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.

Cordage Institute, 994 Old Eagle School Rd., Suite 1019, Wayne, PA 19087-1866
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WARNING

THE IMPROPER USE OF ROPE IS

DANGEROUS

FIBER ROPE WILL FAIL IF WORN, DAMAGED, ABUSED, OVERLOADED OR NOT PROPERLY MAINTAINED.

Rope Failure Can Cause Serious Injury or Death.

Please read this before using any fiber rope

- USER is responsible to determine suitability of a rope for specific applications.
- KNOW the working load limit (WLL) of your rope. Get WLL from manufacturer or supervisor.
- USE ONLY rope in good condition, without cuts or pulled strands.
- DO NOT exceed WLL or shock load.
- DO NOT stand within recoil (snapback) area.
- DO NOT use over rough surfaces without chafe protection.
- USE sheaves with a minimum of 8 times the rope diameter.
- DO NOT bend around unprotected, sharp corners.
- Inspect your rope BEFORE and after each USE.

There are many standards and guidelines for the use of rope in specific applications. Contact the Cordage Institute: 994 Old Eagle School Road, St. 1019. Wayne, PA 19087-1866. Tel: 610-971-4854 Email: info@ropecord.com

FOLLOW THESE RULES FOR SAFETY AND GOOD CARE OF ROPE

Make sure your rope size is adequate for the job. DON'T USE TOO SMALL A ROPE. A table of specifications is available from your dealer, distributor, or the manufacturer.

Keep rope clean. Don't drag rope over ground or other rough gritty surfaces. This allows abrasive particles to work into the rope and damage fibers.

Uncoil rope properly. Lay coil flat with Inside end of rope nearest the deck. Loosen lashings and covering. Reach down through center of coil and pull rope up through from inside the coil.

Prevent kinks, which cause permanent damage and weakening of the rope. If rope is continually twisted in one direction, as over a winch, counteract by throwing in twist in opposite direction.

Dry rope before storing. Manila ropes mildew and decay if stored wet; a cool, dry room with free air circulation provides the best storage. Do not store in direct sunlight.

Protect rope from chemicals such as acids, alkalis, oils, paints and other agents not chemically neutral.

Reverse rope ends regularly, particularly when used in tackle. This permits even wearing and assures longer useful life. Should a short section become badly worn, cut it out and splice with a long or short splice as appropriate. Rope loses strength as it becomes worn.

Avoid sudden strains. Shock loading, as jerking, may cause failure of a rope normally strong enough to handle the load. When using tackle or slings, apply a steady, even pull to get full strength from rope.

CAUTION: Heat can seriously affect the strength of synthetic ropes.
The temperature at which a 50% strength loss can occur are:
Polypropylene: 200 F Nylon: 300 F Polyester: 350 F
Kevlar/Technora: 400 F Dyneema/Spectra: 150 F

VULCAN
Tel: 800-588-5226

VULCAN
Safety Inspection Card

DATE: _____ BY: _____

LOCATION: _____

_____

TYPE OF USE: _____

OEM PART# _____

INSPECTION CRITERIA:

(P) Pass (F) Fail	Pre-Use/Post-Use
Abrasion	_____ /_____
Glazing (Heat Damage)	_____ /_____
Diameter Integrity	_____ /_____
Discoloration	_____ /_____
Flexibility	_____ /_____
Core Fiber Exposure	_____ /_____
Kinking or Hockling	_____ /_____

NOTES:

Feel free to make copies of this card for proper maintenance of your inspection records.

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Safety Inspection Card Definitions

ABRASION: Rupture or fraying of fibers due to wear and or rupture due to motion against other fibers or rope components or contact surface.

GLAZING: A fusing or melting of the fibers that gives a hare glassy surface feel due to overheating or excessive friction over a surface or the rope itself.

DIAMETER INTEGRITY: An increase or decrease in rope diameter due to excessive abrasion, glazing, foreign objects in the core, or reduction in core size due to broken fibers.

DISCOLORATION: Fading, streaking or staining due to chemicals or other outside agents that may cause a reduction of strength of the rope.

FLEXIBILITY: A loss in the ability to bend for the type and construction of the rope.

CORE FIBER EXPOSURE: The core from the center of the rope may work itself through the cover and may cause a loss of strength and the ability of the rope to function over a sheave.

KINKING OR HOCKLING: A short twist, curl or bend in one or more of the yard or rope strands, will cause a reduction in rope strength.

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