Stormwater Best Management Practice

Riprap

Minimum Measure: Construction Site Stormwater Runoff Control;
Subcategory: Erosion Control

Description

Riprap is a layer of large stones that protects soil from erosion in areas of high or concentrated flows. It is especially useful for armoring channel and ditch banks, among other features. Construction staff may also pair riprap with other stormwater control measures to reduce stormwater flow rates.

Applicability

Riprap is useful in areas where other erosion control practices have exceeded their stabilization capacity (MPCA, 2019). For example, riprap can stabilize cut-and-fill slopes; channel side slopes and bottoms; inlets and outlets for culverts, bridges, slope drains, grade stabilization structures, and storm drains; and streambanks.

Siting and Design Considerations

Riprap can be unstable on very steep slopes, especially when site developers use rounded rock. For slopes steeper than 2:1, developers should consider using materials other than riprap for erosion protection. Construction sequencing is important, as construction staff that use riprap in high-flow locations often struggle to remove it after placement (WDE, 2014).

When installing riprap, construction staff should consider the following design recommendations (MDE, NRCS, & MASCD, 2011):

- *Gradation*. Use a well-graded mixture of rock sizes instead of one uniform size. Design engineers can determine a minimum size based on standard design equations and site-specific flow regimes.
- *Riprap size*. Riprap size depends on the shear stress of the flows that the riprap will be subject to, which design engineers can determine using standard design equations. Median stone diameters range from 9.5 to 23 inches, with no stones larger than 34 inches.

A riprap-lined bank surrounding a newly constructed detention pond.

- *Stone quality*. Stone for riprap should consist of field stone or quarry stone that is angular, variably sized and resistant to cracking during freeze and thaw cycles. Most igneous stones, such as granite, have suitable durability. Do not use crushed concrete for riprap.
- *Riprap depth*. Riprap minimum depths depend upon site flow regimes, median riprap size and local design requirements. Consult and appropriately implement local design standards.
- *Filter material*. To prevent underlying soil from moving through the riprap, apply a filter fabric, geotextile material or layer of gravel before applying the riprap.
- *Riprap upper limits*. Place riprap so it extends up to the maximum flow depth, or to a point where the land surface is stable or vegetation will be satisfactory to control erosion.
- *Curves*. Consult local design standards to ensure riprap extends far enough upstream and downstream of any curve.
- *Wire riprap enclosures*. Consider using chain link fencing or wire mesh to secure riprap installations, especially on steep slopes or in high-flow areas.

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This practice is typically referred to as a gabion. Consult local design standards for more information.

Limitations

The steepness of the slope limits the applicability of riprap, because slopes greater than 2:1 can cause riprap loss due to erosion and sliding. Improper use of riprap can increase erosion. Additionally, riprap can be hard to maintain if sediment inundates it; therefore, construction staff should not locate riprap downstream of an area with sediment-laden stormwater.

Maintenance Considerations

Inspect riprap areas annually and after major storms. If storms damage the riprap or geotextile material, repair it promptly to prevent a progressive failure. If a location repeatedly needs repairs, evaluate the site to determine if the original design conditions have changed. Also, weed and brush growth control may be necessary. Maintain the line, grade and cross section as designed. Remove accumulated sediment and debris if using riprap for energy dissipation (MDE, NRCS, & MASCD, 2011).

Effectiveness

Proper design and installation of riprap can reduce flow velocities and prevent erosion of the protected area.

Cost Considerations

The cost of riprap varies depending on location, material type, maintenance frequency and installation method. Hand-placed riprap can cost up to $750 per cubic yard, while random riprap can cost as little as $64 per cubic yard (MPCA, 2019).

Additional Information

Additional information on related practices and the Phase II MS4 program can be found at EPA's National Menu of Best Management Practices (BMPs) for Stormwater website

References

Maryland Department of the Environment (MDE), Natural Resources Conservation Service (NRCS), & Maryland Association of Soil Conservation Districts (MASCD). (2011). *2011 Maryland standards and specifications for soil erosion and sediment control.* Baltimore, MD: Maryland Department of the Environment.

Minnesota Pollution Control Agency (MPCA). (2019). *Minnesota stormwater manual*.

Washington State Department of Ecology (WDE) (2014). *2012 stormwater management manual for western Washington as amended in December 2014* (Vol. II) (Publication Number 14-10-055).