

इंटरनेट

मानक

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“The Right to Information, The Right to Live”

“पुराने को छोड़ नये के तरफ”

Jawaharlal Nehru

“Step Out From the Old to the New”

IS 16013 (2012): Welded Wire Gabions (metallic-coated or metallic-coated with PVC coating) Specification [MED 10: Wire Ropes and Wire Products]



“ज्ञान से एक नये भारत का निर्माण”

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“ज्ञान एक ऐसा खजाना है जो कभी चुराया नहीं जा सकता है”

Bhartrhari—Nitiśatakam

“Knowledge is such a treasure which cannot be stolen”

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भारतीय मानक

वैलिडड तार गैबियन (धातु चढी या धातु चढीत
पी वी सी चढी) — विशिष्टि

Indian Standard

WELDED WIRE GABIONS
(METALLIC-COATED OR METALLIC-COATED WITH
PVC COATING) — SPECIFICATION

ICS 25.220.99;77.140.65

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BUREAU OF INDIAN STANDARDS
MANAK BHAVAN, 9 BAHADUR SHAH ZAFAR MARG
NEW DELHI 110002

FOREWORD

This Indian Standard was adopted by the Bureau of Indian Standards, after the draft finalized by the Wire Ropes and Wire Products Sectional Committee had been approved by the Mechanical Engineering Division Council.

Gabions are widely used to protect land from erosion, channel lining, construction of earth retaining structures, etc. It was therefore felt necessary to develop an Indian Standard on gabions and gabion mattresses due to large use of the item for protection against land erosion. Gabions and gabion mattresses can be either welded wire fabric or, may be mechanically twisted wire gabions. This standard deals with gabions and gabion mattresses made out of metallic coated welded wire fabric.

Since the product is being used for hilly area, river beds forest area as well as near sea beds for protection of land and minimize land erosion, this standard covers all the areas wherein this product can be used. This standard also specifies the requirement of gabions based on its use and also specifies the requirements for gabion and gabion mattresses for different size panel. For use of welded gabions in moisture and salty condition, galvanized coating on wire with additional coating of PVC has been prescribed.

There is a separate Indian Standard which lays down requirements for 'mechanically woven double twisted gabions, rivet mattresses and rock fall netting'.

This standard does not intend to address all of the safety concerns, associated with the use of gabions and gabion mattresses. It is the responsibility of the manufacturers and users of this standard to establish and employ appropriate safety measures and to ensure compliance to applicable regulations.

In the formulation of this standard guidance has been taken from ASTM A 974-97 'Specification for welded wire fabric gabions and gabion mattresses [metallic-coated or polyvinyl chloride (PVC) coated]'.

The composition of the Committee responsible for the formulation of this standard is given in Annex A.

For the purpose of deciding whether a particular requirement of this standard is complied with, the final value, observed or calculated, expressing the result of a test or analysis, shall be rounded off in accordance with IS 2 : 1960 'Rules for rounding off numerical values (*revised*)'. The number of significant places retained in the rounded off value should be the same as that of the specified value in this standard.

Indian Standard

WELDED WIRE GABIONS (METALLIC-COATED OR METALLIC-COATED WITH PVC COATING) — SPECIFICATION

1 SCOPE

This standard specifies requirements for gabions and gabion mattresses manufactured from metallic-coated welded wire fabric, and metallic-coated wire for spiral binders, lacing wire, and stiffeners. The metallic-coated fabric may be PVC coated after fabrication. The spiral binders, lacing wire, and stiffeners may be PVC coated after metallic coating.

2 REFERENCES

The following standards contain provisions, which through reference in this text, constitute provisions of this standard. At the time of publication, the editions indicated were valid. All standards are subject to revision and parties to agreements based on this standard are encouraged to investigate the possibility of applying the most recent editions of the standards indicated below:

<i>IS No./ International Standards</i>	<i>Title</i>
432 (Part 2) : 1982	Specification for mild steel and medium tensile steel bars and hard drawn steel wire for concrete reinforcement: Part 2 Hard-drawn steel wire (<i>third revision</i>)
1956 (Part 5) : 1976	Glossary of terms relating to iron and steel: Part 5 Bright steel bar and steel wire (<i>first revision</i>)
2633 : 1986	Method for testing uniformity of coating on zinc coated articles (<i>second revision</i>)
4826 : 1979	Specification for hot-dipped galvanized coatings on round steel wires (<i>first revision</i>)
4948 : 2002	Welded steel wire fabric for general use — Specification (<i>second revision</i>)
6745 : 1972	Methods for determination of mass of zinc coating on zinc coated iron and steel articles
12753 : 1989	Electrogalvanized coatings on round steel wire — Specification
13360 (Part 3/Sec1) : 1995	Plastics — Methods of testing: Physical and dimensional properties, Section 1 Determination of density

<i>IS No./ International Standards</i>	<i>Title</i>
	and relative density of non-cellular plastics
(Part 5/Sec 1) : 1996	Mechanical properties, Section 1 Determination of tensile properties — General principles
(Part 5/Sec 11) : 1992	Mechanical properties, Section 11 Determination of indentation hardness of plastics by means of durometer (shore hardness)
(Part 8/Sec 14) : 2005	Permanences/Chemical properties, Section 14 Determination of the effects of exposure to damp heat, water spray and salt mist
ISO 2178 : 1982	Non-magnetic coatings on magnetic substrates — Measurement of coating thickness — Magnetic method

3 TERMINOLOGY

For the purpose of this standard, definitions given in IS 1956 (Part 5) and the following shall apply.

3.1 Gabion — A wire fabric container, uniformly partitioned, of variable size, interconnected with other similar containers, and filled with stone at the site of use, to form flexible, permeable, monolithic structures for retaining walls, sea walls, channel linings, revetments, and weirs for the purpose of erosion control (*see* Fig. 1). Typical gabion sizes are given in Table 1.

3.2 Gabion Mattress — A gabion with relatively small height in relation to the lateral dimensions, generally used for lining channels (*see* Fig. 2). Typical gabion mattress sizes are given in Table 2.

3.3 Lacing Wire — A metallic-coated steel wire or metallic-coated steel wire with PVC coating employed in assembly and to interconnect empty gabion units/mattresses, and to close and secure stone-filled units, used as an alternate to spiral binders.

3.4 Spiral Binder — A length of metallic-coated steel wire or metallic-coated steel wire with PVC coating preformed into a spiral, employed to assemble and interconnect empty gabion units/mattresses, and to

close and secure stone-filled units, used as an alternate to lacing wire.

3.5 Stiffener — A length of metallic-coated steel wire or metallic-coated steel wire with PVC coating used for support by forming a diagonal brace across the corners, inside of the gabion container. Stiffeners are produced using lacing wire for on-site applications or shipped preformed using heavier wire gauge as shown in Table 3.

3.6 Welded Wire Fabric — A material composed of mild or stainless steel wire as drawn, fabricated into sheet (or mesh) formed by the process of electric resistance welding. The finished material shall consist essentially of a series of longitudinal and transverse wires arranged substantially at right angles to each other and then welded together at all points of intersection.

4 CLASSIFICATIONS

Welded wire gabions shall be classified according to coating, as follows:

- a) Class A, consists of 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.
- b) Class B, consists of 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.
- c) Class C, consists of welded wire fabric, spiral binders, lacing wire, and stiffeners as Class A or Class B and over coated with PVC.

5 MATERIALS AND MANUFACTURE

5.1 The wire used in the manufacture of welded wire fabric for use in gabions shall conform to the specifications given in **5.1.1** as appropriate for the class ordered, except that the tensile strength shall conform to **6.1**. The wire may be produced from any grade of steel specified in IS 432 (Part 2).

5.1.1 Class A, welded wire fabric shall be manufactured from zinc-coated steel wire conforming to IS 4826 (heavy coated) or IS 12753 (heavy coated) wire. Criteria for uniformity of zinc coating in these specifications shall be checked for conformity on the welded wire fabric sample with the welded joints in accordance with **12.2**.

5.1.2 Class B, welded wire fabric shall be manufactured from uncoated steel wire conforming to IS 432 (Part 2) and the fabric shall be subsequently zinc-coated by the hot-dip process.

5.2 Spiral binders, lacing wire, and stiffeners shall be made of wire having a tensile strength in accordance with **6.1**, having the same coating material as that of the welded wire fabric specified in purchase order and conforming to IS 4826 (heavy coated) or IS 12753 (heavy coated).

5.3 Welded wire fabric shall be assembled by automatic machines or other suitable mechanical means which will ensure accurate spacing and alignment of all members of the finished fabric with specified tolerances. Longitudinal and transverse members of the welded wire fabric shall be connected at every intersection by the process of electric resistance welding to meet the requirements of **6.2**.

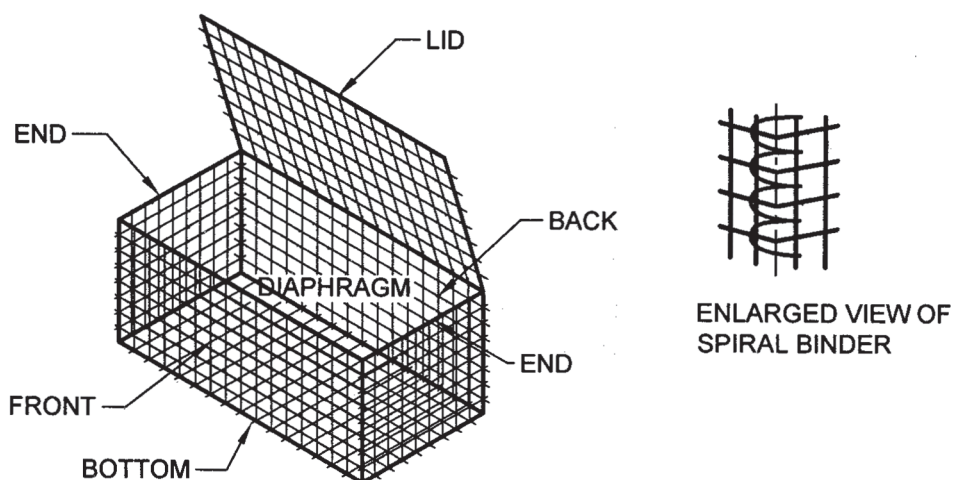


FIG. 1 GABION

5.4 The PVC coating used in the manufacture of PVC coated gabions and gabion mattresses shall conform to requirements of 7.2.

5.4.1 The PVC coated welded wire fabric shall have the PVC coating fused and bonded onto the metallic-coated welded wire fabric after fabrication of mesh. No cutting of the panels closer than 6 ± 3 mm to the weld shall be permitted after fabrication in order to prevent exposure near the welds.

5.4.2 The PVC coated wire for spiral binders, lacing wire, and stiffeners shall have the PVC coating fused and bonded or extruded and adhered, onto the metallic-coated wire.

5.5 Gabions and gabion mattresses shall be manufactured with all components mechanically connected at the production facility with the exception of the mattress lid which may be supplied separately (see Fig. 1 and Fig. 2). All gabions (see Fig. 3) and gabion mattresses (see Fig. 2) shall be supplied in the collapsed form, either folded and bundled or rolled, for shipping.

Table 1 Typical Gabion Sizes
(Clause 3.1)

SI No.	Length m	Height m	Width m	Number of Cells	Capacity m ³
(1)	(2)	(3)	(4)	(5)	(6)
i)	1.80	0.90	0.90	2	1.46
ii)	2.70	0.90	0.90	3	2.19
iii)	3.60	0.90	0.90	4	2.92
iv)	1.20	1.20	1.20	1	1.73
v)	2.70	0.90	0.30	3	0.73
vi)	2.70	0.90	0.45	3	1.09

Table 2 Typical Gabion Mattress Sizes
(Clause 3.2)

SI No.	Length m	Height m	Width m	Number of Cells	Area m ²
(1)	(2)	(3)	(4)	(5)	(6)
i)	2.70	1.80	0.15	3	4.86
ii)	3.60	1.80	0.15	4	6.48
iii)	2.70	1.80	0.23	3	4.86
iv)	3.60	1.80	0.23	4	6.48
v)	2.70	1.80	0.30	3	4.86
vi)	3.60	1.80	0.30	4	6.48

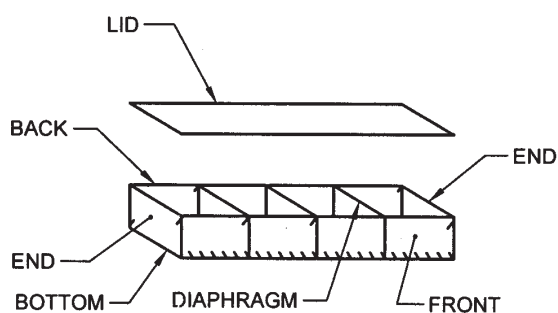


FIG. 2 GABION MATTRESS

Table 3 Wire Diameters
(Clauses 3.5, 8.1 and 8.2)

SI No.	Mesh Opening mm	Minimum Nominal Diameter Metallic-Coated Wire ¹⁾ mm	Minimum Diameter, PVC Coated (Including Coating) Wire ²⁾ mm
(1)	(2)	(3)	(4)
i)	75 × 75 / 38 × 75	3.0	3.80
ii)	100 × 100 / 50 × 100	4.0	4.80
iii)	150 × 150 / 75 × 150	4.0	4.80
iv)	Lacing wire	3.0	3.80
v)	Preformed wire spiral binders	3.0	3.80
vi)	Stiffeners	4.0	4.80

¹⁾ The metallic-coated wire shall have the size tolerances in accordance with IS 4826 (heavy coated) or IS 12753 (heavy coated) or IS 432 (Part 2) for Class B.

²⁾ The minimum thickness of the PVC overcoats which covers the wire shall be 0.40 mm measured radially at any cross-section transverse to the wire length.

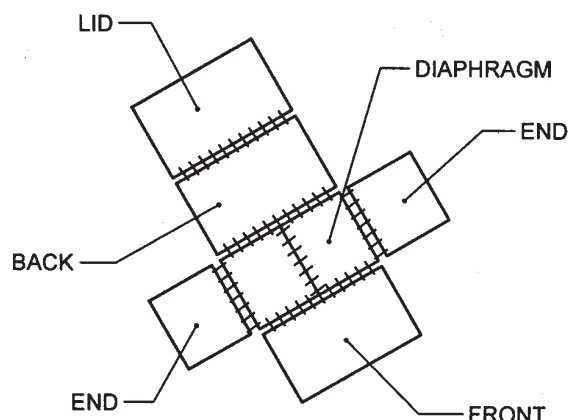


FIG. 3 PRE-ASSEMBLED GABION

6 MECHANICAL PROPERTIES

6.1 Tensile Strength

The tensile strength of the wire used for the welded wire fabric, spiral binders, lacing wire, and stiffeners shall be soft in accordance with the requirements of IS 4826 (heavy coated) or IS 12753 (heavy coated) for Class A gabions or hard drawn wire according to IS 432 (Part 2) for Class B gabions. 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 gabion mattresses shall use the same temper wire as per given order.

6.2 Weld Shear Strength

When tested in accordance with 12.5, the minimum average shear value, in Newton, shall be 70 percent of

the tensile strength of the wire or as indicated in Table 4, whichever is greater (*see* IS 4948). Typical minimum average shear strengths is given in Table 4.

Table 4 Shear Strength

Sl No.	Minimum Wire Diameter mm	Minimum Strength N	Breaking Shear Strength N
(1)	(2)	(3)	(4)
i)	3.0	2 520	1 760
ii)	4.0	4 480	3 140
iii)	5.0	7 000	4 900

6.2.1 Conformance to Requirement

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 tested complies with the value in 6.2 or if the average of the test results for all welds tested complies with the value in 6.2.

6.3 Panel to Panel Joint Strength

The minimum strength of the joined panels, when tested as given in 12.6, shall be as specified in Table 5.

Table 5 Panel to Panel Joint Strength

Sl No.	Mesh Size mm	Exterior Panels kN/m	Diaphragm Panels kN/m
(1)	(2)	(3)	(4)
i)	75 × 75 Mesh/ 38 × 75 Mesh	20.4	8.7
ii)	100 × 100 Mesh/ 50 × 100 Mesh	27.2	11.6
iii)	150 × 150 Mesh/ 75 × 150 Mesh	18.1	7.7

7 PHYSICAL PROPERTIES

7.1 Metallic Coating

The coating weights shall conform to the requirements of IS 4826 (heavy coated) or IS 12753 (heavy coated) for zinc coating (including the zinc coating on the Class B fabric). Uniformity of zinc coating shall be determined according to IS 2633 with requirements as per IS 4826 on samples of welded wire fabric that is random sample with minimum two welded joints.

7.2 PVC Coating on Wire and Welded Fabric

The initial properties of PVC coating material on the wire and welded wire fabric shall have a demonstrated ability to conform to the following requirements:

- a) *Specific gravity* — In the range from 1.20 to

1.40, when tested in accordance with IS 13360 (Part 3/Sec 1).

- b) *Tensile strength* — Not less than 15.7 MPa, when tested in accordance with tested in accordance with IS 13360 (Part 5/ Sec 1).
- c) *Hardness test* — Shore 'A' not less than 75, when tested in accordance with test method given IS 13360 (Part 5/ Sec 11).
- d) *Salt spray exposure* — The PVC shall show no effect after 3 000 h of salt spray exposure in accordance with IS 13360 (Part 8/Sec 14).
- e) *Adhesion*—The PVC coating shall adhere to the wire such that the coating breaks rather than separates from the wire when tested in accordance with 12.4.
- f) *Bend test* — The PVC coated wire, when subjected to a single 360° bend at -18°C around a mandrel ten times the diameter of the wire, shall not exhibit breaks or cracks in the PVC coating.

8 DIMENSIONS AND TOLERANCES

8.1 The diameter of metallic-coated wire shall conform to Table 3.

8.2 The minimum thickness of the PVC coating shall be as given in Table 3.

8.3 Gabions shall have a mesh opening of 75 mm × 75 mm or 100 mm × 100 mm or 150 mm × 150 mm. Gabion mattresses shall have a mesh opening of 38 mm × 75 mm or 50 mm × 100 mm or 75 mm × 150 mm. Mesh opening shall be considered to be centre-to-centre distance between two consecutive longitudinal or transverse wires. The permissible tolerance shall be ± 3.0 mm.

8.4 Spiral binders shall have a minimum inside diameter of 20 mm; minimum pitch of 25 mm and a maximum inside diameter of 60 mm and a maximum pitch of 75 mm.

8.5 The width, height, and length of the gabion as assembled shall not differ more than ±5 percent from the ordered size prior to filling.

8.6 The width and length of the gabion mattress as assembled shall not differ more than ± 5 percent and the height shall not differ more than ±10 percent from the purchases specified size prior to filling.

9 WORKMANSHIP

Workmanship and finish as determined by visual inspection shall conform to requirements of this standard.

10 SAMPLING

Samples for determination of the mechanical and

physical properties of welded wire fabric shall be obtained by cutting from the finished fabric a full-width section of sufficient length to perform the testing. Samples for the determination of mechanical and physical properties of coated wire used for spiral binders, lacing wire, and stiffeners shall be selected at random in sufficient number to perform the testing.

11 NUMBERS OF TESTS

Perform a minimum of four tests for conformance to tensile strength of metallic-coated wire, weld shear strength, wire and fabric dimensions, metallic coating weight, PVC coating thickness, adhesion of PVC coating, and mandrel bend from each 19 000 m² of fabric or remaining fraction thereof. Perform a minimum of four tests for conformance to tensile strength, wire dimensions, coating weight, PVC coating thickness, adhesion of PVC coating, and mandrel bend from the wire accessories used with each 19 000 m² of fabric. The lot shall be acceptable if the results of all four tests conform to the requirements.

12 TEST METHODS

12.1 Metallic Coating Weight

Perform coating weight tests in accordance with tests in IS 6745 as applicable. For coating weight tests on wire of the welded wire fabric, secure multiple lengths between welds, including both longitudinal and transverse wire, and cut no closer than 6.4 mm from any weld. The combined length shall be 305 mm, minimum, but preferably about 610 mm.

12.2 Uniformity of Coating Test

Perform uniformity of coating tests on the welded wire fabric samples with welded joints in accordance with IS 2633 with number of dips requirements as per IS 4826 as applicable for heavy coated wire. The test specimens for the uniformity of coating tests shall be of dimensions as per **12.5.4** and **12.5.4.1**.

12.3 PVC Coating Thickness

12.3.1 Determine the thickness of the PVC coating on an individual piece of wire removed from the fabric.

12.3.2 Determine the diameter of the metallic-coated wire after stripping the PVC coating by chemical means. Determine the thickness of the PVC coating by scraping the coating from one side of the wire and measuring the reduced diameter with a micrometer. The thickness of the coating at this point is the difference between the measurement thus obtained and the measured diameter of the metallic-coated wire. Determine the thickness of the coating at right angles to the first determination in a similar manner. When removing the PVC coating by scraping, take care not

to remove any of the metallic surfaces. The magnetic method may be able to be applied as a non-destructive measurement of the thickness in accordance with ISO 2178.

12.4 PVC Adhesion Test

Make two cuts parallel to the axis of the wire through the coating, approximately 1.6 mm apart, at least 12.7 mm long. With a knife, peel back a section of the coating between 3.2 mm and 6.4 mm long to produce a tab. Attempt to remove the 1.6 mm strip of coating by pulling the tab. The lot shall be acceptable, if the coating breaks rather than separates from the core wire on all four specimens.

12.5 Weld Shear Strength of Fabric

12.5.1 General

This test method covers the procedure for determining the strength of welded intersections of welded wire fabric.

12.5.2 Significance and Use

The weld shear strength is a measure of the ability of welds in wire fabric to resist the forces imposed on the wires tending to pull them apart.

12.5.3 Apparatus

Use a testing fixture such as shown in Fig. 4, which is intended to stress the vertical wire close to its centerline, and to prevent rotation of the horizontal wire. This fixture can be used in most tensile testing machines and should be hung in a ball and socket arrangement at the center of the machine. This or a similarly effective fixture designed on the same principle is acceptable (*see* IS 4948).

12.5.4 Test Specimens

Test specimens shall be obtained by cutting, from the finished fabric, a full-width section including at least two transverse wires.

12.5.4.1 The transverse wire of each specimen shall extend approximately 25 mm on each side of the longitudinal wire. The longitudinal wire of each test specimen shall be of such length below the transverse wire so as to be adequately engaged by the grips of the testing machine. It shall be of such length above the transverse wire that its end shall be above the centerline of the upper bearing of the testing device.

12.5.4.2 A test specimen shall consist of four welds selected at random from one transverse wire for weld shear strength. If the width of the fabric is such as not to include four welds that are suitable for testing, additional welds shall be taken from a second transverse wire to total four (welds at the edge wire are

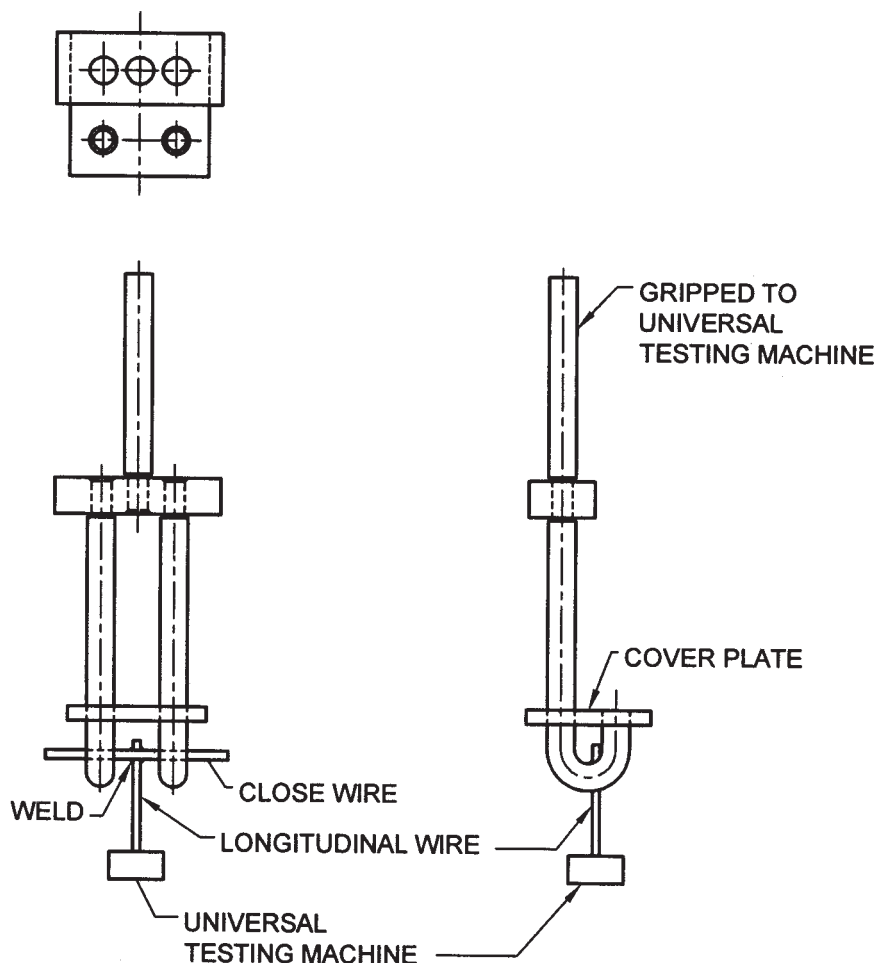


FIG. 4 WELDED WIRE FABRIC WELD TESTER

excluded from testing as there is no overhang to permit proper testing). If the average weld shear strength from the four specimens does not conform to the requirement of 6.2, test all the welds across the width (excluding edge welds) on one transverse wire, or on two transverse wires, if some of the initial specimens were from the second transverse wire.

12.5.5 Weld Shear Test Procedure

Insert the long end of the vertical wire through the notch in the anvil. The vertical wire shall be in contact with the surface of the free-rotating rollers while the horizontal wires shall be supported by the anvil on each side of the slot. The bottom jaws of the testing machine shall grip the lower end of the vertical wire and the load shall be applied at a rate of stressing not to exceed 690 MPa/min.

12.5.6 Report

Report the test results to the nearest 25 N for both individual results and the average of all tests.

12.6 Panel to Panel Connection

Join a set of two identical rectangular gabion panels, each with a width of 900 mm and a minimum length of 220 mm, by any of the following methods:

12.6.1 Lacing Wire

Lacing wire shall be alternately single and double-looped with spacing not to exceed 150 mm. Secure ends with two complete revolutions and finish with a one-half hitch.

12.6.2 Spiral Binders

Spiral binders shall pass through the openings. Securely tie at both ends to prevent unraveling when a load is applied in accordance with the minimum strength requirements of 6.3.

12.6.3 Mount each of the two panels on a loading machine with grips or clamps such that panels are uniformly secured along the full-width. The grips or clamps shall be designed to transmit only tension forces. The load then will be applied at a uniform

rate not exceeding 1 050 N/s until maximum load is obtained. The maximum load is reached when a drop of strength is observed with subsequent loading.

13 MARKING

13.1 Each finished product shall be marked legibly and indelibly with the following details on a metal tag:

- a) Name of manufacturer;
- b) Product class;
- c) Mesh size, in mm;
- d) Mesh wire diameter, in mm;
- e) Length, width and height of gabion/gabion mattress, in m;
- f) Class of coating;
- g) Batch number or date of manufacturing; and
- h) Any other information as specified by the purchaser.

13.2 BIS Certification Marking

The details available with the Bureau of Indian Standards.

13.2.1 The use of the Standard Mark is governed by the provisions of the *Bureau of Indian Standards Act, 1986* and the Rules and Regulations made thereunder. The details of conditions under which a license for the use of the Standard Mark may be granted to manufacturers or producers may be obtained from the Bureau of Indian Standards.

13.3 The following information shall be supplied by the purchaser/indenter:

- a) Gabions or gabion mattresses;
- b) Size in m (length × width × height);
- c) Class (*see 4*);
- d) Mesh size in mm and mesh wire diameter, in mm;
- e) IS designation and year of issue;
- f) Quantity (number of units);
- g) Manufacturer's certificate, if required (*see 14*); and
- h) Any other requirement.

NOTE — A typical ordering description is as follows: 100 gabions, Size: 1.80 m × 0.90 m × 0.90 m, Mesh Size: 100 mm × 100 mm × 4.0 mm as shown on plans; Class A or Class B; with required spiral binders, lacing wire and stiffeners.

14 CERTIFICATES

When specified in the purchase order or contract, a manufacturer's certificate shall be furnished to the purchaser that the material has been manufactured, tested, and inspected in accordance with requirements of this standard and has been found to be conforming to the requirements. When specified in the contract or purchase order, reports of the test results for each batch supplied shall be furnished.

15 INSTALLATION MANUAL

The manufacturer shall supply an installation manual for installation of the product.

ANNEX A (Foreword)

COMMITTEE COMPOSITION

Wire Ropes and Wire Products Sectional Committee, MED 10

<i>Organization</i>	<i>Representative(s)</i>
Directorate General of Mines Safety, Dhanbad	SHRI G. N. VENKATESH (<i>Chairman</i>)
Amar Promoters Pvt Ltd, Solan	SHRI VIRENDER AGARWAL SHRI JATINDER AGARWAL (<i>Alternate</i>)
Bharat Coking Coal Ltd, Dhanbad	SHRI K. K. S. SINHA SHRI U. S. PANDEY (<i>Alternate</i>)
Bharat Wire Ropes Ltd, Mumbai	SHRI D. M. SHAH SHRI ASHWINI LOKHANDE (<i>Alternate</i>)
Central Institute of Mining and Fuel Research, Dhanbad	SHRI AWADESH MAHTO SHRI S. K. RITOLIA (<i>Alternate</i>)
Directorate of Quality Assurance, New Delhi	COL K. SURESH COL V. V. KADAM (<i>Alternate</i>)
Directorate General Factory Advice Service & Laboratory Institute, Mumbai	SHRI G. M. E. K. RAJ SHRI S. N. BORKER (<i>Alternate</i>)
Directorate General of Civil Aviation, New Delhi	SHRI R. C. GUPTA SHRI M. M. KAUSHAL (<i>Alternate</i>)
Directorate General of Supplies & Disposals (Quality Assurance Wing), New Delhi	SHRI AKHILESH KUMAR SHRI R. K. AGARWAL (<i>Alternate</i>)
Directorate General of Aeronautical Quality Assurance, New Delhi	SHRI S. C. SHARMA SHRI RISHI KUMAR (<i>Alternate</i>)
Eastern Coalfields Ltd, Kolkata	SHRI CHATERJEE SHRI KAPIL K. RAI (<i>Alternate</i>)
Garware Wall Ropes Ltd, Pune	SHRI RAVI SHANKAR SINGH SHRI S. G. WANKHEDE (<i>Alternate</i>)
Ministry of Shipping, New Delhi	SHRI A. R. RAO SHRI D. J. BASU (<i>Alternate</i>)
Maccaferri Environmental Solutions (P) Ltd, Pune	SHRI ASHISH D. GHARPURE SHRIMATI MINIMOL KORULLA (<i>Alternate</i>)
National Test House, Kolkata	SHRI S. P. ROY SHRI R. N. RAM (<i>Alternate</i>)
Oil and Natural Gas Commission, Dehradun	SHRI R. K. GARG SHRI P. K. SOOD (<i>Alternate</i>)
Orient Wire Ropes, Indore	SHRI SAMEER GOLWELKAR SHRI SHISHIR AKARTE (<i>Alternate</i>)
Paradip Port Trust, Paradip	SHRI B. B. PANIGRAHI SHRI MOHAN PATEL KHETRA (<i>Alternate</i>)
South Eastern Coalfields Ltd, Bilaspur	SHRI S. K. MISHRA SHRI G. RAMASWAMI (<i>Alternate</i>)
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The Shipping Corporation of India Ltd, Mumbai	SHRI G. S. BHALLA CAPT R. MODI (<i>Alternate</i>)
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