

ROAD COMMISSION FOR OAKLAND COUNTY

SPECIAL PROVISION
FOR
GABION FACED MSE WALLS

RCOC/DESIGN:JJ/JO

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a. Description

This work shall be done in accordance with section 205 of the *Michigan Department of Transportation (MDOT) 2020 Standard Specifications for Construction*, except as herein provided.

This specification covers the use of double twisted hexagonal wire mesh and welded wire mesh baskets with gray Polyvinyl chloride (PVC) coating filled with stone used for constructing gabion faced mechanically stabilized earth (MSE) retaining structures.

1. Definitions

A. "Gabions" are defined as twisted woven wire mesh box or welded wire mesh box shaped baskets of various sizes and dimensions filled with hard, durable rock.

B. The "selvedges" of the gabion baskets are the thicker perimeter wires to which the wire mesh is secured as to withstand sudden or gradual stress from any direction.

C. The "diaphragms" are internal wire mesh partitions, which divide the gabions into cells.

D. "Lacing" or "tie wire" is the wire used to assemble and join the gabion units.

E. "Connecting wires" are the internal wires used to prevent the gabions from bulging.

F. "Alternative fasteners" are ASTM approved wire fasteners used to close the gabion lids.

G. "Polyvinyl chloride (PVC) coating" is used to coat the wire gabion baskets and soil reinforcement mesh.

H. "Soil reinforcement/soil reinforcing mesh/reinforcement mat" is the reinforcing material used to construct the MSE portion of the retaining wall.

I. "Reinforcing wires" are the thicker wires incorporated into the netting during fabrication.

b. Materials

1. Gabion Rock

Furnish hard, durable rock that is resistant to weathering and free of organic and spoil material. Rock shall conform to Table 1: Rock Properties.

Table 1: Rock Properties

	Minimum	Maximum
(a) Unit mass of a filled basket	100 pcf	110 pcf
(b) Gradation dimension	4 inches	8 inches

The Contractor shall supply a written Certificate of Compliance that the gabion rock meets the Table 1: Rock Properties specified above and section 916.01.C, Riprap.

Rock shall conform to the section 916.01.C, Riprap, of the *MDOT 2020 Standard Specifications for Construction*. Verification of the unit shall be performed when ordered by the Engineer. The rock supplied for the project shall be used for verification. Filling shall be done using the same method intended for actual construction. The mass of a rock-filled gabion shall be determined using available certified scales. The volume for calculating the unit mass shall be determined on the theoretical volume of the standard gabion which is rock-filled and weighed.

2. Gabion Material - Basket mesh.

At the Contractor's option, either twisted mesh or welded mesh shall be used, in conformance with this Special Provision. For each standard gabion size, the same mesh style shall be used for the base, front, ends, back, diaphragms, and lid panels.

All Gabion material shall be aluminized or galvanized wire, coated with gray-colored PVC, and manufactured according to the following ASTM standards, which are hereby made a part of this specification:

A. ASTM A975, "Double-Twisted Hexagonal Mesh Gabions and Revet Mattresses (Metallic-Coated Steel Wire or Metallic-Coated Steel Wire with Poly Vinyl Chloride (PVC) Coating)"

B. ASTM A974, "Welded Wire Fabric Gabion and Gabion Mattresses (Metallic Coated or Polyvinyl Chloride (PVC) Coated)"

The twisted mesh gabions, if chosen for this project, shall consist of double-twisted wire mesh, lacing wire, stiffeners, and fasteners made from wire that is galvanized or aluminized, and overcoated with PVC, before being double-twisted into mesh.

The welded mesh gabions, if chosen for this project, shall consist of welded wire mesh, lacing wire, stiffeners, and fasteners made from wire that is either galvanized or aluminized, and is overcoated with PVC, after mesh fabrication and welding.

Twist or weld the mesh from either galvanized steel wire conforming to ASTM A641, Class 3 or aluminized steel wire conforming to ASTM A809. Use wire which has a minimum tensile strength of 60,000 pounds per square inch when tested according to AASHTO T244. Make the mesh openings with a maximum dimension less than the gabion rock to be used with the mesh.

Fabricate the mesh for polyvinyl chloride (PVC) coated baskets with the properties as shown in Table 2: Basket Mesh Properties.

Table 2: Basket Mesh Properties

	Twisted wire	Welded wire
Diameter of gabion mesh core wire	0.1063 inches	0.118 inches
Diameter of gabion mesh core wire plus PVC coating	0.146 inches	0.158 inches
PVC coated gabion mesh opening	3.25 by 4.5 inches	3 by 3 inches

Twisted-wire mesh: form the mesh in a uniform hexagonal pattern with non-raveling double twists and tie the perimeter edges of the mesh for each panel to selvedge wire having the following minimum diameters. Furnish selvedge wire from the same type of material and strength used for the gabion wire mesh. Refer to Table 3: Twisted Wire Mesh Properties.

Table 3: Twisted Wire Mesh Properties

Diameter of selvedge core wire	0.1338 inches
Diameter of selvedge core wire plus PVC coating	0.173 inches

Welded-wire mesh: Weld each connection to obtain minimum average weld shear strength of 472 pounds with no value less than 450 pounds.

3. Gabion Material - Soil Reinforcing Mesh / Tensile Strength.

Furnish soil reinforcing mesh from the same type of material and strength used for the gabion basket wire. The soil reinforcing mesh shall have a minimum tensile strength of 2900 pounds per foot.

For twisted wire mesh: the minimum tensile strength shall be parallel to twist. The minimum strength requirements shall be per ASTM A975.

For welded wire mesh: the minimum tensile strength shall apply to the mesh and welds. The minimum strength requirements shall be supported with test results, documentation, and written certification to the Engineer.

4. Polyvinyl Chloride (PVC) Coating.

Use either a fusion bonded or extruded coating to coat the galvanized or aluminized mesh. Polyvinyl chloride coated baskets shall conform to Table 4: PVC Coating Properties.

Table 4: PVC Coating Properties

(a) Color	Gray
(b) Nominal thickness of PVC coating	0.0216 inches not less than 0.015 inches
(c) Specific gravity, ASTM D 792 and ASTM D 2287	1.30 to 1.35
(d) Tensile strength, ASTM D 412	2,985 psi minimum
(e) Modulus of elasticity, ASTM D 412	2,700 psi minimum at 100% strain
(f) Hardness - shore "D", ASTM D 2240	between 50 and 60
(g) Brittleness temperature, ASTM D 746	15 °F max
(h) Abrasion resistance, ASTM D 1242, method B at 200 cycles, CSI-A abrader tape, 80 grit	12% maximum mass loss
(i) Salt spray - (ASTM B 117) test period of 3000 hours and ultraviolet light exposure (ASTM D 1499 and ASTM G 23 using apparatus type E at 145 °F) for 3000 hours	No visual effect (c) $\Delta < 6\%$ (d) $\Delta < 25\%$ (e) $\Delta < 25\%$ (f) $\Delta < 10\%$ (h) $\Delta < 10\%$ elongation $\Delta < 10\%$
(j) Creeping Corrosion - max penetration of the wire from a square cut end, when the specimen has been immersed for 2000 hours in a 5% solution HCl (hydrochloric acid 12 Be)	shall be less than 1 inch
(k) Mandrel bend, 360° bend at 0 °F around a mandrel 10 times the wire diameter	No breaks or cracks in coating

5. Gabion Permanent Fasteners.

A. Lacing Wire (Twisted Wire Mesh)

Furnish the following nominal-sized diameter wire of the same type, strength, and coating as the gabion basket mesh. Refer to Table 5: Twisted Wire Mesh for Lacing Wire Properties.

Table 5: Twisted Wire Mesh for Lacing Wire Properties

Diameter of lacing core wire	0.091 inches
Diameter of lacing core wire plus PVC coating	0.127 inches

B. Spiral binders (Welded Wire Mesh)

Form with wire having at least the same diameter, type, strength, and coating as the gabion basket mesh.

C. Alternate Tying Fasteners (Twisted Wire and Welded Wire Mesh)

Furnish gray PVC coated fasteners according to the basket manufacturer's specification that remain closed when subjected to a 1400-pound tensile force while confining the maximum number of wires to be confined in the gabion

structure. Submit installation procedures and fastener test results to the Engineer for approval.

Alternate tying fasteners may be used for gabion basket lid closure only.

6. Internal Connecting Wire

Form the internal connecting wire with wire having at least the same diameter, type, strength, and coating as the lacing wire as described in Gabion Permanent Fasteners - Lacing Wire section above.

7. Geotextile Separator – Non-Woven

The non-woven geotextile separator shall be used to line the vertical and horizontal surfaces between the soil and gabion wall faces per the plans. Seams in the geotextile shall be overlapped a minimum distance of 2 foot.

8. Material Certification

All materials for the gabions and gabion assembly shall conform to the provisions in these special provisions. Each shipment of gabion baskets to the project site shall be accompanied by a written Certificate of Compliance conforming to the provisions in section 105, of the *MDOT 2020 Standard Specifications for Construction*. Furnishing a certification of compliance does not waive inspection, sampling, or testing of materials.

c. Construction

The following construction sections consist of a Gabion and MSE section. These sections shall be used concurrently in order to construct the gabion faced MSE wall.

1. Gabion Construction

A. Gabion Foundation Preparation.

The foundation on which the gabions are to be placed shall be cut or filled and graded to the lines and grades shown on the drawings. Surface irregularities, loose material, vegetation, and all foreign matter shall be removed from foundation surface area. When fill is required, it shall consist of materials as shown on the plans and typical cross sections. Gabions and bedding or specified geotextiles shall not be placed until the foundation preparation is completed, and the subgrade surfaces and assumed soil values for design have been inspected and approved by the Engineer.

Compaction of bedding or filter material will be required per plans and specifications. The surface of the finished material shall be to grade and free of mounds or dips. Extra care shall be taken with foundation preparations in order to ensure a level and smooth surface. Geotextile shall be installed in accordance with the requirements of the plans and specifications.

B. Gabion Basket Assembly.

Fabricate gabion baskets (twisted and welded) in the dimensions required with a dimension tolerance of ± 5 percent. Where the length of the basket exceeds 1.5 times its width, equally divide the basket into cells less than or equal to the basket width using diaphragms of the same type and size mesh as the basket panels. Prefabricate each basket with the necessary panels and diaphragms secured so they rotate into place.

Do not damage wire PVC coatings during basket assembly, structure erection, cell filling, or backfilling. Rotate the basket panels into position and join the vertical edges with fasteners according to the Gabion Structure Erection subsection. Temporary fasteners may be used for basket assembly if they are supplemented during structure erection with permanent fasteners according to the Gabion Structure Erection subsection. Rotate the diaphragms into position and join the vertical edges according to the Gabion Structure Erection subsection.

C. Gabion Structure Erection.

Place the empty gabion baskets on the foundation and interconnect the adjacent baskets along the top and vertical edges using permanent fasteners.

Where lacing wire is used, wrap the wire with alternating single and double loops every other mesh opening and not more than 4 inches apart. Where alternate fasteners are used (for gabion lid closure only), space the fasteners in every mesh opening and not more than 4 inches apart.

In the same manner, interconnect each vertical layer of baskets to the underlying layer of baskets along the front, back, and sides. Stagger the vertical joints between baskets of adjacent rows and layers by at least one cell length.

Interior diaphragms will be required where any inside dimension exceeds 3 feet for gabion baskets thicker than 1 foot. Diaphragms will be installed to assure that no open intervals are present that exceeds 3 feet. For baskets 1 foot or less, rectangular cells are allowed with dimensions 3 feet in one direction and not to exceed 6 feet in the perpendicular direction.

Backfill placement shall closely follow erection of each course of gabions. Backfill shall be first placed near the rear and middle of the reinforcement mesh and worked toward the gabion facing. Backfill shall be carefully placed to avoid any damage or disturbance of the wall materials or misalignment of the gabions or reinforcement elements. Any wall materials, which become damaged during backfill placement, shall be removed and replaced at the Contractor's expense. At each reinforcement level, the backfill shall be placed to the level of the connection to eliminate voids beneath the reinforcement elements.

D. Gabion Cell Filling

Remove all kinks and folds in the wire mesh and properly align all the baskets. Place rock carefully in the basket cells to prevent bulging of the baskets and to minimize voids in the rock fill. Maintain the basket alignment.

Place internal connecting wires in each unrestrained exterior basket cell in the cells in the following manner. This includes interior basket cells left temporarily unrestrained.

Fill each cell to 1/3 its depth, then place internal connecting wires in each direction as shown on the plans, concurrently with rock placement. Loop each end of the connecting wires around two mesh openings. When the cell is 2/3 full, repeat this operation.

Fill the cells in any row or layer so that no cell is filled more than 1 foot above an adjacent cell. At no point in the filling process may rock be mechanically placed from a height of over 1 foot from machine to fill area. Repeat this process until the basket is full and the lid bears on the final rock layer. Completely fill cells so that the lid will bear on the rock when it is secured. Secure the lid so that no more than a 1-inch gap remains at any connection.

Secure the lid to the sides, ends, and diaphragms according to the Gabion Structure Erection subsection. Make all exposed basket surfaces smooth and neat with no sharp rock edges projecting through the wire mesh.

Gabion rows or layers not completed at the end of each shift, shall have the last gabion filled with rock tied internally as an end gabion.

E. Gabion Testing for Unit Mass.

Contractor shall perform an in-place unit mass test for each 500 cubic yards of gabions placed using a scale approved by the Engineer. The engineer may reduce the frequency of these tests if the proper unit mass is being consistently obtained.

If the unit mass of the gabion weighed is less than the minimum required, the gabion will be rejected. In the event a gabion is rejected, weigh additional gabions to establish that the minimum acceptable unit mass is being obtained before continuing with gabion construction.

F. Gabion Backfilling.

Place non-woven geotextile separator over the back face of the gabion structure. Also place non-woven geotextile separator over the portion of front and end structure faces which will be below grade and which will be exposed to backfill material. No temporary stakes shall be placed through the geotextile material. Concurrently with the cell filling operation, backfill and compact the area behind the gabion structure with Backfill Select per the Special Provision of the item in

the proposal book according to *MDOT 2020 Standard Specifications for Construction* section 206. At areas within 3 feet of the gabion structure, use an acceptable lightweight mechanical or vibratory compactor.

2. MSE Construction

A. MSE Wall General.

Grade the foundation for a width equal to the length of reinforcing mesh plus 18 inches. Where the wall is set on a rocky or unsuitable foundation, place 6 inches of Backfill Select according to the Special Provision of the item in the proposal book and *MDOT 2020 Standard Specifications for Construction* section 206 under the reinforcing mesh.

Do not use or place a concrete leveling pad under the gabion faced MSE wall.

B. MSE Wall Erection.

Place the first lift of backfill before filling the gabion baskets. Furnish and construct gabion structures according to the Gabion Construction section. Lay reinforcement mesh horizontally on compacted fill and normal to the face of the wall. Connect the gabion facing unit to reinforcement mesh with tie wire at 4-inch nominal spacing with alternating single and double locked loops per the details shown on the plans. Pull and anchor the reinforcement mesh taut before placing additional backfill.

Behind a linear gabion wall, adjacent edges of soil-reinforcing mesh shall be butted and tied together per the half-hitch tying detail shown on plans. Alternatively, the soil reinforcement edges may be overlapped with adjacent reinforcing mesh sheets a minimum of 12 inches along the edges perpendicular to the face.

Behind a curving or angled gabion wall, adjacent edges of soil-reinforcing mesh shall be overlapped per the plan detail.

C. MSE Wall Backfilling.

Backfill the mechanically stabilized volume with Backfill Select according to the Special Provision of the item in the proposal book *MDOT 2020 Standard Specifications for Construction* section 206 and Special Provision for Backfill, Select. Ensure that no voids exist below the reinforcing mesh. Compact each layer according to *MDOT 2020 Standard Specifications for Construction* section 206 and Special Provision for Backfill, Select, except use an acceptable lightweight mechanical or vibratory compactor within 3 feet of the wall face. Where the stabilized volume supports spread footings for bridges or other structural loads, compact the top 5 feet to at least 100 percent of the maximum density.

Do not damage or disturb the gabion facing or reinforcing elements. Do not operate equipment directly on top of the reinforcing mesh. Correct all damaged, misaligned, or distorted wall elements.

At the end of the day's operation, slope the last lift of backfill away from the wall face to direct surface runoff away from the wall. Do not allow surface runoff from adjacent areas to enter the wall construction area.

Place granular select backfill closely following erection of each course of reinforcing mesh and gabion baskets. Prior to backfilling, place non-woven geotextile separator on the back of the gabion basket per the plan detail. Place a minimum of 6 inches of uncompacted backfill material over the reinforcing mesh before any equipment is permitted to operate above the reinforcement. All equipment used for backfill placement shall be track-mounted. The backfilling procedure shall be as approved by the Engineer and shall not cause any distortion in the wall face.

The reinforcing mesh shall be placed to lay flat and pulled tight prior to backfilling. After a layer of reinforcement has been placed, suitable means, such as pins or small piles of select backfill material, shall be used to hold the reinforcing mesh in position until the subsequent select backfill layer can be placed. Under no circumstances shall any vehicle be allowed on the reinforcing mesh before at least 6 inches of select backfill material has been placed. Sudden braking and sharp turning, sufficient to displace fill, shall not be allowed.

Backfill shall be placed, spread, and compacted in such a manner to minimize the development of wrinkles and/or displacement of the reinforcing mesh.

Turning of vehicles shall be kept to a minimum to prevent tracks from displacing the select backfill material and the reinforcing mesh.

d. Measurement and Payment

The completed work, as described, will be measured and paid for at the contract unit price using the following pay item:

Pay Item	Pay Unit
Gabion, MSE Retaining Wall, PVC.....	Square Yard

Gabion, MSE Retaining Wall, PVC includes equipment, labor and materials, (including gabion baskets, soil reinforcing mesh, gabion hardware and connections, gabion rock, and non-woven geotextile separator), to complete this item. Payment for **Gabion, MSE Retaining Wall, PVC** includes the soil reinforcing mesh and mesh overlaps. Measure **Gabion, MSE Retaining Wall, PVC** by the square yard on the vertical plane of front wall face. The mechanically stabilized select granular backfill shall be measured and paid for separately.