SP-150358a
(Replaces SP-150358)

SPECIAL PROVISIONS
FOR
TIEBACK-ANCHORED SOLDIER PILE AND LAGGING WALL WITH AESTHETIC CONCRETE FACING

Black Hawk County
NHSX-058-1(95)--3H-07

Effective Date
February 20, 2018

THE STANDARD SPECIFICATIONS, SERIES 2015, ARE AMENDED BY THE FOLLOWING MODIFICATIONS AND ADDITIONS. THESE ARE SPECIAL PROVISIONS AND THEY SHALL PREVAIL OVER THOSE PUBLISHED IN THE STANDARD SPECIFICATIONS.

150358a.01 DESCRIPTION.

A. This work shall consist of furnishing and constructing a Tieback- Anchored Soldier Pile and Lagging Wall with Aesthetic Concrete Facing at each location shown on the Plans in accordance with this Special Provision, information shown on the Plans, including lines, grades and dimensions, and contractor-prepared submittals and shop drawings.

B. The work shall be completed by a specialty contractor having experience in the construction of tieback-anchored soldier pile and lagging walls per requirements herein. The aesthetic concrete facing component of the wall shall be completed by a contractor having experience in concrete wall construction, including concrete painting and use of concrete formliners, and may or may not be the same contractor as the specialty wall contractor. The work shall be coordinated between each contractor performing work to provide a completed wall consistent with the Plans and contractor-prepared submittals and shop drawings.

C. The tieback-anchored soldier pile and lagging wall shall be constructed from existing ground elevation using the “top-down” construction method. Wall components include:

1. Steel dual channel-section piles with each dual channel-section pile placed and concreted within drilled shafts;

2. One or two tieback anchors per pile dependent upon location;

3. Timber lagging between piles;

4. A permanent cast-in-place (CIP) reinforced concrete, including coping where indicated; and

5. Closure walls where indicated.

6. Associated items include moment slabs, ramp barrier rails, barrier walls, and fence, where indicated. Ramp barrier rails and fence are per the Standard Specifications.

7. The timber lagging retains in-situ material during the construction phase. The permanent CIP concrete facing includes an aesthetic relief.

D. The aesthetic requirements for the wall shall be per the Plans and aesthetic-related special provisions. The completed wall aesthetic features shall be consistent with the bridge aesthetic features, including texture and color requirements.

E. The intended general construction sequence for the tieback-anchored soldier pile and lagging wall is as shown on the Plans. The Contractor shall provide a specific construction sequence. The Contractor's construction sequence shall be consistent with the project staging requirements. The exact limits of the wall staging and details of the wall construction, including closure walls at wall/abutment interfaces for Walls 417 and 517, shall be included in the Contractor's specific construction sequence. Closure wall excavation and construction shall not damage in-place piles and/or tie-back anchors. Bridge abutment piles shall be driven prior to drilling of shafts for wall construction in front of the abutment within the same construction stage. The wall shall be constructed within the geometric limitations of the project. Geometric limitations include that all wall elements, including tiebacks, shall be located entirely within the permanent right of way and the wall shall be constructed within staging and temporary traffic control constraints.

F. The Contractor is responsible for the final design and details of the tieback anchors and timber lagging as follows:

- Trumpet Design
- Anchor Heads
- Centralizers
- Anchor Corrosion Protection System
- Grouting Procedure
- Jacking Assembly, including hydraulic jack and pump, stressing anchorage, pressure gages/load cells, dials to measure movement, and jack chair
- Final Anchor Bond Length
- Timber Lagging Design

G. For the tieback anchors, the Contractor shall select the drilling method, grouting method, grouting pressures, and, subject to the minimum values shown in the Plans, determine the bond length and bond diameter. The Contractor shall be responsible for installing tieback anchors that will develop the load-carrying capacity indicated on the Plans in accordance with the testing subsection of these Special Provisions.

H. The anchor tendon shall be protected from corrosion as shown on the plans and in accordance with these Special Provisions.

I. The timber lagging shall be designed by the Contractor, subject to requirements per the plans and these Special Provisions.

150358a.02 MATERIALS.

A. Delivery, Storage, and Handling.

1. Do not deliver materials to the site until the Engineer has approved the submittals outlined in Article 150358a.03, B of this Special Provisions.

2. The designated storage location or locations shall be protected from theft, vandalism, passage of vehicles, and other potential sources of damage to materials delivered to the site.

3. Protect the materials from the elements by appropriate means.
   a. Cement and additives for grout shall be stored under cover and protected against moisture.
   b. All steel components shall be protected from the elements at all times. Steel bar tendons shall be stored and handled in a manner such that no damage or corrosion to any component part occurs. Storage and handling shall be in accordance with the manufacturer's recommendations and subject to the following:
      1) Damage to the steel bar tendon, the corrosion protection, and/or the epoxy coating as a result of abrasions, cuts, nicks, welds, and weld splatter will be cause for rejection by the Engineer.
      2) The steel bar tendon shall be protected if welding is to be performed in the vicinity. Grounding of welding leads to the tendon is forbidden. The tendon shall be protected from dirt, rust, or deleterious substances. A light coating of rust on the steel is acceptable. Heavy corrosion or pitting will be cause for rejection by the Engineer.
      3) Prior to inserting a tendon in the drill hole, the Contractor and the CQA engineer shall examine the tendon for damage to the encapsulation and the sheathing. If, in the opinion of the CQA Engineer, the encapsulation is damaged, the Contractor shall repair the encapsulation in accordance with the tendon supplier's recommendations. If, in the opinion of the CQA engineer, the smooth sheathing has been damaged, the Contractor shall repair it with ultra high molecular weight polyethylene tape. The tape should be spiral wound around the tendon to completely seal the damaged area. The pitch of the spiral shall ensure a double thickness at all points.
      4) Banding for fabricated tendons shall be padded to avoid damage to the tendon corrosion protection. Upon delivery, the fabricated anchors or the prestressing steel for fabrication of the tendons on site and all hardware shall be stored and handled in such a manner to avoid mechanical damage, corrosion, and contamination with dirt or deleterious substances.
      5) Lifting of the pre-grouted tendons shall not cause excessive bending, which can debond the prestressing steel from the surrounding grout.
      6) Tendons shall not be exposed to excessive heat (that is, more than 230°C).
      7) All of the tendon bond length must be free of dirt, manufacturers' lubricants, corrosion-inhibitive coatings, or other deleterious substances that may significantly affect the grout-to-tendon bond or the service life of the tendon.
      8) Tendons shall be cut with an abrasive saw or, with the approval of the tendon supplier, an oxyacetylene torch.
      9) Pregrouting of encapsulated tendons shall be done on an inclined, rigid frame or bed by injecting the grout from the low end of the tendon.

B. Slurry for Shaft Excavation.

If shaft excavation requires the wet method using slurry, the slurry material shall be in conformance with Article 2433.02 of the Standard Specifications.

C. Steel Soldier Pile.

1. Furnish steel channels rolled from steel meeting the requirements of ASTM A 572 Grade 50 with cross section dimensions meeting the requirements of ASTM A 6 for the section number designated. Only field welding will be allowed. Complete fabrication and welding according to Article 2408.03, B of the Standard Specifications. The steel channels shall be of the type and weight shown on the Plans.

2. Store, transport, and handle piles in a manner to prevent bending stresses or other damage.

3. Provide details of placement of structural steel soldier piles, including support and centralization methods.

4. Completely assemble the structural steel soldier piles, spacers, centering devices, and other necessary appurtenances as a prefabricated unit and place immediately after the shaft excavation is inspected and accepted, and just prior to shaft concrete placement.

5. Unless other types of spacers are approved by the Engineer, use rolling spacers for the structural steel soldier piles to minimize disturbance of the shaft sidewalls and to facilitate removal of the casing during concrete placement. Use concrete spacers or other approved non-corrosive spacing devices along the shaft at intervals not exceeding 10 feet to ensure concentric location of the structural steel soldier pile within the shaft excavation. As a minimum, provide a set of centering devices within 2 feet of the top and 2 feet of the bottom of the shaft. The centering devices shall be of adequate dimension to maintain the specified clearance between the outside of the structural steel soldier pile and the side of the excavated hole or casing.

D. Concrete for Drilled Shaft.

1. All materials, proportioning, air entraining, mixing, slump, and transporting of PCC shall be according to Section 2403 of the Standard Specifications, except as modified herein.

2. Water/cement ratio: not to exceed 0.45.

3. Use Class C Structural Concrete with a slump of 8 inches ±1.5 inches.

4. Portland cement: meet the requirements of ASTM C 150 Type I / II and Section 4101 of the Standard Specifications.

5. Air entrainment: apply Section 2403 of the Standard Specifications.

6. Mid-range water reducer is required according to Materials I.M. 403.

7. Retarder is required according to Materials I.M. 403 to maintain workable concrete.

8. Do not use Ground Granulated Blast Furnace Slag (GGBFS).

9. Lean cement concrete backfill shall consist of Type I or Type II Portland cement, fine aggregate, and water. Each cubic yard of lean-mix concrete backfill shall consist of a minimum of one 94 pound sack of Portland cement. The 28 day compressive strength of lean cement concrete shall be 50 pounds per square inch, minimum, and 100 pounds per square inch, maximum.

E. Tieback Anchors.

1. Shop or field fabricate anchors from materials conforming to requirements herein and consistent with accepted Contractor submittals required per the Construction Section of this Special Provision.

2. **Steel Bar Tendons.**
   - **a.** Fabricate tieback anchor tendons from single elements of one of the following materials:
     - **1)** Steel bars conforming to AASHTO M 275
     - **2)** Steel bars conforming to ASTM A 722.
   - **b.** Provide centralizers at maximum intervals of 10 feet with the deepest centralizer located 1 foot from the end of the anchor and the upper centralizer for the bond zone located no more than 5 feet from the top of the tendon bond length.

3. **Steel Bar Couplers.**

Steel bar couplers shall be capable of developing 100% of the minimum specified ultimate tensile strength of the steel bar.

4. Anchorage Devices.

a. Stressing anchorages shall be accomplished using a combination of steel bearing plate with a wedge plate and wedges. The steel bearing and wedge plate may also be combined into a single element. Anchorage devices shall be capable of developing 95% of the specified minimum ultimate tensile strength (SMTS) of the steel bar tendon. The anchorage devices shall conform to the static strength requirements of Section 3.1.6 (1) and Section 3.1.8 (1) and (2) of the PTI "Guide Specification for Post-Tensioning Materials."

b. Fabricate the bearing plate from steel conforming to AASHTO M 183 or M 222 specifications, or equivalent, or may be a ductile iron casting conforming to ASTM A 536.

c. Fabricate the trumpet from a steel pipe or tube or from PVC pipe. Steel pipe or tube shall conform to the requirements of ASTM A 53 for pipe or ASTM A 500 for tubing. Steel trumpets shall have a minimum wall thickness of 1/8 inch for diameters up to 4 inches and 1/4 inch for larger diameters. PVC pipe shall conform to ASTM A 1785, Schedule 40 minimum. PVC trumpets shall be positively sealed against the bearing plate and aligned with the tendon to prevent cracking during stressing.

d. Fabricate anchorage covers from steel or plastic with a minimum thickness of 0.09 inch. The joint between the cover and the bearing plate shall be watertight.

e. Design wedges to preclude premature failure of the steel bar tendon due to notch or pinching effects under static and dynamic strength requirements of Section 3.1.6 (1) and Section 3.1.8 (1) and 3.1.8 (2) of the PTI "Post Tensioning Manual." Wedges shall not be reused.

f. Anchor nuts and other threadable hardware for epoxy coated bars shall comply with the requirements for carrying capacity and shall be designed to thread over the epoxy coated bar.

5. Centralizers.

Fabricate centralizers from plastic, steel, or material which is non-detrimental to the prestressing steel. Wood shall not be used. The centralizer shall be able to support the tendon in the drill hole and position the tendon so a minimum of 1/2 inch of grout cover is provided and shall permit grout to freely flow around the tendon and up the drill hole.

6. Bondbreaker.

Fabricate the bondbreaker from a smooth plastic tube or pipe having the following properties:

a. Resistant to chemical attack from aggressive environments, grout, or corrosion inhibiting compound;

b. Resistant to aging by ultra-violet light;

c. Fabricated from material non-detrimental to the tendon;

d. Capable of withstanding abrasion, impact, and bending during handling and installation;

e. Enables the tendon to elongate during testing and stressing; and

f. Allows the tendon to remain unbonded after lock-off.

7. Cement Grout.

Use type I, II, III, or V Portland cement conforming to AASHTO M 85 for grout. The grout shall be a pumpable neat mixture of cement and water and shall be stable (bleed less than 2%), fluid, and provide a minimum 28 day compressive strength of at least 3000 psi measured in accordance with ASTM C 109 at time of stressing.

8. Admixtures.

Admixtures which control bleed, improve flowability, reduce water content, and retard set may be used in the grout subject to the approval of the Engineer. Admixtures, if used, shall be compatible with the prestressing steels and mixed in accordance with the manufacturer's recommendations. Expansive admixtures may only be added to the grout

used for filling sealed encapsulations, trumpets, and anchorage covers. Accelerators shall not be permitted.

9. Grout Tubes.
Grout tubes shall have an adequate inside diameter to enable the grout to be pumped to the bottom of the drill hole. Grout tubes shall be strong enough to withstand a minimum grouting pressure of 145 psi. Postgrout tubes shall be strong enough to withstand postgrouting pressures.

10. Heat Shrinkable Sleeves.
Fabricate heat shrinkable sleeves from a radiation crosslinked polyolefin tube internally coated with an adhesive sealant. Prior to shrinking, the tube shall have a nominal wall thickness of 0.025 inch. The adhesive sealant inside the heat shrinkable tube shall have a nominal thickness of 0.02 inch.

11. Sheath.
Use a sheath as part of the corrosion protection system for the unbonded length portion of the tendon. Fabricate the sheath from one of the following:

- **a.** A polyethylene tube pulled or pushed over the steel tendon. The polyethylene shall be Type II, III or IV as defined by ASTM D 1248 (or approved equal). The tubing shall have a minimum wall thickness of 0.06 inch.
- **b.** A hot-melt extruded polypropylene tube. The polypropylene shall be cell classification B55542-11 as defined by ASTM D 4101 (or approved equal). The tubing shall have a minimum wall thickness of 1.5 mm.
- **c.** A hot-melt extruded polyethylene tube. The polyethylene shall be high density Type III as defined by ASTM D1248 (or approved equal). The tubing shall have a minimum wall thickness of 0.06 inch.
- **d.** Plastic pipe or tube of PVC conforming to ASTM D 1784 Class 13464-B. The pipe or tube shall be Schedule 40 at a minimum.

12. Corrosion Protection.

a. Protection Requirements.
Construct the tieback anchor, including the anchorage, unbonded length, and bonded length, with Class I corrosion protection in accordance with PTI DC35.1-14 (Recommendations for Prestressed Rock and Soil Anchors, Post-Tensioning Institute). Design and construct the corrosion protection system to provide reliable tieback anchors for temporary and permanent structures.

b. Anchorage Protection.

1) All stressing anchorages permanently exposed to the atmosphere shall be grout-filled cover, except, for restressable anchorages, a corrosion inhibiting compound must be used. Stressing anchorages encased in concrete at least 2 inches thick do not require a cover.

2) Seal the trumpet to the bearing plate and shall overlap the unbonded length corrosion protection by at least 4 inches. The trumpet shall be long enough to accommodate movements of the structure and the tendon during testing and stressing.

3) Completely fill the trumpet with grout, except restressable anchorages must use corrosion inhibiting compounds. Compounds may be placed any time during construction. Compound-filled trumpets shall have a permanent seal between the trumpet and the unbonded length corrosion protection. The corrosion inhibiting compound placed in either the free length or the trumpet area shall be an organic compound (that is, grease or wax) with appropriate polar moisture displacing, corrosion inhibiting additives and self-healing properties. The compound shall permanently stay viscous and be chemically stable and nonreactive with the prestressing steel, the sheathing material, and the anchor grout. Grout must be placed after the tieback anchor has been tested and stressed to the lock-off load.

Trumpets filled with grout shall have either a temporary seal between the trumpet and the unbonded length corrosion protection or the trumpet shall fit tightly over the unbonded length corrosion protection for a minimum of 4 inches.

c. Unbonded Length Protection.

1) Corrosion protection of the unbonded length shall be provided by a combination of sheaths, sheath filled with a corrosion inhibiting compound or grout, or a heat shrinkable tube internally coated with a mastic compound, depending on the tendon class. The corrosion inhibiting compound shall completely coat the tendon elements, fill the void between them and the sheath. Provisions shall be made to retain the compound within the sheath.

2) The corrosion protective sheath surrounding the unbonded length of the tendon shall be long enough to extend into the trumpet, but shall not come into contact with the stressing anchorage, the bearing plate, or the anchor head, during testing. Any excessive protection length shall be trimmed off.

3) For pregrouted encapsulations and all Class I tendons, a separate bondbreaker or common sheath shall be provided for supplemental corrosion protection or to prevent the tendon from bonding to the grout surrounding the unbonded length.

d. Unbonded Length/Bond Length Transition.

Design and fabricate the transition between the corrosion protection for the bonded and unbonded lengths to ensure continuous protection from corrosive attack.

e. Tendon Bond Length Protection for Encapsulated Tendons (Class I).

1) Use a grout-filled, corrugated plastic encapsulation or a grout-filled, deformed steel tube. Fabricate the encapsulation from one of the following:

a) High density corrugated polyethylene tubing conforming to the requirements of AASHTO M 252 and having a minimum wall thickness of 0.06 inch except pregrouted tendons which may have a minimum wall thickness of 0.04 inch.

b) Deformed steel tubing or pipes conforming to ASTM A 52 or A 500 with a minimum wall thickness of 0.2 inch.

c) Corrugated, polyvinyl chloride tubes manufactured from rigid PVC compounds conforming to ASTM D 1784, Class 13464-B

2) The steel tendon can be grouted inside the encapsulation prior to inserting the tendon into the drill hole or after the tendon has been placed.

3) Centralizers or grouting techniques shall ensure a minimum of 1/2 inch of grout cover over the encapsulation.

f. Coupler Protection.

On encapsulated bar tendons (Class I), cover the coupler and any adjacent exposed bar sections with a corrosion-proof compound or wax-impregnated cloth tape. Cover the coupler area by a smooth plastic tube complying with the requirements set forth in Article 150358a.02, E, 11 of these specifications, overlapping the adjacent sheathed tendon by at least 1 inch. Seal the two joints each by a coated heat shrink sleeve of at least 6 inches, or approved equal. Completely fill the space inside the cover tube with corrosion-proof compound.

13. Water.

Water for mixing grout shall be potable, clean, and free of injurious quantities of substances known to be harmful to Portland cement or steel tendon.

J. Timber Lagging.

Timber used for lagging shall be construction grade rough cut or better and shall be the full dimension thickness shown in the shop drawings. Minimum thickness is 4 inches.

K. Structural Concrete.

Apply Section 2403 of the Standard Specifications.

L. Geocomposite Drainage Material.

Geocomposite drainage material shall be MiraDRAIN 9000 drainage panels or equivalent material approved by the Engineer.

M. Drainage Pipes.
Materials and details shall conform to the plans and Standard Specifications.

N. Steel Reinforcement.
Apply Section 2404 of the Standard Specifications.

O. Plastic Waterstop.
Sika Greenstreak Waterstop Shape #703, or approved equivalent.

P. Concrete Facing Chamfers.

1. Inserts used within the forms to create chamfers may be made of wood, steel, plastic or other nonporous material capable of withstanding anticipated concrete pour pressures without physical defects. Wood inserts, if used, shall be free of grain, texture, warp, twist, checks or cracks, and shall be presoaked prior to placement of concrete in the forms. Chamfer inserts shall not impress a texture in the concrete.

2. Chamfer inserts shall not allow leakage of concrete between the form and the insert. When steel forms are used, rustication and chamfer strips may be rigidly attached to the inside form surface. When steel forms are not used, fasten strips to the forms in a manner which will permit them to remain in the concrete when the forms are removed. Leave inserts in place until they can be removed without damaging surrounding concrete.

3. Design the inserts to form the chamfers to the lines, depths and dimensions shown in the Plans. Create inserts using a minimum number of splice joints in their length. Splices, if used, shall be tightly joined so as not to allow gaps or leaks, and shall not create any change in alignment or dimensions of the chamfer in the formed concrete surface.

Q. Steel Chain Link Fence.
Apply Section 2519 of the Standard Specifications.

150358a.03 QUALIFICATIONS.

A. Contractor Qualifications.

1. The Contractor performing the design and construction of the work shall have a minimum of 5 years of experience in anchored wall design and construction and shall submit evidence of successful completion of at least five similar projects. The Contractor may utilize the services of an independent design consultant to meet the requirements of this section.

2. The Contractor's staff shall include at least one registered Professional Engineer licensed to perform work in the State of Iowa. The Contractor shall assign an engineer with at least 3 years of experience in the design and construction of permanent anchored walls to supervise the work. The Contractor shall assign superintendents or foremen with a minimum of 2 years of experience in the supervision of permanent anchored wall construction. The Contractor may ~~not use consultants or manufacturer's representatives in order~~ utilize the services of an independent design consultant for the design of the permanent anchored walls and to meet the requirements of this section.

3. At least 2 weeks prior to the beginning the work, submit to the Engineer a report which identifies the personnel who will be performing and supervising the work. The report shall include the names of an engineer-in-charge, superintendents, and drill operators. The report

shall also contain a list of employer's names and telephone numbers, location and dates of previous projects, and the extent of work performed. This information must be verifiable.

4. The Superintendent shall be present at the job site at all times during the performance of the work.

5. Drill Operators shall have successfully installed three permanent soldier pile and lagging walls.

6. Welding Personnel shall be qualified per ANSI/AASHTO/AWS D1.5:2015 Bridge Welding Code Section 5 Part B. For tubular (API or ASTM A53) Material, Welding Personnel shall be qualified per ANSI/AASHTO/AWS D1.1:2015.

B. Qualification Submittals.

1. Submit a list containing at least five projects completed within the last 5 years. For each project, include with this submittal at a minimum: (1) name of client contact, address, and telephone number; (2) location of project; (3) contract value; (4) scheduled completion date and actual completion date for the project.

2. Resumes of the Contractor’s staff shall be submitted to the Department for review as part of the Contractor bid. Only those individuals designated as meeting the qualifications requirements shall be used for the project. The Contractor cannot substitute for any of these individuals without written approval of the Engineer. The Engineer will approve or reject the Contractor’s qualifications and staff within 15 working days after the Department’s receipt of the submission. Work shall not be started on any anchored wall system nor materials ordered until the Contractor’s qualifications have been approved by the Engineer. The Engineer may suspend the work if the Contractor substitutes unqualified personnel for approved personnel during construction. If work is suspended due to the substitution of unqualified personnel, the Contractor shall be fully liable for additional costs resulting from the suspension of work and no adjustment in contract time resulting from the suspension of work will be allowed.

150358a.04 CONSTRUCTION.

A. Submittals.

All submittals shall be submitted to the Engineer for review and acceptance. Acceptance of any and all submittals does not relieve the Contractor of responsibility for the adequacy of the construction of tieback-anchored soldier pile and lagging wall to achieve the required results and for the successful completion of the work. Do not incorporate any submittal item into the work, nor order, fabricate, and/or deliver any material or component, prior to receiving acceptance of the Engineer regarding the same.

1. Submit a Design Package. The Design Package shall include detailed calculations for the anchor system and for the temporary timber lagging. Each design shall be signed and sealed by a Professional Engineer currently licensed in the State of Iowa.

2. Submit a specific construction sequence. The sequence shall detail all required staging of the wall construction and shall include a proposed schedule for the completion of wall elements and the work to be performed during each construction stage.

3. Submit a proposed tieback-anchored soldier pile and lagging wall installation plan detailing the technical, equipment, and logistical requirements of the entire wall installation including sections detailing installation of all pertinent wall components. The drilled shaft installation section shall include all the requirements listed in Article 2433.03, B, 2 of the Standard Specifications.

4. Submit shop drawings, including but not limited to:
- **a.** Grade and strengths of all construction materials used.
- **b.** Materials, details, arrangement, and method of construction of the proposed tieback-anchored soldier pile and lagging retaining wall system.
- **c.** Details for the timber lagging.
- **d.** Method for installing soldier piles, including pre-drilling procedures. Driven soldier piles are not permitted.
- **e.** Mix designs for structural and lean concrete and procedures for placing the concrete in accordance with the provisions outlined herein.
- **f.** A tieback anchor schedule with identification information consistent with the plans and including all information not designated on the Plans:
  - **1)** Proposed design bonded length; and
  - **2)** Minimum proposed total anchor length.
- **g.** A drawing of the tieback anchor tendon and the corrosion protection system including specific details and manufacturer product identification for the following:
  - **1)** Spacers and their location;
  - **2)** Centralizers and their location;
  - **3)** Unbonded length corrosion protection system;
  - **4)** Bonded length corrosion protection system;
  - **5)** Anchorage and trumpet; and
  - **6)** Anchorage corrosion protection system.
- **h.** Certificates of Compliance for the following materials, if used. The certificate shall state that the material or assemblies to be provided will fully comply with the requirements of the contract.
  - **1)** Steel tendon;
  - **2)** Portland cement;
  - **3)** Stressing hardware;
  - **4)** Bearing plates; and
  - **5)** Corrosion protection system.

5. Submit descriptive data and operating procedures for all equipment to be used. This shall include, at a minimum; machinery required to drill shafts; install soldier piles, tieback anchors, and timber lagging; excavate soil; and remove obstructions. All pertinent equipment data including sizes, weights, capacities, torques, and operating frequencies shall be included in the submittal.

6. Submit mill test reports for the steel tendon and the bearing plate steel. The Engineer may require the Contractor to provide samples of any anchor material intended for use on the project.

7. Submit calibration data for each test jack, load cell, primary pressure gauge, and reference pressure gauge to be used.

8. Submit a record report to the Engineer within 20 calendar days after completion of the anchor work. The Record Report shall at a minimum include the following:
- **a.** Prestressing steel manufacturer's mill test reports for the tendons incorporated into the installation;
- **b.** Grouting records indicating grout pressures as well as the cement type and quantity of cement injected;
- **c.** Anchor test results and associated graphs; and
- **d.** As-Built Drawings documenting the following for all anchors:
  - **1)** Location and orientation;
  - **2)** Capacity;
  - **3)** Tendon type; and
  - **4)** Total length, bonded length, and unbonded length.

B. General Construction Methods.

1. Install and maintain the tieback-anchored soldier pile and lagging wall in accordance with the design as shown on the Plans and on the accepted contractor submittals and shop drawings, and in such a manner as to minimize movement, settlement, or loss of ground, removal of fines from adjacent ground, and to prevent damage to or movement of adjacent structures and/or utilities.

2. Field welding shall be performed by certified welders in accordance with the plan notes and these Special Provisions.

3. The wall construction shall be in accordance with the construction sequence and installation plan per submittal requirements herein, using materials as specified herein. Testing shall be in accordance with requirements herein. Additional construction requirements include the following:

a. Construct drilled shafts with soldier piles in accordance with Article 2433.03 of the Standard Specifications with the following revisions and additional requirements:

1) Construction tolerance requirements on the plans and herein supersede the requirements listed in Article 2433.03, A of the Standard Specifications.

2) Submittal requirements herein supersede the requirements listed in Article 2433.03, B of the Standard Specifications.

3) The requirements of Article 2433.03, H of the Standard Specifications are applicable by substituting “Steel Reinforcing Pile” for “Steel Reinforcing Cage”.

4) Crosshole Sonic Log (CSL) Testing per Article 2433.03, J of the Standard Specifications is not required.

5) A Test Shaft per Article 2433.03, L of the Standard Specifications is not required.

6) After drilled shaft is completed to the elevation shown on the plans and the soldier pile section is set in-place, the drilled shaft structural concrete shall be immediately tremied to the proposed bottom of permanent facing elevation followed by the lean concrete. Excavate downward and install timber lagging per Plans as excavation progresses to approximately 2 feet below the tieback anchor location. Ensure in-situ material is retained and there is no loss of material at bottom of in-place lagging. Place aggregate behind lagging as required to eliminate voids between lagging and in-situ material. Place fill in accordance with Article 2432.03, G, 4 of the Standard Specifications. Aggregate placement shall proceed at a pace that prevents movement of the wall, movement of retained material behind the wall, and loss of ground.

b. Drilling methods for tieback anchors shall be determined by the Contractor, subject to the requirements herein, including submittal requirements herein. The Contractor shall be responsible for using a drilling method to establish a stable hole of adequate dimensions, within the tolerances specified. Drilling methods may involve, amongst others, rotary, percussion, rotary/percussive or auger drilling; or percussive or vibratory driven casing.

c. Holes for tieback anchors shall be drilled at the locations and to the length, inclination, and diameter shown on the Plans or the accepted Contractor submittals. The drill bit or casing crown shall not be more than 0.1 inch smaller than the specified hole diameter. At the excavation face the drill hole shall be located between the pile channels and vertically within 12 inches of the elevation shown on the Plans or the accepted submittals. The drill hole shall be located so the longitudinal axis of the drill hole and the longitudinal axis of the tendon are parallel. In particular, the tieback anchor hole shall not be drilled in a location that requires the tendon to be bent in order to enable the bearing plate to be connected to the supported structure. At the point of entry the tieback anchor shall be installed within ± 3 degrees of the inclination from horizontal shown on the Plans or the accepted submittals. At the point of entry the horizontal angle made by the tieback anchor and the structure shall be within ±3 degrees of a line drawn perpendicular to the plane of the structure unless otherwise shown on the Plans or accepted submittals. The

tieback anchors shall not extend beyond the right-of-way or easement limits shown on the Plans.

d. Tendon requirements include the following:

1) Tendons shall be placed in accordance with the Plans and details and the recommendations of the tendon manufacturer and/or the specialty contractor. The tendon shall be inserted into the drill hole to the desired depth without difficulty. When the tendon cannot be completely inserted, the Contractor shall remove the tendon from the drill hole and clean or redrill the hole to permit insertion. Partially inserted tendons shall not be driven or forced into the hole.

2) Each anchor tendon shall be inspected by field personnel during installation into the drill hole or casing. Damage to the corrosion protection system shall be repaired, or the tendon replaced if not repairable. Loose spacers or centralizers shall be reconnected to prevent shifting during insertion. Damaged fusion-bonded epoxy coatings shall be repaired in accordance with the manufacturer's recommendations. If the patch is not allowed to cure prior to inserting the tendon in the drill hole, the patched area shall be protected by tape or other suitable means.

3) The rate of placement of the tendon into the hole shall be controlled such that the sheathing, coating, and grout tubes are not damaged during installation of the tendon. Anchor tendons shall not be subjected to sharp bends. The bottom end of the tendon may be fitted with a cap or bullnose to aid its insertion into the hole, casing, or sheathing.

e. Grouting requirements include the following:

1) Use a neat cement grout or a sand-cement grout. The cement shall not contain lumps or other indications of hydration. Admixtures, if used, shall be mixed in accordance with the manufacturer's recommendations.

2) The grouting equipment shall produce a grout free of lumps and undispersed cement. A positive displacement grout pump shall be used. The pump shall be equipped with a pressure gauge to monitor grout pressures. The pressure gauge shall be capable of measuring pressures of at least 145 psi or twice the actual grout pressures used by the Contractor, whichever is greater. The grouting equipment shall be sized to enable the grout to be pumped in one continuous operation. The mixer should be capable of continuously agitating the grout.

3) Inject the grout from the lowest point of the drill hole. The grout may be pumped through grout tubes, casing, hollow-stem-augers, or drill rods. The grout can be placed before or after insertion of the tendon. The quantity of the grout and the grout pressures shall be recorded. The grout pressures and grout takes shall be controlled to prevent excessive heave or fracturing.

4) After the tendon is installed, the drill hole may be filled in one continuous grouting operation except that pressure grouting shall not be used in the free length zone. The grout at the top of the drill hole shall not contact the back of the structure or the bottom of the trumpet.

5) If the tieback anchor is installed in a fine-grained soil using drill holes larger than 6 inches in diameter, then the grout above the top of the bond length shall be placed after the tieback anchor has been tested and stressed. The Engineer will allow the Contractor to grout the entire drill hole at the same time if the Contractor can demonstrate that his particular tieback anchor system does not derive a significant portion of its load-carrying capacity from the soil above the bond length portion of the tieback anchor.

6) If grout protected tendons are used for tieback anchors anchored in rock, then pressure grouting techniques shall be utilized. Pressure grouting requires that the drill hole be sealed and that the grout be injected until a minimum 50 psi grout pressure (measured at the top of the drill hole) can be maintained on the grout for at least 5 minutes.

7) The grout tube may remain in the hole on completion of grouting if the tube is filled with grout.

8) After grouting, the tendon shall not be loaded for a minimum of 3 days.

f. Anchorage Installation requirements include the following:
1) The anchor bearing plate and the anchor head or nut shall be installed perpendicular to the tendon, within ±3 degrees and centered on the bearing plate, without bending or kinking of the steel tendon elements. Wedge holes and wedges shall be free of rust, grout, and dirt.
2) The stressing tail shall be cleaned and protected from damage until final testing and lock-off. After the anchor has been accepted by the Engineer, the stress tail shall be cut to its final length according to the tendon manufacturer's recommendations.

150358a.05 TESTING AND ACCEPTANCE OF TIEBACK ANCHORS.

A. Test each tieback anchor. No load greater than 10% of the design load shall be applied to the tieback anchor prior to testing. The maximum test load shall be no less than 1.33 times the design load and shall not exceed 80% of the specified minimum ultimate tensile strength (SMTS) of the tendon steel. Simultaneously apply the test load to the entire tendon. Stressing of single elements of multi-element tendons is not permitted.

B. Equipment.

1. The testing equipment shall consist of:
a. A dial gauge or vernier scale capable of measuring to the nearest 0.001 inch shall be used to measure the tieback anchor movement. The movement-measuring device shall have a minimum travel equal to the theoretical elastic elongation of the total anchor length at the maximum test load and it shall have adequate travel so the tieback anchor movement can be measured without resetting the device at an interim point.
b. A hydraulic jack and pump shall be used to apply the test load. The jack and a calibrated primary pressure gauge shall be used to measure the applied load. The jack and primary pressure gauge shall be calibrated by an independent firm as a unit. The calibration shall have been performed within 45 working days of the date when the calibration submittals are provided to the Engineer. Testing cannot commence until the Engineer has approved the calibration. The primary pressure gauge shall be graduated in 100 psi increments or less. The ram travel shall be at least 6 inches and preferably not be less than the theoretical elongation of the tendon at the maximum test load. If elongations greater than 6 inches are required, restroking can be allowed.
c. A calibrated reference pressure gauge shall also be kept at the site to periodically check the production (that is, primary pressure) gauge. The reference gauge shall be calibrated with the test jack and primary pressure gauge. The reference pressure gauge shall be stored indoors and not subjected to rough treatment.
d. An electrical resistance load cell and readout shall be used when performing an extended creep test.

2. The stressing equipment shall be placed over the anchor tendon in such a manner that the jack, bearing plates, load cells and stressing anchorage are axially aligned with the tendon and the tendon is centered within the equipment.
a. The stressing equipment, the sequence of stressing and the procedure to be used for each stressing operation shall be determined at the planning stage of the project. The equipment shall be used strictly in accordance with the manufacturer's operating instructions.
b. Stressing equipment shall preferably be capable of stressing the whole tendon in one stroke to the specified Test Load and the equipment shall be capable of stressing the tendon to the maximum specified Test Load within 75% of the rated capacity. The pump shall be capable of applying each load increment in less than 60 seconds.
c. The equipment shall permit the tendon to be stressed in increments so that the load in the tendon can be raised or lowered in accordance with the test specifications, and allow the anchor to be lift-off tested to confirm the lock-off load.

d. Stressing equipment shall be recently calibrated within an accuracy of ± 2% prior to use. The calibration certificate and graph shall be available on site at all times. The calibration shall be traceable to the National Institute of Standards and Technology (NIST).

C. Load Testing Setup.

1. Dial gauges shall bear on the pulling head of the jack and their stems shall be coaxial with the tendon direction. The gauges shall be supported on an independent, fixed frame, such as a tripod, which will not move as a result of stressing or other construction activities during the operation.

2. Prior to setting the dial gauges, the Alignment Load (AL) shall be accurately placed on the tendon. The magnitude of AL depends on the type and length of the tendon.

3. Regripping of strands, which would cause overlapping wedge bites, or wedge bites on the tendon below the anchor head, shall be avoided.

4. Stressing and testing of multiple element tendons with single element jacks is not permitted.

5. Stressing shall not begin before the grout has reached adequate strength.

D. Performance Tests.

1. Two percent of the tieback anchors for each design load shall be performance tested in accordance with the procedures described below. The Engineer shall select the tieback anchors to be performance tested. The remaining tieback anchors shall be tested in accordance with the proof test procedures.

2. The performance test shall be made by incrementally loading and unloading the tieback anchor in accordance with the schedule provided. The load shall be raised from one increment to another immediately after recording the tieback anchor movement. The tieback anchor movement shall be measured and recorded to the nearest 0.001 inch with respect to an independent fixed reference point at the alignment load and at each increment of load. The load shall be monitored with the primary pressure gauge. The reference pressure gauge shall be placed in series with the primary pressure gauge during each performance test. If the load determined by the reference pressure gauge and the load determined by the primary pressure gauge differ by more than 10%, the jack, primary pressure gauge and reference pressure gauge shall be recalibrated at no expense to the Department. At load increments other than the maximum test load, the load shall be held just long enough to obtain the movement reading.

3. The maximum test load in a performance test shall be held for 10 minutes. A load cell shall be used to monitor small changes in load during constant load-hold periods.

4. The jack shall be adjusted as necessary in order to maintain a constant load. The load-hold period shall start as soon as the maximum test load is applied and the tieback anchor movement, with respect to a fixed reference, shall be measured and recorded at 1 minute, 2, 3, 4, 5, 6, and 10 minutes. If the tieback anchor movement between 1 minute and 10 minutes exceeds 0.04 inch, the maximum test load shall be held for an additional 50 minutes. If the load hold is extended, the tieback anchor movement shall be recorded at 15 minutes, 20, 30, 40, 50, and 60 minutes.

5. Performance test steps shall be in accordance with the table below:

Table 151001.05-1: Performance Test Steps.

Step	Loading	Applied Load	Record and Plot Total Movement (d_{ti})	Record and Plot Residual Movement (d_{ri})	Calculate Elastic Movement (d_{ei})
1	Apply alignment load (AL)				
2	Cycle 1	0.25DL	d_{t1}		
		AL		d_{r1}	$d_{t1} - d_{r1} = d_{e1}$
3	Cycle 2	0.25DL	d_2		
		0.50DL	d_{t2}		
		AL		d_{r2}	$d_{t2} - d_{r2} = d_{e2}$
4	Cycle 3	0.25DL	d_3		
		0.50DL	d_3		
		0.75DL	d_{t3}		
		AL		d_{r3}	$d_{t3} - d_{r3} = d_{e3}$
5	Cycle 4	0.25DL	d_4		
		0.50DL	d_4		
		0.75DL	d_4		
		1.00DL	d_{t4}		
		AL		d_{r4}	$d_{t4} - d_{r4} = d_{e4}$
6	Cycle 5	0.25DL	d_5		
		0.50DL	d_5		
		0.75DL	d_5		
		1.00DL	d_5		
		1.2DL	d_{t5}		
		AL		d_{r5}	$d_{t5} - d_{r5} = d_{e5}$
7	Cycle 6	0.25DL	d_6		
		0.50DL	d_6		
		0.75DL	d_6		
		1.00DL	d_6		
		1.2DL	d_6		
		1.33DL	d_{t6}, zero reading for creep test		
8	Hold load for 10 minutes while recording movement at specified times. If the total movement measured during the load hold exceeds the specified maximum value then the load hold should be extended to a total of 60 minutes.				
9	Cycle 6 cont'd.	AL		d_{r6}	Cycle 6: $d_{tn} - d_{r6} = d_{e6}$
Notes: AL = Alignment Load, DL = Design Load, d_i = total movement at a load other than maximum for cycle, i = number identifying a specific load cycle.					

E. Proof Tests.

1. Perform the proof test on every tieback anchor by incrementally loading the tieback anchor in accordance with the following schedule. Raise the load from one increment to another immediately after recording the tieback anchor movement. Measure and record the tieback anchor movement to the nearest 0.001 inch with respect to an independent fixed reference point at the alignment load and at each increment of load. Monitor the load with the primary pressure gauge. At load increments other than the maximum test load, hold the load just long enough to obtain the movement reading.

Table SP-151001.05-2 PROOF TEST SCHEDULE

Step	Load
1	AL
2	0.25DL
3	0.50DL
4	0.75DL
5	1.00DL
6	1.20DL
7	1.33DL
8	Reduce to lock-off load
9	AL (optional)
10	Adjust to lock-off load

2. Hold the maximum test load in a proof test for 10 minutes. Adjust the jack as necessary in order to maintain a constant load. Start the load-hold period as soon as the maximum test load is applied and the tieback anchor movement with respect to a fixed reference is measured and recorded at 1 minute, 2, 3, 4, 5, 6, and 10 minutes. If the tieback anchor movement between 1 minute and 10 minutes exceeds 0.04 inch, hold the maximum test load for an additional 50 minutes. If the load hold is extended, record the tieback anchor movements at 15 minutes, 20, 30, 40, 50, and 60 minutes.

F. Creep Tests.

1. Creep testing shall be required on one anchor at the highest design load and one anchor at the second highest design load. The Engineer will select those tieback anchors that are to be creep tested. The stressing equipment shall be capable of measuring and maintaining the hydraulic pressure within 145 psi.

2. The extended creep test shall be made by incrementally loading and unloading the tieback anchor in accordance with the performance test schedule provided in Section D. At the end of each loading cycle, the load shall be held constant for the observation period indicated in the creep test schedule below. The times for reading and recording the tieback anchor movement during each observation period shall be 1 minute, 2, 3, 4, 5, 6, 10, 15, 20, 25, 30, 45, 60, 75, 90, 100, 120, 150, 180, 210, 240, 270, and 300 minutes as appropriate for the load increment. Each load-hold period shall start as soon as the test load is applied. In a creep test, the primary pressure gauge and reference pressure gauge will be used to measure the applied load and the load cell will be used to monitor small changes in load during constant load-hold periods. The jack shall be adjusted as necessary in order to maintain a constant load.

3. Plot the tieback anchor movement and the residual movement measured in an extended creep test. Plot the creep movement for each load hold as a function of the logarithm of time.

Table SP-151001.05-3 Extended Creep Test Schedule

Load	Observation period (min.)
AL	
0.25DL	10
0.50DL	30
0.75DL	30
1.00DL	45
1.20DL	60
1.33DL	300

G. Tieback Anchor Acceptance Criteria.

1. A performance-tested or proof-tested tieback anchor with a 10 minute load hold shall be acceptable if the: (1) tieback anchor resists the maximum test load with less than 0.04 inch of movement between 1 minute and 10 minutes; and (2) total elastic movement at the maximum test load exceeds 80% of the theoretical elastic elongation of the unbonded length.

2. A performance-tested or proof-tested tieback anchor with a 60 minute load hold shall be acceptable if the: (1) tieback anchor resists the maximum test load with a creep rate that does not exceed 0.08 inch in the last log cycle of time; and (2) total elastic movement at the maximum test load exceeds 80% of the theoretical elastic elongation of the unbonded length.

3. A tieback anchor subjected to extended creep testing is acceptable if the: (1) tieback anchor resists the maximum test load with a creep rate that does not exceed 0.08 inch in the last log cycle of time; and (2) total elastic movement at the maximum test load exceeds 80% of the theoretical elastic elongation of the unbonded length.

4. The initial lift-off reading shall be within ±5% of the designed lock-off Load. If this criterion is not met, then the tendon load shall be adjusted accordingly and the initial lift-off reading repeated.

H. Procedures for Anchors Failing Acceptance Criteria.

1. Anchors that do not satisfy the minimum apparent free length criteria shall be either rejected and replaced at no additional cost to the Department or locked off at not more than 50% of the maximum acceptable load attained. In this event, no further acceptance criteria are applied.

2. Regroutable anchors which satisfy the minimum apparent free length criteria but which fail the extended creep test at the test load may be postgrouted and subjected to an enhanced creep criterion. This enhanced criterion requires a creep movement of not more than 0.04 inch between 1 and 60 minutes at test load. Anchors which satisfy the enhanced creep criterion shall be locked off at the design lock-off load. Anchors which cannot be postgrouted or regroutable anchors that do not satisfy the enhanced creep criterion shall be either rejected or locked off at 50% of the maximum acceptable test load attained. In this event, no further acceptance criteria are applied. The maximum acceptable test load with respect to creep shall correspond to that where acceptable creep movements are measured over the final log cycle of time.

3. In the event that an anchor fails, the Contractor shall modify the design and/or construction procedures. These modifications may include, but are not limited to, installing additional anchors, modifying the installation methods, reducing the anchor design load by increasing the number of anchors, increasing the anchor length, or changing the anchor type. Any modification of design or construction procedures shall be at no change in the contract price. A description of any proposed modifications must be submitted to the Engineer in writing. Proposed modifications shall not be implemented until the Contractor receives written approval from the Engineer.

I. Anchor Lock-off Requirements.

1. After testing has been completed, the load in the tendon shall be such that after seating losses (that is, wedge seating), the specified lock-off load has been applied to the anchor tendon.

2. The magnitude of the lock-off load shall be specified by the Engineer, and shall not exceed 70% Fpu, where Fpu is the specified minimum tensile strength of the tendon as defined in the pertinent ASTM specification.

3. The wedges shall be seated at a minimum load of 50% Fpu. If the lock-off load is less than 50% Fpu, shims shall be used under the wedge plate and the wedges seated at 50% Fpu. The shims shall then be removed to reduce the load in the tendon to the desired lock-off load. Bar tendons may be locked off at any load less than 70% Fpu.

J. Anchor Lift-Off Test.

After transferring the load to the anchorage, and prior to removing the jack, a lift-off test shall be conducted to confirm the magnitude of the load in the anchor tendon. This load is determined by reapplying load to the tendon to lift off the wedge plate (or anchor nut) without unseating the wedges (or turning the anchor nut). This moment represents zero time for any long time monitoring.

150358a.06 CONSTRUCTION TOLERANCES.

A. Drilled shaft excavations and completed soldier piles not constructed within the required tolerances will be considered unacceptable. Correct all unacceptable drilled shaft excavations and completed soldier piles to the Engineer's satisfaction. Ensure the soldier pile is within 1 1/2 inches of the indicated horizontal plan location at front of wall finished grade elevation. Ensure the vertical alignment of drilled shaft excavation and pile do not vary from the plan alignment by more than 2 inches per 10 feet.

B. Casing dimensions are subject to American Pipe Institute tolerances applicable to regular steel pipe.

C. See Article 150358a.04, B, 3, c of this specification for allowed variances in tieback anchor drill hole location and inclination angles.

D. Furnish materials and work necessary, including engineering analysis and redesign, to complete corrections for out of tolerance conditions (without either cost to the Department or an extension of the completion dates of the project).

150358a.07 METHOD OF MEASUREMENT.

Measurement for items associated with Tieback-Anchored Soldier Pile and Lagging Wall will be measured as follows:

A. Granular Material for Blanket and Subdrain: Measurement will be in cubic yards based on the payment limits shown on the contract documents.

B. Class 23 Excavation: Measurement will be in cubic yards based on the payment limits shown on the contract documents.

C. Facing Wall Concrete: Measurement will be in cubic yards based on the payment limits shown on the contract documents.

D. Reinforcing Steel, Epoxy Coated: Section 2404 applies.

E. Subdrains: Section 2502 applies.

F. Structural Steel: Section 2408 applies.

G. Concrete Drilled Shaft: Feet, to the nearest 1 foot, constructed.

H. Chain Link Fence: linear feet constructed, of the height and type specified, measured along the fence at the bottom of the fabric.

I. Lean Cement Concrete: The Engineer will compute in cubic yards the total volume of the lean cement concrete placed using dimensions shown in the contract documents, along with the changes that have been made according to a written order from the Engineer. Additional concrete required to bring the facing or cap to the required elevation will not be measured for payment if such addition is made necessary by inaccuracies in the shape or placement of steel or concrete beams or by distortion of falsework.

J. Tieback Anchors: The quantity of tieback anchors (each) will be shown in the contract documents.

K. Geocomposite Drainage Panel: Will be measured per square yard, as shown in the contract documents.

L. Aesthetic Facing: Plan Quantities will be used. Final measurement will not be made.

M. Structural Concrete Coating: Plan Quantities will be used. Final measurement will not be made.

N. Temporary Timber Lagging: Plan Quantities will be used. Final measurement will not be made.

O. Waterstops and other incidental items necessary for the construction of the walls are incidental to other items and will not be measured or paid for.

150358a.08 BASIS OF PAYMENT.

Payment for all individual items will be made at the contract unit prices per measurement unit as defined above. Payment is full compensation for all work necessary, including but not limited to all contractor submittals, design, materials, labor, testing, and incidentals necessary for the in-place completion of the wall.