BRITISH STANDARD

BS ISO
10425:2003

Steel wire ropes for the petroleum and natural gas industries — Minimum requirements and terms of acceptance

ICS 75.180.10; 77.140.65

BSi
British Standards

National foreword

This British Standard reproduces verbatim ISO 10425:2003 and implements it as the UK national standard.

The UK participation in its preparation was entrusted to Technical Committee MHE/2, Wire ropes, which has the responsibility to:

— aid enquirers to understand the text;

— present to the responsible international/European committee any enquiries on the interpretation, or proposals for change, and keep the UK interests informed;

— monitor related international and European developments and promulgate them in the UK.

A list of organizations represented on this committee can be obtained on request to its secretary.

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INTERNATIONAL STANDARD

ISO 10425

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Steel wire ropes for the petroleum and natural gas industries — Minimum requirements and terms of acceptance

Câbles en acier pour les industries du pétrole et du gaz naturel — Exigences minimales et conditions de réception

Reference number
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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

The main task of technical committees is to prepare International Standards. Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

ISO 10425 was prepared by Technical Committee ISO/TC 105, *Steel wire ropes*.

Introduction

This International Standard is based upon API[1)] Specification 9A, 24th edition, June 1995.

This International Standard was developed in response to worldwide demand for minimum specifications for ropes for use on equipment and machinery associated with the petroleum and natural gas industries.

In recognition of equipment already in use and originally designed to accommodate rope sizes (nominal rope diameters) based on “English” units, some of the more common “converted SI unit” sizes have also been included.

In addition, and in recognition of equipment already in use and designed to operate with ropes having specific rope grades (e.g. IPS), based on “US” wire levels, these grades have also been included in order to give prominence to the required minimum values of breaking force associated with these grades and help to ensure that existing design safety levels are maintained.

Having due regard to size and breaking force for a particular rope class or construction, in some cases it is possible to safely substitute a US customary size and grade with one based solely on SI units and grade, and vice-versa. To assist in this process, this International Standard gives a size range for each nominal rope diameter and equivalent minimum breaking forces (converted from US customary units) for comparison, although it is recommended that the equipment designer or rope manufacturer (or other competent person) is consulted prior to ordering a substitute rope.

It should also be noted that a particular design of rope may be capable of offering a higher breaking force value than the one specified either in the relevant table in this International Standard or by the manufacturer in his catalogue. In such cases, a higher minimum breaking force value (or actual breaking force value if the rope has already been manufactured and tested) may be provided by the manufacturer before an order is placed.

Designers of new equipment are encouraged to select ropes having the preferred SI units and grades.

To complement this International Standard, ISO 17893, covering definitions, designation and classification, has been prepared.

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1) American Petroleum Institute, 1220 L Street NW, Washington D.C. 20005, USA.

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Steel wire ropes for the petroleum and natural gas industries — Minimum requirements and terms of acceptance

1 Scope

This International Standard specifies the minimum requirements and terms of acceptance for the manufacture and testing of steel wire ropes not exceeding rope grade 2160 for the petroleum and natural gas industries.

Typical applications include tubing lines, rod hanger lines, sand lines, cable-tool drilling and clean out lines, cable tool casing lines, rotary drilling lines, winch lines, horse head pumping unit lines, torpedo lines, mast-raising lines, guideline tensioner lines, riser tensioner lines, mooring and anchor lines. Ropes for lifting slings and cranes, and wire for well-measuring and strand for well-servicing, are also included.

The minimum breaking forces for the more common sizes, grades and constructions of stranded rope are given in tables. However, this International Standard does not restrict itself to the classes covered by those tables. Other types, such as ropes with compacted strands and compacted (swaged) ropes, may also conform with its requirements. The minimum breaking force values for these ropes are provided by the manufacturer.

For information only, other tables present the minimum breaking forces for large diameter stranded and spiral ropes (i.e. spiral strand and locked coil), while approximate nominal length masses for the more common stranded rope constructions and large diameter stranded and spiral ropes are also given.

2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 2232:1990, *Round drawn wire for general purpose non-alloy steel wire ropes and for large diameter steel wire ropes — Specifications*

ISO 4345, *Steel wire ropes — Fibre main cores — Specification*

ISO 4346, *Steel wire ropes for general purposes — Lubricants — Basic requirements*

ISO 6892, *Metallic materials — Tensile testing at ambient temperature*

ISO 7500-1, *Metallic materials — Verification of static uniaxial testing machines — Part 1: Tension/compression testing machines — Verification and calibration of the force-measuring system*

ISO 7800, *Metallic materials — Wire — Simple torsion test*

ISO 7801, *Metallic materials — Wire — Reverse bend test*

ISO 17893[2)], *Steel wire ropes — Definitions, designations and classifications*

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2) To be published.

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 17893 apply.

4 Requirements

4.1 Material

4.1.1 Wire

The wires for stranded ropes and well-servicing strand of carbon steel shall, before rope fabrication, conform to the diameter, tensile, torsion and, when applicable, zinc-coating requirements specified in Annex A.

The methods of test for wires of tensile strength grades 1 370 N/mm^2, 1 570 N/mm^2, 1 770 N/mm^2, 1 960 N/mm^2 and 2 160 N/mm^2 shall be in accordance with those given in ISO 2232.

The methods of test for wires of tensile strength grades Levels 2, 3, 4 and 5 shall be in accordance with Annex B.

For those ropes where a rope grade is applicable, the tensile strength grade of the wires shall be subject to the limits given in Table 1.

NOTE The minimum breaking force values of those ropes of grades 1770, 1960 and 2160 as covered by the tables are calculated on the basis of rope grade and not individual wire tensile strength grades or levels.

Table 1 — Range of wire tensile strength grades

Rope grade	Wire tensile strength grades N/mm^2
1770	1 570 or Level 2 to 1 960 or Level 4
1960	1 770 or Level 3 to 2 160 or Level 5
2160	1 960 or Level 4 to 2 160 or Level 5
IPS	Level 2 or 1 570 to Level 4 or 1 960
EIP	Level 3 or 1 770 to Level 5 or 2 160
EEIP	Level 4 or 1 960 to Level 5 or 2 160

For those ropes (e.g. larger diameter ropes) where a rope grade is not applicable, the tensile strength grades of the wires shall be one, or a combination, of those given in Annex A.

All wires of the same nominal diameter in the same wire layer shall be of the same tensile strength grade.

Well-measuring wire and wires used in the manufacture of well-servicing strand shall normally be of carbon steel but other materials (e.g. stainless steel) may be used.

The purchaser should specify any particular material requirements.

4.1.2 Core

Cores of stranded ropes shall normally be of steel or fibre, although other types, such as composites (e.g. steel plus fibres or plastics) or cores made of solid polymer, may also be supplied.

The purchaser should specify the type of core.

Fibre cores shall conform to ISO 4345.

The fibre cores for single-layer stranded ropes larger than 8 mm diameter shall be doubly closed (i.e. from yarn into strand and from strand into rope). Natural fibre cores shall be treated with an impregnating compound to inhibit rotting and decay.

Steel cores shall be either an independent wire rope (IWRC) or wire strand (WSC).

Steel cores of single-layer stranded ropes larger than 12 mm diameter shall be an independent wire rope (IWRC), unless specified otherwise.

4.1.3 Lubricant

Lubricants shall conform to ISO 4346.

4.2 Rope manufacture

4.2.1 General

In stranded ropes, all the wire layers in a strand shall have the same direction of lay. The lay lengths of corresponding wire layers in strands of the same size, construction and strand layer shall be uniform.

The core of a stranded rope, except for compacted (swaged) ropes, shall be designed (steel) or selected (fibre) so that in a new rope under no load there is clearance between outer strands.

The rope ends shall be secured such that they are prevented from unlaying

4.2.2 Wire joints

Diameters shall be continuous, but, for wires other than well-measuring wires, if joints are necessary in wires over 0,4 mm they shall have their ends joined by brazing or welding.

For stranded ropes, the minimum distance between joints within one strand shall be 18 × rope diameter (d).

For spiral ropes, the minimum distance between joints in any wire layer shall be 36 × diameter of the wire layer.

Wires up to and including 0,4 mm may be joined by twisting or by ends being simply inserted into the strands' formation.

4.2.3 Preformation and postformation

Stranded ropes shall be preformed or postformed or both, unless specified otherwise by the purchaser.

NOTE Some parallel-closed ropes and rotation-resistant ropes may be non-preformed.

4.2.4 Construction

The rope construction shall be either one of those covered in Annex G or as stated by the manufacturer.

The constructions of compacted strand ropes, compacted (swaged) ropes, large diameter (i.e. over 60 mm) stranded ropes and spiral ropes (i.e. spiral strand and full-locked coil) shall be stated by the manufacturer.

Where only the rope class is specified by the purchaser, the construction supplied shall be stated by the manufacturer.

For well-servicing strand, the construction shall be either 1 × 16M or 1 × 19M or as stated by the manufacturer.

4.2.5 Rope grade

The rope grades for the more common classes and sizes of stranded ropes shall be as given in Annex G.

Intermediate grades may be supplied by agreement between the purchaser and the manufacturer or supplier.

NOTE Not all ropes (e.g. large diameter stranded ropes and spiral ropes) will necessarily have a nominated rope grade.

4.2.6 Wire finish

The finish of the wires shall be uncoated (bright), zinc-coated class B or zinc-coated class A.

For ropes of bright wire finish, substitution of bright wires by zinc-coated wires shall be limited to inner wires, centre wires, filler wires and core wires.

For ropes of zinc-coated wire finish, all of the wires shall be zinc-coated, including those of any steel core.

Where zinc-coated is specified, this may also include zinc alloy Zn95/Al5.

4.2.7 Direction and type of rope lay

The direction and type of rope lay for stranded ropes shall be one of the following:

a) right ordinary lay (sZ)[3)];

b) left ordinary lay (zS)[4)];

c) right lang lay (zZ)[5)];

d) left lang lay (sS)[6)];

e) right alternate lay (aZ)[7)];

f) left alternate lay (aS)[8)].

Well-servicing strand shall be left lay (S).

Spiral ropes (i.e. spiral strand and full locked coil) shall be either right (Z) or left lay (S).

The direction and type of rope lay should be specified by the purchaser.

4.2.8 Designation and classification

For the purposes of this International Standard, the designation and classification systems according to ISO 17893 shall apply.

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3) Formerly referred to as right-hand ordinary (designated RHO) and right regular lay (designated RRL).

4) Formerly referred to as left-hand ordinary (designated LHO) and left regular lay (designated LRL).

5) Formerly referred to as right-hand langs (designated RHL) or right lang lay (designated RLL).

6) Formerly referred to as left-hand langs (designated LHL) or left lang lay (designated LLL).

7) Formerly designated RAL.

8) Formerly designated LAL.

4.3 Diameter

4.3.1 General

The nominal diameter shall be that by which the wire, strand or rope is designated.

4.3.2 Tolerance

When measured in accordance with 5.1.3, the measured (actual) diameter of stranded ropes shall be within the tolerances given in Table 2.

Table 2 — Tolerances on rope diameter (stranded rope)

Nominal rope diameter d mm	Tolerance as percentage of nominal diameter	
	Ropes with strands that are exclusively of wire or incorporate solid polymer centres	Ropes with strands that incorporate fibre centres
2 u d < 4	+8	+9 0
4 u d < 6	+7	+9 0
6 u d < 8	+6	+8 0
W 8	+6	+7 0

When measured in accordance with 5.1.3, the measured (actual) diameter of spiral ropes shall be within + of the nominal diameter.

5

0 %

When measured in accordance with 5.1.3, the measured (actual) diameter of well-servicing strand shall be within the tolerances given in Annex D.

4.3.3 Difference between diameter measurements

For stranded and spiral ropes, the difference between any two of the four measurements taken in accordance with 5.1.3 and expressed as a percentage of the nominal diameter shall not exceed the values given in Table 3.

Table 3 — Permissible differences between any two diameter measurements

Nominal rope diameter d	Ropes with strands that are exclusively of wire or incorporate solid polymer centres and spiral ropes	Ropes with strands that incorporate fibre centres
mm	%	%
2 u d < 4	7	—
4 u d < 6	6	8
6 u d < 8	5	7
W 8	4	6

4.4 Lay length

For single-layer ropes of 6 × 7 class, the length of lay of the finished rope shall not exceed 8 × rope diameter (d).

For other single-layer ropes with round strands (except those with three or four strands), parallel-lay closed ropes and rotation-resistant ropes with round strands or shaped strands, the length of lay of the finished rope shall not exceed 7,25 × rope diameter (d).

For single-layer ropes with shaped strands, e.g. triangular strand, the length of lay of the finished rope shall not exceed 10 × rope diameter (d).

For well-servicing strand, the length of lay of the finished strand shall not exceed 10 × strand diameter (d).

4.5 Breaking force

4.5.1 Well-measuring wire

The minimum breaking force for a given diameter of well-measuring wire shall be as given in Clause C.1.

When tested in accordance with the method specified in Clause C.2, the measured breaking force shall be greater than or equal to the minimum breaking force.

4.5.2 Well-servicing strand

The minimum breaking force for a given diameter and construction shall be either

a) as given in Annex D, or

b) as stated by the manufacturer.

When tested in accordance with Method 1 (see 5.1.4.1), the measured breaking force shall be greater than or equal to the minimum breaking force.

4.5.3 Stranded ropes and spiral ropes

4.5.3.1 General

The minimum breaking force, F_{min}, for a given rope diameter and construction shall be either

a) as given in Annex G for stranded ropes, or

b) as stated by the manufacturer.

NOTE 1 Values of minimum breaking force for large diameter stranded and spiral ropes are given for information in Annex J.

For those ropes covered in Annex G, the minimum breaking force of intermediate rope diameters shall be calculated with the respective minimum breaking force factors in accordance with Annex F.

When tested in accordance with Method 1 of 5.1.4.1, the measured breaking force, F_m, shall be greater than or equal to the minimum breaking force, F_{min}.

Breaking force testing requirements shall be in accordance with Table 4.

NOTE 2 The requirements for breaking force take into account: (i) the rope size; (ii) whether or not ropes are produced in series, i.e. repeatedly produced; (iii) whether or not the minimum breaking force factor is consistent throughout a range of diameters; (iv) whether or not the manufacturer is operating a quality system in accordance with ISO 9001, certified by an accredited third party certification body.

4.5.3.2 Ropes produced in series — Manufacturer operating a quality system in accordance with ISO 9001, certified by an accredited third party certification body

The manufacturer shall be able to provide the results from type testing in accordance with the sampling and acceptance criteria given in Annex H.

Type testing shall be repeated on any rope that has its design changed in any way which results in a modified (e.g. increased) breaking force. If the same design, apart from wire tensile strength grades, is used for ropes of a lower grade or lower breaking force, or both, than the one which has successfully passed the type testing requirements, it shall not be necessary to repeat the tests on those ropes provided the breaking force is calculated with the same spinning loss.

Subsequent production lengths of ropes produced in series shall be deemed to conform to the breaking force requirements when the manufacturer has satisfactorily completed

a) the appropriate type tests (see Annex H), and

b) a periodic breaking force test in accordance with Method 1 or one of the alternative methods, known as Methods 2 and 3 (see 5.1.4.2 and 5.1.4.3),

on a sample from every twentieth production length.

Table 4 — Breaking force testing requirements

Rope diameter d mm	Min. breaking force factor	Manufacturer operating a quality system in accordance with ISO 9001, certified by an accredited third party certification body	Manufacturer NOT operating a quality system in accordance with ISO 9001, certified by an accredited third party certification body
d u 60	Same factor throughout a sub-group of rope diameters	Breaking force test in accordance with 5.1.4.1 (Method 1) on a sample from each production length; or, if produced in series, Type testing in accordance with H.1.1 plus periodic test in accordance with 5.1.4.1 (Method 1), 5.1.4.2 (Method 2) or 5.1.4.3 (Method 3) on a sample from every twentieth production length relating to the sub-group of diameters.	Breaking force test in accordance with 5.1.4.1 (Method 1) on a sample from each production length.
	Different factor throughout a sub-group of rope diameters	Breaking force test in accordance with 5.1.4.1 (Method 1) on a sample from each production length; or, if produced in series, Type testing in accordance with Annex H.1.2 plus periodic test in accordance with 5.1.4.1 (Method 1), 5.1.4.2 (Method 2) or 5.1.4.3 (Method 3) on a sample from every twentieth production length of a given rope diameter and construction.	Breaking force test in accordance with 5.1.4.1 (Method 1) on a sample from each production length.
d > 60		Breaking force test in accordance with 5.1.4.1 (Method 1), 5.1.4.2 (Method 2) or 5.1.4.3 (Method 3) on a sample from each production length, or either of the following: a) if produced in series, type testing in accordance with Clause H.2 plus periodic test in accordance with 5.1.4.1 (Method 1), 5.1.4.2 (Method 2) or 5.1.4.3 (Method 3) on a sample from every twentieth production length; or b) if produced for supply as a set of ropes of the same design for a specific installation, the alternative breaking force testing and sampling as also given in Clause H.2.	Breaking force test in accordance with 5.1.4.1 (Method 1), 5.1.4.2 (Method 2) or 5.1.4.3 (Method 3) on a sample from each production length.

NOTE The result from Method 1 is known as measured breaking force. The result from Method 2 is known as calculated measured (post-spin) breaking force. The result from Method 3 is known as calculated measured (pre-spin) breaking force.

4.6 Length

For those ropes not forming part of an assembly, the actual length of rope supplied shall be the specified nominal length subject to the following tolerances.

a) Up to and including 400 m: $^{5}_{0}$ %

$^{+}$ of the specified length.

b) Over 400 m, up to and including 1 000 m: $^{20}_{0}$ m

$^{+}$.

c) Over 1 000 m: $^{2}_{0}$ %

$^{+}$ of the specified length.

The rope shall be measured under no load.

Ropes required with smaller length tolerance should be the subject of agreement between the purchaser and the manufacturer.

5 Verification of requirements and test methods

5.1 Stranded ropes and spiral ropes

5.1.1 Materials

Compliance with the wire, core and lubricant requirements shall be through a visual verification of the inspection documents supplied with the wire, core and lubricant.

5.1.2 Rope manufacture

Compliance with the requirements for wire joints and preformation shall be through visual verification.

5.1.3 Test on rope for diameter

Diameter measurements shall be taken on a straight portion of rope, either under no tension or a tension not exceeding 5 % of the minimum breaking force, at two positions spaced at least 1 m apart. At each position, two measurements, at right angles, of the circumscribed circle diameter shall be taken. The measuring equipment shall extend over at least two adjacent strands (see Figure 1). The average of these four measurements shall be the measured diameter.

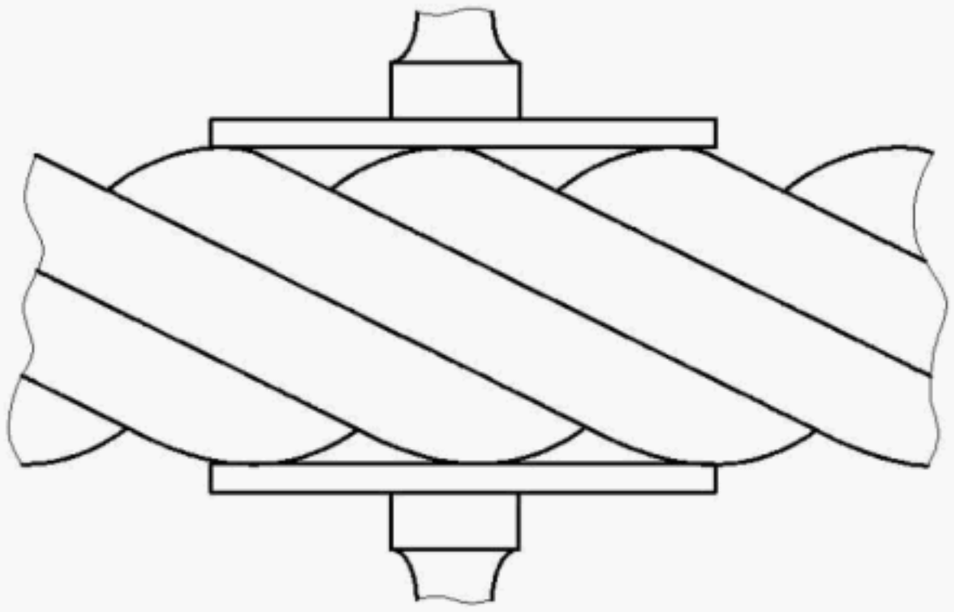


Figure 1 — Method of measuring rope diameter

5.1.4 Test on rope for breaking force

5.1.4.1 Method 1 — Measured breaking force

The method shall be in accordance with Annex E.

The rope shall be deemed to have satisfied the breaking force requirement when the measured breaking force reaches or exceeds the minimum value.

When the minimum breaking force is not reached, three additional tests may be carried out, one of which shall achieve or exceed the minimum breaking force value.

5.1.4.2 Method 2 — Calculated measured (post-spin) breaking force

Add together the measured breaking forces of all individual wires after they have been removed from the rope and multiply this value by either

a) the spinning loss factor derived from Annex F, or

b) the partial spinning loss factor obtained from the results of type testing.

The partial spinning loss factor used in the calculation shall be the lowest of the three values obtained from type testing.

In the case of triangular strand ropes, the triangular centre of the strand may be considered as an individual wire.

Test the wires in accordance with the wire tensile test specified in Clause B.2 or in ISO 6892.

NOTE The result from this test is known as the “calculated measured (post-spin) breaking force”.

When this method (i.e. Method 2) is used for the periodic test (see Table 4) and the calculated measured (post-spin) breaking force value is less than the intended minimum breaking force value, carry out another test using Method 1.

If the measured (actual) breaking force in this second test fails to meet the intended minimum breaking force value, de-rate the minimum breaking force to a value not exceeding the measured (actual) breaking force value and repeat the type testing using Method 1.

In such cases, either de-rate the rope grade in line with the de-rated minimum breaking force value or delete it from the rope designation.

5.1.4.3 Method 3 — Calculated measured (pre-spin) breaking force

Add together the measured breaking forces of all the individual wires before they are laid into the rope and multiply this value by the total spinning loss factor obtained from the results of type testing. The total spinning loss factor used in the calculation shall be the lowest of the three values obtained from type testing.

The wires shall be tested in accordance with the wire tensile test specified in ISO 6892.

NOTE The result from this test is known as the “calculated measured (pre-spin) breaking force”.

When this method (i.e. Method 3) is used for the periodic test (see Table 4) and the calculated measured (pre-spin) breaking force value is less than the intended minimum breaking force value, carry out another test using Method 1.

If the measured (actual) breaking force in this second test fails to meet the intended minimum breaking force value, de-rate the minimum breaking force to a value not exceeding the measured (actual) breaking force value and repeat the type testing using Method 1.

In such cases, either de-rate the rope grade in line with the de-rated minimum breaking force value or delete it from the rope designation.

5.1.5 Tests on wires from the rope

When tests, if any, are required to be performed on wires taken from the rope after fabrication, and unless specified otherwise by the purchaser, sampling, test methods and acceptance criteria shall be in accordance with Annex I.

If tests on the wires are required to be carried out, this should be stated in the purchaser’s order.

5.2 Tests on well-measuring wire

The tests shall consist of a simultaneous elongation and tensile test and a separate torsion test. Testing methods and acceptance criteria shall be in accordance with Annex C.

5.3 Tests on well-servicing strands

The tests shall consist of a measured diameter in accordance with 5.1.3 and a breaking force test in accordance with 5.1.4.1.

5.4 Facilities for witnessing tests

The manufacturer shall offer the purchaser or purchaser's representative all necessary facilities for the witnessing of tests (when these are performed) or for the examination of records of type tests in order to be assured of compliance with this International Standard, or both.

Test lengths required by the purchaser should be ordered as additional lengths.

6 Information for use

6.1 Certificate

6.1.1 General

A certificate shall confirm conformance with this International Standard and, unless specified otherwise by the purchaser, shall give at least the following information:

a) certificate number;

b) name and address of the manufacturer;

c) rope designation or rope description;

d) minimum breaking force;

e) date of issue of the certificate and authentication.

Quantity and nominal length of rope may also be included

The certificate shall enable traceability of the rope.

6.1.2 Test results

When actual test results are required to be certified (see above), the certificate shall additionally give either a) or b) or both, as follows:

a) breaking force test on rope — state which value, i.e.

   1) measured breaking force, or

   2) calculated measured (post-spin) breaking force, or

   3) calculated measured (pre-spin) breaking force;

b) tests on wires —

1) number of wires tested,

2) nominal dimension of wire,

3) measured dimension of wire (diameter or height of profile),

4) breaking force of wire,

5) tensile strength of wire (based on nominal dimension),

6) number of torsions completed (and test length),

7) mass of coating.

6.2 Packaging and marking

6.2.1 Packaging

Ropes shall be supplied in coils or on reels at the discretion of the manufacturer.

The purchaser should specify any particular packaging requirements.

Rotation-resistant ropes should be supplied on reels.

6.2.2 Marking

The rope manufacturer's or supplier's name and address, certificate number if appropriate (see 6.1), length and rope designation shall be legibly and durably marked on a tag attached to each coil or a plate attached to each reel of rope.

Annex A

(normative)

Dimensional and mechanical properties of round wires (before rope fabrication)

A.1 Tensile strength grades 1 370 N/mm^2, 1 570 N/mm^2, 1 770 N/mm^2, 1 960 N/mm^2 and 2 160 N/mm^2

The permitted variations in tensile strengths of non-alloyed steel wires shall not exceed the nominal values by an amount greater than those given in Table A.1. The values of tensile strength grade are the lower (minima) limits for each tensile strength grade.

Table A.1 — Permitted variations in tensile strength

Nominal diameter mm	Permitted variation in tensile strength above nominal N/mm^2
0,2 u δ < 0,5	390
0,5 u δ <1,0	350
1,0 u δ < 1,5	320
1,5 u δ < 2,0	290
2,0 u δ < 3,5	260
3,5 u δ < 7,0	250

In the case of alloy steel wires, the maximum values shall be no greater than the minimum value plus 15 %.

The diameter tolerances, minimum number of torsions and minimum masses of coating shall be in accordance with the values given in Table A.2.

NOTE The values in Table A.2 are based on ISO 2232 with an extended size range and additional tensile strength grades at the lower and higher ends.

Table A.2 — Diameter tolerances, minimum number of torsions and minimum masses of zinc for tensile strength grades 1 370 N/mm2, 1 570 N/mm2, 1 770 N/mm2, 1 960 N/mm2 and 2 160 N/mm2

Nominal diameter of wire	Tolerance		Min. number of torsions based on 100δ								Min. mass Zn	
	Bright and galv. or Zn95/Al5	Galv. or Zn95/Al5	Bright and galvanized or Zn95/Al5					Galvanized or Zn95/Al5			Galv. or Zn95/Al5	
	Quality B	Quality A	Quality B					Quality A				
mm	mm		Tensile strength grade (N/mm^2)								g/m^2	
			1 370	1 570	1 770	1 960	2 160	1 370	1 570	1 770	1 960	B	A
0,20 u δ < 0,25	± 0,008	—										20	
0,25 u δ < 0,30	± 0,008	—										30	
0,30 u δ < 0,40	± 0,01	± 0,025										30	
0,40 u δ < 0,50	± 0,01	± 0,025										40	75
0,50 u δ < 0,55	± 0,015	± 0,03	34	30	28	25	23					50	90
0,55 u δ < 0,60	± 0,015	± 0,03	34	30	28	25	23					50	90
0,60 u δ < 0,65	± 0,015	± 0,03	34	30	28	25	23					60	120
0,65 u δ < 0,70	± 0,015	± 0,03	34	30	28	25	23					60	120
0,70 u δ < 0,75	± 0,015	± 0,03	34	30	28	25	23		21	19	17	60	120
0,75 u δ < 0,80	± 0,015	± 0,03	34	30	28	25	23		21	19	17	60	120
0,80 u δ < 0,85	± 0,015	± 0,03	34	30	28	25	22		21	19	17	60	140
0,85 u δ < 0,90	± 0,015	± 0,03	34	30	28	25	22		21	19	17	60	140
0,90 u δ < 0,95	± 0,015	± 0,03	34	30	28	25	22		21	19	17	70	150
0,95 u δ < 1,00	± 0,015	± 0,03	34	30	28	25	22		21	19	17	70	150
1,00 u δ < 1,10	± 0,02	± 0,04	33	29	26	23	21		20	18	13	80	160
1,10 u δ < 1,20	± 0,02	± 0,04	33	29	26	23	21		20	18	13	80	160
1,20 u δ < 1,30	± 0,02	± 0,04	33	28	25	22	20		18	15	10	90	170
1,30 u δ < 1,40	± 0,02	± 0,04	33	28	25	22	19		18	15	10	90	170
1,40 u δ < 1,50	± 0,02	± 0,04	33	28	25	22	19		18	15	10	100	180
1,50 u δ < 1,60	± 0,02	± 0,04	33	28	25	22	19		18	15	10	100	180
1,60 u δ < 1,70	± 0,02	± 0,04	33	28	25	22	19		18	15	10	100	200
1,70 u δ < 1,80	± 0,02	± 0,05	33	28	25	22	19		18	15	10	100	200
1,80 u δ < 1,90	± 0,025	± 0,05	32	27	24	21	18		17	14	9	100	200
1,90 u δ < 2,00	± 0,025	± 0,05	32	27	24	21	18		17	14	9	110	215
2,00 u δ < 2,10	± 0,025	± 0,05	32	27	24	21	18		17	14	9	110	215
2,10 u δ < 2,20	± 0,025	± 0,06	32	27	24	21	18		17	14	9	110	215
2,20 u δ < 2,30	± 0,025	± 0,06	31	27	24	21	18	20	17	14	9	125	230
2,30 u δ < 2,40	± 0,025	± 0,06	30	27	24	21	18	20	17	14	9	125	230
2,40 u δ < 2,50	± 0,025	± 0,06	29	26	23	20	18	19	15	12	7	125	230
2,50 u δ < 2,60	± 0,025	± 0,06	29	26	23	20	18	19	15	12	7	125	230
2,60 u δ < 2,70	± 0,025	± 0,06	29	26	23	20	18	19	15	12	7	125	230
2,70 u δ < 2,80	± 0,025	± 0,06	29	26	23	20	18	19	15	12	7	135	240
2,80 u δ < 2,90	±0,03	± 0,07	28	26	23	20	18	19	15	12	7	135	240

Table A.2 (*continued*)

Nominal diameter of wire	Tolerance		Min. number of torsions based on 100δ								Min. mass Zn	
	Bright and galv. or Zn95/Al5	Galv. or Zn95/Al5	Bright and galvanized or Zn95/Al5				Galvanized or Zn95/Al5				Galv. or Zn95/Al5	
	~~Quality B~~	~~Quality A~~	~~Quality B~~				~~Quality A~~					
mm	mm		Tensile strength grade (N/mm^2)								g/m^2	
			1 370	1 570	1 770	1 960	2 160	1 370	1 570	1 770	1 960	B	A
2,90 u δ < 3,00	± 0,03	± 0,07	28	26	23	20	18	18	15	12	7	135	240
3,00 u δ < 3,10	± 0,03	± 0,07	27	25	21	18	16	18	12	8	5	135	240
3,10 u δ < 3,20	± 0,03	± 0,07	27	25	21	18	16	13	12	8	5	135	240
3,20 u δ < 3,30	± 0,03	± 0,07	27	25	21	18	16	13	12	8	5	135	250
3,30 u δ < 3,40	± 0,03	± 0,07	27	25	21	18	16	13	12	8	5	135	250
3,40 u δ < 3,50	± 0,03	± 0,07	27	25	21	18	16	13	12	8	5	135	250
3,50 u δ < 3,60	± 0,03	± 0,07	26	24	20	16	14	11	10	6	5	135	250
3,60 u δ < 3,70	± 0,03	± 0,07	26	24	20	16	14	11	10	6	5	135	260
3,70 u δ < 3,80	± 0,03	± 0,07	25	23	19	15	13	11	8	6	5	135	260
3,80 u δ < 3,90	± 0,03	± 0,07	24	22	18	14	12	11	7	6	4	135	260
3,90 u δ < 4,00	± 0,03	± 0,07	24	22	18	14	12	10	7	6	4	135	260
4,00 u δ < 4,20	± 0,03	± 0,08	23	21	17	13	11	9	6	6	4	150	275
4,20 u δ < 4,40	± 0,03	± 0,08	21	19	15	11		8	6	5	4	150	275
4,40 u δ < 4,60	± 0,03	± 0,08	20	18	14	10		7	6	5		150	275
4,60 u δ < 4,80	± 0,03	± 0,08	18	16	12	8		6	5	4		150	275
4,80 u δ < 5,00	± 0,03	± 0,08	17	14	11	7		5	4	3		150	275
5,00 u δ < 5,20	± 0,03	± 0,08	17	14	11	7		5	4	3		150	300
~~5,20 u δ < 5,40~~	~~± 0,03~~	~~± 0,08~~	~~14~~	~~12~~	~~10~~			~~5~~	~~4~~	~~3~~		~~160~~	~~300~~
5,40 u δ < 5,60	± 0,04	± 0,09	12	10	8			4	3	2		160	300
5,60 u δ < 5,80	± 0,04	± 0,09	10	8	6			3	2	2		160	300
5,80 u δ < 6,00	± 0,04	± 0,09	8	6	6			3	2	2		160	300
6,00 u δ < 6,25	± 0,04	± 0,09	8	6	6			3	2	2		160	300
~~6,25 u δ < 6,50~~	~~± 0,04~~	~~± 0,09~~	~~7~~	~~6~~	~~5~~			~~2~~	~~2~~			~~160~~	~~300~~
6,50 u δ < 6,75	± 0,04	± 0,09	6	5	4			2	2			160	300
6,75 u δ < 7,00	± 0,04	± 0,10	6	5	4			2	2			160	300

A.2 Tensile strength grades Levels 2, 3, 4 and 5

The diameter tolerances of bright and drawn galvanized wires shall be in accordance with Table A.3.

The diameter tolerances of final galvanized wires shall be in accordance with Table A.4.

The individual minimum breaking loads of bright and drawn galvanized wires and minimum number of torsions shall be in accordance with Table A.5.

The individual minimum breaking loads and torsions of final galvanized wires shall be in accordance with those given in Table A.5 — subject to a reduction of 10 %.

The maximum values of tensile strength shall be no more than 207 N/mm^2 (30 000lb/in^2) greater than the minimum values.

The minimum masses of zinc for drawn galvanized and final galvanized wires shall be in accordance with Tables A.6 and A.7 respectively.

Table A.3 — Diameter tolerances for bright and drawn galvanized wires

Nominal diameter of wire		Total variation			
		Minus		Plus	
mm	(in)	mm	(in)	mm	(in)
0,25 u δ u 0,64	(0.010 u δ u 0.025)	0,01	(0.000 3)	0,02	(0.000 7)
0,64 < δ u 1, 50	(0.025 < δ u 0.060)	0,01	(0.000 5)	0,03	(0.001)
1,50 < δ u 2,36	(0.060 < δ u 0.093)	0,03	(0.001)	0,03	(0.001)
2,36 < δ u 3,61	(0.093 < δ u 0.142)	0,03	(0.001)	0,04	(0.001 5)
3,61 < δ u 5,08	(0.142 < δ u 0.200)	0,04	(0.001 5)	0,05	(0.002)
5,08 < δ u 6,35	(0.200 < δ u 0.250)	0,05	(0.002)	0,05	(0.002)

Table A.4 — Diameter tolerances for final galvanized wires

Nominal diameter of wire		Total variation			
		Minus		Plus	
mm	(in)	mm	(in)	mm	(in)
0,64 u δ u 1,55	(0.025 u δ u 0.061)	0,03	(0.001)	0,03	(0.001)
1,55 < δ u 2,01	(0.061 < δ u 0.079)	0,05	(0.002)	0,05	(0.002)
2,01 < δ u 3,61	(0.079 < δ u 0.142)	0,08	(0.003)	0,08	(0.003)
δ > 3,61	(δ > 0.142)	0,10	(0.004)	0,10	(0.004)

Table A.5 — Minimum breaking force and minimum number of torsions for Levels 2, 3, 4 and 5

Nominal diameter of wire		Level 2			Level 3			Level 4			Level 5		
		Minimum breaking force		Torsion	Minimum breaking force		Torsion	Minimum breaking force		Torsion	Minimum breaking force		Torsion
mm	(in)	N	(lb)		N	(lb)		N	(lb)		N	(lb)	
0,25	0.010	76	17	254	89	20	234	98	22	218	107	24	190
0,28	0.011	93	21	231	107	24	213	120	27	198	129	29	173
0,30	0.012	111	25	212	129	29	195	142	32	182	151	34	158
0,33	0.013	129	29	195	151	34	180	651	37	168	178	40	146
0,36	0.014	151	34	181	173	39	167	191	43	156	205	46	136
0,38	0.015	173	39	169	200	45	156	218	49	145	236	53	126
0,41	0.016	196	44	158	227	51	146	249	56	136	267	60	118
0,43	0.017	222	50	149	254	57	137	280	63	128	302	68	111
0,46	0.018	249	56	141	285	64	130	316	71	121	338	76	105
0,48	0.019	276	62	133	320	72	123	351	79	114	378	85	100
0,51	0.020	307	69	126	351	79	116	387	87	108	418	94	94
0,53	0.021	338	76	120	387	87	111	427	96	103	458	103	90
0,56	0.022	369	83	115	427	96	106	467	105	98	503	113	86
0,58	0.023	405	91	110	467	105	101	512	115	94	552	124	82
0,61	0.024	440	99	105	507	114	97	556	125	90	600	135	78
0,64	0.025	476	107	101	547	123	93	605	136	86	649	146	75
0,66	0.026	516	116	97	592	133	89	654	147	83	703	158	72
0,69	0.027	556	125	93	641	144	86	703	158	80	756	170	70
0,71	0.028	596	134	90	689	155	83	756	170	77	814	183	67
0,74	0.029	641	144	87	738	166	80	810	182	74	872	196	65
0,76	0.030	685	154	84	787	177	77	867	195	72	934	210	62
0,79	0.031	729	164	81	841	189	75	925	208	69	996	224	60
0,81	0.032	778	175	78	894	210	72	983	221	67	1 059	238	58
0,84	0.033	827	186	76	952	214	70	1 045	235	65	1 125	253	57
0,86	0.034	876	197	74	101 0	227	68	1 112	250	63	1 192	268	55
0,89	0.035	930	209	72	1 068	240	66	1 174	264	61	1 263	284	53
0,91	0.036	983	221	70	1 130	254	64	1 245	280	60	1 339	301	52
0,94	0.037	1 036	233	68	1 192	268	62	1 312	295	58	1 410	317	50
0,97	0.038	1 094	246	66	1 259	283	61	1 383	311	56	1 486	334	49
0,99	0.039	1 152	259	64	1 326	298	59	1 454	327	55	1 566	352	48
1,02	0.040	1 210	272	62	1 392	313	57	1 530	344	53	1 646	370	46
1,04	0.041	1 272	286	61	1 463	329	56	1 606	361	52	1 726	388	45
1,07	0.042	1 334	300	59	1 535	345	55	1 686	379	51	1 810	407	44
1,09	0.043	1 397	314	58	1 606	361	53	1 766	397	50	1 899	427	43
1,12	0.044	1 459	328	57	1 681	378	52	1 846	415	48	1 988	447	42
1,14	0.045	1 526	343	55	1 757	395	51	1 930	434	47	2 077	467	41
1,17	0.046	1 592	358	54	1 833	412	50	2 015	453	46	2 166	487	40
1,19	0.047	1 664	374	53	1 913	430	49	2 104	473	45	2 260	508	39
1,22	0.048	1 735	390	52	1 993	448	48	2 193	493	44	2 357	530	38
1,24	0.049	1 806	406	51	2 077	467	47	2 282	513	43	2 455	552	38
1,27	0.050	1 877	422	50	2 162	486	46	2 375	534	42	2 553	574	37
1,30	0.051	1 953	439	49	2 246	505	45	2 469	555	42	2 655	597	36
1,32	0.052	2 028	456	48	2 335	525	44	2 566	577	41	2 758	620	35
1,35	0.053	2 108	474	47	2 424	545	43	2 664	599	40	2 865	644	35
1,37	0.054	2 184	491	46	2 513	565	42	2 762	621	39	2 971	668	34

Table A.5 (*continued*)

Nominal diameter of wire		Level 2			Level 3			Level 4			Level 5		
		Minimum breaking force		Torsion	Minimum breaking force		Torsion	Minimum breaking force		Torsion	Minimum breaking force		Torsion
mm	(in)	N	(lb)		N	(lb)		N	(lb)		N	(lb)	
1,40	0.055	2 264	509	45	2 607	586	41	2 865	644	38	3 082	693	33
1,42	0.056	2 349	528	44	2 700	607	41	2 967	667	38	3 194	718	33
1,45	0.057	2 429	546	43	2 793	628	40	3 074	691	37	3 305	743	32
1,47	0.058	2 513	565	43	2 891	650	39	3 180	715	36	3 421	769	32
1,50	0.059	2 598	584	42	2 989	672	38	3 287	739	36	3 536	795	31
1,52	0.060	2 687	604	41	3 091	695	38	3 398	764	35	3 652	821	30
1,55	0.061	2 776	624	40	3 194	718	37	3 509	789	35	3 772	848	30
1,57	0.062	2 865	644	40	3 296	741	37	3 625	815	34	3 896	876	29
1,60	0.063	2 958	665	39	3 398	764	36	3 741	841	33	4 021	904	29
1,63	0.064	3 047	685	38	3 505	788	35	3 856	867	33	4 146	932	28
1,65	0.065	3 145	707	38	3 616	813	35	3 977	894	32	4 275	961	28
1,68	0.066	3 238	728	37	3 723	837	34	4 097	921	32	4 404	990	28
1,70	0.067	3 336	750	37	3 834	862	34	4 217	948	31	4 533	1 019	27
1,73	0.068	3 434	772	36	3 945	887	33	4 341	976	31	4 666	1 049	27
1,75	0.069	3 532	794	36	4 061	913	33	4 466	1 004	30	4 804	1 080	26
1,78	0.070	3 634	817	35	4 177	939	32	4 595	1 033	30	4 942	1 111	26
1,80	0.071	3 736	840	35	4 297	966	32	4 724	1 062	29	5 080	1 142	26
1,83	0.072	3 839	863	34	4 412	992	31	4 853	1 091	29	5 218	1 173	25
1,85	0.073	3 941	886	34	4 533	1 019	31	4 986	1 121	29	5 360	1 205	25
1,88	0.074	4 048	910	33	4 657	1 047	30	5 120	1 151	28	5 507	1 238	24
1,91	0.075	4 154	934	33	4 777	1 074	30	5 528	1 182	28	5 653	1 271	24
1,93	0.076	4 266	959	32	4 906	1 103	30	5 395	1 213	27	5 800	1 304	24
1,96	0.077	4 372	983	32	5 031	1 131	29	5 533	1 244	27	5 947	1 337	23
1,98	0.078	4 484	1 008	31	5 160	1 160	29	5 676	1 276	27	6 098	1 371	23
2,01	0.079	4 599	1 034	31	5 289	1 189	28	5 818	1 308	26	6 254	1 406	23
2,03	0.080	4 710	1 059	30	5 418	1 218	28	5 960	1 340	26	6 410	1 441	22
2,06	0.081	4 826	1 058	30	5 551	1 248	28	6 107	1 373	26	6 565	1 476	22
2,08	0.082	4 942	1 111	30	5 685	1 278	27	6 254	1 406	25	6 721	1 511	22
2,11	0.083	5 062	1 138	29	5 822	1 309	27	6 405	1 440	25	6 886	1 548	22
2,13	0.084	5 182	1 165	29	5 956	1 339	27	6 552	1 473	25	7 046	1 584	21
2,16	0.085	5 302	1 192	29	6 098	1 371	26	6 708	1 508	24	7 210	1 621	21
2,18	0.086	5 422	1 219	28	6 236	1 402	26	6 859	1 542	24	7 375	1 658	21
2,21	0.087	5 547	1 247	28	6 378	1 434	26	7 014	1 577	24	7 544	1 696	21
2,24	0.088	5 671	1 275	28	6 521	1 466	25	7 175	1 613	23	7 713	1 734	20
2,26	0.089	5 796	1 303	27	6 668	1 499	25	7 330	1 648	23	7 882	1 772	20
2,29	0.090	5 925	1 332	27	6 810	1 531	25	7 490	1 684	23	8 055	1 811	20
2,31	0.091	6 049	1 360	27	6 957	1 564	24	7 655	1 721	23	8 229	1 850	20
2,34	0.092	6 183	1 390	26	7 108	1 598	24	7 820	1 758	22	8 407	1 890	19
2,36	0.093	6 312	1 419	26	7 259	1 632	24	7 984	1 795	22	8 585	1 930	19
2,39	0.094	6 445	1 449	26	7 410	1 666	24	8 149	1 832	22	8 763	1 970	19
2,41	0.095	6 579	1 479	25	7 562	1 700	23	8 318	1 870	22	8 945	2 011	19
2,44	0.096	6 712	1 509	25	7 717	1 735	23	8 491	1 909	21	9 127	2 052	18
2,46	0.097	6 845	1 539	25	7 873	1 770	23	8 660	1 947	21	9 310	2 093	18
2,49	0.098	6 983	1 570	25	8 033	1 806	23	8 834	1 986	21	9 496	2 135	18
2,51	0.099	7 121	1 601	24	8 189	1 841	22	9 012	2 026	21	9 683	2 177	18

Table A.5 (*continued*)

Nominal diameter of wire		Level 2			Level 3			Level 4			Level 5		
		Minimum			Minimum			Minimum			Minimum		
		breaking force		Torsion	breaking force		Torsion	breaking force		Torsion	breaking force		Torsion
mm	(in)	N	(lb)		N	(lb)		N	(lb)		N	(lb)	
2,54	0.100	7 264	1 633	24	8 349	1 877	22	9 185	2 065	20	9 875	2 220	18
2,57	0.101	7 401	1 664	24	8 513	1 914	22	9 363	2 105	20	10 066	2 263	18
2,59	0.102	7 544	1 696	24	8 678	1 951	22	9 545	2 146	20	10 262	2 307	17
2,62	0.103	7 686	1 728	23	8 843	1 988	21	9 723	2 186	20	10 453	2 350	17
2,64	0.104	7 833	1 761	23	9 007	2 025	21	9 910	2 228	20	10 653	2 395	17
2,67	0.105	7 980	1 794	23	9 176	2 063	21	10 093	2 269	19	10 849	2 439	17
2,69	0.106	8 126	1 827	23	9 345	2 101	21	10 279	2 311	19	11 049	2 484	17
2,72	0.107	8 273	1 860	22	9 514	2 139	21	10 466	2 353	19	11 249	2 529	16
2,74	0.108	8 425	1 894	22	9 688	2 178	20	10 657	2 396	19	11 454	2 575	16
2,77	0.109	8 576	1 928	22	9 861	2 217	20	10 844	2 438	19	11 658	2 621	16
2,79	0.110	8 727	1 962	22	10 035	2 256	20	11 040	2 482	18	11 867	2 668	16
2,82	0.111	8 878	1 996	22	10 213	2 296	20	11 231	2 525	18	12 076	2 715	16
2,84	0.112	9 034	2 031	21	10 391	2 336	20	11 427	2 569	18	12 285	2 762	16
2,87	0.113	9 190	2 066	21	10 568	2 376	19	11 623	2 613	18	12 494	2 809	15
2,90	0.114	9 345	2 101	21	10 746	2 416	19	11 823	2 658	18	12 708	2 857	15
2,92	0.115	9 505	2 137	21	10 929	2 457	19	12 023	2 703	18	12926	2 906	15
2,95	0.116	9 661	2 172	21	11 111	2 498	19	12 223	2 748	17	13 139	2 954	15
2,97	0.117	9 826	2 209	20	11 298	2 540	19	12 428	2 794	17	13 357	3 003	15
3,00	0.118	9 986	2 245	20	11 485	2 582	18	12 632	2 840	17	13 580	3 053	15
3,02	0.119	10 146	2 281	20	11 672	2 624	18	12 837	2 886	17	13 798	3 102	15
3,05	0.120	10 310	2 318	20	11 858	2 666	18	13 046	2 933	17	14 025	3 153	14
3,07	0.121	10 475	2 355	20	12 050	2 709	18	13 255	2 980	17	14 247	3 203	14
3,10	0.122	10 644	2 393	19	12 241	2 752	18	13 464	3 027	17	14 474	3 254	14
3,12	0.123	10 813	2 431	19	12 432	2 795	18	13 678	3 075	16	14 701	3 305	14
3,15	0.124	10 978	2 468	19	12628	2 839	18	13 891	3 123	16	14 932	3 357	14
3,18	0.125	11 151	2 507	19	12 824	2 883	17	14 105	3 171	16	15 163	3 409	14
3,20	0.126	11 320	2 545	19	13 019	2 927	17	14 323	3 220	16	15 395	3 461	14
3,23	0.127	11 494	2 584	19	13 215	2 971	17	14 541	3 269	16	15 630	3 514	14
3,25	0.128	11 667	2 623	18	13 415	3 016	17	14 758	3 318	16	15 866	3 567	13
3,28	0.129	11 841	2 662	18	13 615	3 061	17	14 981	3 368	16	16 102	3 620	13
3,30	0.130	12 018	2 702	18	13 820	3 107	17	15 203	3 418	15	16 342	3 674	13
3,33	0.131	12 192	2 741	18	14 025	3 153	17	15 426	3 468	15	16 582	3 728	13
3,35	0.132	12 370	2 781	18	14 229	3 199	16	15 653	3 519	15	16 822	3 782	13
3,38	0.133	12 552	2 822	18	14 434	3 245	16	15 879	3 570	15	17 067	3 837	13
3,40	0,134	12 730	2 862	18	14 643	3 292	16	16 106	3 621	15	17 312	3 892	13
3,43	0.135	12 913	2 903	17	14 852	3 339	16	16 333	3 672	15	17 561	3 948	13
3,45	0.136	13 095	2 944	17	15 061	3 386	16	16 564	3 724	15	17 810	4 004	13
3,48	0.137	13 282	2 986	17	15 270	3 433	16	16 800	3 777	15	18 059	4 060	13
3,51	0.138	13 464	3 027	17	15 483	3 481	16	17 031	3 829	14	18 312	4 117	12
3,53	0.139	13 651	3 069	17	15 697	3 529	15	17 267	3 882	14	18 562	4 173	12

Table A.5 (*continued*)

Nominal diameter of wire		Level 2			Level 3			Level 4			Level 5		
		Minimum breaking force		Torsion	Minimum breaking force		Torsion	Minimum breaking force		Torsion	Minimum breaking force		Torsion
mm	(in)	N	(lb)		N	(lb)		N	(lb)		N	(lb)	
3,56	0.140	13 838	3 111	17	15 915	3 578	15	17 503	3 935	14	18 819	4 231	12
3,58	0.141	14 025	3 153	17	16 128	3 626	15	17 743	3 989	14	19 073	4 288	12
3,61	0.142	14 216	3 196	17	16 346	3 675	15	17 983	4 043	14	19 331	4 346	12
3,63	0.143	14 407	3 239	16	16 569	3 725	15	18 223	4 097	14	19 589	4 404	12
3,66	0.144	14 598	3 282	16	16 787	3 774	15	18 468	4 152	14	19 851	4 463	12
3,68	0.145	14 790	3 325	16	17 009	3 824	15	18 713	4 207	14	20 114	4 522	12
3,71	0.146	14 985	3 369	16	17 232	3 874	15	18 957	4 262	14	20 376	4 581	12
3,73	0.147	15 181	3 413	16	17 458	3 925	15	19 202	4 317	13	20 643	4 641	12
3,76	0.148	15 377	3 457	16	17 681	3 975	14	19 451	4 373	13	20 910	4 701	11
3,78	0.149	15 572	3 501	16	17 908	4 026	14	19 700	4 429	13	21 177	4 761	11
3,81	0.150	15 773	3 546	16	18 139	4 078	14	19 954	4 486	13	21 448	4 822	11
3,84	0.151	15 973	3 591	15	18 366	4 129	14	20 203	4 542	13	21 720	4 883	11
3,86	0.152	16 173	3 636	15	18 597	4 181	14	20 456	4 599	13	21 991	4 944	11
3,89	0.153	16 373	3 681	15	18 828	4 233	14	20 714	4 657	13	22 267	5 006	11
3,91	0.154	16 578	3 727	15	19 064	4 286	14	20 968	4 714	13	22 542	5 068	11
3,94	0.155	16 782	3 773	15	19 295	4 338	14	21 226	4 772	13	22 818	5 130	11
3,96	0.156	16 987	3 819	15	19 531	4 391	14	21 488	4 831	13	23 098	5 193	11
3,99	0.157	17 192	3 865	15	19 771	4 445	14	21 746	4 889	13	23 379	5 256	11
4,01	0.158	17 401	3 912	15	20 007	4 498	13	22 009	4 948	12	23 659	5 319	11
4,04	0.159	17 605	3 958	15	20 247	4 552	13	22 271	5 007	12	23 944	5 383	11
4,06	0.160	17 814	4 005	14	20 487	4 606	13	22 538	5 067	12	24 228	5 447	10
4,09	0.161	18 028	4 053	14	20 732	4 661	13	22 805	5 127	12	24 513	5 511	10
4,11	0.162	18 237	4 100	14	20 972	4 715	13	23 072	5 187	12	24 802	5 576	10
4,14	0.163	18 450	4 148	14	21 217	4 770	13	23 339	5 247	12	25 091	5 641	10
4,17	0.164	18 664	4 196	14	21 462	4 825	13	23 610	5 308	12	25 380	5 706	10
4,19	0.165	18 877	4 244	14	21 711	4 881	13	23 881	5 369	12	25 674	5 772	10
4,22	0.166	19 095	4 293	14	21 960	4 937	13	24 153	5 430	12	25 967	5 838	10
4,24	0.167	19 309	4 341	14	22 209	4 993	13	24 428	5 492	12	26 261	5 904	10
4,27	0.168	19 527	4 390	14	22 458	5 049	13	24 704	5 554	12	26 555	5 970	10
4,29	0.169	19 749	4 440	14	22 707	5 105	12	24 980	5 616	12	26 853	6 037	10
4,32	0.170	19 967	4 489	14	22 961	5 162	12	25 260	5 679	11	27 151	6 104	10
4,34	0.171	20 189	4 539	13	23 214	5 219	12	25 536	5 741	11	27 453	6 172	10
4,37	0.172	20 412	4 589	13	23 472	5 277	12	25 816	5 804	11	27 756	6 240	10
4,39	0.173	20 634	4 639	13	23 726	5 334	12	26 101	5 868	11	28 058	6 308	10
4,42	0.174	20 857	4 689	13	23 984	5 392	12	26 386	5 932	11	28 360	6 376	10
4,45	0.175	21 084	4 740	13	24 242	5 450	12	26 670	5 996	11	28 667	6 445	9
4,47	0.176	21 306	4 790	13	24 504	5 509	12	26 955	6 060	11	28 974	6 514	9
4,50	0.177	21 533	4 841	13	24 766	5 568	12	27 240	6 124	11	29 286	6 584	9
4,52	0.178	21 764	4 893	13	25 029	5 627	12	27 529	6 189	11	29 593	6 653	9
4,55	0.179	21 991	4 944	13	25 291	5 686	12	27 818	6 254	11	29 904	6 723	9
4,57	0.180	22 222	4 996	13	25 554	5 745	12	28 111	6 320	11	30 220	6 794	9
4,60	0.181	22 454	5 048	13	25 821	5 805	12	28 405	6 386	11	30 531	6 864	9
4,62	0.182	22 685	5 100	13	26 088	5 865	11	28 698	6 452	11	30 847	6 935	9
4,65	0.183	22 916	5 152	12	26 354	5 925	11	28 992	6 518	11	31 167	7 007	9
4,67	0.184	23 152	5 205	12	26 626	5 986	11	29 286	6 584	10	31 483	7 078	9

Table A.5 (*continued*)

Nominal diameter of wire		Level 2			Level 3			Level 4			Level 5		
		Minimum			Minimum			Minimum			Minimum		
		breaking force		Torsion	breaking force		Torsion	breaking force		Torsion	breaking force		Torsion
mm	(in)	N	(lb)		N	(lb)		N	(lb)		N	(lb)	
4,70	0.185	23 388	5 258	12	26 897	6 047	11	29 584	6 651	10	31 803	7 150	9
4,72	0.186	23 623	5 311	12	27 168	6 108	11	29 882	6 718	10	32 123	7 212	9
4,75	0.187	23 859	5 364	12	27 440	6 169	11	30 184	6 786	10	32 448	7 295	9
4,78	0.188	24 099	5 418	12	27 711	6 230	11	30 487	6 854	10	32 773	7 368	9
4,80	0.189	24 339	5 472	12	27 987	6 292	11	30 785	6 921	10	33 098	7 441	9
4,83	0.190	24 575	5 525	12	28 263	6 354	11	31 092	6 990	10	33 422	7 514	9
4,85	0.191	24 820	5 580	12	28 543	6 417	11	31 394	7 058	10	33 751	7 588	9
4,88	0.192	25 060	5 634	12	28 819	6 479	11	31 701	7 127	10	34 081	7 662	8
4,90	0.193	25 305	5 689	12	29 099	6 542	11	32 008	7 196	10	34 410	7 736	8
4,93	0.194	25 549	5 744	12	29 379	6 605	11	32 319	7 266	10	34 739	7 810	8
4,95	0.195	25 794	5 799	12	29 659	6 668	11	32 626	7 335	10	35 072	7 885	8
4,98	0.196	26 039	5 854	12	29 944	6 732	11	32 937	7 405	10	35 411	7 961	8
5,00	0.197	26 283	5 909	11	30 229	6 796	10	33 249	7 475	10	35 744	8 036	8
5,03	0.198	26 532	5 965	11	30 513	6 860	10	33 565	7 546	10	36 082	8 112	8
5,05	0.199	26 781	6 021	11	30 798	6 924	10	33 880	7 617	10	36 420	8 188	8
5,08	0.200	27 030	6 077	11	31 087	6 989	10	34 196	7 688	9	36 758	8 264	8
5,11	0.201	27 280	6 133	11	31 372	7 053	10	34 512	7 759	9	37 101	8 341	8
5,13	0.202	27 533	6 190	11	31 661	7 118	10	34 828	7 830	9	37 443	8 418	8
5,16	0.203	27 787	6 247	11	31 954	7 184	10	35 148	7 902	9	37 786	8 495	8
5,18	0.204	28 040	6 304	11	32 244	7 249	10	35 468	7 974	9	38 128	8 572	8
5,21	0.205	28 294	6 261	11	32 537	7 315	10	35 793	8 047	9	38 475	8 650	8
5,23	0.206	28 547	6 418	11	32 831	7 381	10	36 113	8 119	9	38 822	8 728	8
5,26	0.207	28 805	6 476	11	33 124	7 447	10	36 438	8 192	9	39 169	8 806	8
5,28	0.208	29 063	6 534	11	33 422	7 514	10	36 763	8 265	9	39 520	8 885	8
5,31	0.209	29 321	6 592	11	33 720	7 581	10	37 092	8 339	9	39 872	8 964	8
5,33	0.210	29 579	6 650	11	34 018	7 648	10	37 417	8 412	9	40 223	9 043	8
5,36	0.211	29 837	6 708	11	34 316	7 715	10	37 746	8 486	9	40 579	9 123	8
5,38	0.212	30 100	6 767	11	34 614	7 782	10	38 075	8 560	9	40 930	9 202	8
5,41	0.213	30 362	6 826	11	34 917	7 850	10	38 408	8 635	9	41 286	9 282	8
5,44	0.214	30 624	6 885	11	35 219	7 918	10	38 742	8 710	9	41 647	9 363	7
5,46	0.215	30 887	6 944	10	35 522	7 986	9	39 071	8 784	9	42 002	9 443	7
5,49	0.216	31 154	7 004	10	35 824	8 054	9	39 409	8 860	9	42 363	9 524	7
5,51	0.217	31 416	7 063	10	36 131	8 123	9	39 743	8 935	9	42 723	9 605	7
5,54	0.218	31 683	7 123	10	36 438	8 192	9	40 081	9 011	9	43 088	9 687	7
5,56	0.219	31 950	7 183	10	36 745	8 261	9	40 419	9 087	9	43 448	9 768	7
5,59	0.220	32 221	7 244	10	37 052	8 330	9	40 757	9 163	8	43 813	9 850	7
5,61	0.221	32 488	7 304	10	37 363	8 400	9	41 100	9 240	8	44 182	9 933	7
5,64	0.222	32 760	7 365	10	37 670	8 469	9	41 438	9 316	8	44 547	10 015	7
5,66	0.223	33 031	7 426	10	37 981	8 539	9	41 780	9 393	8	44 916	10 098	7
5,69	0.224	33 302	7 487	10	38 297	8 610	9	42 127	9 471	8	45 285	10 181	7
5,72	0.225	33 574	7 548	10	38 609	8 680	9	42 470	9 548	8	45 654	10 264	7
5,74	0.226	33 845	7 609	10	38 924	8 751	9	42 816	9 626	8	46 028	10 348	7
5,77	0.227	34 121	7 671	10	39 240	8 822	9	43 163	9 704	8	46 402	10 432	7
5,79	0.228	34 396	7 733	10	39 556	8 893	9	43 510	9 782	8	46 775	10 516	7
5,82	0.229	34 672	7 795	10	39 872	8 964	9	43 862	9 861	8	47 149	10 600	7

Table A.5 (*continued*)

Nominal diameter of wire		Level 2			Level 3			Level 4			Level 5		
		Minimum breaking force		Torsion	Minimum breaking force		Torsion	Minimum breaking force		Torsion	Minimum breaking force		Torsion
mm	(in)	N	(lb)		N	(lb)		N	(lb)		N	(lb)	
5,84	0.230	34 948	7 857	10	40 192	9 036	9	44 209	9 939	8	47 527	10 685	7
5,87	0.231	35 228	7 920	10	40 508	9 107	9	44 560	10 018	8	47 905	10 770	7
5,89	0.232	35 504	7 982	10	40 828	9 179	9	44 911	10 097	8	48 283	10 855	7
5,92	0.233	35 784	8 045	9	41 153	9 252	9	45 267	10 177	8	48 661	10 940	7
5,94	0.234	36 064	8 108	9	41 473	9 324	9	45 623	10 257	8	49 044	11 026	7
5,97	0.235	36 345	8 171	9	41 798	9 397	9	45 975	10 336	8	49 426	11 112	7
5,99	0.236	36 629	8 235	9	42 123	9 470	8	46 335	10 417	8	49 809	11 198	7
6,02	0.237	36 910	8 298	9	42 447	9 543	8	46 691	10 497	8	50 191	11 284	7
6,05	0.238	37 194	8 362	9	42 772	9 616	8	47 051	10 578	8	50 578	11 371	7
6,07	0.239	37 479	8 426	9	43 101	9 690	8	47 411	10 659	8	50 965	11 458	7
6,10	0.240	37 764	8 490	9	43 426	9 763	8	47 772	10 740	8	51 352	11 545	6
6,12	0.241	38 048	8 554	9	43 755	9 837	8	48 132	10 821	8	51 744	11 633	6
6,15	0.242	38 337	8 619	9	44 089	9 912	8	48 497	10 903	8	52 131	11 720	6
6,17	0.243	38 622	8 683	9	44 418	9 986	8	48 857	10 984	8	52 522	11 808	6
6,20	0.244	38 911	8 748	9	44 751	10 061	8	49 226	11 067	8	52 918	11 897	6
6,22	0.245	39 200	8 813	9	45 080	10 135	8	49 591	11 149	7	53 309	11 985	6
6,25	0.246	39 494	8 879	9	45 414	10 210	8	49 955	11 231	7	53 705	12 074	6
6,27	0.247	39 783	8 944	9	45 752	10 286	8	50 325	11 314	7	54 101	12 163	6
6,30	0.248	40 076	9 010	9	46 086	10 361	8	50 694	11 397	7	54 497	12 252	6
6,32	0.249	40 366	9 075	9	46 424	10 437	8	51 063	11 480	7	54 893	12 341	6
6,35	0.250	40 659	9 141	9	46 757	10 512	8	51 437	11 564	7	55 293	12 431	6

Table A.6 — Minimum masses of zinc for drawn galvanized wire Levels 2, 3, 4 and 5

Nominal diameter of wire		Minimum mass of zinc coating	
mm	(in)	g/m^2	(oz/ft^2)
0,46 to 0,72	(0.018 to 0.028)	30	(0.10)
0,73 to 1,53	(0.029 to 0.060)	60	(0.20)
1,54 to 2,29	(0.061 to 0.090)	90	(0.30)
2,30 to 3,56	(0.091 to 0.140)	120	(0.40)

Table A.7 — Minimum masses of zinc for final galvanized wire Levels 2, 3, 4 and 5

Nominal diameter of wire		Minimum mass of zinc coating	
mm	(in)	g/m^2	(oz/ft^2)
0,72 to 1,20	(0.028 to 0.047)	60	(0.20)
1,21 to 1,38	(0.048 to 0.054)	120	(0.40)
1,39 to 1,61	(0.055 to 0.063)	150	(0.50)
1,62 to 2,01	(0.064 to 0.079)	180	(0.60)
2,02 to 2,34	(0.080 to 0.092)	210	(0.70)
2,35 and larger	(0.093 and larger)	240	(0.80)

Annex B
(normative)

Methods of wire testing for Levels 2, 3, 4 and 5

B.1 Diameter test

The diameter shall be determined from two measurements in two perpendicular directions on the same section and the same diametrical plane using a measuring instrument, for example, a micrometer, accurate to 0,01 mm.

B.2 Tensile test

Specimens shall not be less than 450 mm (= 18 in) long, and the distance between the grips of the testing machine shall not be less than 305 mm (= 12 in). The speed of the movable head of the testing machine, under no load, shall not exceed 0,5 mm/s (= 1 in/min). Any specimen breaking within 6 mm (= 1/4 in) of the jaws may be disregarded and a retest performed.

B.3 Torsion test

The distance between the jaws of the testing machine shall be 203 mm ± 1 mm (= 8 in ± 1/16 in). In order to save time during tests, the distance may be shortened to as small as 100 wire diameters.

One end of the wire shall be rotated with respect to the other end at uniform speed not to exceed sixty 360°. revolutions per minute, until breakage occurs.

The machine shall be equipped with an automatic counter to record the number of revolutions causing breakage. One jaw shall be fixed axially and the other jaw movable axially and arranged for applying tension weights to wire under test. Tests in which breakage occurs within 3 mm (= 1/8 in) of the jaw may be discounted.

During the torsion test, tension weights as shown in Table B.1 shall be applied to the wire being tested. Tension weights shall not exceed twice the minimum values given in Table B.1.

When the distance between the jaws of the testing machine is other than 203 mm, the minimum torsion values given in Table A.5 shall be adjusted in direct proportion to the change in jaw spacing.

B.4 Zinc coating tests

The determination of mass of zinc shall be carried out in accordance with Annex A of ISO 2232:1990. An adhesion test shall be carried out in accordance with Annex B of ISO 2232:1990.

Table B.1 — Applied tension for torsion tests

Nominal diameter of wire		Minimum applied tension	
mm	(in)	N	(lbf)
0,28 to 0,42	(0.011 to 0.016)	4	(1)
0,43 to 0,52	(0.017 to 0.020)	9	(2)
0,53 to 0,77	(0.021 to 0.030)	18	(4)
0,78 to 1,02	(0.031 to 0.040)	27	(6)
1,03 to 1, 28	(0.041 to 0.050)	36	(8)
1,29 to 1, 53	(0.051 to 0.060)	40	(9)
1,54 to 1,79	(0.061 to 0.070)	49	(11)
1,80 to 2,04	(0.071 to 0.080)	58	(13)
2,05 to 2,30	(0.081 to 0.090)	71	(16)
2,31 to 2,55	(0.091 to 0.100)	85	(19)
2,56 to 2,80	(0.101 to 0.110)	93	(21)
2,81 to 3,06	(0.111 to 0.120)	102	(23)
3,07 to 3,31	(0.121 to 0.130)	111	(25)
3,32 to 3,57	(0.131 to 0.140)	116	(26)
3,58 to 3,82	(0.141 to 0.150)	125	(28)
3,83 to 4,07	(0.151 to 0.160)	133	(30)
4,08 to 4,33	(0.161 to 0.170)	142	(32)
4,34 to 4,58	(0.171 to 0.180)	151	(34)
4,59 to 4,84	(0.181 to 0.190)	160	(36)
4,85 to 5,09	(0.191 to 0.200)	169	(38)
5,10 to 5,34	(0.201 to 0.210)	178	(40)
5,35 to 5,60	(0.211 to 0.220)	187	(42)
5,61 to 5,85	(0.221 to 0.230)	196	(44)
5,86 to 6,10	(0.231 to 0.240)	205	(46)
6,11 to 6,35	(0.241 to 0.250)	214	(48)

Annex C
(normative)

Requirements for bright or drawn galvanized well measuring wire

C.1 Dimensional and mechanical properties

Diameters, diameter tolerances, minimum breaking forces and elongation shall be in accordance with Table C.1.

Table C.1 — Diameters, diameter tolerances, minimum breaking forces, torsions and elongation

Wire diameter		Approximate mass		Grade IPS				Grade EIP				Grade EEIP			
				Breaking force min.		Tor. min.	Elong. min.	Breaking force min.		Tor.[a] min.	Elong.[a] min.	Breaking force min.		Tor.[a] min.	Elong.[a] min.
mm	in	kg/m	lb/ft	kN	lb		%	kN	lb		%	kN	lb		%
± 0,03	± 0,001														
1,68	(0.066)	0,018	(0.012)	3,61	(81)	32	1-1/2	4,27	(960)	—	—	4,42	(994)	—	—
1,83	(0.072)	0,021	(0.014)	4,27	(961)	29	1-1/2	5,12	(1 150)	—	—	5,24	(1 178)	—	—
2,08	(0.082)	0,027	(0.018)	5,51	(1239)	26	1-1/2	6,49	(1 460)	—	—	6,75	(1 517)	—	—
2,34	(0.092)	0,034	(0.023)	6,88	(1547)	23	1-1/2	8,14	(1 830)	—	—	8,43	(1 895)	—	—
2,67	(0.105)	0,045	(0.030)	8,74	(1966)	20	1-1/2	10,50	(2 360)	—	—	10,89	(2 449)	—	—
2,74	(0.108)	0,048	(0.032)	9,38	(2109)	19	1-1/2	11,08	(2 490)	—	—	11,48	(2 581)	—	—
3,18	(0.125)	0,062	(0.042)	12,43	(2794)	—[a]	1-1/2	14,68	(3 300)	—	—	15,20	(3 418)	—	—
3,25	(0.128)	0,065	(0.044)	13,01	2 924	—[a]	1-1/2	15,35	(3 450)	—	—	15,94	(3 584)	—	—

[a] Values to be agreed between purchaser and manufacturer.

C.2 Test method

A specimen of wire approximately 1 m long shall be cut from each coil of well-measuring wire. One section of this wire shall be tested for elongation and tensile strength. The ultimate elongation shall be measured on a 250 mm length of specimen, at instant of rupture, which shall occur within the 250 mm gauge length. When determining elongation, a stress shall be imposed upon the wire equal to 690 N/mm^2 (100 000 psi) at which point the extensometer is applied. The reading of the extensometer should be increased by 0,4 % to allow for the initial elongation occurring before application of the extensometer.

The remaining section of the test specimen shall be measured for size and tested for torsional requirements in accordance with B.1 and B.3 of Annex B respectively.

If, when making any individual test, the first specimen fails, not more than two additional specimens from the same coil of wire shall be tested. If the average of any two tests shows acceptance, it shall be used as the value to represent the wire.

Annex D
(normative)

Physical dimensions and mechanical properties of well-servicing strand

Diameters, diameter tolerances and minimum breaking forces shall be in accordance with Table D.1.

Table D.1 — Diameters, diameter tolerances and minimum breaking forces

Nominal diameter		Diameter tolerance				Approximate mass		Minimum breaking force			
		min.		max.				Grade IPS		Grade EIP	
mm	(in)	mm	(in)	mm	(in)	kg/m	(lb/ft)	kN	(lb)	kN	(lb)
4,76	(3/16)	4,775	(0.188)	5,105	(0.201)	0,109	(0.073)	18,7	(4 200)	20,9	(4 700)
5,56	(7/32)	5,563	(0.219)	5,893	(0.232)	0,149	(0.100)	26,2	(5 900)	29,4	(6 600)
6,35	(1/4)	6,350	(0.250)	6,731	(0.265)	0,189	(0.127)	32,5	(7 300)	36,5	(8 200)
7,94	(5/16)	7,950	(0.313)	8,357	(0.329)	0,327	(0.220)	49,4	(11 100)	55,6	(12 500)

Annex E
(normative)

Determination of breaking force (Method 1)

E.1 Testing machine

The testing machine shall conform to the corresponding specifications given in ISO 7500-1.

E.2 Length of test piece

The minimum free test length, excluding terminations, shall be in accordance with Table E.1.

Table E.1 — Test lengths

Nominal rope diameter d mm	**Minimum test length** mm	
	Stranded rope	Spiral rope
d u 6	300	500
6 < d u 20	600	1 000
20 < d u 60	30d	50d
d > 60	3 000	

E.3 Selection of test piece

The test piece shall be representative of the rope as a whole. The selected test piece shall have its ends secured to ensure that the wires and strands remain undisturbed. Similarly secure the end of the rope from which the test piece is taken.

When cutting the test piece from the rope, neither the test piece nor the main part of the rope shall be damaged.

E.4 Method of test

E.4.1 Preparation

Mount and secure the test piece in the machine so as to ensure that all wires in the rope are subjected to the force during the test.

If sockets or cones are to be used, socketing shall be in accordance with the appropriate ISO, or equivalent, procedure.

E.4.2 Procedure

After 80 % of the minimum breaking force of the rope has been applied, increase the force at a rate not more than 0,5 % of the minimum breaking force per second.

The measured breaking force is reached when no further increase in applied force is possible.

The test may be terminated without breaking the rope when the minimum breaking force is achieved or exceeded.

The test may be discounted where the rope fracture occurs within a distance equivalent of six rope diameters from the base of the grip or the termination and the intended minimum breaking force has not been reached.

Annex F

(normative)

Calculation of minimum breaking force for ropes in accordance with Annex G — Rope grades 1770, 1960 and 2160

The minimum breaking force, F_{min}, expressed in kilonewtons, shall be calculated using the following equation:

$$F_{min} = \frac{K \cdot d^2 \cdot R_r}{1\,000}$$

where

d is the nominal diameter of the rope, in millimetres;

R_r is the rope grade, in newtons per square millimetre;

K is the empirical factor for the minimum breaking force for a given rope class. (K_1 is the factor for ropes with a fibre core, K_2 that for ropes with an independent wire rope core and K_3 the factor for ropes with a wire strand core or centre.)

Table F.1 summarizes the factors used in the calculation of minimum breaking force for those ropes covered by Tables G.1 to G.16.

Table F.1 — Factors for stranded wire ropes for general lifting applications

Type of rope	Class	Ropes with fibre core or fibre centre			Ropes with steel core or wire strand centre					
		Nominal length mass factor (approx.)	Nominal metallic cross-sectional area factor	Min. breaking force factor	Nominal length mass factor		Nominal metallic cross-sectional area factor		Min. breaking force factor	
		W_1	C_1	K_1	W_2	W_3	C_2	C_3	K_2	K_3
Single-layer round strand rope	6 × 7	0,345	0,369	0,332	0,384	0,384	0,432	0,432	0,359	0,388
	6 × 19	0,359	0,384	0,330	0,400		0,449		0,356	
	8 19	0,340	0,349	0,293	0,407		0,457		0,356	×
	6 36	0,367	0,393	0,330	0,409		0.460		0,356	×
	8 36	0,348	0,357	0,293	0,417		0,468		0,356	×
	6 × 19M	0,346	0,357	0,307		0,381		0,418	0,332	0,362
Rotation-resistant rope	6 × 37M	0,346	0,357	0,295	0,381	0,381	0,418	0,418	0,319	0,346
	18 × 7	0,382		0,328		0,401		0,433		0,328
	34 (M) × 7	0,390		0,318		0,401		0,428		0,318
	35 (W) × 7					0,454		0,480		0,360[a]
										0,350[b]

NOTE 1 The nominal length mass factors and nominal cross-sectional area factors are only for information.

NOTE 2 See ISO 17893 for calculation of nominal length mass, nominal metallic cross sectional area and minimum breaking force using the factors in this table.

NOTE 3 Spinning loss factor, k, is obtained by dividing K by C.

a Up to and including rope grade 1960.

b Greater than rope grade 1960 up to and including rope grade 2160.

Annex G

(normative)

Tables of breaking forces for the more common classes, sizes and grades of stranded ropes up to and including 60 mm diameter

The following tables give the breaking forces of the more common classes, sizes and grades of stranded ropes up to and including 60 mm diameter.

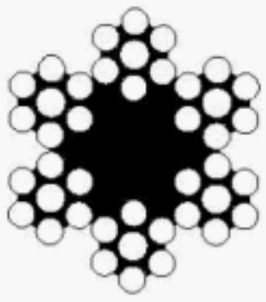
Higher values of minimum breaking force than those given in the Tables may be guaranteed by the manufacturer.

NOTE 1 The equivalent minimum breaking force values in kilonewtons for rope grades IPS, EIP and EEIP are given for comparison with the minimum breaking force values for grades 1770, 1960 and 2160.

NOTE 2 The conversion factor from short tons to kilonewtons is 8,896.

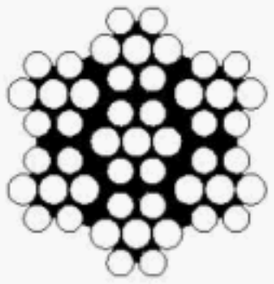
NOTE 3 The values of nominal length mass are approximate and are given for information.

Table G.1 — Class 6 × 7 fibre core

Typical cross-section	Typical construction			
	Rope construction	Strand construction	Outer wires	
			Total	Per strand
	6 × 7-FC	1-6	36	6

Nominal rope diameter		Diameter tolerance		Approximate nominal length mass		Minimum breaking force (F_{min})					
		min.	max.			Grade 1770	Grade 1960	Grade IPS		Grade EIP	
mm	(in)	mm	mm	kg/100 m	(lb/ft)	kN	kN	kN	(short tons)	kN	(short tons)
6		6,00	6,36	12,4		21,2	23,4				
(6,35)	(1/4)	6,35	6,73		(0.09)			23,5	(2.64)	25,8	(2.90)
7		7,00	7,42	16,9		28,8	31,9				
(7,94)	(5/16)	7,94	8,42		(0.15)			36,5	(4.10)	40,1	(4.51)
8		8,00	8,40	22,1		37,6	41,6				
9		9,00	9,45	27,9		47,6	52,7				
(9,5)	(3/8)	9,53	10,0		(0.21)			52,1	(5.86)	57,4	(6.45)
10		10,0	10,5	34,5		58,8	65,1				
11		11,0	11,6	41,7		71,1	78,7				
(11,1)	(7/16)	11,1	11,7		(0.29)			70,5	(7.93)	77,6	(8.72)
12		12,0	12,6	49,7		84,6	93,7				
(12,7)	(1/2)	12,7	13,3		(0.37)			91,6	(10.3)	101	(11.3)
13		13,0	13,7	58,3		99,3					
14		14,0	14,7	67,6		115	110				
(14,3)	(9/16)	14,3	15, 0		(0.47)		128	116	(13.0)	127	(14.3)
(15,9)	(5/8)	15,9	16,7		(0.58)			141	(15.9)		
16		16,0	16,8	88,3		150	167				
18		18,0	18,9	112		190	211				
19		19,0	20,0	125		212	235				
(19,1)	(3/4)	19,1	20,0					202	(22.7)	222	(25.0)
20		20,0	21,0	138	(0.84)	235	260				
22		22,0	23,1	167		284	315				
(22,2)	(7/8)	22,2	23,3		(1.15)			273	(30.7)	301	(33.8)
24		24,0	25,2	199		338	375				
(25,4)	(1)	25,4	26,7		(1.50)			353	(39.7)	389	(43.7)
26		26,0	27,3	233		397	440				
28		28,0	29,4	270		461	510				
(28,6)	(1-1/8)	28,6	30,0		(1.89)			443	(49.8)	488	(54.8)
(31,8)	(1-1/4)	31,8	33,3		(2.34)			543	(61.0)	597	(67.1)
32		32,0	33, 6	353		602	666				
(34,9)	(1-3/8)	34,9	36,7		(2.83)			650	(73.1)	715	(80.4)
35		35,0	36,8	423		720	797				
36		36,0	37,8	447		762	843				
38		38,0	39,9	498		849	940				
(38,1)	(1-1/2)	38,1	40,0		(3.37)			767	(86.2)	843	(94.8)
40		40,0	42,0	552		940	1 040				

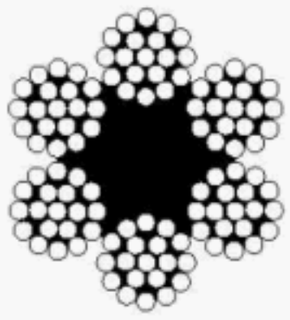
Table G.2 — Class 6 × 7 steel core

Typical cross-section	Typical construction			
	Rope construction	Strand construction	Outer wires	
			Total	Per strand
	6 × 7-WSC 6 × 7-IWRC	1-6 1-6	36 36	1 1

Nominal rope diameter		Diameter tolerance		Approximate nominal length mass		Minimum breaking force (F_{min})					
		min.	max.			Grade 1770	Grade 1960	Grade IPS		Grade EIP	
mm	(in)	mm	mm	kg/100 m	(lb/ft)	kN	kN	kN	(short tons)	kN	(short tons)
6		6,00	6,36	13,8		22,9	25,3				
(6,35)	(1/4)	6,35	6,73		(0.11)			25,3	(2.84)	27,8	(3.12)
7		7,00	7,42	18,8		31,1	34,5				
(7,94)	5/16)	7,94	8,42		(0.17)			39,2	(4.41)	43,1	(4.85)
8		8,00	8,40	24,6		40,7	45,0				
9		9,00	9,45	31,1		51,5	57,0				
(9,5)	(3/8)	9,53	10,0		(0.24)			56,0	(6.30)	61,6	(6.93)
10		10,0	10,5	38,4		63,5	70,4				
11		11,0	11,6	46,5		76,9	85,1				
(11,1)	(7/16)	11,1	11,7		(0.33)			75,8	(8.52)	83,4	(9.37)
12		12,0	12,6	55,3		91,5	101				
(12,7)	(1/2)	12,7	13,3		(0.43)			98,7	(11.1)	109	(12.2)
13		13,0	13,7	64,9		107	119				
14		14,0	14,7	75,3		125	138				
(14,3)	(9/16)	14,3	15,0		(0.55)			125	(14.0)	137	(15.4)
(15,9)	(5/8)	15,9	16,7		(0.68)			152	(17.1)	167	(18.8)
16		16,0	16,8	98,3		163	180				
18		18,0	18,9	124		206	228				
19		19,0	20,0	139		229	254				
(19,1)	(3/4)	19,1	20,0		(0.98)			217	(24.4)	238	(26.8)
20		20,0	21,0	154		254	281				
22	(7/8)	22,0	23,1	186		308	341				
(22,2)	(7/8)	22,2	23,3		(1.33)			294	(33.0)	323	(36.3)
24		24,0	25,2	221		366	405				
(25,4)	(1)	25,4	26,7		(1.73)			380	(42.7)	418	(47.0)
26		26,0	27,3	260		430	476				
28		28,0	29,4	301		498	552				
(28,6)	(1-1/8)	28,6	30,0		(2.19)			476	(53.5)	524	(58.9)
(31,8)	(1-1/4)	31,8	33,3		(2.71)			584	(65.6)	642	(72.2)
32		32,0	33,6	393		651	721				
(34,9)	(1-3/8)	34,9	36,7		(3.28)			699	(78.6)	770	(86.5)
35		35,0	36,8	470		778	778				
36		36,0	37,8	498		824	912				
38		38,0	39,9	554		918	1 020				
(38,1)	(1-1/2)	38,1	40,0		(3.90)			825	(92.7)	907	(102)
40		40,0	42,0	614		1 020	1 130				

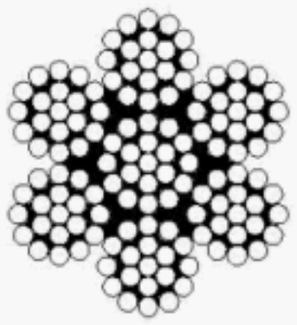
NOTE For smaller diameters with wire strand core (WSC), breaking force factor K_3 may be used in the calculation of minimum breaking force. The values of breaking force given in the table are for ropes with independent wire rope core (IWRC) using K_2.

Table G.3 — Class 6 × 19M fibre core

Typical cross-section	Typical construction			
	Rope construction	Strand construction	Outer wires	
			Total	Per strand
	6 × 19M-FC	1-6/12	72	12

Nominal rope diameter		Diameter tolerance		Approximate nominal length mass	Minimum breaking force (F_{min})	
					Grade 1770	Grade 1960
mm	(in)	min. mm	max. mm	kg/100 m	kN	kN
3		3,00	3,24	3,11	4,89	5,42
4		4,00	4,28	5,54	8,69	9,63
5		5,00	5,35	8,65	13,6	15,0
6		6,00	6.36	12,5	19,6	21,7
7		7,00	7,42	17,0	26,6	29,5
8		8,00	8.40	22,1	34,8	38,5
9		9,00	9,45	28,0	44,0	48,7
(9,5)	(3/8)	9,53	10,0			
10		10,0	10.,5	34,6	54,3	60,2
11		11,0	11,6	41,9	65,8	72,8
(11,1)	(7/16)	11,1	11,7			
12		12,0	12,6	49,8	78,2	86.6
(12,7)	(1/2)	12,7	13,3			
13		13,0	13,7	58,5	91,8	102
14		14,0	14,7	67,8	107	118
(14,3)	(9/16)	14,3	15,0 (15,9)	(5/8)	15,9 16,7	
16		16,0	16,8	88,6	139	154
18		18,0	18,9	112	176	195
19		19,0	20,0	125	196	217
(19,1)	(3/4)	19,1	20,0			
20		20,0	21,0	138	217	241
22		22,0	23,1	167	263	291
(22,2)	(7/8)	22,2	23,3			
24		24,0	25,2	199	313	347
(25,4)	(1)	25,4	26,7			
26		26,0	27,3	234	367	407
28		28,0	29,4	271	426	472
(28,6)	(1-1/8)	28,6	30,0 (31,8)	(1-1/4)	31,8 33,3	
32		32,0	33,6	354	556	616

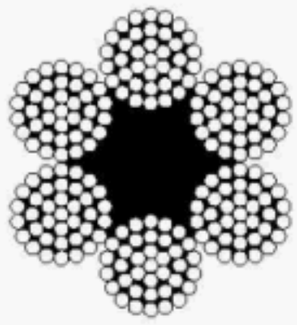
Table G.4 — Class 6 × 19M steel core

Typical cross-section	Typical construction			
	Rope construction	Strand construction	Outer wires	
			Total	Per strand
	6 × 19M-WSC	1-6/12	72	12
	6 × 19M-IWRC	1-6/12	72	12

Nominal rope diameter		Diameter tolerance		Approximate nominal length mass	Minimum breaking force (F_{min})	
		min.	max.		Grade 1770	Grade 1960
mm	(in)	mm	mm	kg/100m	kN	kN
8		8,00	8,40	24,7	37,6	41,6
9		9,00	9,45	31,2	47,6	52,7
(9,5)	(3/8)	9,53	10,0			
10		10,0	10,5	38,6	58,8	65,1
11		11,0	11,6	46,7	71,1	78,7
(11,1)	(7/16)	11,1	11,7			
12		12,0	12,6	55,6	84,6	93,7
(12,7)	(1/2)	12,7	13,3			
13		13,0	13,7	65,2	99,3	110
14		14,0	14,7	75,7	115	128
(14,3)	(9/16)	14,3	15,0 (15,9)	(5/8) 15,9 16,7		
16		16,0	16,8	98,8	150	167
18		18,0	18,9	125	190	211
19		19,0	20,0	139	212	235
(19,1)	(3/4)	19,1	20,0			
20		20,0	21,0	154	235	260
22		22,0	23,1	187	284	315
(22,2)	(7/8)	22,2	23,3			
24		24,0	25,2	222	338	375
(25,4)	(1)	25,4	26,7			
26		26,0	27,3	261	397	440
28		28,0	29,4	303	461	510
(28,6)	(1-1/8)	28,6	30,0 (31,8)	(1-1/4) 31,8 33,3		
32		32,0	33,6	395	602	666

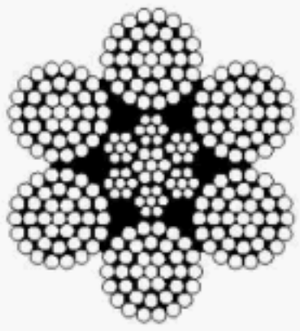
NOTE For smaller diameters with wire strand core (WSC), breaking force factor K_3 may be used in the calculation of minimum breaking force. The values of breaking force given in the table are for ropes with independent wire rope core (IWRC) using K_2.

Table G.5 — Class 6 × 37M fibre core

Typical cross-section	Typical construction			
	Rope construction	Strand construction	Outer wires	
			Total	Per strand
	6 × 37M-FC	1-6/12/18	108	18

Nominal rope diameter		Diameter tolerance		Approximate nominal length mass	Minimum breaking force (F_{min})	
		min.	max.		Grade 1770	Grade 1960
mm	(in)	mm	mm	kg/100m	kN	kN
5		5,00	5,35	8,65	13,9	14,6
6		6,00	6,36	12,5	18,8	20,8
7		7,00	7,42	17,0	25,6	28,3
8		8,00	8,40	22,1	33,4	37,0
9		9,00	9,45	28,0	42,3	46,8
(9,5)	(3/8)	9,53	10,0			
10		10,0	10,5	34,6	52,2	57,8
11		11,0	11,6	41,9	63,2	70,0
(11,1)	(7/16)	11,1	11,7			
12		12,0	12,6	49,8	75,2	83,3
(12,7)	(1/2)	12,7	13,3			
13		13,0	13,7	58,5	88,2	97,7
14		14,0	14,7	67,8	102	113
(14,3)	(9/16)	14,3	15,0 (15,9)	(5/8)	15,9	16,7
16		16,0	16,8	88,6	134	148
18		18,0	18,9	112	169	187
19		19,0	20,0	125	188	209
(19,1)	(3/4)	19,1	20,0			
20		20,0	21,0	138	209	231
22		22,0	23,1	167	253	280
(22,2)	(7/8)	22,2	23,3			
24		24,0	25,2	199	301	333
(25,4)	(1)	25,4	26,7			
26		26,0	27,3	239	353	391
28		28,0	29,4	271	409	453
(28,6)	(1-1/8)	28,6	30,0 (31,8)	(1-1/4)	31,8	33,3
32		32,0	33,6	354	535	592
(34,9)	(1-3/8)	34,9	36,7			
35		35,0	36,8	424	640	708
36		36,0	37,8	448	677	749
38		38,0	39,9	500	754	835
(38,1)	(1-1/2)	38,1	40,0			
40		40,0	42,0	554	835	925

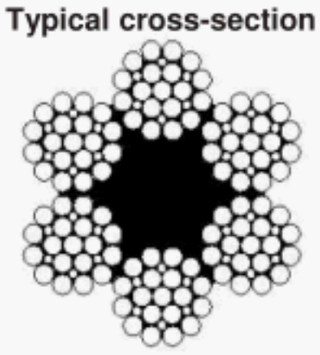
Table G.6 — Class 6 × 37M steel core

Typical cross-section	Typical construction			
	Rope construction	Strand construction	Outer wires	
			Total	Per strand
	6 × 37M-WSC	1-6/12/18	108	18
	6 × 37M-IWRC	1-6/12/18	108	18

Nominal rope diameter		Diameter tolerance		Approximate nominal length mass	Minimum breaking force (F_{min})	
		min.	max.		Grade 1770	Grade 1960
mm	(in)	mm	mm	kg/100m	kN	kN
8		8,00	8,40	24,4	39,2	43,4
9		9,00	9,45	30,9	49,6	54,9
(9,5)	(3/8)	9,53	10,0			
10		10,0	10,5	38,1	61,2	67,8
11		11,0	11,6	46,1	74,1	82,1
(11,1)	(7/16)	11,1	11,7			
12		12,0	12,6	54,9	88,2	97,7
(12,7)	(1/2)	12,7	13,3			
13		13,0	13,7	64,4	95,4	106
14		14,0	14,7	74,7	111	126
(14,3)	(9/16)	14,3	15,0 (15,9)	(5/8) 15,9	16,7	
16		16,0	16,8	97,5	145	160
18		18,0	18,9	123	183	203
19		19,0	20,0	138	204	226
(19,1)	(3/4)	19,1	20,0			
20		20,0	21,0	152	226	250
22		22,0	23,1	184	273	303
(22,2)	(7/8)	22,2	23,3			
24		24,0	25,2	219	325	360
(25,4)	(1)	25,4	26,7			
26		26,0	27,3	258	382	423
28		28,0	29,4	299	443	490
(28,6)	(1-1/8)	28,6	30,0 (31,8)	(1-1/4) 31,8	33,3	
32		32,0	33,6	390	578	640
(34,9)	(1-3/8)	34,9	36,7			
35		35,0	36,8	467	692	766
36		36,0	37,8	494	732	810
38		38,0	39,9	550	815	903
(38,1)	(1-1/2)	38,1	40,0			
40		40,0	42,0	610	903	1000

NOTE For smaller diameters with wire strand core (WSC), breaking force factor K_3 may be used in the calculation of minimum breaking force. The values of breaking force given in the table are for ropes with independent wire rope core (IWRC) using K_2.

Table G.7 — Class 6 × 19 fibre core

Typical cross-section	Typical construction			
	Rope construction	Strand construction	Outer wires	
			Total	Per strand
	6 × 19S-FC	1-9-9	54	9
	6 × 21F-FC	1-5F-5-10	60	10
	6 × 26WS-FC	1-5-5F-10	60	10
	6 × 19W-FC	1-6-6+6	72	12
	6 × 25F-FC	1-6-6F-12	72	12

Nominal rope diameter		Diameter tolerance		Approximate nominal length mass		Minimum breaking force (F_{min})								
						Grade 1770	Grade 1960	Grade 2160	Grade IPS		Grade EIP		Grade EEIP	
mm	(in)	min. mm	max. mm	kg/100 m	(lb/ft)	kN	kN	kN	kN	(short tons)	kN	(short tons)	kN	(short tons)
6		6,00	6,36	12,9		21,0	23,3	25,7						
(6,35)	(1/4)	6,35	6,73		(0.11)				24,4	(2.74)	26,8	(3.01)		
7		7,00	7,42	17,6		28,6	31,7	34,9						
(7,94)	(5/16)	7,94	8,42		(0.16)				37,9	(4.26)	41,7	(4.69)		
8		8,00	8,40	23,0		37,4	41,4	45,6						
9		9,00	9,45	29,1		47,3	52,4	57,7						
(9,5)	(3/8)	9,53	10,0		(0.24)				54,3	(6.10)	59,7	(6.71)	65,7	(7.38)
10		10,0	10,5	35,9		58,4	64,7	71,3						
11		11,0	11,6	43,3		70,7	78,3	86,2						
(11,1)	(7/16)	11,1	11,7		(0.32)				73,6	(8.27)	81,0	(9.10)	89,0	(10.0)
12		12,0	12,6	51,7		84,1	93,1	103						
(12,7)	(1/2)	12,7	13,3		(0.42)				95,2	(10.7)	105	(11.8)	115	(12.9)
13		13,0	13,7	60,7		98,7	109	120						
14		14,0	14,7	70,4		114	127	140						
(14,3)	(9/16)	14,3	15,0		(0.53)				120	(13.5)	133	(14.9)	145	(16.3)
(15,9)	(5/8)	15,9	16,7		(0.66)				149	(16.7)	164	(18.4)	180	(20.2)
16		16,0	16,8	91,9		150	166	182						
18		18,0	18,9	116		189	210	231						
19		19,0	20,0	130		211	233	257						
(19,1)	(3/4)	19,1	20,0		(0.95)				212	(23.8)	233	(26.2)	256	(28.8)
20		20,0	21,0	144		234	259	285						
22		22,0	23,1	174		283	313	345						
(22,2)	(7/8)	22,2	23,3		(1.29)				286	(32.2)	315	(35.4)	347	(39.0)
24		24,0	25,2	207		336	373	411						
(25,4)	(1)	25,4	26,7		(1.68)				372	(41.8)	409	(46.0)	450	(50.6)
26		26,0	27,3	243		395	437	482						
28		28,0	29,4	281		458	507	559						
(28,6)	(1-1/8)	28,6	30,0		(2.13)				468	(52.6)	515	(57.9)	566	(63.6)
(31,8)	(1-1/4)	31,8	33,3		(2.63)				575	(64.6)	633	(71.1)	696	(78.2)
32		32,0	33,6	368		598	662	730						
(34,9)	(1-3/8)	34,9	36,7		(3.18)				691	(77.7)	761	(85.5)	836	(94.0)
35		35,0	36,8	440		716	792	873						
36		36,0	37,8	465		757	838	924						
38		38,0	39,9	518		843	934	1 030						
(38,1)	(1-1/2)	38,1	40,0		(3.78)				818	(92.0)	898	(101)	987	(111)
40		40,0	42,0	574		935	1 040	1 140						
(41,3)	(1-5/8)	41,3	43,3		(4.44)				952	(107)	1 050	(118)	1 150	(129)
44		44,0	46,2	695		1 130	1 250	1 380						
(44,5)	(1-3/4)	44,5	46,7		(5.15)				1 100	(124)	1 210	(136)	1 330	(150)
45		45,0	47,3	727		1 180	1 310	1 440						
(47,6)	(1-7/8)	47,6	50,0		(5,91)				1 250	(141)	1 380	(155)	1 520	(171)
48		48,0	50,4	827		1 350	1 490	1 640						
(50,8)	(2)	50,8	53,3		(6.73)				1 420	(160)	1 570	(176)	1 730	(194)
51		51,0	53,6	934		1 520	1 680	1 850						
52		52,0	54,6	971		1 580	1 750	1 930						
(54,0)	(2-1/8)	54,0	56,7		(7.60)				1 590	(179)	1 750	(197)	1 930	(217)
56		56,0	58,8	1 130		1 830	2 030	2 240						

(57,2)	(2-1/4)	57,2	60,0		(8.52)				1 780	(200)	1 960	(220)	2 150	(242)	
60		60,0	63,0	1 290		2 100	2 330	2 570							

Table G.8 — Class 6 × 19 steel core

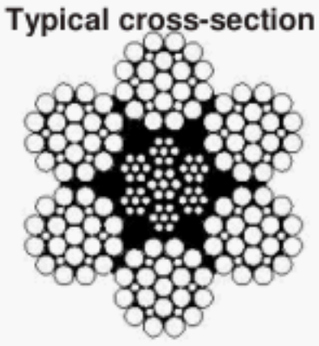
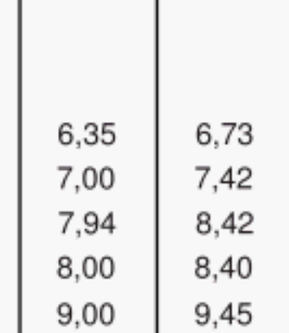
Typical cross-section						Typical construction						
						Rope construction	Strand construction	Outer wires				
								Total	Per strand			
						6 × 19S-IWRC	1-9-9	54	9			
						6 × 21F-IWRC	1-5F-5-10	60	10			
						6 × 26WS-IWRC	1-5-5F-10	60	10			
						6 × 19W-IWRC	1-6-6+6	72	12			
						6 × 25F-IWRC	1-6-6F-12	72	12			
Nominal rope diameter		Diameter tolerance		Approximate nominal length mass		Minimum breaking force (F_{min})						
		min.	max.			Grade 1770	Grade 1960	Grade 2160	Grade IPS		Grade EIP		Grade EEIP	
mm	(in)	mm	mm	kg/100 m	(lb/ft)	kN	kN	kN	kN	(short tons)	kN	(short tons)	kN	(short tons)
6		6,00	6,36	14,4		22,7	25,1	27,7						
(6,35)	(1/4)	6,35	6,73		(0.12)				26,2	(2.94)	30,2	(3.40)		
7		7,00	7,42	19,6		30,9	34,2	37,7						
(7,94)	(5/16)	7,94	8,42		(0.18)				40,7	(4.58)	46,9	(5.27)		
8		8,00	8,40	25,6		40,3	44,7	49,2						
9		9,00	9,45	32,4		51,0	56,5	62,2						
(9,5)	(3/8)	9,53	10,0		(0.26)				58,4	(6.56)	67,2	(7.55)	73,8	(8.30)
10		10,0	10,5	40,0		63,0	69,8	76,9						
11		11,0	11,6	48,4		76,2	84,4	93,0						
(11,1)	(7/16)	11,1	11,7		(0.35)				79,1	(8.89)	90,7	(10.2)	99,6	(11.2)
12		12,0	12,6	57,6		90,7	100	111						
(12,7)	(1/2)	12,7	13,3		(0.46)				102	(11.5)	118	(13.3)	130	(14.6)
13		13,0	13,7	67,6		106	118	130						
14		14,0	14,7	78,4		124	137	151						
(14,3)	(9/16)	14,3	15,0		(0.58)				129	(14.5)	149	(16.8)	165	(18.5)
(15,9)	(5/8)	15,9	16,7		(0.72)				157	(17.7)	183	(20.6)	202	(22.7)
16		16,0	16,8	102		161	179	197						
18		18,0	18,9	130		204	226	249						
19		19,0	20,0	144		227	252	278						
(19,1)	(3/4)	19,1	20,0		(1.04)				228	(25.6)	262	(29.4)	288	(32.4)
20		20,0	21,0	160		252	279	308						
22		22,0	23,1	194		305	338	372						
(22,2)	(7/8)	22,2	23,3		(1.41)				308	(34.6)	354	(39.8)	390	(43.8)
24		24,0	25,2	230		363	402	443						
(25,4)	(1)	25,4	26,7		(1.85)				399	(44.9)	460	(51.7)	506	(56.9)
26		26,0	27,3	270		426	472	520						
28		28,0	29,4	314		494	547	603						
(28,6)	(1-1/8)	28,6	30,0		(2.34)				503	(56.5)	578	(65.0)	636	(71.5)
(31,8)	(1-1/4)	31,8	33,3		(2.89)				617	(69.4)	711	(79.9)	782	(87.9)
32		32,0	33,6	410		645	715	787						
(34,9)	(1-3/8)	34,9	36,7		(3.49)				743	(83.5)	854	(96.0)	943	(106)
35		35,0	36,8	490		772	855	942						
36		36,0	37,8	518		817	904	997						
38		38,0	39,9	578		910	1 010	1 110						
(38,1)	(1-1/2)	38,1	40,0		(4.16)				880	(98.9)	1 010	(114)	1 110	(125)
40		40,0	42,0	640		1 010	1 120	1 230						
(41,3)	(1-5/8)	41,3	43,3		(4.88)				1 020	(115)	1 170	(132)	1 300	(146)
44		44,0	46,2	774		1 220	1 350	1 490						
(44,5)	(1-3/4)	44,5	46,7		(5.66)				1 180	(133)	1 360	(153)	1 500	(169)
45		45,0	47,3	810		1 280	1 410	1 560						
(47,6)	(1-7/8)	47,6	50,0		(6.49)				1 350	(152)	1 550	(174)	1 710	(192)
48		48,0	50,4	922		1 450	1 610	1 770						
(50,8)	(2)	50,8	53,3		(7.39)				1 530	(172)	1 760	(198)	1 930	(217)
51		51,0	53,6	1 040		1 640	1 810	2 000						
52		52,0	54,6	1 080		1 700	1 890	2 080						
(54,0)	(2-1/8)	54,0	56,7		(8.34)				1 710	(192)	1 970	(221)	2 160	(243)
56		56,0	58,8	1 250		1 980	2 190	2 410						
(57,2)	(2-1/4)	57,2	60,0		(9.35)				1 910	(215)	2 200	(247)	2 420	(272)
60		60,0	63,0	1 440		2 270	2 510	2 770						

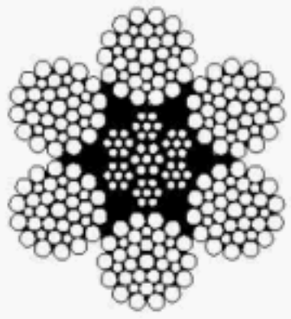
Table G.9 — Class 6 × 36 fibre core

Typical cross-section	Rope construction	Typical construction: Strand construction	Outer wires: Total	Outer wires: Per strand
	6 × 31WS-FC	1-6-6+6-12	72	12
	6 × 36WS-FC	1-7-7+7-14	84	14
	6 × 41WS-FC	1-8-8+8-16	96	16
	6 × 41SF-FC	1-8-8-8F-16	96	16
	6 × 49SWS-FC	1-8-8-8+8-16	96	16
	6 × 46WS-FC	1-9-9+9-18	108	18

Nominal rope diameter		Diameter tolerance		Approximate nominal length mass		Minimum breaking force (F_{min})									
		min.	max.			Grade 1770	Grade 1960	Grade 2160	Grade IPS		Grade EIP		Grade EEIP		
mm	(in)	mm	mm	kg/100 m	(lb/ft)	kN	kN	kN	kN	(short tons)	kN	(short tons)	kN	(short tons)	
(6,35)	(1/4)	6,35	6,73		(0.11)				24,4	(2.74)	26,8	(3.01)			
7		7,00	7,42	18,0		28,6	31,7	34,9							
(7,94)	(5/16)	7,94	8,42		(0.16)				37,9	(4.26)	41,7	(4.69)			
8		8,00	8,40	23,5		37,4	41,4	45,6							
9		9,00	9,45	29,7		47,3	52,4	57,7							
(9,5)	(3/8)	9,53	10,0		(0.24)				54,3	(6.10)	59,7	(6.71)	65,7	(7.38)	
10		10,0	10,5	36,7		58,4	64,7	71,3							
11		11,0	11,6	44,4		70,7	78,3	86,2							
(11,1)	(7/16)	11,1	11,7		(0.32)				73,6	(8.27)	81,0	(9.10)	89,0	(10.0)	
12		12,0	12,6	52,8		84,1	93,1	103							
(12,7)	(1/2)	12,7	13,3		(0.42)				95,2	(10.7)	105	(11.8)	115	(12.9)	
13		13,0	13,7	62,0		98,7	109	120							
14		14,0	14,7	71,9		114	127	140							
(14,3)	(9/16)	14,3	15,0		(0.53)				120	(13.5)	133	(14.9)	145	(16.3)	
(15,9)	(5/8)	15,9	16,7		(0.66)				149	(16.7)	164	(18.4)	180	(20.2)	
16		16,0	16,8	94,0		150	166	182							
18		18,0	18,9	119		189	210	231							
19		19,0	20,0	132		211	233	257							
(19,1)	(3/4)	19,1	20,0		(0.95)				212	(23.8)	233	(26.2)	256	(28.8)	
20		20,0	21,0	147		234	259	285							
22		22,0	23,1	178		283	313	345							
(22,2)	(7/8)	22,2	23,3		(1.29)				286	(32.2)	315	(35.4)	347	(39.0)	
24		24,0	25,2	211		336	373	411							
(25,4)	(1)	25,4	26,7		(1.68)				372	(41.8)	409	(46.0)	450	(50.6)	
26		26,0	27,3	248		395	437	482							
28		28,0	29,4	288		458	507	559							
(28,6)	(1-1/8)	28,6	30,0		(2.13)				468	(52.6)	515	(57.9)	566	(63.6)	
(31,8)	(1-1/4)	31,8	33,3		(2.63)				575	(64.6)	633	(71.1)	696	(78.2)	
32		32,0	33,6	376		598	662	730							
(34,9)	(1-3/8)	34,9	36,7		(3.18)				691	(77.7)	761	(85.5)	836	(94.0)	
35		35,0	36,8	450		716	792	873							
36		36,0	37,8	476		757	838	924							
38		38,0	39,9	530		843	934	1 030							
(38,1)	(1-1/2)	38,1	40,0		(3.78)				818	(92.0)	898	(101)	987	(111)	
40		40,0	42,0	587		935	1 040	1 140							
(41,3)	(1-5/8)	41,3	43,3		(4.44)				952	(107)	1 050	(118)	1 150	(129)	
44		44,0	46,2	711		1 130	1 250	1 380							
(44,5)	(1-3/4)	44,5	46,7		(5.15)				1 100	(124)	1 210	(136)	1 330	(150)	
45		45,0	47,3	743		1 180	1 310	1 440							
(47,6)	(1-7/8)	47,6	50,0		(5.91)				1 250	(141)	1 380	(155)	1 520	(171)	
48		48,0	50,4	846		1 350	1 490	1 640							
(50,8)	(2)	50,8	53,3		(6.73)				1 420	(160)	1 570	(176)	1 730	(194)	
51		51,0	53,6	955		1 520	1 680	1 850							
52		52,0	54,6	992		1 580	1 750	1 930							
(54,0)	(2-1/8)	54,0	56,7		(7.60)				1 590	(179)	1 750	(197)	1 930	(217)	
56		56,0	58,8	1 150		1 830	2 030	2 240							

(57,2)	(2-1/4)	57,2	60,0		(8.52)				1 780	(200)	1 960	(220)	2 150	(242)	
60		60,0	63,0	1 320		2 100	2 330	2 570							

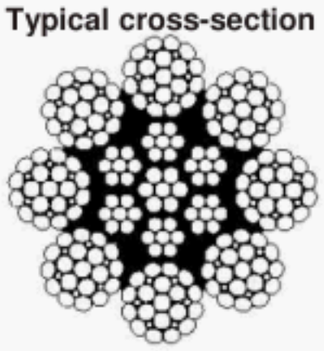
Table G.10 — Class 6 × 36 steel core

Typical cross-section						Rope construction	Typical construction Strand construction	Outer wires	
								Total	Per strand
						6 × 31WS-IWRC	1-6-6+6-12	72	12
						6 × 36WS-IWRC	1-7-7+7-14	84	14
						6 × 41WS-IWRC	1-8-8+8-16	96	16
						6 × 41SF-IWRC	1-8-8-8F-16	96	16
						6 × 49SWS-IWRC	1-8-8-8+8-16	96	16
						6 × 46WS-IWRC	1-9-9+9-18	108	18

Nominal rope diameter		Diameter tolerance		Approximate nominal length mass		Minimum breaking force (F_{min})							
						Grade 1770	Grade 1960	Grade 2160	Grade IPS		Grade EIP		Grade EEIP
mm	(in)	min. mm	max. mm	kg/100 m	(lb/ft)	kN	kN	kN	kN	(short tons)	kN	(short tons)	kN
(6,35)	(1/4)	6,35	6,73		(0.12)				26,2	(2.94)	30,2	(3.40)	
7		7,00	7,42	20,0		30,9	34,2	37,7					
(7,94)	(5/16)	7,94	8,42		(0.18)				40,7	(4.58)	46,9	(5.27)	
8		8,00	8,40	26,2		40,3	44,7	49,2					
9		9,00	9,45	33,1		51,0	56,5	62,2					
(9,5)	(3/8)	9,53	10,0		(0.26)				58,4	(6.56)	67,2	(7.55)	73,8	(8.30)
10		10,0	10,5	40,9		63,0	69,8	76,9					
11		11,0	11,6	49,5		76,2	84,4	93,0					
(11,1)	(7/16)	11,1	11,7		(0.35)				79,1	(8.89)	90,7	(10.2)	99,6	(11.2)
12		12,0	12,6	58,9		90,7	100	111					
(12,7)	(1/2)	12,7	13,3		(0.46)				102	(11.5)	118	(13.3)	130	(14.6)
13		13,0	13,7	69,1		106	118	130					
14		14,0	14,7	80,2		124	137	151					
(14,3)	(9/16)	14,3	15,0		(0.58)				129	(14.5)	149	(16.8)	165	(18.5)
(15,9)	(5/8)	15,9	16,7		(0.72)				157	(17.7)	183	(20.6)	202	(22.7)
16		16,0	16,8	105		161	179	197						
18		18,0	18,9	133		204	226	249						
19		19,0	20,0	148		227	252	278						
(19,1)	(3/4)	19,1	20,0		(1.04)				228	(25.6)	262	(29.4)	288	
20		20,0	21,0	164		252	279	308						(32.4)
22		22,0	23,1	198		305	338	372						
(22,2)	(7/8)	22,2	23,3		(1.41)				308	(34.6)	354	(39.8)	390	(43.8)
24		24,0	25,2	236		363	402	443						
(25,4)	(1)	25,4	26,7		(1.85)				399	(44.9)	460	(51.7)	506	(56.9)
26		26,0	27,3	276		426	472	520						
28		28,0	29,4	321		494	547	603						
(28,6)	(1-1/8)	28,6	30,0		(2.34)				503	(56.5)	578	(65.0)	636	(71.5)
(31,8)	(1-1/4)	31,8	33,3		(2.89)				617	(69.4)	711	(79.9)	782	(87.9)
32		32,0	33,6	419		645	715	787						
(34,9)	(1-3/8)	34,9	36,7		(3.49)				743	(83.5)	854	(96.0)	943	(106)
35		35,0	36,8	501		772	855	942						
36		36,0	37,8	530		817	904	997						
38		38,0	39,9	591		910	1 010	1 110						
(38,1)	(1-1/2)	38,1	40,0		(4.16)				880	(98.9)	1 010	(114)	1 110	(125)
40		40,0	42,0	654		1 010	1 120	1 230						
(41,3)	(1-5/8)	41,3	43,3		(4.88)				1 020	(115)	1 170	(132)	1 300	(146)
44		44,0	46,2	792		1 220	1 350	1 490						
(44,5)	(1-3/4)	44,5	46,7		(5.66)				1 180	(133)	1 360	(153)	1 500	(169)
45		45,0	47,3	828		1 280	1 410	1 560						
(47,6)	(1-7/8)	47,6	50,0		(6.49)				1 350	(152)	1 550	(174)	1 710	(192)
48		48,0	50,4	942		1 450	1 610	1 770						
(50,8)	(2)	50,8	53,3		(7.39)				1 530	(172)	1 760	(198)	1 930	(217)
51		51,0	53,6	1 060		1 640	1 810	2 000						
52		52,0	54,6	1 110		1 700	1 890	2 080						
(54,0)	(2-1/8)	54,0	56,7		(8.34)				1 710	(192)	1 970	(221)	2 160	(243)
56		56,0	58,8	1 280		1 980	2 190	2 410						

(57,2)	(2-1/4)	57,2	60,0		(9.35)				1 910	(215)	2 200	(247)	2 420	(272)
60		60,0	63,0	1 470		2 270	2 510	2 770						

Table G.11 — Class 8 × 19 steel core

Typical cross-section	Typical construction			
	Rope construction	Strand construction	Outer wires	
			Total	Per strand
	8 × 19S-IWRC	1-9-9	72	9
	8 × 21F-IWRC	1-5F-5-10	80	10
	8 × 26WS-IWRC	1-5-5+5-10	80	10
	8 × 19W-IWRC	1-6-6+6	96	12
	8 × 25F-IWRC	1-6-6F-12	96	12

Nominal rope diameter		Diameter tolerance		Approximate nominal length mass		Minimum breaking force (F_{min})							
						Grade 1770	Grade 1960	Grade 2160	Grade IPS		Grade EIP		Grade EEIP	
mm	(in)	min. mm	max. mm	kg/ 100 m	(lb/ft)	kN	kN	kN	kN	(short tons)	kN	(short tons)	kN	(short tons)
(6,35)	(1/4)	6,35	6,73		(0.12)				26,2	(2.94)	30,2	(3.40)		
7		7,00	7,42	19,9		30,9	34,2	37,7						
(7,94)	(5/16)	7,94	8,42		(0.19)				40,7	(4.58)	46,9	(5.27)		
8		8,00	8,40	26,0		40,3	44,7	49,2						
9		9,00	9,45	33,0		51,0	56,5	93,0						
(9,5)	(3/8)	9,53	10,0		(0.27)				58,4	(6.56)	67,2	(7.55)	73,8	(8.30)
10		10,0	10,5	40,7		63,0	69,8	76,9						
11		11,0	11,6	49,2		76,2	84,4	93,0						
(11,1)	(7/16)	11,1	11,7		(0.37)				79,1	(8.89)	90,7	(10.2)	99,6	(11.2)
12		12,0	12,6	58,6		90,7	100	111						
(12,7)	(1/2)	12,7	13,3		(0.48)				102	(11.5)	118	(13.3)	130	(14.6)
13		13,0	13,7	68,8		106	118	130						
14		14,0	14,7	79,8		124	137	151						
(14,3)	(9/16)	14,3	15,0		(0.61)				129	(14.5)	149	(16.8)	165	(18.5)
(15,9)	(5/8)	15,9	16,7		(0.76)				157	(17.7)	183	(20.6)	202	(22.7)
16		16,0	16,8	104		161	179	197						
18		18,0	18,9	132		204	226	249						
19		19,0	20,0	147		227	252	278						
(19,1)	(3/4)	19,1	20,0		(1.09)				228	(25.6)	262	(29.4)	288	(32.4)
20		20,0	21,0	163		252	279	308						
22		22,0	23,1	197		305	338	372						
(22,2)	(7/8)	22,2	23,3		(1.48)				308	(34.6)	354	(39.8)	390	(43.8)
24		24,0	25,2	234		363	402	443						
(25,4)	(1)	25,4	26,7		(1.93)				399	(44.9)	460	(51.7)	506	(56.9)
26		26,0	27,3	275		426	472	520						
28		28,0	29,4	319		494	547	603						
(28,6)	(1-1/8)	28,6	30,0		(2.45)				503	(56.5)	578	(65.0)	636	(71.5)
(31,8)	(1-1/4)	31,8	33,3		(3.02)				617	(69.4)	711	(79.9)	782	(87.9)
32		32,0	33,6	417		645	715	787						
(34,9)	(1-3/8)	34,9	36,7		(3.66)				743	(83.5)	854	(96.0)	943	(106)
35		35,0	36,8	499		772	855	942						
36		36,0	37,8	527		817	904	997						
38		38,0	39,9	588		910	1 010	1 110						
(38,1)	(1-1/2)	38,1	40,0		(4.35)				880	(98.9)	1 010	(114)	1 110	(125)
40		40,0	42,0	651		1 010	1 120	1 230						
(41,3)		41,3	43,3		(5.11)				1 020	(115)	1 170	(132)	1 300	(146)
44	(1-5/8)	44,0	46,2	788		1 220	1 350	1 490						
(44,5)		44,5	46,7		(5.95)				1 180	(133)	1 360	(153)	1 500	(169)
45	(1-3/4)	45,0	47,3	824		1 280	1 410	1 560						
(47,6)	(1 7/8)	47,6	50,0		(6.80)				1 350	(152)	1 550	(174)	1 710	(192)
48		48,0	50,4	938		1 450	1 610	1 770						
(50,8)	(2)	50,8	53,3		(7.73)				1 530	(172)	1 760	(198)	1 930	(217)
51		51,0	53,6	1 060		1 640	1 810	2 000						
52		52,0	54,6	1 100		1 700	1 890	2 080						
(54,0)	(2-1/8)	54,0	56,7		(8.73)				1 710	(192)	1 970	(221)	2 160	(243)
56		56,0	58,8	1 280		1 980	2 190	2 410						

(57,2)	(2-1/4)	57,2	60,0		(9.79)				1 910	(215)	2 200	(247)	2 420	(272)
60		60,0	63,0	1 470		2 270	2 510	2 770						

Table G.12 — Class 8 × 36 steel core

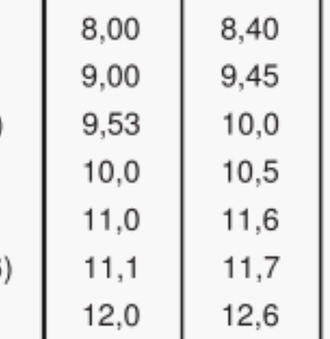
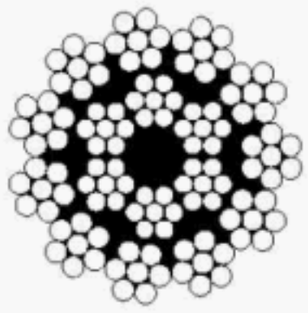
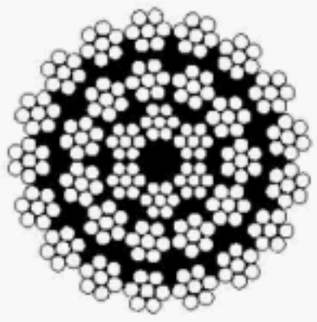
Typical cross-section						Typical construction									
						Rope construction		Strand construction			Outer wires				
						8 × 31WS-IWRC 8 × 36WS-IWRC 8 × 41WS-IWRC		1-6-6+6-12 1-7-7+7-14 1-8-8+8-16			Total		Per strand		
Nominal rope diameter		Diameter tolerance		Approximate nominal length mass		Minimum breaking force (F_{min})									
		min.	max.			Grade 1770	Grade 1960	Grade 2160	Grade IPS		Grade EIP		Grade EEIP		
mm	(in)	mm	mm	kg/100 m	(lb/ft)	kN	kN	kN	kN	(short tons)	kN	(short tons)	kN	(short tons)	
8		8,00	8,40	26,7		40,3	44,7	49,2							
9		9,00	9,45	33,8		51,0	56,5	62,2							
(9,5)	(3/8)	9,53	10,0		(0.27)				58,4	(6.56)	67,2	(7.55)	73,8	(8.30)	
10		10,0	10,5	41,7		63,0	69,8	76,9							
11		11,0	11,6	50,5		76,2	84,4	93,0							
(11,1)	(7/16)	11,1	11,7		(0.37)				79,1	(8.89)	90,7	(10.2)	99,6	(11.2)	
12		12,0	12,6	60,0		90,7	100	111							
(12,7)	(1/2)	12,7	13,3		(0.48)				102	(11.5)	118	(13.3)	130	(14.6)	
13		13,0	13,7	70,5		106	118	130							
14		14,0	14,7	81,7		124	137	151							
(14,3)	(9/16)	14,3	15,0		(0.61)				129	(14.5)	149	(16.8)	165	(18.5)	
(15,9)	(5/8)	15,9	16,7		(0.76)				157	(17.7)	183	(20.6)	202	(22.7)	
16		16,0	16,8	107		161	179	197							
18		18,0	18,9	135		204	226	249							
19		19,0	20,0	151		227	252	278							
(19,1)	(3/4)	19,1	20,0		(1.09)				228	(25.6)	262	(29.4)	288	(32.4)	
20		20,0	21,0	167		252	279	308							
22		22,0	23,1	202		305	338	372							
(22,2)	(7/8)	22,2	23,3		(1.48)				308	(34.6)	354	(39.8)	390	(43.8)	
24		24,0	25,2	240		363	402	443							
(25,4)	(1)	25,4	26,7		(1.93)				399	(44.9)	460	(51.7)	506	(56.9)	
26		26,0	27,3	282		426	472	520							
28		28,0	29,4	327		494	547	603							
(28,6)	(1-1/8)	28,6	30,0		(2.45)				503	(56.5)	578	(65.0)	636	(71.5)	
(31,8)	(1-1/4)	31,8	33,3		(3.02)				617	(69.4)	711	(79.9)	782	(87.9)	
32		32,0	33,6	427		645	715	787							
(34,9)	(1-3/8)	34,9	36,7		(3.66)				743	(83.5)	854	(96.0)	943	(106)	
35		35,0	36,8	511		772	855	942							
36		36,0	37,8	540		817	904	997							
38		38,0	39,9	602		910	1 010	1 110							
(38,1)	(1-1/2)	38,1	40,0		(4.35)				880	(98.9)	1 010	(114)	1 110	(125)	
40		40,0	42,0	667		1 010	1 120	1 230							
(41,3)	(1-5/8)	41,3	43,3		(5.11)				1 020	(115)	1 170	(132)	1 300	(146)	
44		44,0	46,2	807		1 220	1 350	1 490							
(44,5)	(1-3/4)	44,5	46,7		(5.92)				1 180	(133)	1 360	(153)	1 500	(169)	
45		45,0	47,3	844		1 280	1 410	1 560							
(47,6)	(1-7/8)	47,6	50,0		(6.80)				1 350	(152)	1 550	(174)	1 710	(192)	
48		48,0	50,4	961		1 450	1 610	1 770							
(50,8)	(2)	50,8	53,3		(7.73)				1 530	(172)	1 760	(198)	1 930	(217)	
51		51,0	53,6	1 080		1 640	1 810	2 000							
52		52,0	54,6	1 130		1 700	1 890	2 080							
(54,0)	(2-1/8)	54,0	56,7		(8.73)				1 710	(192)	1 970	(221)	2 160	(243)	
56		56,0	58,8	1 310		1 980	2 190	2 410							
(57,2)	(2-1/4)	57,2	60,0		(9.79)				1 910	(215)	2 200	(247)	2 420	(272)	
60		60,0	63,0	1 500		2 270	2 510	2 770							

Table G.13 — Class 18 × 7

Typical cross-section	Typical construction			
	Rope construction	Strand construction	Outer wires	
			Total	Per strand
	17 × 7-FC	1-6	66	6
	17 × 7-WSC	1-6	66	6
	18 × 7-FC	1-6	72	6
	18 × 7-WSC	1-6	72	6

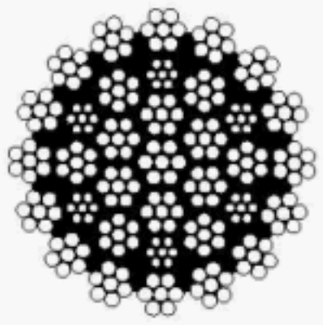
Nominal rope diameter		Diameter tolerance		Approximate nominal length mass				Minimum breaking force (F_{min})					
		min.	max.	Core — FC		Core — WSC		Grade 1770	Grade 1960	Grade IPS		Grade EIP	
mm	(in)	mm	mm	kg/100 m	(lb/ft)	kg/100 m	(lb/ft)	kN	kN	kN	(short tons)	kN	(short tons)
6		6,00	6,36	13,8		14,4		20,9	23,1				
(6,35)	(1/4)	6,35	6,73		(0.11)		(0,11)			22,3	(2.51)	24,6	(2.77)
7		7,00	7,42	18,7		19,6		28,4	31,5				
(7,94)	(5/16)	7,94	8,42		(0.17)		(0,18)			34,7	(3.90)	38,3	(4.30)
8		8,00	8,40	24,4		25,7		37,2	41,1				
9		9,00	9,45	30,9		32,5		47,0	52,1				
(9,5)	(3/8)	9,53	10,0		(0.24)		(0,26)			49,7	(5.59)	54,5	(6.15)
10		10,0	10,5	38,2		40,1		58,1	64,3				
11		11,0	11,6	46,2		48,5		70,2	77,8				
(11,1)	(7/16)	11,1	11,7		(0.33)		(0,35)			67,4	(7.58)	73,9	(8.33)
12		12,0	12,6	55,0		57,7		83,6	92,6				
(12,7)	(1/2)	12,7	13,3		(0.43)		(0,45)			87,6	(9.85)	95,8	(10.8)
13		13,0	13,7	64,6		67,8		98,1	109				
14		14,0	14,7	74,9		78,6		114	126				
(14,3)	(9/16)	14,3	15,0		(0.55)		(0,57)			110	(12.4)	121	(13.6)
(15,9)	(5/8)	15,9	16,7		(0.68)		(0,71)			136	(15.3)	149	(16.8)
16		16,0	16,8	97,8		103		149	165				
18		18,0	18,9	124		130		188	208				
19		19,0	20,0	138		145		210	232				
(19,1)	(3/4)	19,1	20,0		(0.97)		(1,02)			194	(21.8)	214	(24.0)
20		20,0	21,0	153		160		232	257				
22		22,0	23,1	185		194		281	311				
(22,2)	(7/8)	22,2	23,3		(1.32)		(1,39)			262	(29.5)	289	(32.5)
24		24,0	25,2	220		231		334	370				
(25,4)	(1)	25,4	26,7		(1.73)		(1,82)			341	(38.3)	375	(42.2)
26		26,0	27,3	258		271		392	435				
28		28,0	29,4	299		314		455	504				
(28,6)	(1-1/8)	28,6	30,0		(2.19)		(2,30)			429	(48.2)	472	(53.1)
(31,8)	(1-1/4)	31,8	33,3		(2.70)		(2,84)			527	(59.2)	579	(65.1)
32		32,0	33,6	391		411		594	658				
(34,9)	(1-3/8)	34,9	36,7		(3.27)		(3,43)			634	(71.3)	697	(78.4)
35		35,0	36,8	468		491		711	788				
36		36,0	37,8	495		520		752	833				
38		38,0	39,9	552		579		838	928				
(38,1)	(1-1/2)	38,1	40,0		(3.89)		(4,09)			751	(84.4)	826	(92.8)

Table G.14 — Class 34(M) × 7

Typical cross-section	Typical construction			
	Rope construction	Strand construction	Outer wires	
			Total	Per strand
	34(M) × 7-FC	1-6	102	6
	34(M) × 7-WSC	1-6	102	6
	36(M) × 7-FC	1-6	108	6
	36(M) × 7-WSC	1-6	108	6

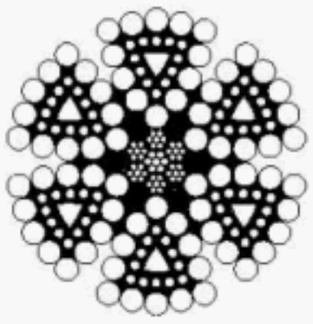
Nominal rope diameter		Diameter tolerance		Approximate nominal length mass				Minimum breaking force (F_{min})					
		min.	max.	Core — FC		Core — WSC		Grade 1770	Grade 1960	Grade IPS		Grade EIP	
mm	(in)	mm	mm	kg/100 m	(lb/ft)	kg/100 m	(lb/ft)	kN	kN	kN	(short tons)	kN	(short tons)
10		10,0	10,5	39,0		40,1		56,3	62,3				
11		11,0	11,6	47,2		48,5		68,1	75,4				
(11,1)	(7/16)	11,1	11,7		(0.32)		(0.33)			69,5	(7.81)	77,0	(8.65)
12		12,0	12,6	56,2		57,7		81,1	89,8				
(12,7)	(1/2)	12,7	13,3		(0.42)		(0.43)			90,7	(10.2)	101	(11.3)
13		13,0	13,7	65,9		67,8		95,1	105				
14		14,0	14,7	76,4		78,6		110	122				
(14,3)	(9/16)	14,3	15,0		(0.53)		(0.55)			115	(12.9)	127	(14.3)
(15,9)	(5/8)	15,9	16,7		(0.66)		(0.68)			141	(15.9)	157	(17.7)
16		16,0	16,8	99,8		103		144	160				
18		18,0	18,9	126		130		182	202				
19		19,0	20,0	141		145		203	225				
(19,1)	(3/4)	19,1	20,0		(0.95)		(0.98)			205	(23.0)	226	(25.4)
20		20,0	21,0	156		160		225	249				
22		22,0	23,1	189		194		272	302				
(22,2)	(7/8)	22,2	23,3		(1.29)		(1.33)			278	(31.3)	308	(34.6)
24		24,0	25,2	225		231		324	359				
(25,4)	(1)	25,4	26,7		(1.69)		(1.74)			363	(40.8)	402	(45.2)
26		26,0	27,3	264		271		380	421				
28		28,0	29,4	306		314		441	489				
(28,6)	(1-1/8)	28,6	30,0		(2.14)		(2.20)			460	(51.7)	509	(57.2)
(31,8)	(1-1/4)	31,8	33,3		(2.64)		(2.72)			568	(63.8)	628	(70.6)
32		32,0	33,6	399		411		576	638				
(34,9)	(1-3/8)	34,9	36,7		(3.20)		(3.29)			687	(77.2)	761	(85.5)
35		35,0	36,8	478		491		690	764				
36		36,0	37,8	505		520		729	808				
38		38,0	39,9	563		579		813	900				
(38,1)	(1-1/2)	38,1	40,0		(3.80)		(3.91)			817	(91.8)	907	(102)
40		40,0	42,0	624				901	997				(119)
(41,3)	(1-5/8)	41,3	43,4		(4.46)		(4.59)			961	(108)	1 060	
44		44,0	46,2	755				1 090	1 210				

Table G.15 — Class 35(W) × 7

Typical cross-section	Typical construction			
	Rope construction	Strand construction	Outer wires	
			Total	Per strand
	35(W) × 7	1-6	96	6
	40(W) × 7	1-6	108	6

Nominal rope diameter		Diameter tolerance		Minimum breaking force (F_{min})					
				Grade 1770		Grade 1960		Grade 2160	
		min.	max.						
mm	(in)	mm	mm	kN	(short tons)	kN	(short tons)	kN	(short tons)
8		8,00	8,40	40,8	(4.52)	45,2	(5.08)	48,4	(5.44)
9		9,00	9,45	51,6	(5.80)	57,2	(6.43)	61,2	(6.88)
(9,5)	(3/8)	9,53	10,0						
10		10,0	10,5	63,7	(7.16)	70,6	(7.94)	75,6	(8.50)
11		11,0	11,6	77,1	(8.67)	85,4	(9.60)	91,5	(10.3)
(11,1)	(7/16)	11,1	11,7						
12		12,0	12,6	91,8	(10.3)	102	(11.5)	109	(12.3)
(12,7)	(1/2)	12,7	13,3						
13		13,0	13,7	108	(12.1)	119	(13.4)	128	(14.4)
14		14,0	14,7	125	(14.1)	138	(15.5)	148	(16.6)
(14,3)	(9/16)	14,3	15,0 (15,9)	(5/8)	15,9	16,7			
16		16,0	16,8	163	(18.3)	181	(20.3)	194	(21.8)
18		18,0	18,9	206	(23.2)	229	(25.7)	245	(27.5)
19		19,0	20,0	230	(25.9)	255	(28.7)	273	(30.7)
(19,1)	(3/4)	19,1	20,0						
20		20,0	21,0	255	(28.7)	282	(31.7)	302	(33.9)
22		22,0	23,1	308	(33.9)	342	(38.4)	366	(41.1)
(22,2)	(7/8)	22,2	23,3						
24		24,0	25,2	367	(41.3)	406	(45.6)	435	(48.9)
(25,4)	(1)	25,4	26,7						
26		26,0	27,3	431	(48.4)	477	(53.6)	511	(57.4)
28		28,0	29,4	500	(56.2)	553	(62.6)	593	(66.7)
(28,6)	(1-1/8)	28,6	30,0 (31,8)	(1-1/4)	31,8	33,3			
32		32,0	33,6	652	(73.3)	723	(81.3)	774	(87.0)
(34,9)	(1-3/8)	34,9	36,7						
35		35,0	36,8	781	(87.8)	864	(97.1)	926	(104)
36		36,0	37,8	826	(92.9)	914	(103)	980	(110)
38		38,0	39,9	920	(103)	1 020	(115)	1 090	(126)
(38,1)	(1-1/2)	38,1	40,0						
40		40,0	42,0	1 020	(115)	1 130	(127)	1 210	(136)
(41,3)	(1-5/8)	41,3	43,3						

Table G.16 — Class 6 × V25TS steel core

Typical cross-section	Typical construction			
	Rope construction	Strand construction	Outer wires	
			Total	Per strand
	6 × V25	V-12/12	72	12
	6 × V25B	3 × 2/12/12	72	12
	6 × V25B	3 × 2-3F/12/12	72	12
	6 × V25B	1-6K/12/12	72	12
	6 × V28B	3 × 2-3F/12/15	90	15

Nominal rope diameter		Diameter tolerance		Approximate nominal length mass		Minimum breaking force (F_{min})			
						Grade IPS		Grade EIP	
mm	(in)	min. mm	max. mm	kg/100 m	(lb/ft)	kN	(short tons)	kN	(short tons)
12		12,0	12,6						
(12,7)	(1/2)	12,7	13,3	69,9	(0.47)	112	(12.6)	125	(14.0)
13		13,0	13,7						
14		14,0	14,7						
(14,3)	(9/16)	14,3	15,0	89,3	(0.60)	142	(16.0)	157	(17.6)
(15,9)	(5/8)	15,9	16,7	110	(0.74)	174	(19.6)	193	(21.7)
16		16,0	16,8						
18		18,0	18,9						
19		19,0	20,0						
(19,1)	(3/4)	19,1	20,0	158	(1.06)	250	(28.1)	276	(31.0)
20		20,0	21,0						
22		22,0	23,1						
(22,2)	(7/8)	22,2	23,3	216	(1.45)	338	(38.0)	373	(41.9)
24		24,0	25,2						
(25,4)	(1)	25,4	26,7	281	(1.89)	439	(49.4)	484	(54.4)
26		26,0	27,3						
28		28,0	29,4						
(28,6)	(1-1/8)	28,6	30,0	356	(2.39)	553	(62.2)	609	(68.5)
(31,8)	(1-1/4)	31,8	33,3	439	(2.95)	679	(76.3)	747	(84.0)
32		32,0	33,6						
(34,9)	(1-3/8)	34,9	36,7	531	(3.57)	818	(91.9)	898	(101)
35		35,0	36,8						
36		36,0	37,8						
38		38,0	39,9						
(38,1)	(1-1/2)	38,1	40,0	632	(4.25)	961	(108)	1 060	(119)
40		40,0	42,0						
(41,3)	(1-5/8)	41,3	43,3	743	(4.99)	1 130	(127)	1 250	(140)
44		44,0	46,2						
(44,5)	(1-3/4)	44,5	46,7	862	(5.79)	1 300	(146)	1 430	(161)
45		45,0	47,3						
(47,6)	(1-7/8)	47,6	50,0	990	(6.65)	1 490	(167)	1 640	(184)
48		48,0	50,4						
(50,8)	(2)	50,8	53,3	1 120	(7.56)	1 680	(189)		
51		51,0	53,6					1 840	(207)
52		52,0	54,6						
(54,0)	(2-1/8)	54,0	56,7	1 270	(8.54)	1 880	(211)	2 060	(232)
56		56,0	58,8						
(57,2)	(2-1/4)	57,2	60,0	1 420	(9.57)	2 110	(237)	2 310	(260)
60		60,0	63,0						
(60,3)	(2-3/8)	60,3	63,3	1 590	(10.7)	2 320	(261)	2 550	(287)

Annex H

(normative)

Sampling and acceptance criteria for type testing of ropes produced in series

H.1 Sizes up to and including 60 mm diameter

H.1.1 Ropes having same minimum breaking force factor throughout a sub-group of rope diameters

The manufacturer shall divide the intended size range into sub-groups based on the following:

nominal diameter up to and including 6 mm;

over 6 mm up to and including 12 mm;

over 12 mm up to and including 24 mm;

over 24 mm up to and including 48 mm;

over 48 mm up to and including 60 mm.

For each of the sub-groups representing the intended range and having the same construction, grade and minimum breaking force factor, the manufacturer shall perform a breaking force test in accordance with 5.1.4.1 (Method 1) on a sample from each of three separate production lengths of rope of different nominal diameters.

If all three samples pass the test, all rope sizes within that sub-group of that particular rope construction, grade and minimum breaking force factor shall be deemed to have satisfied the type testing requirements; otherwise, breaking force testing shall continue on a sample from each consecutive production length of rope within that sub-group until the above requirements are met.

H.1.2 Ropes having different minimum breaking force factors throughout a sub-group of rope diameters

The manufacturer shall perform a breaking force test in accordance with 5.1.4.1 (Method 1) on a sample from each of three separate production lengths of rope of the same nominal diameter.

If all three samples pass the test, that rope diameter and construction having that particular minimum breaking force factor shall be deemed to have satisfied the breaking force type testing requirements.

If one of the samples fails the test, the tests shall be repeated until the measured breaking forces of three consecutive production lengths of that rope diameter and construction meet or exceed the minimum breaking force value.

H.2 Sizes over 60 mm diameter

For each rope of a given diameter, construction and minimum breaking force, the manufacturer shall perform a breaking force test in accordance with 5.1.4.1 (Method 1), 5.1.4.2 (Method 2) or 5.1.4.3 (Method 3) on a sample from each of three separate production lengths.

If all three samples pass the test, that rope diameter and construction having that particular minimum breaking force shall be deemed to have satisfied the breaking force type testing requirements.

If one sample fails the test, the tests shall be repeated until the measured breaking forces of three consecutive production lengths of that rope diameter and construction meet or exceed the minimum breaking force value.

Alternatively, where the manufacturer intends to produce multiple production lengths of the same rope on the same closing machine with the same machine settings to the same design, the number of samples for breaking force testing may be calculated using the $\sqrt{N-1}$ rounded down to the next whole number with a minimum of 1, where N is the number of production lengths (i.e. closer loadings).

The ropes shall be deemed to comply if the measured breaking forces, when tested in accordance with 5.1.4.1 (Method 1), 5.1.4.2 (Method 2) or 5.1.4.3 (Method 3), meet or exceed the minimum value.

If one of the samples fails the test, tests shall be carried out on a sample from each of the remaining production lengths.

Only those ropes that pass the test shall be deemed to have satisfied the breaking force requirement

Annex I

(informative)

Tests on wires from the rope (if specified by the purchaser)

I.1 General

If tests on wires are required to be carried out, these are usually in respect of diameter, tensile strength and torsions; and, when applicable, zinc coating.

For the purposes of evaluating the test results, the manufacturer should indicate the nominal dimensions and tensile strength grades of the wires.

The sample selected should be of sufficient length to allow for retest.

NOTE These requirements do not apply to compacted strand ropes and compacted (swaged) ropes.

I.2 Sampling

I.2.1 Stranded rope

For each layer of strands, including those in the core, one strand of each construction within that layer shall be selected and the wires tested. If there are more than eight strands of the same diameter and construction in one layer, the wires from two strands of that diameter and construction shall be tested.

Unless specified otherwise, the samples of wires taken for tests shall not include filler or centre wires.

I.2.2 Spiral rope

Unless specified otherwise, the test pieces shall be obtained by separating the wires of each layer into groups. A group shall consist only of wires of the same type and size from a particular wire layer. 25 % of the wires from each group, with a minimum of three, shall be randomly selected and subjected to the required tests.

I.3 Test methods and acceptance criteria

I.3.1 General

I.3.1.1 Stranded ropes

For each requirement, a maximum of 5 % of wires tested, rounded up to the nearest whole number of wires, shall be permitted to lie outside the values specified.

When the same wire fails in more than one test (e.g. torsion and tensile), this is counted as one failure.

I.3.1.2 Spiral ropes

Wires from the rope conform to this International Standard if not more than one wire in any diameter group fails any of the tests specified. If two or more wires of any diameter group fail to pass any of the tests specified, all of the remaining wires of that group shall be tested in respect of the test in which these wires have failed; if the number of wires which fails these tests is less than two, the wires shall be deemed to conform.

When the same wire fails in more than one test (e.g. torsion and tensile), this shall count as one failure.

I.3.2 Dimension (diameter or height)

When tested in accordance with 5.1 of ISO 2232:1990, 5 % of the wires may exceed by up to 50 % the tolerance specified in Annex A of the present International Standard.

I.3.3 Tensile strength

When tested in accordance with ISO 6892 or the method given in Clause B.2 (for Levels 2, 3, 4 and 5), the measured values shall be in accordance with the values given in Annex A with an expanded tolerance of 50 N/mm2 at the lower end.

For ropes with shaped (e.g. triangular) strands, the expanded tolerance at the lower end shall be equivalent to 5 % of the tensile strength grade of the wire.

I.3.4 Torsion

I.3.4.1 General

A length of 100d for the test piece between grips is preferred. If this length cannot be adopted, an alternative length may be chosen at the wire manufacturer's discretion (e.g. for wire Levels 2, 3, 4 and 5). In this case, the number of torsions which the wire shall withstand shall be proportional to the numbers specified for a test length of 100d.

I.3.4.2 Stranded ropes

For ropes with round strands, when tested in accordance with ISO 7800 or the method given in Clause B.2, as appropriate, the measured values of round wires of 0,5 mm diameter and larger shall be at least 85 % of the values specified in Annex A, rounded down to the next whole number.

For ropes with shaped strands with more than one layer of round wires in the strands, the values resulting from the above for round strands shall be reduced by one torsion each.

For ropes with shaped strands with only one layer of round wires in the strands, the values resulting from the above for round strands shall be reduced by two torsions each.

See I.3.5 for test on wires less than 0,5 mm diameter.

I.3.4.3 Spiral ropes

When tested in accordance with ISO 7801, the measured values of round and shaped wires shall be at least 75 % of the pre-spin (before fabrication) values, rounded down to the next whole number.

I.3.5 Knot

This test shall apply to wires smaller than 0,5 mm diameter in substitution of the torsion test.

Each single wire with one simple knot shall withstand without breaking a force of at least 45 % of the force corresponding to the tensile strength grade.

I.3.6 Coating of wires

I.3.6.1 Stranded ropes

When measured in accordance with Annex A of ISO 2232:1990, the permissible reduction of mass of zinc or Zn 95/Al 5 coating from the pre-spin (before fabrication) minimum values shall not be more than the values given in Table I.1.

Table I.1 — Permissible reduction of minimum mass of zinc coating of wires for stranded ropes

Minimum mass before rope fabrication	Permissible reduction after rope making
g/m^2	
< 40	2
40 to < 80	4
80 to < 120	6
120 to < 160	8
160 to < 200	10
200 to < 300	15
300 to < 400	20
> 400	25

I.3.6.2 Spiral ropes

When measured in accordance with the method specified in Annex A of ISO 2232:1990, the actual mass of coating of shaped and round wires shall be at least 95 % and 92,5 % respectively of the pre-spin (before fabrication) minimum values.

Annex J
(informative)

Large diameter ropes

See Tables J.1 to J.3.

Table J.1 — Class — Large-diameter, six-stranded rope

Nominal rope diameter		Diameter range		Approximate length mass		Minimum breaking force	
		min.	max.				
mm	(in)	mm	mm	kg/100 m	(lb/ft)	kN	(short tons)
63,5	(2-1/2)	63,5	66,7	1 730	(11.6)	2 950	(332)
66,7	(2-5/8)	66,7	70,0	1 910	(12.8)	3 240	(364)
69,9	(2-3/4)	69,9	73,4	2 080	(14.0)	3 530	(397)
73,0	(2-7/8)	73,0	76,7	2 280	(15.3)	3 840	(432)
76,2	(3)	76,2	80,0	2 470	(16.6)	4 160	(468)
79,4	(3-1/8)	79,4	83,4	2 680	(18.0)	4 490	(505)
82,6	(3-1/4)	82,6	86,7	2 900	(19.5)	4 830	(543)
85,7	(3-3/8)	85,7	90.0	3 130	(21.0)	5 180	(582)
88,9	(3-1/2)	88,9	93,3	3 380	(22.7)	5 520	(621)
95,3	(3-3/4)	95,3	100	3 870	(26.0)	6 270	(705)
102	(4)	102	107	4 400	(44.0)	6 340	(713)
108	(4-1/4)	108	113	4 960	(49.6)	7 110	(799)
114	(4-1/2)	114	120	5 570	(55.7)	7 900	(888)
121	(4-3/4)	121	127	6 200	(62.1)	8 730	(981)
127	(5)	127	133	6 870	(68.8)	9 590	(1 078)
133	(5-1/4)	133	140	7 410	(49.8)	9 960	(1 120)
140	(5-1/2)	140	147	8 110	(54.5)	10 800	(1 219)
146	(5-3/4)	146	153	8 870	(59.6)	11 700	(1 320)
152	(6)	152	160	9 680	(65.0)	12 700	(1 426)

NOTE The breaking force values above apply to ropes with bright or zinc-coated quality B wires. The values of breaking force for ropes with a heavier mass of coating than quality B may be lower than those given above.

Table J.2 — Class — Large diameter spiral strand

Nominal rope diameter		Diameter range		Approximate length mass		Minimum breaking force	
		min.	max.				
mm	(in)	mm	mm	kg/100 m	(lb/ft)	kN	(short tons)
102	(4)	102	107	5 500	(37.0)	8 830	(993)
108	(4-1/4)	108	113	5 700	(38.3)	9 810	(1 100)
114	(4-1/2)	114	120	6 600	(44.4)	11 000	(1 240)
121	(4-3/4)	121	127	7 300	(49.1)	12 300	(1 380)
127	(5)	127	133	8 200	(55.1)	13 500	(1 520)
133	(5-1/4)	133	140	8 800	(59.1)	14 700	(1 650)
140	(5-1/2)	140	147	9 600	(64.5)	16 700	(1 880)
146	(5-3/4)	146	153	10 900	(73.2)	17 900	(2 010)
152	(6)	152	160	11 600	(78.0)	19 700	(2 210)

Table J.3 — Class — Large diameter full-locked coil

Nominal rope diameter		Diameter range		Approximate length mass		Minimum breaking force	
		min.	max.				
mm	(in)	mm	mm	kg/100 m	(lb/ft)	kN	(short tons)
76,2	(3)	76,2	80,0	3 300	(22.2)	5 450	(613)
82,6	(3-1/4)	82,6	86,7	3 900	(26.2)	6 480	(728)
88,9	(3-1/2)	88,9	93,3	4 500	(30.2)	7 450	(837)
95,3	(3-3/4)	95,3	100	5 150	(34.6)	8 540	(960)
102	(4)	102	107	5 950	(40.0)	9 850	(1 110)
108	(4-1/4)	108	113	6 600	(44.4)	10 100	(1 140)
114	(4-1/2)	114	120	7 300	(49.1)	12 200	(1 370)
121	(4-3/4)	121	127	8 250	(55.4)	13 800	(1 550)
127	(5)	127	133	9 100	(61.2)	15 100	(1 700)
140	(5-1/2)	140	147	10 900	(73.3)	18 300	(2 060)

Annex K

(informative)

Information with enquiry or order

The following information should be provided by the purchaser when making an enquiry or placing an order:

a) reference to this International Standard;

b) quantity and length;

c) nominal diameter;

d) rope class or construction;

e) core type;

f) rope grade;

g) wire finish;

h) lay direction and type;

i) preformation;

j) lubrication;

k) any particular marking requirements;

l) any particular packing requirements;

m) minimum breaking force required.

Bibliography

[1] ISO 9001, *Quality management systems — Requirements*

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