SPECIAL SPECIFICATION

4253

Prestressed Ground Anchors

1. **Description.** Install post-tensioned ground anchors in place, with grouting as required in accordance with the plans and these specifications. Ensure the ground anchors provide the load carrying capacities as required in the anchors that will develop the load as required in the plans and the approved working drawings in accordance with the testing requirements of this specification.

The Contractor has the option of furnishing any type of post-tensioning system meeting the requirements of these specifications. The Contractor may also propose to use proprietary systems which do not conform to all provisions of this specification, if the concept is approved by the Engineer. The system selected must provide the magnitude and distribution of design prestressing force and minimum ultimate strength required by the plans without exceeding allowable temporary stresses. Ensure design procedures, coefficients, and allowable stresses are in accordance with the latest Standard AASHTO Specifications for Highway Bridges.

2. **Materials.** Provide materials required for use under this Item conforming to Table 1:

<table>
<thead>
<tr>
<th>Material</th>
<th>Conform to Item</th>
</tr>
</thead>
<tbody>
<tr>
<td>Structural Steel</td>
<td>Item 441 and 442</td>
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<tr>
<td>Prestressing Steel</td>
<td>Item 426</td>
</tr>
<tr>
<td>Hydraulic Cement</td>
<td>Item 421</td>
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<tr>
<td>Concrete</td>
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</tbody>
</table>

Provide prestressing steel conforming to one of the following types:

- Seven wire strand conforming to ASTM Designation A416; or
- High-tensile strength alloy bars conforming to the requirements of ASTM designation A722.

Bars with greater minimum ultimate strength, but otherwise produced and tested in accordance with ASTM Designation A722, may be used provided they have no properties which make them less satisfactory than the specified material. Wire or strand with greater ultimate strength but otherwise produced and tested in accordance with ASTM designation A416 and A421, and the requirements of this specification, are permitted provided the physical properties as outlined in the applicable specification are shown on the shop drawings and provided they have no properties which make them less satisfactory than the specified material.
Each ground anchor tendon is a single bar or a group of strands having a common end anchorage used to apply a prestressing force to a structural member. Provide coated (unbonded) tendons except the portion which is established as the anchorage length. Coat the tendons a minimum of 15 ft. Ensure the anchorage length is bare and completely free of grease or other contaminants. The minimum acceptable anchorage length is 10 ft. in rock and 15 ft. in soil.

Provide end anchorages and tendon couplers that develop at least 100% of the required ultimate strength of the tendon with a minimum elongation of 2%.

Use material for coating unbonded tendons that is a non-volatile, low friction mineral oil base grease, with a rust preventing additive having a relatively uniform viscosity in a temperature range of 20 F to 120 F. Provide a protective sheathing around the tendon throughout the coated length consisting of 0.04 in. minimum thickness polyethylene or polyvinyl chloride tubing capable of maintaining the tendon tightly bundled and containing the lubricant.

Provide grout for ground anchors that is a neat cement or sand cement mixture, with a 7-day compressive strength of 3500 psi. Determine grout strengths by testing 2-in. cubes in accordance with Test Method TEX-307-D or 3 in. diameter by 6 in. high cylinders in accordance with Test Method TEX-418-A. Determine the grout strength by testing the initial grout batch. Additional testing is necessary if the grout mixture is modified or if required by the Engineer. If allowed by the Engineer, test results from previous projects using an identical grout mix may be accepted.

Instead of cement grout, an epoxy or polyester resin grout may be used to grout anchors in rock. Use the resin grout in accordance with the manufacturer’s recommendations.

Identify the tendons by heat number, or reel number in the case of seven wire strand, and tag them for identification. Identify anchorage assemblies in a like manner. At the request of the Engineer, furnish specimens for test purposes in accordance with Test Method TEX-710-I. Provide mill test reports for tendons used in permanent anchors.

Test complete tendons for compliance with the requirements of this specification at no expense to the Department and certify the results in writing. In addition, furnish for testing, one specimen of each size of prestressing tendon with end fittings attached at each end for ultimate strength tests only.

Provide a specimen 5 ft. in clear length measured between the ends of the fittings. If the results of the test indicate the necessity of check tests, furnish additional specimens at no cost to the Department. For prestressing systems previously tested and approved on Department projects, compete tendon samples need not be furnished, provided there is no change in the material, design, or details previously approved. For the shop drawings or prestressing details, identify the project on which approval was obtained, otherwise sampling will be necessary.

For prefabricated ground anchor assemblies, notify the Materials and Tests Engineer at least 10 days before installing the end fittings or heading the wires so that sampling and testing may be arranged.
3. **Packaging, Storing, and Handling.** Protect the prestressing steel against physical damage and corrosion from the time of manufacture to grouting or encasing in concrete.

Rust on prestressing steel which can be removed by light rubbing is acceptable. Streaks or spots which may remain after rust removal are acceptable if no pitting is present. Tight mill scale is acceptable but remove loose mill scale.

Protect prefabricated ground anchor assemblies from moisture by taping, wrapping, or by other acceptable means.

4. **Equipment.** Furnish suitable equipment to drill the holes to the diameter, depth, and line as specified in this specification or on the approved working drawings.

Furnish suitable hydraulic jacks for stressing the tendons. Equip jacks with gauges graduated to read directly to one percent of the total load applied, and calibrated to measure accurately the stress induced in the steel.

Provide jacks with a stroke of adequate length so that the stressing, including temporary overstress, can be done in one movement. Equip them with proper ports or windows for adequate visual examination and measurement of tendon movement. Ensure they are also capable of slow release of stress to allow relaxation from overstress to the proper seating force.

Furnish a grout mixer and pump of sufficient capacity to properly place grout in the quantities required.

5. **Working Drawings.** Submit working drawings for the ground anchors sufficiently in advance of the installation of the ground anchors. Provide the details containing the necessary information for construction including:

   A. **Prestressing Details.** On the drawings show details of type, size, number of units per ground anchor, ground anchor diameter, inclination, forces applied per anchor, end anchorage systems, grouting and venting ports, grouting procedure, acceptable elongation, temporary overstress, and other information necessary to properly complete the work.

      On these details show the method of support for the ground anchors to insure that the proper location in the center of the hole can be maintained.

   B. **Anchor Layout.** Provide drawings showing the layout of the anchors and design forces relative to the proposed wall.

      Submit six sets of working drawings on standard 22 in. by 34 in. sheets. On these drawings, show the layout of the anchors and design forces relative to the proposed wall.

6. **Construction.**

   A. **General.** Before stressing the anchors, furnish certified copies of load calibration curves on the jacks and gauge systems to be used in the work. Recalibrate the stressing systems when required by the Engineer.
B. **Drilling.** Drill the hole within +/- 3 degrees from the line specified on the approved working drawings.

C. **Grouting.** Clear the hole of debris before placing the tendon. Insert the tendon in the hole and use supports to ensure that the tendon is centered in the hole with a maximum 1 in. of sag between the supports. Provide a grouting pipe that allows placing the grout from the bottom of the hole. Before beginning to pump the grout, check the grout tubes to ensure they are clear. When the tendon is grouted through the center of a hollow auger, no grout tube or centralizers are required as long as grout pressure is maintained while withdrawing the auger.

Grout the anchors immediately after placing them in the hole. Pump the grout from the bottom of the hole toward the top, continuously under pressure, until the grout is within approximately one foot of the top of the hole. Grout the hole full length in one stage with clearance provided between the grout and the tendon anchorage.

If the grout level in the hole cannot be maintained, withdraw the tendon and redrill the hole after at least 24 hours have passed.

Record the data shown in Table 2 concerning the grouting:

| Table 2  
| Grouting Data to Record |
|---|---|
| Water-cement ratio | |
| Types of additives | |
| Types of cement | |
| Volume of grout | |

D. **Post-Tensioning.** Do not begin post-tensioning until the concrete in the associated structural members has reached the design strength specified.

Provide suitable means for measuring the movement of the anchor head to the nearest 0.001 in.

Indicate on the prestressing details, a sequence of post-tensioning that prevents overstressing the structural member.

Ensure the prestressing details submitted reflect the following general tensioning procedure modified as required for each particular installation, unless otherwise required by the plans.

1. Tendons in the sequence designated in the Prestressing Details.

2. Perform initial tensioning to take the slack out of the tendons at 10% of the maximum tensioning load unless otherwise shown on the approved Prestressing Details.

3. After the initial tensioning, set up an independent reference to measure the anchor movement. Ensure the movement measured between the maximum proof load and the lock-off load is within the following limits:
a. Determine the minimum movement limit based on the elastic elongation calculated using 80% of the unbonded length.

b. Determine the maximum movement limit based on the elastic elongation calculated using the entire unbonded length plus 50% of the bonded length.

If the movement measured is not within the above specified limits, the anchor will be rejected. In that case, install a replacement anchor at no cost to the Department.

4. Perform proof loading of every anchor of not less than 133% of its design load. During the proof loading operation, do not allow the prestressing force to exceed 80% of the guaranteed ultimate strength of the prestressing steel. The duration of the proof loading is 2 minutes. If the anchor movement exceeds 0.02 in. in 2 minutes, proceed as described in the performance test section with the load held for a total of 60 minutes. Transfer (lock-off) the prestressing force at a level of between 10% and 70% of its guaranteed ultimate tensile strength, as required, to provide the design loads shown on the plans.

5. Perform testing of 5% or a minimum of 3 anchors, whichever is greater, in accordance with the following procedures.

   Conduct the performance test by incrementally loading and unloading the anchor in accordance with the following schedule. Hold the loads, except the maximum test load, only long enough to obtain the movement reading.

   | AL  | AL  |
   | 0.25 DL | 0.25 DL |
   | AL  | 0.50 DL |
   | 0.25 DL | 0.75 DL |
   | 0.50 DL | 1.00 DL |
   | AL  | 1.20 DL |
   | 0.25 DL | AL   |
   | 0.50 DL | 0.25 DL |
   | 0.75 DL | 0.50 DL |
   | AL  | 0.75 DL |
   | 0.25 DL | 1.00 DL |
   | 0.50 DL | 1.20 DL |
   | 0.75 DL | 1.33 DL | Maximum Testload
   | 1.00 DL | AL   |

   Hold the maximum testload held for 10 minutes. Record the anchor movement with respect to a fixed reference at 1, 2, 3, 4, 5, and 10 minutes. If the movement between 1 minute and 10 minutes exceeds 0.04 in., continue the test for an additional 50 minutes. If the test is extended, record the movement at 15, 20, 30, and 60 minutes. Measure the time from when the pump is started after the 1.20 DL load increment.

6. Perform lift off tests 48 hours after the initial tensioning on the first three permanent anchors installed at each wall location before final grouting. Ensure the lift off load within 10% of the lock off load.
7. Perform final grouting of the anchor plate area as indicated on the plans within 3 days after tensioning and lift off tests for a soil anchor have been completed.

Ground anchors will be considered acceptable if the anchor movement in any testing does not exceed 0.08 in. per log cycle of time. The anchor movements must also fall within the limits stated in Article 6.D.3. above.

Anchors which fail to attain the maximum test load required as stated above may be incorporated into the wall at a load capacity equal to one half their failure loads. The failure load is the load indicated by the pressure gauge 10 minutes after failure occurs. Then install additional anchors to replace or supplement the failed anchor. The Contractor is responsible for the entire cost of installing any required additional anchors, or changes in the original anchor design.

7. Measurement and Payment: The work performed, materials furnished, labor, tools, equipment, and incidentals will not be measured or paid for directly, but are subsidiary to the Item “Retaining Walls” as required by the plans and contract.