

SECTION 02471

ROCK ANCHORS

PART 1. GENERAL

1.1 Work Overview

- A. Examine all of the Contract Documents to assess full extent of the Work.
- B. Coordinate work with that of all other trades affecting or affected by work of this section. Cooperate with such trades to assure the steady progress of all work under the contract.

1.2 Related Sections

- A. Earthwork is specified in Section 02200.
- B. Concrete is specified in Section 03300.
- C. Reinforcing steel is specified in Section 03300.

1.3 Description

- A. The work to be done under this section includes drilling, furnishing, delivery, unloading, storing, installation, stressing and securing the 140 kip minimum design load permanent rock anchor systems as described herein and as shown on the drawings.
- B. Rock anchors shall consist of continuous upset threaded steel bars, provided with a factory-applied double corrosion protection and PVC bond breaker, installed in oversized drilled holes in rock, fully encapsulated with cement grout. Rock anchors shall be post-tensioned to 140 kips, and shall include the associated hardware to facilitate post-tensioning, and connection to the structure.

1.4 References

- A. The International Building Code, latest edition.
- B. American Society for Testing and Materials (ASTM).
- C. American Institution of Steel Construction (AISC).
- D. American Concrete Institute (ACI).
- E. Post-Tensioning Institute (PTI) "Recommendations for Prestressed Rock and Soil Anchors," Post-Tensioning Manual, Fourth Addition.

1.5 Site and Subsurface Conditions

The Waterview at Bayside Condominium

- A. Subsurface investigation data are available in the report entitled “Report on Subsurface Explorations and Foundation Design Recommendations, The Proposed Waterview Apartments at Bayside, 405 Cumberland Avenue, Portland, Maine”, dated 18 March 2005, by Haley & Aldrich, Inc. A copy of this report has been also been included in Division 0 – Supplemental Information of the project documents.
- B. Prior to submitting a bid, the Contractor shall review and understand the information contained in the report. The geotechnical investigation report is made available to the Contractor for information on factual data only, and shall not be interpreted as a warranty of subsurface conditions, whether interpreted from written text, boring logs or other data.
- C. Available soil and rock samples recovered from borings may be examined at the office of Haley & Aldrich, Inc., 75 Washington Avenue, Suite 203, Portland, Maine, 04101. The boring information is considered to represent the conditions at the locations of the test borings and at the time that the test borings were made. The Contractor should anticipate variations from the conditions disclosed by the borings in planning and estimating the work.
- D. The Engineer does not guarantee the accuracy of boring information, which is made available to the Contractor for information, to be used at their own risk. No claim for extra compensation or extension of time will be considered on account of any variation in soil or water conditions between those indicated by the borings and those actually encountered.

1.6 Submittals

- A. Submit detailed shop drawings showing overall configuration, assembly and layout of work. Show details of fabrication and detail of interface with adjacent work.
- B. Submit the following information 1 week prior to the first installation of rock anchors in the field:
 - 1. Literature describing the factory-applied double corrosion protection.
 - 2. Details of the cement grout mix design proposed for use.
 - 3. Certified mill reports for rock anchors upon delivery to the site.
- D. Design calculations for the anchorage, including bearing plates, signed and sealed by a registered professional engineer in the state of Maine.
- E. Prior to testing rock anchor installations, submit manufacturer’s information for the equipment to be used to conduct proof tests on rock anchors. Submit diagram(s) showing the geometry of proof test equipment relative to rock anchor bar, end hardware method of locking-off the post-tension load, and calibration data for the system of jack and gauges, including the following:
 - 1. A calibration, conducted by a certified testing agency, of the complete proof test assemblies, together as unit. Calibration of the assembly shall have been conducted within six months prior to conducting the first proof test, and shall be presented in the form of a plot of gauge pressure versus actual jack force.
 - 2. A diagram of the Contractor’s proposed test equipment setup(s) for monitoring the elongation of the bars during proof testing of rock anchors. The test

The Waterview at Bayside Condominium

equipment setup(s) proposed shall be completely independent of the jack, shall include a micrometer dial gauge capable of measuring anchor bar elongation to the nearest 0.001 inch, having two inches of travel, and be mounted on an adjustable tripod or other device with flexible extension arms, or a “gooseneck” to permit rapid alignment of the dial gauge axis with the axis of the rock anchor.

1.7 Quality Assurance

- A. Full time monitoring of the Work of this section will be provided by the Owner’s Geotechnical Representative. No work shall be completed except in the presence of an authorized representative of the Owner’s Representative.
- B. Rock anchors, and their installation and testing, shall meet or exceed the minimum requirements specified herein and those recommended by the manufacturer.
- C. Comply with all rules, regulations, laws and ordinances of the State of Maine, City of Portland, and all other authorities having jurisdiction. All labor, materials, equipment and services necessary to make work comply with such requirements shall be provided without additional cost to Owner.
- D. The Foundation Contractor and anchor supplier shall furnish evidence that they have been engaged in successful installation, supply and testing (respectively) of anchors for a least five years.
- E. Rock anchors shall be handled, transported, stacked and protected to prevent damage. The Contractor shall deliver rock anchors at times and in sequence to assure continuity of rock anchor installation.

1.8 Bidding Requirements

- A. The base bid of the Contractor shall include the total price for the installation of the estimated quantity of rock anchors indicated on the drawings. This price shall include furnishing of all bars, bearing plates, nuts, washers, drilling hole, cleaning, grouting and redrilling as necessary, installing, tremie grouting, testing and post-tensioning, and all work incidental thereto.
- B. Rock anchors rejected in accordance with the provisions of these specifications will not be paid for. The Contractor will be paid at the contract price for one replacement rock anchor installed and accepted according to the provisions of these specifications. If more than one replacement rock anchor is required to compensate for a rejected rock anchor, the Contractor will be paid at the contract price for only one anchor. Additional rock anchors required to compensate for rock anchors installed out of design location shall be installed at no additional cost to the Owner.
- C. No separate payment will be made for grouting and redrilling holes.

PART 2. PRODUCTS

2.1 Rock Anchors

The Waterview at Bayside Condominium

- A. Rock anchor bars shall be grade 150 steel, continuous upset threaded bars manufactured by the Williams Form Engineering Corporation or Dywidag Systems International conforming to ASTM A722, Type II, cold stretched and stress relieved. Rock anchor bars shall be one and three-eighth (1-3/8) inch diameter or equivalent cross-sectional area of 1.58-sq. in., and have double corrosion protection. The installed anchors shall have a smooth PVC tube (bond breaker) provided over the stressing length, which shall form a gas and watertight barrier resistant to chemical attacks and aging around the steel bar.
- B. Each rock anchor shall consist of a maximum of two pieces of deformed bar encased in PVC corrugated sheathing. A smooth sheathing fitting snugly over the corrugated sheathing in the free stressing length shall guarantee unobstructed elongation during stressing. The deformed bar shall be centered in the corrugated sheathing and the annular space between the bar and the sheathing shall be filled with cement grout. The anchor shall be pre-assembled and pre-grouted at the factory prior to shipping to the job site. Each bar shall have a minimum of three centering devices to center the bar in the drilled hole. Rock anchor bars may be in two lengths with only one coupling allowed. No coupling will be allowed in the bonded length. The coupling shall be in the bond breaker portion of the bar.
- C. The stressing head assembly of the rock anchors shall include steel bearing plate and a hexagonal nut seating designed by the Contractor.
 - 1. Bearing plates: Bearing plates shall conform to ASTM A36. The Contractor shall determine size of the bearing plates.
 - 2. Washers: Washers shall be hardened steel conforming to ASTM F436, and shall be four inches in diameter, and one-quarter inch thick. Center holes shall be one-quarter inch larger in diameter than the anchor bar.
 - 3. Nuts: Hexagonal nuts and anchor nuts shall be hexagonal head, heavy duty type, conforming to AISI CD1036 and AISI CD1045, respectively, and to the bar manufacturer's specifications.
- D. Cement grout for encapsulating rock anchors shall be a neat cement grout, with a maximum water-cement ratio of 0.45 by weight, and have a minimum 28-day compressive strength of 6,000 psi to achieve an effective bond between grout and the rock, and the grout and the bar. Minimum grout-rock bond stress (working-stress) is 60 psi for 6,000-psi strength grout.

2.2 Corrosion Protection

- A. Field patching and splicing or repair material must be compatible with the double corrosion protection, and inert in concrete. The material shall be suitable for splicing and repairs made by the Contractor of the splice and areas of the coating damaged during fabrication and/or handling.
- B. Areas to be spliced or patched shall be clean and free of surface contaminants. The areas shall be promptly treated in accordance with the epoxy coating manufacturer's recommendations, and before detrimental oxidation occurs.
- C. All elements of rock anchors shall be epoxy-coated, including ends of cut bars, bearing plates, washers and nuts.

The Waterview at Bayside Condominium

- D. A plastic cap and plastic nut filled with mastic corrosion inhibitor (grease) will encapsulate the hexagonal nut for corrosive protection.
- E. Grease for the coupling and stressing head assembly shall be mastic coating repairs due to damage, bar cutting and installation of end hardware.

PART 3. EXECUTION

3.1 Installation of Rock Anchors

- A. Complete foundation excavation to the required footing subgrades indicated on the Drawings and pile installation and construction of pile caps.
- B. During construction of formwork and installation of steel reinforcing for the footings, place a suitably-sized Schedule 80 PVC sleeve at anchor locations. PVC sleeves shall extend through the entire footing depth and any flowable fill use to level the bedrock surface, and be plugged during concreting to avoid fouling of the PVC sleeves with concrete.
- C. Drilling of Holes:
 - 1. Drill 5-in. diameter holes through the PVC sleeve, a sufficient distance into bedrock to provide the capacities required, but not less than the minimum distance required, as shown on the Drawings. Use percussion drilling methods.
 - 2. Overdrill the hole at least 6 in. deeper than the depth required but not more than 12 in.
 - 3. After drilling, clean each hole of all drill cuttings, sludge and debris prior to grouting.
- D. Insert and center the rock anchor in the drill hole. Install the coupling and corrosion protection in accordance with manufacturer's instructions. As a minimum, the coupling shall be centered on the two bars, locked in place by set screws, the annular space filled with grease and protected by heat shrink plastic sheathing.
- E. Cement Grouting:
 - 1. Cement grout shall be installed in one phase.
 - 2. Grout the annular space between rock anchor and the drill hole with cement grout using the tremie method to expel all water and loose debris from the drill hole. The bottom of the tremie pipe shall not be raise above the top of the grout in the drill hole during tremie grouting. Grout the entire bar length to the top of the hole. Regrout as necessary if grout settles. The rock anchor will be considered grouted when there is full return of undiluted grout from the top of the hole. If grout loss from the drill hole exceeds three times the volume of the annular space between the drill hole and the rock anchor, grouting will be discontinued, the rock anchor removed from the hole, and the drill fully grouted. Redrill the hole after at least one day.
- F. Tensioning of rock anchors:

The Waterview at Bayside Condominium

1. Prior to post-tensioning of or proof testing of rock anchors, allow the footing concrete to cure.
 2. Rock anchors shall be tensioned by direct pull with hollow ram hydraulic jack, so mounted as to prevent bending of the bar.
 3. All anchors shall be proof tested and then locked off at 140 kips.
 4. Nuts and bearing plates for rock anchors shall be tightened against the collar of the drill hole.
- G. Cutting of bar lengths for any purpose shall be performed utilizing diamond-edge cutting wheels. Torch cutting of bars will not be permitted.
- H. Incorporate rock anchors into the spread footings. Provide concrete over all parts of the stressing head assembly as indicated on the Drawings.

3.2 Proof Testing and Post-Tensioning of Rock Anchors

- A. All rock anchors shall be proof-tested prior to post-tensioning. Proof testing and tensioning shall not commence until 72 hours after placement of cement grout.
- B. The proof test shall be performed by incrementally loading the anchor in accordance with the following schedule. At each increment, the movement of the tendon shall be recorded to the nearest 0.001 in. with respect to the independent fixed reference point. The jack load shall be monitored with a pressure gauge. The increments of load shall be (P= 140 kips):

Proof Test

0
0.25P
0.50P
0.75P
1.00P
1.25P
1.00P
140 kips (lock-off load)

The maximum load shall be maintained until the movement in the last five minutes is less than 0.004 in.

- C. A proof test shall be considered acceptable if the following are satisfied:
1. The rock anchor develops the maximum required load (125 percent 140 kips) before the end of the bar extends 0.25 in., plus the theoretical elastic elongation. The theoretical elastic elongation shall be computed based on the unbonded length, plus 50 percent of the bond length.
 2. The maximum load can be maintained until the rate of movement is less than that specified above.
 3. After post-tensioning of the anchor is complete, do not relax tension for any purpose.

END OF SECTION