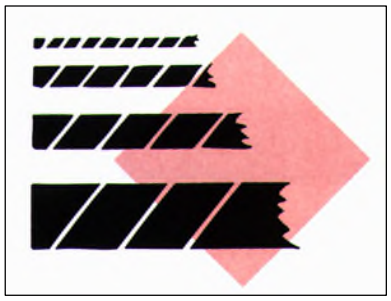
Critical Conditions of Use

Risk factors which must be taken into consideration when using natural or synthetic fiber rope include:

1. Small size ropes are used (because they can be more severely damaged by cutting, abrasion and sunlight).
2. Loads weights are not accurately known.
3. Operators are poorly trained.
4. Operation/use procedures are not well defined and/or controlled.
5. Rope inspection is infrequent.
6. Abrasion, cutting or dirt penetration are present.
7. Shock loads or extreme dynamic loading is likely.
8. High temperatures are present.
9. Chemicals are present.
10. Ropes are kept in service indefinitely.
11. Tensions on the rope are maintained continuously for long periods.
12. Rope can be subject to sharp bends or is used over sheaves/pulleys or surfaces with too small a radius.
13. If knots are used (because strength is reduced by up to 50-60%).
14. Death, injury or loss of valuable property may result from failure.

SAFE SERVICE OF NATURAL AND SYNTHETIC FIBER ROPES



SELECT THE CORRECT SIZE

A rope too small may fail quickly; one too large will prove expensive. Don't work any rope above one-fifth (1/5th) or twenty percent (20%) of its breaking strength. In analyzing a number of mooring line accidents in which synthetic lines were involved, we have also found that replacing manila on a "strength" basis with synthetics results in a line of too small diameter to take a stopper properly and one which presents too small a surface to the face of a gypsy head or bitt for even heaving or surging when under strain. The result is that they melt and stick and then let go all at once. It is recommended that manila mooring lines should be replaced by synthetics on a "diameter for diameter" basis rather than a "strength for strength" one. The longer wear and safer handling characteristics justify the greater initial cost.

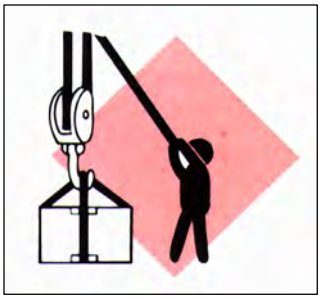
STOP UNNECESSARY WEAR

All rope will be severely damaged if subjected to rough surfaces of sharp edges. Outer and inner rope fibers contribute equally to the strength of your rope. If worn out, the rope is naturally weakened. Eliminate rubbing, drugging, dirt penetration or working over rough surfaces. Chaffing will occur with surface contact either on the rope itself or an external fitting. such as bitt, cleat, chock or block or fairlead. Care must be taken to keep all surfaces smooth and free from burrs, paint and rust. Keep sheaves smooth and free to rotate to reduce wear. Burrs should be filed down or ground smooth. Protect rope surfaces with chafing gear, such as canvas wrapped and tied around the rope. Discarded fire hose skinned on the line before splicing has proven satisfactory for this. Pad corners of sharp objects when lifting, and avoid strain on sharp bends. Remove kinks if they form.

Friction causes more failures in working lines than any other cause. Heat generated by friction will often be great enough to melt or fuse polyolefin filaments, causing a skin on the rope surface, then suddenly gives way. Nylon and Dacron must also be handled with care, especially on moving flat capstans and rendering on bitts. With new synthetics use at least six full turns on a capstan. As the rope wears in, the turns can be gradually decreased. Keep slippage of line on the capstan at a minimum.

Abrasion resistance is usually a factor of the hardness of the rope used, in both natural and synthetic fibers. The hard lay rope will stand up better in use; however, some of the ease of handling and splicing characteristics must be sacrificed. Manufacturers' medium lay will usually give satisfactory service, but in extreme cases where abrasion cannot be avoided, a hard or extra lay should be used. An advantage of nylon rope over manila rope is that nylon rope can hold a load even when a considerable number of the yarns have been abraded

With respect to the elasticity of nylon mooring lines under load, nylon will stretch and thin out but will return to normal size when free of tension. Nylon, because of its great elasticity, far excels all other materials in this characteristic. Assuming manila is one, nylon would be 8.6, Dacron 4.0, polypropylene 5.2. This high energy absorption quality can be dangerous. When a synthetic line reaches its elastic limit and parts, it will "snap back" and sometimes cause serious damage and personal injury. Avoid standing in direct line of pull.



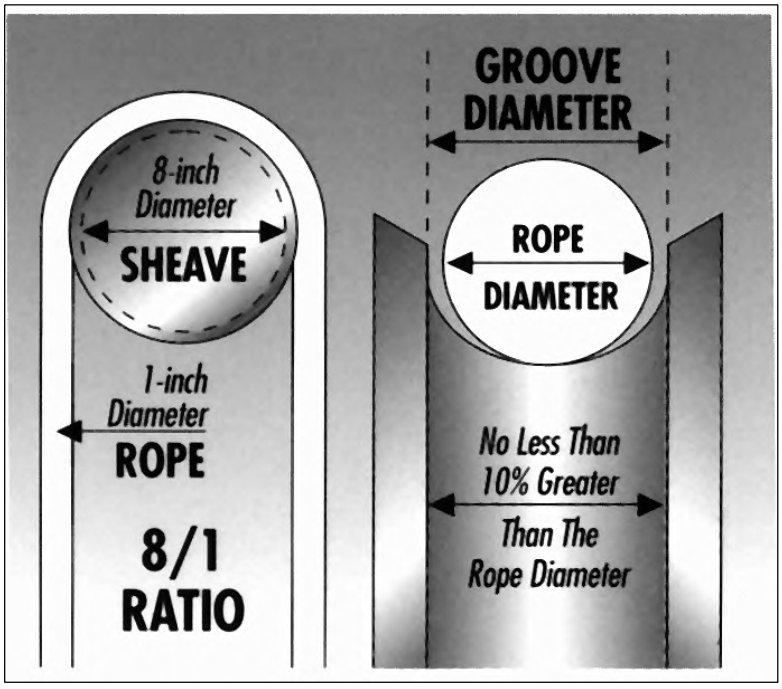
USE RIGHT SHEAVES

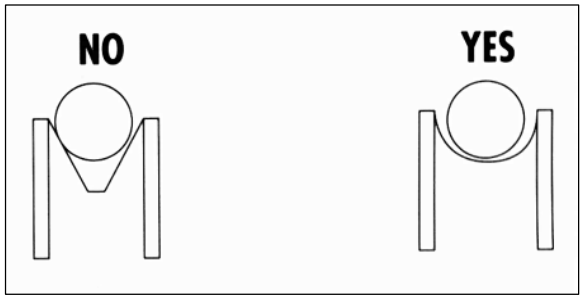
Failure to provide proper bending radius (sheaves) causes added friction and rope wear. Over a long period the fibers will crack and a loss of strength will result.

The old standard for bending radius for twisted fiber rope was three (3) times the circumference of the rope. This applies to chocks, bitts, and the cheeks of blocks. The bending radius for sheaves is two (2) times the circumference of the rope.

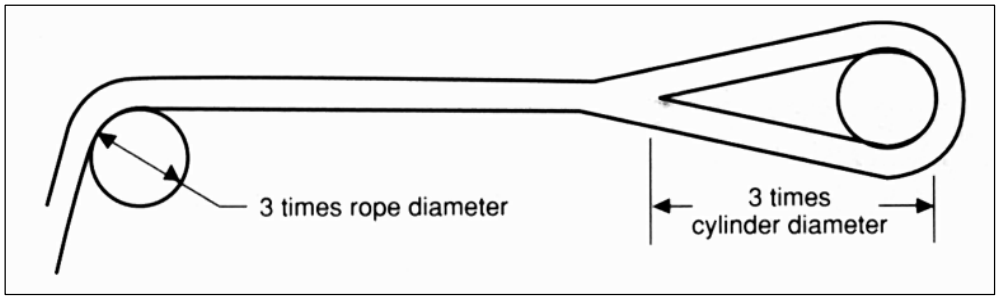
Today cordage manufactures recommend large sheave diameters. In order to assure maximum efficiency and safety

- Sheaves for twisted and plaited rope should be no less than ten (10) times rope diameter.
- Sheaves for braided rope should be no less than eight (8) times rope diameter.
- Sheaves for Kevlar braided rope should be no less than twenty to twenty-four (20-24) times rope diameter.
- For power transmission or for use with continuous load, sheaves should be at least forty (40) times the diameter of the rope.



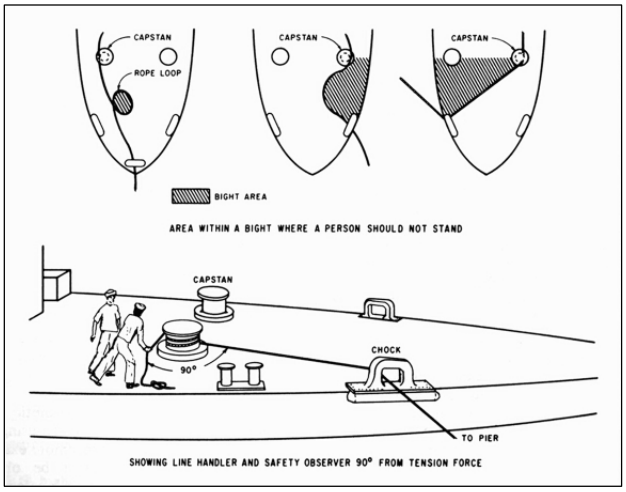


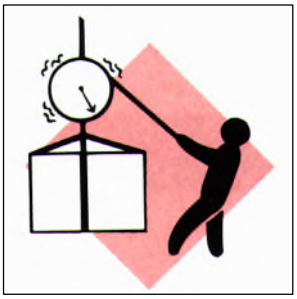
The sheave groove diameter should be no less then 10% greater than the rope diameter. Never use wire rope or V-belt sheaves. The sheave groove should be round in shape. Sheaves with V-belt grooves should be avoided, as they tend to pinch and damage the rope through excessive friction and crushing of the rope fibers.



Sharp bends significantly reduce rope strength. When a rope bends more than 10° around bitts, and chocks, or for that matter any working surface friction increases significantly. A working rope should never be subjected to a bend less than three (3) times rope diameter. A bend ratio of four (4) times, or more, will prolong rope life. Eye splice length should be at least three (3) times the diameter of the cylinder (bitt, etc.) over which the eye is to be used. A length of five (5) times diameter is perhaps best.

Never allow anyone to stand in line with or within 45° on either side of a rope under tension. Should the rope fail or other parts of the assembly fail, the recoil force could cause serious injury or damage, especially if nylon rope is in use.



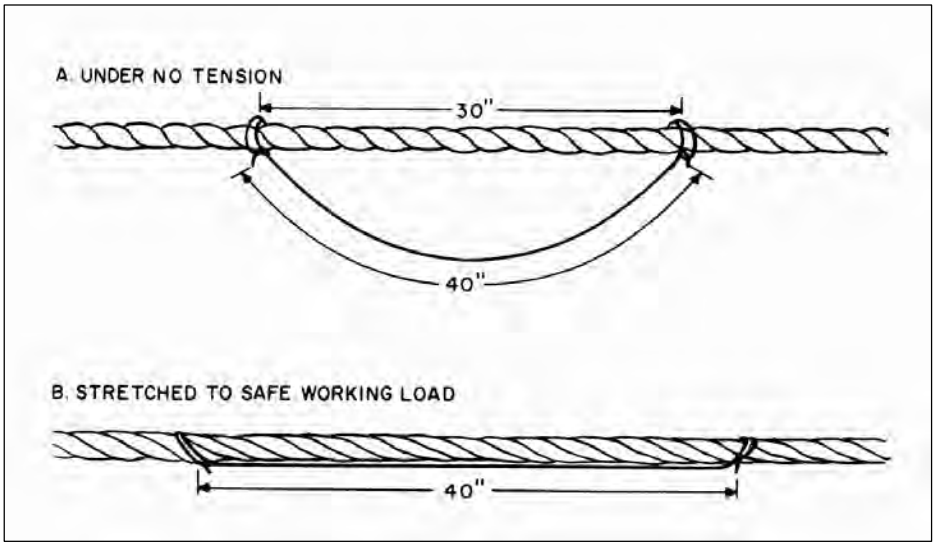


AVOID OVERLOADS

The safe working load ranges for any new rope is between 8-20% of its minimum tensile strength. Make enough allowances for safety if your rope is old or worn. Ignoring this safety factor causes early rope replacement and is dangerous to men and materials. A normal safe working load for used nylon rope in good condition is 25% of its breaking strain.

Seamen who work with natural fiber rope soon learn how to judge load and tension on such lines by the sounds that they produce. Unfortunately, although synthetic lines under heavy strain thin down considerably, they give no audible indication of stress - even when they are about to part. For this reason, a tattletale cord should be attached to synthetic lines when they are to be subjected to loads that may exceed their Safe Working Load (SWL). A tattletale cord is a bight of heavy cord or light small stuff tucked between two measured points on the working line. The line, when tensioned to its SWL, will stretch to a certain percentage of its length. When this point is reached, the small stuff becomes taut, warning that there is danger of exceeding the line's SWL.

Type of Synthetic Rope	Length of Cord (Inches)	Distance (Inches)	Critical Stretch (Percentage)
Nylon (Three Strand Twisted)	40"	30"	40%
Nylon (Double Braid)	48"	40"	20%
Nylon (Plaited)	40"	30"	40%
Polyester (Three Strand Twisted)	40"	34"	20%
Polypropylene (Three Strand Twisted)	36"	30"	20%



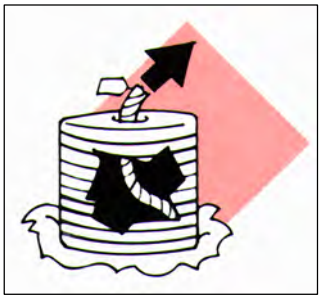
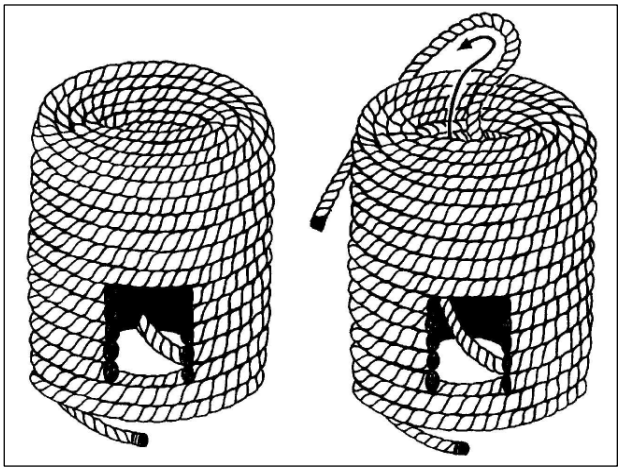


Figure 17 -Tattletale in use on a three strand twisted nylon rope

TO UNCOIL ROPE

A new coil of fiber line should be opened or uncoiled in the following manner:

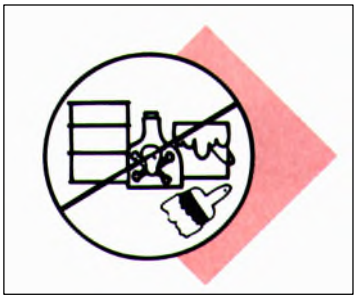
1. A new coil of rope should be placed flat on its end with the "tag" end down, positioning the bitter end down on the lower inside of the coil.
2. Remove the outside lashings and unfasten the inside bands.
3. Reach down through the eye of coil and pull out the inside end, where tag is attached. Pulling out the amount of line desired through the eye of the coil.
4. Coil the line down with the lay. Right lay fiber rope should be coiled clockwise. Left lay fiber rope should be coiled counter-clockwise.
5. Keep the burlap or covering intact to protect the coil. Uncoiling a line improperly can cause kinks in the line.



New coil of fiber rope

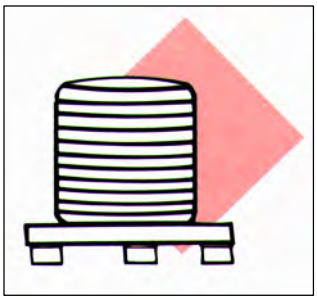
Uncoiling a new rope

A new coil of Nylon line should be opened by unreeling it from a reel.



KEEP AWAY FROM CHEMICALS

Acids, Alkalis and certain organic compounds are injurious to rope. If exposed, wash thoroughly and inspect before using. Watch for battery and building cleaning acids, caustic soda and paint. All ropes whether natural or synthetic are lubricated in the manufacturing process. Do not attempt to add lubrication, as you will in all probability do more harm than good.



STORE PROPERLY

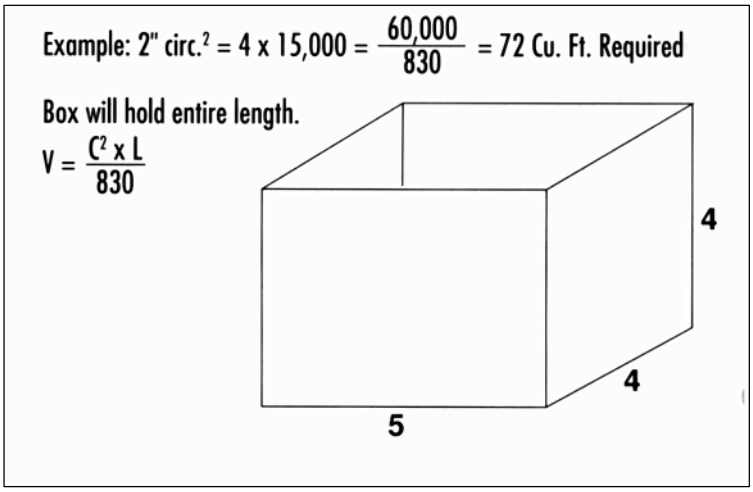
Natural fibers are weakened by mildew and rot. Manila rope must be stored in a cool dry room with plenty of ventilation to avoid dry rot and mildew. There have been several treatments impregnated into ropes during their manufacture. Most of them are copper compounds and have proven very satisfactory as long as they last. However, they all wash out in water after prolonged use and it is very difficult to replace the treatments. Synthetic ropes are not subject to dry rot and the mildew that attaches itself to them is not detrimental. Synthetics should be stored at moderate temperatures away from steam pipes, etc., and direct sunlight. Optimally, line should be stored in dry, cool place with good air circulation protected from prolonged exposure to sunlight. The line itself must be clean and dry. Wooden grates should be placed on concrete or steel floors to provide ventilation underneath the line. Rope may be stored in a ventilated box or covered with a tarp to keep temperature at minimum. Always stow lines away from steam pipes or heated metal bulkheads. Keep rats away.

BOX OR BIN STORAGE

The following formula is for computing the rope capacity of a box or bin. This formula may be used to determine how much rope of a given size can be stored in a box or bin - or to compute the size of box or bin needed to accommodate a given length and size of rope.

V = Cubic footage required
C = Rope circumference in inches
L = Length of rope in feet

(Volume = length x width x depth) l, w, d are in feet

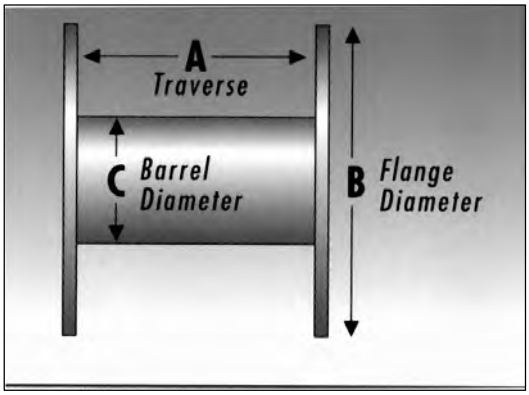


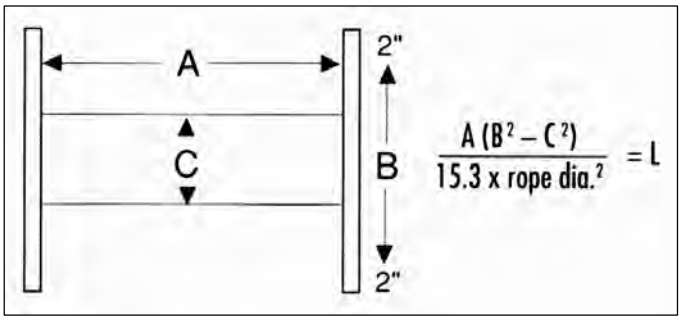
REEL OR DRUM STORAGE

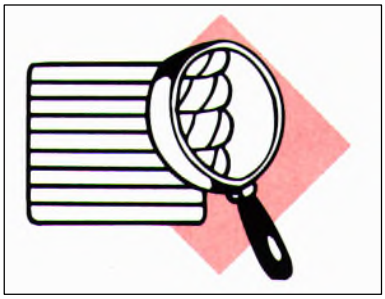
The following formula is for computing the rope capacity of a reel or drum. This formula may be used to determine how much rope of a given size can be stored in a reel or drum - or to compute the size of reel or drum needed to accommodate a given length and size of rope.

A = Reel width in inches
B = Reel flange diameter in inches
C = Reel barrel diameter in inches
L = Rope length in feet

A, B, C, and Rope Diameter are in inches, L is in feet.



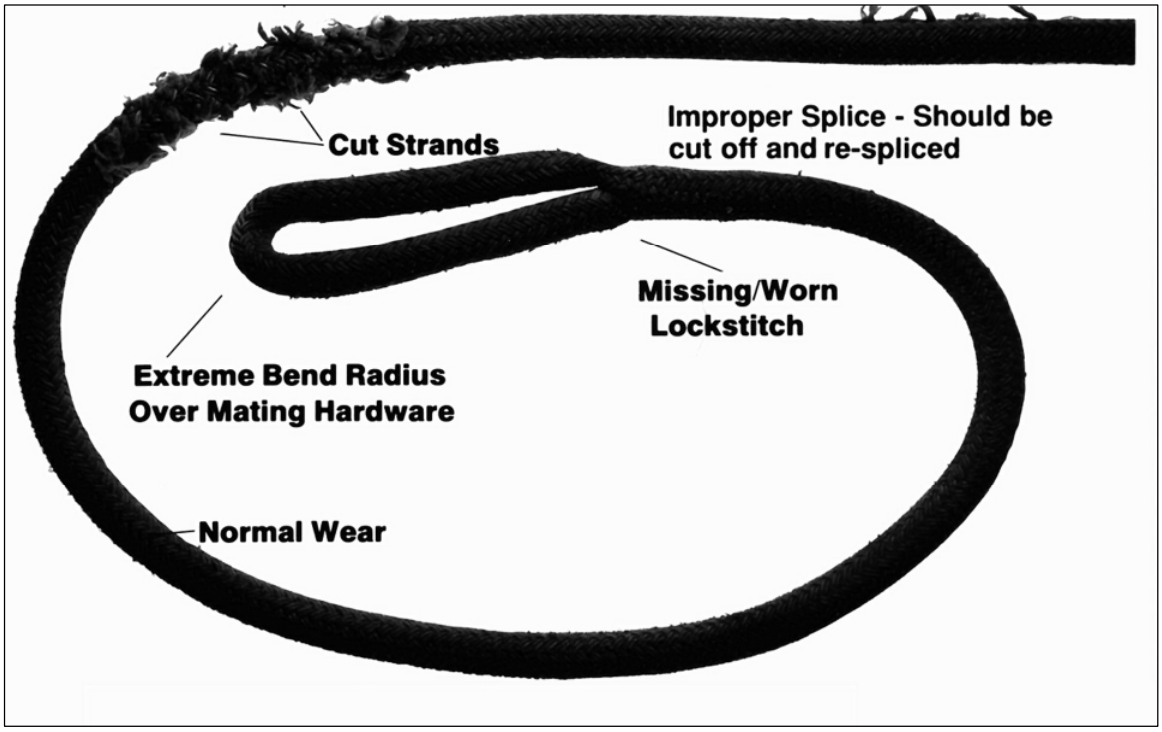




INSPECT ROPE CONDITION

Inspect rope frequently, whether working or in storage. No type of visual inspection can be guaranteed to accurately and precisely determine the actual residual strength of a particular line. Both the inner and outer fibers contribute to the strength of the rope. When either is worn, the rope is naturally weakened. Check frequently for frayed strands and broken yarns. Pulled strands should be re-threaded into the lay of the rope if possible. A pulled strand can easily snag during line handling operations. Open-up the lay and look for powdered fiber between the strands. This is an indication of internal wear. A heavily use rope will often become compacted or hard which indicates reduced strength. When the fibers show wear in any given area, the rope should be cropped to remove the damaged area and re-spliced. If there is any doubt, safe working practice requires that rope strength be downgraded or the line replaced if necessary.

It is often very difficult to detect damage to a manila rope. If there is no dry rot present, spread the strands and check for strand abrasion in the core of the rope. Try to test the fiber strength by comparing it with the fiber from a new rope. On larger ropes cut out one inside yarn, remove turn and test the individual fibers for strength, comparing it with a fiber from a new rope. An experienced rope handler can determine much by general appearance. It is much more difficult to determine internal damage in synthetic ropes. Look over the line carefully for surface cuts and chaffed places. Glazing or fussing on the surface ordinarily does not have an appreciable effect on the strength of the rope. Often this fuzziness acts as cushion to help prevent further chaffing and abrasion. Cut off a one-foot piece and count the number of broken yarns. This divided by the total number of yarns in the rope will give an approximate percentage of the strength left.



Occasionally reverse your rope, end-for-end, to distribute the wear more evenly. Use worn rope only where strength failure will not cause injury or damage.