

## ROCKSECTION GABION BOXES

### PART 1 - GENERAL

#### A. Description

This work shall consist of furnishing, assembling, and filling double twist woven wire mesh gabions with rock to the dimensions, lines and grades shown on the plans, or as determined by the Engineer.

#### B. Related Work Specified Elsewhere

1. Not Applicable

### PART 2 - MATERIALS

#### C. Woven Mesh Gabions

1. Wire - GalMac<sup>®</sup> (Zinc-5% aluminum-mischmetal [Zn-5% Al-MM] alloy) Coated (manufactured by Maccaferri Inc.) or approved equal:
  - a. All tests on the wire must be performed prior to manufacturing of the mesh.
  - b. *Tensile strength*: the wire used for the manufacturing gabions and lacing wire, shall have a maximum tensile strength of 75,000 psi (~515 MPa), in accordance with ASTM A856/A856M.
  - c. *Elongation*: the test must be carried out on a sample at least 12 inches (~30 cm) long. Elongation shall not be less than 12%, in accordance with ASTM A370.
  - d. *GalMac<sup>®</sup> or approval equal product coating*: meets the minimum coating thickness according to ASTM A856/A856M, Class III soft temper coating.
  - e. *Adhesion of GalMac<sup>®</sup> or approval equal product coating*: the adhesion of the coating to the wire shall be such that, when the wire is wrapped six turns around a mandrel having four times the diameter of the wire, it does not flake or crack when rubbing it with the bare fingers, in accordance with ASTM A856/A856M.
2. PVC (Polyvinyl Chloride) Coating
  - a. *Specific gravity*: between 1.33 and 1.34 in accordance with ASTM D792, Table 1.
  - b. *Hardness*: between 50 and 60 Shore D, according to ASTM D 2240.
  - c. *Tensile strength*: not less than 2,985 psi (~20.6 MPa), according to ASTM D412.

- d. *Modulus of elasticity*: not less than 2,700 psi (~18.6 MPa), according to ASTM D412.
- e. *Abrasion resistance*: the percentage of weight loss shall be less than 12%, according to ASTM D1242.
- f. *Heat Aging Test*: prior to UV and abrasion degradation, the PVC polymer coating shall have a projected durability life of 50 years or more when tested in accordance with UL 746B.
- g. The accelerated aging tests are:
  - (1) *Salt spray test*: test period 3,000 hours, test method ASTM B117
  - (2) *Exposure to UV rays*: test period 3,000 hours at 145°F (63°C), test method ASTM D1499 and ASTM G152
  - (3) *Brittleness temperature*: no higher than 15°F (- 9°C), or lower temperature when specified by the purchaser, when tested in accordance with ASTM D746
- h. The properties after aging tests shall be as follows:
  - (1) *Appearance of coated mesh*: no cracking, stripping or air bubbles, and no appreciable variation in color
  - (2) *Specific gravity*: variations shall not exceed 6%
  - (3) *Hardness*: variations shall not exceed 10%
  - (4) *Tensile strength*: variations shall not exceed 25%
  - (5) *Modulus of elasticity*: variations shall not exceed 25%
  - (6) *Abrasion resistance*: variations shall not exceed 10%
  - (7) *Brittleness temperature*: shall not exceed + 64°F (+18°C).

3. GalMac<sup>®</sup> and PVC coated wire mesh gabions or approved equal gabions product (8 x 10 mesh type):
  - a. *PVC coating thickness*: Nominal – 0.02 inch (~0.5 mm), Minimum – 0.015 inch (~0.38 mm)
  - b. *Mesh Wire*: Diameter – 0.106 inch (~2.70 mm) internal, 0.146 inch (~3.70 mm) external
  - c. *Selvedge Wire*: Diameter – 0.134 inch (~3.40 mm) internal, 0.174 inch (~4.40 mm) external
  - d. *Mesh Opening*: Nominal Dimension D = 3.25 inch (~83 mm).
4. GalMac<sup>®</sup> or approved equal product and PVC coated lacing wire and internal stiffeners:
  - a. *PVC coating thickness*: Nominal – 0.02 inch (~0.5 mm), Minimum – 0.015 inch (~0.38 mm)
  - b. *Lacing wire*: Diameter – 0.087 inch (~2.20 mm) internal, 0.127 inch (~3.20 mm) external
  - c. *Connecting Wire (Cross-Tie Wire)/Stiffener wire*: Diameter - 0.087 inch (~2.20 mm) internal, 0.127 inch (~3.20 mm) external
  - d. *Preformed Stiffener*: Diameter – 0.134 inch (~3.4 mm) internal, 0.174 inch (~4.4 mm) external
5. Steel Mesh properties

Steel mesh shall comply with the below minimum strength requirements:

<b>Minimum Strength Requirements of Mesh and Connections</b>		
<b>Test Property</b>	<b>Test Method</b>	<b>Minimum Test Value</b>
Mesh Tensile Strength	ASTM A975	3425 lb/ft (50.0 kN/m)
Punch Test Resistance	ASTM A975	5300 lb (23.6 kN)
Connection to Selvedges	ASTM A975	1200 lb/ft (17.5 kN/m)
Panel to Panel Connection	ASTM A975	1200 lb/ft (17.5 kN/m)

6. Ring Fasteners (Overlapping Fasteners):
  - a. Stainless Steel overlapping fasteners may be used in lieu of, or in conjunction with lacing wire for basket assembly and installation.
  - b. High tensile strength fasteners shall be installed at nominal spacing of 4 inches (~100 mm), not to exceed 6 inches (~150 mm). This is based on a 1,200 lb/ft

(~17.5 kN/m) pull apart resistance for GalMac® or approved equal product and PVC coated wire mesh with this spacing (ASTM A975 Section 13.1.2).

- c. Field samples of fasteners used for assembly and installation shall be tested for compliance with the ASTM A975 Section 13.1.2.2 Pull-Apart Resistance. Producer or supplier of the wire mesh shall provide certification no later than 15 days prior to starting construction.
- d. When tested in accordance with Section 13.1.2.1, the average maximum resistance of the fasteners from the field shall not be lower than 90% of the resistance provided in the certification.
- e. Stainless Steel Fasteners: Diameter = 0.120 inch (~3.05 mm), according to ASTM A313/A313M, Type 302, Class I.
- f. Tensile strength: 222,000 to 253,000 psi (1530-1744 MPA) in accordance with ASTM A313/A313M Table 5.
- g. Proper installation of rings: A properly formed ring fastener shall have a nominal overlap of one (1) inch after closure (please see drawings related to construction details).

#### 7. Tolerances

- a. *Wire*: GalMac® or approved equal product coating, in accordance with ASTM A856/A856M, Class III soft temper coating.
- b. *Gabions*: ± 5% on the length, width, and height.
- c. *Mesh opening*: Tolerances on the hexagonal, double twisted wire mesh opening shall not exceed ± 10% on the nominal dimension D value which is 3.25 inches (please see drawings related to construction details):

## 8. Standard Unit Size

<b>Typical Gabion Sizes</b>			
<b>L=Length ft (m)</b>	<b>W=Width ft (m)</b>	<b>H=Height ft (m)</b>	<b># of cells</b>
6 (1.8)	3 (0.9)	3 (0.9)	2
9 (2.7)	3 (0.9)	3 (0.9)	3
12 (3.6)	3 (0.9)	3 (0.9)	4

Note: All sizes and dimensions are nominal. Tolerances of  $\pm 5\%$  of the width, length, and height of the gabions shall be permitted. The number of diaphragms is one less than the number of cells reported in the last column in the table above (i.e. two cells will have one diaphragm in the middle).

## 9. Fabrication

- a. Gabions shall be manufactured and shipped with all components mechanically connected at the production facility. The front, base, back and lid of the gabions 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 basket and top, or lid, shall be selvaged with wire having a larger diameter.
- b. The gabion is divided into cells by means of diaphragms positioned at approximately 3 ft (~0.9 m) centers. The diaphragms shall be secured in position to the base so that no additional lacing is necessary at the jobsite.

## 10. Rock

- a. The rock used in gabions shall be granite, hard, angular to round, durable and of such quality that they shall not disintegrate on exposure to water or weathering during the life of the structure. The rock materials should meet the following requirements:

Quality Characteristic	Test Method	Requirement
Dry Unit Weight (Minimum)	ASTM D7263	130 pounds per cubic foot (pcf)
Apparent Specific Gravity (Minimum)	California Test 206	2.5
Absorption (Maximum %)	California Test 206	4.2
Durability Index (Minimum)	California Test 229	52

Durability Absorption Ratio (DAR) = Durability Index/ (Percent Absorption+1)

If DAR is greater than 10, the absorption value may exceed 4.2% specified above.

If DAR is greater than 24, the durability index may be less than 52 specified above.

- b. The rock used to fill-in gabions shall range between 4 inches (~0.10 m) and 8 inches (~0.20 m). The range in sizes shall allow for a variation of 5% oversize and/or 5% undersize rock, provided it is not placed on the gabion exposed surface.
- c. Flat or needle-shaped rock must not be used unless the individual rock thickness is greater than 0.33 times the length.
- d. The size shall be such that a minimum of three layers of rock must be achieved when filling the gabions.
- e. Place rock in end gabion cell first and continue filling interior gabion cells.

### PART 3 - SUBMITTALS

Submit the following list of documents for Engineer's review and approval prior to material supply.

1. Product Data: submit manufacturer's product technical specifications, and product installation instructions.
2. Sample: submit wire mesh samples at least 12 inches by 12 inches to include edge and selvedge wires.
3. Certificate of Compliance: Submit written manufacturer's certificate of compliance. Manufacturer's Certificate of Compliance shall be signed by person authorized to bind the manufacturer's certifications and must have Manufacturer's name and product manufacturing location.
4. Equivalent products or any value engineering proposal using alternate products is acceptable. For equivalent products or any value engineering proposal using alternate product, submit the following in addition to above listed documents to the PID and Engineer for review. Engineer's and PID's approvals are needed prior to ordering and bringing the equivalent product to the Magalia Dam Spillway Interim Repair site to start the construction of the proposed gabion wall. Submittal for equivalent products or any value engineering proposal should be submitted in a timely manner for review and approval.

- a. Test reports from a third-party (i.e. an independent) test laboratory in the USA to verify the product compliance with ASTM A975.
- b. Mill certifications of the wire used in manufacturing the product.
- c. Submit Manufacturer's Quality Control Manual along with certificate signed by person authorized to bind the manufacturer's certifications.
- d. List of at least ten government projects where the product has been successfully installed.
- e. Manufacturer shall demonstrate at least 10 years of continuous experience in manufacturing gabions, and at least 3.0 million cubic yards of gabions.
- f. Shop drawings and design calculations along with test reports, signed and sealed by the Professional Engineer registered in the state of project location.
- g. The following tests shall be carried out on a minimum of three randomly selected field samples of lacing wire.
  - (1) Wire diameter.
  - (2) Tensile strength.
  - (3) PVC coating thickness.
  - (4) Ring fastener individual pull apart strength.

#### PART 4 - QUALITY ASSURANCE

- A. A manufacturer's representative to provide reasonable installation support.
- B. The General Contractor shall have personnel with at least 3 years of experience installing gabions and have installed a minimum of 1000 cubic yards of gabions in each of the last three years.
- C. In case the General Contractor does not meet the qualifications based on the above requirements, acquire necessary onsite training from manufacturer prior to construction or the services of a qualified gabion/mattress subcontractor must be utilized.

#### PART 5 - CONSTRUCTION REQUIREMENTS

##### A. Assembly

1. Gabions are supplied folded flat and packed in bundles. The units are assembled individually by erecting the sides, ends, and diaphragms, ensuring that all panels are in the correct position, and the tops of all sides are aligned. The four corners shall be

connected first, followed by the internal diaphragms to the outside walls. All connections should use lacing wire or ring fasteners as previously described in PART 2 – MATERIALS, Paragraphs 4 and 6.

2. The procedure for using lacing wire consists of cutting a sufficient length of wire, and first looping and/or twisting to secure the lacing wire to the wire mesh. Proceed to lace with alternating double and single loops through every mesh opening approximately every 6 inches (~150 mm), pulling each loop tight and finally securing the end of the lacing wire to the wire mesh by looping and/or twisting. The use of ring fasteners shall be in accordance with the manufacturer's recommendations as specified in PART 2 – MATERIALS, Paragraph 6. (please see drawings related to construction details).

#### B. Installation

1. After initial assembly, the gabions are carried to their final position and are securely joined together along the vertical and top edges of their contact surfaces using the same connecting procedure(s) described in PART 5 – CONSTRUCTION REQUIREMENTS, Section A. Whenever a structure requires more than one layer, the upper empty baskets shall also be connected to the top of the lower layer along the front and back edges of the contact surface using the same connecting procedure(s) described in PART 5 – CONSTRUCTION REQUIREMENTS, Section A.

#### C. Filling

1. Gabions shall be filled with rock as specified in PART 2 – MATERIALS, Paragraph 10.
2. During the filling operation some manual stone placement is required to minimize voids.
3. The exposed faces of vertical structures may be carefully hand placed to give a neat, flat, and compact appearance.
4. Care shall be taken when placing fill material to ensure that the sheathing on the PVC coated baskets is not damaged.
5. The cells 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 (~0.30 m) higher than the adjoining cell. It is also recommended to slightly overfill the baskets by 1 to 2 inches (~25 to ~50 mm) to allow for settlement of the rock.

#### D. Internal Connecting Wires

1. Cross ties / preformed stiffeners or lacing wire can be used as internal connecting wires when a structure requires more than one layer of gabions to be stacked on top of each other.
2. Internal Connecting Wires with lacing wire shall connect the exposed face of a cell to the opposite side of the cell.
3. Internal Connecting Preformed stiffeners shall connect the exposed face of a cell to the adjacent side of the cell.
4. Preformed stiffeners are installed at 45° to the face/side of the unit, extending an equal distance along each side to be braced (approximately 1 foot. (~300 mm)).
5. An exposed face is any side of a gabion cell that will be exposed or unsupported after the structure is completed.

#### E. 3 Feet (~0.9m) High Gabions

1. 3 feet (~0.9 m) high gabions shall be filled in three layers, 1 foot (~300 mm) at a time. Internal connecting wires (cross-tie wires) and corner stiffeners shall be installed after the placement of each layer, that is, at 1 foot (~300 mm) high and 2 feet (~600 mm) high.

#### F. Lid Closing

1. Once the gabion baskets are completely full, the lids will be pulled tight until the lid meets the perimeter edges of the basket. A tool such as a lid closer can be used. The lid must then be tightly laced and/or fastened along all edges, ends and top(s) of diaphragm(s) in the same manner as described in PART 5 – CONSTRUCTION REQUIREMENTS, Section A.

#### G. Mesh Cutting and Folding

1. Where shown in the drawings or otherwise directed by the Engineer, the gabions shall be cut, folded and fastened together to suit site conditions. The mesh must be cleanly cut and surplus mesh either folded back or overlapped so that it can be securely fastened together with lacing wire or fasteners in the manner described in PART 5 – CONSTRUCTION REQUIREMENTS, Section A. Any reshaped gabions shall be assembled, installed, filled and closed as specified in the previous sections.

END OF SECTION