

# REPUBLIC OF THE PHILIPPINES DEPARTMENT OF PUBLIC WORKS AND HIGHWAYS OFFICE OF THE SECRETARY

MANILA



SUBJECT: Amendment to DPWH Standard Specification for Item 1714 – Gabions and Mattresses

It has been the thrust of the Department to provide effective standard specifications in the implementation of various infrastructure projects. As such, there is a need to set an updated standard specification for the proper fabrication and installation of gabions and mattresses in flood control projects. The attached amendment for the **DPWH Standard Specification** for **Gabions and Mattresses, Item 1714** is hereby prescribed for the guidance and compliance of all concerned.

This specification shall form part of the on-going revision of the DPWH Standard Specifications for Public Work Structures – Buildings, Ports and Harbors, Flood Control and Drainage Structure and Water Supply Systems, Volume III, 1995 Edition.

This Order shall take effect immediately.

71 MARK A. VILLAR

Secretary

14.1.2 FET/RGT

Department of Public Works and Highways Office of the Secretary

#### Amendment to DPWH Standard Specification for ITEM 1714 – GABIONS AND MATTRESSES

#### 1714.1 Description

This Item shall consist of furnishing, forming cages, cylinders or boxes filled with rocks installed at the locations designated, in accordance with this Specification and in conformity with the lines, grades, dimensions, and arrangements shown on the Plans or as directed by the Engineer.

#### **1714.2 Material Requirements**

#### 1714.2.1 General

1. Wire mesh gabions shall be constructed of steel wire mesh and shall be supplied in various lengths and heights. A double twisted wire mesh container of variable sizes, uniformly partitioned into internal cells, interconnected with other similar units, and filled with stones at the project site to form flexible, permeable, monolithic structures such as retaining walls, sea walls, channel linings, revetments and weirs for erosion control. The lengths shall be multiples of 2, 3 or 4 times the width of the gabion and heights shall be 0.50 m to 1.00 m or as shown on the Plans. The horizontal width shall not be less than one (1) meter. Gabion furnished shall be of uniform width.

The width, height and length of the gabion as manufactured shall not differ by more than  $\pm 5$  percent from the ordered size prior to filling.

2. Mattresses are double twisted wire mesh container uniformly partitioned into internal cells with relatively small height in relation to other dimensions, having smaller mesh openings than the mesh used for wire mesh gabions. Mattresses are generally used for riverbank protection and channel linings. The length shall be three (3) m to six (6) m, the width shall be two (2) m and the height shall be 0.17 m, 0.23 m or 0.30 m or as shown on the Plans.

The width and length of the revet mattress as manufactured shall not differ by more than  $\pm 5$  percent, and the height shall not differ more than  $\pm 10$  percent from the ordered size prior to filling.

3. Polyester net gabions shall be made of knit structured net bag and shall be supplied in various diameters and heights. It shall have a robust engineered net structure that shall be lifted without damage even when filled with tonnage of stones.

The material for the net gabion shall be polyester. Polyester is a term often defined as "long-chain polymers chemically composed of at least 85 percent by weight of an ester and a dihydric alcohol and a terephthalic acid". In other words, it means the linking of several esters within the fibers. Reaction of alcohol with carboxylic acid results in the formation of esters. Polyester is a category of polymers that contain the ester functional group in their main chain. As a specific material, it most commonly refers to a type called polyethylene terephthalate (PET).

Type A polyester net gabion shall be used as river revetment and as foot protection around bridge piers. It shall also be used as emergency measures during flood situations.

Type B polyester net gabions shall be used as foundation and foot protection of seashore protective structures and as slope protection along seashores. It is also used for temporary road slope protections.

## 1714.2.2 Wire Mesh Gabions and Mattresses

The wire used in the manufacture of double-twisted mesh for use in gabions and mattresses shall conform to the Specifications as shown below as appropriate for the style ordered.

- **1714.2.2.1** Style 1 double-twisted mesh shall be manufactured from zinc-coated steel wire conforming to Specification ASTM A641M, Standard Specification for Zinc–Coated (Galvanized) Carbon Steel Wire, Class 3 coating, soft temper.
- **1714.2.2.2** Style 2 double-twisted mesh shall be manufactured from Zn-5A1-MM-coated steel wire conforming to Specification ASTM A856M, Standard Specification for Zinc five (5) percent Aluminum-Mischmetal Alloy-Coated Carbon Steel Wire, Class 3 coating, soft temper.
- **1714.2.2.3** Style 3 double-twisted mesh shall be manufactured from the same type of metallic-coated steel wire as Style 1 with an additional PVC coating extruded into the metallic-coated steel wire. The PVC coating shall conform to the following requirements:

Property	Requirement	Test Method
1. Specific Gravity	1.30 to 1.35	ASTM D792
2. Tensile Strength, Min.	20.6 MPa	ASTM D412
3. Modulus of Elasticity, Min.	18.6 MPa	ASTM D412
4. Hardness, shore "D"	between 50 & 60	ASTM D2240
5. Brittleness Temp, Max.	-9°C or lower temperature	ASTM D746
6. Resistance to Abrasion, % Weight loss, Max.	12	ASTM D1242

#### Table 1714.1 – Requirements for PVC Coating

The PVC coating shall not show cracks or breaks after the wires are twisted in the fabrication of the mesh.

**1714.2.2.4** Style 4 double-twisted mesh shall be manufactured from aluminum-coated steel wire conforming to Specification ASTM A809, Standard Specification for Aluminum-Coated (Aluminized) Carbon Steel Wire, soft temper.

## 1714.2.3 Lacing Wire and Stiffener

Lacing wire and stiffeners shall be made of wire having the same coating material as the double-twisted wire mesh conforming to Specification ASTM A641M, ASTM A856M or ASTM A809 with a tensile strength in accordance with Subsection 1714.2.7, Mechanical Properties.

**1714.2.4** Fasteners made from zinc-coated steel wire, zinc-five (5) percent aluminum mischmetal alloy-coated steel wire and aluminum-coated steel wire shall be Type

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A, B, or C and shall conform to Table 2 – Tensile Requirements—Finish 1 (Drawn to Size Metallic Coated), Regular or Class 1 Coating (One Class on Coating Type A) or Table 3 – Tensile Requirements—Finish 2 (Metallic Coated at Size) Regular, Class 1 or Class 3 Coating (One Class on Coating Type A) of ASTM A764, Standard Specification for Metallic Coated Carbon Steel Wire, Coated at Size and Drawn to Size for Mechanical Springs.

**1714.2.5** Wire mesh gabions and mattresses shall be manufactured with all components mechanically connected at the production facility with the exception of the mattresses lid that is produced separately from the base. All gabions and mattresses shall be supplied in collapsed form, either folded and bundled or rolled, for shipping.

## **1714.2.6** Dimensions

The minimum size of the galvanized and PVC coated wire to be used in the fabrication of the wire mesh gabions and mattresses shall be as follows:

Gabions and	Gabi	ons	Mattresses		
Mattresses Wires	Metallic Coated	PVC Coated	Metallic Coated	PVC Coated	
Body Wires	3.05	2.70	2.20	2.20	
Selvedge or Perimeter Wire	3.80	3.40	2.70	2.70	
Tying and Connecting Wire	2.20	2.20	2.20	2.20	

#### **Table 1714.2 – Wire Diameters**

Diameter Tolerances for Galvanized Wire to be used in the fabrication of wire mesh gabion and mattress shall be  $\pm$  0.10 mm.

The nominal and the minimum thickness of PVC coating shall be 0.50 mm and 0.38 mm, respectively.

#### **1714.2.7 Mechanical Properties**

Tensile Strength – The tensile strength of zinc-coated wire used in the fabrication of wire mesh gabions and mattresses when tested in accordance with ASTM A370, Standard Test Methods and Definitions for Mechanical Testing of Steel Products, shall be as follows:

## Table 1714.3 – Strength Requirements of Zinc-Coated Wires

Gabions and Mattresses	Strength, MPa			
Wires	Gabions	Mattresses		
Body Wire	350 - 485	350 - 515		
Selvedge or Perimeter Wire	350 - 485	350 - 485		
Tying and Connecting Wire	350 - 515	350 - 515		

# 1714.2.8 Weight of Coating

The minimum weight of zinc per unit area of uncoated wire surface shall be in accordance with ASTM A975, Standard Specification for Double – Twisted Hexagonal Mesh Gabions and Revet Mattresses [Metallic-Coated Steel Wire or Metallic – Coated Steel Wire with Poly(Vinyl Chloride) (PVC) Coating] or as follows:

# Table 1714.4 – Minimum Weights of Zinc Coating

Wire Diameter, mm	Class 3 or A Coating, g/m², ASTM A 641
Over 1.90 to 2.30	220
Over 2.30 to 2.70	230
Over 2.70 to 3.10	240
Over 3.10 to 3.50	260
Over 3.50 to 3.90	270

The minimum weight of aluminum coating per unit area of uncoated wire surface shall be in accordance with ASTM A809, Standard Specification for Aluminum-Coated (Aluminized) Carbon Steel Wire:

# Table 1714.5 – Minimum Weights of Aluminum Coating

Wire Diameter, mm	Minimum Weight of Coating, g/m <sup>2</sup>
2.03 to under 2.34	92
2.34 to under 2.69	98
2.69 to under 3.76	107
3.76 to under 6.20	122
6.20	122

## **1714.2.9 Polyester Net Gabions**

## 1714.2.9.1 Structural Features

The knitted (raschel) net bags shall be made from recycled polyethylene terephthalate (PET) bottles. It shall be durable to resist drop impact and to avoid the development of ruptures due to abrasion against rocks and gravels in rivers or seashores. The physical properties and strength requirements of the net bag are shown in Table 1714.6 and Table 1714.7, respectively.

Drementer	Turne	Weight							
Property	туре	1ton	2 ton	3 ton	4 ton	6 ton	8 ton		
Width	idth A		2800 mm	3400 mm	3400 mm	-	-		
(Minimum)	В	1800 mm	2250 mm	2600 mm	2850 mm	4000 mm	4000 mm		
Height	A 1600 m		2100 mm	2200 mm	2800 mm	-	-		
(Minimum)	(Minimum) <b>B</b> 1600 mm		600 mm 2150 mm 2400 mm 265		2650 mm	2700 mm	2700 mm		
Mesh	esh A		1670dtex <sup>A</sup> x 10 <sup>B</sup>		1670dtex <sup>A</sup> x 15 <sup>B</sup>		-		
Composition	position B		1670dtex <sup>A</sup> × 80 <sup>B</sup>		1670dtex <sup>A</sup> x 80 <sup>B</sup>		1670dtex <sup>A</sup> x 128 <sup>B</sup>		
March Cine A		25 mm	25 mm	25 mm 25 mm		-			
Mesh Size	В	75 mm	75 mm	50 mm	75 mm	50 r	nm		
Canacity (m3)	Α	0.5 - 0.62	1.0 - 1.25	1.5 – 1.9	2.0 - 2.25	-	-		
	В	0.5 - 0.65	1.0 - 1.25	1.5 – 1.9	2.0 - 2.5	3.0 - 3.75	4.0 - 5.0		

# **Table 1714.6 – Physical Requirements**

A Decitex is a unit for the mass of fiber in grams per 10,000 meters.

B Number of strings

Droporty	Tune	Weight						
Property	Type	1ton	2 ton	3 ton	4 ton	6 ton	8 ton	
Tensile Strength	A	<u>&gt;</u> 450	<u>&gt;</u> 450	<u>&gt;</u> 650	<u>&gt;</u> 650	-	-	
(N/String)	В	<u>&gt;</u> 2700	<u>&gt;</u> 2700	<u>&gt;</u> 2700	<u>&gt;</u> 2700	<u>&gt;</u> 4000	<u>&gt;</u> 4000	
Clongation Date	A	30% <u>&gt;</u> 50%	30% <u>&gt;</u> 50%	30% <u>&gt;</u> 50%	30% <u>&gt;</u> 50%	-	-	
Elongation Rate	В	30% <u>&gt;</u> 50%						

## 1714.2.9.2 Method of Tensile Test for the Net Yarn

The test method for tensile strength of the net yarn shall be as specified below and in accordance with ASTM D7179, Standard Test Method for Determining Geonet Breaking Force. When the tensile strength and elongation of the material are verified, the test method which is equivalent to or covering the following specifications shall be adopted.

- 1. The temperature condition inside the laboratory shall be 20 °C±2 and the relative humidity shall be 65±2 percent. In case it is difficult to follow this standard ambient condition, the actual temperature and humidity inside the laboratory during the test period shall be recorded.
- 2. The specimen shall have a length of 250 mm and 10 test pieces shall be taken from the area at least 50 cm from the end of net fabric. The specimen shall then be stored in the laboratory under the above-mentioned condition for 24 hours.
- 3. After 24 hours, five (5) test pieces shall be taken each in lateral and longitudinal directions from the specimen that is a total of 10 pieces, respectively, and the tensile strength at break shall be measured with the constant-rate-of extension type tensile tester.
- 4. During the measurement process, the steel hooks shall be fixed on the constant-rate-of extension type tensile tester, then the test piece with two (2) knots per a net yarn is suspended by the upper and lower hooks.
- 5. In case the specimen accidentally breaks in the hook and shows irregular values, test shall be repeated.

6. The highest and lowest values shall be recorded. The average of the 10 results shall also be evaluated, and shall become the tensile strength.

## **1714.2.9.3** Other Characteristic Features

The net bag shall be durable enough to prevent any sort of deterioration due to prolonged exposure to harsh environmental and weather conditions, such as pollution, humidity, strong sunlight, wind, moisture, and extreme temperature.

It shall also have high chemical resistance or the strength to protect against chemical attack or solvent reaction especially when exposed to high temperature, concentration of chemicals, exposure duration and mechanical load.

It shall also be flame-retardant so that when it melts by fire, the flame shall not spread. It shall not emit pyric toxic gas, and other toxic substance that could obstruct eco-systemic habitation underwater. The Contractor shall submit Material Safety Data Sheet (MSDS) of the polyester net bag, similar certificates or test results in order to confirm these features to the Engineer.

## 1714.2.10 Rope

## 1714.2.10.1 Structural Features

The rope for lifting and tying the net bags shall be made of spun-dyed polyester. It shall have enough strength to hold the filling materials. The rope requirements are shown in Table 1714.8.

Dresentar	Turne	Weight						
Property	гуре	1ton	2 ton	3 ton	4 ton	6 ton	8 ton	
Diameter (mm)	•							
Neck Tying	A	6.00	6.00	6.00	6.00	-	-	
Rope	В	6.00	6.00	6.00	6.00	6.00	6.00	
Suspending	Α	9.00	9.00	12.00	12.00	-	-	
Rope	В	9.00	9.00	12.00	12.00	18.00	18.00	
Bottom Tying	Α	9.00	9.00	9.00	9.00	-	· -	
Rope	В	9.00	9.00	9.00	9.00	12.00	12.00	
Tensile Strength (kN/string)								
Neck Tying	A	<u>&gt;</u> 3.50	<u>&gt;</u> 3.50	<u>&gt;</u> 3.50	<u>&gt;</u> 3.50		-	
Rope	В	<u>&gt;</u> 3.50	<u>&gt; 3.50</u>	<u>&gt;</u> 3.50	<u>&gt;</u> 3.50	<u>&gt;</u> 3.50	<u>&gt;</u> 3.50	
Suspending	A	<u>≥</u> 12.00	<u>&gt; 12.00</u>	<u>&gt;</u> 22.00	<u>&gt;</u> 22.00	-		
Rope	В	<u>≥</u> 12.00	<u>&gt;</u> 12.00	<u>&gt;</u> 22.00	<u>&gt;</u> 22.00	<u>&gt;</u> 46.70	<u>&gt;</u> 46.70	
Bottom Tying	Α	<u>&gt;</u> 12.00	<u>&gt;</u> 12.00	<u>&gt;</u> 12.00	<u>&gt; 12.00</u>	-		
Rope	В	<u>≥ 12.00</u>	<u>&gt; 12.00</u>	<u>&gt; 12.00</u>	<u>&gt;</u> 12.00	<u>&gt;</u> 22.00	<u>&gt;</u> 22.00	
Elongation Rate (%)								
Neck Tying	A	<u>&lt;</u> 40%	<u>&lt;</u> 40%	<u>&lt;</u> 40%	<u>&lt;</u> 40%	-	-	
Rope	В	<u>&lt;</u> 40%	<u>&lt;</u> 40%	<u>&lt;</u> 40%	<u>≤</u> 40%	<u>&lt;</u> 40%	<u>&lt;</u> 40%	
Suspending	A	<u>&lt; 40%</u>	<u>&lt;</u> 40%	<u>&lt;</u> 40%	<u>&lt;</u> 40%		-	
Rope	В	<u>&lt;</u> 40%						
Bottom Tying	Α	<u>&lt;</u> 40%	<u>&lt;</u> 40%	<u>&lt;</u> 40%	<u>&lt;</u> 40%	-	-	
Rope	В	<u>&lt;</u> 40%						

Table 1714.8 – Rope Requirements

## **1714.2.10.2 Method of Tensile Test for the Rope**

The method of tensile test for the rope shall be as specified below. When the tensile strength and elongation of the material are verified, the test method which is equivalent or covering the following specifications shall be adopted.

- 1. The condition inside the laboratory shall be as discussed in Subsection 1714.2.9.2 (1), Method of Tensile Test for the Net Yarn.
- 2. The specimen for the test shall have sufficient length to take the effective length indicated in item number seven (7) below. It shall be stored in the laboratory under the above-mentioned ambient condition, until the difference of the mass of specimen becomes less than 0.3 percent from the one previously weighed one (1) hour or longer. The mass (kg) of the specimen shall then be recorded. Five (5) pieces of specimens shall be tested.
- 3. After weighing the mass (kg), both ends of the specimen shall be stretched, the specimen shall be on a plane, and its length (l<sub>1</sub>) shall be measured. Two marks at 30 cm or 50 cm interval shall be indicated in the middle part of the specimen, and the distance (d<sub>1</sub>) between these two (2) marks shall be measured.
- 4. The specimen shall be attached to a constant-rate-of-traverse type tensile tester, and the load shall be increased gradually. When the load reaches the initial load specified in Table 1714.9, increasing of the load shall then be stopped, and the distance (d<sub>2</sub>) between the two marks shall be measured.
- 5. The length of one (1) strand generated by twisting in unit of mm at three (3) locations shall be measured, and the obtained three (3) measurements shall be averaged.
- 6. The load again shall be increased gradually and continuously until the specimen rope breaks down. The speed shall be within 300 mm/min until the load reaches 50 percent of the specified tensile strength in Table 1714.9 and thereafter within 150 mm/min.
- 7. The effective length of the specimen, such as the inside distance between the clamps of tester, shall be 30 times or more than the nominal thickness. However, the specimen's length shall be limited to 0.5 m.
- 8. In case the specimen accidentally breaks in the hook and shows irregular values, test shall be repeated.
- 9. The highest and lowest values shall be recorded. The average of the five (5) results shall also be evaluated and this becomes the tensile strength.
- 10. During the test of the tensile strength, the distance between the two (2) marks placed in the middle part of the specimen shall be measured when the test load reaches 75 percent of the specified tensile strength of the rope. The elongation percentage shall be calculated by the following formula:

# Elongation percentage (%) = $\frac{d_3-d_2}{d_2} \times 100$

where,

- $d_2$ : Distance (cm) between Two (2) Marks on the specimen after Initial Loading.
- d<sub>3</sub> : Distance (cm) between Two (2) Marks Measured, When Test Load Reaches 75 percent of Specified Tensile Strength of Rope.

Thickness (mm)	Initial Load (N)	Tensile Strength (kN)
6	39	3.53
9	98	7.45
12	180	14.6

# Table 1714.9 – Test Criteria for Polyester Rope

# 1714.2.11 Filling Materials

Rocks used in gabions and mattresses shall consist of hard, durable rock pieces that will not deteriorate when submerged in water or exposed to severe weather conditions. Rock pieces shall be generally uniformly graded in sizes ranging from 100 mm to 200 mm. Filled gabions shall have a minimum density of 1,400 kg/m<sup>3</sup>. Voids shall be evenly distributed.

No rock size shall exceed 2/3 the mattress depth and at least 85 percent by weight of the stone shall have a size greater than 80 mm. No stone shall be able to pass through the mesh.

The filling materials for polyester net gabions shall either be cobble stones, rubbles, broken stones, concrete lumps or other filling materials as approved by the Engineer. The filling materials shall conform to the requirements shown in Table 1714.10.

Broporty	Tuno			We	ight		
Ргорегсу	Type	1ton	2 ton	3 ton	4 ton	6 ton	8 ton
Diamotor (mm)	A	50 - 190	50 - 190	50 - 190	50 - 190	-	-
Diameter (mm)	В	100 - 190	100 - 190	100 - 190	100 - 190	100 - 190	100 - 190

Table 1714.10 – Filling Materials Requirements

# 1714.2.12 Filter Fabric

The filter fabric material shall consist of non-woven filaments formed from plastic yarn of a long – chain synthetic polymer composed of at least 85 percent by weight polyolefin, or polyesters, and shall contain stabilizers and/or inhibitors added to the base plastic to make the filaments resistant to deterioration due to ultra violet light and heat exposure. After forming, the fabric shall be processed so that the filaments retain their relative positions with respect to each other. The fabric shall be free of defects or flaws which significantly affect its physical and/or filtering properties. The texture of the fabric shall be such that the gabion and foundation will remain in an equilibrium state and not slip or slide. The filter fabric shall be rot

proof, mildew proof, insect resistant and have a high dimensional stability when wet. The fabric shall also have good soil filtration characteristics, high resistance to tear propagation in all directions, and meet the following specifications:

	ASTM	Geotextile Property Requirements					
Geotextile Property	Test	Sepa	ration	Soil Sta	Soil Stabilization		
	Method	Woven	Nonwoven	Woven	Nonwoven		
AOS	D4751	No. 3	0 Max.	No. 4	0 Max.		
Water Permittivity	D4491	0.02 se	ec⁻¹ Min.	0.10 se	ec-1 Min.		
Grab Tensile Strength, in machine and x-machine direction	D4632	115 kg. Min.	75 kg. Min.	145 kg. Min.	92 kg. Min.		
Grab Failure Strain, in machine and x-machine direction	D4632	< 50%	≥ 50%	< 50%	≥ 50%		
Seam Breaking Strength	D4632	100 kg. Min.	65 kg. Min.	125 kg. Min.	80 kg. Min.		
Puncture Resistance	D6241	225 kg. Min.	140 kg. Min.	280 kg. Min.	195 kg. Min.		
Tear Strength, in machine and x-machine direction	D4533	35 kg. Min.	23 kg. Min.	50 kg. Min.	35 kg. Min.		
Ultraviolet (UV) Radiation Stability	D4355	50% strength retained Min., after 500 hours in xenon arc device					

# Table 1714.11 – Types of Geotextile for Filter Fabric

# **1714.3 Construction Requirements**

# 1714.3.1 Wire Mesh Gabions and Mattresses

# **1714.3.1.1** 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 conforming to the specified requirements. Gabions and bedding or specified geotextiles shall not be placed until the foundation preparation is completed, and the subgrade surfaces have been inspected and approved by the Engineer.

# 1714.3.1.2 Fabrication

1. Wire mesh gabions and mattresses shall be in the form of rectangular baskets of the required dimensions and shall be manufactured from wire as specified in Subsection 1714.2.2, Wire Mesh Gabions and Mattresses. Gabions shall be made of steel wire double twisted forming a uniform hexagonal mesh type 8 x 10 having a nominal mesh openings of 83 x 114 mm. Mattresses shall be made of steel wire double twisted forming a uniform hexagonal mesh type 6 x 8 having a nominal mesh openings of 64 x 83 mm. Tolerances

on the hexagonal, double-twisted wire mesh opening shall not exceed  $\pm 10$  percent on the nominal dimension D values, 64 mm for mattresses and 83 mm for gabions. The edges shall be formed into a securely connected selvedge adequate to prevent raveling.

Individual basket ties and connections shall be made by using a quantity of wire not less than 8 percent of the weight of each basket.

2. When the wire mesh gabion length exceeds its width, it shall have securely tied diaphragms connected at all edges to form individual cells of equal length and width.

Wire mesh gabions shall be fabricated in such a manner that the sides, ends, lids and diaphragms can be assembled at the construction site into rectangular baskets of the specified sizes. Wire mesh gabions shall be of single unit construction, base, lids, ends and sides shall be either woven into a single unit or one edge of these members connected to the base section of the gabion in such a manner that the strength and flexibility at the point of connection is at least equal to that of the mesh.

The wire mesh gabion shall be equally divided by diaphragms, placed at not more than one (1) m intervals, and of the same mesh and gauge as the body of the gabions, into cells the length of which does not exceed the horizontal 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 junction will be necessary.

3. Four (4) cross-connecting wires shall be provided in each cell having a height of one-half (1/2) the width or less, and eight (8) cross-connecting wires shall be provided in each cell having a height greater than one-half (1/2) the width.

All perimeter edge of the mesh forming the gabion shall be securely selvedged so that the joints, by tying the selvedges, have at least the same strength as the body of the mesh.

Selvedge wire used through all the edges (perimeter wire) shall not be less than 3.80 mm diameter and shall meet the same specifications as the wire mesh.

## 1714.3.1.3 Assembly and Construction

1. Wire mesh gabions shall be installed in a workmanlike manner. The gabions shall be placed on a smooth foundation. The final line and grade shall be approved by the Engineer.

Each wire mesh gabion unit shall be assembled by binding together all vertical edges with wire ties on approximately 152 mm spacing or by a continuous piece of connecting wire stitched around the vertical edges with a coil every 102 mm. Empty gabion units shall be set to line and grade as shown on the Plans or as described by the Engineer. Wire ties or connecting wires shall be used to join the units together in the same manner as described above for assembling. Internal tie wires shall be uniformly spaced and securely fastened in each cell of the structure.

A standard fence stretcher, chain fall, or iron rod may be used to stretch the wire baskets and hold alignment.

2. When possible the subgrade of the mattress and gabion shall be properly compacted to a depth of 150 mm. The Contractor shall consider the cost of subgrade preparation in the

unit prices. Filter fabric as beds of gabions and mattresses forming the structure shall be suitably leveled and shall be securely connected along the complete length of all contact edges by means of the above specified tying and connecting wire.

3. Before the filling material is placed, the wire mesh gabions and mattresses shall be carefully selected for uniformity of size, and the pieces shall be hand placed to provide a neat appearance as approved by the Engineer.

The vertical joints of gabions and mattress baskets shall be staggered as in running bond in brickwork.

- 4. The cells in any row shall be filled in stage so that local deformation may be avoided. That is at no time shall the cell be filled to a depth exceeding 300 mm more than the adjoining cell.
- 5. Filter fabric shall be placed between earth surface and gabion or mattress structures. Filter fabric shall be rolled out into a flat non-rutted surface free from sharp objects, weighing down the edges. Construction equipment shall not be allowed into unprotected fabric. Jointing is normally affected by overlapping not less than 300 mm, but it is preferable to joint by sewing or industrial stapling. Joint edges should be facing downwards to avoid protruding through the surface material.

## 1714.3.1.4 Filling Operation

The wire mesh gabions shall be carefully filled with rock, either by machine or hand methods, ensuring alignment, avoiding bulges, and providing a compact mass that minimizes voids. Machine placement will require supplementing with handwork to ensure the desired results. The cells in any row shall be filled in stages so that the depth of rock placed in any one (1) cell does not exceed the depth of rock in any adjoining cell by more than 304 mm. Along the exposed faces, the outer layer of stone shall be carefully placed and arranged by hand to ensure a neat, compact placement with a uniform appearance.

The last layer of rock shall be uniformly leveled to the top edges of the gabions. Lids shall be placed over the rock filling using only approved lid closing tools as necessary. The use of crowbars or other single point leverage bars for lid closing is prohibited due to the potential for damage to the baskets.

Any damage to the wire or coatings during assembly, placement and filling shall be repaired promptly in accordance with the manufacturer's recommendations or replaced with undamaged gabion baskets.

#### **1714.3.2 Polyester Net Gabions**

#### 1714.3.2.1 Delivery, Storage and Handling

All net bags and ropes shall be stored, immediately upon delivery at the project site. Provisions for storage shall be sufficient, clean and free from hazardous materials. Net bags shall not be stored or mixed with other construction materials. Delivery and handling shall be done in such a manner that no damage to polyester net gabions shall occur.

To avoid dropping the bag during the installation, the hook shall be detached after the polyester net gabions are placed at the designated locations. Polyester net bags and ropes shall be kept away from flammable materials/substances.

#### 1714.3.2.2 Equipment

The equipment for filling the polyester net gabion shall be a 128 HP hydraulic crawler backhoe with a capacity of one (1) cubic meter. A 25-tonner crawler crane shall be used for lifting the filled polyester net gabion to its designated location as shown on the drawing or as directed by the Engineer.

In case the general equipment is not suitable to the site conditions, alternative equipment shall be proposed by the Contractor depending on the site condition and approved by the Engineer prior to utilization.

#### 1714.3.2.3 Site Preparation

Clearing and grubbing shall be undertaken prior to placing of polyester net gabion. In underwater conditions such as rivers, debris and other unnecessary obstructions shall be removed prior to placement of polyester net gabion.

#### 1714.3.2.4 Filling and Tying

The neck tying structure of polyester net gabion shall have a shape that would not project a tying knot to outside of the net bag. Tying shall be done firmly and secured so as not to allow the filling materials to spread outside of the net while lifting, installing, placing, and arranging to the desired location, elevation, and alignment.

The net bag shall be fitted inside a cylindrical mold preferably made of a steel frame. The net bag shall be visually examined to confirm that there is no damage and shall be fixed completely and held firm on the mold. Then the filling materials shall be fed into the bag by a backhoe.

## 1714.3.2.5 Trial Section

At the first structure of polyester net gabions, the trial section shall be made with the close supervision by the Engineer to demonstrate the adequacy of the proposed working method. The demonstration section shall be at least 20 linear meters in the longitudinal length.

Within seven (7) days after completion of the trial section, the Engineer shall determine and approve the adequacy of the section. The trial section shall be treated as part of the permanent works as to the instruction of the Engineer. The trial section shall be removed if so determined by the Engineer.

#### 1714.3.2.6 Installation

After filling the net bag, the neck shall be tied up with a rope, the mold shall be opened and the net shall be hoisted and moved by crane on the desired location, elevation and alignment as provided in the drawing or as directed by the Engineer. Lifting ropes shall be arranged to have the same length so that the lifting load shall be divided evenly to each lifting rope. The quality of installation work of the polyester net gabion shall be confirmed with the shape of the polyester net gabion and the quantity of the consumed net bag as determined in the design and in accordance with the Plans.

The polyester net gabion shall take the following form after installation:

Property	Туре	Weight						
		1ton	2 ton	3 ton	4 ton	6 ton	8 ton	
Diameter (mm)	A	1600	2100	2300	2700	-	-	
	В	1700	2100	2400	2700	3300	3600	
Height (mm)	A	480	600	700	750	-	-	
	B	<u>550</u>	700	750	900	950	950	
Circumferential	A	320	350	400	420	-	-	
height (mm)	В	300	400	500	500	500	500	

Table 1714.12 – Dimension Requirement after Installation of Net Gabions

# **1714.4** Method of Measurement

The quantities to be paid for shall be the number of cubic meter of gabions and mattresses and the area of filter cloth completed and accepted.

Polyester net gabions shall be paid for each number of polyester net gabion in bag-filled materials installed and arranged properly as to the required location, elevation, and alignment shown on the drawings and as approved by the Engineer.

# 1714.5 Basis of Payment

Quantities determined as provided above shall be paid for at the appropriate contract unit price per unit of measurement for the Pay Item shown in the Bid Schedule, which price and payment shall constitute full compensation for all necessary excavation, subgrade preparation, for furnishing, placing polyester net gabions or placing wire baskets and fill materials and for all labor, equipment accessories, tools, and incidentals necessary to complete the Item.

Payment shall be made under:

Pay Item Number	Description	Unit of Measurement
1714 (1) a1	Gabions, 0.5m x 1m x 3m, Metallic Coated	Cubic Meter
1714 (1) a2	Gabions, 0.5m x 1m x 4m, Metallic Coated	Cubic Meter
1714 (1) a3	Gabions, 1m x 1m x 2m, Metallic Coated	Cubic Meter
1714 (1) a4	Gabions, 1m x 1m x 3m, Metallic Coated	Cubic Meter
1714 (1) a5	Gabions, 1m x 1m x 4m, Metallic Coated	Cubic Meter
1714 (1) a6	Gabions, 0.5m x 1m x 2m, Metallic Coated	Cubic Meter
1714 (1) b1	Gabions, 0.5m x 1m x 3m, PVC Coated	Cubic Meter
1714 (1) b2	Gabions, 0.5m x 1m x 4m, PVC Coated	Cubic Meter
1714 (1) b3	Gabions, 1m x 1m x 2m, PVC Coated	Cubic Meter
1714 (1) b4	Gabions, 1m x 1m x 3m, PVC Coated	Cubic Meter
1714 (1) b5	Gabions, 1m x 1m x 4m, PVC Coated	Cubic Meter

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Pay Item Number	Description	Unit of Measurement
1714 (1) b6	Gabions, 0.5m x 1m x 2m, PVC Coated	Cubic Meter
1714 (2) a1	Mattresses, 0.3m x 2m x 6m, Metallic Coated	Cubic Meter
1714 (2) a2	Mattresses, 0.3 x 2m x 6m, PVC Coated	Cubic Meter
1714 (3)	Filter Cloth	Square Meter
1714 (4) a1	Polyester Net Gabion, 1 tonne, Type I	Each
1714 (4) a2	Polyester Net Gabion, 2 tonnes, Type I	Each
1714 (4) a3	Polyester Net Gabion, 3 tonnes, Type I	Each
1714 (4) a4	Polyester Net Gabion, 4 tonnes, Type I	Each
1714 (4) b1	Polyester Net Gabion, 1 tonne, Type II	Each
1714 (4) b2	Polyester Net Gabion, 2 tonnes, Type II	Each
1714 (4) b3	Polyester Net Gabion, 3 tonnes, Type II	Each
1714 (4) b4	Polyester Net Gabion, 4 tonnes, Type II	Each
1714 (4) b5	Polyester Net Gabion, 5 tonnes, Type II	Each
1714 (4) b6	Polyester Net Gabion, 6 tonnes, Type II	Each

#### References:

- DPWH Standard Specifications for Public Works Structures (Buildings, Ports and Harbors, Flood Control and Drainage Structures and Water Supply Systems) Volume III, 1995 Edition
   Item 1404 – Filter Fabric and Aggregates
- 2. DPWH Standard Specifications for Public Highways, Bridges and Airports, Volume II, 2012 Edition
  Item 511 Gabions and Mattresses
- 3. https://www.astm.org
  - ASTM A 975
    - ASTM 974
- 4. www.permathene.com/documents/reference/installation/modular-gabions-inst.pdf
- 5. http://downloads.transportation.org/AASHTO\_Materials\_Standards\_by\_Standard\_Number.pdf
- 6. Department Order No. 143, Series of 2017, Revised Standardized Pay Items of Work for Civil Works Construction for Infrastructure Projects
- 7. http://ftp.dot.state.tx.us/pub/txdot-info/cmd/cserve/specs/2004/standard/s459.pdf
- 8. Construction Specification Wire Mesh Gabions and Mattresses