SP-231013
(New)

SPECIAL PROVISIONS
FOR
PERMANENT TIEBACK ANCHORS FOR CONCRETE RETAINING WALL

Polk County
STP-U-1945(858)--70-77

Effective Date
December 19, 2023

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.

231013.01 GENERAL.

A. Description.
The work covered under this special provision includes all necessary design and construction requirements for providing tieback anchors for the reconstructed concrete river wall (concrete retaining wall) shown on the plans. The tieback anchors shall consist of permanent ground anchors. The Contractor shall design and construct the tieback anchors in accordance with these Special Provisions, the Standard Specifications, and the plan. The Permanent Tieback Anchors may be utilized to support temporary sheet pile shoring at the discretion of the Contractor.

B. Qualifications.

1. The performance of tieback walls is strongly influenced not only by the methods and materials used, but also the experience of the Contractor. Contractors specializing in the design and construction of tieback walls shall be responsible for the tieback anchor final design. The guidelines presented herein are intended for evaluating tieback anchor design, stability considerations, and corrosion protection requirements.

2. The Contractor shall submit proof of five tieback walls successfully completed within the past 2 years. The Contractor's staff shall include a Professional Engineer licensed in the State of Iowa with at least 5 years' experience in the design and construction of tieback structures. In addition, their staff shall include a supervisory engineer for the project, having at least 3 years of design and construction experience in tieback work, and a foreman and drill operator with a minimum of 2 years' experience.

3. The Engineer will approve or reject the Contractor's qualifications and staff within 15 working days after receipt of the submission. Work shall not be started on any anchored wall system nor materials ordered until approval of the Contractor's qualifications are given. The Engineer

may suspend the ground anchor 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.

C. Design Criteria.

1. The tieback anchor design shall be in accordance with the 8th Edition of AASHTO LRFD Bridge Design Specifications, Series of 2017, and the "Recommendations for Prestressed Rock and Soil Anchors" from the Post Tensioning Institute (PTI). The design shall consider the internal and global stability of the concrete retaining wall and the tieback anchors. The Contractor's design of the tieback anchors shall include consideration of the following information.

a. Wall layout and location drawings and cross-sections as shown on the plans.
b. Service loads and maximum permissible length of tieback anchors, measured between the back of temporary shoring and the projected levee influence line indicated in the plans.
c. New and existing utility locations.
d. Location of Right-of-Way and easements.
e. The geotechnical investigation report(s), which can be provided upon request that has been completed for this project. Any additional soil investigation desired shall be at the cost of the Contractor.
f. Geochemistry of soil and ground water for corrosion potential.
g. Additional soil investigation desired, or soil design information required for this design, shall be at the cost of the Contractor.

2. The tieback anchors shall be designed to safely support the service loads provided in the plans and all construction loads, and all temporary and permanent loads without allowing undesirable deflections and settlement. The tieback anchor loads indicated in the plans are based on at-rest soil conditions. Design drawings shall be prepared showing the proposed method for tieback retaining wall work, including plan, elevation and sections of the wall, spacing of tie-back anchors, and a sufficient number of details to clearly illustrate the work. The relationship of the tiebacks to the projected levee influence line, right-of-way and easement lines, existing buildings, other structures, utilities, streets and other construction shall be clearly indicated. Projected levee influence lines, utility locations as shown on the plans and as provided to the Contractor by the Contracting Authority shall be shown. Also, the Contractor shall develop a procedure to monitor movements of the tieback anchors throughout the construction period as described in Article 231013.01, D. These drawings, showing all of the above information, shall be prepared by the Contractor’s engineer, and shall bear his seal and signature.

D. Submittals.

1. The Contractor shall provide design calculations and drawings of the proposed tieback anchors, including geotechnical analysis and global stability check. All final design calculations and final plans shall be stamped and signed by the Contractor’s engineer. The wall(s) shall follow the lines, grades, and location as shown on the plans. The wall shall be designed to conform to the levee influence line, right-of-way, and easement restrictions provided and shall protect existing and proposed utilities given on the plans or discovered during construction.

2. The drawings shall include all details, dimensions, and cross-sections necessary to construct the tieback anchors for the concrete retaining wall. The drawings and calculations shall include, but are not limited to, the following:

a. A description of the tieback installation including drilling procedures, grout mix design and placement method, and stressing information. The Contractor shall also submit the methods and materials used in filling the annulus over the unbonded length of the anchor.
b. A description of any temporary supports needed until the tieback anchors have been

installed and loaded to the design load.

c. Anchor capacity, ground anchor design load, type of tendon/rod, anchorage hardware, minimum bonded length and unbonded lengths, minimum anchor lengths, angle of installation, spacers and centralizers, and tieback locations and spacings.

d. The Contractor shall submit detailed plans as specified in Article 231013.03, G for the method proposed to be followed for the tieback anchor testing to the Engineer for approval prior to the tests. This shall include all necessary drawings and details to clearly describe the method proposed.

e. The Contractor shall submit to the Engineer calibration data for each load cell, test jack, pressure gauge and master pressure gauge to be used. The calibration tests shall have been performed by an independent testing laboratory and shall have been performed within 60 calendar days of the date submitted. The Engineer will approve or reject the calibration data after receipt of the data. Testing shall not commence until the Engineer has approved the load cell, test jack, pressure gauge and master pressure gauge calibrations.

f. Corrosion protection details for anchorages and tendons/rods.

g. Details of the connection of the tieback anchors to concrete retaining wall.

h. An elevation view of the concrete retaining wall, showing all tieback anchors and anchor identification number.

i. A plan view of the wall indicating the offset from the construction centerline to the face of the wall at all changes in horizontal alignment.

j. A plan to monitor alignment, tilt and elevation of the concrete retaining wall after construction of the concrete retaining wall. This plan shall include inclinometers or survey monitoring points on the wall spaced every 25 feet. The data shall be collected at least every 15 days, and at the completion of the project, and submitted to the Engineer for review. If alignment movements are detected, they shall be reported to the Engineer immediately.

k. The relationship between the concrete retaining wall, temporary shoring, and tieback anchors to the projected levee influence line, and existing and proposed utilities shall be clearly shown.

l. Provide a cross section at each tieback anchor location with X, Y, Z coordinates to indicate the proximity of the ends of tieback anchors relative to the proposed levee influence line.

m. All plans shall be prepared on 11 inch by 17 inch sheets including borders. Each sheet shall have a title block in the lower right-hand corner. Design calculations shall be on 8 ½ inch by 11 inch sheets.

3. Before construction begins, the Engineer shall be allowed 30 days to review the Contractor's design calculations and drawings. Included in this review is a check of global stability by the Geotechnical Engineer hired by the Contracting Authority. The review and acceptance of the final plans and methods of construction by the Engineer will not in any way relieve the Contractor of their responsibility for the successful completion of the work. Upon final acceptance of the project, the Contractor shall furnish the Engineer with a complete set of reproducible drawings.

E. Pre-construction Conference.

1. A pre-construction conference shall be held at least 5 working days prior to the Contractor beginning any tieback anchor installation work at the site to discuss construction procedures, personnel, and equipment to be used. Those attending shall include:

a. The superintendent, on site supervisors, and all foremen in charge of installing the tieback anchors, grout, and tensioning and testing the tieback anchors.

b. The Engineer and their designated representatives, including key inspection personnel.

2. If the Contractor's key personnel change, or if the Contractor proposes a significant revision of the approved installation plan, an additional conference shall be held before any additional work is performed.

231013.02 MATERIALS.

A. Structural and Reinforcing Steel.

1. Structural steel shall be in accordance with AASHTO M 270 Grade 50W and ASTM A709 Grade 50W.

2. Welding shall be in accordance with ANSI/AASHTO/AWS D1.5 Bridge Welding Code.

B. Tieback Anchors.

1. All materials for tieback anchors shall comply with the current "Recommendations for Prestressed Rock and Soil Anchors" from the PTI.

2. Tieback tendons shall be fabricated from prestressing steel conforming to one of the following requirements:
- **a.** Continuously threaded steel bars conforming to AASHTO A-722 "Uncoated High-strength Steel Bars for Prestressed Concrete"; or
- **b.** Seven-wire strand conforming to the requirements of AASHTO M203 (ASTM A-416) "Uncoated Seven-wire Stress Relieved Strand for Prestressed Concrete."

3. Anchorages shall be capable of developing 95 % of the guaranteed minimum ultimate tensile strength of the prestressing steel tendon.

4. Prestressing steel couplers shall be capable of developing 95 % of the guaranteed minimum ultimate tensile strength of the prestressing steel.

5. Spacers shall be used to separate elements of a multi-element tendon in the bond length. They shall be fabricated from plastic, steel or other materials (except wood), which is non-detrimental to the prestressing steel. A combination centralizer-spacer may be used.

6. Centralizers shall be fabricated from plastic, steel or materials (except wood) that are non-detrimental to the tieback tendon. The centralizer shall be able to support the tendon in the drill hole and position the tendon so a minimum of 0.5 inches of grout cover is provided and shall permit grout to freely flow up the drill hole.

7. Corrosion protection for the tieback tendons shall be in accordance with Article 231013.03, F and fabricated from the following:
- **a.** Corrosion-inhibiting grease shall conform to the requirements of Section 3.2.5 of the PTI "Specification for Unbonded Single Strand Tendons."
- **b.** The bondbreaker for strand tendon unbonded length shall be:
  - **1)** A polyethylene tube pulled or pushed over a strand. 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 60 mils ± 10 mils; or
  - **2)** A hot-melt extruded polypropylene tube applied over a corrosion inhibiting grease coated strand. The polypropylene shall be cell classification PP 210 B5554211, as defined by ASTM D 4101 (or approved equal). The tubing shall have a minimum wall thickness of 60 mils ± 10 mils.
  - **3)** A hot-melt extruded polyethylene tube applied over a corrosion inhibiting grease coated strand. The polyethylene shall be high density Type III as defined by ASTM D 3350 and ASTM D 1248 (or approved equal). The tubing shall have a minimum wall thickness of 60 mils ± 10 mils.

8. The bondbreaker for bar tendon unbonded length shall be a low density polyethylene tubing, polypropylene tubing or polyvinyl chloride tubing with a minimum wall thickness of 40 mils ± 10 mils.

9. Corrugated tubes shall be:
- **a.** High density corrugated polyethylene tubing conforming to the requirement of AASHTO M 252 with a minimum wall thickness of 30 mils; or
- **b.** Corrugated polyvinyl chloride tubes manufactured from rigid PVC compounds conforming to ASTM D 1784, Class 13464-8; or
- **c.** Deformed steel tubing or pipes with a minimum wall thickness of 25 mils.

10. Fusion bonded, epoxy coating shall be in accordance with AASHTO M284, except that it shall have a film thickness of 15 mils.

11. Heat-shrink tubing shall be an irradiated, heat shrinkable polyethylene tube internally coated with a thixotropic sealant. Prior to shrinking the tube shall have a nominal wall thickness of 24 mils. The adhesive sealant inside the tube shall have a nominal thickness of 20 mils.

12. A trumpet shall be used to provide a transition from the anchorage to the unbonded length corrosion protection and shall be fabricated from a steel pipe or tube conforming to the requirements of ASTM A 53 for pipe or ASTM A 500 for tubing. The trumpet shall have a minimum wall thickness of 0.125 inches for diameters up to 4 inches and 0.20 inches for larger diameters.

C. Grout for Tieback Anchors.

1. Water for mixing grout shall be potable.

2. Admixtures that control bleed, improve flowability, reduce water content and retard set may be used in the grout. Expansive admixtures may only be added to the grout used for filling encapsulations, trumpets and anchorage covers. Expansive admixtures shall not be permitted in the bond length grout. Accelerators shall not be permitted. Admixtures, if used, shall be compatible with prestressing steels and mixed in quantities not to exceed the manufacturer's recommendations.

231013.03 CONSTRUCTION.

A. Tieback Tendon Fabrication.

1. The tendons can be either shop or field fabricated from prestressing steel and materials conforming to the requirements of the Materials subsection of this Specification. The tendon shall be fabricated as shown on the approved Working Drawings.

2. The Contractor shall select the type of tendon to be used. The tendon shall be sized so the design load does not exceed 60 % of the minimum specified ultimate tensile strength of the tendon, and the maximum test load does not exceed 80 % of the minimum specified ultimate tensile strength of the tendon.

B. Tieback Corrosion Protection.

1. The Contractor shall provide "Class 1" corrosion protection (double corrosion protection) for all tiebacks in accordance with the "Recommendations for Prestressed Rock and Soil Anchors" from the PTI.

2. The corrosion protection of the tendon unbonded length shall be provided by a sheath completely filled with corrosion inhibiting grease or grout, or a heat shrinkable tube internally coated with an elastic adhesive. If grease is used under the sheath, provisions shall be made to prevent the grease from escaping at the ends of the sheath. The grease shall completely coat the tendon, fill the void between the tendon and the sheath and fill the interstices between the wires of the seven-wire strands. The Working Drawings shall show how the Contractor will

provide a transition between the bond length and the unbonded length corrosion protection. If the sheath is grout filled, a separate bondbreaker must be provided. The bondbreaker shall prevent the tendon from bonding to the grout surrounding the unbonded length.

C. Tendon Bond Length.

1. The Contractor shall be responsible for determining the bond length and tendon bond length necessary to develop the design load required, and in accordance with the Testing subsection of this Special Provision. The total anchor length shall not be less than that indicated in the approved shop plans. The minimum bond length shall be 10 feet in rock and 15 feet in soil.

2. The unbonded tendon length shall extend beyond the critical failure surface and be a minimum of the lengths shown in the plans. The critical failure surface starts at the bottom of the existing concrete wall and river box culvert. The wall anchor system shall be checked for adequate stability. The overall stability of the earth mass being retained shall be checked and shall have a minimum factor of safety of 1.3.

D. Storage and Handling of Tieback Tendons.

1. Tendons shall be handled and stored in such a manner as to avoid damage or corrosion. Damage to the prestressing steel as a result of abrasions, cuts, nicks, welds and weld splatter will be cause for rejection. The prestressing steel shall be protected if welding is to be performed in the vicinity. Ground of welding leads to the prestressing steel is forbidden. Prestressing steel shall be protected from dirt, rust or deleterious substances. A light coating of rust on the steel is acceptable. If heavy corrosion or pitting is noted, the tendons shall be rejected.

2. The Contractor shall use care in handling and storing the tendons at the site. Prior to inserting a tendon in the drill hole, the Contractor and the Inspector shall examine the tendon for damage to the prestressing steel, the encapsulation and the bond breaker. If the encapsulation is damaged, it shall be repaired in accordance with the tendon supplier's recommendations. If the bond breaker has been damaged, it can be repaired with ultra high molecular weight polyethylene. The tape should be spirally wound around the tendon so as to completely seal the damaged area. The pitch of the spiral shall ensure a double thickness at all points.

E. Drilling and Grouting Tiebacks.

1. The Contractor shall select the drilling method, the grouting procedure, and the grouting pressure used for the installation of the ground anchor.

2. Drill holes for the tiebacks at the locations indicated on the approved shop plans. Core drilling, rotary drilling, or auger drilling may be used. A tolerance of ± three degrees in any direction will be permitted on the tieback angle, and ± 12 inches on the location at the point of entry. Tieback angles shown in the Contractor's working drawings may be changed providing the design loads are changed accordingly.

3. When caving conditions are encountered, no further drilling will be allowed until the Contractor selects a method to prevent ground movement. The Contractor may use a temporary casing. The Contractor's method to prevent ground movement will be approved by the Engineer. The casings for the anchor holes, if used, shall be removed. The drill hole shall be located so the longitudinal axis of the drill hole and the longitudinal axis of the tendon are parallel. The ground anchor shall not be drilled in a location that requires the tendon to be bent in order to enable the tendon to be connected to the soldier pile. The ground anchors shall not extend beyond the Tieback Anchor Limits as shown in the Contractor’s working drawings.

4. 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 re-drill the hole to permit insertion. Partially inserted tendons shall not be driven or forced into the hole.

5. The Contractor shall use a neat cement grout or a sand-cement grout as shown on the approved mix design. The cement shall not contain lumps or other indications of hydration. Admixtures, if used, shall be mixed in accordance with the manufacturer's recommendations. Design strength of the grout shall be a minimum of 4000 psi. However, adequacy of grout strength shall be determined by testing each tieback.

6. 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 150 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.

7. The grout shall be injected 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 in soils or fracturing of rock formations.

8. Except where indicated below, the grout above the top of the bond length may be placed at the same time as the bond length grout, but it shall not be placed under pressure. The grout at the top of the drill hole shall not contact the back of the structure or the bottom of the trumpet before testing the tiebacks.

9. Upon completion of the grouting, the grout tube may remain in the hole, but it shall be filled with grout. After grouting, the tendon shall not be tested for a minimum of 3 days.

10. If the ground anchor is installed in fine-grained soils using drill holes larger than 6 inches in diameter, no grout shall be placed above the top of the bond length during the time the bond length grout is placed. The grout above the top of the bond length shall be placed after the ground anchor has been tested and stressed. The grout at the top of the drill hole shall not contact the back of the structure or the bottom of the trumpet. Except as otherwise noted, only nonstructural filler shall be placed above the bond length grout prior to testing and acceptance of the anchor. The Contractor may place structural grout above the bond length grout prior to testing and acceptance of the anchor subject to the following conditions:
- **a.** The anchor unbonded length shall be increased by 8.5 feet minimum.
- **b.** The grout in the unbonded zone shall not be placed by pressure grouting methods.

F. Installation and Corrosion Protection of the Trumpet and Anchorage.

1. The corrosion protection surrounding the unbonded length of the tendon shall extend up beyond the bottom seal of the trumpet or 1 foot into the trumpet if no trumpet seal is provided. If the protection does not extend beyond the seal or sufficiently far enough into the trumpet, the Contractor shall extend the corrosion protection or lengthen the trumpet.

2. The corrosion protection surrounding the unbonded length of the tendon shall not contact the bearing plate or the anchorhead during testing and stressing. If the protection is too long, the Contractor shall trim the corrosion protection to prevent contact.

3. The bearing plate and anchorhead shall be placed so the axis of the tendon is perpendicular to the bearing plate within ± 3 degrees and the axis of the tendon shall pass through the center of the bearing plate.

4. If grout protected tendons or fusion-bonded epoxy encapsulations are used, the bearing plate, anchorhead and trumpet shall be electrically isolated from the surrounding concrete, or any metallic element embedded in the structure.

5. The most critical area to protect from corrosion is in the vicinity of the trumpet and anchorage. Trumpets shall be completely filled with grout or corrosion inhibiting grease after the tieback has been tested and locked-off. Trumpet grease can be placed anytime during construction. Trumpet grout shall be placed after the ground anchor has been tested. The Contractor shall demonstrate to the Engineer that the procedures selected by the Contractor for placement of either grease or grout will produce a completely filled trumpet.

6. All anchorages permanently exposed to the atmosphere shall be covered with a corrosion inhibiting grease-filled or grout-filled cover. The Contractor shall demonstrate to the Engineer that the procedures selected by the Contractor for placement of either grease or grout will produce a completely filled cover. If the Plans require restressable anchorages, corrosion inhibiting grease must be used to fill the anchorage cover and trumpet.

7. Anchorage devices shall be capable of developing 95 percent of the minimum guaranteed ultimate tensile strength of the prestressing steel tendon. The anchorage devices shall conform to the static strength requirements of Section 3.1.1 and Section 3.1.8(1) of the PTI "Guide Specification for Post Tensioning Materials".

8. The bearing plates shall be sized so the bending stresses in the plate do not exceed the yield strength of the steel when a load equal to 95 % of the minimum guaranteed ultimate tensile strength of the tendon is applied; and the average bearing stress on the concrete does not exceed that recommended in Section 3.1.7 of the PTI, "Guide Specification For Post Tensioning Materials."

9. The trumpet shall have an inside diameter equal to or larger than the hole in the bearing plate. The trumpet shall be long enough to accommodate movements of the structure during testing and stressing. For strand tendons with encapsulation over the unbonded length, the trumpet shall be long enough to enable the tendon to make a transition from the diameter of the tendon in the unbonded length to the diameter of the tendon at the anchorhead without damaging the encapsulation. Trumpets filled with corrosion-inhibiting grease shall have a permanent Buna-N rubber or approved equal seal provided between the trumpet and the tendon unbonded length corrosion protection. Trumpets filled with grout shall have a temporary seal provided between the trumpet and the tendon unbonded length corrosion protection or the trumpet shall overlap the tendon unbonded length corrosion protection.

G. Tieback Testing Procedure.

1. Each tieback shall be tested in accordance with the "Recommendations for Prestressed Rock and Soil Anchors" from the PTI.

2. The Contracting Authority will engage a testing laboratory to review all proof, performance and creep tests by the Contractor. The testing laboratory will also perform strength tests of the tie back anchor grout.

3. Each tieback anchor shall be tested. No load greater than 10% of the design load can be applied to the tieback anchor prior to testing. The maximum test load shall not exceed 80 % of the minimum specified tensile strength of the tendon. The test load shall be simultaneously applied to the entire tendon. Stressing of single elements of multi-element tendons shall not be permitted.

4. Supplementary Extended Creep Testing will be required.

5. The loads on the tiebacks during the testing shall be monitored with an electric load cell. The Contractor shall provide the electric load cell and a readout device.

6. The testing equipment shall consist of:
- **a.** A dial gauge or vernier scale capable of measuring to 0.001 inches 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.
- **b.** A hydraulic jack and pump shall be used to apply the test load. The jack and a calibrated pressure gauge shall be used to measure the applied load. The jack and 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 submitted. Testing cannot commence until the Engineer has approved the calibration. The pressure gauge shall be graduated in 100 psi increments or less. The ram travel of the jack shall not be less than the theoretical elastic elongation of the total anchor length at the maximum test load.
- **c.** A calibrated reference pressure gauge shall also be kept at the site. The reference gauge shall be calibrated with the test jack and pressure gauge.
- **d.** The Contractor shall provide an electrical resistance load cell and readout to be used when performing a creep test.
- **e.** The stressing equipment shall be placed over the tieback 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.

7. Performance Testing.
- **a.** The Engineer will select the tieback anchors to be performance tested. The first production tieback anchor shall be performance tested.
- **b.** Five percent of the tieback anchors or a minimum of three tieback anchors per wall, whichever is greater, shall be performance tested in accordance with the following procedures. The remaining tieback anchors shall be tested in accordance with the proof test procedures.
- **c.** The performance test shall be made by incrementally loading and unloading the tieback anchor in accordance with the following schedule. 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 inches with respect to an independent fixed reference point at the alignment load and at each increment of load. The load shall be monitored with a pressure gauge. The reference pressure gauge shall be placed in series with the pressure gauge during each performance test. If the load determined by the reference pressure gauge and the load determined by the pressure gauge differ by more than 10%, the jack, pressure gauge and reference pressure gauge shall be recalibrated at no expense to the Contracting Authority. At load increments other than the maximum test load, the load shall be held just long enough to obtain the movement reading.

PEFORMANCE TEST SCHEDULE			
INCREMENT	LOAD	INCREMENT	LOAD
1	AL	15	AL
2	0.25DL *	16	0.25DL
3	AL	17	0.50DL
4	0.25DL	18	0.75DL
5	0.50DL	19	1.00DL
6	AL	20	1.20DL *
7	0.25DL	21	AL
8	0.50DL	22	0.25DL
9	0.75DL *	23	0.50DL

10	AL	24	0.75DL
11	0.25DL	25	1.00DL
12	0.50DL	26	1.20DL
13	0.75 DL	27	1.33DL *
14	1.00DL *	28	REDUCE TO LOCK-OFF LOAD
Where: AL – is the alignment load DL – is the tieback anchor design load			

d. The maximum test load in a performance test shall be held for 10 minutes. The jack shall be re-pumped 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, 2, 3, 4, 5, 6, 7, 8, 9 and 10 minutes. If the tieback anchor movement between 1 minute and 10 minutes exceeds 0.04 inches, the maximum load test 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, 25, 30, 45 and 60 minutes.

e. The Contractor shall plot the tieback movement versus load for each load increment marked with an asterisk (*) in the performance test schedule and plot the residual movement of the tendon at each alignment load versus the highest previously applied load.

8. Proof Testing.

a. The proof test shall be made by incrementally loading the tieback in accordance with the Proof Test Schedule.

b. The proof test shall be performed by incrementally loading the tieback anchors in accordance with the following schedule. 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 inches with respect to an independent fixed reference point at the alignment load and at each increment of load. The load shall be monitored with a pressure gauge. At load increments other than the maximum test load, the load shall be held just long enough to obtain the movement reading.

c. The maximum test load in a proof test shall be held for 10 minutes. The jack shall be re-pumped 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, 2, 3, 4, 5, 6, 7, 8, 9 and 10 minutes. If the tieback anchor movement between 1 minute and 10 minutes exceeds 0.04 inches, the maximum test load shall be held for an additional 50 minutes. If the load hold is extended, the tieback anchor movements shall be recorded at 15 minutes, 20, 25, 30, 45 and 60 minutes.

PROOF TEST SCHEDULE	
INCREMENT	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
Where: AL – is the alignment load DL – is the tieback anchor design load	

d. The contractor shall plot the tieback anchor movement versus load for each load increment in the proof test.

9. Creep Testing.

a. The Engineer will locate two tieback anchors to be creep tested for Soldier Pile and Lagging Retaining Walls No. 1 & No. 3. The Engineer will locate one tieback anchor to be creep tested for Soldier Pile and Lagging Retaining Wall No. 2.

b. The creep test shall be made by incrementally loading and unloading the tieback anchor in accordance with the performance test schedule given above. 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, 2, 3, 4, 5, 6, 7, 8, 9, 10, 15, 20, 25, 30, 45, 60, 75, 90, 100, 120, 150, 180, 210, 240, 270 and 300 minutes, as appropriate. Each load hold period shall start as soon as the test load is applied. In a creep test, the 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 a constant load hold period. The jack shall be re-pumped as necessary in order to maintain a constant load.

CREEP TEST SCHEDULE	
LOAD	OBSERVATION PERIOD (min.)
AL	-
0.25DL	10
0.50DL	20
0.75DL	30
1.00DL	45
1.20DL	60
1.33DL	300

c. The Contractor shall plot the tieback anchor movement and the residual movement measured in the creep test as described for the performance test above. The Contractor shall also plot the creep movement for each load hold as a function of the logarithm of time.

10. Tieback Test Acceptance Criteria.

a. General.

1) Acceptance criteria shall follow the "Recommendations for Prestressed Rock and Soil Anchors" from PTI, and the following sections.

2) Retesting of the tieback shall not be allowed.

b. Performance and Proof Testing.

1) A performance or proof tested tieback anchor with a 10 minute load hold is acceptable if the tieback anchor carries the maximum test load with less than 0.04 inches of movement between 1 minute and 10 minutes, and if the total movement at the maximum test load exceeds 80 % of the theoretical elastic elongation of the unbonded length.

2) A performance or proof tested tieback anchor with a 60 minute load hold is acceptable if the tieback anchor carries the maximum test load with a creep rate that does not exceed 0.08 inches per log cycle of time and if the total movement at the maximum test load exceeds 80 % of the theoretical elastic elongation of the unbonded length.

c. Creep Testing.

A creep tested tieback anchor is acceptable if the tieback anchor carries the maximum test load with a creep rate that does not exceed 0.08 inches per log cycle of time and if the total movement at the maximum test load exceeds 80 % of the theoretical elastic elongation of the unbonded length.

d. If the total movement of a tieback anchor at the maximum test load does not exceed 80 % of the theoretical elastic elongation of the unbonded length, the Contractor shall replace the tieback anchor at no additional cost to the Contracting Authority.

e. Tieback anchors which have a creep rate greater than 0.08 inches per log cycle of time can be incorporated in the finished wall at a load equal to one-half their failure load. To determine the failure load, allow the load to stabilize for 10 minutes after the tieback has failed.

f. When a tieback anchor fails, the Contractor may modify the design and/or construction procedures. These modifications may include, but are not limited to, installing replacement tieback anchors, reducing the design load by increasing the number of tieback anchors, modifying the installation methods, increasing the bond length or changing the tieback anchor type. Any modification which requires changes to the structure must have prior approval by the Engineer. Any modifications of design or construction procedures shall require a revised submittal as detailed in Article 231013.01, D. Any modifications of design or construction procedures shall be at no change in the contract price or contract time.

g. Retesting of the tieback anchor shall not be allowed.

11. Lock-off.

a. Upon completion of the test, the load shall be adjusted to the lock-off load indicated in the working drawings and transferred to the anchorage device. The tieback anchor may be completely unloaded prior to lock-off. After transferring the load and prior to removing the jack, a lift-off reading shall be made. The lift-off reading shall be within 10% of the specified lock-off load.

b. If the load is not within 10% of the specified lock-off load, the anchorage shall be reset and another lift-off reading shall be made. This process shall be repeated until the desired lock-off load is obtained.

231013.04 METHOD OF MEASUREMENT.

The quantity of Permanent Tieback Anchors to be paid will be the number of tieback anchors shown on the plans.

231013.05 BASIS OF PAYMENT.

The number of Permanent Tieback Anchors shown on the plans will be paid at the contract unit price for Permanent Tieback Anchors. This payment shall be full compensation for all work associated with the tieback anchors as shown on the plans, and as described in these special provisions and specifications. This includes all design work, submittals, materials, tieback installation and testing, supplemental geotechnical exploration, testing, and analysis necessary to design the tieback anchors or complete the tieback anchor installation, monitoring of soils stability and movement, and all other incidental items.