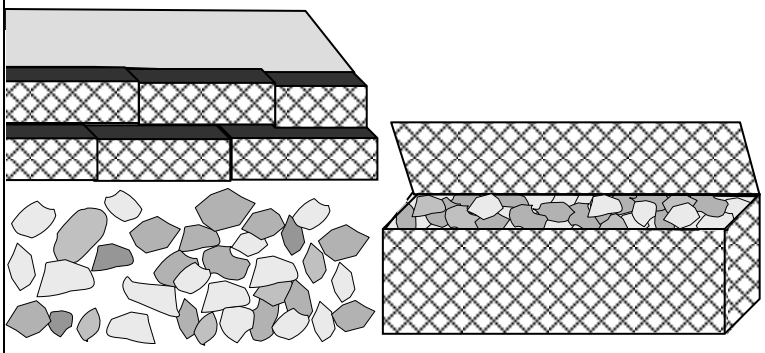
ACTIVITY: Gabions

ES – 28



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Targeted Constituents				
● Significant Benefit		◗ Partial Benefit		○ Low or Unknown Benefit
● Sediment	○ Heavy Metals	○ Floatable Materials	○ Oxygen Demanding Substances	
○ Nutrients	○ Toxic Materials	○ Oil & Grease	○ Bacteria & Viruses	○ Construction Wastes

Description

Gabions are large rectangular wire mesh boxes that are filled with large stone or riprap. Gabions can be used as drainage channels, low retaining walls, bridge abutments and approaches, culvert headwalls, flow aprons, drop structures or as general landscaping elements. Thin gabions, typically called revet mattresses or reno mattresses, are used for drainage channels and slopes. The wire mesh is typically galvanized to resist corrosion, and may also receive a PVC coating if intended for use in water.

Suitable Applications

- Along a streambank or drainage channel, as a stable lining that resists erosion.
- On shorefronts and riverfronts, or other areas subject to wave action.
- Near bridge abutments or wingwalls.
- Around culvert outlets and inlets to prevent scour and undercutting.
- On slopes and areas where conditions may not allow vegetation to grow.
- As a low retaining wall in non-critical areas or as a landscaping element.

Advantages

- A gabion is a manufactured engineering product that can be installed in a variety of situations. The manufacturer provides design guidelines and detailed instructions.
- Gabions are flexible, and minor settling can be accommodated. Gabions can be easily adapted and fitted around pipes and other structures.
- Gabions are permeable and are not subject to hydrostatic pressure buildup. With careful maintenance, gabions allow vegetation to grow.
- Skilled labor (other than an equipment operator) is not needed for assembly and filling of gabions. Gabions can be assembled on the project site in difficult terrain. Gabions are inexpensive when compared to rigid structures and retaining walls.

Disadvantages

- Gabions must be carefully constructed in order to properly function for many years. There are many instances of gabion failure (see the "Limitations" section later in this BMP). Wire mesh is subject to corrosion and physical damage.
- Gabions are not very attractive in many situations, often due to poor maintenance.
- Gabions are a structural element (similar to a retaining wall) that must be professionally designed. Foundations and surcharged loads must be considered.

Design Considerations

A gabion wall is the equivalent of a gravity-design retaining wall. Analysis for a gabion wall should include basic computations for structural failure such as sliding, overturning and settlement. In structural situations for walls over 4 feet high, this will require the design of a professional engineer who will consider field conditions, quality of materials, surcharged loads such as vehicle traffic, adequate drainage, foundations, etc. A gabion wall should not be specified just because the project designer is not willing to perform structural calculations for a concrete retaining wall.

A geotextile filter fabric is usually placed beneath gabions to maintain separation from underlying soils. Also, a filter fabric is necessary within stream channels to avoid loss of fine-grained soils. The filter fabric should be anchored securely using anchor trenches, stakes, staples, sewing or a combination of methods. A layer of aggregate or sand can also be placed beneath gabions to maintain separation from underlying soils, in addition to filter fabric. In general, a filter fabric is more reliable with much smaller installation costs. See ES-23 (Riprap) for further discussion of using aggregate or sand as a granular drainage filter.

The wire mesh, in addition to being galvanized, can also be coated with PVC to further resist deterioration. The wire mesh should have multiple twists in order to resist unraveling or falling apart. Since the wire mesh will eventually corrode and fail, gabion wall design should consider overall stability without the wire mesh. Soil and dirt may or may not fill the stone voids to act as a bonding agent. Or trees can help to reinforce a gabion structure. This will not generally occur at locations in or near flowing water, and grout can be specified in critical areas.

Gabion applications for slope stabilization, where wave action or flowing water is not a concern, should be sized for stability. Angular riprap or crushed rock typically has a natural angle of repose in the neighborhood of 40°, so that a slope of 1.5 to 1 for most slopes. See ES-23 (Riprap) for discussion of slope stability and average stone size, D_{50}. The angle of repose does not take into account any external forces (such as vehicles, people, storms, groundwater, earthquakes, other ground vibrations). Sliding may occur on geotextile filter fabric which is not sufficiently anchored. Slope stability analyses should be performed by a professional engineer for all gabion installations which are critical or potentially hazardous.

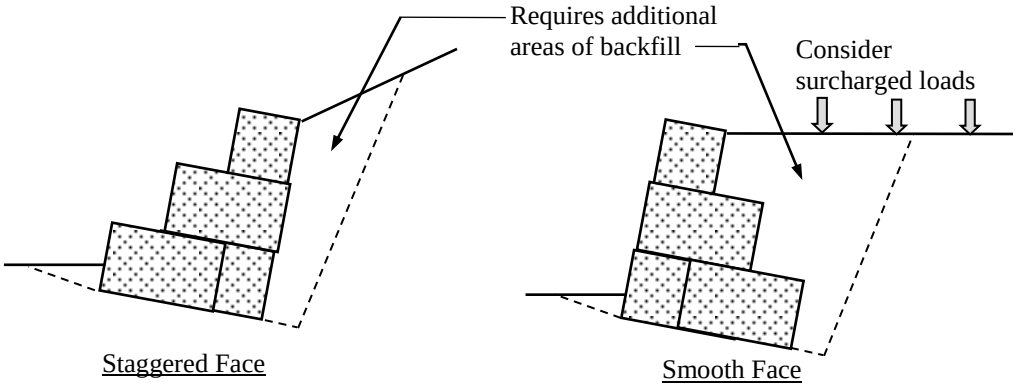

Figure ES-28-1
Typical Gabion Wall Geometry

Installation

Installation of gabions must be in accordance with the manufacturer's instructions and according to the design documents. Installation should be accomplished within a short time frame (1 or 2 days) to minimize potential for damage from stormwater runoff.

General Subgrade Preparation

- Clear and grade the area of trees, brush, vegetation and unsuitable soils. Provide equipment access as necessary for earthwork and handling of large rocks. Prepare the subgrade to the specified depth necessary for installation of gabions. Compact subgrade firmly to prevent slumping or undercutting. Excavate anchor trenches as necessary for installation of geotextile filter fabric.
- Install geotextile filter fabric to maintain separation of rock material with the underlying soil. Geotextile filter fabric should be placed so that it is not stretched tight and conforms closely to the subgrade. Secure filter fabric by using anchor trenches, stakes, staples, sewing or any other means necessary according to manufacturer's recommendations.
- Place a layer of aggregate or sand (if specified by design for use as a bedding layer or as a granular filter) so that the layer is smoothly graded and well-compacted. A typical layer of aggregate or sand is 4 inches thick when used only as a bedding material. A granular filter of aggregate or sand is usually 6 inches thick.

Wire Mesh & Stone

- Fold each gabion panel to the proper shape, using heavy gauge wire as recommended by the manufacturer. Reinforce panels as necessary. Lace all contact edges for adjacent gabions as construction proceeds. Joints are staggered and interlocked for gabion walls to provide maximum stability.
- Use external anchors and tensioning ropes as needed to ensure that the gabions are properly squared and vertical. Typically the manufacturer will specify that connecting wires should be used between each lift.
- Place hard durable stone in lifts 12 inches thick. The lifts should be thoroughly tied together with large stones protruding from one layer into the other. The average depth is usually determined by frequent measurements throughout installation. Any change in thickness should be accomplished gradually.
- Small gabion installations typically use a track loader bucket or a backhoe bucket. For large gabion installations, it may be beneficial to use a conveyor or crane. Minimize drop height to avoid damaging the wire mesh gabion or the underlying geotextile cloth. Adjust stones by hand in order to prevent large gaps or voids. Verify that the stone surfaces bear against each other for structural integrity.
- The typical stone gradation is between 4 to 8 inches, such that all stone will be retained by the particular mesh size. Hand placement of stones may be used at locations to improve the appearance of the exposed gabion faces.
- Close lids securely using lace or other fasteners as recommended by the manufacturer. If the wire mesh has been cut, then securely fasten to other parts of the gabion structure.

Grout (optional)

- In most cases, grouting is not necessary. Grouting may be desirable at some locations where flowing water may cause scour or settlement. Grout should be

composed of one part portland cement and four parts of sand measured by volume, and then mixed thoroughly with sufficient water to a consistency so that the grout can flow into and completely fill the voids.

- When grouting is used, prevent earth or sand from filling the spaces between the stones before the grout is poured. Immediately before pouring grout, the stones should be wetted by sprinkling. Carefully finish the grouted surface using small hand tools, and remove excess grout without disturbing gabion structure. Allow grout to harden and set before any stormwater is received. Keep grout moist with water that is free from salt or alkali for a period of not less than 72 hours.

Limitations

A gabion wall is a structural element (similar to a retaining wall) that must be professionally designed and carefully constructed. Gabion installations can fail or deteriorate for many of the following reasons:

Foundation -

- Soil is not suitable for use as a structural foundation.
- Foundation is not adequately compacted and prepared.
- Flowing water erodes the soil underneath or behind the gabion.
- Geotextile filter fabric is not used beneath gabion to retain fine soils.
- Erosion or scour occurs beneath the gabion structure.

Installation -

- Not following manufacturer's instructions for wires, fasteners, and lacing.
- Ordering the wrong gradations of large stone.
- Not using lifts to place stone, or not adjusting stones by hand to fill voids.
- Failure to protect the wire mesh gabion during the process of unloading stones.
- Improper or inadequate backfill.

Design -

- Prevent surcharged loads above gabion wall unless specifically designed.
- Displacement may occur if the slopes are too steep.

Maintenance

Gabions typically require very little maintenance. Inspect gabion installation regularly for settlement, scour, damaged wire mesh, or wire corrosion. Periodically check for excessive growth of bushes, trees, weeds and other vegetation. Remove vegetation as needed to maintain channel flow capacity and prevent damage to gabions.

At many locations the wire mesh will eventually fail (particularly near flowing water), so it is important to design a gabion retaining wall to remain structurally sound without relying on the wire mesh. If long-term problems are noted, a major redesign and construction effort may be necessary.

References

141, 159, 161, 162, 167, 179 (see BMP Manual Chapter 10 for list)

Typical vendor information from : Maccaferri http://www.maccaferri.com
TerraAqua http://www.terraaqua.com/