



Oregon Department of Transportation
GEOHYDRO SECTION
Geotechnical Unit

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TO: Larry Olsen
2B District Manager

December 13, 1999

FROM: Don Turner, C.E.G.
Geotechnical Designer

SUBJECT: Geotechnical Recommendations
MP 13.3 Rockfall
Pacific Highway 1E, MP 13.3
Clackamas County

I performed a reconnaissance of the site with Amy Pfeiffer and Rich Watanabe of the Geology office on Monday, Dec. 6. We observed about 5 to 10 cubic meters of rock in the ditch and a 1-meter deep overhang of remaining rock. The rock slope above the overhang is about 7 meters high and has vertical fractures spaced fairly evenly about 1 to 2 meters apart. The existing ditch is up to 1 meter wide and the slope has been covered with gabion wire slope protection mat. The upper rock is hard basalt while the lower half is composed of weathered basalt breccia.

Weathering and erosion of the softer rock in the lower half of the cut allows water and plant roots to loosen this material. Further undercutting will leave the upper rock blocks unsupported, but the rate of undercutting appears to be relatively slow, as evidenced by the minor amount of undercutting elsewhere on the rock slope. Neither the narrow ditch or the slope protection mat will prevent a larger quantity of rock from falling onto the roadway. The most feasible option to prevent a larger rock slope failure is to install tensioned rock bolts in the upper rock blocks. The attached photo shows the recommended locations of the bolts.

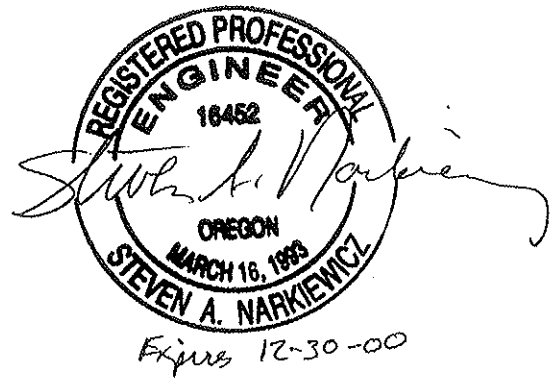
As shown in the photo, 15 rock bolts are recommended. They will need to be 4.57-meter (15 feet) long, 25mm diameter hollow core bars. Access to install the bolts will need to be from a crane, which will make closing of 1 northbound lane necessary during the work. The estimated duration of the work is up to 1 week. The bolts will be installed under the slope protection mat and the protection mat panels can either be temporarily rolled up and fastened or a flap can be cut in the panels in the locations of the bolts, which would be closed after the bolts are installed.

Specifications are attached. Bolts cost about \$180 per meter installed for an approximate cost of \$12,420. Mobilization may add another \$15,000. Bid items for TPDT, signing and flagging should be included.

We can assist with assembling the contract and we will be available to provide inspection assistance during the bolt installation. Inspection costs will be about \$1500.

Designed by: Don Turner, C.E.G.

Reviewed by: Steve Narkiewicz, P.E.



Cc: Hank Schmid
Amy Pfeiffer

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Proposed Bolt Locations
MP B.3 Rocket - Hwy 99E



ROCK BOLTING

SCOPE:

This work consists of furnishing and installing approximately fifteen 4.57 meter (15 feet) long rock bolts, complete with component parts, in accordance with these specifications. Install the bolts at the approximate locations shown on the plans and/or by the project manager on the site.

SUBMITTALS:

The following items shall be provided at the pre-construction conference for approval:

1. Written evidence that the rock bolting foreman and the rock bolting drillers have performed satisfactory work in similar capacities for a sufficient length of time to be fully qualified to perform their duties. The foreman must have not less than 1500 hours of demonstrated experience in rock bolting. The drillers must not have less than 1000 hours of demonstrated experience in drilling and rock bolting. Documentation submitted must have the name, address, and present employer of proposed foreman. Experience documentation shall include project names, location, year constructed, hours of experience, owners name and a phone number who can verify experience.
2. A detailed work plan which shall include drilling methods and equipment. Proposed drill hole diameter, rock bolts, couplers, bearing plates, anchorage washers and all hardware including the manufacturers certifications shall be included. The manufacturers recommended installation, stressing and grouting procedures shall be included. A grout mix design is required. Calibration data shall be supplied for each torque wrench to be used. An independent testing laboratory shall perform the calibration tests within 60 calendar days of the data submitted.
3. The rock bolt foreman shall be on the project site at all times during rock bolting.

ROCK BOLT GENERAL DATA:

All rock bolts including anchorage, couplers, corrosion protection, nuts, washers, and other appurtenances shall be products of a manufacturer regularly engaged in the manufacture of rock bolts.

The design load of each bolt is 111kN. Rock bolts shall be sized so the design load does not exceed 60 percent of the minimum guaranteed ultimate tensile strength. The mechanical head assembly shall be capable of providing the required design load anchorage.

The rock bolts shall be handled in a manner that will avoid damage or corrosion. Damage to the rock bolt as a result of abrasions, cuts, nicks, welds, or weld splatter will be cause for rejection. All mill scale, flaking, rust, and grease must be removed prior to installation. A light coating of tight rust is acceptable. Heavy corrosion or pitting will be cause for rejecting the bolt.

MECHANICAL ANCHORAGE ROCK BOLTS:

Rock bolts shall be hollow core, mechanical anchorage bolts fabricated from ASTM A-615, Grade 60 deformed bars. The bolts shall be completely fabricated at the point of manufacture under controlled shop conditions. A mechanical anchorage assembly shall be at the end of the bolt rod and shall be capable of exceeding the ultimate tensile strength of the bolt rod. The anchor assembly shall be designed to prestress the bolt prior to grouting.

Couplings for connecting sections of rock bolts shall have a center stop and be capable of developing at least 90 percent of the ultimate tensile strength of the bolt. Coupling shall not interfere with grout flow. The threaded end of the rock bolt shall have a minimum of 0.3 meters of threads.

BEARING PLATES AND ACCESSORIES:

Bearing plates shall be 12 mm thick, 0.2m by 0.2m flat and conform to ASTM F-432. Bearing plates shall have a keyhole opening sufficient to accommodate the bolt rod and allow verification of grout return. Hardware, nuts, washers and accessories shall be as recommended by the manufacturer.

CEMENT GROUT and GROUTING ACCESSORIES:

Grout shall be a Wil-X-Cement non-shrink grout mixed with 2.5 gallons of water per 55 lb. pail, or equivalent. Alternate grouts may be considered that have a fineness as in high early strength cements, such as Portland Type III (4500cm²/gm), as measured by the Blaine method. If Portland cement is used, an expansive additive such as "Wil-Grout" powder additive in the proportion 0.005% of the weight of cement (2 grams- 1 level teaspoon- for each 94 lb. Sack of cement) shall be required. Hopper working capacity shall be at least 10 gallons.

The grout shall have a minimum compressive strength of (Modified ASTM C-109):
3 days in moist air/ 4 days in water = 19.3 Mpa (2800 psi)

Grout tubes, grout sealers, and other grouting accessories for grouting rock bolts shall be types as recommended by the manufacturer and as approved by the Engineer.

TORQUE EQUIPMENT:

The equipment used to effectively seat and tighten the rock bolt and/or establish the anchorage in the hole shall be approved by the project manager and be utilized as per the manufacturers recommendations.

The torque wrench shall have the capacity at least 20% greater than the manufacturers recommended anchor setting torque. An independent testing laboratory shall confirm the torque wrench accuracy and be at least +/-2% of the full scale reading with a resolution of at least 1% of the full scale reading.

HOLES:

The holes shall be drilled horizontal to downward up to 5 degrees from horizontal.

Holes for rock bolts shall be accurately drilled to the diameter recommended by the rock bolt manufacturer or as approved by the project manager. The drilling equipment shall be capable of drilling holes up to 5 meter long. Each hole shall be cleaned of all debris prior to insertion of the anchor.

INSTALLATION:

Install and tension rock bolts in accordance with the manufacturers recommendations or as directed by the project manager. Place rock bolts in the holes and position the bolt threads so threads extending beyond the nut shall be 1-1/2 times the diameter of the bolt, but not more than 762 mm.

Beveled or hemispherical washers shall be used to provide uniform bearing on the bearing plate. A machine washer shall be place between the nut and the beveled washer. No lubrication of the washer, bolt and threads is permitted. Orient the bearing plate so the grout opening is up.

GROUTING:

Completely fill the annulus to fully encapsulate the rock bolts in grout. Pump grout down the inside of the bolt in a continuous operation until the grout exits through the keyhole. Check the grout level and add additional grout if necessary to insure that the annulus around the bolt is completely filled. Bolts must be completely filled before acceptance. Spilled grout shall be washed off the rock surface.

High grout quantities should be anticipated due to open fractures in rock. The project manager prior to use shall approve any changes in the grouting procedure to reduce quantity.

Grout samples must be provided for testing on request. Bolts grouted with grout that does not meet design strength will be replaced at the contractors expense.

MEASUREMENT:

Rock bolts will be paid on a lineal meter basis of 111kN design load bolts properly installed, tensioned, grouted and accepted. The estimated quantity of rock bolts is 69 lineal meters.

PAYMENT:

The accepted quantity will be paid for at the unit price per lineal meter for the item 111kN Rock Bolt. Payment will be full compensation for furnishing all labor, equipment and materials necessary to complete installation of the bolts.