ITEM #0506070A – GROUND ANCHORS

ITEM #0506071A – PERFORMANCE TEST FOR GROUND ANCHORS

ITEM #0506072A – EXTENDED CREEP TEST FOR GROUND ANCHORS

ITEM #0506073A – PROOF TEST FOR GROUND ANCHORS

DESCRIPTION:
The work shall consist of installing permanent ground anchors as specified herein and as shown on the plans. The Contractor shall furnish all labor, materials, supervision and equipment required to complete the work. The contractor shall select the foundation anchor type, drilling method, grouting method, grouting pressures, and subject to the minimum values in the contract documents, determine the bond length, and anchor diameter. The Contractor shall also be responsible for surveying, designing, installing, quality control, and testing ground anchors that will develop the load-carrying capacity indicated on the Contract Drawings in accordance with this Specification.

Subsurface conditions are provided on the boring logs contained in the plan sheets.

The Contractor shall also be responsible for containment, hauling and legal disposal of all-drilling fluids and excavated materials, in accordance with this Specification, Section 1.10 of the Form 816 and all applicable local codes and regulations.

The use of down-hole hammers will not be permitted unless the Engineer provides written authorization.

QUALIFICATIONS AND SUBMITTALS:
1-Qualifications: The Contractor performing the work described in this Specification shall have installed permanent ground anchors for a minimum of 3 years.

The Contractor shall assign an engineer, licensed in the State of Connecticut, to supervise the work. The Contractor's engineer will have at least 3 years of experience in the design and construction of permanent anchored structures. The Contractor may not use consultants or manufacturer’s representatives in order to meet the requirements of this section.

Drill operators shall also have a minimum of 3 years experience installing permanent ground anchors with the Contractor’s organization.

The Engineer shall suspend the work if the Contractor substitutes personnel without prior written approval. If work is suspended due to the unauthorized substitution of 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.

2-Design Criteria: Unless shown on the plans or otherwise directed in writing by the Engineer, the Contractor shall select the type of tendon to be used. The maximum tendon loading can not exceed the following percentages of the specified minimum tensile strength (SMTS):

Tendon Design Load……	60 percent of the SMTS of the prestressing steel
Lock-off Load……..	70 percent of the SMTS of the prestressing steel
Test Load ……	80 percent of the SMTS of the prestressing steel

The Contractor shall be responsible for determining the bond length necessary to develop the design load indicated on the Contract Drawings or in accordance with this Specification. However, minimum bond length shall be 15 feet for strand and bar tendons in soil, 15 feet for strand tendons in rock and 10 feet for bar tendons in rock.

The free stressing length (unbonded length) shall be not less than 10 feet for bar tendons and 15 feet for strand tendons regardless of soil or rock or as shown on the plans whichever is greater.

Strand and bar tendons shall not extend beyond the right-of-way limit shown on the contract drawings.

3-Submittals: The Contractor shall submit with the Working Drawings, their qualifications including resumes of the Contractors personnel (drill operator(s), and Contractors engineer). For each project, include (1) name of client contract, address, and telephone number; (2) location of project; (3) contract value; (4) relevant anchor work and (5) scheduled completion date and actual completion date for the work.

Working Drawings and supporting documentation for the design and construction of the ground anchors shall be submitted to the Engineer for review in accordance with Article 1.05.02-2. The Working Drawing submission shall include:

A) Proposed start date and detailed construction sequence with the proposed drilling methods and equipment including drill hole diameter proposed to achieve the specified pullout resistance values. Information on space requirements and excavation methods (if required) to access each anchor location will also be provided.

B) Ground anchor schedule giving: anchor number; design load; type and size of tendon; minimum total anchor length; minimum bond length; minimum tendon bond length; and minimum unbonded length.

C) A scale drawing of the ground anchor tendon and the corrosion protection system including spacers; centralizers; unbonded length corrosion protection system; bond length corrosion protection system; anchorage and trumpet; and anchorage corrosion protection system.

D) Plan view showing location of anchor and location of property line and/or limits of permanent easement.

E) Certified Test Reports and Materials Certification for the following materials, if used: prestressing steel (stand or bar); portland cement; prestressing hardware; bearing plates; and corrosion protection system.

F) Quality Control details including anchor drilling, anchor installation with lifting methods and grout placement.

G) Grout Mix Design including compressive stress strength test results (AASHTO T106/ASTM C109) supplied by a qualified independent testing lab verifying the specified minimum 7 day and 28 day grout compressive strengths.

H) Identification number and certified calibration report for each test jack, load cell primary pressure gauge and reference pressure gauge to be used. Jack and pressure gauge shall be calibrated as a unit. Calibration records shall include the date tested, device identification number, and the results shall be certified to an accuracy of 2 percent or less traceable to the National Bureau of Standards by a qualified independent testing laboratory within 90 days prior to submittal. The Engineer may request additional calibration(s) at any time during construction if there is evidence of improper handling of equipment or improper readings. No compensation will be provided for additional calibrations.

MATERIALS:

1-Grout:

Cement shall be Portland Cement Type I, II, III (ASTM C150)
Fine Aggregrate meeting Section M.03.01-2
Potable water

The grout mixture shall have a minimum 28-day compressive strength of at least 3000 psi measured in accordance with ASTM C 109 at the time of stressing and 60 percent of design strength at 7 days. Bleed shall be less than 2 percent. Admixtures will be used in strict accordance with the manufacturers' recommendations, subject to the approval of the Engineer. Accelerators, and expansive admixtures, will not be permitted.

Non-shrink, non-staining grout meeting Section M.03.01 may be used for filling sealed encapsulations, trumpets, and anchorage covers.

2-Steel Elements:

A) Prestressing Steel: Ground anchor tendons shall be fabricated from single or multiple elements of one of the following prestressing steels:
   ASTM A 722 Steel Bars
   ASTM A 416 (uncoated seven-wire strand)
   ASTM A 886 (indented seven-wire strand)
   ASTM A 882 (epoxy coated, seven-wire strand)

B) Prestressing Steel Couplers: Prestressing steel bar couplers shall be capable of developing 100 percent of the minimum specified ultimate tensile strength of the prestressing steel bar. Steel strands used for a soil or rock anchor shall be continuous with no splices.

C) Anchorage devices: shall be capable of developing 95 percent of the specified minimum ultimate tensile strength (SMTS) of the prestressing steel tendon.

D) Bearing plate: ASTM A 709 Grade 36 or ASTM A536

E) Trumpet: ASTM A 53 for pipe, ASTM A 500 for tubing. Minimum wall thickness of 0.25 inches.

F) Anchorage Covers: ASTM A 709 Grade 36 or ASTM A53 for pipe, ASTM A536 for ductile iron, or ASTM 500 for tubing.

G) Wedges: new steel elements be designed to preclude premature failure of the prestressing steel due to notch or pinching effects under static and dynamic strength meeting requirements of Section 3.1.6 (1) and Section 3.1.8 (1) and 3.1.8 (2) of the Guide Specification contained in the PTI "Post Tensioning Manual". Wedges for epoxy coated strand shall be designed to be capable of biting through the epoxy coating and into the strand. Removal of the epoxy coating from the strand to allow the use of standard wedges is permitted. Anchor nuts and other threadable hardware for epoxy coated bars shall be designed to thread over the epoxy coated bar and still comply with the requirements for carrying capacity.

3-Miscellaneous Anchor Elements:

A) Bondbreaker: The bondbreaker shall be fabricated from a smooth plastic tube or pipe having the following properties:
   1. resistant to grout, or corrosion inhibiting compound;
   2. resistant to aging and by ultra-violet light;
   3. nondetrimental to the tendon;
   4. capable of withstanding handling and installation methods;
   5. enable the tendon to elongate during testing and stressing; and
   6. allow the tendon to remain unbonded after lock-off.

B) Centralizers and Spacers: Centralizers and spacers shall be fabricated from plastic, steel or other material that is nondetrimental to the prestressing steel. Wood shall not be used. A combination centralizer-spacer may be used.

4-Corrosion Protection Elements:

A) Tendon Bond Length Protection for Grout Protected Tendons:
   A grout-filled, corrugated plastic encapsulation or a grout-filled, deformed steel tube shall be used. The prestressing steel can be grouted inside the encapsulation prior to inserting the tendon into the drill hole or after the tendon has been placed.

Tendon Bond Length Encapsulations: The tendon bond length to be encapsulated to provide additional corrosion protection, the encapsulation shall be fabricated from one of the following:

1. High density corrugated polyethylene tubing conforming to the requirements of AASHTO M 252 and having a minimum wall thickness of 1/16 inch except pregrouted tendons, which may have a minimum wall thickness 3/64 inch.
2. Deformed steel tubing or pipes conforming to ASTM A 52 or A 500 with a minimum wall thickness of 3/16 inch.
3. Corrugated, polyvinyl chloride tubes manufactured from rigid PVC compounds conforming to ASTM D 1784, Class 13464-B.
4. Fusion-bonded epoxy conforming to the requirements of AASHTO M 284.

B) Unbonded Length Protection:

1. Bar Tendons

A smooth bond breaker shall provide corrosion protection of the unbonded length over a grout filled bar sheath. The corrosion inhibiting compound shall completely coat the tendon element.

2. Strand Tendons

Corrosion protection of the unbonded length shall encapsulate tendons composed of individual grease filled extruded strand sheaths with a common smooth sheath; or individual grease filled strand sheaths with a grout filled smooth sheath. The corrosion inhibiting compound shall completely coat the tendon elements, fill the void between them and the sheath, and fill the interstices between the wires of 7-wire strands. Provisions shall be made to retain the compound within the sheath.

Sheath: A sheath shall be used as part of the corrosion protection system for the unbonded length portion of the tendon. The sheath shall be fabricated from one of the following:

1. A polyethylene tube (minimum 1/16 in wall thickness) pulled or pushed over the prestressing steel. The polyethylene shall be Type II, III or IV as defined by ASTM D 1248.
2. A hot-melt extruded polypropylene tube (minimum 1/16 in wall thickness). The polypropylene shall be cell classification B55542-11 as defined by ASTM D 4101.
3. A hot-melt extruded polyethylene tube (minimum 1/16 in wall thickness). The polyethylene shall be high density Type III as defined by ASTM D 1248.
4. Steel tubing (minimum 3/16 in wall thickness) conforming to ASTM A 500.
5. Steel pipe (minimum 3/16 in wall thickness) conforming to ASTM A 53.
6. Schedule 40 plastic pipe or tube of PVC conforming to ASTM D 1784 Class 13464-B.

Where corrugated pipe is used as a sheath a separate bondbreaker or common smooth sheath shall be provided in the unbonded length to allow the prestressing steel to freely elongate during stressing and to remain unbonded to the surrounding grout after lock-off.

C) Unbonded Length/Bond Length Transition:
The transition between the corrosion protection for the bonded and unbonded length shall be designed and fabricated to ensure continuous protection from corrosive attack.

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 during testing. Any excessive protection length shall be trimmed off.

D) Anchorage Protection:
The corrosion inhibiting compound placed in either the free length or the trumpet area shall be an organic compound (i.e., 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 tendon, sheathing material, and the anchor grout.

1. Anchorages shall be encased in a minimum 2 inch thick concrete or grout-filled cover, or be completely covered in a corrosion inhibiting compound.

2. Centralizers and spacers (multi-element tendon) shall be provided at maximum intervals of 10 feet with the deepest centralizer located within two foot of 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. Centralizers shall be able to support the tendon in the drill hole and position the tendon so a minimum of 1 inch of grout cover is provided and shall permit grout to freely flow around the tendon and up the drill hole. Spacers shall be used to separate elements of a multi-element tendon and shall permit grout to freely flow around the tendon and up the drill hole.

3. The trumpet shall be sealed to the bearing plate and shall overlap the unbonded length corrosion protection by at least 4 inch. The trumpet shall be long enough to accommodate movements of the structure and the tendon during testing and stressing without damaging the encapsulation, regardless of type of tendon.

4. The trumpet shall be completely filled 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. Grout must be placed after the ground 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 inch.

E) Coupler Protection:
The coupler and any adjacent exposed bar sections shall be covered with a corrosion-proof compound of wax-impregnated cloth tape. The coupler area shall be covered by a smooth plastic tube complying with the requirements set forth in this Specification, overlapping the adjacent sheathed tendon by at least 1 inch. The two joints shall be sealed each by a coated heat shrink sleeve of at least 6-inch length, or approved equal. The corrosion-proof compound shall completely fill the space inside the cover tube.

Heat shrinkable sleeves shall be fabricated from crosslinked polyolefin tube coated with an adhesive sealant. Prior to shrinking, the tube shall have a nominal wall thickness of 0.02 inches. The adhesive sealant shall have a nominal thickness of 0.02 inches.

Strand couplers are not permitted.

A minimum of 1 inch of grout cover over the encapsulation shall be provided.

Construction Methods:
1-Records
The Contractor shall compile the following report on an accepted form, for each anchor that is installed:

A) **As-built drawings** showing the location, elevations, and orientation of each ground anchor, anchor type, anchor capacity, tendon type, total anchor length, bond length, unbonded length, and tendon bond length.

B) **Drilling and grouting conditions** containing date of drilling and grouting, diameter of drill hole, drilling method, depth of stratum penetration, quantity of water entering the hole during grouting, groundwater elevation, grouting pressures and quantity injected.

C) **Testing requirements and results**, anchor test results and graphs, extended creep tests, and lock-off loads. Testing equipment shall include dial gauges, dial gauge support, jack and pressure gauge, electronic load cell, and a reaction frame.

The Contractor shall provide the Engineer with a copy of this report immediately after each anchor is tested and/or locked-off.

2-Tendon Storage and Handling:
Tendons shall be handled and stored in such a manner as to avoid damage or corrosion. Heavy corrosion or pitting, damage to the prestressing steel, the corrosion protection, and/or the epoxy coating shall be cause for rejection by the Engineer. Grounding of welding leads to the prestressing steel is forbidden. Prestressing steel exposed to excessive heat (i.e., more than 400^{o} F) shall be rejected.

Lifting of pre-grouted tendons shall be to manufacturers' recommendations and not cause excessive bending, which can debond the prestressing steel from the surrounding grout.

3-Drilling:
The Contractor shall be responsible for selecting drilling equipment and methods suitable to establish a stable hole of adequate dimensions, within the tolerances specified. Down-hole hammers are not permitted unless the Engineer provides **written** authorization.

Holes for anchors shall be drilled at the location [± 3 inches], orientation [± 3°inclination and/or lateral direction] and to the length as shown on the Contract Drawings, the approved Working Drawings or as directed by the Engineer. The Contractor is to select the diameter of the hole required to develop the specified pullout resistance. The drill bit or casing crown shall not be more than 1/8 inch smaller than the specified hole diameter. If caving ground is encountered the Contract is to adjust his drill method, including drilling fluid, use of drilling casing, etc..

4-Tendon Insertion:
The tendon shall be inserted into the drill hole at a rate that does not damage the sheathing, coating, and grout tubes; and shall not be driven or forced. When the tendon cannot be completely inserted, the Contractor shall remove the tendon from the drill hole and clean and/or redrill the hole to permit insertion. Strand tendons shall be straightened by hand during installation. The bottom end of the tendon may be fitted with a cap or bullnose to aid its insertion into the hole, casing, or sheathing.

5-Grouting:
The grouting equipment shall produce a uniformly mixed grout free of lumps and undispersed cement, and be capable of continuously agitating the grout. A positive displacement grout pump shall be used. The pump shall be equipped with a pressure gauge capable of measuring pressures of at least 145 Psi or twice the actual grout pressures used whichever is greater. The grouting equipment shall be sized to enable three times the theoretical grout volume to be placed in one continuous operation.

The grout shall be injected from the lowest point of the drill hole. 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. Grout will be placed by means of a tremie pipe from the bottom of the pile upward to avoid segregation. The grout will be placed immediately after the drill hole is cleaned to the satisfaction of the Engineer, and the steel reinforcing with centering devices is installed.

The grout at the top of the drill hole shall not contact the back of the structure or the bottom of the trumpet.

If the ground anchor is installed in a fine-grained soil using drill holes larger than 6” in diameter, then the grout above the top of the bond length shall be placed after the ground 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 ground anchor system does not derive a significant portion of its load-carrying capacity from the soil above the bond length portion of the ground anchor.

If grout protected tendons are used for ground 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 five (5) minutes.

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

After grouting, the tendon shall not be loaded for a minimum of 3 days and the grout has achieved a minimum of 60% of the ultimate design strength.

5-Anchorage Installation:
The anchor bearing plate and the anchor head or nut shall be installed perpendicular [± 3°] to the tendon, centered on the bearing plate, without bending or kinking of the prestressing steel elements. Wedge holes and wedges shall be clean.

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 manufacture's recommendations.

The corrosion protection surrounding the unbonded length of the tendon shall extend up beyond the bottom seal of the trumpet or 4 inch into the trumpet if no trumpet seal is provided. The corrosion protection surrounding the unbonded length of the tendon shall not contact the bearing plate or the anchor head during testing and stressing.

STRESSING, LOAD TESTING AND ACCEPTANCE:
1 – General: Each ground anchor shall be tested. No load greater than ten (10) percent of the design load can be applied to the ground anchor prior to testing. The maximum test load shall be no less than 1.50 times the design load and shall not exceed 80 percent of the specified minimum ultimate tensile strength (SMTS) of the prestressing steel 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.

2 – Stressing Equipment: The testing equipment shall consist of:
A dial gauge or vernier scale capable of measuring to the nearest 0.001 inch shall be used to measure the ground anchor movement. The movement-measuring device shall have a minimum travel equal to twice the theoretical elastic elongation of the total anchor length at the maximum test load and it shall have adequate travel so the ground anchor movement can be measured without resetting the device at an interim point.

A hydraulic jack and pump shall be used to apply the test load. The jack and a calibrated primary pressure gauge shall measure the applied load. Testing cannot commence until the Engineer has approved the calibration. The primary pressure gauge shall be graduated in 100 Psi increments or less. Stressing equipment shall 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 percent of the rated capacity. The pump shall be capable of applying each load increment in less than 60 seconds.

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.

A calibrated reference pressure gauge shall also be kept at the site to periodically check the production (i.e., 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.

The Contractor shall provide an electrical resistance load cell and readout to be used when performing an extended creep test.

The stressing equipment shall be placed over the ground 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 in centered within the equipment.

3 – Load Testing Setup:

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

B) Prior to setting the dial gauges, an Alignment Load (AL) of no more than 5 % of design load shall be placed on the tendon.

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

D) Stressing and testing of multiple elements tendons with single element jacks is not permitted.

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

4 – Performance Tests:

A) The number of ground anchors as shown on the plans or as directed by the Engineer shall be Performance Tested in accordance with the procedures described below. The Engineer shall select the ground anchors to be performance tested. The remaining ground anchors shall be tested in accordance with the proof test procedures (see Part 5).

B) The performance test shall be made by incrementally loading and unloading the ground anchor in accordance with the schedule provided. The load shall be raised from one increment to another immediately after recording the ground anchor movement. The ground anchor movement shall be measured and recorded to the nearest 0.001 inch with respect to an independent fixed 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 ten (10) percent, the jack, the primary pressure gauge and the reference pressure gauge shall be recalibrated at no expense to the State. 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 performance test shall be held for ten (10) minutes.

PERFORMANCE TEST SCHEDULE

Step	Load
1	AL
2	0.25DL
3	AL
4	0.25DL
5	0.50DL
6	AL
7	0.25DL
8	0.50DL
9	0.75DL
10	AL
11	0.25DL
12	0.50DL
13	0.75DL
14	1.00DL
15	AL
16	0.25DL
17	0.50DL
18	0.75DL
19	1.00DL
20	1.20DL
21	AL
22	0.25DL
23	0.50DL
24	0.75DL
25	1.00DL
26	1.20DL
27	1.33DL
28	HOLD FOR 10 MINUTES
29	AL
30	Adjust to lock-off load

D) 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 ground 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 ground anchor movement between one (1) and ten (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 ground anchor movement shall be recorded at 15 minutes, 20, 30, 40, 50 and 60 minutes.

5 - Proof Tests:

The proof test shall be performed by incrementally loading the ground anchor in accordance with the following schedule. The load shall be raised from one increment to another immediately after recording the ground anchor movement. The ground 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. At load increments other than the maximum test load, the load shall be held just load enough to obtain the movement reading.

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

The maximum test load in a proof test shall be held for ten (10) minutes. 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 ground 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 ground anchor movement between one (1) and ten (10) minutes exceeds 0.04 inch, the maximum test load shall be held for and additional 50 minutes. If the load hold is extended, the ground anchor movements shall be recorded at 15 minutes, 20, 30, 40, 50 and 60 minutes.

6 – Extended Creep Tests:

A) An Extended Creep Test shall be performed on the number of ground anchors as shown on the plans or as directed by the Engineer. The Engineer shall select the ground anchors to be performance tested. The stressing equipment shall be capable of measuring and maintaining the hydraulic pressure within 50 psi. A load cell shall be used to monitor small changes in load during constant load-hold periods.

B) The extended creep test shall be made by incrementally loading an unloading the ground anchor in accordance with the performance test schedule in Part 4. At the end of each loading cycle, the load shall be held constant for the observation period indicated in the extended creep test schedule below. The times for reading and recording the ground 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.

C) The Contractor shall plot the ground anchor movement and the residual movement measured in an extended creep test. The Contractor shall also plot the creep movement for each load hold as a function of the logarithm of time.

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

7 – Ground Anchor Acceptance Criteria:

A) A performance- tested or proof- tested ground anchor with a 10 minute load-hold shall be acceptable if the: (1) ground 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 percent of the theoretical elastic elongation of the unbonded length.

B) A performance- tested or proof- tested ground anchor with a 60 minute load-hold shall be acceptable if the: (1) ground 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 percent of the theoretical elastic elongation of the unbonded length.

C) A ground anchor subjected to extended creep testing is acceptable if the: (1) ground 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 percent of the theoretical elastic elongation of the unbonded length.

D) The initial lift-off reading shall be within plus or minus five (5) percent 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.

8 - Procedures for Anchors Failing Acceptance Criteria:

A) Anchors that do not satisfy the minimum apparent free length criteria shall be either rejected and replaced at no additional cost to the State or locked off at not more than 50 percent of the maximum acceptable load attained.

B) Regroutable anchors which satisfy the minimum apparent free length criteria but which fail the extended creep test at the test load may be post-grouted and subjected to an enhanced creep criterion. This enhanced criterion requires a creep movement of not more than 0.04 inch between 1 minute 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 post-grouted or regroutable anchors that do not satisfy the enhanced creep criterion shall either be rejected or locked off at 50% of the maximum acceptable test load attained.

C) In the event that an anchor fails, the contractor shall immediately modify the design and/or construction procedures. These modifications may include, but are not limited to, 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, or increase in the number of anchors shall be at no cost to the State. 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.

9- Anchor Lock–Off:

A) After testing has been completed, the load in the tendon shall be such that after seating losses (i.e., wedge seating), the specified lock-off load has been applied to the anchor tendon. If no lock-off load is provided on the plans the lock-off load is to be between 75 and 100 percent of the anchor design load.

B) The wedges shall be seated at a minimum load of 50% ultimate load for tendon (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.

10- 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.

Method of Measurement: The quantity of ground anchors to be paid for will be the number of ground anchors installed and accepted. Should the Contractor elect to use an alternate number of ground anchors, the number of ground anchors to be paid for will not exceed that shown in the Contract Documents. The quantity of performance and extended creep tests to be paid for a maximum of once each per anchor location and this/these test(s) will only be the paid if the ground anchor is accepted.

Basis of Payment: The quantity of ground anchors as determined above will be paid for at the contract price per unit of measurement for the particular pay item listed below and shown in the bid schedule, which price and payment will be full compensation for the cost of furnishing all labor, equipment and material required to complete the work described in this section.

Payment will be made under:

Pay Item	Pay Unit
Ground Anchors	Each
Performance Test for Ground Anchors	Each
Extended Creep Test for Ground Anchors	Each