CORDAGE INSTITUTE

STANDARDS

POLYESTER/POLYOLEFIN DUAL FIBER ROPE
3-Strand Construction

CI 1302A-96
V.2
April, 1999
Supersedes September 1996 V.1

1. Scope

1.1 This standard covers 3 strand fiber rope of polyester and polyolefin composite for general marine, industrial, commercial and consumer use.

1.2 This standard does not purport to address all of the safety problems associated with its use. It is the responsibility of the user of this standard to select a size to meet working load requirements, to establish appropriate safety and health practices, and to determine the applicability of regulatory limitations prior to its use.

1.3 The values stated in inch-pound units are to be regarded as standard. The values in SI units are provided for use where required.

1.4 In the event of any conflict between the text of this document and any references cited, the text of this document takes preference.

2. References and Other Requirements

2.1 CI 1201 (current): Fiber Rope — General Standards. This standard contains provisions for ordering, workmanship, inspection, testing, marking, packaging and labeling, which are applicable to this standard, unless otherwise specified. (Available from the Cordage Institute.)

2.2 CI 1500 (current): Test Methods for Fiber Ropes. This standard provides the test methods to determine rope physical properties. (Available from the Cordage Institute.)

2.3 ASTM D4268 (current): Standard Test Methods for Testing Fiber Ropes. This standard provides the test methods to determine rope physical properties. (Available from ASTM, 100 Barr Harbor Dr., West Conshohocken, PA 19428-2959 USA.)

2.4 CI ES-1 and ES-8P (current) Eye Splice Instructions for 3 and 8-strand rope. Available from the Cordage Institute.

2.5 CI 1401 (current) Safe Use Guidelines included as page 4 of this document.

3. Materials

The rope shall be made of fibers as stated below.

3.1 Polyester

The polyester portion of the rope shall be continuous filament, heat and light resistant fiber of industrial (high tenacity) grade of at least 7.0 grams per denier tenacity.

3.2 Polyolefin

The polyolefin portion of the rope shall be suitable strength to meet all the requirements of this specification.

3.3 Extraneous Materials

No extraneous materials shall be added for the purpose of weighting the rope. Extractable matter of the finished rope shall not exceed 2%.

4. Construction

4.1 3-strand rope shall be made with 3 strands, each having an identical structure and number of yarns. The use of an internal marker or surface yarn marker shall be the only exception to the strand-to-strand uniformity requirement. The strands shall be formed and the rope laid to produce a torque balanced product.

4.2 **Strands.** The strands shall be constructed as indicated below.

4.2.2 **Cover Yarns.** The cover yarns shall be made with polyester fibers covering a polyolefin core and shall contain a minimum of 40 percent by weight of polyester fiber.

4.2.3 **Inside Yarns.** When inside yarns are used, they may consist of 100% polyolefin fibers.

4.3 **Elongation.** The elongation of the ropes shall not exceed 45% at the breaking point when tested according to Cordage Institute Standard Test Method CIA-3 or ASTM D-4268 (current).

4.4 **Spliceability.** The finished rope shall be easily spliceable using the Cordage Institute splicing procedures for 3-strand rope (ES-1).

5. Physical Properties

The physical properties of the rope shall meet those listed in Table 1. The Design Factor range and the Working Load Limit (WLL) ranges are provided as guidelines only; it is the responsibility of the user of this standard to determine a specific value for a specific application. (See Safe Use Guidelines CI 1401 (current), page 4.)

6. Key Words

Polyester/Polypropylene rope, combination rope, dual fiber rope, rope, 3-strand rope.

Table 1. Physical Properties

Nominal Size (1) Diameter In.	(mm)	Size No. (circ.)	Linear Density(2) lbs/100'	(ktex)	New Rope Min Breaking Strength(3) Lbs.	(daN)	Design Factor Range(4)	Working Load Limits(5) Range Lbs (daN) 1/12 – 1/5
1/4	(6)	3/4	1.6	(23.8)	1,200	(534)	12–5	100 (44)–240 (107)
5/16	(8)	1	2.5	(37.2)	1,870	(832)	12–5	156 (69)–374 (166)
3/8	(10)	1 1/8	3.6	(53.6)	2,700	(1,201)	12–5	225 (100)–540 (240)
7/16	(11)	1 1/4	4.8	(71.4)	3,500	(1,557)	12–5	292 (130)–700 (311)
1/2	(12)	1 1/2	6.2	(92.3)	4,400	(1,957)	12–5	367 (163)–880 (391)
9/16	(14)	1 3/4	7.9	(118)	5,200	(2,313)	12–5	433 (193)–1,040 (463)
5/8	(16)	2	9.5	(141)	6,100	(2,713)	12–5	508 (226)–1,220 (543)
3/4	(18)	2 1/4	13.5	(201)	8,400	(3,736)	12–5	700 (311)–1,680 (747)
7/8	(22)	2 3/4	18.0	(268)	11,125	(4,948)	12–5	927 (412)–2,225 (990)
1	(24)	3	21.8	(324)	13,175	(5,860)	12–5	1,098 (488)–2,635 (1,172)
1 1/16	(26)	3 1/4	24.5	(365)	14,775	(6,572)	12–5	1,231 (548)–2,955 (1,314)
1 1/8	(28)	3 1/2	27.1	(403)	16,325	(7,261)	12–5	1,360 (605)–3,265 (1,452)
1 1/4	(30)	3 3/4	33.4	(497)	19,900	(8,862)	12–5	1,658 (738)–3,980 (1,770)
1 5/16	(32)	4	36.5	(543)	21,950	(9,763)	12–5	1,829 (814)–4,390 (1,953)
1 1/2	(36)	4 1/2	47.0	(699)	28,250	(12,566)	12–5	2,354 (1,047)–5,650 (2,513)
1 5/8	(40)	5	55.0	(819)	32,950	(14,656)	12–5	2,746 (1,221)–6,590 (2,931)
1 3/4	(44)	5 1/2	62.0	(923)	36,850	(16,391)	12–5	3,071 (1,366)–7,370 (3,278)
2	(48)	6	81.0	(1,205)	48,050	(21,373)	12–5	4,004 (1,781)–9,610 (4,275)
2 1/8	(52)	6 1/2	91.0	(1,354)	53,950	(23,997)	12–5	4,496 (2,000)–10,790 (4,799)
2 1/4	(56)	7	101	(1,503)	59,950	(26,666)	12–5	4,996 (2,222)–11,990 (5,333)
2 1/2	(60)	7 1/2	124	(1,845)	73,550	(32,715)	12–5	6,129 (2,726)–14,710 (6,543)
2 5/8	(64)	8	136	(2,024)	80,650	(35,873)	12–5	6,721 (2,989)–16,130 (7,175)
2 3/4	(68)	8 1/2	161	(2,396)	95,400	(42,434)	12–5	7,950 (3,536)–19,080 (8,487)
3	(72)	9	174	(2,589)	102,900	(45,770)	12–5	8,575 (3,814)–20,580 (9,154)
3 1/4	(80)	10	212	(3,155)	122,800	(54,621)	12–5	10,233 (4,552)–24,560 (10,924)
3 1/2	(88)	11	250	(3,720)	144,800	(64,407)	12–5	12,067 (5,367)–28,960 (12,881)
4	(96)	12	300	(4,465)	171,000	(76,061)	12–5	14,250 (6,338)–34,200 (15,212)
4 1/4	(104)	13	345	(5,134)	195,800	(87,092)	12–5	16,317 (7,258)–39,160 (17,418)
4 1/2	(112)	14	395	(5,878)	224,800	(99,991)	12–5	18,733 (8,333)–44,960 (19,998)
5	(120)	15	455	(6,771)	254,700	(113,291)	12–5	21,225 (9,441)–50,940 (22,658)
5 5/16	(128)	16	506	(7,530)	282,600	(125,700)	12–5	23,550 (10,475)–56,520 (25,140)
5 5/8	(136)	17	562	(8,364)	312,300	(138,911)	12–5	26,025 (11,576)–62,460 (27,782)
6	(144)	18	635	(9,450)	351,000	(156,125)	12–5	29,250 (13,010)–70,200 (31,225)

(1) Diameter is approximate and is actually determined by linear density. See Safe Use Guidelines CI 1401 (current), page 4.

(2) Linear Density is considered standard. Tolerances are: ±10% for diameters 3/16" – 5/16" inclusive; ± 8% for diameters 3/8" – 9/16" inclusive; ± 5% for 5/8" diameter and up. The metric unit of linear density is Ktex (kilotex).

(3) New rope Minimum Breaking Strength is based on data from a number of manufacturers and represents a value of 2 standard deviations below the mean, established by regression analysis.

(4) For critical applications, refer to Safe Use Guidelines CI 1401 (current) on page 4.

(5) Working Load Limit is determined by dividing the new rope Minimum Breaking Strength by the selected Design Factor. Important information is given in CI 1401 (current) on page 4.

Cordage Institute International Guideline CI 1401-06 • Safer Use of Fiber Rope • May 2006

Purpose

This Guideline is provided to help in the selection and safer use of cordage products. Compliance with Cordage Institute Standards and Guidelines does not guarantee safe use under all circumstances, and the Institute disclaims any responsibility for any accidents that may occur.

1. Overview

There are inherent risks in the use of rope and cordage because such products are subject to highly variable conditions that change over time. Therefore, Design Factor selections and Working Load Limits must be calculated with consideration of exposure to risk and actual conditions of use for each application. If in doubt, consult an experienced engineer or other qualified individual regarding the design, application and selection of a rope product.

2. Minimum Breaking Strength

The Minimum Breaking Strength (MBS) is the force that a given rope is required to meet or exceed in a laboratory test when it is new and unused. MBS values are given in Cordage Institute Standards and individual manufacturers' specifications.

3. Working Load / Working Load Limit

The Working Load (WL) is the weight or force applied to rope or cordage in a given application.

The Working Load Limit (WLL) is a guideline for the maximum allowable capacity of a rope product and **should not be exceeded**.

Applied loads higher than a specified WLL can overstress and damage fibers, resulting in premature rope failure. The Working Load of an application should not exceed the WLL of the rope for optimal product performance and the safety of personnel and property.

4. Design Factors

The Design Factor (DF) is the ratio between the MBS and WL. This value is the margin of safety for an application. For a particular application, the factors affecting rope behavior and the degrees of risk to life, personnel and property must be considered when setting a DF.

Commercial and industrial users must determine a DF based on actual service conditions and establish operating procedures for a specific application. A "general use" consumer must also assess his application and determine conditions of use and hazards that may apply.

As a rule, the more severe the application, the higher the DF needs to be. Selection of a DF in the general range between 5:1 and 12:1 is recommended. A design factor at the low end of this range should only be selected with expert knowledge of conditions and professional estimate of risk. DF at or above the high end of the range should be used for more severe conditions of use. When in doubt, always select the highest practical DF, or contact the manufacturer for additional guidance. Engineering assistance may be necessary to determine the service loads and risks and to set the appropriate DF.

Considerations in the Selection of a Design Factor

• Experience is the best guide for determining a DF. Select a DF value used in a similar application that proved successful.

• Consider increasing the Design Factor if:
- Problems have previously been observed in similar applications
- Injury, death or loss of property may result if rope fails
- Loads are not accurately known
- High or continuous dynamic loads are anticipated (See Section 6)
- Shock loads are anticipated
- Extensive cyclic loads are likely to occur
- Tension is on the rope for long periods
- Knots are used, as knots can reduce strength by as much as 50%
- Operators are not well trained
- Operation/use procedures are not well defined and/or controlled.
- Severe abrasion is likely to occur from exposure to rough surfaces or cutting edges, or by contamination from dirt and grit.

Expert Guidance is Strongly Suggested for the Following Situations

• Rope is used constantly over pulleys or around a small bend.
• Rope is used at elevated temperature that may glaze, weaken or melt the fibers.
• Rope is used in the presence of hazardous chemicals.
• Rope is not new and is of unknown properties and/or prior use.
• Rope is not inspected frequently or adequately.
• Rope will be in service for long periods that may lose strength due to fatigue.

CI Guideline 2003 Fibers for Cable, Cordage, Rope and Twine explains some of the effects of elevated temperature and chemicals on synthetic fibers.

5. Calculation of Values

After the WL has been estimated and the DF for an application has been determined, a rope can be selected by calculating the necessary new rope Minimum Breaking Strength. The required MBS is determined by multiplying the Working Load by Design Factor. WL*DF=MBS. For example, an application with a Working Load of 3 tons and a Design Factor of 10 would require an rope with MBS = 3*10 = 30 tons.

Similarly, the Working Load Limit of a new rope is determined by dividing the Minimum Breaking Strength by the Design Factor for a given application. MBS÷DF=WLL. Examples of WLL, based on a DF of 5:1 and 12:1, are given in individual Cordage Institute Standards. The WLL in CI standards are for new ropes with standard terminations.

6. Dynamic Loading

Nearly all rope in use is subject to Dynamic Loading to some degree. Whenever a load is picked up, stopped, moved or swung there is an increased force due to the acceleration or dynamics of the movement. The more rapidly or suddenly such actions occur, the greater the forces. In extreme cases, the force sustained by the rope may be two, three, or even more times the static load. (e.g., when picking up a tow on a slack line or using a rope to stop a falling object) Therefore, in applications such as towing lines, lifelines, safety lines, climbing ropes, etc., the DF must reflect the added risk involved. If significant dynamic load is foreseen, a DF at or above the high end of the range should be considered. Loads should be handled slowly and smoothly to minimize dynamic effects.

Users should also be aware that dynamic effects are greater on a low-elongation rope, such as manila, than a high-elongation rope, such as nylon. Also note that dynamic effects are more significant on short segments of rope as opposed to longer ones.

Excessive dynamic loading will shorten the life of a line and/or cause premature failure.

7. Recoil/Snapback Safety Warning

When a tensioned rope breaks, an attachment fails, or either are suddenly released, the energy in the rope will cause it or the attachment to recoil back in unpredictable directions with great force, resulting in possible injury or death to persons in its path. Persons should never stand in line with or in the general path of rope under tension to avoid snapback injuries.

8. Special Applications

The DF ranges can be lower or higher than recommended in applications where actual field experience has proven successful, where a recognized standard or specification exists, where qualified professionals have made a thorough engineering analysis of all conditions of use and/or a regulatory agency has granted specific permission. In such controlled cases, breaking strength, elongation, energy absorption, and other factors, including operating procedures, must be evaluated during the selection of the Design Factor.

In addition to the above, more specific guidelines should be considered for applications such as life safety and marine use.

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