Grouted Boulders Construction Guidance Checklist

MHFD
MILE HIGH FLOOD DISTRICT

mhfd.org

12575 W Bayaud Avenue
Lakewood, CO 80228

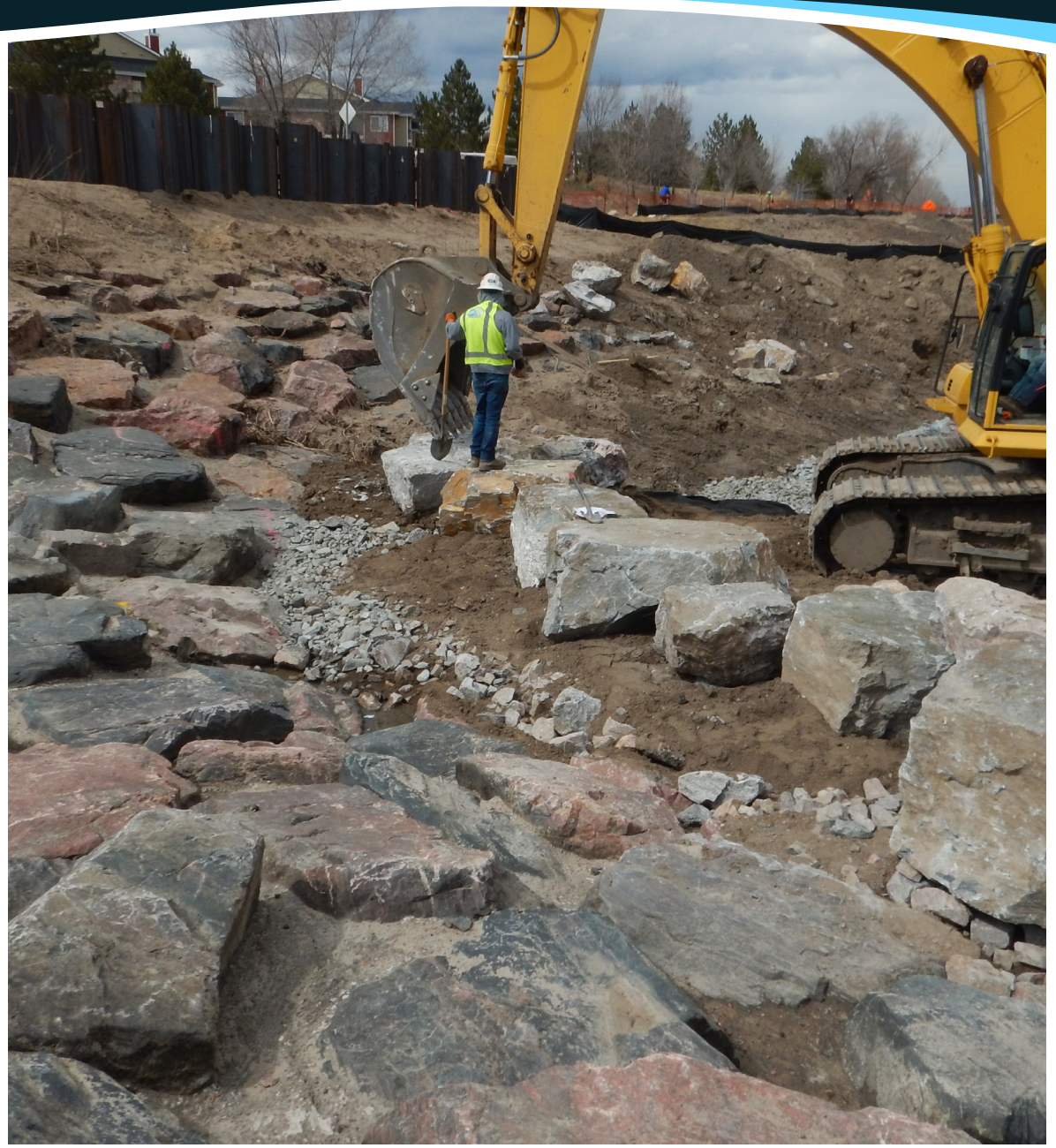
303.455.6277

contact@mhfd.org

Scan the code for our Construction Management playlist on YouTube

Grouted Boulders Introduction

- Grouted Boulders are a mixture of large quarried rock (boulders) placed close together and concrete (grout) filling the voids between the boulders.
- Grouted Boulders are commonly used for drop structures on streams, boulder walls, and erosion protection at large pipe outfalls



Grouted Boulders Subgrade

Step 1 (Subgrade):

- Verify that the subgrade is firm, compacted according to specifications, and not frozen.
- Boulders should always be placed directly on native subgrade without granular bedding unless approved by the Engineer.

Grouted Boulders Trenches

STEP 2A (Cutoff Wall Trenches):

Grouted boulder drop structures require cutoff walls that consist of either sheet pile or grout poured into trenches. Verify that trenches are excavated to the depth and width specified on the DRAWINGS and free of debris and loose soil.

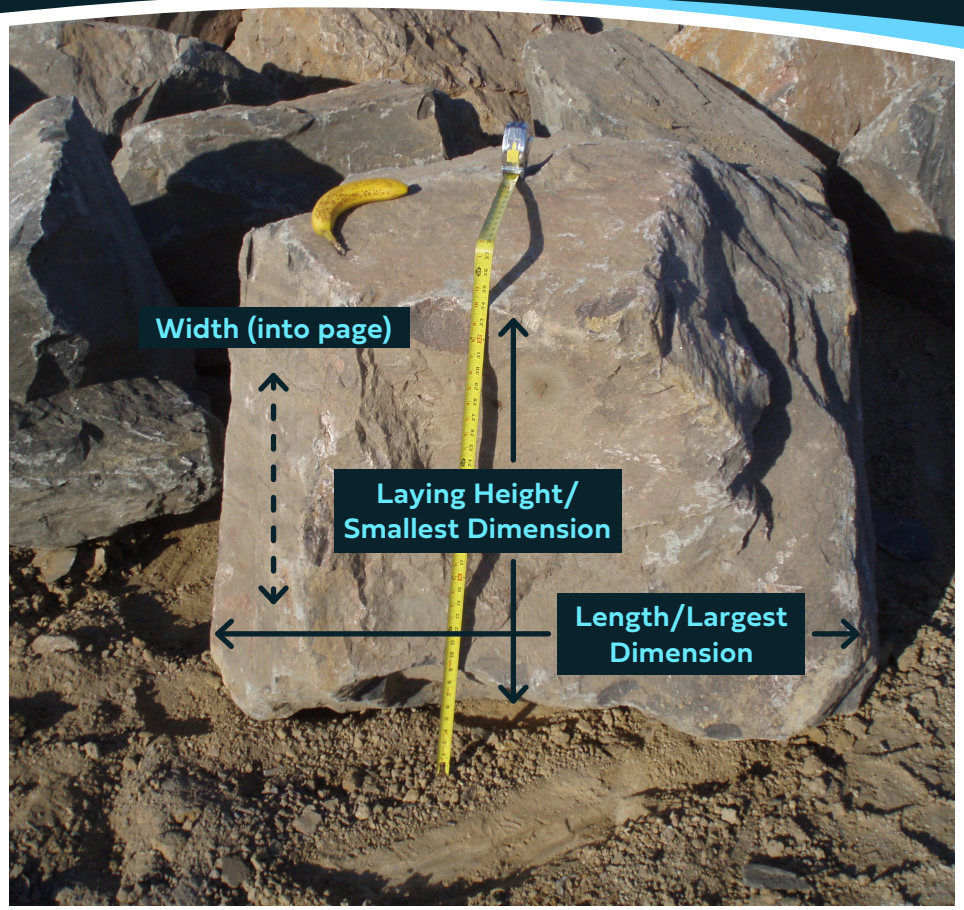
STEP 2B (Perimeter Trenches):

Perimeter trenches are commonly required around drop structures to protect the grouted boulders from lateral scouring. Confirm that these are excavated a minimum of 1-foot below subgrade.

Grouted Boulder Materials

STEP 3 (Boulders):

- Verify that the size of boulders delivered to site are correct. The District has 5 different boulder size classifications:
  - B24 = 24-inch nominal size
  - B30 = 30-inch nominal size
  - B36 = 36-inch nominal size
  - B42 = 42-inch nominal size
  - B48 = 48-inch nominal size



- Confirm that the nominal size dimension, which is the smallest dimension or "laying height" of individual boulders, is within the range tolerance listed in Table 2 of the District specification.
- Confirm that the ratio of largest to smallest rock dimension of individual boulders is a maximum of 1.5:1 ratio.

Grouted Boulder Materials

Large quarried boulders are most commonly used for grouted boulder structures and boulder walls.

Sometimes rounder rock is used to provide a more natural cobble look.

STEP 4 (Boulder Placement):

- Verify that boulders are placed with the required boulder height (nominal dimension) vertical.
- Confirm that boulders are placed with tops of boulders at elevations indicated on the DRAWINGS.
- It's acceptable to use 1 small piece of riprap to level one end of a boulder or to keep it from rotating out of position (see below).

Grouted Boulders Installation

STEP 4 (Boulder Placement):

Boulders should be placed as tightly together as possible without touching while providing enough room between to allow grout to fill the gaps. Verify that adjacent boulders are placed 1.5 to 3.5-inches away and voids do not exceed 4-inches. A 2-inch x 4-inch board can be used to confirm gap dimensions.

STEP 5:

- Verify that any rebar and weep drains are installed where specified on the DRAWINGS.

STEP 6 (Pre-cleaning before grout):

- Verify that debris, loose soil, and small rock is removed from around the boulders.
- Make sure boulders are clean and contact surface kept wet prior to receiving grout.

STEP 7 (Check Grout Mix):

- Review grout tickets to confirm that grout delivered to site is the pre-approved mix and contains the appropriate quantity of fibermesh.
- Visually verify that grout contains:
  - Fibermesh (0.5 to 0.75-inch long synthetic fibers)
  - Appropriate course aggregate (3/8-inch pea gravel)
  - Flows easily between the gaps in the boulders
- Confirm that the temperature of the grout immediately before placement is within the range required in the specifications.
- Make sure that the time elapsed from when water is added to the mix until the grout is placed does not exceed the maximum allowed in the specifications.

STEP 8 (Grout Placement):

Verify that grout is delivered with a grout pump using a 4-inch diameter nozzle. A large pump truck with a long reach is commonly needed for grouting large boulder areas.

STEP 8 (Grout Placement):

- Verify that grout is placed in a manner that fills all voids between boulders from the subgrade to the thickness depth shown on the DRAWINGS. Grout thickness is typically specified as 1/2 the boulder height, but no more than 2/3 the boulder height. Keeping the grout level low and leaving more of the boulder height visible, improves the structure appearance. Consult design engineer for desired aesthetics.

- Make sure that grout is injected starting with the nozzle near the bottom and raising it as the grout fills, while vibrating grout into place using a "pencil" vibrator.

Grouted Boulders Installation

STEP 8 (Grout Placement): Make sure that all cleaning and finishing are complete.

- Make sure that all spilled grout is immediately cleaned off the boulders with water before it cures.
- Verify that all grout is smooth and graded around boulders with a brush to provide a broom finish.

Grouted Boulders Installation

STEP 9 (Curing): After grout is placed and the boulders are cleaned, the grout shall be cured. Confirm that appropriate curing methods and hot/cold weather protection are implemented:

- Hot Weather: Moisture curing or spraying liquid membrane curing compound. If curing compound is used, make sure that the contractor is careful to not get any on the boulders.
- Cold Weather: Covering with insulation blankets or heated enclosures.

Grouted Boulders Installation

Final Product:

A close-up view of a good finished installation with the boulders clean and visible and grout recessed about ½ the boulder height.

Grouted Boulders Installation

Final Product:

A finished grouted boulder drop structure with boulders placed tightly together and grout level kept low, providing an attractive appearance.