that includes the following information, at a minimum: part/item number, description, material, manufacturer and model. The manufacturer need not be identified for common off-the-shelf accessories as defined in 960-2. Submit details of typical local zone reinforcement in the PT system shop drawings signed and sealed by a Specialty Engineer. Indicate that all major PT system components, as defined in 960-2, are stamped with the following:

1. Manufacturer's name
2. Trademark model number
3. Size corresponding to catalog description on PT system drawings.

For each PT system, submit a package that includes calculations, shop drawings, test reports, proof of current laboratory accreditations, and all material and component certifications required throughout this Section. Proof of current laboratory accreditation must specifically indicate applicable accreditation categories related to PT systems.

Include a cover letter with the package signed by an officer of the PT system supplier (vendor) certifying that:

1. The submitted PT system, as a whole and all of its individual components, meet or exceed all material and component/system requirements of this Section, as demonstrated by the submittal.

2. All testing required by this Section was performed as defined in 960-3.1 and that all tests were performed to applicable ASTM and fib Specifications.

3. The PT system meets the requirements of Section 462.