

**FY 2017/2018 QC Category No. 10D  
STATEWIDE INSPECTION GUIDELIST  
Bridge Structures - Post-tensioning (PT)**

**GENERAL**

1. The PT supervisor (Level II) and PT crew members (Level I) must successfully complete a Post-Tensioning Institute (PTI) course and be qualified by CTQP. The PT crew must have at least two CTQP qualified members one of which may be the supervisor. [Spec. 105-8 & 462-4]
2. The grouting supervisor must successfully complete an American Segmental Bridge Institute (ASBI) course and be qualified by CTQP as Level II and grouting crew members must successfully complete an ASBI or PTI course and be qualified by CTQP as Level I. The grouting crew must have at least two CTQP qualified members one of whom may be the supervisor. [Spec. 105-8 & 462-4]
3. Conduct all stressing and filler injection operations in the presence of the Engineer. [Spec. 105-8 & 462-4]
4. The vacuum grouting foreman must have experience and training in the use of vacuum grouting equipment and procedures. [Spec. 105-8 & 462-4]
5. The Filler Injection Foreman and the QC Inspector both must successfully complete an ASBI grouting course and be qualified by CTQP as Level II. In addition, the Filler Injection Foreman and the QC Inspector both must be ASBI-certified in the flexible filler process. Filler injection crew members must successfully complete an ASBI grouting course and be qualified by CTQP, one of whom must be CTQP Level II qualified. Filler injection crew members must be ASBI-certified in the flexible filler injection process. [Spec. 105-8 & 462-4]
6. The vacuum flexible filler repair foreman must have experience and training in the use of vacuum flexible filler repair equipment and procedures. [Spec. 105-8 & 462-4]

**MATERIALS**

7. All materials must be stored in weatherproof buildings, sheds or containers. [Spec. 462-6]
8. The following material Specs must be met: 413-Methacrylate, 926-Epoxy Grout, 930-Magnesium Ammonium Phosphate Concrete, 931-Mild Reinforcing Steel, 938-Duct Filler, 960-Post-Tensioning components, 975-Elastomeric Coating Systems. [Spec. 462-2]
9. Prestressing materials that must be approved, be in compliance and be undamaged are: prestressing steel including strands and bars, and PT systems including anchorage assemblies, bearing plates, couplers, anchorage caps, vent tubes, valves, inlets/outlets, ducts, wedge plates & wedges. [Spec. 462-2, 933 & 960]

10. Ducts must be protected from a variety of damaging elements at all times, be securely and completely sealed at ends with end caps/plugs, and be stored properly. [Spec. 462-6]
11. Inlets/outlets must have mechanical shut offs, be the correct diameter, extend sufficiently, and be properly bonded to the duct. Inlets and outlets must be protected from degradation, crushing, contamination, or any other damage during all construction operations. [Spec. 462-7 & Good Practice]
12. Duct fillers must be on the APL. On-site grout filler must be properly stored for not more than one month. Do not use stored filler that has exceeded the manufacturer's recommended usage date. [Spec. 462-6, 923 & 938]
13. Grouts must be mixed with the specified water; fluidity must be maintained per manufacturer's limits; wick induced bleed tests must be performed. Grouts that are more than 6 months old must be retested and certified or removed from the project. [Spec. 462-6, 923 & 938]
14. All Post-Tensioning system components must be from a single supplier. Post-Tensioning systems must be listed on the Structures Design Office (SDO) list of Approved Post-Tensioning Systems. [Spec. 462-1 & 960]
15. Certain materials must be sampled and tested, others must be certified, and some require LOT number identification at all times. [Spec. 462-6]
16. These tests may be required: Tendon Modulus of Elasticity Test (if required by Plans or Engineer), In Place Wobble or Friction Test (required for tendons longer than 100'). [Spec. 462-8]

### ***PROTECTION OF PT STEEL***

17. PT steel must be clean, bright, uniformly colored; have no corrosion pitting; and be rejected if damaged or deteriorated. [Spec. 462-6]
18. PT strands must be low relaxation (stabilized) per the requirements of ASTM A416 and be in shipping containers with special corrosion inhibitor and in packaging that must be marked with specified information. [Spec. 462-6 & 933]
19. All PT superstructure steel must be stressed and filler injected within 14 calendar days after placement in its final position. PT Substructure steel must be stressed and filler injected within 21 days of placement. [Spec. 462-7]
20. If chloride contamination requires remediation, duct flushing may be performed using water with slack lime or quicklime. Dry duct with oil-free compressed air, vacuuming, or as approved by the Engineer. [Spec. 462-7]
21. Provide an absolute seal of anchorage and duct termination locations per approved system drawings. [Spec. 462-7]

## **FABRICATION**

22. Duct splices must be minimized. [Spec. 462-7]
23. Internal ducts must be secured at not more than 30" intervals for steel pipes, 24" intervals for round plastic ducts, and 12" intervals for flat plastic ducts. Ducts, joints, tendons, rebar and anchorages must be within specified position tolerances. [Spec. 462-7]
24. External tendon duct must be straight between connections to internal locations. [Spec. 462-7]
25. Ensure all curved or straight PT duct alignments are smooth and continuous, with no kinks or dents. Accomplish any deviations in alignment with smooth unkinked transitions. Ducts must be installed within the tolerances. [Spec. 462-7]
26. Ensure all anchorages are installed at the desired positions, proper entrance/exit angles of tendon paths to face of concrete are within 3 degrees, and minimum cover is achieved. Ensure that the anchorage reinforcement starts within ½ inches of the back of the main anchorage plates. [Spec 462-7]
27. Ducts, anchorage connections, splices, inlets and outlets must be sealed at all times except that low point drains must be open just prior to tendon installation and again just prior to filler injection. [Spec. 462-7]
28. Tape is not permitted for repairing or sealing splices, joints, couplings or for making connections. [Spec. 462-7]
29. PT ducts must be located per plans, shop drawings, specifications, or per Engineer if conflicting with reinforcement. Position of PT ducts prevails over reinforcing. [Spec. 462-7]
30. When required by the Engineer, the duct system must be pressure tested just prior to placement of concrete at 7.5 psi for 1 minute and have pressure loss of not more than 0.75 psi or 10%. [Spec. 462-8]
31. When required by the Engineer for vacuum assisted filler injection, the duct system must be pressure tested just prior to placement of concrete at 90% vacuum for 5 minutes and have vacuum loss of no more than 10%. [Spec. 462-8]
32. After concrete is placed and cured, a torpedo, ¼ inch smaller all around than the duct, must be passed through all ducts to detect blockages without excessive effort or mechanical assistance. Correction of blockages requires approval of the Engineer. Flat, 4-strand transverse tendon ducts in segmental box girders may be proved by moving the tendons freely by hand within the duct a minimum of one foot in each direction. [Spec. 462-8]

## **POST-TENSIONING OPERATIONS**

33. Tendons must be pulled or pushed through ducts without snagging and during the insertion of a post-tensioning strand into a duct; the strand shall not be intentionally rotated to facilitate insertion by any mechanical device. [Spec. 462-7]
34. PT forces must not be applied until concrete has minimum compressive strength required by Contract Documents. [Spec. 462-7]
35. Initial, permanent and maximum tendon stresses must be within specified limits and single or double end stressing must be per plans or shop drawings or Engineer. [Spec. 462-7]
36. Stressing equipment must be provided by the PT system supplier and stressing jacks must be calibrated, and a master gauge may be used. [Spec. 462-7]
37. Tendon elongations must be measured to the nearest 1/16-inch and observed elongation shall be within 7% of theoretical. Tendons must not be overstressed to achieve the required elongation. [Spec. 462-7]
38. A tendon force diagram reflecting the PT system actually used must be submitted and if friction is too high a graphite lubricant may be used with written approval of the Engineer. [Spec. 462-7]
39. Tendon wires may break or slip but failed wires must never exceed 5% of the tendon cross sectional area; PT force must be at least 98% of that required for the particular stage of construction and 98% of original total design PT force in completed structure. [Spec. 462-7]
40. Cut PT steel by an abrasive saw or plasma torch not less than 3/4 to 1-1/2 inches from the anchoring device. Flame cutting of PT steel is not allowed. Do not cut tendon to final length prior to acceptance. [Spec. 462-7]
41. Records of the tendon stressing operation are required and must contain 17 items required by the specification as well as any other relevant information. [Spec. 462-7]
42. For internal and external ducts, after stressing and prior to filler injection, the system must be pressure tested at 50 psi for 1 minute with pressure loss of not more than 25 psi for tendons equal to or less than 150 ft. and a pressure loss not more than 15 psi for tendons longer than 150 ft. and corrections must be made with approval of the Engineer. [Spec. 462-8]
43. Within 4 hours after stressing, all duct openings, other than anchorage caps, must be sealed. Do not install anchorage cap until tendon has been accepted. If acceptance of tendon will be delayed more than four hours after stressing, immediately provide temporary weatherproofing of tendons at open ends of anchorages. If tendons and anchorages are temporarily weatherproofed, install anchorage caps within 1 day of tendon being accepted. If tendon contamination

occurs, the tendon is to be removed, the duct flushed with potable water and a new tendon installed. [Spec. 462-7]

### ***FILLER INJECTION OPERATIONS***

44. A filler injection Plan must be submitted and approved 6 weeks before the start of any scheduled filler operations. Filler injection must be performed according to the approved Plan and modifications to the Plan must be approved before they are used. [Spec. 462-7]
45. A pre-filler injection meeting must be conducted with Contractor, Subcontractor, and Engineer and should include all individuals involved in managing, performing and inspecting the filler operation. [Spec. 462-7]

### ***FILLER INJECTION OPERATIONS: GROUT***

46. Grouting equipment must be per Spec. and shall include a colloidal mixer, storage hopper, water meter, positive displacement pump, pump pressure gage, vacuum grouting equipment, and standby equipment. [Spec. 462-7]
47. Maximum grout temperature must not exceed 90°F and grouting operations are prohibited when the ambient temperature is below 40°F or is expected to fall below 40°F within one day after grouting. [Spec. 462-7]
48. Efflux or Wet Density testing must be performed on the pumped grout initially and at the anchorage outlet when discharge begins and a bleed test is required at the start of each days grouting. A failing test requires adjustments to the grout mix before the resumption of grouting. [Spec. 462-7 & 938]
49. Normal pumping pressure must range from 10 psi to 50 psi measured at the grout inlet. The maximum pumping pressure of 145 psi for round ducts and 75 psi for flat ducts at the grout inlet must not be exceeded. [Spec. 462-7]
50. The discharge from outlets must follow the order in the Grouting Plan and once the anchorage outlet is closed, discharge a minimum of 2 gallons of grout from the anchorage cap outlet into a clean receptacle to ensure that free air and water are completely expelled. [Spec. 462-7]
51. After initial grouting is complete and the system is sealed, the pressure must be increased to the equivalent realized grout pumping pressure for 2 minutes to check for leaks. If no leaks, reduce pressure to 5 psi for a minimum of 10 min. for any entrapped air to flow to high points. Increase pumping pressure not to exceed actual realized pumping pressure of duct and discharge grout at each high point outlet to eliminate any entrapped air or water after specified ten minute period has expired. Then bleed each high point and leave 30 psi residual pressure. [Spec. 462-7]
52. If grouting pressure exceeds the maximum allowed, move pumping to the next outlet where grout has flowed and resume as per Spec. If grouting cannot be completed, resume vacuum grouting after 48 hours. [Spec. 462-7]

53. Vertical tendons require that the grout level be above the anchorage and prestressing plate at all times. [Spec. 462-7]
54. Grout inlets and outlets shall not be opened for at least 24 hours after grouting. [Spec. 462-8]
55. After grout is cured, all high points along the tendons as well as the inlets and outlets located at the anchorages must be drilled and inspected with a borescope or probe per Spec. and within 4 hours of drilling, seal the drilled void. Any significant deficiency voids that are found must be filled using the vacuum grouting method within 48 hours. [Spec. 462-8]
56. When grouting is incomplete, a borescope must be used to establish the limits of sound grout. Probing is not allowed. The remaining unfilled duct must be vacuum grouted per specification. [Spec. 462-8]
57. Submit a Grouting Operations Report within 5 days of filler injection. [Spec. 462-7]

#### ***FILLER INJECTION OPERATIONS: WAX***

58. Wax injection equipment must be per Spec. and shall include wax melting units, wax mixer, storage reservoir, pump, volumetric flow rate meter, displacement volumetric meters, vacuum wax injection equipment, vacuum pump equipment, and standby equipment. [Spec. 462-7]
59. The wax temperature range during injection must be between 212 °F and 240°F. Minimum ambient temperatures during injection as specified by the manufacturer. [Spec. 462-7]
60. Inject wax at a velocity of 40-70 feet per minute. The maximum pumping pressure of 145 psi at the pump and 75 psi at the inlet must not be exceeded. [Spec. 462-7]
61. Wax inlets and outlets shall not be opened until wax has cooled for at least 24 hours after injection. [Spec. 462-8]
62. After wax has cooled, visually inspect ports for leaks at all high points along tendon as well as inlets or outlets located at anchorages; repair leaks per Wax Injection Operations Plan. Between 24 and 48 hours after injection sound ducts with a rubber mallet for voids and remove all inspection port caps and visually inspect. Fill voids created by inspection and replace and seal all port caps. [Spec. 462-8]
63. Address voids deeper than ½ inch or if strands are exposed and uncoated in accordance with the Wax Injection Operations Plan. [Spec. 462-8]
64. When wax injection is incomplete, use a borescope to explore voided areas. Fill voids using volumetric measuring vacuum wax injection. [Spec. 462-8]
65. Submit a filler injection report within 5 days of filler injection. [Spec. 462-7]

## **FINAL FINISHING AND PROTECTION**

66. Lifting and access holes must be patched with Magnesium Ammonium Phosphate Concrete or Type Q Epoxy. Before patching, surfaces must be cleaned with grit or water blasting methods at 10,000 psi pressure. [Spec. 462-7, 930 & 926]
67. After deck grooving, patched areas must be coated with Methacrylate extending 6" beyond the perimeter of the patched area. [Spec. 462-7]
68. Grout inlets/outlets must be sealed with a threaded plastic plug and be patched with epoxy. [Spec. 462-7 & 926]
69. Anchorages must be protected within 7 days of filler injection completion and epoxy grout pourbacks must be placed in properly prepared forms using specified placement methods. Surfaces in contact with pourback material must be cleaned with grit or water at 3,000psi. Protect anchorages as per Index 21802 or as otherwise indicated in the contract documents. [Spec. 462-7 & 926]
70. Pour backs or anchorage caps must be coated with elastomeric material 30 to 45 mils thick over a properly cleaned surface and only after concrete to be coated is at least 28 days old and within 90 days of filler injection. The coating material must be applied to a test block per Spec. and applicators must have 3 years of experience with similar materials. [Spec. 462-7 & 975]

## **CRACK AND DUCT INSPECTION**

71. Inspect all post-tensioned concrete box girder top slab, bottom slab and web wall interior and exterior surfaces for cracks immediately after all post-tensioning of a span is complete. If the segmental cantilever erection method is used, inspect all surfaces of web walls of all previously placed segments after each new segment is placed. Since these cracks can be very narrow and hard to see, use of a magnifying device, high intensity white light and spraying with water to increase their visibility may be beneficial during inspection. The width, length, depth, termination points, and precise location of any cracks must be properly documented to scale (crack map). Report all cracks to the Project Administrator so that their status can be addressed immediately. [Spec. 400-21 & CPAM 10.7]
72. Monitor and document growth of individual cracks to determine if cracks are active or dormant. [Spec. 400-21 & CPAM 10.7]
73. Inspect external tendon ducts and couplers for filler voids, wax leaks, fractured grout, delamination, as well as duct and coupler material punctures, splits or other damage by sounding them and by visual inspection of all visible duct and coupler surfaces. Sound each duct and coupler a minimum of seven days after injection is complete by tapping the surface using a hammer for grout or a rubber mallet for flexible filler. Use a tapping force that will not cause the duct or coupler material to split, dent, crush or incur any other damage and that will not cause fracturing, chipping or damage to the filler within the duct or coupler. Sound each duct and

coupler at 12 inch intervals along their length and at each interval, as a minimum, tap them on the top sides and bottom. [CPAM 10.7]

74. Mark the limits of any defect on the surface of the duct or coupler with a high visibility permanent marker and when it can be determined for sounding or observation alone, label the defect type as one or more of the following: void, leak, fracture, delamination, split, other. [CPAM 10.7]