BMP 17.00. Rock Slope Armor

DESIGN CONSIDERATIONS

Objectives

The primary purpose of Rock Slope Armor is to protect slopes with erodible or ice-rich soils from wind and water erosion, including rainfall, sheet flow run-on, or seepage. Rock Slope Armor may temporarily stabilize slopes until final stabilization is achieved, or may serve as final non-vegetative permanent stabilization on slopes when implemented in accordance with the Alaska Construction General Permit (Alaska CGP).

Description

Rock Slope Armor is a layer of rock, such as ditch lining rock, cobble rock, concrete rubble, or riprap, which is hand or mechanically placed on an erodible soil slope.

Other Names

Rock Slope Protection.

Applicability

Rock Slope Armor is applicable to:

- Slopes where unanticipated flows are encountered. On a cut slope, this could be due to run-on. A temporary diversion should be installed to allow construction of the cut slope, but the rock slope armor provides permanent stabilization.

- Fill slopes around the inlet and outlet of culverts.

- On bridge abutments above the design water elevation and at points where bridge scuppers discharge near or on abutments.

- The downside of roadway superelevations where the ground surface slopes away from the roadway (foreslopes).

- On slopes where groundwater seeps or springs occur.

- On cut slopes into ice-rich soils or that seep permafrost melt.

Selection Considerations

The designer must have information about the slope length, steepness, embankment or cut slope soil type and gradation, groundwater seepage, and potential for melting permafrost. The ditch may also need to be lined.

This best management practice (BMP) is not intended for stream banks, channel bottoms, the side slopes of waterbodies below the design high water surface elevation, or for shorelines subject to wave action, because these situations require more design.

Geotechnical expertise is required when using this BMP for embankments over 20 feet in height, embankments on soft or ice-rich soils or potentially unstable ground, embankments that could impact adjacent structures, if there is a potential for a significant groundwater gradient beneath the cut slope or embankment, or if surface water levels are significantly higher on one side of the embankment than the other.

Rock size and range of sizes should be considered. A well graded mix, with rocks in a range of sizes, should be selected. Rocks of uniform rock size, or a rock mix with very large and very small rocks with few intermediate-sized rocks (a "gap-graded" mixture), is more likely to become dislodged causing the armor to fail.

Rock shape should be considered. Angular or sub-angular rocks have better performance than round rocks because they are less likely to become dislodged. Round rock should not be used on slopes steeper than 2:1. Soundness and durability should be indicated.

The designer may specify whether rock is hand placed or spread mechanically. When placing by hand, rocks should be placed so that the longitudinal axis is perpendicular to the slope face and fall line. Rocks may also be dumped and spread in layers using a bulldozer or other means, in which case care should be taken not to damage underlying filter material (if specified). In either case, the larger rocks should be placed in the footing trench, segregation by rock size should be minimized, and rocks should be placed so there is a minimum of voids.

When considering rock for bridge scuppers or downspout energy dissipaters, consider whether downspout extenders to route water to vegetated or stabilized areas could be used instead.

Design

Slope of Area to be Protected: Slopes between 1.5:1 and 3:1. Flatter slopes should be seeded or revegetated; or, if in a location where vegetation cannot be established (such as areas shaded by bridges), consider a pea gravel layer. Steeper slopes require geotechnical engineering and a specification for angular rock.

Rock Properties: Specify rock properties or criteria, such as durability, wear (for instance, per AASHTO T 96), minimal clay lumps and friable particles (for instance, per AASHTO T 112), or shape.

Armor Rock Size: When used on a slope, specify a rock size based on steepness of slope, soil type, and expected seepage pore water pressure. Specify whether a key-in trench is required at the toe of the slope and, if so, the key-in dimensions.

Size rock for bridge scuppers or downspout energy dissipaters based on expected flow velocity.

Rock Gradation: Design particle size distribution of the armor rock mix. Once a size range has been designed, the designer can reference an Alaska Department of Transportation & Public Facilities (ADOT&PF) riprap, rock, ditch lining, or aggregate specification (e.g. ADOT&PF's Standard Specification for Highways or Standard Specifications for Airport Construction) if one is available or create a specification for the project's bid documents.

Rock Layer Thickness: Unless rip rap is specified, the designer needs to specify the thickness. If using riprap, the layer thickness will be defined by the riprap classification. Typically, only one layer is needed.

Rock Layer Height and Length: The designer needs to specify this on the plans.

Filter Fabric or Layer: A filter fabric or filter layer should be specified if either of the following apply:

$$\frac{D_{15} \; rock \; armor \; layer}{D_{85} \; fill \; or \; cut \; slope \; soil} > 5$$

or

$$\frac{D_{15} \; rock \; armor \; layer}{D_{15} \; fill \; or \; cut \; slope \; soil} > 40$$

Other Designer Responsibilities: The designer needs to add slope preparation and run-on diversion, as appropriate.

Relationship to Other Erosion and Sediment Control Measures

This should be a BMP of last resort, except in ice-rich permafrost slopes, where it is the preferred treatment. Install upgradient controls to divert water from the slope shoulder where possible. Other temporary or permanent stabilization methods should be considered, including: Rolled Erosion Control Product (RECP), Hydraulic Erosion Control Product, (HECP), Compost Blanket, Temporary Seeding, and Permanent Seeding.

Rock Slope Armor is different from Slope Drain in that it is used to stabilize a slope in response to dispersed or minimally concentrated flow; whereas a Slope Drain is used to convey concentrated flows down a slope to an appropriate discharge location.

Common Failures or Misuses

- Slope too steep for rock size results in rock displacement and downslope movement of rocks.

- Failure to install up-gradient stormwater controls.

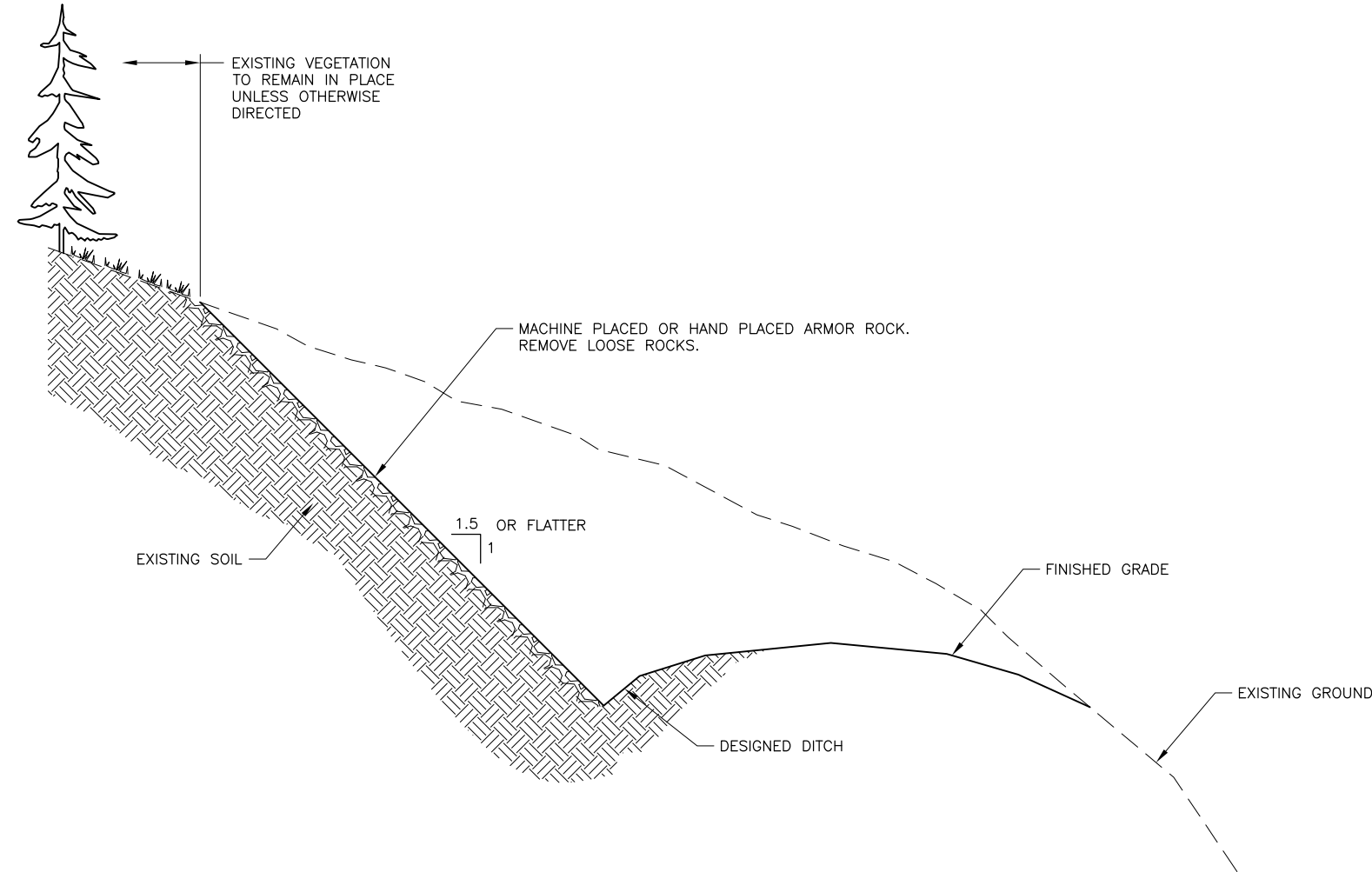- Rock not properly graded results in downslope movement of rocks.

<u>SPECIFICATIONS</u>

Standard Specifications

- 679 – Rock Slope Armor

- 610-2.01 Ditch Lining (0-50 percent less than 3-inch; up to 8-inch maximum)

- 611-2.01 Riprap

- 703-2.10 Porous Backfill (3-inch minus rock)

Drawing

- BMP-17.00   Rock Slope Armor

EXISTING VEGETATION
TO REMAIN IN PLACE
UNLESS OTHERWISE
DIRECTED

MACHINE PLACED OR HAND PLACED ARMOR ROCK.
REMOVE LOOSE ROCKS.

EXISTING SOIL

1.5 OR FLATTER
1

FINISHED GRADE

EXISTING GROUND

DESIGNED DITCH

PROFILE

ROCK SLOPE ARMOR
NOT TO SCALE

ROCK SLOPE ARMOR NOTES:
MATERIALS
ROCK: COBBLE, GRAVEL, CRUSHED GRAVEL, CRUSHED ROCK,
OR ANY COMBINATION OF THESE, MEETING SPECIFICATIONS AT
610−2.01 (DITCH LINING), 611−2.01 (RIPRAP), OR 703−2.10
(POROUS BACKFILL). USE ANGULAR ROCK ON SLOPES
STEEPER THAN 2:1.

INSTALLATION
1. PREPARE THE SLOPE AS DESCRIBED IN THE CONTRACT
   OR AS DIRECTED BY THE ENGINEER.

2. MINIMIZE CONCENTRATED RUN−ON FROM
   CROSS−GRADIENT AND UP−GRADIENT SOURCES BY SITE
   GRADING AND/OR DIRECTING OR DIVERTING RUN−ON OR
   RUN−OFF AWAY FROM THE SLOPE FACE.

3. IF SPECIFIED ON THE PLANS OR DIRECTED BY THE
   ENGINEER, INSTALL THE FILTER FABRIC OR FILTER LAYER.
   AFTER CLEARING DEBRIS FROM SLOPE INSTALL FILTER
   FABRIC ACCORDING TO MANUFACTURER'S
   RECOMMENDATIONS.

4. INSTALL THE ROCK STARTING AT THE BOTTOM OF THE
   SLOPE AND PROCEEDING IN HORIZONTAL LIFTS UPWARDS.

5. PLACE STONES TO THE THICKNESS, HEIGHT, AND LENGTH
   SHOWN ON THE PLANS. DUMP SMALL ROCKS AND
   SPREAD BY BULLDOZER OR OTHER SUITABLE EQUIPMENT.
   DURING SPREADING, DO NOT CRACK THE ROCK.

INSPECTION
1. INSPECT FOR DAMAGE TO THE ROCK ARMOR, INCLUDING
   DISPLACED STONES, SLUMPING, AND EROSION AT EDGES,
   ESPECIALLY DOWNSLOPE.

MAINTENANCE
1. REPAIR DAMAGED ROCK ARMOR SLOPE OR EDGES AS
   SOON AS PRACTICABLE AND BEFORE FURTHER DAMAGE
   CAN OCCUR.

REVISIONS		
Date	Description	By

State of Alaska DOT&PF

ROCK SLOPE
ARMOR

APPROVED

Date 12/2015 X/XX/XX

BMP−17.00