

ROPE RETIREMENT

ROPE LIFE FACTORS: 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.

The use of rope for any purpose subjects it to friction, bending and tension. All rope hardware, sheaves, rollers, capstans, cleats, as well as knots are, in varying degrees, damaging to the rope. It is important to understand that rope is a moving, working, strength member and even under the most ideal conditions will lose strength during use in any application. Maximizing the safety of rope performance is directly related to how strength loss is managed and making sure ropes are retired from service before they can create a dangerous situation. Ropes are serious working tools and used properly will give consistent and reliable service. The cost of replacing a rope is extremely small when compared to the physical damage or personnel injury a worn out rope can cause.

SELECTION

STEP 1: 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 straightforward like comparing rope specifications. Others are less qualitative like a preference for a specific color or how a rope feels in your hand. Cutting corners, reducing application factors, 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 out last a smaller rope – because of the greater surface wear distribution. By the same token, a stronger rope will out last a weaker one – because it will be used at a lower percentage of its break strength with less chance of over stressing.

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.

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, a loose or mushy rope will almost always have higher break strengths than a similar rope that is firm and holds its shape.

CONSTRUCTION & ABRASION

Rope construction plays an important role in resistance to normal wear and abrasion. Braided ropes have a basically round, smooth construction that tends to flatten out somewhat on a bearing surface. This distributes the wear over a much greater area, as opposed to the crowns of a three-strand or, to a lesser degree, on an eight-strand rope.

All ropes should be protected against sharp and abrasive surfaces. Wire ropes tend to score and gouge chocks and bitts creating cutting edges that can damage synthetic ropes. Weld beads on repaired capstans, fairleads, etc. are equally damaging unless dressed down smoothly.

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USAGE

STEP 2: USE ROPE PROPERLY; DO NOT ABUSE OR SHOCK LOAD IT, OBSERVE RECOMMENDED USAGE FACTORS FOR BENDING AND WORK LOADS. KEEP ROPES CLEAN AND ELIMINATE ABRASION WHENEVER POSSIBLE.

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%. 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 WORK LOAD LIMIT (FOR CATALOGUED ROPES)

Construction	Working Load (% of break strength)
3-Strand	20%
8-Strand	20%
12-Strand	20%
Double Braid	20%

BENDING

Any sharp bend in a rope under load decreases its strength substantially and may cause premature damage and failure. Sheave diameters on rotating sheave blocks should be 10 times the rope diameter for twisted ropes and 8 times the rope diameter for braided ropes. The diameter on fixed pin terminations should be at least 3 times the rope diameter (i.e., the pin diameter for 1/2" diameter rope should be no less than 1-1/2" in diameter).

KNOTS

While it is true that a knot reduces rope strength, it is also true that a knot is a convenient way to accomplish rope attachment. The strength loss is a result of the tight bends that occur in the knot. With some knots, ropes can lose up to 50% of their strength. It is vital that the reduction in strength by the use of knots be taken into account when determining application. To avoid knot strength reduction, it is recommended that a rope be spliced according to the manufacturer's instructions. Splice terminations are used in all our ropes to determine new and unused tensile strengths. Therefore, whenever possible, spliced terminations should be used to maximize the rope strength for new and used ropes.

ROPE STORAGE

Keep ropes clean and dry as possible and store them away from chemical contaminants and heat sources.

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 work load range.

RETIREMENT **STEP 3: 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 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 abrasion, glossy or glazed areas, inconsistent diameter, discoloration, and inconsistencies in texture and stiffness.

UNDERSTANDING THE ROPE DESIGN/CONSTRUCTION

It is first important to understand the design of the specific rope in use. Most ropes are designed to have features specifically tailored to their application. These features can lead to misconceptions during visual inspections. When a rope has a braided cover, it is only possible to visually inspect the cover (which, at best, carries only 50% of the load). Rope designs utilizing HMPE fibers will show initial rapid abrasion until the rope has a fuzzy appearance – this appearance actually acts as a protective layer.

DETERMINE THE AVERAGE CONDITION OF THE ROPE

The average condition of a rope can be an important factor in determining the rope’s retirement. To determine the average condition, walk the entire length of the rope and document its overall condition. Many ropes can be classified by the total amount of overall wear and cleanliness. Below are three different rope conditions depicting a new rope (*fig. 1*), a used rope (*fig. 2*), and a severely abraded rope (*fig. 3*).

Please note that there are various degrees of rope conditions not shown here.



FIG. 1 New rope



FIG. 2 Used rope



FIG. 3 Severely abraded rope

ABRASION

When the rope is first put into service the outer filaments of the rope will quickly fuzz up (*fig. 2*). 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 (*fig. 3*), 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.

LOCATE AREAS DEVIATING FROM AVERAGE

Many times a rope will have areas that are routinely used around a bit, through a chock, or buried on the winch drum. These areas typically have different wear patterns than the average condition of the rope. Pay close attention to these areas in the future and frequently examine them for rapid changes in appearance. 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. Internal abrasion can be determined by pulling one strand away from the others and looking for powdered or broken fiber filaments (*fig. 4 & fig. 5*). To determine the extent of outer fiber damage from abrasion, a single strand in the all abraded areas should be examined. Each examination of a surface yarn should be compared to an internal yarn (*fig. 6*).



FIG. 4



FIG. 5



FIG. 6

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It should be noted that comparing diameters of the yarns does not give an accurate measure of the retained strength. Since the strength should depend on the cross-sectional area of the yarn, a diameter difference alone will underestimate the true abrasion reduction. If the diameter of the abraded yarn is 1/2 the diameter of the internal yarn, the strength of the abraded yarn is nearly 1/4 that of the internal yarn. Determining the extent of fiber loss due to abrasion can be difficult. Since all the strands are twisted, the outer fibers which are the most prone to abrasion damage, rotate through the rope's length. Therefore on a single strand, the fibers that have been abraded on one pick, are not necessarily the fibers being abraded on the next. However, over a long distance, a single yarn could have the majority of fiber loss due to abrasion.

GLOSSY OR GLAZED AREAS

Glossing or glazing can occur from two different mechanisms. The most common and relatively benign form of glossing or glazing on a rope is generally caused by compression, which typically occurs when the rope is wound on the winch drum, around bits, or through chocks or staples. This form of glossing can be determined on 8 and 12 strand products by compressing the rope length wise forming a "bird cage" (fig. 7) After numerous "bird cage" cycles the glossy region will become more pliable and begin to resemble normal rope. If the glazed section remains hardened, this could be a sign of heat damage. Heat damaged rope typically has 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.



FIG. 7 Bird cage



FIG. 8 Compressed area

INCONSISTENT 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.

DISCOLORATION

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

INCONSISTENCY IN TEXTURE & STIFFNESS

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

CRITICAL & MELTING TEMPERATURE

Fiber Type	Critical	Melting
Polypropylene	121° C	166° C
HMPE	66° C	147° C
Technora	232° C	482° C *
Nylon	121° C	238° C
Polyester	177° C	249° C
Manila	82° C	177° C *





* CHARRING POINT

High temperatures can be achieved when surging rope on a capstan or drum end, checking ropes on bits, and 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 insure 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 a steam line or any other hot surfaces. 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.

ROPE RETIREMENT VISUAL GUIDE & CHECK LIST


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VOLUME REDUCTION

<p>EXAMPLE 1</p>  <p>Rope displaying original bulk.</p>	<p>EXAMPLE 2</p>  <p>Rope displaying 25% strand volume reduction from abrasion – rope should be retired from service.</p>
<p>EXAMPLE 3</p>  <p>Rope strands showing full volume.</p>	<p>EXAMPLE 4</p>  <p>Rope strands reduced by 25% abrasion. Pulled strands should be worked back into the rope so they won't continue to snag and eventually cut.</p>

*Amount of volume reduction that indicates retirement depends on rope construction. refer to “check list” below.

CUT STRANDS

<p>EXAMPLE 1</p>  <p>Rope displays two adjacent cut strands. This rope should either be retired or the cut section should be removed and the remaining rope re-spliced.</p>

*Number of cut strands that indicate retirement depends on the rope construction. See “check list” below.

COMPRESSION

<p>EXAMPLE 1</p> <p>Rope exhibits fiberset from compression. A slight sheen is visible.</p> 	<p>EXAMPLE 2</p> <p>This is not a permanent characteristic and can be eliminated by flexing the rope. This conditions should not be confused with glazed or melted fiber (see Melting below).</p> 
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MELTING OR GLAZING

<p>EXAMPLE 1</p> <p>Damage depicted at left caused by excessive heat which melted and fused the fibers. This area will be extremely stiff.</p> 	<p>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.</p>
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CHECK LIST

CONDITION	DISCARD POINT	CONDITION	DISCARD POINT
1. ORIGINAL ROPE BULK REDUCED BY ABRASION:		4. FIBER STRANDS CUT:	
• Double braid* cover by 50%	✓	• Double braid* by three or more adjacent strands cut	✓
• Twelve-strand braid by 25%	✓	• Twelve-strand braid by two or more adjacent strands cut	✓
• Eight-strand plait by 25%	✓	• Eight-strand plait by one or more adjacent strands cut	✓
• Three-strand by 10%	✓	• Three-strand by one or more adjacent strands cut	✓
• Localized or extended areas	✓	5. INCONSISTENCY OF TEXTURE:	
2. DIAMETER INCONSISTENCY:		• Localized or extended areas of stiffness	✓
• Localized diameter reduction	✓	6. GLOSSY OR GLAZED FIBER:	
• Flat areas	✓	• Localized or extended areas	✓
• Lumps and bumps in rope	✓		
3. DISCOLORATION:			
• Localized or extended areas caused by chemical contamination	✓		

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