****

USACE / NAVFAC / AFCEC / NASA	**UFGS-31 36 00 (February 2021)**

Preparing Activity: USACE	**Superseding without Revision UFGS-31 36 00 (August 2008)**

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2021

****

SECTION TABLE OF CONTENTS

DIVISION 31 - EARTHWORK

SECTION 31 36 00

GABIONS

02/21

PART 1 GENERAL

1.1 SUMMARY
1.2 UNIT PRICES
1.2.1 Filter Material
1.2.1.1 Payment
1.2.1.2 Measurement
1.2.1.3 Unit of Measure
1.2.2 Gabion [and Mattress] Protection
1.2.2.1 Payment
1.2.2.2 Measurement
1.2.2.3 Unit of Measure
1.3 REFERENCES
1.4 DEFINITIONS
1.4.1 Rate of Aggressiveness
1.4.2 Double Twisted Wire Mesh Gabions[and Mattresses]
1.4.2.1 Style 1
1.4.2.1.1 Permanent
1.4.2.1.2 Temporary
1.4.2.2 Style 2
1.4.2.2.1 Permanent
1.4.2.2.2 Temporary
1.4.2.3 Style 3
1.4.2.4 Style 4
1.4.3 Welded Wire Fabric Gabions[and Mattresses]
1.4.3.1 Style 1
1.4.3.2 Style 2
1.4.3.3 Style 3
1.4.3.3.1 Permanent
1.4.3.3.2 Temporary
1.4.3.4 Style 4
1.4.3.5 Style 5
1.5 SUBMITTALS
1.6 QUALITY ASSURANCE
1.6.1 Samples
1.6.2 Test Report or Documents

1.7 DELIVERY, STORAGE, AND HANDLING

PART 2 PRODUCTS

2.1 MATERIALS
2.1.1 Double twisted wire mesh Gabions[and Mattresses]
2.1.1.1 Metallic Coating
2.1.1.2 PVC for Coating
2.1.1.2.1 Specific Gravity
2.1.1.2.2 Tensile Strength
2.1.1.2.3 Modulus of Elasticity
2.1.1.2.4 Hardness
2.1.1.2.5 Brittleness Temperature
2.1.1.2.6 Resistance to Abrasion
2.1.1.2.7 Salt Spray Exposure and Ultra Violet Light Exposure
2.1.1.2.8 Evaluation of Coating After Salt Spray and Ultraviolet Exposure Test
2.1.1.3 Wire Tensile Strength
2.1.1.4 Mesh Strength and Panel to Panel Joint Strength
2.1.2 Welded Wire Fabric Gabions[and Mattresses]
2.1.2.1 Metallic Coating
2.1.2.2 PVC for Coating
2.1.2.2.1 Adhesion
2.1.2.2.2 Mandrel Bend
2.1.2.2.3 Specific Gravity
2.1.2.2.4 Tensile Strength
2.1.2.2.5 Modulus of Elasticity
2.1.2.2.6 Hardness
2.1.2.2.7 Brittleness Temperature
2.1.2.2.8 Resistance to Abrasion
2.1.2.2.9 Salt Spray Exposure and Ultra Violet Light Exposure
2.1.2.2.10 Evaluation of Coating After Salt Spray and Ultraviolet Exposure Test
2.1.2.3 Wire Tensile strength
2.1.2.4 Weld Shear Strength
2.1.2.4.1 Minimum Average Shear Value
2.1.2.4.2 Panel to Panel Joint Strength
2.1.3 Alternative Wire Fasteners for Gabions[and Mattresses]
2.1.3.1 Ring Fasteners
2.1.3.1.1 Salt Spray Test
2.1.3.1.2 Pull-Apart Resistance Test
2.1.3.2 Spiral Binders
2.1.4 Testing
2.1.5 Stone Fill
2.1.5.1 General
2.1.5.1.1 Delivery
2.1.5.1.2 Sources
2.1.5.1.3 Properties
2.1.5.1.4 Non-Listed Source
2.1.5.2 Stone Quality
2.1.5.3 Gradation
2.1.5.3.1 Oversize Rock
2.1.5.3.2 Undersize Rock
2.1.6 Filter Material

PART 3 EXECUTION

3.1 FOUNDATION PREPARATION
3.2 FILTER PLACEMENT

3.3 ASSEMBLY
3.3.1 Double twisted wire mesh Gabions
3.3.2 Double Twisted Wire Mesh Revet Mattresses
3.3.3 Welded Wire Fabric Gabions[and Gabion Mattresses]
3.4 LACING OPERATIONS
3.4.1 Double Twisted Wire Mesh Gabions[and Mattresses]
3.4.1.1 Lacing Wire
3.4.1.2 Steel Wire Ring Fasteners
3.4.2 Welded Wire Mesh Gabions[and Mattresses]
3.5 INSTALLATION AND FILLING
3.5.1 Double Twisted Wire Mesh Gabions
3.5.2 Double Twisted Wire Mesh Revet Mattresses
3.5.3 Welded Wire Fabric Gabions
3.5.4 Welded Wire Fabric Gabion Mattresses
3.5.5 Non-Rectangular Shapes
3.6 CLOSING

ATTACHMENTS:

sources

-- End of Section Table of Contents --

****

USACE / NAVFAC / AFCEC / NASA	**UFGS-31 36 00 (February 2021)**

Preparing Activity: USACE	**Superseding without Revision UFGS-31 36 00 (August 2008)**

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2021
****

SECTION 31 36 00

GABIONS
02/21

****
NOTE: This guide specification covers the requirements for the procurement and installation of steel wire mesh gabion and mattress units used as a measure of protection against erosion forces of stream flow in water courses and slope instability. This section was originally developed for USACE Civil Works projects.

Adhere to UFC 1-300-02 Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR).
****

PART 1 GENERAL

1.1 SUMMARY

The work under this specification includes furnishing, assembling, filling and tying open wire mesh rectangular compartmented gabions [and mattresses] placed on a prepared surface of [filter material] [geotextile], [geotextile and filter materials], as specified, and in accordance with the lines, grades, and dimensions shown or otherwise established in the field.

a. Gabions[and mattresses] are wire mesh containers of variable sizes, uniformly partitioned into internal cells, interconnected with other similar units, and filled with stone at the project site to form

flexible, permeable, monolithic structures. Gabions[and mattresses] shall be manufactured with all components mechanically connected at the production facility with the exception of the mattress lid, which is produced separately from the base. The supply to the jobsite of unassembled individual wire mesh components (panels) forming gabions [and mattresses] will not be permitted.

b. Definitions of terms specific to this specification and to all materials furnished on the jobsite, with the exception of the rock to fill the baskets and the filter material, shall refer and be in compliance with ASTM A975 for double twisted wire mesh Gabions[and Revet mattresses], or with ASTM A974 for welded wire fabric Gabions[and Gabion Mattresses]. [For ease of reference, the term "mattress" will be used in this specification in place of Revet mattress and/or Gabion mattress, where the statement is of general nature and it is not specific to the double twisted or welded wire mesh products.]

1.2 UNIT PRICES

****

NOTE: For small projects, the district may opt to use lump sum payment.

Double twisted wire mesh gabions manufactured in SI (metric) units are different in size from those manufactured in English (inch-pound) units.

Sizes for double twisted wire mesh gabions and mattresses in SI (metric) units must refer to Tables 3 and 5 on ASTM A975. Sizes for double twisted wire mesh gabions and mattresses in English (inch-pound) units must refer to Tables 4 and 6 on ASTM A975. Sizes for welded wire mesh gabions and mattresses both in SI (metric) and English (inch-pound) units must refer to Table 1 on ASTM A974.

This note also applies to the subparagraphs below titled Unit of Measure.

****

1.2.1 Filter Material

1.2.1.1 Payment

Payment will be made for costs for filter material, including furnishing, hauling, placing, and maintenance of the filter layers until placement of the gabion [and mattress] cover is completed and accepted. No payment will be made for excess thickness of filter layers or for material required to replace material lost by rain wash, wind erosion, or otherwise, except for additional filter material ordered in writing.

1.2.1.2 Measurement

Filter material will be measured for payment based upon computations made from the theoretical filter thickness as specified or shown, and the areas acceptably placed where shown or staked in the field.

1.2.1.3 Unit of Measure

Unit of measure is cubic meter cubic yard.

1.2.2 Gabion [and Mattress] Protection

1.2.2.1 Payment

Payment will be made for costs associated with gabion [or mattress protection], including the costs of furnishing, assembling, and placing the wire baskets, the stone fill, and all other materials, labor, equipment, tools, supplies, and incidental costs in connection with completing this item of work.

1.2.2.2 Measurement

Gabions [or mattresses] meeting the requirements of these specifications and acceptably placed within the limits indicated on the drawings or otherwise established in the field, will be measured for payment by the cubic meter cubic yard of stone filled gabions [or mattresses] in place.

1.2.2.3 Unit of Measure

Unit of measure will be cubic meter cubic yard.

1.3 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ASTM INTERNATIONAL (ASTM)

ASTM A90/A90M	(2013; R 2018) Standard Test Method for Weight [Mass] of Coating on Iron and Steel Articles with Zinc or Zinc-Alloy Coatings
ASTM A313/A313M	(2017) Standard Specification for

	Stainless Steel Spring Wire
ASTM A370	(2020) Standard Test Methods and Definitions for Mechanical Testing of Steel Products
ASTM A428/A428M	(2010; R 2014) Standard Test Method for Weight (Mass) of Coating on Aluminum-Coated Iron or Steel Articles
ASTM A641/A641M	(2019) Standard Specification for Zinc-Coated (Galvanized) Carbon Steel Wire
ASTM A764	(2007; R 2017) Standard Specification for Metallic Coated Carbon Steel Wire, Coated at Size and Drawn to Size for Mechanical Springs
ASTM A809	(2008; R 2017) Standard Specification for Aluminum-Coated (Aluminized) Carbon Steel Wire
ASTM A853	(2019) Standard Specification for Steel Wire, Carbon, for General Use
ASTM A856/A856M	(2003; R 2020) Standard Specification for Zinc-5% Aluminum-Mischmetal Alloy-Coated Carbon Steel Wire
ASTM A974	(1997; R 2016) Standard Specification for Welded Wire Fabric Gabion and Gabion Mattresses (Metallic Coated or Polyvinyl Chloride (PVC) Coated)
ASTM A975	(2011; R 2016) 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)
ASTM B117	(2019) Standard Practice for Operating Salt Spray (Fog) Apparatus
ASTM C33/C33M	(2018) Standard Specification for Concrete Aggregates
ASTM C136/C136M	(2019) Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates
ASTM D412	(2016) Standard Test Methods for Vulcanized Rubber and Thermoplastic Elastomers - Tension
ASTM D638	(2014) Standard Test Method for Tensile Properties of Plastics
ASTM D746	(2014) Standard Test Method for Brittleness Temperature of Plastics and Elastomers by Impact

ASTM D792	(2013) Density and Specific Gravity (Relative Density) of Plastics by Displacement
ASTM D1499	(2013) Filtered Open-Flame Carbon-Arc Type Exposures of Plastics
ASTM D2240	(2015; E 2017) Standard Test Method for Rubber Property - Durometer Hardness
ASTM D5312/D5312M	(2012; R 2013) Evaluation of Durability of Rock for Erosion Control Under Freezing and Thawing Conditions
ASTM G152	(2013) Operating Open Flame Carbon Arc Light Apparatus for Exposure of Nonmetallic Materials

U.S. ARMY CORPS OF ENGINEERS (USACE)

COE CRD-C 144	(1992) Standard Test Method for Resistance of Rock to Freezing and Thawing

1.4 DEFINITIONS

1.4.1 Rate of Aggressiveness

The determination of the rate of aggressiveness (non-aggressive, moderately, or highly aggressive) shall be made on a project-to-project basis, due to the many variables involved and the lack of criteria of general validity. It is normally recommended for the choice to be based on all the available data and on the experience of existing gabion structures in similar environments.

1.4.2 Double Twisted Wire Mesh Gabions[and Mattresses]

Classified according to the wire coating, which is applied prior to manufacturing the mesh. Coating styles are as follows:

1.4.2.1 Style 1

Wire mesh made from wire which is zinc coated before being double twisted into mesh. Fasteners, lacing wire, and stiffeners are produced from zinc-coated wire. Style 1 for the wire coating is normally recommended for:

1.4.2.1.1 Permanent

Gabion[or mattress] structures, for works installed in non-aggressive or non-polluted environments, and this condition remains unaltered over time.

1.4.2.1.2 Temporary

Gabion[or mattress] structures, for works in moderately aggressive environments, depending on the minimum design life of the structure.

1.4.2.2 Style 2

Wire mesh made from wire which is coated with Zn-5Al-MM before being double twisted into mesh. Fasteners, lacing wire, and stiffeners are also produced from Zn-5Al-MM coated wire. Style 2 for the wire coating is normally recommended for:

1.4.2.2.1 Permanent

Gabion[or mattress] structures, for works installed in moderately aggressive environments.

1.4.2.2.2 Temporary

Gabion[or mattress] structures, for works in aggressive environments, depending on the minimum design life of the structure.

1.4.2.3 Style 3

Wire mesh, lacing wire, and stiffeners as Style 1 and overcoated with PVC. Fasteners shall be of stainless steel wire. Style 3 for the wire coating is normally recommended for both permanent and temporary gabion structures, for works installed in aggressive or polluted environments, or when the aggressiveness of the site is moderately unpredictable or variable from low to high.

1.4.2.4 Style 4

Wire mesh made from wire which is aluminum-coated before being double twisted into mesh. Fasteners, lacing wire, and stiffeners are also produced from aluminum-coated wire. Style 4 for the wire coating is very seldom used in the gabion industry. Its life expectancy shall be adequately documented to guarantee its consistency and reliability.

1.4.3 Welded Wire Fabric Gabions[and Mattresses]

Classified according to wire coating styles as follows:

1.4.3.1 Style 1

Welded wire fabric made from wire which is zinc coated before being welded into fabric. Spiral binders, lacing wire, and stiffeners are produced from zinc-coated wire. Style 1 for the wire coating is normally recommended for temporary gabion[or mattress] structures, for works in non-aggressive or non-polluted environments.

1.4.3.2 Style 2

Welded wire fabric which is made from uncoated wire and the fabric is subsequently zinc-coated after fabrication. Spiral binders, lacing wire, and stiffeners are produced from zinc-coated wire. Style 2 for the wire coating is normally recommended for permanent gabion[or mattress] structures, for works installed in non-aggressive or non-polluted environments, and this condition remains unchanged over time

1.4.3.3 Style 3

Welded wire fabric made from wire which is coated with zinc-5 percent aluminum-mischmetal alloy (Zn-5Al-MM) before being welded into fabric.

Spiral binders, lacing wire, and stiffeners are also produced from zinc-5 percent aluminum-mischmetal alloy (Zn-5Al-MM) coated wire. Style 3 for the wire coating is normally recommended for:

1.4.3.3.1 Permanent

Gabion[or mattress] structures, for works installed in moderately aggressive environments.

1.4.3.3.2 Temporary

Gabion[or mattress] structures, for works in aggressive environments, depending on the minimum design life of the structure.

1.4.3.4 Style 4

Welded wire fabric made from wire which is aluminum-coated before being welded into fabric. Spiral binders, lacing wire, and stiffeners are also produced from aluminum-coated (aluminized) wire. Style 4 for the wire coating is very seldom used in the gabion industry. Its life expectancy shall be adequately documented to guarantee its consistency and reliability.

1.4.3.5 Style 5

Welded wire fabric, spiral binders, lacing wire, and stiffeners as Styles 1, 2, 3, or 4, and overcoated with PVC. Style 5 for the wire coating is normally recommended for both permanent and temporary gabion structures, for works installed in aggressive or polluted environments, or when the aggressiveness of the site is moderately unpredictable or variable from low to high.

1.5 SUBMITTALS

****

NOTE: Review submittal description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a “G” to an item, if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy, Air Force, and NASA projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

Choose the first bracketed item for Navy, Air Force and NASA projects, or choose the second bracketed item for Army projects.

****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are [for Contractor Quality Control approval.][for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government.] Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-04 Samples

Gabions or Mattresses
Alternative Wire Fasteners

SD-06 Test Reports

Gabions or Mattresses
Alternative Wire Fasteners; G[, [_____]]

SD-07 Certificates

Stone Fill
Filter Material

1.6 QUALITY ASSURANCE

1.6.1 Samples

Furnish samples of materials used to fabricate the gabions or mattresses to the Contracting Officer 60 days prior to start of installation. Samples will be tested in accordance with specification and either ASTM A974 or ASTM A975 depending on which system is being furnished by the Contractor. The Government reserves the right to test additional samples to verify the submitted test records at the Government's expense. When the first test results indicate that the fasteners do not meet the specified requirements, the additional test will be at the Contractor's expense. The fasteners will be rejected after two tests failing to meet the requirements.

1.6.2 Test Report or Documents

Copies of all test results shall be furnished to the Technical Representative of this specification, USACE District, Vicksburg, 4155 Clay St., Vicksburg, MS 39183-3435, Attn: Dale Goss (ED-GI).

1.7 DELIVERY, STORAGE, AND HANDLING

****

NOTE: Delivery to the jobsite of unassembled units

will not be permitted, due to the increased labor and onsite supervision time, and to the fact that assembly is made on the jobsite and not in the quality-controlled manufacturer's facility.

Moreover, unassembled units delivered to the jobsite increase the likelihood to perform the construction by attaching units with a missing end panel rather than using entirely pre-assembled baskets. This will lower the structural integrity of the system, its strength at the connections and its overall resistance to the earth pressures.

It will be the responsibility of the manufacturer to guarantee that gabions are manufactured and delivered with all components mechanically attached, as required in ASTM A975 (Section 6.4) and ASTM A974 (Section 6.5).

****

Gabions[and mattresses] shall be delivered with all components mechanically connected at the production facility[with the exception of the mattress lid, which is produced separately from the base]. All gabions[and mattresses] are supplied in the collapsed form, either folded or bundled or rolled, for shipping. Bundles are banded together at the factory for ease of shipping and handling. [Mattress bases and lids may be packed in separate bundles].

a. Mattress lids may be supplied either as individual units (bundled) or in roll form. Lacing wire shall be shipped in coils with a diameter of the coil approximately 0.60 m 2 feet. Fasteners shall be shipped in boxes. Preformed stiffeners shall be shipped in bundles.

b. Deliver gabions[and mattresses] to the jobsite labeled in bundles. Labels show the dimensions of the gabions[or mattresses] included, the number of pieces and the color code.

PART 2 PRODUCTS

2.1 MATERIALS

****

NOTE: The use of the most appropriate Style for the wire coating in double twisted and welded wire gabions [and mattresses] is determined by the minimum required design life of the structure in relationship with the aggressiveness of the surrounding environment (air and water quality).

****

2.1.1 Double twisted wire mesh Gabions[and Mattresses]

Double twisted wire mesh gabions[and mattresses] shall be [Style 1], [Style 2], [Style 3], [and] [Style 4] manufactured with a non-raveling mesh made by twisting continuous pairs of wires through three half turns (commonly called double twisted) to form a hexagonal-shaped opening. Gabion [and mattress] sizes, wire diameters, mesh opening sizes, and tolerances shall comply with the requirements of ASTM A975 (Tables 1, 3, 4, 5, 6, and Sections 9). Gabions [and Mattresses] shall meet the

following test requirements:

2.1.1.1 Metallic Coating

The coating weights shall conform to the requirements of [ASTM A641/A641M, Class 3 (Style 1)], [ASTM A856/A856M (Style 2)], [ASTM A90/A90M] or [ASTM A428/A428M] as applicable, and [ASTM A809 (Style 4)].

2.1.1.2 PVC for Coating

The PVC coating shall show no cracks or breaks after the wires are twisted in the fabrication of the mesh. The initial properties of PVC coating material shall have a demonstrated ability to conform to the following requirements:

2.1.1.2.1 Specific Gravity

In the range from 1.30 to 1.35 dN/dm3, when tested in accordance with test method ASTM D792

2.1.1.2.2 Tensile Strength

Not less than 20.6 MPa 2985 psi when tested in accordance with test method ASTM D412

2.1.1.2.3 Modulus of Elasticity

Not less than 18.6 MPa 2700 psi when tested in accordance with test method ASTM D412

2.1.1.2.4 Hardness

Shore "D" between 50 and 60, when tested in accordance with test method ASTM D2240

2.1.1.2.5 Brittleness Temperature

Not higher than -9 degrees C 15 degrees F, or lower temperature when specified by the purchaser, when tested in accordance with test method ASTM D746.

2.1.1.2.6 Resistance to Abrasion

The percentage of the weight loss shall be less than 12 percent

2.1.1.2.7 Salt Spray Exposure and Ultra Violet Light Exposure

The PVC shall show no effect after 3,000 h of salt spray exposure in accordance with ASTM B117. The PVC shall show no effect of exposure to ultra violet light with test exposure of 3,000 h, using apparatus Spectral Irradiance of Open Flame Carbon Arc with Daylight Filters and 63 degrees C 145 degrees F, when tested in accordance with practice ASTM D1499 and ASTM G152

2.1.1.2.8 Evaluation of Coating After Salt Spray and Ultraviolet Exposure Test

After the salt spray test and exposure to ultraviolet light, the PVC coating shall not show cracks nor noticeable change of color, or blisters

or splits. In addition, the specific gravity, tensile strength, hardness and resistance to abrasion shall not change more than 6 percent, 25 percent, and 10 percent respectively, from their initial values.

2.1.1.3 Wire Tensile Strength

The tensile strength of the wire used for the double twisted mesh, lacing wire, and stiffener, when tested in accordance with Test Methods and definitions ASTM A370, shall be in accordance with the requirements of [ASTM A641/A641M (Style 1)], [ASTM A809 (Style 4)], and [ASTM A856/A856M (Style 2)], for soft temper wire.

2.1.1.4 Mesh Strength and Panel to Panel Joint Strength

The minimum strength requirements of the mesh, selvedge wire to mesh connection, panel to panel connection, and punch test, when tested in accordance with ASTM A975 Section 13.1, shall be as shown in Table 1. The strength values reported in kN/m lb/ft are referred to the unitary width of the specimen. The panel to panel test shall demonstrate the ability of the fastening system to achieve the required strength, and indicate the number of wire revolutions for the lacing wire or the ring spacing for ring fasteners used. The same number of wire revolutions or ring spacing shall be used in the field installation. Pleating the based panel to obtain internal panels is prohibited.

TABLE 1
Minimum Strength Requirements of Mesh and Connections

Test Description	Gabions, metallic coated	Gabions, PVC coated	[Revet mattresses] (metallic and PVC coated)
Tensile strength parallel to twist	51.1 kN/m3500 lb/ft	42.3 kN/m2900 lb/ft	33.6 kN/m2300 lb/ft
Tensile strength perpendicular to twist	26.3 kN/m1800 lb/ft	20.4 kN/m1400 lb/ft	13.1 kN/m900 lb/ft
Connection to selvedges	20.4 kN/m1400 lb/ft	17.5 kN/m1200 lb/ft	10.2 kN/m700 lb/ft
Panel to panel (using lacing wire or ring fasteners)	20.4 kN/m1400 lb/ft	17.5 kN/m1200 lb/ft	10.2 kN/m700 lb/ft
Punch Test	26.7 kN6000 lb	23.6 kN5300 lb	17.8 kN4000 lb

2.1.2 Welded Wire Fabric Gabions[and Mattresses]

Welded wire fabric gabions[and mattresses] shall be [Style 1], [Style 2], [Style 3], [Style 4], [and] [Style 5] manufactured with a welded wire mesh composed of a series of longitudinal and transverse steel wires arranged substantially at right angles to each other, and welded together at the points of intersection by electrical resistance welding to form fabricated sheets. Gabion [and mattress] sizes, wire diameters, mesh opening sizes, physical properties of the PVC for coating, and tolerances shall comply with the requirements of ASTM A974 (Tables 1, 2, 3, and Sections 9). Gabions [and Mattresses] shall meet the following test requirements:

2.1.2.1 Metallic Coating

The coating weights shall conform to the requirements of [ASTM A641/A641M, Class 3 (Style 1)], [ASTM A856/A856M (Style 2)], [ASTM A90/A90M] or [ASTM A428/A428M] as applicable, and [ASTM A809 (Style 4)].

2.1.2.2 PVC for Coating

PVC adhesion test shall be PVC coating shall show no cracks or breaks after the wires are twisted in the fabrication of the mesh. The initial properties of the PVC coating on the wire and welded wire fabric shall have a demonstrated ability to conform to the following requirements:

2.1.2.2.1 Adhesion

The PVC coating shall adhere to the wire such that the coating breaks rather than separates from the wire, in accordance with test method ASTM A974 Section 13.3;

2.1.2.2.2 Mandrel Bend

The PVC-coated wire when subjected to a single 360 bend at -18 degrees C 0 degrees F around a mandrel ten times the diameter of the wire, shall not exhibit breaks or cracks in the PVC coating;

2.1.2.2.3 Specific Gravity

In the range from 1.20 to 1.40 dN/dm3, when tested in accordance with test method ASTM D792;

2.1.2.2.4 Tensile Strength

Not less than 15.7 MPa 2275 psi when tested in accordance with test method ASTM D638;

2.1.2.2.5 Modulus of Elasticity

Not less than 13.7 MPa 1980 psi at 100 percent strain, when tested in accordance with test method ASTM D638;

2.1.2.2.6 Hardness

Shore "A" not less than 75, when tested in accordance with test method ASTM D2240;

2.1.2.2.7 Brittleness Temperature

Not higher than -9 degrees C 15 degrees F, or lower temperature when specified by the purchaser, when tested in accordance with test method ASTM D746.

2.1.2.2.8 Resistance to Abrasion

The percentage of the weight loss shall be less than 12 percent;

2.1.2.2.9 Salt Spray Exposure and Ultra Violet Light Exposure

The PVC shall show no effect after 3,000 h of salt spray exposure in accordance with ASTM B117. The PVC shall show no effect of exposure to

ultra violet light with test exposure of 3,000 h, using apparatus Spectral Irradiance of Open Flame Carbon Arc with Daylight Filters and 63 degrees C 145 degrees F, when tested in accordance with practice ASTM D1499 and ASTM G152;

2.1.2.2.10 Evaluation of Coating After Salt Spray and Ultraviolet Exposure Test

After the salt spray test and exposure to ultraviolet light, the PVC coating shall not show cracks nor noticeable change of color, or blisters or splits. In addition, the specific gravity, tensile strength, hardness and resistance to abrasion shall not change more than 6 percent, 25 percent, and 10 percent respectively, from their initial values.

2.1.2.3 Wire Tensile strength

The tensile strength of the wire used for the welded wire fabric, spiral binders, lacing wire and stiffeners shall be soft medium in accordance with ASTM A641/A641M (Style 1), ASTM A856/A856M (Style 3), and ASTM A809 (Style 4) or hand drawn in accordance with ASTM A853 (Style 2). The cross-sectional area of the test specimen shall be based on the diameter of the metallic coated wire. All the wires used in the fabrication of gabions [and mattresses] must use the same temper wire in accordance with given order.

2.1.2.4 Weld Shear Strength

2.1.2.4.1 Minimum Average Shear Value

The minimum average shear value in Newtons pounds-force shall be 70 percent of the breaking strength of the wire or as indicated in the table as follows, whichever is greater, when tested in accordance with ASTM A974 Section 13.4. Typical minimum average shear strengths as specified are as follows:

TABLE 2
Minimum average shear strength values for the welded mesh

Wire diameter mminch	Min. Av. Shear Strength Nlbs	Min. Shear Strength Nlbs
2.200.087	1300292	1000225
2.700.106	2100472	1600360
3.050.120	2600584	2000450

The material shall be deemed to conform with the requirements for weld shear strength if the average of the test results of the first four specimens or if the average of the test results for all welds tested comply with TABLE 2.

2.1.2.4.2 Panel to Panel Joint Strength

The minimum strength of the joined panels, when tested as described in ASTM A974 Section 13.5, shall be as follows:

TABLE 3 Panel to panel joint strength for welded gabions			
Test Description	Gabions, metallic coated (kN/mlb/ft)	Gabions, PVC coated (kN/mlb/ft)	[Revet mattresses] (metallic and PVC coated) (kN/mlb/ft)
Connection to selvedges	20.41400	17.51200	10.2700
Panel to panel (using lacing wire or ring fasteners	20.41400	17.51200	10.2700

The strength values reported in kN/m lb/ft are referred to the unitary width of the specimen. The panel to panel test shall demonstrate the ability of the fastening system to achieve the required strength, and indicate the number of wire revolutions for the lacing wire used. The same number of wire revolutions shall be used in the field installation.

2.1.3 Alternative Wire Fasteners for Gabions[and Mattresses]

****

NOTE: The use of steel rings is normally accepted in ASTM A975, for woven wire gabions and mattresses. Stainless steel rings will be used on PVC coated gabions or mattresses which meet the requirements of ASTM A313/A313M. Accepted alternative wire fasteners for welded wire gabions and mattresses are spiral binders, according to ASTM A974. The inclusion of rings for welded gabions is allowed only if proper guarantees over the pull apart, connection strength and long term durability (salt spray) are provided.

****

Subject to approval of the Contracting Officer, alternative fastening systems may be used in lieu of lacing wire. Alternative fasteners to lacing wire recommended for woven wire gabions and mattresses, according to ASTM A975, are steel ring fasteners for metallic coated gabions and mattresses, or stainless steel rings for PVC coated gabions and mattresses. For each shipment of wire gabions or mattresses delivered to the site, furnish the Contracting Officer, in duplicate, test reports or records that have been performed during the last year on all material contained within the shipment meets the composition, physical, and manufacturing requirements stated in this specification. Ring fasteners for woven wire gabions and mattresses shall comply with the minimum requirements indicated in paragraph Ring Fasteners below, and they shall develop a minimum panel to panel joint strength as indicated in TABLE 1. Alternative fasteners to lacing wire for welded wire gabions and mattresses, according to ASTM A974, are spiral binders. Spiral binders for welded wire gabions and mattresses shall comply with the minimum requirements indicated in paragraph Spiral Binders below. Ring fasteners may alternatively be used for welded wire gabions or mattresses, provided that they comply with the minimum specified requirements (salt spray and pull-apart resistance). Connections panel to panel for welded gabions and mattresses with ring fasteners shall develop a minimum joint strength as indicated in TABLE 3. Provide a complete description of the fastener system and a description of a properly installed fastener, including drawings or photographs if necessary. Provide test results that demonstrate that the alternative-fastening system meets the requirements of the specifications, according to the following criteria:

a. That the proposed fastener system can consistently produce a panel to panel joint strength as indicated in the TABLE 1 for double twisted wire mesh gabions and TABLE 3 for welded wire mesh gabions;

b. That the proposed fastener system does not cause damage to the protective coating on the wire;

c. That the Contractor has the proper equipment and trained employees to correctly install the fasteners;

d. That proper installation can be readily verified by visual inspection.

Samples of wire fasteners with their certified test records shall be submitted at least 60 days in advance to the Contracting Officer for approval. The Government reserves the right to test additional samples to verify the submitted test records at the Government's expense. When the first test results indicate that the fasteners do not meet the specified requirements, the additional test will be at the Contractor's expense. The fasteners will be rejected after two tests failing to meet the requirements.

2.1.3.1 Ring Fasteners

The tensile strength of the zinc-coated steel wire, zinc-5 percent aluminum coated mischmetal alloy-coated steel wire and aluminum-coated steel wire used for fasteners shall be in accordance with the requirements of ASTM A764, Type A, B, or C, Table 2 or Table 3. The tensile strength of stainless steel wire used for fasteners shall be in accordance with the requirements of ASTM A313/A313M, Type 302, Table 2. Any fastener system shall give the number of fasteners required to comply with TABLE 1, in accordance with ASTM A975 (Section 13.1.2) for woven wire gabions and mattresses, and TABLE 3, in accordance with ASTM A974 (Section 7.3), for welded wire gabions and mattresses. Ring fasteners shall not be installed more than 100 mm 4 inches apart. Each fastener type shall be closed and the free ends of the fastener shall overlap a minimum of 25 mm 1 inch. The manufacturer or supplier shall state the number of fasteners required for all vertical and horizontal connections for single and multiple basket joining. Approved ring fasteners including fasteners made of stainless steel shall be subject to the salt spray test and pull-apart resistance test and shall be documented by actual testing of panel to panel connections within the last year by validated laboratories.

2.1.3.1.1 Salt Spray Test

A set of two identical rectangular gabion panels, each with a width about 10-1/2 mesh openings along a selvedge wire, shall be joined by properly installed wire fasteners along the two selvedge wires so that each fastener confines two selvedge and two mesh wires. If the fasteners are also to be used to joint two individual empty gabion baskets, two additional selvedge wires which are each mechanically wrapped with mesh wires shall be included so that each fastener confines four selvedge and four mesh wires. The set of the jointed panels shall be subject to salt spray test, ASTM B117, for a period of not less than 48 hours. At the end of the test, the fasteners, the selvedge, or mesh wires confined by the fasteners shall show no rusty spots on any part of the surface excluding the cut ends. A properly installed fastener shall meet the following requirements:

a. Each interlocking fastener shall be in a locked and closed position.

b. Each ring fastener shall be closed, and the free ends of the fastener shall overlap a minimum of 25 mm 1 inch.

2.1.3.1.2 Pull-Apart Resistance Test

A new set of the jointed panels, which are prepared by the same method as specified in the salt spray test but without being subject to the 48-hour salt spray test, shall be mounted on a loading machine with grips or clamps such that the panels are uniformly secured along the full width. The grips or clamps shall be designed to transmit only tension forces. The load will then be applied at a uniform rate of 220 N/s 50 lbs/sec until failure occurs. The failure is defined as when the maximum load is reached and a drop of strength is observed with subsequent loading or the opening between any two closest selvedge wires, applicable to a fastener confining either two or four selvedge wires, becomes greater than 50 mm 2 inches at any place along the panel width. The strength of the jointed panels at failure shall have a minimum as indicated in TABLE 1 or TABLE 3.

2.1.3.2 Spiral Binders

Spiral binders are defined as a length of metallic coated steel wire or metallic coated steel wire with PVC coating preformed into a spiral, used to assemble and interconnect empty gabion and/or mattress units, and to close and secure stone-filled units. Spiral binders shall be fabricated with the same wire and coating style as the wire mesh. Test requirements for spiral binders shall refer to TABLE 3 regarding Metallic Coating, PVC for coating, Tensile Strength, and Panel to Panel Joint Strength.

.2.1.4 Testing

Test records made within one year by certified laboratories and Government agencies will be used to determine the acceptability of the fastening system. Samples of wire fasteners and samples of material for fabricating the gabions and mattresses with their certified test records shall be submitted at least 60 days in advance to the Contracting Officer for approval. The Government reserves the right to test additional samples to verify the submitted test records at the Government's expense. When the first test results indicate that the fasteners do not meet the specified requirements, the additional test will be at the Contractor's expense. The fasteners will be rejected after two tests failing to meet the requirements.

2.1.5 Stone Fill

Submit a certificate or affidavit signed by a legally authorized official of the supplier of the stone fill and the supplier of the natural filter material (se next main paragraph below) that it meets the quality required and gradation limits specified.

2.1.5.1 General

****

NOTE: Stones having a lower unit (not less than 2240 kg/m3 140 lb/ft3) may be approved by the Contracting Officer, provided that the design is performed on the selected unit weight and the stone has a performance record to prove its durability.

If stone sources are not listed in the bid documents, the District must ensure that these sources contain stone with required quality and quantity. It is the Contractor's responsibility to determine that the selected source is capable of supplying the quantities and gradation needed and at the rate needed. Acceptance of a source of stone does not imply acceptance of all material from the source, when such materials are unsuitable as determined by the Contracting Officer.
****

For gabions[and mattresses], the ability to function properly depends upon their stability, which is partly depending upon the rocks filling them. Rock sizes should be chosen to prevent them from falling through the mesh of the gabions [or mattresses]. The rock has also to withstand natural weathering processes during the life of the project that would cause it to breakdown to sizes smaller than the wire mesh opening dimensions. Rock to fill gabions[and mattresses] shall be durable and of suitable quality to ensure permanence in the structure and climate in which it is to be used.

2.1.5.1.1 Delivery

Deliver rock to the work site in a manner to minimize its reduction in sizes (breakdown) during the handling of the rock, and place and secure within the assembled and interconnected gabion[or mattress].

2.1.5.1.2 Sources

The sources from which the Contractor proposes to obtain the material shall be selected well in advance of the time when the material will be required in the work. The inclusion of more than 5 percent by weight of dirt, sand, clay, and rock fines will not be permitted. Rock may be of a natural deposit of the required sizes, or may be crushed rock produced by any suitable method and by the use of any device that yields the required size limits chosen in TABLE 4.

2.1.5.1.3 Properties

Rocks shall be 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. [Selected stone from the required excavation may be used if satisfying all requirements as to quality and dimensions.] [All stone shall be obtained from one of the [sources listed below][sources listed at the end of this section]].

2.1.5.1.4 Non-Listed Source

As an option, propose to furnish stone from one non-listed source. The Government [will][may] make such investigations and tests as necessary to determine whether acceptable stone can be produced from the proposed source. Suitable samples of stone fill material shall be collected in the presence of a Government representative and submitted to the Contracting Officer for approval prior to delivery of any such material to the work site. Unless otherwise specified, all test samples shall be obtained and delivered at the Contractor's expense to [_____] at least 60 days in advance of the time when placing of the stone-filled gabions [or

mattresses] is expected to begin. Suitable tests and/or service records will be used to determine the acceptability of the stone. In the event suitable test reports and service records are not available, as in the case of newly operated sources, the material may be subjected to petrography analysis, specific gravity, absorption, wetting and drying, freezing and thawing, and such other tests as may be considered necessary to demonstrate to the satisfaction of the Contracting Officer that the materials are acceptable for use in the work. All tests will be made by or under the supervision of the Government and at its expense.

2.1.5.2 Stone Quality

Stone fill, crushed stone, shall meet the quality requirements of ASTM C33/C33M, and freezing and thawing requirements of [ASTM D5312/D5312M][COE CRD-C 144] for the region of the United States in which the structure will be constructed.

2.1.5.3 Gradation

Gradation of stone for gabions shall be performed every 1000 tons placed under this contract in accordance with ASTM C136/C136M. Sizes of rock to fill gabions and mattresses are chosen on the basis of the mesh sizes, the structure's thickness, and within the limits shown in TABLE 4. Within each range of sizes, the rock shall be large enough to prevent individual pieces from passing through the mesh openings. Each range of sizes may allow for a variation of 5 percent oversize rock by weight, or 5 percent undersize rock by weight, or both.

2.1.5.3.1 Oversize Rock

In all cases, the sizes of any oversize rock shall allow for the placement of three or more layers of rock within each gabion compartment[and two or more layers of rock within each mattress compartment dependent upon the height of the mattress].

2.1.5.3.2 Undersize Rock

In all cases, undersize rock shall be placed within the interior of the gabion or mattress compartment and shall not be placed on the exposed surface of the structure. There shall be a maximum limit of 5 percent undersize or 5 percent oversize rock, or both, within each gabion[or mattress] compartment. The required rock gradation is reported in Table 4.

TABLE 4
Required rock gradation for gabions [and mattresses]

Type of Structure	Thickness/Height (mminch	Rock Sizes (mminch)
[Mattresses]	1706	75 - 1303 - 5
[Mattresses]	2309	75 - 1303 - 5
[Mattresses or] Gabions	30012	100 - 2004 - 8
Gabions	500 18 or higher	100 - 2004 - 8

2.1.6 Filter Material

****

NOTE: When a filter layer is required beneath the gabion or mattress foundation, care must be taken to ensure that the minimum thickness is achieved evenly across the surface to be protected. To assure sufficient relative permeability and drainage, to prevent the migration of slope materials into the filter layer, and for the retention of filter materials by the overlying gabion units, the particle size distribution of the filter material should conform to "Filter Design," Appendix E of EM 1110-2-1913."

Stone-filled units have a potential for becoming impermeable. For extreme cases of long protected slope distances, or any application where large volumes of seepage or captured runoff is anticipated, design consideration should be given to the carrying capacity of the filter material and the need for providing pipe drains through the gabion units.

Although the provision of a pervious filter layer beneath gabion slope protection is preferred, particularly for slopes steeper than 1V on 2H, construction economy may be achieved in some cases through the use of geotextile. The specifications for the geotextile should be in accordance with the instructions contained in Section 31 05 19.13 GEOTEXTILES FOR EARTHWORK.

****

The material shall meet the quality requirements of ASTM C33/C33M for the region in which the structure is located. The gradation test shall be performed in accordance with ASTM C136/C136M. Filter material shall consist of sand and gravel or crushed stone, well graded between the prescribed limits listed below.

[

Sieve Designations US Standard Square Mesh	Percent By Weight Passing
[_____]	[_____]

]

[Filter fabrics shall meet the provisions of Section 31 05 19.13 GEOTEXTILES FOR EARTHWORK].

PART 3 EXECUTION

3.1 FOUNDATION PREPARATION

Foundation preparation [may][shall not] take place on frozen or snow-covered ground. After excavation or stripping, to the extent indicated on the drawings or as directed by the Contracting Officer, all remaining loose or otherwise unsuitable materials shall be removed. All depressions shall be carefully backfilled to grade. If pervious materials are encountered in the foundation depressions, the areas shall be backfilled with free-draining materials. Otherwise, the depressions shall

be backfilled with suitable materials from adjacent required excavation, or other approved source, and compacted to a density at least equal to that of the adjacent foundation. Any debris that will impede the proper installation and final appearance of the gabion layer shall also be removed, and the voids carefully backfilled and compacted as specified above. Immediately prior to placing the material, the Contracting Officer shall inspect the prepared foundation surface, and no material shall be placed thereon until that area has been approved.

3.2 FILTER PLACEMENT

Filter material shall be spread uniformly on the prepared foundation surface in a manner satisfactory to the Contracting Officer, and to the slopes, lines, and grades as indicated on the drawings or as directed. Placing of filter material by methods, which will tend to segregate particle sizes, will not be permitted. Any damage to the foundation surface during the filter placement shall be repaired before proceeding with the work. Compaction of the filter materials will not be required, but it shall be finished to present a reasonably even surface free from mounds or windrows.

3.3 ASSEMBLY

3.3.1 Double twisted wire mesh Gabions

The gabions shall be opened and unfolded one by one on a flat, hard surface. Gabion units over 1.82 m 6 foot in length usually have an extra shipping fold, which must be removed. The sides, ends and diaphragms shall be lifted up into a vertical position to form an open box shape. The back and the front panels of the gabion shall be connected to the end panels and center diaphragms. The top corner of the end panels and center diaphragms have a selvedge wire extending approximately 100 mm 4 inches out from the corner edge. The end panels and the diaphragms shall be raised to a vertical position and the selvedge wire shall be wrapped around the edge wire of the top and back panels.

[3.3.2 Double Twisted Wire Mesh Revet Mattresses

****
NOTE: Remove this paragraph if not needed.
****

The mattress shall be laid on a flat, hard surface. When the units are unfolded for assembly, depending on their length, they will have one or two shipping folds, which must be removed. The double flap of the side panel shall be folded in and wired to the diaphragm. At the corners, the end flaps shall be folded along the sides and the joint laced up. Each Revet mattress shall be assembled individually, by erecting the sides, ends and diaphragms, ensuring that all creases are in the correct position and the tops of all sides are level.

]3.3.3 Welded Wire Fabric Gabions[and Gabion Mattresses]

The gabions[or gabion mattresses] shall be opened and unfolded on a flat, hard surface. The units shall be rotated into position and the edges joined with fasteners for assembly. Where spiral fasteners are used, the ends shall be crimped to secure them in place. Where lacing wire is used, the wire shall be wrapped with alternating double and single loops with spacings not to exceed 150 mm 6 inches. Ends shall be secured with two

complete revolutions and finished with a one-half hitch. The same fastening procedures shall be used to secure interior diaphragms and end panels. When two gabions are placed side by side, the two end panels may be connected along the vertical edges with a single spiral fastener.

3.4 LACING OPERATIONS

3.4.1 Double Twisted Wire Mesh Gabions[and Mattresses]

Either lacing wire or ring fasteners are permitted to lace double twisted wire mesh gabions[or revet mattresses].

3.4.1.1 Lacing Wire

When using lacing wire, a piece of wire 1.2 to 1.5 times the length of the edge to be laced shall be cut off. If the edge of the basket is 0.91 m 3 foot long, no more than 1.2 to 1.5 m 4 to 5 feet of wire should be used at a time to lace. For vertical joints, starting at the bottom end of the panel, the lacing wire shall be twisted and wrapped two times around the bottom selvedge and double and single loops shall be alternated through at intervals not bigger than 100 to 150 mm 4 to 6 inches. The operation shall be finished by looping around the top selvedge wire. The use of pliers to assemble the units with lacing wire is normally recommended.

3.4.1.2 Steel Wire Ring Fasteners

When steel wire ring fasteners are used, the rings shall be installed at the top and bottom connections of the end and center diaphragms. The ring spacing shall be based on the minimum pull apart strength as specified in TABLE 1. In any case, the maximum ring spacing along the edges shall not exceed 0.15 m 6 inches. The use of either a mechanical or a pneumatic fastening tool for steel wire ring fasteners is required. Ring fasteners shall be galvanized, stainless steel or Zn-5 percent aluminum-mischmetal alloy coated.

3.4.2 Welded Wire Mesh Gabions[and Mattresses]

Either lacing wire or spiral binders are permitted to lace welded wire mesh gabions[or gabion mattresses]. The empty units shall be placed on the foundation and interconnected with the adjacent unit along the top, bottom and vertical edges using spiral fasteners. Lacing wire may be used in lieu of spiral binders for the interconnection of gabions[or mattresses] as specified above. The connection with lacing wire or spiral binders shall be based on the minimum panel to panel joint strength as specified in TABLE 3. Spiral binders shall be screwed along the connecting edges, and then each end crimped to secure the spiral in place. Each layer of gabions[or mattresses] shall be interconnected to the underlying layer along the front, back and sides.

3.5 INSTALLATION AND FILLING

Empty gabion[and mattress] units shall be assembled individually and placed on the approved surface to the lines and grades as shown or as directed, with the sides, ends, and diaphragms erected in such a manner to ensure the correct position of all creases and that the tops of all sides are level. All gabion units shall be properly staggered [horizontally][and vertically] as shown in the construction drawings. Finished gabion[or mattress] structures shall have no gaps along the perimeter of the contact surfaces between adjoining units. All adjoining empty gabion

units shall be connected along the perimeter of their contact surfaces in order to obtain a monolithic structure. All lacing wire terminals shall be securely fastened. All joining shall be made through selvedge-to-selvedge or selvedge-to-edge wire connection; mesh-to-mesh or selvedge-to-mesh wire connection is prohibited except in the case where baskets are offset or stacked and selvedge-to-mesh or mesh-to-mesh wire connection would be necessary. As a minimum, a fastener shall be installed at each mesh opening at the location where mesh wire meets selvedge or edge wire.

a. The initial line of basket units shall be placed on the prepared [filter layer surface][foundation] and adjoining empty baskets set to line and grade, and common sides with adjacent units thoroughly laced or fastened. They shall be placed in a manner to remove any kinks from the mesh and to a uniform alignment. The basket units then shall be partially filled to provide anchorage against deformation and displacement during the filling operation. The stone shall be placed in the units as specified in paragraph Stone Fill, subparagraph Gradation, part b.

b. Undue deformation and bulging of the mesh shall be corrected prior to further stone filling. Care shall be taken, when placing the stone by hand or machine, to assure that the PVC coating on gabions will not be damaged. All visible faces shall be filled with some hand placement to ensure a neat and compact appearance and that the void ratio is kept to a minimum.

c. Uniformly overfill gabions [and mattresses] by about 25 to 50 mm 1 to 2 inches to compensate for future rock settlements. Gabions [and mattresses] can be filled by any kind of earth-filling equipment, such as a backhoe, gradall, crane, etc. The maximum height from which the stones may be dropped into the baskets shall be 0.91 to 1.20 m 3 to 4 feet. If PVC coated materials are used, no work shall take place unless the ambient temperature is above -7 degrees C 20 degrees F.

3.5.1 Double Twisted Wire Mesh Gabions

After the foundation has been prepared, the pre-assembled gabions shall be placed in their proper location to form the structure. Gabions shall be connected together and aligned before filling the baskets with rock. All connections (panel-to-panel) and basket-to-basket shall be already carried out as described in paragraph ASSEMBLY. Stone fill shall have a gradation of 0.10 to 0.20 m 4 to 8 inches, as described in paragraph Gradation, and shall be placed in 0.30 m 1 foot lifts. Cells shall be filled to a depth not exceeding 0.30 m 1 foot at a time. The fill layer should never be more than 0.30 m 1 foot higher than any adjoining cell. Stiffeners or internal cross ties shall be installed in all front and side of the gabions at 1/3 and 2/3 of the height for 0.91 m 3 feet or higher gabions, as the cell is being filled. Stiffeners shall be installed in the center of the cells. In 0.46 m 1.5 foot high units, stiffeners or internal crossties are not required. Internal cross ties, or alternatively the preformed stiffeners, shall be looped around three twisted wire mesh openings at each basket face and the wire terminals shall be securely twisted to prevent their loosening. The number of voids shall be minimized by using a well-graded stone in order to achieve a dense, compact stone fill. All corners shall be securely connected to the neighboring baskets of the same layer before filling the units. When more than one layer of gabions is required, in order for the individual units to become incorporated into one continuous structure, the next layer of

gabions shall be connected to the layer underneath after this layer has been securely closed. Gabions shall be uniformly overfilled by about 25 to 50 mm 1 to 2 inches to compensate for future rock settlements.

[3.5.2 Double Twisted Wire Mesh Revet Mattresses

****
NOTE: Remove this paragraph if not needed.
****

After being assembled, the revet mattresses shall be placed in their proper location and securely attached to the adjacent units. For structural integrity, all adjoining empty units shall be connected by means of lacing wire or ring fasteners along the edges of their contact surfaces in order to form a monolithic structure. Revet mattresses shall be placed and securely connected while empty. The filling shall be done unit by unit; however, several units can be pre-assembled prior to filling the units. Revet mattress units shall be filled with hard, durable, clean stone having a gradation as indicated in paragraph Gradation. Care shall be taken to ensure that diaphragm tops are accessible for wiring. On slopes, the Revet mattress shall be laid with the 1.83 m 6 foot dimension (width) longitudinally to the slope and progressing up the slope, except for small ditches or where otherwise specified in the project. When the installation is performed on a slope, the filling of the baskets shall start from the lower side of the bank. Where Revet mattresses are to be placed on steep slopes (3H to 2V), the units shall be secured by hardwood pegs driven into the ground just below the upper end panel, at 1.83 m 6 foot centers, or as specified in the project. When the Revet mattress is to be placed over a geotextile, care shall be taken to ensure that any projecting ends of wire are bent upward to avoid puncturing or tearing the cloth. Lids shall be securely connected to the ends of the mattress and to the top sides and diaphragms using alternate double and single loops, or steel wire ring fasteners, as indicated in paragraph FOUNDATION PREPARATION. In case that more adjacent bases are to be covered at one time, mesh rolls shall be used in place of unit size lids. Revet mattresses shall be uniformly overfilled by about 25 to 50 mm 1 to 2 inches to compensate for future rock settlements.

]3.5.3 Welded Wire Fabric Gabions

After the foundation has been leveled, the assembled gabions shall be placed in their proper location to form the structure. Care shall be taken to ensure that the top of the diaphragms are aligned correctly. The diaphragms shall be securely connected by either spiral binders or lacing wire. Gabions shall be connected together and aligned before filling them with 100 to 200 mm 4 to 8 inch diameter rocks. Rock filling material shall be as specified in paragraph Gradation and shall be placed in 0.30 m 1 foot lifts. The fill layer shall be carefully hand-packed and braced to prevent bulging. Stiffeners shall be provided every 0.30 m 12 inch levels for 0.91 m 3 foot or higher gabions. Stiffeners shall be formed from lacing wire and placed across the corners at 0.30 m 12 inches from the corner, providing a diagonal bracing. Preformed hooked stiffeners can be utilized. Care shall be taken to ensure the number of voids is minimized by using a well-graded stone and avoiding large rocks in order to achieve a dense, compact compartment. After each 0.30 m 1 foot lift has been placed, it shall be leveled for the next lift. Almost all gabion structures consist of more than one course of gabions; in order that the individual gabions may become incorporated into one continuous structure, they shall be wired to neighboring gabions and the course below, before

filling. Gabions shall be uniformly overfilled by about 25 to 50 mm 1 to 2 inches to compensate for future rock settlements.

[3.5.4 Welded Wire Fabric Gabion Mattresses

****
NOTE: Remove this paragraph if not needed.
****

After being assembled, the Gabion mattresses shall be placed in their proper location and securely attached to the adjacent units. For structural integrity, all adjoining empty units shall be connected by means of lacing wire or spiral binders along the edges of their contact surfaces in order to form a monolithic structure. Gabion mattresses shall be placed and securely connected while empty. The filling shall be done unit by unit; however, it is recommended that several units be pre-assembled prior to filling the units. Gabion mattress units shall be filled with hard, durable, clean stone having a gradation as indicated in paragraph Gradation. Care shall be taken to ensure that diaphragm tops are accessible for wiring.

a. On slopes, the Gabion mattress shall be laid with the 1.83 m 6 foot dimension (width) longitudinal to the bank, with the exception of small ditches or when otherwise specified in project. When the installation is performed on a slope, the filling of the units shall start from the lower side of the bank. Where Gabion mattresses are to be placed on steep slopes (3H to 2V), the units shall be secured by galvanized pipes driven into the ground inside the upper end panel, at 1.83 m 6 foot centers, or as specified in the project.

b. When the Gabion mattress is to be placed over a geotextile, care shall be taken to ensure that any projecting ends of wire are bent upward to avoid puncturing or tearing the cloth.

c. Lids shall be securely connected to the ends of the mattress and to the sides and diaphragms using alternate double and single loops, or steel wire ring fasteners, as indicated in paragraph FOUNDATION PREPARATION. In case that more adjacent bases are to be covered at one time, mesh rolls can be used in place of unit size lids. Gabions mattresses shall be uniformly overfilled by about 25 to 50 mm 1 to 2 inches to compensate for future rock settlements.

]3.5.5 Non-Rectangular Shapes

Gabion[and mattress] units can conform to bends up to a radius of curvature of 18 to 21 m 60 to 70 feet without alterations. Units shall be securely connected together first, and be placed to the required curvature, holding them in position by staking the units to the ground with hardwood pegs before filling. For other shapes, bevels and miters can be easily formed by cutting and folding the panels to the required angles.

3.6 CLOSING

Lids shall be tightly secured along all edges, ends and diaphragms in the same manner as described for assembling. Adjacent lids may be securely attached simultaneously. The panel edges shall be pulled to be connected using the appropriate closing tools where necessary. Single point leverage tools, such as crowbars, may damage the wire mesh and shall not

be used. All end wires shall then be turned in.

-- End of Section --