ROPE INSPECTION AND RETIREMENT

There are basically three steps to consider in providing the longest possible service life for ropes, the safest conditions and long range economy: Selection, Usage, and Retirement.

1 SELECTION: SELECT THE RIGHT ROPE FOR THE JOB IN THE FIRST PLACE:

Selecting a rope involves evaluating a combination of factors. Some of these factors are straight forward like comparing rope specifications. Others are less quantitative like a preference for a specific color or how a rope feels in your hand. Cutting corners, reducing sizes or strengths on an initial purchase creates unnecessary replacements, potentially dangerous conditions and increases long term costs. Fiber and construction being equal, a larger rope will outlast a smaller rope, because of the greater surface wear distribution. By the same token, a stronger rope will outlast a weaker one, because it will be used at a lower percentage of its break strength with less chance of overstressing.

Consider the opinion of professional climbers who may have more experience as to how well a rope performs. Consider also the reputation of the rope manufacturer. Are they involved with and supportive of the arborist industry? Do they stand behind their products with consistent quality and reliable service? Buying unproven ropes because they are a little less expensive is false economy and can lead to disaster.

STRENGTH

When given a choice between ropes, select the strongest of any given size. A load of 200 pounds represents 2% of the strength of a rope with a breaking strength of 10,000 pounds. The same load represents 4% of the strength of a rope that has a breaking strength of 5,000 pounds. The weaker rope is having to work harder and as a result will have to be retired sooner. Braided ropes are stronger than twisted ropes that are the same size and fiber type.

ELONGATION

It is well accepted that ropes with lower elongation under load will give you better load control, a big help at complicated job sites. However, ropes with lower elongation that are shock loaded, like a lowering line, can fail without warning even though it appears to be in good shape. Low elongating ropes should be selected with the highest possible strength. Both twisted ropes and braided ropes are suitable for rigging. Twisted rope has lower strength and more stretch. Braided rope has higher strength and lower stretch.

FIRMNESS

Select ropes that are firm and round and hold their shape during use. Soft or mushy ropes will snag easily and abrade quickly causing accelerated strength loss. Because the fibers are in a straighter line, which improves strength but compromises durability, loose or mushy rope will almost always have higher break strengths than a similar rope that is firm and holds its shape.

2 USAGE: USE ROPE PROPERLY: OBSERVE RECOMMENDED SAFETY FACTORS. KEEP ROPES CLEAN AND AVOID SHOCK LOADS WHENEVER POSSIBLE.

Proper use of your ropes, maintaining them, and staying within recommended working loads will allow you to get the most from your rope investment. Working loads are calculated to maximize safety and extend the working life of both climbing and rigging lines. Dirt and grit embedded in the fibers can also significantly shorten rope life. Keep them clean, bagged and properly stored when not in use.

WORKING LOADS

Working loads are the loads that a rope is subjected to in everyday activity. They are normally expressed as a percentage of new rope strength and should not exceed 20% for rigging lines and 10% for climbing lines. A point to remember is that a rope may be severely overloaded or shock loaded in use without breaking. However, damage and strength loss may have occurred without any visible indication. The next time the rope is used under normal working loads the acquired weakness can cause it to break. Do not blame the rope, it was simply overloaded and failed from what is known as fatigue.

RECOMMENDED WORKLOAD LIMIT
(expressed as a percent of new rope strength)

Rope Used	Braided	Twisted
Climbing Line	10%	10%
Rigging Line	20%	20%

SHOCK LOADS

Shock loads are simply a sudden change in tension – from a state of relaxation or low load to one of high load. Any sudden load that exceeds the work load by more than 10% is considered a shock load. The further an object falls, the greater the impact. Synthetic fibers have a memory and retain the effects of being overloaded or shock loaded and can fail at a later time, even though loaded within the normal working load range.

Sheeve diameters on rotating sheave blocks

Twisted Rope = 10 times the rope diameter

Braided Rope = 8 times the rope diameter

Fixed PIN Termination Diameter

The diameter on fixed pin termination should be at least 3 times the diameter – i.e., the bending radius for 1/2" rope should be 1-1/2"

KNOTS AND HITCHES

While it is true that a knot reduces rope strength, it is also true that a knot is a convenient way to attach a rope to tree limbs and other ropes. The strength loss is a result of the tight bends that occur in the knot. With some knots, ropes can loose up to 50% of their strength, which is part of the reason the work load limit should not exceed 20% of the rope strength.

ROPE STORAGE

Keep your ropes as clean and dry as possible and store them away from heat sources. Many climbers keep their ropes in special rope bags, which keep them clean and makes them easy to identify at the job site.

3 RETIREMENT: RETIRE ROPE FROM USE WHEN IT HAS REACHED ITS DISCARD POINT

One of the most frequently asked questions is "When should I retire my rope?" The most obvious answer is before it breaks. But, without a thorough understanding of how to inspect it and without knowing the load history, you are left making an educated guess. Unfortunately, there are no definitive rules nor industry guidelines to establish when a rope should be retired because there are so many variables that affect rope strength. Factors like load history, bending radius, abrasion, chemical exposure or some combination of those factors, make retirement decisions difficult. Inspecting your rope should be a continuous process of observation before, during and after each use. In synthetic fiber ropes the amount of strength loss due to abrasion and/or flexing is directly related to the amount of broken fiber in the rope's cross section. After each use, look and feel along every inch of the rope length inspecting for damage as listed below.

ABRASION

When the rope is first put into service, the outer filaments of the rope will quickly fuzz up. This is the result of these filaments breaking and this roughened surface actually forms a protective cushion and shield for the fibers underneath. This condition should stabilize, not progress. If the surface roughness increases, excessive abrasion is taking place and strength is being lost. As a general rule for braided ropes, when there is 25% or more wear from abrasion the rope should be retired from service. In other words, if 25% or more of the fiber is broken or worn away the rope should be removed from service. With three-strand ropes, 10% or more wear is accepted as the retirement point.

Look closely at both the inner and outer fibers. When either is worn the rope is obviously weakened. Open the strands and look for powdered fiber, which is one sign of internal wear. Estimate the internal wear to estimate total fiber abrasion. If total fiber loss is 20%, then it is safe to assume that the rope has lost 20% of its strength as a result of abrasion.

GLOSSY OR GLAZED AREAS

Glossy or glazed areas are signs of heat damage with more strength loss than the amount of melted fiber indicates. Fibers adjacent to the melted areas are probably damaged from excessive heat even though they appear normal. It is reasonable to assume that the melted fiber has damaged an equal amount of adjacent unmelted fiber.

DISCOLORATION

With use, all ropes get dirty. Be on the lookout for areas of discoloration that could be caused by chemical contamination. Determine the cause of the discoloration and replace the rope if it is brittle or stiff.

INCONSISTANT DIAMETER

Inspect for flat areas, bumps or lumps. This can indicate core or internal damage from overloading or shock loads and is usually sufficient reason to replace the rope.

INCONSISTANT TEXTURE/STIFFNESS

Inconsistant texture or stiff areas can indicate excessive dirt or grit embedded in the rope or shock load damage and is usually reason to replace the rope.

TEMPERATURE

When using rope, friction can be your best friend or worst enemy if it is not managed properly. By definition, friction creates heat, the greater the friction, the greater the heat buildup. Heat is an enemy to synthetic fiber and elevated temperatures can drastically reduce the strength and/or cause rope melt-through.

High temperatures can be achieved when surging rope on a capstan, checking ropes on a cable, or running over stuck or non-rolling sheaves or rollers. Each rope's construction and fiber type will yield a different coefficient of friction (reluctance to slip) in a new and used state. It is important to understand the operational demands and ensure the size, rope construction and fiber type be taken into account to minimize heat buildup.

Never let ropes under tension rub together or move relative to one another. Enough heat to melt the fibers can buildup and cause the rope to fail as quickly as if it had been cut with a knife.

Always be aware of areas of heat buildup and take steps to minimize it; under no circumstances let any rope come in contact with an exhaust muffler or any other hot object.The strength of a used rope can be determined by testing, but the rope is destroyed in the process so the ability to determine the retirement point before it fails in service is essential. That ability is based on a combination of education in rope use and construction along with good judgment and experience. Remember, you almost always get what you pay for in the form of performance and reliability.

The critical and melting temperatures for synthetic fibers are listed below:

TEMPERATURES	Critical	Melting
Dyneema®	150° F	297° F
Manila	180° F	350° F*
Polypropylene	250° F	330° F
Nylon	350° F	460° F
Polyester	350° F	480° F
Technora	450° F	900° F*

**While the term "melting" does not apply to these fibers, they do undergo extreme degradation at these temperatures: Technora and Manila char.*

ROPE INSPECTION CHECK LIST

Condition Discard Point

1. Original rope bulk reduced by abrasion:

- Double braid* cover by 50% ☑
- Twelve-strand braid by 25% ☑
- Eight-strand plait by 25% ☑
- Three-strand by 10% ☑

2. Fiber strands cut:

- Double braid* by three or more adjacent strands cut ☑
- Twelve-strand braid by two or more adjacent strands cut ☑
- Eight-strand plait by one or more adjacent strands cut ☑
- Three-strand by one or more adjacent strands cut ☑

**Refers to double braids that have both core and cover strength members.*

3. Diameter inconsistency:

- Localized diameter reduction ☑
- Flat areas ☑
- Lumps and bumps in rope ☑

4. Glossy or glazed fiber:

- Localized or extended areas ☑

5. Inconsistency of texture:

- Localized or extended areas of stiffness ☑

6. Discoloration:

- Localized or extended areas caused by chemical contamination ☑

ORIGINAL BULK NEW ROPE

VOLUME REDUCTION

Rope displaying 25% strand volume reduction from abrasion – rope should be retired from service.

Note: Amount of volume reduction that indicates retirement depends on rope construction. Refer to "check list" at left.

PULLED STRAND

Rope displays a snagged strand. If the strand can be worked back into the rope, no need to retire. If not, this indicates a retirement point.

CUT STRANDS

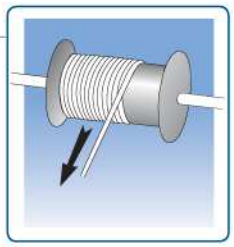
Rope displays two adjacent cut strands. This rope should either be retired or the cut section should be removed. If possible, re-splice.

Note: Number of cut strands that indicate retirement depends on rope construction. See "check list" at left.

MELTING OR GLAZING

Damage depicted below caused by excessive heat, which melted and fused the fibers. This area will be extremely stiff. Unlike fiber compression, melting damage cannot be mitigated by flexing the rope. Melted areas must be cut out and rope respliced or the rope must be retired.

REMOVING ROPE FROM REEL OR COIL



Synthetic fiber ropes are normally shipped on reels for maximum protection while in transit. The rope should be removed from the reel by pulling it off the top while the reel is free to rotate. This can be accomplished by passing a pipe through the center of the reel and jacking it up until the reel is free from the ground. Rope should never be taken from a reel lying on its side. If the rope is supplied on a coil, it should always be uncoiled from the inside so that the first turn comes off the bottom in a counter-clockwise direction.

ROPE STORAGE

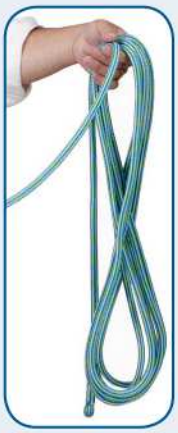


FIGURE 8

Great care must be taken in the stowage and proper coiling of braided ropes.

Braided ropes have no built-in twist and are far more resistant to kinking, than three-strand ropes. Even if kinks do develop they do not develop further into hockles.

The best method for making up braided rope is in figure-eight fashion. The rope should not be hand coiled in either direction as this merely puts turn into the line, which may develop into kinks when paying-out. Remember that there is no turn or twist in the line to begin with, so do not produce it by coiling.

COILING – TWISTED ROPES

Three-strand ropes should be coiled in a clockwise direction (or in the direction of the lay of the rope) and uncoiled in a counter-clockwise direction to avoid kinks.

BAGGING

Bagging is the most common method of storing braided or twisted climbing lines. The rope is allowed to fall into its natural position without deliberate direction.

AVOID KINKING AND HOCKLING

The continuous use of a line on one side of a winch or windlass is a common abuse that can render a line useless in a comparatively short time. Repeated hauling of a line over a winch in a counterclockwise direction will extend the lay of the rope and simultaneously shorten the twist of each strand. As this action continues, kinks (or hockles) will develop. Once these hockles appear, they cannot be removed and the rope is permanently damaged at the point of hockling.

If, on the other hand, the line is continuously hauled over a winch in a clockwise direction, the rope lay is shortened and the rope becomes stiff and will kink readily.

To avoid detrimental conditions, the direction of turns over the winch should be alternated regularly. Clock-wise turns are recommended for the initial use of a new line. If this practice is observed, the original rope balance will be maintained and the lines will have a much longer useful life.

Excessive turns can cause kinking in any rope but hockles can occur only in the basic "twisted" ropes (three-strand, four-strand and cable-laid).

Braided and plaited ropes cannot be hockled; their inter-locking strand construction prevents the unlaying. Strands run in both directions creating a torque-free balance thus eliminating any inherent tendency toward twist or rotation. Swivels can be used safely but are seldom necessary. One word of caution here: when marrying a braided line to a twisted line (and also to wire rope) the twisted line can impart its twist to the braided line if the ropes are married without a swivel in between.

A braided or plaited rope, being torque-free, can have twist induced by constant working on winches and capstans. If a twist develops, it can easily be removed by "counter-rotating" when the rope is relaxed.

A hockled rope.

STANDARDS FOR STRENGTH AND USAGE

NEW ROPE TENSILE STRENGTHS

New rope tensile strengths are based on tests of new and unused rope of standard construction in accordance with manufacturer's Standard Test Methods. It can be expected that strengths will decrease as soon as a rope is put into use. Because of the wide range of rope use, changes in rope conditions, exposure to the many factors affecting rope behavior, and the possibility of risk to life and property, it is impossible to cover all aspects of rope applications or to make blanket recommendations as to working loads.

WORKING LOAD

Working loads are for rope in good condition with appropriate splices, in noncritical applications and under normal service conditions. Working loads are based on a percentage of the approximate breaking strength of new and unused rope of current manufacture. For our arborist rope products, when used under normal conditions, the working load percentage is 20% of published strengths for rigging lines and 10% for climbing. Normal working loads do not cover dynamic conditions such as shock loads or sustained loads, nor do they cover where life, limb or valuable property are involved. In these cases a lower working load must be used.

A higher working load may be selected only with expert knowledge of conditions and professional estimates of risk, if the rope has been inspected and found to be in good condition, and if the rope has not been subject to dynamic loading (such as sudden drops, snubs or pick-ups), excessive use, elevated temperatures, or extended periods under load.

NORMAL WORKING LOADS

Normal working loads are not applicable when rope has been subject to dynamic loading. Whenever a load is picked up, stopped, moved or swung there is an increased force due to dynamic loading. The more rapidly or suddenly such actions occur, the greater the increase will be. In extreme cases, the force put on the rope may be two, three, or even more times the normal load involved. Examples could be ropes used as a tow line, picking up a load on a slack line, or using rope to stop a falling object. Dynamic effects are greater on a low elongation rope such as polyester than on a high elongation rope such as nylon, and greater on a short rope than on a long one. Therefore, in all such applications normal working loads as given do not apply.

ROPE INSPECTION

Avoid using rope that shows signs of aging and wear. If in doubt, destroy the used rope. No type of visual inspection can be guaranteed to accurately and precisely determine the actual residual strength. When the fibers show wear in any given area, the rope should be re-spliced, downgraded, or replaced. Check the line regularly for frayed strands and broken yarns. Pulled strands should be re-threaded into the rope if possible. A pulled strand can snag on a foreign object during rope operation. Both outer and inner rope fibers contribute to the strength of the rope. When either is worn, the rope is naturally weakened. Open the strands of the rope and look for powdered fiber, which is one sign of internal wear. A heavily used rope will often become compacted or hard, which indicates reduced strength. The rope should be discarded if this condition exists.

AVOID OVERHEATING

Heat can seriously affect the strength of synthetic ropes. The temperatures at which 50 percent strength loss can occur are: Polypropylene 250° F, Nylon 350° F, Polyester 350° F. When using rope where the temperature exceeds these levels (or if it is too hot to hold), consult the manufacturer for recommendations as to the size and type of rope for the proposed continuous heat exposure conditions. When using ropes on a capstan or winch, care should be exercised to avoid surging while the capstan or winch head is rotating.The friction from this slippage causes localized overheating that can melt or fuse synthetic fibers, resulting in severe loss of tensile strength.

STORAGE

All rope should be stored clean, dry, out of direct sunlight, and away from extreme heat. It should be kept off the floor on racks to provide ventilation underneath. Never store rope on a concrete or dirt floor, and under no circumstances should cordage and acid or alkalies be kept in the same vicinity. Some synthetic rope (in particular polypropylene or polyethylene) may be severely weakened by prolonged exposure to ultraviolet (UV) rays unless specifically stabilized and/or pigmented to increase UV resistance. UV degradation is indicated by discoloration and the presence of splinters and slivers on the surface of the rope.

DYNAMIC LOADING

For dynamic loading applications involving severe exposure conditions, or for recom-mendations on special applications, consult the manufacturer.

DANGER TO PERSONNEL

Persons should be warned against the serious danger of standing in line with a rope under tension. Should the rope part, it may recoil with considerable force. In all cases where any such risks are present, or if there is any question about the loads involved or the condition of use, the working load should be substantially reduced and the rope properly inspected before every use.

AVOID ABRASIVE CONDITIONS

All rope will be severely damaged if subjected to rough surfaces or sharp edges. Chocks, bitts, winches, drums and other surfaces must be kept in good condition and free of burrs and rust. Pulleys must be free to rotate and should be of proper size to avoid excessive wear.

SPLICING AND KNOTS

Splices should be used instead of knots whenever possible because knots can decrease rope strength up to 50%. When splices are used, always use the manufacturer's recommended splicing procedures. When knots are used, be sure to take into consideration the knot's corresponding reduction to the rope strength and adjust your working load accordingly.

WINCHING LINES

Braided rope can develop a twist when constantly used on a winch. This makes handling more difficult; the rope should be relaxed and rotated in the opposite direction to remove a twist. To avoid this condition, the direction of turns over the winch should be alternated regularly.

AVOID CHEMICAL EXPOSURE

Rope is subject to damage by chemicals. Consult the manufacturer for specific chemical exposure, such as solvents, acids, and alkalies. Consult the manufacturer for recommendations when a rope will be used where chemical exposure (either fumes or actual contact) can occur.