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# Cordage Institute International Standard

## Fiber Ropes General Standard

CI 1201-14  
May 2014

### 1. Scope

- 1.1. This standard covers the general requirements for ordering, materials, manufacturing, product identification, quality assurance, performance, testing, packaging, labeling and certification that are applicable to all standards for fiber cordage and ropes. It is intended to be used with individual Cordage Institute standards where referenced. The term “rope” shall include both fiber cordage and rope products.
- 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 establish appropriate safety and health practices, to determine the applicability of regulatory limitations prior to its use and to select a size and type of cordage or rope that will satisfy the conditions of use and degree of risk for a specific application. Refer to CI 1401 for safe use guidelines. Physical properties, such as material, strength, length, unit weight, are covered in separate CI Standards for particular types of fiber rope properties.
- 1.3. In the event of any conflict between the text of this document and any references cited, the text of this document takes preference.
- 1.4. For a product not covered by a Cordage Institute standard, a contract or purchase order may reference this standard and an applicable rope standard with its source.

### 2. Referenced Documents

- 2.1. CI 1202: Terminology. This document provides definitions of terms used in Cordage Institute standards and guidelines.
- 2.2. CI 1401: Safe Use Guidelines. This document provides important information on the safe use of rope, including determining working load limits for conditions of use.
- 2.3. CI 1500: Test Methods for Fiber Ropes. This standard provides both general and special test methods to determine rope physical properties.
- 2.4. CI 1503: Test Method for Yarn-on-Yarn Abrasion. This document provides the test method for measurement of abrasion resistance properties of synthetic fibers in dry and wet conditions.
- 2.5. CI 2009P: Performance Requirements for Marine Grade Polyester Yarn for Fiber Rope. This document provides minimum performance requirements for marine grade polyester yarn.

- 2.6. CI 2009N Guideline: Performance Requirements for Marine Grade Nylon Yarn for Fiber Rope.

### 3. Terminology

- 3.1. Units - The values stated in SI units are to be regarded as standard. The values in inch-pound units are provided for use where required.
- 3.2. Definitions – CI 1202 contains definitions of terms used in Cordage Institute standards and guidelines. Specific definitions for terms unique to a particular standard will be included under the Terminology section of that standard.

### 4. Ordering Information

- 4.1. Product Description: Contracts or purchase orders referring to a Cordage Institute standard should reference the applicable CI standard and include the following information:
  - 4.1.1. Nominal size by diameter or size number
  - 4.1.2. Material type: Nylon, Polyester, Polypropylene, Manila, Sisal, etc
  - 4.1.3. Construction: 3 strand, 8 Strand, 12-strand Braid, Double Braid, Solid Braid, Hollow Braid. Etc.
    - 4.1.3.1. Enhanced performance properties, if applicable
  - 4.1.4. Quantity by weight (mass), finished length or units
  - 4.1.5. Manufacturer's identification and product nomenclature, as applicable
- 4.2. Additional requirements (optional)
  - 4.2.1. Special diameter and a tolerance, if required
  - 4.2.2. Special finishes or coatings
  - 4.2.3. Hardness value (Stranded Rope only)
  - 4.2.4. Ultra-Violet (sunlight) protection, if other than normal
  - 4.2.5. Color of rope, other than natural
  - 4.2.6. Identification marker(s), if required
  - 4.2.7. Packaging, if other than standard
  - 4.2.8. Labeling, if other than standard
  - 4.2.9. Special quality assurance and/or testing, if required
  - 4.2.10. Certification, if required

### 5. Materials

- 5.1. Fibers and Yarns
  - 5.1.1. All yarns and fibers used in a rope, except for identification or marker yarns, shall be as described in the individual rope standard.
  - 5.1.2. Certification of fibers and yarns used in a rope shall be subject to agreement between the manufacturer and the purchaser.
- 5.2. Treatments or Finishes
  - 5.2.1. Coatings, impregnations or finishes, to provide special characteristics to the rope, shall be as agreed to between manufacturer and purchaser.

- 5.2.2. The treatment applied may change the linear density when compared to an untreated rope. The minimum break strength shall be determined with the treatment or finish applied. Any treatment or finish applied beyond that from the manufacturer shall not reduce the minimum breaking strength of the rope and is not to be included under extractable matter.

## 6. Manufacturing

- 6.1. The finished rope shall meet or exceed all the requirements of this standard and the applicable product standard.
- 6.2. The finished rope shall contain no cuts, kinks, soft spots, chafed or damaged sections, or broken, loose or projecting ends in the rope or its strands other than those permitted in Section 11.3.5.
- 6.3. Unless otherwise specified, the length of each finished rope shall be continuous throughout its ordered length.

## 7. Product Identification

- 7.1. Internal or surface markers may be used to identify the manufacturer. The manufacturer shall register their marker(s) with the Cordage Institute. Normally, only 11 mm diameter (7/16 inch) and larger rope will include internal markers, except for braided constructions.
- 7.2. When specified in a fiber rope standard, or the contract or purchase order, the manufacturer shall identify their product by using an internal water resistant marker tape.

## 8. Physical Properties

- 8.1. Physical properties for a rope shall be as provided in the individual product standard.

## 9. Performance Requirements

- 9.1. Performance requirements of a rope shall meet or exceed the requirements of the individual rope standard.
- 9.2. When required, performance properties such as elasticity, splice ability and hardness shall be included in the individual rope standard.
- 9.3. Marine grade ropes are intended to provide extended service life in a marine environment. Ropes with this designation shall be made of yarns which meet the criteria specified in CI 2009P or CI2009N.

## 10. Packaging and Labeling

- 10.1. Packaging
- 10.1.1. Common package unit may be reel, coil, hank, box, bag or bulk, or as ordered.
- 10.1.2. The ends of the rope shall be cut off squarely and be securely whipped, taped or heat sealed.
- 10.1.3. Unless otherwise specified, rope shall be packaged in one continuous length.
- 10.1.4. Standard length is considered to be 183 m (600 feet) or 366 m (1200 feet). Other lengths including fabricated lines may be specified.
- 10.2. Labeling

- 10.2.1. Commercial Use – Each packaging unit (reel, coil, hank, box, bag, bulk) shall be identified with the following information on a waterproof tag or label:
- Product description
  - Diameter or size number in in/lbs and/or metric units.
  - Weight or length in in/lbs and/or metric units.
  - Minimum breaking strength (MBS) or working load in pounds (force) and/or “SI (metric)”
  - Manufacturer’s name and address.
  - Country of origin.
- 10.2.2. Federal Trade Commission regulations for labeling shall take precedence, whenever applicable.
- 10.2.3. The use of Warning Labels is encouraged.

## 11. Quality Assurance

### 11.1. Summary

- 11.1.1. Each rope shall meet all the requirements of this standard and the applicable product.
- 11.1.2. Quality Assurance of the finished cord or rope product shall be the responsibility of the manufacturer, unless otherwise specified in the contract or purchase order.
- 11.1.3. The purchaser shall have the option to have a representative present during any inspection, measurement and/or testing by the manufacturer. The purchaser, at his expense, reserves the right to perform, or have a third party perform, any of the inspections and tests set forth herein and in the applicable cord/rope standard. In case of dispute, a representative of the rope manufacturer shall have the option to be present during an inspection, measurement or test.

### 11.2. Sampling

- 11.2.1. When specified by purchaser or contract, samples for material and component inspection shall be taken at random in accordance with Table 1 below
- 11.2.2. Samples from each shipping unit in the lot shall be the number and length required to perform the specified inspections and tests. They shall be included in the delivered weight and length.

Table 1	Units (1)	Sample Size (2)
Samples required for Visual Examination and Finishing Rope Testing	1-3	1
	4-15	2
	16-40	3
	41-110	5
	111-300	7
	301-500	10
	501 and Over	15

(1) Coils, Hanks, Reels, Spools, Boxes, or Bags

- (2) Sample to be taken from first 70 feet or the first 10% of the unit, if less than 600 feet. On lengths longer than 600 ft. the quantity and location of test specimens are to be agreed upon between buyer and seller.

- 11.2.3. Each item shall meet all requirements of this standard. The inspections and tests set forth in this standard and the individual fiber rope standard shall become part of the manufacturer's overall inspection system and quality assurance program.

### 11.3. End Item Inspection

- 11.3.1. When required ten percent of the gross length contained on each sample unit, but not more than 18.3 m (60 feet) shall be subject to examination. The sample units from each shipping unit shall be randomly selected and the sample size shall be the specified number. If any defects are noted in the original test units, an equal number of additional test units shall be randomly selected and if any additional defects are noted the entire lot shall be selected.

- 11.3.2. Agreement between the buyer and the seller may allow correction and/or repair of variances.

- 11.3.3. Acceptance or Rejection shall be based on the **category** and the number of variances, as listed below. A sample containing no major variances and not more than two **of the categories of** minor variances shall be considered as acceptable.

- 11.3.4. Major Variance(s): One or more shall cause cord/ rope to be rejected.

- a) Length of unit is less than specified
- b) Linear density is not within allowable tolerances
- c) Cord/rope ends knotted or spliced to make a continuous length
- d) Package units not in continuous length, unless otherwise permitted
- e) Cord/rope has cuts, snags, pulled yarn or strands, knots, kinks
- f) Cord/rope has chafed or damaged sections
- g) Braid has soft spots
- h) Multiplier, for braided rope, does not meet standard (braid too loose or too tight)
- i) No documentation on strand interchanges
- j) Yarns per strand or number of strands not as specified
- k) If identification marker required, marker omitted, incorrect, illegible or not covered.
- l) Color not as specified
- m) Coil or reels improperly or not firmly wound or other factors affecting free and easy unwinding or uncoiling of the rope

- 11.3.5. Minor Variance(s): **Minor Variance(s) shall be categorized in one of the following categories:**

- a) Broken, loose or projecting ends in the rope or strand.
  - b) Excessive loose fiber ends on surface, or in gaps between strands.
  - c) Ends not cut off squarely, not securely whipped, taped or heat-sealed.
  - d) Stain on surface/cover of cord/rope, visible at 1 m (3 feet).
- Three or more minor defects, as interpreted above, would be a Major variance and cause for spool to be rejected.

**A variance in three of the four categories must exist in order to constitute a Major Variance.**

### 11.4. Compliance Testing

11.4.1. Compliance with the physical property requirements of an individual rope standard shall be by documentation of previous testing of the ordered product, or by an actual test of the product.

11.4.2. Unless otherwise stated, testing shall be based on Cordage Institute standard CI 1500 Test Method for Fiber Rope. CI 1500 provides methods for all the basic required tests called for in an individual rope standard plus methods for determining other physical properties, under wet and dry conditions, such as cyclic loading and elongation.

11.4.3. If required by the purchaser, a report of the test results shall be provided.

#### 11.5. Certification

11.5.1. When specified in the purchase order or contract, the purchaser shall be furnished Certification that samples have been tested, inspected and documented as required by this standard and that all requirements in the applicable individual rope standard have been met.

## 12. Special Requirements

12.1. End user applications may dictate special requirements beyond the scope of a specific standard and these will be by agreement between the buyer and the seller.

## 13. Key Words

13.1. Cordage, Cordage Standards, Cordage Institute Standards, Fiber Rope, Laid Rope, Plaited Rope, Rope, Rope Standards

### **⚠ WARNING**

The use of rope and cordage products has inherent safety risks which are subject to highly variable conditions and which may change over time. Compliance with standards and guidelines of the Cordage Institute does not guarantee safe use under all circumstances, and the Institute disclaims any responsibility for accidents which may occur. If the user has any questions or uncertainties about the proper use of rope or cordage or about safe practices, consult a professional engineer or other qualified individual.

## **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 in a particular application and should not be exceeded.

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

## **4. Design Factors**

The Design Factor (DF) is the ratio between the minimum breaking strength and working load, (MBS/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, industrial and "general use" consumers should determine a DF based on actual service conditions and establish operating procedures for a specific application. The consumer must also assess his application and determine any hazards that may exist.

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. **This specific range of values does not apply to Life Safety ropes and/or rope products designed and manufactured for specific engineered services.** 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. 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. Expert guidance is strongly suggested when shock loads are possible and/or when the rope is used for lifting purposes.

### **Considerations in the Selection of a Design Factor**

- Select a DF value supported by industry standards, best practices, and/or regulations.
- All components of the system should be considered when determining the DF
- 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 reduce strength
  - Operators are in training or are not well experienced
  - Operation/use procedures are not well defined and/or controlled.

- Abrasion may 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 cause strength loss 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.  $WL \times DF = MBS$ . For example, an application with a Working Load of 3 tons and a Design Factor of 10 would require rope with  $MBS = 3 \times 10 = 30$  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.  $MBS \div DF = WLL$ . Examples of WLL based on a DF are given in some individual Cordage Institute Standards. The WLL in CI standards are for new ropes with standard terminations.

## **6. Dynamic Loading**

A dynamic load is any load that is not static, such as a live load or a wind load. If not properly taken into account, dynamic loading could shorten the service life of a rope and may even cause failure.

Dynamic load effects are influenced by the stiffness or modulus of the rope and are more severe when using low-stretch rope. Dynamic load effects are more severe on short sections of rope. In extreme dynamic loading cases, the forces sustained by the rope may be two, three or more times the static load.

When an object is moved the force on the rope increases due to acceleration or deceleration. The more rapidly or suddenly such actions occur, the greater the forces. Objects should be moved slowly and smoothly to minimize dynamic effects whenever possible.

When dynamic loading is anticipated, the Design Factor should be calculated based on the dynamic instead of the static load. The advice of a qualified individual should be used in calculating the Design Factor.

## **7. Recoil/Snapback Safety Warning**

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

## **8. Special Applications**

The DF ranges can be raised or lowered for applications where 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.

When warning tags are provided by the product manufacturer, they should be attached to each rope per industry or application specific guidelines.

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