615.5.01 Adjustments

General Provisions 101 through 150.

Section 617—Permanent Anchored Walls

617.1 General Description

This work includes furnishing materials, labor, tools, equipment, and other incidental items to design, detail, and construct an anchored wall. This Specification applies to any Contractor-proposed alternate design of Department-furnished plans.

617.1.01 Definitions

Anchor—Synonymous with the terms tie-back or tie-down.

The term Anchored Wall includes the following items:

- Anchors
- Soldier piles
- Lagging
- Facing
- Drainage

617.1.02 Related References

A. Standard Specifications

Section 500—Concrete Structures

Section 511—Reinforcement Steel

Section 853—Reinforcement and Tensioning Steel

B. Referenced Documents

General Provisions 101 through 150.

617.1.03 Submittals

A. Proof of Ability

Submit the following proof of ability (or ability of the Subcontractor) when requested by the Department to design or construct anchored walls:

- Evidence of successfully completing at least 5 Projects similar in concept and scope to the proposed wall.
- Resumes of foremen, anchor testing personnel, and drilling operators to be employed on this Project. Show the type, length, and number of ground anchors each has installed or tested within the past 5 years.
- Evidence of experience in anchor testing. Persons performing anchor testing must prove experience by performing sample tests supervised by the Engineer.

The Department is the sole judge of the qualifications of the foreman, drilling operator, and testing personnel. Do not begin wall construction until the Engineer has approved proof of ability.

B. Design Criteria for Alternate Design

If the Department receives more than 2 submittals of the Plans and calculations for review, the Contractor will be assessed $60 per hour of engineering time for reviews in excess of the 2 submittals.

C. Construction Drawings and Design Notes

If a Contractor-proposed alternate anchored wall is a part of the low bid, submit construction drawings and design notes within 28 days of the date of award of the Contract. The Design Engineer shall prepare and stamp the submission.

Include design notes and reproducible drawings in the submission concerning the following:

- Details, dimensions, and schedules of reinforcing steel, including dowels or studs for attaching the facing to the tied back wall
- Details of the anchors and soldier piling, including spacing and size of piles and spacing and angle of anchor installation
- Detailed plans for anchor proof and performance testing that show loading and measuring devices used and procedures followed

D. Wall Final Plans and Calculations

Submit final wall plans and calculations to the Department for review and approval before beginning construction on the wall The time required for Plan and calculation preparation and review will be charged to the allowable Contract time. The Department has 30 days for Plan and calculation review per Item after receiving the structure calculations and drawings.

New submittals from the Contractor showing corrections from the Department's review or changes to ease construction or to correct field errors have a 30-day review. The Department is the sole judge of information adequacy.

The Department's review and acceptance of the final Plans and construction methods does not relieve the Contractor from successfully completing the work. Time extensions are not granted for Contractor delays from untimely submissions and insufficient information.

E. Admixture Literature

Before using an admixture, submit to the Engineer the manufacturer's literature. Indicate the admixture type and the manufacturer's recommendations for mixing the admixtures with grout.

F. Structural Steel

Submit to the Engineer the mill test reports for each heat or lot of prestressing material used to fabricate tendons.

617.2 Materials

A. Concrete

Use concrete that conforms to Section 500.

B. Reinforcing Steel

Use reinforcing steel that conforms to Section 511.

C. Structural Steel

Use structural steel as follows:

1. Use prestressing bars made of continuously threaded full-length steel that conforms to ASTM Designation A 722, Type II. Do not use couplers.

   Ensure material requirements, coating application, and epoxy coating sampling and testing conform to Section 514.
2. Use full-length prestressing strands and wires according to Section 853.

D. Cement Grout

Produce cement grout using Portland cement that conforms to AASHTO M 85, Type I, II, or III, and potable water. Use cement that is fresh and free of lumps and hydration.

Follow these restrictions if using admixtures:

1. Do not use admixtures with chemicals that may harm the prestressing steel or cement.
2. Do not use expansive additives that cause air bubbles in the grout.
3. If approved by the Engineer, use admixtures that will impart low water content, flowability, and minimum bleeding in the cement grout.

E. Plastic

For corrosion protection, use polypropylene plastic that conforms to designation grade II 26500D as per ASTM D-2146. Ensure that the environmental stress crack resistance of the material prevents failures at 1,000 hours when tested by ASTM D-1693.

F. Corrosion Inhibitor

Use corrosion inhibitor (grease) that conforms to the following test requirements:

- Drop point 300 °F (149 °C) minimum by ASTM D-566
- Flash point 300 °F (149 °C) minimum by ASTM D-92
- Water content 0.1 percent maximum by ASTM D-95
- Rust grade 7 or better after 720 hours, aggressive conditions: rust grade 7 or better after 1,000 hours by ASTM B-117 and ASTM D-610

Water-soluble ions must follow these requirements:

1. Oil separation—0.5 percent by weight maximum at 160 °F (71 °C) by FIMS791B, Method 321.2
2. Soak test—5 percent salt fog at 100 °F (38 °C) 5 mils (0.13 mm) (Q panel type S). (Immerse panels in 50 percent salt solution and expose to 5 percent salt fog—no emulsification after 720 hours—by ASTM B-117 modified.)

Chlorides	10 ppm max by ASTM B-512
Nitrates	10 ppm max by ASTM D-992
Sulfates	10 ppm max by APHA427D

617.2.01 Delivery, Storage, and Handling

A. Protection Systems

Protect prestressed rock and soil anchors against corrosion by properly storing, fabricating, and handling the tendon components before inserting them into the borehole.

Avoid prolonged exposure of the tendon components to the elements, and avoid mechanical or physical damage that reduces or impairs the component's ability to resist adverse conditions during service.

Tendon components will be rejected for heavy corrosion or pitting, but not for a light coating of rust.

Use the protection systems as follows:

1. Prestressing Steel

   Protect the entire length of prestressing steel from the anchor plate to the end of the tendon from corrosion.

   a. Encase the prestressing steel in a corrugated plastic tube.
   b. Use cement grout to fill the voids between the tube and the prestressing steel and the tube and the soil. Fill the cement grout between the soil and the tube to at least 1/2 in (13 mm) thick and extend the entire length of the tendon.
   c. Provide centralizers spaced a maximum of 5 ft (1.5 m) center-to-center throughout the bond length. Do not use wood or material harmful to the tendon steel or corrugated plastic tubing as centralizers.
   d. Provide a smooth piece of plastic sheath to encapsulate the entire free length. Do not splice the sheath. Ensure that the sheath is at least 0.05 in (1.27 mm) thick.
   e. Place a grease film, compounded to lubricate and inhibit corrosion, between the sheath and the prestressing steel in the entire free length. Ensure that the plastic sheath is seamless, hot melt extruded polypropylene shrunk tightly onto the grease.

      Ensure that the sheath has a coefficient of friction with the steel of less than 0.05 and a wall thickness of at least 0.05 in. (1.27 mm).
   f. Ensure that the sheath exerts a positive pressure on the grease. Ensure that the grease film is at least 0.01 in (0.25 mm) thick. Minimize the void space between the sheath and the steel by filling visible void spaces with grease and sealing the bottom to keep the grout out.

2. Area Underneath Anchorage

   Protect the area immediately behind the stressing anchorage.

   a. Weld a pipe sleeve to the bearing plate, and seal the pipe sleeve to the anchor sheath at the other end of the sleeve.
   b. Clean the pipe sleeve to remove dirt, rust, or other harmful material before inserting the tendon into the pipe sleeve.

c. If a seal is not provided at the lower end of the pipe sleeve, during installation and grouting fill the lower end of the pipe sleeve with grout.

Keep the pipe sleeve free of harmful material until the upper portion of the pipe sleeve and anchor head is filled with grout.

d. After stressing the anchors, fill the void inside the sleeve and anchor head with anti-bleed expansion grout.

3. Anchorage

Encase the anchorage system head at each lift into a corrosion protective system before proceeding to the next lift. Install the protective system for each lift within 30 days after installing the anchors for that lift.

Ensure that the anchorage system has a cover of at least 3 in (75 mm) once the wall face is placed.

617.3 Construction Requirements

617.3.01 Personnel

A. Contractor Qualifications

The Contractor and Subcontractor shall be experienced in designing or constructing permanently anchored walls. Provide at least one Registered Professional Engineer licensed to perform work in the State of Georgia and a supervising Engineer for the Project with at least 5 years of experience in constructing permanently anchored walls.

Furnish verification of these qualifications to the Engineer before beginning operations.

B. Design Engineer

The Design Engineer shall:

- Be registered as a Professional Engineer in the State of Georgia
- Have considerable knowledge and experience designing and constructing anchored walls
- Be available at any time during the Contract to discuss the design of the walls with the Department

C. Registered Professional Engineer

Retain the services of a second registered Professional Engineer licensed to perform work in the state of Georgia and prequalified by the Department. The Engineer shall operate independently from the Professional Engineer of Subsection 617.3.01.A, "Contractor Qualifications."

This Engineer will independently check the design calculations and Plan details for the permanent anchored walls before submitting them to the Department for review.

617.3.02 Equipment

A. Anchorage and Hardware

Use anchorage and hardware suitable for the type of anchor tendon used. Ensure that anchorage and hardware are capable of the following:

- Developing 95 percent of the guaranteed specified minimum ultimate tensile strength of the tendon, when tested in the unbonded state and without failure of the tendon
- Holding a load of prestressing steel that produces a stress of at least 95 percent of the guaranteed specified minimum ultimate tensile strength of the prestressing steel, without exceeding the anticipated set and without causing anchorage or prestressing steel failure
- Lifting-off, detensioning, or retensioning a tendon before secondary grouting to fill voids at the top of the pipe sleeve

B. Anchor Nut and Plate for Bars

Use anchor nuts and plates for bars that have complementary spherical shapes at the contact areas.

617.3.03 Preparation

Before beginning the work, survey the condition of the adjoining properties. Keep records and photograph settlement or cracking of adjacent structures that may become the subject of possible damage claims. Deliver the report to the Department before beginning work at the site.

Obtain a Foundation Investigation Report from the Geotechnical Engineering Bureau of the Department to assist in evaluating existing conditions for design and construction.

617.3.04 Fabrication

A. Tendons

Fabricate the tendons according to the approved details.

1. Keep the tendons free of dirt, rust, or other harmful substances.
2. Use a plastic sheath that is a single piece without splices.
3. Install the sheath at the fabrication shop, not in the field.
4. Before installation, handle and store the tendons so as to avoid corrosion and physical damage.

   Tendons will be rejected for damage such as abrasions, cuts, nicks, welds, weld splatters, or heavy corrosion and pitting.

   Replace the tendons at the Contractor's expense for material replacements or time delays.
5. Repair damaged coatings in the field at the Engineer's approval.

617.3.05 Construction

A. Design Criteria for Alternate Design

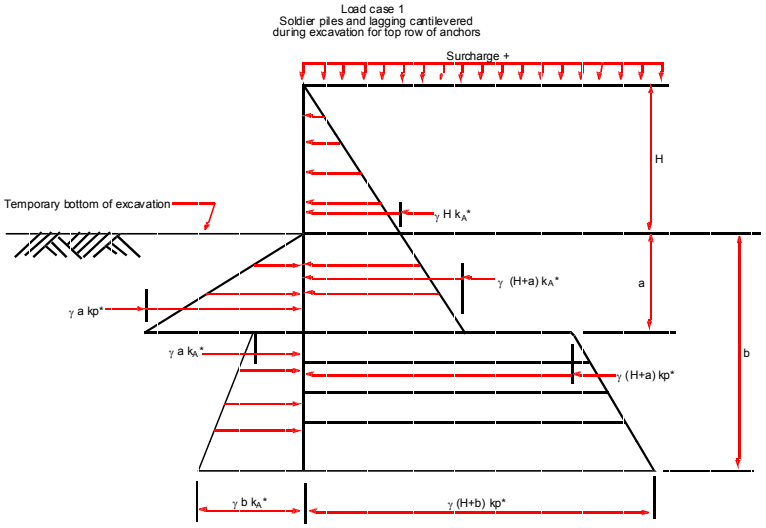
The design criteria for a proposed alternate or design include:

1. Design rock anchors and soil anchors according to this Specification.
2. Assume responsibility for lagging. Design the lagging with sound engineering principles.
3. Use reinforced concrete facing according to the latest AASHTO Standard Specifications for Highway Bridges, including interims.

   Ensure that the facing structural thickness is at least 12 in (300 mm). Perform architectural facing treatment as shown on the Department drawings.
4. Ensure that the concrete strength for a proposed alternate is at least 3,000 psi (20 MPa) 28-day strength. Extend the facing 2 ft (600 mm) below the gutterline or, if applicable, the ground line adjacent to the wall unless otherwise indicated on the Plans.
5. Design soldier piles for shear, bending, and axial stresses according to the latest AASHTO design criteria.

   Use steel or concrete soldier piles with a steel yield strength at least 36,000 psi (248 MPa). Ensure that the concrete has a 28-day strength of at least 3,000 psi (20 MPa).
6. Design and install permanent drainage systems behind the wall. Connect drainage systems to the nearest drop inlet using pipe or free drainage through traffic barriers or other obstructions.

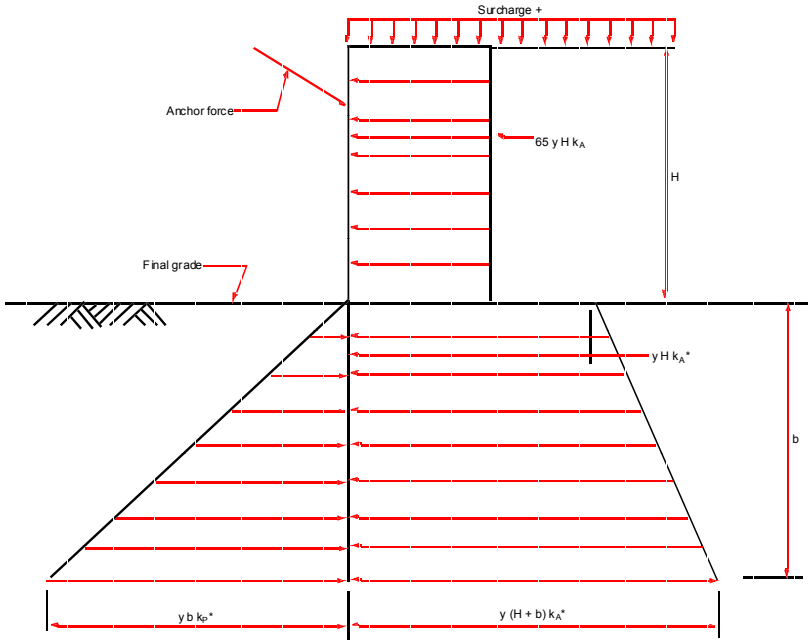
   Ensure that holes through traffic barriers or facing are no higher than 3 in (75 mm) above the gutterline or ground line.
7. Have the wall design account for live load, dead load, and wind load from traffic barriers, lights, overhead signs, or other appendage on top or adjacent to the wall. Figure 1, Figure 2, and Figure 3 indicate loading conditions for soldier piles, lagging, and anchors at critical stages of construction.



\+ Design pressure diagram shall include the effect of surcharge loading
* NOTE: The above diagrams apply for cohesionless soils. For cohesive soils the effect of cohesion may be considered.
Where lagging is in place, active earth pressure acts over the entire wall surface. Below lagging, active earth pressure acts only on the soldier pile width and passive earth pressure is generated as follows:
A) In sands and saprolitic soils (with blow counts of 10 or greater) passive pressure is generated over 3 times the soldier pile width.
B) In clays, non-saprolitic silts, and saprolitic soils (with blow counts of 10 or less) passive pressure is generated over the width of the soldier pile.
Vertical component of anchor force must be resisted by embedded length of soldier piles below assumed excavation.
γ is the soil unit weight in pounds per cubic foot.

Figure 1

Load Case II
Intermediate Excavations for Subsequent Anchor Installations



* See "NOTE" Figure 1.
\+ Design pressure diagram shall include the effect of surcharge loading.

K_A = Coefficient of active earth pressure
K_P = Coefficient of passive earth pressure
γ = Soil density

Figure 2

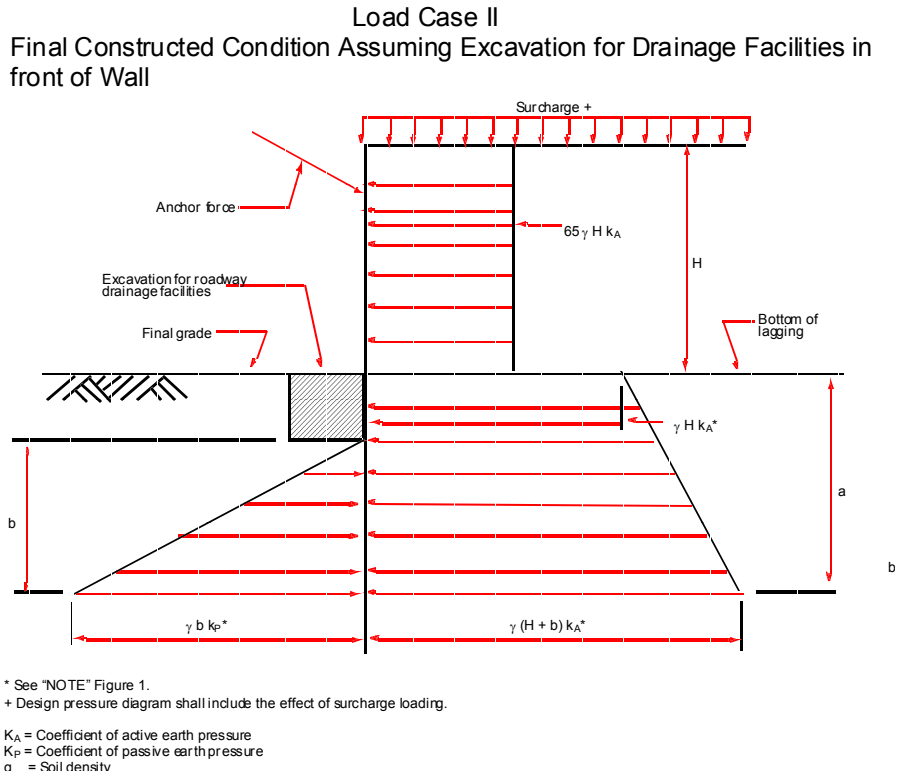


Figure 3

8. Ensure that the wall is compatible with horizontal and vertical criteria indicated on the Department Plans.
9. Include the following on the design criteria for rock anchors:
   a. Determine the tendon size to ensure that the anchor design load is no greater than 53 percent of the guaranteed ultimate tensile strength of the tendon.
   b. Ensure that the free stressing length is no less than 15 ft (4.5 m).
   c. Estimate the bond length using the following equation:

      Lb = P/(3.1416) (d) (tw)

      where

      Lb= Bond length (not less than 10 ft [3 m])

      P= Design load for the anchor

      d= Diameter of the drill hole

      tw= Bond stress in the interface between the rock and grout

      When determining the bond stress, consider the critical nature of the anchor application, rock property variations, and installation procedures.
10. Include the following in the design criteria for soil anchors:
    a. Analyze the anchor structure system to ensure a well-anchored structure.
    b. Analyze the overall earth mass stability and the assumed failure plane to ensure that the anchor bond length is started at least 5 ft (1.5 m) beyond the failure plane. Consider the following in the analysis:
       - Type of foundation, nearness, and susceptibility to movement of adjacent buildings (see Figure 4).
       - Interaction of anchor groups when the anchor center-to-center spacing is less than or equal to 6 times the bulb diameter

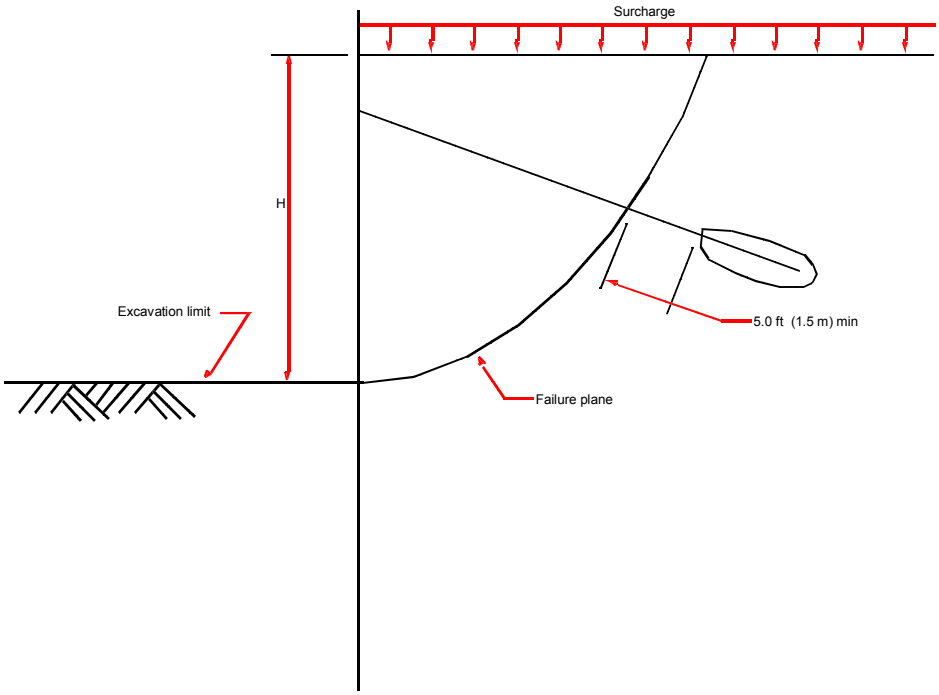


Figure 4 (metric)

c. Determine the tendon size so that the anchor design load does not exceed 53 percent of the guaranteed ultimate tensile strength of the tendon.

d. Ensure that the free stressing length is at least 15 ft. (4.5 m).

e. Use the existing theoretical and empirical methods only to predict anchor capacity for preliminary design estimates. Verify the final anchor capacity by field testing each anchor.

11. Retain a second registered Professional Engineer to operate independently from the Design Engineer Professional Engineer of Subsection 617.3.01.B.

    Have this Engineer independently check the design calculations and Plan details of the permanent anchored walls before submitting them to the Department for review.

B. Ground Movements and Load Transfer Instruments

The Department may install devices to monitor ground movements and load transfers during and after construction. The Department will schedule installation to minimize interference with the Contractor's operations. Cooperate with the instrumentation installers. Anticipate delays of two to four hours per instrumented anchor.

Although the Instrumentation Specialist maintains the instruments, assume responsibility for damage to the instruments, connections, or readouts from operations. Replace and install damaged equipment at the Department's approval and at the Contractor's expense.

C. Rock Anchors

1. When required on the Plan or by the Engineer, use a prestressed rock anchor made of high-strength steel tendon fitted with a stressing anchorage at one end and a way to transfer force to the grout and rock on the other end.
2. Insert the rock anchor tendon into a prepared hole of suitable length and diameter, fixed to the rock, and stressed to a specified force. The basic components of a prestressed rock anchor are as listed below:
   a. Prestressing steel may be single or multiple wires, strands, or bars. The rock anchor length is composed of these two parts:
      - Bond length (socket)—the portion of the anchor that transmits the force to the surrounding rock
      - Free length (stressing length)—the portion of the anchor free to elongate elastically during stressing

b. The stressing anchorage is the device that permits the stressing and anchoring of the prestressing steel under load.

c. The fixed anchorage is a mechanism opposite the stressing anchorage on the tendon that transfers the induced force to the surrounding grout or rock. Deformed bars and strand tendons do not have fixed anchorages since the anchor load is transferred to the grout by bond.

d. Provide grout, vent pipes, and miscellaneous appurtenances to inject the anchor grout. Pump grout through the drill casing or rods.

D. Rock Anchor Installation

Install the rock anchors as follows:

1. Before installation, visit the site to observe existing conditions that may affect the work or design, if applicable, and to review the geotechnical data available for the Project.
2. Drive or drill the holes for the anchors by core drilling, rotary drilling, auger drilling, or percussion drilling. If using water in the drilling operation, dispose of the water to minimize wall erosion.

   Repair water erosion damage to the site at no cost to the Department.
3. If the hole will not stand open, install casing to maintain a clean and open hole. Ensure that the hole diameter is at least 3 in (75 mm) if no pressure grouting is used.

   Pressure grouting is grouting with a pressure greater than 60 psi (415 kPa).
4. Ensure that the drill bit diameter is not less than 1/8 in (3 mm) smaller than the specified hole diameter.
5. Start anchor holes within an angle tolerance of 1 to 3 degrees from the inclination specified on the approved design Plans. Do not allow holes to deviate from a straight line by more than 1 to 2 in. (25 to 50 mm) in 10 ft. (3 m).

   Do not allow holes to extend outside the Right-of-Way limits. Thoroughly clean holes of rock dust, rock chips, grease, or other material before inserting the tendon.
6. Install the tendon in the casing or in a hole drilled for the anchor. Ensure that the tendon's corrosion protection is not damaged during handling or installation.
7. Install the tendon in the bond length, to achieve at least 0.5 in (13 mm) of grout cover.

   Degrease the bond length of strands or wires before installing by using Acetone, MEK, or MIBK. Do not leave residue on the tendon. Use other substances only after the Department's approval. Include the costs of cleaning tendons in the price bid for Contract Items.
8. If using multi-element tendons without a fixed anchorage at the lower end, adequately space the tendon elements to achieve proper grout coverage.

   NOTE: Do not use anchors to ground electric equipment and do not subject anchor tendons to sharp bends.
9. Provide centralizers spaced a maximum of 5 ft (1.5 m) center to center throughout the bond length. Do not use wood spacers or other material harmful to the tendon steel or sheathing.
10. Inject the grout at the lowest point of the anchor and place over the entire anchor length.
    a. Ensure that the grouting equipment can continuously mix and produce lump-free grout.

       Equip the grout pump nozzle with a grout pressure gauge capable of measuring pressure of at least 150 psi, (10 kPa) or twice the actual pressure used.

    b. Base the material proportions used in the grout on grout tests made before beginning the grouting. Or, select the proportions based on prior documented experience with similar materials and equipment under comparable field conditions.

    c. Use the minimum water content necessary for proper placement and do not exceed a water-cement ratio of 0.45. Do not leave grout in the mixer longer than 45 minutes.

       Only fill voids at the top of the free length with grout after final lock-off.
11. After grouting, do not disturb the tendon until the grout has reached a cube strength of 3,500 psi (25 MPa). Keep the mouth of the hole clean after grouting. Record the following data in a Project field book during the grouting operation:
    - Type of mixer
    - Water-cement ratio
    - Type of additives

- Grout pressure
- Type cement
- Test sample strengths (before stressing)
- Volume of grout placed in bond and free lengths

12. If using pressure grouting, choose whether to perform a watertightness test. However, if injecting grout with a pressure of 60 psi (415 kPa) or less, always perform a watertightness test.

    Perform the test as follows:

    a. Fill the entire hole in the rock with water and subject it to a pressure of 5 psi (35 kPa) in excess of the hydrostatic head as measured at the top of the hole.
    b. If after 10 minutes the leakage rate from the hole exceeds 0.001 gal per inch diameter per foot of depth per minute (12 mL per 25 mm diameter per meter of depth per minute), consolidate grout, redrill, and retest the hole. If the second watertightness test fails, repeat the entire process.
    c. During the tests, observe holes adjacent to the hole being tested for watertightness to detect and seal inter-hole connections.
    d. If finding artesian or flowing water in the drilled hole, maintain the pressure on the consolidation grout until the grout has initially set.

E. Cutting of Tendon Protrusions

After the Engineer accepts an anchor, the portion of the anchored tendon protruding over the anchor may be cut if it is not required for use in retesting. Cut the tendon according to the tendon manufacturer's recommendations as approved by the Engineer. Do not damage the tendon anchor.

F. Redesign

If the anchors fail during performance tests or proof tests, modify the design or construction tests and procedures. The design is subject to Department review. These modifications may include:

- Reducing the anchor design load by increasing the number of anchors
- Increasing the grout pressure
- Requiring post-grouting or increasing the bond length

Modify the design or construction procedures, install the redesigned anchors in the wall, and test as previously defined at no cost to the Department.

Anchors that fail the performance or proof tests may be incorporated in the wall. Propose a reduced design load and retest as noted above. The Department will determine acceptance of such anchors.

G. Soil Anchors

A prestressed soil anchor is a high-strength steel tendon fitted with a stressing anchor at one end and an anchor device that transfers force to the soil on the other end. These anchors are used in clay, silt, sand, or gravel and are inserted in a prepared hole that is drilled or driven into the ground.

The following are the two soil anchors considered for use:

- Friction type—rely on friction between the drilled borehole walls
- Anchor grout—rely on an enlarged pressure-grouted bulb or an underreamed bulb to provide resistance to pull-out

Test the soil anchors after placing the anchor grout and after the curing period. The basic components of the soil anchor are identical to the rock anchor as described previously.

For installation, see Subsection 617.3.05.D, "Rock Anchor Installation," except watertightness tests are not required.

Test and stress soil anchors according to 617.3.06.A , "Anchor Testing and Stressing" except that 15% of the anchors remaining after the initial testing shall be performance tested.

H. Cutting of Tendon Protrusions

See Subsection 617.3.05.E, "Cutting of Tendon Protrusions."

I. Redesign

See Subsection 617.3.05.F, "Redesign."

617.3.06 Quality Acceptance

A. Anchor Testing and Stressing

Perform testing and stressing according to this subsection.

Test each anchor to ensure that the maximum test load does not exceed 80 percent of the guaranteed ultimate tensile strength of the tendon.

Performance test the first 2 anchors installed of each design load capacity and 5 to 10 percent of the remaining anchors (the Engineer will choose the locations). Proof test the remaining anchors.

1. Performance test by incrementally loading and unloading the anchor according to the following schedule.

Cycle	Load
1	AL (AL = Alignment Load)
	0.25P
	AL
2	0.25P
	0.50P
	AL
3	0.25P
	0.50P
	0.75P
	AL
4	0.25P
	0.50P
	0.75P
	1.00P
	AL
5	0.25P
	0.50P
	0.75P
	1.00P
	1.25P
	A L
6	0.25P
	0.50P
	0.75P
	1.00P
	1.25P
	1.50P (Test conditions—hold for at least 50 mins.)

2. Record the tendon movement at each increment to the nearest 0.001 in (0.025 mm) referring to an independent fixed reference point.
3. Monitor the jack load with the production gauge and load cell calibrated as a set.
4. Adjust to a transfer load of 1.0P. Actual lock-off loads may be somewhat higher to account for seating losses.
5. To prevent misalignment of testing equipment, maintain an Alignment Load (AL) of at least 0.05P.

6. Hold the load at each increment long enough to obtain the movement reading.

   Submit the loading and unloading rates (tons [megagrams] per minute) for approval. Each load must be applied in less than 30 seconds after starting the jack pump.

7. Perform the creep test by holding the 1.50P load for 50 minutes while maintaining the load constant. Record the anchor movement (total movement) referenced to a fixed point at 30 seconds, 1, 2, 3, 4, 5, 6, 10, 15, 20, 25, 30, 40, and 50 minutes.

   Begin the observation time when the jack begins to load the anchor from 1.25P to the test load.

8. If performance tests indicate that the loaded substrata is sensitive to creep, maintain the load for an additional 250 minutes and record the movements at 60, 75, 90, 100, 120, 150, 180, 210, 240, 270, and 300 minutes.

9. Have the Engineer review the performance tests to determine if the anchor is acceptable. An anchor is acceptable if:

   - The total movement obtained exceeds 80 percent of the theoretical elastic elongation of the free length and is less than the theoretical elastic elongation of the total of the free length plus 50 percent of the bond length.
   - The creep movement does not exceed 0.08 in (2.00 mm) during 5- to 50-minute time increments regardless of tendon length and load.
   - If held for an additional 250 minutes, creep movement does not exceed 0.08 in (2.00 mm) from the 30-minute to the 300-minute time increment regardless of tendon length and load.

10. Perform proof tests as follows:

    a. Incrementally load the anchor according to the following schedule:

       AL

       0.25P

       0.50P

       0.75P

       1.00P

       1.25P

       1.50P (Test conditions—hold for at least 10 minutes)

    b. At each increment, record the movement of the tendon to the nearest 0.001 in (0.025 mm) referring to an independent fixed reference point.

    c. Monitor the jack load with a production gauge that was calibrated with the load cell used for the performance test.

       If required by the Engineer, monitor the jack load with the production gauge and load cell that were calibrated as a set.

    d. Adjust to a transfer load of 1.0P. Actual lock-off load may be somewhat higher to account for seating losses.

    e. To prevent misalignment of testing equipment, maintain an alignment load (AL) of at least 0.05P.

    f. Perform the creep test by holding the 1.50P load for 10 minutes while maintaining the load constant. Record the anchor movement (total movement) referenced to a fixed point at 30 seconds and 1, 2, 3, 4, 5, 6, and 10 minutes.

       Begin the observation time when the jack begins to load the anchor from 1.25P to the test load.

    g. If the movement between the 1-minute and 10-minute readings exceed 0.040 in (1.00 mm), maintain the load for an additional 40 minutes. Record the movements at 15, 20, 25, 30, 40, and 50 minutes.

    h. Have the Engineer review the proof tests to determine if the anchor is acceptable. An anchor is acceptable if:

       - The total movement obtained exceeds 80 percent of the theoretical elastic elongation of the free length and is less than the theoretical elastic elongation of the total of the free length plus 50 percent of the bond length.
       - The creep movement does not exceed 0.04 in (1.00 mm) during the 1-minute to 10-minute increment regardless of tendon length and load.
       - If held for an additional 40 minutes, creep movement does not exceed 0.08 in (2.00 mm) during the 5- to 50-minute increment regardless of tendon length and load.

11. Use the following test equipment:

    a. Use a dial gauge that can measure elongation to the nearest 0.001 in. (0.025 mm).

b. Use a production gauge with an accuracy of at least 0.5 to 1 percent of full scale with gradation no greater than 100 psi (690 kPa). Ensure that it has a non-parallax dial.

c. Use test gauges with an accuracy of at least 0.25 of 1 percent of full scale with gradations no greater than 50 psi (345 kPa). Ensure that they have a non-parallax dial.

d. Use a load cell with a resolution of at least 1/10 of 1 percent constructed to eliminate inaccuracy with uneven loading.

e. Ensure that the jack, gauges, and load cell are calibrated as a set and independently.

Check the pressure gauge and load cell calibration every week (or when erratic results are found) against a test gauge that is kept onsite for this purpose. Have the Department's Inspector witness these calibration checks. Perform installation, testing, and stressing in the Department Inspector's presence.

12. Perform lift-off tests when using anchors. Make a lift-off reading after transferring the load to the end anchorage and before removing the jack.

a. Determine the load within 5 percent of 1.00P. If the lift-off load is less than 0.95P, reset the end anchorage and make another lift-off reading.

b. Perform additional lift-off tests 7 days after the load was locked-off in the anchor.

After performing 5 additional lift-off tests, perform lift-off tests randomly. The total number of tests will be performed on no more than 10 percent of the remaining anchors.

617.3.07 Contractor Warranty and Maintenance

General Provisions 101 through 150.

617.4 Measurement

Permanently Anchored Walls are not measured separately for payment.

617.4.01 Limits

In cases where additional wall area is required due to unforeseen foundation conditions or other reasons as approved by the Engineer, or, if the wall area is decreased, measurements based on Plan dimensions will be used to adjust the Lump Sum Price Bid referenced under Payment.

617.5 Payment

Payment for this work is made per Lump Sum. Payment includes costs for concrete, reinforcing steel, excavation, backfill, lagging, piles, anchors, labor, design, and other materials and equipment. Payment also includes grouting, drilling holes, post-tensioning, performing and evaluating tests, and submitting records of tests, tools, and other items to complete the work.

Payment will be made under:

Item 617	Permanent anchored wall, wall no.___	Per lump sum

617.5.01 Adjustments

Additional wall area required because of unforeseen foundation conditions or other reasons that are approved by the Engineer, will be paid for by increasing the Lump Sum Price Bid. The increase in wall area will be multiplied by an adjustment price of $45 per square foot ($485 per square meter).

If the wall area is decreased, the Lump Sum Price Bid is adjusted proportionally to the decrease in wall area. The adjustment price is the Lump Sum Price Bid divided by the original plan area of the wall.

No additional compensation will be made for additional material, equipment, design, or other items to comply with the Project specifications as a result of the Department's review of an alternate design. If based on a redesigned wall, the bid price includes costs to comply with the requirements of this Specification.

No additional compensation will be made for subsequent changes or deviations from the approved Plan for additional material, labor, or equipment that may be required to comply with the acceptance criteria of this Specification.