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BUREAU OF INDIAN STANDARDS

DRAFT FOR COMMENTS ONLY

भारतीय मानक **मसौदा**

इस्पात तार रस्सियों और लड़ो की तकनीकी आपूर्ति की शर्ते

(आई एस 6594 का *चौथा पुनरीक्षण*)

Draft *Indian Standard*

TECHNICAL SUPPLY CONDITIONS FOR STEEL WIRE ROPES AND STRANDS

(*Fourth Revision* of IS 6594)

ICS 77.140.65

Wire Ropes and Wire Products Sectional Committee, MED 10	Last date for receipt of comments is **19 June 2024**

FOREWORD

(*Formal clauses to be added later*)

This standard was fist issued in 1972 and subsequently revised in 1977, 2001 and 2018. The standard is being revised again for incorporating the modifications found necessary as a result of experience gained with the use of this standard. Also the major changes in the standard in this revision are given below:

a) Amendment 1 has been incorporated;
b) Clause 3.2.3 Rope Grade has been modified;
c) Material and Size for wire rope has also been modified;
d) Clause 6, General requirements has also been modified; and
e) Clause 10.3 provision for test on individual wires has also been modified.

Connecting symbols for strand, rope and core are given in Annex D. Details to be furnished with enquiry or order and information to be given by the manufacturers are given in Annex E and F respectively.

The advantage of parallel or equal lay ropes is that they are more compact compared to cross lay

ropes and have higher breaking force to approximately 10 percent. Since the wires are laid in strands in single lay, secondary bending/nicking effect of wires in the intermediate layers are practically absent. Also parallel lay ropes are more resistive to abrasion since, outer wire diameter is higher compared to, cross lay ropes.

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 shall be rounded-off in accordance with IS 2: 2022 'Rules for rounding off numerical values (*second revision*)'. The number of significant places retained in the rounded-off value should be the same as that of the specified value in this standard.

Draft *Indian Standard*

TECHNICAL SUPPLY CONDITIONS FOR STEEL WIRE ROPES AND STRANDS

(*Fourth Revision*)

1 SCOPE

This standard describes the technical supply conditions for steel wire ropes of round strand, flattened strand and multi-strand rotation resistant types in ordinary or Lang's lay construction. It also includes locked coil wire ropes. Ropes of round strand and flattened strand types used for hoisting purposes in mines (winding and man riding haulages) are not covered by this standard.

2 REFERENCES

The standards listed below contain provisions which, through reference in this text constitute provision 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:

IS No.	*Title*
IS 1608 (Part 1) : 2022	Metallic materials — Tensile testing at ambient temperature (*first revision*)
IS 1716 : 2023	Metallic materials Wire Reverse bend test (*third revision*)
IS 1717 : 2018	Metallic materials — Wire — Simple torsion test (*fourth revision*)
IS 1804 : 2004	Steel wire ropes — Fibre main cores — Specification (*fourth revision*)
IS 1835 : 1976	Round steel wire for ropes (*third revision*)
IS 2363 : 2022	Glossary of terms relating to wire ropes (*second revision*)
IS 2633 : 1986	Methods for testing uniformity of coating on zinc coated articles (*second revision*)
IS 6745 : 1972	Method for determination of mass of zinc coating on zinc coated iron and steel articles
IS 9182 (Part 1) : 1993	Lubricants for wire ropes and fire cores — Specification: Part 1 Lubricants for fire core of wire-ropes (*first revision*)
IS 9182 (Part 2) : 1993	Lubricants for wire ropes and fire cores — Specification: Part 2 Lubricants for wire strands and ropes (*first revision*)
IS 3973: 2022	Code of practice for the selection, installation and maintenance of wire ropes (*second revision*)

3 TERMINOLOGY

For the purpose of this standard, the definitions given in IS 2363 shall apply, in addition to the following:

3.1 Wire

3.1.1 *Tensile Designation*

A level of requirement of tensile strength which is designated by the minimum value of the appropriate range of tensile strength, in N/nm^2.

3.1.2 *Actual Tensile Strength*

The value obtained when dividing the maximum force achieved during a tensile test by the nominal cross sectional metallic area of the wire.

3.2 Rope

3.2.1 *Fill Factor*

The ratio between the sum of the nominal metallic cross-sectional areas of all the wires in the rope and the area of the rope circle (circumscribing the outer strands of the rope) based on its nominal diameter.

3.2.2 *Metallic Cross-Sectional Area Factor*

Factor derived by multiplying fill factor with $\pi/4$

3.2.3 *Rope Grade*

A level of requirement of breaking force which is designated by a number like 1230, 1370, 1420, 1570, 1770, 1960, 2160 etc., as specified in relevant wire rope standard or intermediate grade as specified by manufacturer but not exceeding 2160.

Not necessarily all ropes shall have wire rope grades e.g. wire ropes with nominal rope diameter larger than 60 mm rope where wire rope grade may not be specified by manufacturer.

NOTE —Rope Grade does not imply that the actual tensile designation of wires in the rope is necessarily of such grade.

3.2.4 *Spinning Loss Factor*

The ratio between the minimum breaking force of the rope to the calculated minimum aggregate breaking force of the rope.

3.2.5 *Breaking Force of Rope*

3.2.5.1 *Minimum breaking force*

The tensile force below which a sample of the wire rope shall not fracture when tested to destruction in the prescribed manner.

NOTE — The value is calculated from the product of the square of the nominal diameter of the rope, the rope grade and the breaking force

factor appropriate to the construction of the rope.

3.2.5.2 *Calculated minimum breaking force*

Designated value obtained by calculation from the sum of the product of cross-sectional metallic area of each wire based on its nominal diameter and its respective tensile designation and a spinning loss factor appropriate to the rope construction.

3.2.5.3 *Actual breaking force*

The maximum tensile force obtained by testing a sample of the rope to destruction in the prescribed manner.

3.2.5.4 *Calculated actual breaking force*

The value obtained by multiplying the sum of the breaking force of all the individual wires removed from the rope with the partial spinning loss factor obtained from the results of type testing.

NOTE — The results of type testing and the derivation of partial spinning loss factor based on the results obtained through **3.2.5.3** and **3.2.5.6** shall form part of manufacturer's technical file.

3.2.5.5 *Minimum aggregate breaking force*

The value of aggregate breaking force obtained from the product of the square of the nominal rope diameter, the metallic cross-sectional area factor appropriate to the construction of rope and the rope grade.

3.2.5.6 *Calculated minimum aggregate breaking force*

The designated value obtained from the sum of the products of the cross-sectional metallic area (based on the nominal wire diameter) and the tensile designation of each wire in the rope.

3.2.5.7 *Measured (actual) aggregate breaking force*

The value obtained by adding together the breaking forces of all the individual wires removed from a rope.

3.2.5.8 *Relation between minimum breaking force and the minimum aggregate breaking force*

The minimum aggregate breaking force can be obtained by multiplying the minimum breaking force of the rope by the factor shown in the notes of the breaking force and mass tables in the relevant specification.

NOTE — Terminology given in clauses **3.2.1**, **3.2.2**, **3.2.4** and **3.2.5.4** are for guidance only.

4 MATERIALS

4.1 Wire

All materials used in manufacture of wire ropes shall be made with the steel, having the chemical composition to grades 1, 2, 3 and 4 (*see* IS 1835).

4.1.1 *Tensile Designation of Wires*

The tensile designation of wires shall be selected by manufacturer as recommended in IS 1835 for round wires so that the minimum breaking force for the designated rope grade is achieved.

4.1.1.1 The various wire properties as recommended in IS 1835, shall be determined for the tensile designation of wire selected by the manufacturer.

4.1.1.2 All wires of the same nominal diameter in the same layer of a rope construction shall be of same tensile designation.

4.1.1.3 For those ropes where a rope grade is applicable, the tensile strength grade for wire shall be subject to the limits given in following table.

Wire tensile strength grades for given rope grades

Rope Grade	Range of wire tensile strength grades (N/mm^2)
1 570	1 370 to 1 770
1 770	1 570 to 1 960
1 960	1 770 to 2 160
2 160	1 960 to 2 160

For those ropes where rope grade is not applicable, the tensile strength grade of the wire shall be one or combination of those given in **3.2.3.**

4.1.1.4 The core wires in the strand, filer wires and wires forming steel main core shall be of any tensile designation as specified in IS 1835 provided it does not exceed the tensile designation of the main wires in the rope.

4.1.1.5 The triangular core wires used in flattened strand rope shall have a minimum tensile strength of 785 N/mm^2.

4.1.1.6 Wire tensile grades 1370 N/mm^2, 2160 N/mm^2 shall be as per ISO 2408 standard.

5 SIZE

The size of the rope shall be expressed in terms of nominal diameter. Most common sizes are given in relevant wire rope standards; however, other sizes may also be supplied as agreed between manufacturer and purchaser. Intermediate size may also be supplied to meet specific requirement and as agreed between manufacturer and purchaser.

5.1 Permissible Variation

The diameter of the rope as supplied, when measured before tensioning in the manner described in Annex A shall be within the limits specified in the relevant wire rope specification. However, in case of a dispute as to compliance of the rope with maximum permissible diameter, the wire rope shall be put under tension which is equal to or neither greater than 8 percent nor, less than 5 percent of the minimum breaking force of the rope in question. If the rope diameter under this condition is within the permissible limit, the rope shall be deemed to have conformed to the relevant specification.

5.2 Permissible Ovality

The measurements for ovality (out-of-roundness) shall be taken in accordance with Annex A. The maximum variation between any of the four measurements shall not exceed the values given below:

Permissible Ovality on Nominal Rope Diameter in Percent		
Nominal Rope Diameter (mm)	*Ropes with Strands Exclusively of Wires*	*Ropes with Strands Having Fibre Core*
2 and 3	7	—
4 and 5	6	—
6 and 7	5	—
8 and above	4	6

6 GENERAL REQUIREMENTS

6.1 The strand/rope designation is done through symbols for some of its key features. Those are described in **6.3.3** Table 1 Table 2, and in Annex D.

NOTE — General requirement given in 6.1 is for guidance only.

6.2 Construction

Rope/strand construction shall be any one of the following types:

a) Equal lay or parallel lay construction;
b) Cross lay construction; and
c) Contra lay construction.

6.2.1 In equal lay or parallel lay construction, all the wires in the strand are laid in the same direction in one operation. The lay length at all the layers remains same and, the wires of any two superimposed layers are parallel to one another resulting line contact.

6.2.2 In cross lay construction, wires in the strand are laid in the same direction, in multiple operations. The wires of the superimposed wire layers cross one another, making point contact.

6.2.3 In contra lay construction, wires in the strand at different layers (or at least the outermost layer of wires) are laid in opposite direction.

6.2.4 *Compacted Strand*

A strand that has been subjected to a compacting process such as drawing, rolling of swaging (Fig. 1).

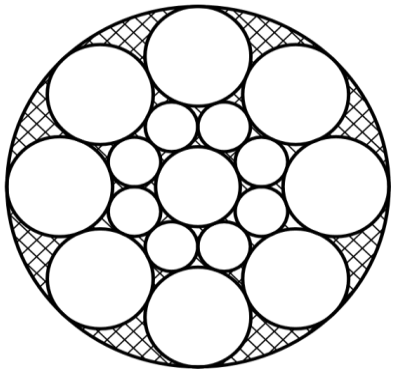


FIG. 1A STRAND BEFORE COMPACTING

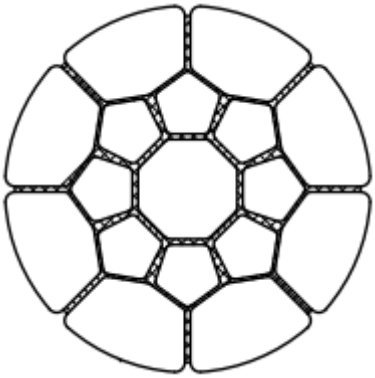


FIG. 1B STRAND AFTER COMPACTING

6.2.5 *Compacted Wire Rope*

A wire rope that has been produced with compacted strands.

6.2.6 *Cushion Core Rope*

A rope in which the steel core is covered or filed with polymer.

6.2.7 *Plastic Valley Filled Rope*

A wire rope that is covered with polymer or all the internal spaces has been filed with polymer.

6.2.8 *Swaged Wire Rope*

The wire rope which is subjected to compacting through swaging process after closing the rope.

6.2.9 *Combination Wire Ropes*

The wire rope in which all or few strands are covered by man-made (synthetic) fibre or natural fibre.

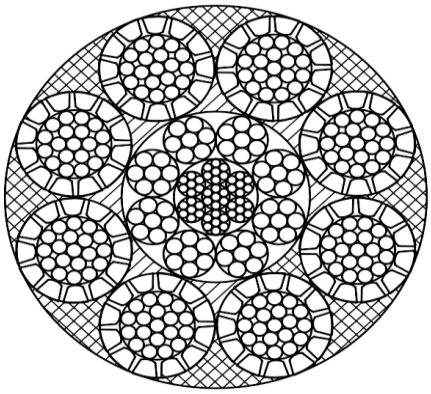


FIG. 2A PLASTIC VALLEY FILLED ROPE

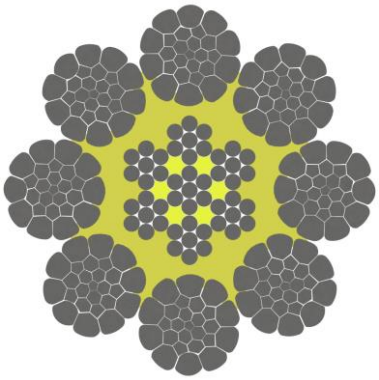


FIG. 2B CUSHION CORE ROPE

6.3 Core

The central or main core of the rope shall be of a size sufficient to give full support to the strands and shall be of fire or wire construction as may be specified by the purchaser.

6.3.1 *Fibre Core*

The fire core shall conform to IS 1804.

6.3.2 *Steel Core*

The steel core shall normally be an independent wire rope. For wire ropes of 12 mm diameter or smaller, wire strand core may be employed. For wire ropes of 13 mm diameter or more, the core shall be an independent wire rope, unless otherwise agreed to between the purchaser and the manufacturer or if the specification to which the rope conforms demands otherwise. In case of multi-strand rotation resistant ropes of all sizes, the core shall be a wire strand.

6.3.2.1 The construction of the wire strand core should normally be the same as that of the outer strands, however a different construction of wire strand core may also be used to increase the flexibility of core as decided by manufacturer. The direction of lay of wire strand core shall be the same as that of the outer strands. The construction of independent wire rope core shall be generally 7 × 7 for ropes having number of outer strands 6 or lesser. Other constructions with higher number of wires or higher number of strands for independent wire rope core may be used as decided by manufacturer. The independent wire rope core for ordinary lay wire ropes shall be of Lang's lay whereas, for Lang's lay wire ropes, the independent wire rope cores shall be of ordinary lay (for single layer ropes only). However, for multi-strand ropes, the internal contra lay rope may be ordinary lay or langs lay as decided by manufacturer. For specially developed constructions, the core lay direction may be decided by manufacturer.

6.3.3 The symbols for the elements of core are shown below:

Symbols Indicating Elements of Core		
	Element	*Symbol*
Core		C
a)	Fibre	F
	i) Natural fibre	FN
	ii) Man-made (synthetic Fibre)	FS
	iii) Solid Polymer Core	SP
b)	Steel core	
	i) Wire strand	WS
	ii) Independent wire rope core	WR
CF means core fire, CFN means core natural fire, CFS means core fibre synthetic, CSP means core solid polymer, CWS means core wire strand and CWR means core wire rope. Other composite cores (steel plus fibres or plastics) may also be supplied.		

Note – Mass and Minimum Breaking force of rope having composite core may be considered same as for Steel core rope and for solid polymer core may be considered same as for fibre core rope unless specified by manufacturer.

6.4 Length

A rope with plain ends shall be not less than the specified length nor shall it exceed the specified length by more than 5 percent for lengths up to 400 m. For lengths 400 m and more, the plus tolerance shall be 20 m for each 1000 m of length or part thereof. The length of the rope with fitted ends shall comply with requirements of the order. The rope length shall be measured without tension unless otherwise specified.

6.5 Mass

The approximate rope mass (expressed in kilogram per 100 m) is calculated as follows:

$$M = Kd^2$$

where,

M = approximate mass per unit length of the rope, in kilogram per 100m;
K = empirical factor for the mass per unit length for a given rope construction, in kg/(100 m.mm^2)
(The values for K shown in Table 1 and 2 are for fully lubricated ropes. Ropes which are not lubricated may be lighter.)
d = nominal diameter of the rope, in millimeter; and

In Table 2,
K_{in} = factor for ropes with natural fibre core;
K_{is} = factor for ropes with man-made (synthetic) fibre core; and
K_2 = factor for ropes with steel core (wire strand core and independent wire rope core).

Table 1 Numerical Values of Factors K and K' for Strand
(*Clauses* 6.1, 6.5 *and* 6.6)

Construction of Strand	**Arrangement of Wires**	**Mass Factor for Strand (*K*)**	**Minimum Breaking Force Factor for Strand (*K'*)**
(1)	(2)	(3)	(4)
1 × 3	(3-0)	0.401 0	0.491 9
1 × 4	(4-0)	0.427 3	0.512 7
1 × 7	(6-1)	0.510	0.544 3
1 × 19 M	(12/6-1)	0.508	0.525 3
1 × 19 J	(12:6-1)	0.508	0.525 3
1 × 37 M	(18/12/6-1)	0.508	0.518 4
1 × 37 J	(18:12:6-1)	0.508	0.518 4
1 × 61 M	(24/18/126-1)	0.506	0.512 1
1 × 61 J	(24:18:12:6-1)	0.506	0.512 1
1 × 91 M	(30/24/18/12/6-1)	0.506	0.510 8
1 × 91 J	(30:24:18:12:6-1)	0.506	0.510 8
1 × 127 M	(36/30/24/18/12/6-1)	0.506	0.510 8
1 × 127 J	(36:30:24:18:12:6-1)	0.506	0.510 8
1 × 169 M	(42/36/30/24/18/12/6-1)	0.506	0.510 8
1 × 169 J	(42:36:30:24:18:12:6-1)	0.506	0.510 8

Multiple operation constructions
Cross lay = M
Contra lay = J

6.6 Minimum Breaking Force

The minimum breaking force (expressed in kilo Newton) is the force, which shall be reached at least in the tensile test to destruction. It is calculated as follows:

$$F_0 = \frac{K' d^2 R_0}{1\,000}$$

where,

F_0 = minimum breaking force, in kilo Newton;
K' = empirical factor for the minimum breaking force for a given rope construction.
d = nominal diameter of the rope, in millimeter;
R_0 = rope grade, in Newton per square millimeter;
and
The values of K' are given in Table 1 and 2.

In Table 2

K_1' = factor for rope with fibre core (natural fibre core and man-made fibre core); and
K_2' = factor for rope with steel core (wire strand core and independent wire rope core)

Table 2 Numerical Vales of Factors K and K' for Rope

(*Clauses* 6.1, 6.5 *and* 6.6)

Class	Rope Construction	Arrangement of Wires in the Strand	Mass Factor for Rope (K)			$\frac{K_2}{K_{in}}$	$\frac{K_2}{K_{IS}}$	Minimum Breaking Force Factor for Rope (K)		$\frac{K_2'}{K_1'}$
			With Natural Fibre Core (K_{in})	With Synthetic Fibre Core (K_{is})	With Steel Core (K_2)			With Fibre Core (K_1')	With Steel Core (K_2')	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
4x19	4×19S	(9-9-1)	0.4100	-	-	-	-	0.36	-	-
	4×25F	(12-6F-6-1)	0.4100	-	-	-	-	0.36	-	-
	4×26SW	(10-5+5-5-1)	0.4100	-	-	-	-	0.36	-	-
4x36	4×31SW	(12-6+6-6-1)	0.4100	-	-	-	-	0.36	-	-
	4×36SW	(14-7+7-7-1)	0.4100	-	-	-	-	0.36	-	-
	4×41SW	(16-8+8-8-1)	0.4100	-	-	-	-	0.36	-	-
5x7	5 × 5	(4-1)	0.321 2	-	-	-	-	0.318 4	-	-
	5 × 7	(6-1)	0.345 3	-	-	-	-	0.346 9	-	-
6x7	6 × 7	(6-1)	0.357 4	0.348 5	0.393 1	1.10	1.13	0.322 2	0.358 8	1.08
	7x7	(6-1)	-	-	0.4040	-	-	-	0.3588	-
6x19M	6 × 19 M	(12/6-1)	0.346 0	0.337 4	0.380 6	1.10	1.13	0.307 3	0.331 9	1.08
	7 x 19M	(12/6-1)	-	-	0.3950	-	-	-	0.3319	-
6x37M	6 × 37 M	(18/12/6-1)	0.346 0	0.337 4	0.380 6	1.10	1.13	0.294 8	0.318 4	1.08
	7 x 37M	(18/12/6-1)	-	-	0.3950	-	-	-	0.3184	-
6x19	6 × 17 S, 6 × 19 S 6 × 25 S	(8-8-1), (9-9-1) (9-9/6-1)	0.372 6	0.363 3	0.409 9	1.10	1.13	0.331 0	0.357 4	1.08
	6 × 19 W	(6 + 6-6-1)	0.372 6	0.363 3	0.409 9	1.10	1.13	0.331 0	0.357 4	1.08
	6 × 21 F, 6 × 25 F, 6x29F	(10-5F-5-1)	0.380 2	0.370 7	0.418 2	1.10	1.13	0.337 7	0.364 7	1.08
		(12-6F-6-1)								
		(14-7F-7-1)								
	6 × 26 SW	(10-5 + 5-5-1)	0.380 2	0.370 7	0.418 2	1.10	1.13	0.329 9	0.356 3	1.08
6x36	6 × 31 SW	(12-6 + 6-6-1)	0.380 2	0.370 7	0.418 2	1.10	1.13	0.329 9	0.356 3	1.08
	6 × 36 SW	(14-7 + 7-7-1)	0.380 2	0.370 7	0.418 2	1.10	1.13	0.329 9	0.356 3	1.08

	6 × 41 SW	(16-8 + 8-8-1)	0.380 2	0.370 7	0.418 2	1.10	1.13	0.329 9	0.356 3	1.08
	6 × 49 SWS	(16-8 + 8-8-8-1)	0.380 2	0.370 7	0.418 2	1.10	1.13	0.329 9	0.356 3	1.08
	6 × 55 SWS	(16-8 + 8-8-8/6-1)	0.380 2	0.370 7	0.418 2	1.10	1.13	0.329 9	0.356 3	1.08
	6×46SW	(18-9+9-9-1)	0.380 2	0.370 7	0.418 2	1.10	1.13	0.329 9	0.356 3	1.08
	6×52SW	(18-9+9-9/6-1)	0.380 2	0.370 7	0.418 2	1.10	1.13	0.329 9	0.356 3	1.08
	6×37SF	(12-12-6F-6-1)	0.380 2	0.370 7	0.418 2	1.10	1.13	0.329 9	0.356 3	1.08
	6×41SF	(16-8F-8-8-1)	0.380 2	0.370 7	0.418 2	1.10	1.13	0.329 9	0.356 3	1.08
	6×43SF	(14-14-7F-7-1)	0.380 2	0.370 7	0.418 2	1.10	1.13	0.329 9	0.356 3	1.08
	6×49SF	(16-16-8F-8-1)	0.380 2	0.370 7	0.418 2	1.10	1.13	0.329 9	0.356 3	1.08
	6×50SFS	(14-14-7F-7-7-1)	0.380 2	0.370 7	0.418 2	1.10	1.13	0.329 9	0.356 3	1.08
	6×55SF	(18-18-9F-9-1)	0.380 2	0.370 7	0.418 2	1.10	1.13	0.329 9	0.356 3	1.08
	6×57SFS	(16-16-8F-8-8-1)	0.380 2	0.370 7	0.418 2	1.10	1.13	0.329 9	0.356 3	1.08
6x12	6 × 12	(12-Fibre)	0.250 6	0.230 6	-	-	-	0.208 5	-	-
6x24	6 × 24 M	(15/9-Fibre)	0.318 4	0.304 1	-	-	-	0.280 2	-	-
	6 × 24 S	(12-12-Fibre)								
8x19	8 × 19 S	(9-9-1)	0.348 5	0.336 2	0.425 1	1.22	1.26	0.287 0	0.338 6	1.18
	8 × 25 F	(12-6F-6-1)	0.356 5	0.344 0	0.434 9	1.22	1.26	0.293 6	0.346 4	1.18
	8×26SW	(10-5+5-5-1)	0.356 5	0.344 0	0.434 9	1.22	1.26	0.286 6	0.338 2	1.18
8x36	8 × 31 SW	(12-6+6-6-1)	0.356 5	0.344 0	0.434 9	1.22	1.26	0.286 6	0.338 2	1.18
	8 × 36 SW	(14-7 + 7-7-1)	0.356 5	0.344 0	0.434 9	1.22	1.26	0.286 6	0.338 2	1.18
	8 × 41SW	(16-8+8-8-1)	0.356 5	0.344 0	0.434 9	1.22	1.26	0.286 6	0.338 2	1.18
	8 × 46 SW	(18-9+9-9-1)	0.356 5	0.344 0	0.434 9	1.22	1.26	0.286 6	0.338 2	1.18
	8×49SWS	(16-8 + 8-8-8-1)	0.356 5	0.344 0	0.434 9	1.22	1.26	0.286 6	0.338 2	1.18
	8×52SW	(18-9+9-9/6-1)	0.356 5	0.344 0	0.434 9	1.22	1.26	0.286 6	0.338 2	1.18
	8 × 55 SWS	(16-8 + 8-8-8/6-1)	0.356 5	0.344 0	0.434 9	1.22	1.26	0.286 6	0.338 2	1.18
	8 × 37 SF	(12-12-6F-6-1)	0.356 5	0.344 0	0.434 9	1.22	1.26	0.286 6	0.338 2	1.18
	8×43SF	(14-14-7F-7-1)	0.356 5	0.344 0	0.434 9	1.22	1.26	0.286 6	0.338 2	1.18
	8×49SF	(16-16-8F-8-1)	0.356 5	0.344 0	0.434 9	1.22	1.26	0.286 6	0.338 2	1.18
	8×50SFS	(14-14-7F-7-7-1)	0.356 5	0.344 0	0.434 9	1.22	1.26	0.286 6	0.338 2	1.18
	8×55SF	(18-18-9F-9-1)	0.356 5	0.344 0	0.434 9	1.22	1.26	0.286 6	0.338 2	1.18
	8×57SFS	(16-16-8F-8-8-1)	0.356 5	0.344 0	0.434 9	1.22	1.26	0.286 6	0.338 2	1.18
18x7	17×7 (11×7:6 × 7-FC), 17×7 (11x7:6×7-1×7)	(6-1)	0.382 8	0.379 0	0.402 0	1.05	1.06	0.318 6	0.328 1	1.03
	18×7 (12×7:6×7-FC), 18×7 (12×7:6x7-1×7)	(6-1)	0.382 8	0.379 0	0.402 0	1.05	1.06	0.318 6	0.328 1	1.03
18x19	18×19S(12×19S:6×19S -FC), 18×19S(12×19S:6×19S -1×19S)	(9-9-1)	0.382 8	0.379 0	0.402 0	1.05	1.06	0.318 6	0.328 1	1.03
34(M)x7	34 × 7 (17×7:11×7 / 6×7) 34 × 7 (17×7 : 11×7 / 6×7 – 1×7)	(6-1)	0.390 2	0.386 3	0.402 0	1.03	1.04	0.312 2	0.318 4	1.02
	36 × 7 (18 × 7:12 × 7/6 × 7) 36 × 7 (18×7 : 12×7 / 6×7 – 1×7)	(6-1)	0.390 2	0.386 3	0.402 0	1.03	1.04	0.312 2	0.318 4	1.02
15x7	15×7	(6-1)	-	-	0.454	-	-	-	0.360(a) 0.350(b)	
	16×7	(6-1)								
35(W)x7	35×7 (16×7:6×7+6×7-6×7-1×7)	(6-1)	-	-	0.454	-	-	-	0.360(a) 0.350(b)	
	28×7 (16×7:4×7+4×7-4×7) (c)	(6-1)	-	-	0.454	-	-	-	0.360(a) 0.350(b)	
	40×7 [18×7:7×7+7×7-7×7-1×7)	(1-6)	-	-	0.454	-	-	-	0.360(a) 0.350(b)	
	29 × 7 [16×7 : (6×7)F – 6×7 – 1×7]	(1-6)	-	-	0.454	-	-	-	0.360(a) 0.350(b)	

35(W)x19	35×19S (16×19S:6×19S+6×19S -6×19S-1×19S)	(9-9-1)	-	-	0.454	-	-	-	0.360(a) 0.350(b)	
	12 × 6:3 × 24	(6-0) & (15/9-Fibre)	0.362 0	-	-	-	-	0.300 0	-	-
	6 × V 8	7D	0.410 0	0.410 0	0.447 0	1.16	1.09	0.362 0	0.384 0	1.06
	6 × V 22	(12/12-D)	0.410 0	0.410 0	0.447 0	1.16	1.09	0.351 0	0.372 0	1.06
	6 × V 25	(12/9-D)	0.410 0	0.410 0	0.447 0	1.16	1.09	0.351 0	0.3720	1.06
	6 × V 31	(18/12-D)	0.410 0	0.410 0	0.447 0	1.16	1.09	0.351 0	0.3720	1.06

(a) Up to rope grade 1960
(b) Rope grade over 1960 up to 2160
(c) 28x7 class rope may be manufactured with or without any core (Fibre or steel) as per manufacturer.
(d) 15x7 class shall have IWRC having more than 7 strands for flexibility and lay direction shall be opposite to rope lay direction for rotational resistance property.

NOTES

1 Multiple operation construction
Cross lay = M
Contra lay = J

2 One operation equal lay construction
F = Filler, S = Seale, W = Warrington, SW Seale Warrington (may also be designated as Warrington Seale 'WS'), SWS = Seale Warrington Seale.

3 Flattened Strand Construction = V
It is not intended to restrict this group of constructions only to the varieties specified here. Other varieties in Seale Warrington (SW), Seale Warrington Seale (SWS), and Seale Filler (SF) types can be developed and are permitted to be manufactured under this group with the consent of the users. Some of the examples are given below:
6 × 46 SW (18-9+9-9-1) 6 × 37 SF (12-12-6F-6-1), 6 × 49 SF (16-16-8F-8-1)
When the core wire in the strand becomes too large, it may be replaced by a small strand of 7 wires (laid 6 wires over 1 wire).
Example:
6 × 61 SF (18-18-9F-9 / 6-1)

4 Any of the wire rope construction specified above may be produced with 'Compacted Strands' and may be manufactured as 'Cushion Core Rope' or 'Plastic Valley Filled Rope'. The rope construction, mass, minimum breaking load and type of polymer for these ropes shall, however, be as decided by the manufacturer with the consent of the consent of the users. Most common constructions, mass factors (for reference) and minimum breaking load factors for compacted ropes are given in Table-3

5 Arrangements of wires in the strand / rope are generally written from outer layer to inner layers as shown in table (e.g. 14-7+7-7-1) or alternatively it may also be written from inner layer to outer layers (e.g. 1-7-7+7-1)

6 6x25F may also be designated as 6x19F (without counting filler wires).

7 18x7 construction and 18x19S construction may also be designated as 19x7 and 19x19S construction respectively (counting the core strand in total strand numbers)

8 35x7 construction may also be designated with 35(W)x7

Table 3 Numerical Vales of Factors K and K' for Compacted Rope

(*Clauses* 6.6)

Class	Construction	Ropes with Fibre Core		Ropes with steel core	
		Weight factor (K)	Minimum Breaking force factor for Rope (K')	Weight factor (K)	Minimum Breaking force factor for Rope (K')
6xk7	6x7	0.4100	0.3750	-	-
6xk19	6 × 17 S, 6 × 19 S 6 × 25 S	0.4250	0.3730	0.477	0.4100
	6 × 19 W				
	6 × 21 F, 6 × 25 F				
	6 × 26 SW				
6xk36	6 × 31 SW				
	6 × 36 SW				
	6 × 41 SW				
	6x46SW				
	6x52SW				
	6x37SF				
	6x43SF				
	6x49SF				
	6x50SFS				
	6x55SF				
	6x57SFS				
	6x37SF				
	6x43SF				
8xk19	8 × 19 S	0.4050	0.3300	0.4950	0.4100
	8 × 25 F				
8xk36	8 × 36 SW				
	8x46SW				
	8 × 37 SF				
	8x43SF				
	8x49SF				
	8x50SFS				
	8x55SF				
	8x57SFS				
18xk7	17×7	0.4270	0.3500	0.4700	0.3700
	18×7				
18xk19	18x19S				
15xk7	15x7	-	-	0.5100	0.4100
	16x7				
35(W)xk7	#28x7	-	-	0.5100	0.4100
	29x7				
	35x7				
	40x7				
35(W)xk19	35x19S				

#28x7 construction rope may be used with or without any core (Fibre or steel)

Note − Compacted strand constructions may be designated with prefix k e.g. 6x36SW may be written as 6xk36SW, 18x7 may be written as 18xk7.

6.7 Lay

6.7.1 *Direction of Lay*

The direction of lay shall be right hand (Z) unless otherwise specified in the order. It shall be ordinary lay or Lang's lay as specified in the respective specification, or the order as applicable.

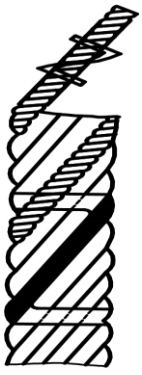
Lang's lay ropes shall be used only when the ends of the rope and the load are secured against rotation. The requirement does not, however, apply to multi strand rotation-resistant ropes, in which the outer layer of the strands may present the Lang's lay appearance.

STRANDED ROPE IN WHICH THE DIRECTION OF LAY OF WIRES IN THE STRANDS IS IN OPPOSITE DIRECTION TO THE LAY OF STRANDS IN THE ROPE IS CALLED ORDINARY LAY

sZ Right Hand Ordinary Lay

zS Left Hand Ordinary Lay

STRANDED ROPE IN WHICH THE DIRECTION OF LAY OF WIRES IN THE STRANDS IS IN THE SAME DIRECTION TO THE LAY OF STRANDS IN THE ROPE IS CALLED LANG'S LAY



Right Hand Lang's Lay

Left Hand Lang's Lay

FIG. 3 DIRECTION OF LAY

NOTE — The first letter denotes the direction of wires in the strand while the second letter denotes the direction of strands in the rope.

In addition to lay directions shown in Fig.3, 'Alternate Lay' which is denoted with 'aZ' (Right Hand Alternate Lay) or 'aS' (Left Hand Alternate Lay) may also be used if agreed between manufacturer and purchaser. The direction of the outer strands is alternatively left and right in 'Alternate Lay'. First letter 'a' denotes 'Alternate' and second letter 'S' or 'Z' shows the direction of strands in rope.

6.7.2 *Length of Lay*

The length of lay shall not exceed 8 times the nominal diameter of the rope.

6.8 Joints

6.8.1 Joints in wires shall be avoided as far as possible, but where necessary, those shall be as widely apart as far as possible, and in no case more than one wire shall be joined in any length of 10 m of strand.

6.8.2 The joints shall be as far as possible brazed or electrically welded. If the joint is brazed, it shall be properly scarfed; if welded it shall be properly annealed.

6.8.3 Tucked joints may be allowed except for ropes for winding or hoisting purposes in mines. The permissible wire sizes for such joints are specified in the respective rope specification.

7 FREEDOM FROM DEFECTS

The completed rope shall be free from defects, loose wires and strands or other irregularities. It shall be evenly laid and shall remain in the condition when properly unwound from a reel or coil.

8 PREFORMING

Round and flattened strand wire rope shall be preformed unless otherwise agreed upon. A multi strand rotation-resistant rope may not require pre-forming by its inherent design.

8.1 Tests for Preforming

A test of the preforming of the rope shall be carried out by unlaying at one end of the rope, two strands opposite to each other for approximately two rope lay lengths. When these two strands are re-laid into the rope the wires shall maintain their position in the strand and the strands shall resume their position in the rope.

NOTE — This operation may result in a very small increase in the diameter of that portion of the rope so tested.

9 LUBRICATION

9.1 The cover wires, the core of the strand, the wires of the main steel core and the rope while being laid up, may be thoroughly treated with lubricant complying with IS 9182 (Part 2).

NOTE — The lubricant used shall be mutually compatible, if more than one lubricant is used.

9.2 The natural fire main core shall be well impregnated with a suitable lubricant conforming to IS 9182 (Part 1). The impregnation of lubricant in the fire core may be done by vacuum, dip or any other suitable process. In dip impregnation, the core shall be immersed in the lubricant maintained at a temperature of 90°C ± 5°C for a minimum period of 4 h to ensure complete saturation of core. The retention of lubricant in the core taken from a new rope shall be a minimum of 10 percent by mass of fire core.

10 TESTS

10.1 Tests on Wires Prior to Rope Manufacture

The rope manufacturer shall ensure that the wires comply with IS 1835, and in particular meet the requirements of this standard with regard to tensile, torsion, reverse bend and when appropriate, galvanizing tests. The test results shall be recorded and shall be available for inspection by the purchaser or his representative at the manufacturer's works. The copy of the test results shall be supplied to the purchaser if so desired in the original enquiry or order for the rope.

10.2 Tests on Completed Ropes (for Routine Test)

10.2.1 *Breaking Force*

The minimum breaking force of the rope shall be as specified in the relevant rope specification. The testing shall be done as per Annex B. In case of ropes having a minimum breaking force of 900 KN or more, the breaking force may at the option of the manufacturer, be tested in accordance with the procedure given in **10.2.1.1**.

If, in addition to the manufacturer's test conducted as per **10.2.1.1**, the purchaser specifies in the order a sample of the rope to be tested to destruction, the test shall be carried out in the manner described in Annex B. This test may be undertaken in-house, if facilities are available or at an independent test house.

10.2.1.1 One metre long sample shall be cut-off from the end of the rope length and unstranded. The wires belonging to different layers of strands, as well as, the wires of the steel core, in case the main rope core is of steel core shall be kept separately. The total number of wires to be tested shall be equivalent to the number of wires in any one strand representing same number of wires

from each layer and location. The average breaking force shall be worked out against each set of wires and shall be multiplied by the total number of wires present under each set in the rope construction to obtain the actual aggregate breaking force of the rope after summing up all these values.

The actual aggregate breaking force value so obtained on multiplication by the partial spinning loss factor obtained through type testing as described in **3.2.5.4** for the related rope construction gives the actual breaking force of the rope.

When actual breaking force is determined through destruction test, the value achieved shall be considered as the breaking force of the rope. The rope shall be deemed to comply with breaking force; requirements provided the value so arrived is more than the minimum breaking force required.

10.3 Tests on Individual Wires

When specified in the order the following procedure for testing of wires from the completed rope shall be adopted (Individual wire for compacted wire ropes and swaged wire ropes to be tested prior to rope manufacture only as per 10.1)

10.3.1 *Sampling Procedure*

Approximately one meter length of rope sample shall be cut-off from the parent reel/coil and unstranded the wires, excluding all core wires, filer wires and the main core wires. The wires belonging to each layer and location in the strand shall then be segregated and mixed in separate groups (layer and location wise).

10.3.1.1 Six sets of nine wires each (total 54 wires) shall then be chosen, out of these segregated groups representing proportionately wire samples from each group (with a minimum of one number for each set) by the purchaser or his representative and shall be tested in the following manner:

a) Nine for the tensile test;
b) Nine for the torsion test;
c) Nine for the reverse bend test;
d) Nine for a repeat tensile test in case of failure;
e) Nine for a repeat torsion test in case of failure; and
f) Nine for a repeat reverse bend test in case of failure.

10.3.1.2 For ropes of 6 × 7, 6 × 8 and 6 × 9 constructions, where the total number of main wires are less than 54, the number of wires for each set shall be chosen as six instead of nine (total 36 wires) and shall be tested similarly as indicated in **10.3.1.1**.

10.3.1.3 The wires meant for tensile test may also be utilized for measuring the diameter of wires.

10.3.1.4 If the purchaser also requires galvanizing test, this shall be carried out on six wires from the set of wires reserved for repeat test.

10.3.2 *Tensile Test*

Test samples taken in the manner described in **10.3.1.1** and **10.3.1.2** and tested in the manner described in IS 1608 (Part 1), shall show a tensile strength in accordance with IS 1835, subjected to a reduction of not more than 50 N/mm^2 from the minimum value for the particular size and tensile designation of the wire.

10.3.3 *Torsion Test*

The test shall be carried out in the manner described in IS 1717 and shall comply with the appropriate requirements of IS 1835, except that the minimum number of torsion may be 75 percent (to the nearest whole number of torsion) of those specified therein.

10.3.4 *Reverse Bend Test*

The wires shall be tested in accordance with IS 1716 and shall comply with the appropriate requirements of IS 1835, except that the minimum number of reverse bend may be 80 percent (to the nearest whole number of bend) of those specified therein.

10.3.5 *Galvanizing Test*

The tests for zinc coating shall be carried out in accordance with IS 6745 and IS 2633, and shall comply with the requirements of IS 1835 allowing a reduction up to 5 percent of the minimum mass of the zinc coating values specified and a reduction of one dip of ‘half minute’ duration than the specified number in the respective specifications mentioned above.

10.3.6 *Diameter of Wire*

The wire shall comply with IS 1835, with respect to the tolerance of diameter.

11 RETEST

If two or more wires fail to comply with any one of the tests specified in **10.3.1.1** and **10.3.1.2** to **10.3.6**, retest shall be made; but, shall be limited to the test under which the failure occurred. If in the retest even two wires fail in any one test the rope represented by the sample shall be deemed not to comply with the specification.

12 INDEPENDENT TEST ON COMPLETED ROPE

12.1 If the purchaser is not satisfied with the tests, the manufacturer shall be at liberty to have tests carried out by an independent testing authority agreed to between the purchaser and the manufacturer, and if the results of such tests are satisfactory the rope shall be deemed to comply with the standard.

12.2 Such independent tests shall be carried out in accordance with the provisions of this standard.

13 CERTIFICATE OF TEST

With each coil or reel of completed rope the manufacturer shall supply a certificate of test. The form of the certificate shall be as indicated in Annex C.

14 MARKING

14.1 Each steel wire ropes and strands shall have the following information marked on a suitable tag in a permanent and legible manner in a location where it is accessible and visible:

a) Name and address of the manufacturer;
b) The size and length of the wire ropes;
c) Rope grade;
d) Lay and core of the wire rope;
e) Coating of rope wires;
f) Reel or coil number along with the order number of purchaser;

In case if wire ropes are supplied in reels, the information may be mentioned on both sides of the reels or on one side and a suitable tag giving the same information may be attached on the other side of the reel.

14.2 BIS Certification Marking

Each steel wire ropes and strands may also be marked with the Standard Mark.

14.2.1 The use of the Standard Mark is governed by the provisions of *Bureau of Indian Standards Act, 2016* and the Rules and Regulations made thereunder. The details of the conditions under which the licence for use of the Standard Mark may be granted to manufacturers or producers may be obtained from the Bureau of Indian Standards.

15 PACKING

The rope shall be suitably protected to avoid damage in transit and corrosion. Ropes of ordinary lay may be supplied in coils or reels as required by the purchaser.

NOTE — Lang's lay ropes and multi strand rotation-resistant ropes should preferably be supplied on reels unless specified otherwise.

ANNEX A

(*Clauses* 5.1 *and* 5.2)

METHOD FOR MEASURING THE DIAMETER OF WIRE ROPE

A-1 The actual diameter of wire ropes shall be measured with a suitable calliper, fitted with jaws broad enough to cover two or more adjacent strands as shown in Fig. 4.

The measurements shall be taken on a straight portion of the rope without tension at two points, spaced at least one meter apart, and at each point two readings of diameter at approximately right angles to each other. The average of these four measurements shall be within the tolerances specified with reference to the nominal diameter.

A-2 Alternatively, the measurement shall be taken on a straight portion of the rope without tension at three points, spaced at least one meter apart and at each point two readings of diameter at approximately at right angles to each other by a normal Vernier calliper. The average of these six measurements shall be within the tolerances specified with reference to the nominal diameter.

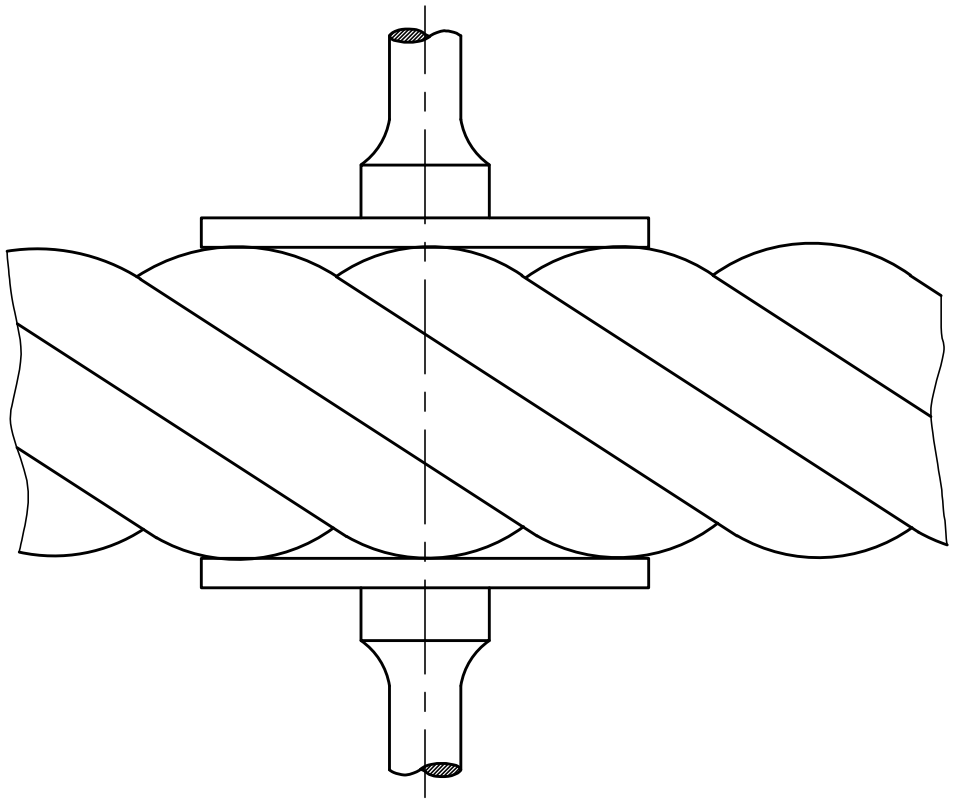


FIG. 4 METHOD OF MEASURING ROPE DIAMETER

ANNEX B

(*Clauses* 10.2.1)

METHOD OF DETERMINATION OF BREAKING STRENGTH

B-1 TESTING MACHINE

A testing machine of suitable capacity and certified accuracy shall be used. The machine shall be subjected to the approval of the purchaser and the manufacturer or their representatives.

B-2 TEST LENGTHS

The test length (distance between the grips) shall be as given in Fig. 2.

B-3 TEST PIECE

B-3.1 The minimum length of the test piece is made up of the test length plus an allowance for gripping.

B-3.2 The test piece shall be representative of the rope as a whole and free from defects. Prior to selection, the ends of the test piece shall be secured to prevent turn being put into or taken out of the test piece. In the same way, the rope from which the test piece is taken shall be secured. When cutting the test piece from the rope, neither the test piece nor the rope shall be damaged.

During testing, the test piece shall be gripped in such a way that all wires in the rope take part in the acceptance of the applied force. It may be useful to provide the test piece with conical sockets. If such sockets are used, care shall be taken so that the casting material penetrates well to ensure intimate cohesion with the untwisted wires.

B-4 TESTING

B-4.1 Not more than 80 percent of the minimum breaking force given in relevant rope, specification may be applied quickly; the remaining force shall be applied slowly, at a rate of application of force not more than 0.5 percent of minimum breaking force per second

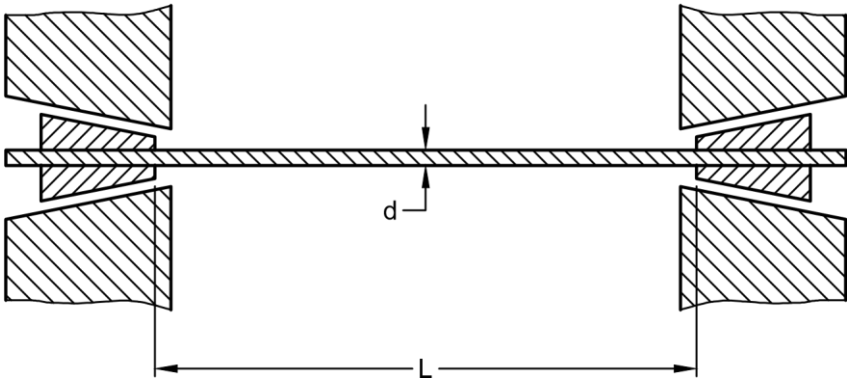
B-4.2 The actual breaking force is reached when no further increase of force is possible.

B-4.3 Tests in which breakage occurs inside or adjacent to the grips failing to achieve the required minimum breaking force may be discarded at the option of the manufacturer and a retest may be conducted.

B-4.4 The elongation of the rope under test shall be measured and a graph indicating the load extension shall be supplied if agreed in the order.

B-5 The test report may also include the following particulars if required by the purchaser:

a) The reference to the method used, that is, this Indian Standard;
b) The results, in terms of magnitude and unit;
c) Any unusual features noted during the test;
d) Any operation not included in this Indian Standard or regarded as optional; and
e) The elongation of test piece in percentage at 80 percent of minimum breaking force.



Rope diameter (d) mm	Minimum Test Length (L) mm
$d \leq 6$	300
$6 \leq d \leq 20$	600
$d > 20$	$30 \times d$

Fig. 5 TEST LENGTHS

ANNEX C

(*Clauses* 13)

PROFORMA FOR THE CERTIFICATE OF TEST AND EXAINATION OF REEL

Certificate No. …… Reel/Coil No. ……

A) Name and address of maker or supplier of rope ……..

B) Particulars of rope

1) Diameter of rope : ……..
2) Number of strand : ……..
3) Number of wires per strand : ……..
4) Lay : ……..
5) Coating : ……..

C) Rope grade : ……

1) Date of test of sample of rope: ……
2) Breaking force of rope (Aggregate/Actual): ……...

D) Name and address of test house making test and examination: ……..

E) Name and designation of signatory of test house conducting the test and examination: ……

……

F) Any other details: ……

I certify that the above particulars are correct and that the wire rope conforms to IS ……..

…….
Signature of competent person
Date : ……..

ANNEX D

(*Clauses* 6.1 *and Foreword*)

CONNECTING SYMBOLS FOR STRAND, ROPE AND CORE

D-1 ARRANGEMENT OF WIRES IN STRAND

Type of Strand	*Connecting Symbol*	*Illustration*
Single operation (equal lay or parallel lay)	Dash(—)	9-9-1 12-6F-6-1
Multiple operation in same direction (cross lay)	Oblique stroke(/)	12/6-1 18/12/6-1
Multiple operation in opposite direction (contra lay)	Colon (:)	12:6-1 18:12:6-1
Warrington layer	Plus sign (+)	6+6-6-1 14-7+7-7-1
Strand centre	Dash (—)	6-1 12-F (Fibre)

D-2 ARRANGEMENT OF STRANDS IN ROPE

Type of Strand	*Connecting Symbol*	*Illustration*
General rope with one layer of strands	Cross sign (×) between number of strands and number of wires per strand	6 × 19S-CF
Core Fibre (CF)	Dash (—)	
Rotation-resistant :	Colon (:)	11 × 7:6 ×
Multi-operation (2 layer) contra lay between outer layer and fist layer of strands		7-CF
Core Fibre (CF)	Dash (—)	
Rotation-resistant :	Colon (:)	18 × 7 : 12
Multi-operation (3 layers) contra lay between outer layer and second layer and cross lay between second and fist lay	Oblique stroke (/)	× 7/6 × 7- CWS
Core Wire Strand (CWS)	Dash (—)	

ANNEX E
(*Foreword*)

INFORMATION TO BE GIVEN WITH THE ENQUIRY OR ORDER

E-1 The following particulars should be given with the enquiry or order:

a) Length and points between which measurements are to be taken;
b) Nominal diameter;
c) Material of the core, fire or steel;
d) Construction of rope;
e) The type of galvanizing, if required: Type .....;
f) Preformed or non-preformed;
g) Rope grade;
h) Breaking force of rope;
j) Whether ordinary lay or Lang's lay, right hand or left hand;
k) Particulars of ends and fittings, whether spliced, socketed or plain, with sketches indicating dimensions if limiting conditions apply;
m) Particulars of inspection and tests required;
n) Whether to be delivered on reels or in coils;
p) "As per IS ...." under which the rope to be supplied; and
q) Additional particulars relevant to standard, if required.

E-2 If the purchaser is uncertain about any of these particulars; reference shall be made to the rope maker, giving details of rope application that is:

a) Particulars of ends and fittings, whether spliced, socketed or plain, with sketches indicating dimensions if limiting conditions apply;
b) Particulars of inspection and tests required;
c) Whether to be delivered on reels or in coils;
d) "As per IS ...." under which the rope to be supplied; and
e) Additional particulars relevant to standard, if required.

ANNEX F

(*Foreword*)

INFORMATION TO BE GIVEN WITH THE MANUFACTURER, IF REQUIRED

F-1 The following information should be given by the manufacturer, if required:

a) Length of the rope and points between which measurements are to be taken;
b) Nominal diameter of rope;
c) Details of construction:
    1) Lang's number of strands;
    2) Lang's construction of strands; and
    3) Lang's whether ordinary lay or Lang's lay right hand or left hand; preformed or non-preformed;
d) Quality of material and designation and tensile range of wire;
e) Material of use;
f) The type of galvanizing, Type .....;
g) Lubricant used;
h) Minimum breaking force of completed rope; and
j) Particulars of end fittings, when specified.