REPUBLIC OF THE PHILIPPINES
DEPARTMENT OF PUBLIC WORKS AND HIGHWAYS
OFFICE OF THE SECRETARY
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SUBJECT: DPWH Standard Specifications for Permanent Ground Anchors, Item 513

In line with the mandate of the Department in providing effective standard specifications to be used in the implementation of various infrastructure projects and in view of the need of setting standard specifications for Permanent Ground Anchors, the attached **DPWH Standard Specifications for Permanent Ground Anchors, Item 513,** are hereby prescribed for the guidance and compliance of all concerned.

These specifications shall form part of the revised edition of the DPWH Standard Specifications (Volume II – Highways, Bridges and Airports).

This order shall take effect immediately.

HERMOGENES E. ERDANE, JR.
Acting Secretary

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DPWH STANDARD SPECIFICATION FOR

ITEM 513 - PERMANENT GROUND ANCHORS

513.1 Description

This Item shall consist of designing, furnishing, installing, testing and stressing permanent cement-grouted ground anchors in accordance with the plans, these specifications, and the special provision.

513.2 Working Drawings

At least 30 days before work is to begin, the Contractor shall submit to the Engineer for review and approval complete working drawings and design calculations describing the ground anchor system or systems intended for use. The submittal shall include the following:

1. A ground anchor schedule giving the following information:

    a. Ground anchor number
    b. Ground anchor design load
    c. Type and size of tendon
    d. Minimum total anchor length
    e. Minimum bond length
    f. Minimum tendon bond length
    g. Minimum unbonded length

2. A drawing of the ground anchor tendon and the corrosion protection system, including details for the following:

    a. Spacers separating elements of tendon and their location
    b. Centralizers and their location
    c. Unbonded length corrosion protection system
    d. Bond length corrosion protection system
    e. Anchorage and trumpet
    f. Anchorage corrosion protection system
    g. Drilled or formed hole size
    h. Level of each stage of grouting, and
    i. Transition between the unbonded length and the bond length corrosion protection system.

3. The grout mix design and procedures for placing the grout.

The Engineer shall approve or reject the Contractor's working drawings within 30 days of receipt of a complete submittal. No work on ground anchors shall begin until working drawings have been approved in writing by the Engineer. Such approval shall not relieve the Contractor of any responsibility under the contract for the successful completion of the work.

513.3 Material Requirements

513.3.1 Prestressing Steel

Ground Anchor tendons shall consists of single or multiple elements of prestressing steel, anchorage devices and, if required, couplers. It shall also conform to any of the following: AASHTO M 203M, AASHTO M 275M, ASTM A 779 and ASSHTO M 203M.

Couplers for tendon sections shall be capable of developing 95 percent of the minimum specified ultimate tensile strength of the tendon.

513.3.2 Grout

Cement shall be Type I, II or III Portland Cement conforming to AASHTO M 85. Cement used for grouting shall be fresh and shall not contain any lumps or other indications of hydration or "pack set."

Grout shall be capable of reaching a cube strength (AASHTO T 106) of 25 Mpa in 7 days. Grout cubes for testing shall be made from random batches of grout as directed. Normally, grout strength testing shall not be required as system performance shall be measured by proof-testing each ground anchor. Grout cube testing shall be required if admixtures are used or irregularities occur in ground anchor testing.

Aggregate shall conform to the requirements for fine aggregate described in Item 405, Structural Concrete.

Admixtures may be used in the grout subject to the approval of the Engineer. Expansive admixtures may only be added to the grout used for filling sealed encapsulations, trumpets, and anchorage covers. Accelerators shall not be used.

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

513.3.3 Centralizers

Centralizers and spacers shall be fabricated from any type of material, except wood, that is not deleterious to the prestressing steel.

513.3.4 Steel Elements

Bearing plates shall be fabricated from steel conforming to AASHTO M 270 (ASTM A 709) Grade 36 minimum, or be a ductile iron casting conforming to ASTM A 536.

Trumpets used to provide a transition from the anchorage to the unbonded length corrosion protection 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. Minimum wall thickness shall be 5mm.

Anchorage covers used to enclose exposed anchorages shall be fabricated from steel, steel pipe, steel tube, or ductile cast iron conforming to the requirements of AASHTO M 270 (ASTM A 709) Grade 36 for steel, ASTM A 53 for pipe, ASTM A 500 for tubing, and ASTM A 536 for ductile cast iron. Minimum thickness shall be 2.5mm.

513.3.5 Corrosion Protection Elements

Sheath for the unbonded length of a tendon shall consist of one of the following:

1. Seamless polyethylene (PE) tube having a minimum wall thickness of 60 mils plus or minus 10 mils. The polyethylene shall be cell classification 334413 by ASTM D 3350.
2. Seamless polypropylene tube having a minimum wall thickness of 60 mils plus or minus 10 mils. The polypropylene shall be cell classification PP210B55542-11 by ASTM D 4101.
3. Heat shrinkable tube consisting of a radiation crosslinked polyolefin tube internally coated with an adhesive sealant. The minimum tube wall thickness before shrinking shall be 24 mils. The minimum adhesive sealant thickness shall be 20 mils.
4. Corrugated polyvinyl chloride (PVC) tube having a minimum wall thickness of 30 mils.

Encapsulation for the tendon bond length shall consist of one of the following:

1. Corrugated high-density polyethylene (HDPE) tube having a minimum wall thickness of 30 mils and conforming to AASHTO M 252 requirements.
2. Deformed steel tube or pipe having a minimum wall thickness of 25 mils.
3. Corrugated polyvinyl chloride (PVC) tube having a minimum wall thickness of 30 mils.
4. Fusion-bonded epoxy conforming to the requirements of AASHTO M 284, except that it shall have a film thickness of 15 mils.

The type of sheath and encapsulation for the tendons selected shall be subjected to the approval of the Engineer.

513.3.6 Miscellaneous Elements

Bondbreaker for a tendon shall consist of smooth plastic tube or pipe that is resistant to aging by ultra-violet light and that is capable of withstanding abrasion, impact and bending during handling and installation.

Spacers for separation of elements of a multi-element tendon shall permit the free flow of grout. They shall be fabricated from plastic, steel, or material which is not detrimental to the prestressing steel. Wood shall not be used.

Centralizers shall be fabricated from plastic, steel, or material, which is not detrimental to either the prestressing steel or any element of the tendon corrosion protection. Woods shall not be used. The centralizer shall be able to maintain the position of the tendon so that a minimum of 13 mm of grout cover is obtained on the tendons, or over the encapsulation.

513.4 Construction Requirements

513.4.1 Fabrication

513.4.1.1. General

Tendons for ground anchors may be either shop or field fabricated from materials conforming to the requirements of Subsection 513.3.1. Tendons shall be fabricated as shown on the approved working drawings. The tendon shall be sized to meet the following:

a. The design load does not exceed 60% of the minimum guaranteed ultimate tensile strength of the tendon

b. The maximum test load does not exceed 80% of the minimum guaranteed ultimate tensile strength of the tendon.

513.4.1.2 Bond Length and Tendon Bond Length

The Contractor shall determine the bond length necessary to develop the design load indicated on the plans and to satisfy the load test requirements. The minimum tendon bond length shall be 3 m in rock, 4.5 m in soil or as shown on the plans, which shall not be less than 3 m.

513.4.1.3 Grout Protected Ground Anchor Tendon

Spacers shall be placed along the tendon bond length of multi-element tendons to separate each of the individual elements so that the prestressing strength will bond to the grout. They shall be located at 3 m maximum centers with the upper one located a maximum of 1.5 m from the top of the tendon bond length and the lower one located a maximum of 1.5 m from the bottom of the tendon bond length.

Centralizers shall be placed along the bond length. They shall be located at 3 m maximum center-to-center spacing with the upper one located a maximum of 1.5 m from the top of the tendon bond length and the lower one located 0.30 m from the bottom of the tendon bond length. Use centralizers that do not impede the free flow of grout up the borehole. Centralizers are not required on tendons installed utilizing a hollow-stem auger if it is grouted through the auger and the drill hole is maintained full of a stiff grout (less than 22.5cm slump) during extraction of the auger. A combination centralizer-spacer may be used.

Centralizers are not required on tendons installed utilizing a pressure injection system in coarse-grained soils using grouting pressures greater than 1 MPa.

513.4.1.4 Encapsulation Protected Ground Anchor Tendon

Where encapsulation of the tendon is required, the tendon bond length shall be encapsulated by a grout-filled corrugated plastic or deformed steel tube, or by a fusion-bonded epoxy coating. The tendon can be grouted inside the encapsulation prior to inserting the tendon in the drill hole or after the tendon has been placed in the drill hole. Punching holes in the encapsulation and allowing the grout to flow from

the encapsulation to the drill hole, or vice versa, will not be permitted. The tendon shall be centralized within the encapsulation and the tube sized to provide a minimum 5mm of grout cover for the prestressing steel. Spacers and centralizers shall be used to satisfy the same requirements for grout protected ground anchor tendons. The anchorage device of tendons protected with fusion-bonded epoxy shall be electrically isolated from the structure.

513.4.1.5 Unbonded Length

The unbonded length of the tendon shall be a minimum of 4.5m or as indicated on the plans or approved working drawings.

A sheath completely filled with corrosion inhibiting grease or grout, or a heat shrinkable tube internally coated with an elastic adhesives shall provide corrosion protection.

If grease is used to fill the sheath, provisions shall be made to prevent it from escaping at the ends. The grease shall completely coat the tendon and fill the interstices between the wire strands. Continuity of corrosion protection shall be provided at the transition from the bonded length to unbonded length of the tendon.

If the sheath provided is not a smooth tube, then a separate bondbreaker must be provided to prevent the tendon from bonding to the anchor grout surrounding the unbonded length.

513.4.1.6 Anchorage and Trumpet

Nonrestressable anchorages may be used unless restressable anchorages are not designated on the plans or specified in the special provisions.

Bearing plates shall be sized so that 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. The size of bearing plates shall not be less than that shown on the plans or on the approved working drawings.

The trumpet shall be welded to the bearing plate. The trumpet shall have an inside diameter at least 6mm greater than the diameter of the tendon at the anchorage. 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.

Trumpet of restressable ground anchors shall be filled with corrosion-inhibiting grease and shall have a permanent Buna-N synthetic rubber or an approved equal seal between the trumpet and the unbonded length corrosion protection.

Trumpet of non-restressable ground anchor shall be filled with grout and shall have a tightly fitting temporary seal between the trumpet and the unbonded length corrosion protection.

513.4.1.7 Tendon Storage and Handling

Tendons shall be stored and handled in such a manner as to avoid damage or corrosion. Damage to tendon's prestressing steel as a result of abrasions, cuts, nicks, welds, weld splatter corrosion or pitting will be a cause for rejection by the Engineer. Grounding of welding leads to the prestressing steel is not permitted. A slight rusting, provided it is not sufficient to cause pits visible to the unaided eye, shall not be cause for rejection. Prior to inserting a tendon into the drilled hole, its corrosion protection elements shall be examined for damage. Any damage found shall be repaired in a manner approved by the Engineer. Degrease the bond length of tendons and remove solvent residue before installation.

513.4.2 Installation

The Contractor shall select the drilling method, the grouting procedure and grouting pressure to be used for the installation of the ground anchor as necessary to satisfy the load test requirements with prior approval of the Engineer.

513.4.2.1 Drilling

The drilling method used may be core drilling, rotary drilling, percussion drilling, auger drilling or driven casing. The method of drilling used shall prevent loss of ground above the drilled hole that may be detrimental to the structure or existing structures. Casing for anchor holes, if used, shall be removed, unless permitted by the Engineer to be left in place. The location, inclination, and alignment of the drilled hole shall be as shown on the plans. Inclination and alignment shall be within plus or minus 3 degrees of the planned angle at the bearing plate, and within plus or minus 30cm of the planned location at the ground surface (point of entry).

513.4.2.2 Tendon Insertion

The tendon shall be inserted into the drilled hole to the desired depth without difficulty. When the tendon cannot be completely inserted it shall be removed and the drill hole cleaned or redrilled to permit insertion. Partially inserted tendons shall not be driven or forced into the hole. Do not extend ground anchors beyond the right-of-way or easement limits.

513.4.2.3 Grouting

A neat cement grout or sand-cement grout conforming to the requirements of Subsection 513.3.2 shall be used. Admixtures, if used, shall be mixed in quantities not to exceed the manufacturer's recommendations.

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 pressures gauge shall be capable of measuring pressures of at least 1MPa or twice the actual grout pressure to be used, whichever is greater. The grouting equipment shall be sized to enable the grout to be pumped in one continuous operation. The mixer shall be capable of continuously agitating the grout during placement.

The grout shall be injected from the lowest point of the drill hole. The grout may be placed either before or after insertion of the tendon. The grout may be pumped through grout tubes, casing, hollow-stem augers or drill rods. The quantity of the grout and the grout pressures for each ground anchor shall be recorded. The grout pressures and grout takes shall be controlled to prevent excessive heaving of the ground or fracturing of rock formations.

Except as 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 stop 150mm from the back of the structure or from the bottom of the trumpet, whichever is lowest.

If the ground anchor is installed in a fine-grained soil using a drilled hole larger than 150mm in diameter, then the grout above the top of the bond length shall be placed after the ground anchor has been load tested. The entire drill hole may be grouted at one time if it can be demonstrated that the ground anchor system does not derive a

significant portion of its load resistance 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 0.35 MPa grout pressure can be maintained on the grout within the bond length for a period of 5 minutes.

Upon completion of grouting, the grout tube may remain in the drill hole provided it is filled with grout.

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

513.4.2.4 Trumpet and Anchorage

The corrosion protection surrounding the unbonded length of the tendon shall extend into the trumpet a minimum of 150mm beyond the bottom seal of the trumpet or 300mm 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 of the anchorhead during load testing and stressing.

The bearing plate and anchorhead shall be placed perpendicular to the axis of the tendon.

The trumpet shall be completely filled with corrosion inhibiting grease or grout. The grease may be placed any time during construction. The grout shall be placed after the ground anchor has been load tested. The Contractor shall demonstrate that the procedures selected for placement of either grease or grout will produce a completely filled trumpet.

Anchorages not encased in concrete shall be covered with a corrosion inhibiting grease-filled or grout-filled steel enclosure.

513.4.3 Testing and Stressing

The Contractor shall test each ground anchor using a maximum test load not to exceed 80% of the minimum ultimate tensile strength of

the tendon. No load greater than 10% of the design load may be applied to the ground anchor prior to load testing. The test load shall be simultaneously applied to the entire tendon

513.4.3.1 Testing Equipment

A dial gauge or vernier scale capable of measuring displacements to 0.025mm shall be used to measure ground anchor movement. It shall have adequate travel so total ground anchor movement can be measured without resetting the device.

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 pressure gauge shall be graduated in 1MPa increments or less. When the theoretical elastic elongation of the total anchor length at the maximum test load exceeds the ram travel of the jack, the procedure for recycling the jack ram shall be included in the working drawings. Each increment of test load shall be applied as rapidly as possible.

A calibrated reference pressure gauge shall be available at the site. The reference gauge shall be calibrated with the test jack and pressure gauge.

An electrical resistance load cell and readout shall be provided when performing a 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 is centered within the equipment.

513.4.3.2 Performance Test

Five percent of the ground anchors or a minimum of three ground anchors, whichever is greater shall be performance tested in accordance with the following procedures. The Engineer shall select the ground anchors to be performance tested. The remaining anchors shall be tested in accordance with the proof test procedures.

The performance test shall be made by incrementally loading and unloading the ground anchor in accordance with the following schedule unless a different maximum test load and schedule are indicated on the plans. 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 0.025mm 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 load increments other than the maximum test load, the load shall be held just long enough to obtain the movement reading.

Performance Test Schedule

Load (START)	**Load** (CONTINUATION)
AL	AL
0.25DL*	0.25DL
AL	0.50DL
0.25DL	0.75DL
0.50DL*	1.00DL
AL	1.20DL*
0.25DL	AL
0.50DL	0.25DL
0.75DL*	0.50DL
AL	0.75DL
0.25DL	1.00DL
0.50DL	1.20DL
0.75DL	1.33DL*
1.00DL*	(Maximum test load)
	Reduce to lock-off load

Where: AL = Alignment load
DL= Design load for ground anchor
* = Graph required

The maximum test load in a performance test shall be held for 10 minutes. The jack shall be repumped 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 shall be measured

and recorded at 1, 2, 3, 4, 5, 6 and 10 minutes. If the ground anchor movement between 1 minute and 10 minutes exceeds 1mm, the maximum shall be recorded at 15, 20, 25, 30, 45 and 60 minutes.

A graph shall be constructed showing a plot of ground anchor movement versus load for each load increment marked with an asterisk (*) in the performance test schedule and a plot of residual ground anchor movement of the tendon at each alignment load versus the highest previously applied load. Graph format shall be approved by the Engineer prior to use.

513.4.3.3 Proof Test

The proof test shall be performed by incrementally loading the ground anchor in accordance with the following schedule unless a different maximum test load and schedule are indicated on the plans. 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 0.025mm 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.

Proof Test Schedule

Load (START)	**Load** (CONTINUATION)
AL	
0.25DL	1.20DL
0.50DL	1.33DL (max test load)
0.75DL	Reduce to lock-off load
1.00DL	

Where: AL = Alignment load
DL= Design load for ground anchor

The maximum test load in a proof test shall be held for 10 minutes. The jack shall be repumped 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 shall be measured and recorded at 1, 2, 3, 4, 5, 6 and 10 minutes. If the ground anchor movement between 1 minute and 10 minutes exceeds 1mm, 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, 20, 30, 45 and 60 minutes. A graph shall be constructed showing a plot of ground anchor movement versus load for each load increment in the proof test. Graph format shall be approved by the Engineer prior to use.

513.4.3.4 Creep Test

Creep tests shall be performed if required by the plans or special provisions. The Engineer shall select the ground anchors to be creep tested.

The creep test shall be made by incrementally loading and unloading the ground anchor in accordance with the performance test schedule used. At the end of each loading cycle, the load shall be held constant for the observation period indicated in the creep test schedule below unless a different maximum test load is indicated on the plans. The times for reading the recording the ground anchor movement during each observation period shall be 1, 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. 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 of load during a constant load-hold period. The jack shall be repumped as necessary in order to maintain a constant load.

Creep Test Schedule

Load	Observation Period (Minutes)
AL	
0.25DL	10
0.50DL	30
0.75DL	30
1.00DL	45
1.20DL	60
1.33DL	300

Where: AL = Alignment load
DL= Design load for ground anchor

A graph shall be constructed showing a plot of the ground anchor movement and the residual movement measured in a creep test as described for the performance test. Also, a graph shall be constructed showing a plot of the ground anchor creep movement for each load-hold as a function of the logarithm of time. Graph formats shall be approved by the Engineer prior to use.

513.4.3.5 Ground Anchor Load Test Acceptance Criteria

A performance-tested or proof-tested ground anchor with a 10-minute load hold is acceptable if the:

1. Ground anchor resists the maximum test load with less than 1mm of movement between 1 and 10 minutes; and
2. Total movement at the maximum test load exceeds 80% of the theoretical elastic elongation of the unbonded length.
3. Total movement at the maximum test load may not exceed the theoretical elastic elongation of the unbonded length plus 50% of the theoretical elastic elongation of the bonded length. [Criterion (3) applies only for a performance-tested ground anchor in competent rock.]

A performance-tested or proof-tested ground anchor with a 60-minute load hold is acceptable if the:

1. Ground anchor resists the maximum test load with a creep rate that does not exceed 0.08 inches in the last log cycle of time
2. Total movement at the maximum test load exceeds 80% of the theoretical elastic elongation of the unbonded length.
3. Total movement at the maximum test load may not exceed the theoretical elastic elongation of the unbonded length plus 50% of the theoretical elastic elongation of the bonded length. [Criterion (3) applies only for a performance-tested ground anchor in competent rock.]

A creep-tested ground anchor is acceptable if the:

1. Ground anchor carries the maximum test load with a creep rate that does not exceed 2mm in the last log cycle of time

2. Total movement at the maximum test load exceeds 80% of the theoretical elastic elongation of the unbonded length.
3. Total movement at the maximum test load may not exceed the theoretical elastic elongation of the unbonded length plus 50% of theoretical elastic elongation of the bonded length. [Criterion (3) applies only for a performance-tested ground anchor in competent rock.]

If the total movement of the ground anchor at the maximum test load does not exceed 80% of the theoretical elastic elongation of the unbonded length, the ground anchor shall be replaced at the Contractor's expense.

A ground anchor which has a creep rate greater than 2mm per log cycle of time can be incorporated into the structure at a design load equal to one-half of its failure load. The failure load is the load resisted by the ground anchor after the load has been allowed to stabilize for 10 minutes.

When a ground anchor fails, the Contractor shall modify the design and/or the installation procedures. These modifications may include, but are not limited to, installing a replacement ground anchor, reducing the design load by increasing the number of ground anchors, modifying the installation methods, increasing the bond length or changing the ground anchor type. Any modification which requires changes to the structure shall be approved by the Engineer. Any modifications of design or construction procedures shall be without additional cost to the Department and without extension of contract time.

Retesting of a ground anchor will not be permitted, except that regrouted ground anchors may be retested.

Complete record of the load testing data during the conduct of Performance Test, Proof Test and Creep Test must be duly signed by the Contractor and his Engineer and submit to the Engineer for evaluation prior to recommendation for payment. However if in the evaluation, a discrepancy in the computation revealed which may affect the ground anchoring, rectification of the anchorage shall be done at Contractor's own expense.

513.4.3.6 Lock Off

Upon successful completion of the load testing, the ground anchor load shall be reduced to the lock-off load indicated on the plans and transferred to the anchorage device. The ground anchor may be

completely unloaded prior to lock-off. After transferring the load and prior to removing the jack, a lift-off load reading shall be made. The lift-off load shall be within 10% of the specified lock-off load. If the load is not within 10% of the specified lock-off load, the anchorage shall be reset and another lift-off load reading shall be made. This process shall be repeated until the desired lock-off load is obtained.

513.5 Method of Measurement

Ground anchors will be measured and paid for by the sum of the bonded and unbonded length of anchor bars installed and accepted as shown on the plans or ordered by the Engineer. No change in the number of ground anchors to be paid for will be made because of the use by the Contractor of an alternative number of ground anchors.

513.6 Basis of Payment

The accepted quantity, measured as prescribed in Section 513.5, shall be paid for at the contract unit price paid for Permanent Ground Anchors, which price and payment shall be full compensation for furnishing all labor, materials, tools, equipment and incidentals and for doing all the work involved in installing the ground anchors (including testing), complete in place, as shown on the plans and as specified in these specifications and the special provisions, and as directed by the Engineer.

Payment will be made under:

Pay Item Number	Description	Unit of Measurement
513	Permanent Ground Anchor	Linear meter