

## **ITEM 634 - GABION EMBANKMENT SLOPE PROTECTION**

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**634.01 Description.** This work shall consist of furnishing, assembling and filling with approved stones, heavily galvanized steel or polyvinyl chloride (PVC) coated wire mesh baskets as supplied by Maccaferri Gabions, Inc., Terra Aqua Gabions or approved equal. Gabions shall be sized as specified and installed to the lines and grades shown on the plans, and placed on a filter fabric as specified below. The work shall include all excavation required and removal of all surplus and unsatisfactory materials. The assembly and erection of gabions shall be accomplished in accordance with the manufacturer's printed instructions or as directed by the Engineer.

**634.02 Gabion Fabrication.** Gabions shall be manufactured in such a manner that their sides, ends, lid and diaphragm(s) can be assembled to form rectangular units of the specified dimensions.

Gabions shall be of a single unit construction. The front, base, back and lid shall be woven into a single unit. The ends and diaphragm(s) shall be factory connected to the base.

All perimeter edges of the mesh forming the gabion shall be securely selvaged so that the joints obtained have at least the same strength as the wire mesh itself.

**634.03 Gabion Dimensions.** The gabion length shall be 1 1/2, 2, 3 or 4 times its horizontal width. The horizontal width shall not be less than 36 inches (0.9 m). However, all gabions furnished by the manufacturer shall be of uniform width and height, unless otherwise noted on the plans. Where the gabion length exceeds 1 1/2 times its horizontal width, the gabion shall be equally divided into cells by diaphragm(s) of the same mesh and gauge as the gabion body.

### **634.04 Materials.**

1. **Mesh.** Mesh openings shall be hexagonal in shape, measuring approximately 3 1/4 by 4 1/2 inches (82.4 by 114.7 mm), uniform in size.

2. **Mesh Joints.** All joints shall be flexible and double twisted to prevent unraveling.
3. **Galvanizing.** All steel wire used shall be galvanized having a minimum amount of zinc coating of 0.80 oz./sq. ft. (244 g/m<sup>2</sup>) of wire, and complying with Federal Specification (QQ-W-461 H, Class 3). All dimensions are subject to a tolerance limit of  $\pm 3$  percent of manufacturer's specified sizes:
4. **Mesh Wire.** The diameter of the steel wire mesh shall be not less than 0.1181 inches (3.0 mm) (U.S. Gauge No. 11) after galvanization.
5. **Selvedge Wire.** The diameter of the selvedge wire, running through all the edges (perimeter wire), shall not be less than 0.1535 inches (3.8 mm) (U.S. Gauge No. 9) after galvanization.
6. **Lacing Wire.** The diameter of the wire, necessary for assembling and lacing the gabion units, shall be not less than 0.0866 inches (2.2 mm) (U.S. Gauge No. 13) after galvanization.

Acceptable alternates to lacing wire are fasteners, if the proposed fastener can produce a joint strength of at least 1400 pounds per linear foot (20.4 kilonewtons per lineal meter) while encompassing a minimum of 4 selvedge wires. Properly formed fasteners shall also meet the following requirements:

- A. they shall be locked and closed;
  - B. they shall consistently resist an opposed tension of at least 600 pounds (2.7 kilonewtons) without pulling apart; and
  - C. they shall not be used to join more wires or larger wires than for which they were tested and approved.
7. **Filter Fabric.** The filter fabric shall be composed of strong rot-proof polymeric fibers formed into a woven or non-woven fabric which meets the following requirements:

Minimum Tensile Strength (ASTM D 1682) 200 lbs. (0.9 kN)

Minimum Burst Strength (ASTM D 751) 400 lbs. (1.8 kN)

Minimum Puncture Strength (ASTM D 751) 80 lbs. (0.4 kN)

Equivalent Opening Size

Soil Type 1 (ST-1) 50%-85% passing U.S. No. 200 (75  $\mu$ m)

Sieve; EOS U.S. No. 70 Size

Soil Type 2 (ST-2) 50% passing U.S. No. 200 (75  $\mu$ m)

Sieve; EOS D85 of Soil-1

Minimum Permeability (50 cm-20 cm Falling Head) 1x10

8. **PVC Coating.** When specified, the coating shall have a nominal thickness of 0.0216 inches (0.5 mm) but not less than 0.015 inches (0.4 mm) in thickness. The protective PVC plastic shall be suitable to resist deleterious effects from exposure to light, immersion in salt or polluted water and shall not show any material difference in its initial compound properties. The PVC compound is also resistant to attack from acids and resistant to abrasion.

Initial properties of the PVC coating shall meet the following requirements:

Specific Gravity:	According to ASTM D-2287 and ASTM D-7-92; in the range of 1.30 to 1.34.
Tensile Strength:	According to ASTM D-412; not less than 2980 PSI (20.5 MPa)
Modules of Elasticity:	According to ASTM D-412; not less than 2700 PSI (18.6 MPa) at 100% strain.
Resistance to Abrasions:	According to ASTM 1242; weight loss < 12% (Method B)
Brittleness Temperature:	According to ASTM D-746, Procedure A: shall be at least 8.3°C (46.9°F) below the minimum temperature at which the gabions will be handled or placed but not higher than -9.4°C (15.1°F)
Hardness:	According to ASTM D-2240; shall be between 50 and 60 Shore D when tested
Creeping Corrosion:	Maximum corrosion penetration to the wire core from a square cut end section shall not be more than 25 mm when the specimen has been immersed for 2000 hours in a 50% solution HCL (hydrochloric acid 12 Be)

Variation of the initial properties will be allowed, as specified below. When the specimen is submitted to the following accelerated aging tests:

Salt Spray Tests:	According to ASTM B-117; period of test -3000 hours.
Exposure to Ultraviolet Rays:	According to ASTM D-1499 and ASTM G-23 (Apparatus Type E); period of test = 300 hours at 63°C (145.4°F).
Exposure to High Temp.:	Testing period: 240 hours at 1-5°C (33.8-41°F). When tested in accordance with ASTM D-1203 and ASTM D-2287.

After the above tests have been performed, the PVC shall exhibit the following properties:

Appearance:	The vinyl coating shall not crack, blister or split and shall not show any remarkable change in color.
Specific Gravity:	Shall not show change higher than 6% of initial value.
Durometer Hardness:	Shall not show change higher than 10% of initial value.
Tensile Strength:	Shall not show change higher than 25% of initial value.
Elongation:	Shall not show change higher than 25% of initial value.
Modules of Elasticity:	Shall not show change higher than 25% of initial value.
Resistance to Abrasion:	Shall not show change higher than 10% of initial value.
Brittleness Temperature:	Cold Blend Temp. - Shall not be higher than -20°C (-4°F). Cold Flex Temp. - Shall not be higher than +18°C (64.4°F).

No work shall take place using the PVC coated material unless the ambient temperature and temperature of the PVC materials are at least - 9.4°C (15°F) above the brittleness temperature of the PVC materials.

**634.05 Tests.** Tensile strength of all wire used for manufacturing the gabions and lacing wire shall range from 60,000 to 80,000 psi.(414 to 552 MPa), in accordance with Federal Specifications (QQ-W-461 H, Class 3), Load Test shall be conducted in accordance with Federal Specifications (QQ-W-461 H, Class 3). Elongation Test shall be conducted in accordance with Federal Specifications (QQ-W-461 H, Class 3). The steel wire diameters are based on the french wire gauges and are approximately the U.S. gauge numbers stated.

**634.06 Assembling.** Gabions are supplied folded flat, tied in pairs and packed in bundles. Single gabions shall be removed from the bundle, unfolded flat on the ground, and all kinks and bends flattened.

The gabion unit shall then be assembled individually, by erecting the sides (front and back), ends and diaphragm(s), ensuring that all creases are in the correct position and the tops of all sides level.

All four corners of the gabion unit shall be laced first, followed by the edges of internal diaphragm(s) to the sides.

The lacing procedure consists of cutting a length of lacing wire (approximately 1 1/2 times the distance to be laced - not to exceed 5 feet (1.5 m)). Secure the wire terminal at the corner by looping and twisting, then proceed to lace with alternating single and double loops at approximately 5 inch (127 mm) intervals. Securely fasten the other lacing wire terminal. All lacing on exposed faces should be done in a manner that will not leave any hazardous edges.

**634.07 Installation.** No foundation preparation work shall take place on frozen or snow covered ground. After excavation or stripping to the extent indicated on the drawings, all remaining loose or otherwise unsuitable materials shall be removed. All depressions shall be carefully backfilled to grade.

The assembled gabion units are carried to the job site and placed in their proper location. For structural integrity, all adjoining empty gabions must be laced along the perimeter of their contact surfaces in order to obtain a monolithic structure.

The following method applies to 3 foot (0.9 m) high gabions; once the gabion units are laced together, they shall be stretched to effective alignment. This operation shall be carried out after several empty gabion units have been positioned. The first gabion in the line shall be partially filled to provide the necessary anchorage. Any stretching shall be carried out using a come-along or other means of at least 1 ton (0.9 metric ton) capacity.

While under tension, the gabion joints shall be carefully controlled against any possible unraveling.

Whenever gabion structures require more than one tier, the upper empty gabion tier (under tension) shall also be laced to the top of the lower one.

1. **Filling.** Gabion units shall be filled with hard, durable, clean stone from 4 to 8 inches (102-203 mm) in size, or as approved by the Engineer.

No stone smaller than 4 inches (102 mm) in size will be used. Stone fill for the gabions shall be tested and approved by the City prior to installation to prevent stone that is too small from being placed in the gabions.

Gabion shall be filled in three layers, 1 foot (0.3 m) at a time. Two connecting wires shall be placed between each layer in all cells along all exposed faces of the gabion structure. All connecting wires shall be looped around two mesh openings and the wire terminals shall be securely twisted to prevent their loosening, or installed diagonally across the corners with preformed stiffeners.

The cells in any row shall be filled in stages so that local deformation may be avoided. That is, at no time shall any cell be filled to a depth exceeding 1 foot (0.3 m) more than the adjoining cell.

Along all exposed gabion faces, the outer layer of stone shall be carefully placed and packed by hand, in order to ensure proper alignment and a neat compact, square appearance.

The last layer of stone shall be uniformly overfilled 1 to 2 inches (25 to 50 mm) to compensate for the future settlement of the rock, but still allow for proper closing of the lid and provide an even surface that is uniform in appearance.

2. **Lid Closing.** The lids shall be stretched tight over the filling, using crow bars or lid closing tools, until the lid meets the perimeter edges of the front and end panels.

The lid shall then be tightly laced along all edges, ends and diaphragm(s) in the same manner as described above for assembling.

3. **Approval.** The City may consider the work as unacceptable if it is visible that baskets have a variation of more than 6 inches (152 mm) from the profile or alignment shown in the plans or as directed by the City.

**634.08 Cutting and Folding Mesh.** Where shown on the drawings or otherwise directed by the Engineer, the gabion mesh shall be cut, folded and wired together to suit existing site conditions. The mesh must be cleanly cut and the surplus mesh cut out completely, or folded back and neatly wired to an adjacent gabion face. The cut edges of the mesh shall be securely laced together with lacing wire in the manner described above for assembling.

The assembling, installation, filling and lid closing of the reshaped gabions shall be carried out as specified above.

**634.09 Method of Measurement.** The number of cubic yards (cubic meters) of gabion embankment slope protection shall be computed from field measurements of completed work accepted in-place.

**634.10 Basis of Payment.** Payments for accepted quantities complete-in-place, will be made at the contract price bid for:

<b>Item</b>	<b>Unit</b>	<b>Description</b>
634	Cubic Yard (Cubic Meters)	Gabion Embankment