

CITY OF MEMPHIS - STANDARD CONSTRUCTION SPECIFICATIONS
SECTION 02371 GABIONS AND REVET MATTRESSES

PART 1 – SCOPE

1.01 This work shall consist of the furnishing and assembling, and installation of filled gabions and revet mattresses for channel stabilization at the locations and to the dimensions shown on the Plans or directed by the Owner. The construction shall be accomplished in accordance with these Specifications and the manufacturer's recommendations. The work shall include furnishing all labor, material, and equipment needed to complete the stabilization work shown on the Plans.

PART 2 – MATERIALS AND EQUIPMENT

2.01 MATERIAL

A. Filter Cloth and Fasteners.

1. The filter cloth material for gabions and revet mattresses shall be pervious sheets of strong, rot-proof plastic fabric meeting the following Specifications:

<u>Physical Property</u>	<u>Test Method</u>	<u>Acceptable Test Results</u>
Tensile Strength, wet, lbs	ASTM D-1682	160 (min)
Elongation, wet, %	ASTM D-1682	65 (min)
Coefficient of Water Permeability, cm/scc	Constant Head	.03 (min)
Puncture Strength, lbs.	ASTM D-751	95 (min)
Pore Size – EOS	Corps of Engineers	40 (max)
U.S. Standard Sieve	CW-02215	

2. The Contractor shall furnish a certified laboratory test report from an approved testing laboratory with each shipment of materials. Laboratory test reports shall include actual numerical test data obtained on this product.

3. Pins may be any commercially available pin 6 inches in length capable of retaining a washer.

4. Washers may be any commercially available washer 2 inches in diameter and compatible with the pin.

5. The pins and washers shall be manufactured from corrosion resistant metal material.

B. Gabions.

1. Gabions shall be made of hexagonal triple twist mesh with heavily galvanized steel wire. The maximum linear dimension of the mesh shall not exceed 4 ½ inches and the area of the mesh opening shall not exceed 10 square inches. The length of gabions shall be a multiple of the width. The width shall not be less than 36 inches. Dimensions for heights, lengths, and widths are subject to a tolerance of approximately 5% of manufacturer's stated sizes.

2. Gabions shall be fabricated in such a manner that the sides, ends, lids, and diaphragms can be assembled at the construction site into a rectangular basket of the specified size. Gabions shall be of single unit construction. The base, lid, and sides shall be woven into a single unit, and the ends shall be connected to the base section of the gabion in such a manner that strength and flexibility at the point of connection is at least equal to that of the mesh. Where the length of the gabion exceeds its width, the gabion shall be divided by diaphragms into cells of equal length and width. The gabion shall be furnished with the necessary diaphragms secured in proper position on the base in such a manner that no additional tying at this juncture will be necessary.

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3. All perimeter edges (mesh edge and selvedge rod wires) of the mesh forming the gabion shall be securely selvaged with wire of not less than 0.153 inch diameter so that the mesh selvage connections have the same strength as the body of the mesh. The wire mesh shall be made of galvanized steel wire having a minimum diameter of 0.118 inches and a tensile strength of 70,000 psi. The minimum zinc coating on all wires shall be 0.80 ounces per square foot, as per Federal Specification QQ-W-461g, Class 3. Lacing wire shall be supplied in sufficient quantity for securely fastening all edges of the gabion and diaphragms and connecting each gabion to adjacent gabions. Stay wire will be supplied in sufficient quantity to provide for the necessary internal connecting wires in each cell. The lacing and stay wire shall meet the same specifications as the wire used in the mesh except that its diameter shall be not less than 0.0866 inches.

4. When PVC gabion is specified, the same requirements as all the above apply except for the wire gauges and the additional carbon black Polyvinylchloride (PVC) coating extruded on to all wires prior to weaving, as follows:

Mesh Wire	0.105"
Mesh edge wire	0.132"
Selvedge rod wire	0.132"
Lacing wire	0.0866"
PVC coating	0.015"

The PVC color is black. Pigment used is carbon black which gives the best result under all conditions of exposure.

5. The protective coating must be resistant to the air and water and must meet the following tests:

a. Immersion of the wire for 20 hours in Hydrochloric acid (solution composed 50% H₂O and 50% HCL concentration 21 Baume-Test temperature 15° C) without noticeable loss of weight due to corrosion of the coating material and without any reduction of the wire's diameter.

b. After immersion of a length of the coated wire in a 3.5% solution of Potassium Permanganate (KMnO₄) for a continuous period of fifty hours at an ambient temperature, the maximum penetration between the coating and the core wire from a square cut end shall be 12 millimeters (0.472 inches).

c. The protective coating will not be altered or deformed by temperature ranging between +158.0° F and -40° F.

C. Gabion Tests and Certification.

1. Elongation.

a. The wire mesh shall have sufficient elasticity to permit elongation of the mesh equivalent to 10% of the length of the section of the mesh under test without reducing the gauge or tensile strength of individual wires to values less than those for similar wire one gauge smaller in diameter.

2. Load Test.

a. A section of the mesh 6 feet long and not less than 3 feet wide, after first being subjected to the elongation test described above, shall withstand a load test of 6,000 pounds applied to an area of one square foot approximately in the center of the section under test. The details of this test are as follows:

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b. An uncut section of mesh 6 feet long, not less than 3 feet wide and including all selvage binding, shall have the ends securely clamped for 3 feet along the width of the sample. When the width of the sample under test exceeds 3 feet, the clamps will be placed in the middle portion of the width, and the excess width will be allowed to fall free on each side of the clamped section. The sample shall then be subjected to sufficient tension to cause 10% elongation of the sample section between the clamps. After elongation and while clamped as described above (and otherwise unsupported), the section shall be subjected to a load applied to an area of one square foot located approximately in the center of the sample section between the clamps, and in a direction perpendicular to the direction of the tension force. The sample shall withstand, without rupture of any wire, or opening of any mesh fastening, an actual load, so applied, equaling or exceeding 6,000 pounds. The ram head used in the test shall be circular with its edges beveled or rounded to prevent cutting of the wires.

3. Single Wire Cut.

a. The wire mesh shall be fabricated in such a manner as to be nonraveling. This is defined as the ability to resist pulling apart at any of the twists or connections forming the mesh when a single wire in a section of mesh is cut and the section of mesh is cut and the section of mesh then subjected to the load test described above.

4. Zinc Coating and Tensile Strength.

a. The tests shall be conducted in accordance with Federal Specifications QQ-W461g, Class 3.

5. Structural Tests and Strength Requirements.

a. The structural tests shall be conducted in accordance with the State of Colorado Department of Highways, Colorado Procedure CPI-6130 "Method of Conducting Strength Tests of Gabions." The table below shows the minimum strengths required:

TABLE FOR MINIMUM STRENGTH

	Required Minimum Strength in pounds per Linear foot Gabions	
	Galvanized	PVC
(1) - Wire Mesh		
(a) pulled parallel to wire twist	3,400	3,000
(b) pulled perpendicular to wire twist	1,000	1,000
(2) - Connection of selvage wire to mesh	2,200	2,000
(3) - Connection of end panels to gabion base	1,500	1,500
(4) - Connection of diaphragm(s) to gabion base	1,000	1,000

6. Certification.

a. Each shipment of gabions to a job site shall be accompanied by a certification which states that the material conforms to the requirements of the contract specifications. The certification shall be on company letterhead and shall be signed by an officer of the company having legal authority to bind the company.

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D. Revet Mattress.

1. The revet mattress shall be made of hexagonal triple twist mesh with heavily galvanized steel wire. The maximum linear dimension of the mesh opening shall not exceed 3-1/4 inches and the area of the mesh opening shall not exceed 6 square inches. Wire mattress units shall be supplied, as specified, in various lengths. The thickness shall be 9 inches. The horizontal width shall be 6 feet, 6 inches. All mattress units furnished by the manufacturer shall be of uniform width and subject to a tolerance of plus or minus 3% of the manufacturer's stated sizes. Wire mattress units shall be fabricated in such a manner that the base, sides, and ends can be assembled at the construction site into a rectangular unit of the specified size. The body of the mattress units shall be of single unit construction, the base, ends and sides formed of a single woven mesh unit. The top shall be a separate woven unit of the same mesh and wire specifications as the body. The mattress unit shall be subdivided into compartments by the insertion of diaphragms made of the same mesh as the rest of the mattress. The diaphragms shall be factory secured in proper position at the base with a continuous spiral wire, in such a manner that no additional tying at this junction will be necessary. All perimeter edges (mesh edge and selvedge rod wires) of the mesh forming the mattress unit will be securely selvedged with wire of not less than 0.153 inch diameter so that the mesh selvedge connections have the same strength as the body of the mesh. The wire incorporated in the mesh constituting the body of the mattress shall be made of galvanized steel wire having a minimum diameter of 0.0866 inches. The diameter of the mesh edge wire and the selvedge rod wire shall be not less than 0.118 inches. The top, a separate unit, shall be fabricated of the same wire quality and diameter as the body for its corresponding constituent parts. The lacing wire shall meet the same specifications as the wire specified for the mesh and its diameter shall be not less than 0.866 inches. The tensile strength of the wire shall be in the range of 60,000 to 80,000 psi. The minimum zinc coating on all wires shall be 0.80 ounces per square foot of uncoated wire surface as per Federal Specifications QQ-W-461g, Class 3.

2. When PVC coated revetment mattress is specified the same requirements as all the above apply except for wire gauges and the additional carbon black Polyvinylchloride (PVC) coating extruded on to all wires prior to weaving, as follows:

Mesh Wire	0.0866"
Mesh edge wire	0.105"
Selvedge rod wire	0.105"
Lacing wire	0.0866"
PVC coating	0.015"

The PVC color is black. Pigment used is carbon black which gives the best result under all conditions of exposure.

3. The protective coating must be corrosion resistant to the air and water and must meet the following tests:

a. Immersion of the wire for 20 hours in Hydrochloric acid (solution composed 50% H₂O and 50% HCL concentration 21 Baume-Test temperature 15°C) or immersion for 60 hours in a saturated solution of salt water at 15°C without noticeable loss of weight due to corrosion of the coating material and without any reduction of the wire's diameter.

b. After immersion of a length of the coated wire in a 3.5% solution of Potassium Permanganate (KMnO₄) for a continuous period of fifty hours at an ambient temperature, the maximum penetration between the coating and the core wire from a square cut end shall be 12 millimeters (0.472 inches).

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c. The protective coating will not be altered or deformed by temperatures ranging between +158.0°F and -40°F.

E. Revet Mattress Tests and Certification.

1. Elongation.

a. The wire mesh shall permit elongation equivalent to a minimum of 10% of the length of the section under test without reducing the gauge or tensile strength of the individual wire.

2. Load Test.

a. An uncut section of the mesh not less than 6 feet long and not less than 3 feet wide, after first being subjected to the elongation tests described above, shall withstand a load test of 4,000 pounds applied to an area of 1 square foot located approximately in the center of the section under test. The details of the test are as follows:

An uncut section of mesh 6 feet long, not less than 3 feet wide and including all selvage bindings, shall have the ends securely clamped for 3 feet along the width of the sample. When the width of the section under test exceeds 3 feet, the clamps shall be placed in the middle portion of the width, and the excess width shall be allowed to fall free on each side of the clamped section. The sample shall then be subjected to a load applied to an area of 1 square foot located approximately in the center of the section between the clamps and in such a direction perpendicular to the direction of the tensile force. The sample shall withstand, without rupture of any wire, or opening of mesh fastening, an actual load so applied equaling or exceeding 4,000 pounds. The ram head used in the test shall be circular with its edges beveled or rounded to prevent cutting of the wires.

3. Single Wire Cut.

a. The wire mesh shall be fabricated in such a manner as to be nonravelling. This is defined as the ability to resist pulling apart at any of the twists or connections forming the mesh when a single wire in a section of mesh is cut and the section of mesh then subjected to the load test described above.

4. Zinc Coating and Tensile Strength.

a. The test shall be conducted in accordance with Federal Specifications QQ-W461g, Class 3.

5. Certification.

a. Each shipment of wire mesh mattress to a job site shall be accompanied by a certification which states that the material conforms to the requirements of the contract specifications. The certification shall be on company letterhead and shall be signed by an officer of the company having legal authority to bind the company.

F. Stone.

1. Stone for filling gabions and revet mattresses shall be clean, hard, durable, free from cracks, pyrite intrusions and other structural defects, and having a density of at least 150 pounds per solid cubic foot. When tested by the Los Angeles method, the percent of wear shall not exceed 60. When the stone is subjected to five alternations of the sodium sulfate soundness test, the weighted percentage of loss shall be not more than 15. Stone for filling

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gabions shall be 4 inches minimum face dimension and 8 inches maximum face dimension with no more than 5 percent passing the 4 inch sieve. Stone for filling revet mattresses shall be 3 inches minimum face dimension and 6 inches maximum face dimension with no more than 5 percent passing the 3 inch sieve.

2.02. EQUIPMENT.

A. All equipment required for the satisfactory performance of the work shall be on the project site and approved before the work will be permitted to begin.

PART 3 – CONSTRUCTION REQUIREMENTS

3.01 CLEARING, GRUBBING, AND EARTHWORK.

A. The area to be occupied by the gabion/revet mattress stabilization shall be cleared of all trees, roots, vegetation, and similar material and graded to the cross-sections shown on the Plans or as directed by the Owner to prepare the foundation for stabilization. Unless otherwise specified herein, make all fill with suitable materials excavated from site. All fills in dry areas shall be compacted to a maximum density of 90 percent as determined by ASTM D 698 (Standard Proctor). Surplus excavated material shall be removed from the site and disposed of as shown on the Plans or as directed by the Owner. Spoil material shall not be disposed of in a watercourse or on the banks of a watercourse.

3.02 PLACING FILTER FABRIC.

A. The filter fabric shall be laid loosely without wrinkles or creases. When more than one width or length of filter fabric is necessary, the joints shall be overlapped a minimum of 24 inches. Securing pins with washers shall be inserted through both strips of overlapped material and into the material beneath, until the washer bears against the fabric and secures it firmly to the base material. These securing pins shall be inserted through the overlapped fabric at no greater than 2 foot intervals along a line through the midpoint of the overlap. If the fabric is torn or damaged, a patch overlapping the edges of the damaged area by 2 feet shall be sewn securely to the fabric with a continuous, monofilament, rot-proof material.

3.03 INSTALLING GABIONS AND REVET MATTRESSES.

A. Each individual gabion or mattress unit shall be assembled by binding together all vertical edges with wire ties on approximately 3 inch spacing or by a continuous piece of lacing wire looped around the vertical edges with a coil about every 3 inches. Empty units shall be set to line and grade on filter cloth as shown on the Plans. Lacing wire shall be used to join the units together in the same manner as described previously for assembling. As many empty gabions or mattress units as practical shall be laced to each other prior to filling to facilitate uniform lacing.

B. The gabion or mattress units shall be filled carefully with clean, hard stone placed by hand or machine to assure good alignment and to avoid bulging of the mesh with a minimum of voids between stones. Gabion units shall be filled in 1 foot lifts, then one connecting wire is placed in each direction and looped around two meshes of the gabion wall. This operation is repeated until the gabion is filled. After the units have been filled, the lids shall be placed so that they meet the sides and ends of the gabions or mattress. The lids shall then be secured to the sides and ends with lacing wire in the manner described previously for assembling.

C. When a complete gabion or mattress unit cannot be installed because of space limitation, the unit shall be cut to fit in the manner indicated on the Plans. When anchor hooks are required as shown on the Plans, they shall be installed so as to be fully embedded in the rock material of the gabion or mattress. Empty gabions or mattress units placed on top of filled units shall be laced to the filled units according to manufacturer's instructions as each unit is placed. If it becomes

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necessary following rock settlement and consolidation, the gabions or revet mattresses shall be opened, filled with additional rock, and the tops laces into place at no cost to the City.

PART 4 – MEASUREMENT

4.01 GABIONS AND/OR REVET MATTRESSES.

A. Gabions and revet mattresses will be measured for payment by the square yard for the thickness specified complete in place, including stone. Area measurements will be calculated by totaling the number and surface area of individual units placed. Clearing and grubbing when required will be measured for payment in conformance with Specification Section 02361 Paragraph 4.01. No measurement for payment will be made for excavation, embankment construction, or grading work required to prepare the foundation or for filter fabric.

4.02 COMPACTION TEST.

A. Soil test as required by the Owner will be paid for by the test as performed by a testing agency which meets the approval of the Owner.

PART 5 – PAYMENT

5.01 GABIONS AND/OR REVET MATTRESSES.

A. The accepted quantities of gabions and/or revet mattresses will be paid for at the contract unit price per square yard for the thickness specified in place which price shall be full compensation for excavation and embankment construction required to grade the site to cross-sections shown on the Plans, furnishing and installing filter fabric, furnishing and assembling the wire units; placing the units; furnishing and placing stone; cleaning up; and furnishing all labor, material, equipment, and incidentals necessary to complete the work.

5.02 COMPACTION TESTING.

A. Accepted quantities of soil compaction tests as required by the Owner will be paid for at the contract unit price per test.

5.03 PAYMENT WILL BE MADE UNDER:

<u>Item No.</u>	<u>Pay Item</u>	<u>Pay Unit</u>
02371-01	GABIONS	Square Yard
02371-01.01.____	___" Thickness Gabions – Galvanized	Square Yard
02371-01.02.____	___" Thickness Gabions – PVC Coated	Square Yard
02371-02	REVET MATTRESSES	Square Yard
02371-02.01	Revet Mattresses – Galvanized	Square Yard
02371-02.02	Revet Mattresses – PVC Coated	Square Yard
02371-03	SOIL COMPACT TEST	Each

END OF SECTION 02371