**ROPE SELECTION** Select the Right Rope for the Job

The use of rope for any purpose subjects it to friction, bending, and tension. All rope hardware, sheaves, rollers, capstans, cleats, and 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 ideal conditions, it will lose strength during use in any application. Maximizing the safety and rope performance begins with selecting the right rope, managing its strength loss through optimal handling practices, and retiring it from service before it creates a dangerous situation. Ropes are serious working tools, and when used properly they will give consistent and reliable service. The cost of replacing a rope is extremely small when compared to the physical damage or injury to personnel a worn out rope can cause.

Selecting a rope involves evaluating a combination of factors. Some of these factors are straightforward like comparing rope specifications. Others are not easily quantified, such as a preference for a specific color or how a rope feels in your hand. Reducing application factors that pertain to sizes or strengths on an initial purchase creates unnecessary frequent replacements and potentially dangerous conditions, in addition to increasing long-term costs. For ropes with equal fiber and construction, a larger rope will outlast a smaller rope because of the greater surface-wear distribution. Similarly, a stronger rope will outlast a weaker one because it will be used at a lower percentage of its break strength with a reduced chance of it being overstressed.

**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 will have to work harder and as a result will have to be retired sooner.

Our published strengths and test results reflect as accurately as possible the conditions under which they are to be used. Because all ropes are terminated with a splice, all published strengths herein are spliced strengths. This is so the customer can select the appropriate size and strength of the rope for the application, and to ensure the utmost in safety and length of service life. When comparing our data to that of other rope manufacturers, please be sure that spliced strengths are used.

**ELONGATION**

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

**SHOCK LOADING**

Working loads as described herein are not applicable when rope has been subjected to shock loading. Whenever a load is picked up, stopped, moved, or swung there is an increased force caused by the dynamic nature of the movement. The force increases as these actions occur more rapidly or suddenly, which is known as “shock loading.” Synthetic fibers have a memory and retain the effects of being overloaded or shocked. A rope that has undergone shock loading can fail at a later time even though it is loaded within the working load range.

Examples of applications where shock loading occurs include ropes used as a tow line, picking up a load on a slack line, or using rope to stop a falling object. In extreme cases, the force put on the rope may be two, three, or more times the normal load involved. Shock loading 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.

For example, the shock load on a winch line that occurs when a 5,000 pound object is lifted vertically with a sudden jerk may “weigh” 30,000 pounds under the dynamic force. If the winch line is rated in the 30,000 pound break strength range, it is very likely to break.

Where shock loads, sustained loads, or where life, limb, or valuable property is involved, it is recommended that an increased working load factor be used.

It is recommended that a lower working load factor be selected with only 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 shock loads, excessive use, elevated temperatures, or extended periods under load.

For dynamic loading applications that involve severe exposure conditions, or for recommendations on special applications, consult the manufacturer.
FIRMNES
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. A loose or mushy rope will almost always have higher break strengths than a similar rope that is firm and holds its shape because the fibers are in a straighter line, which improves strength but compromises durability.

CONSTRUCTION AND ABRASION
It is important to choose the right rope construction for your application because it affects resistance to normal wear and abrasion. Braided ropes have a 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 3-strand or, to a lesser degree, an 8-strand rope.

WORKING LOADS
Working loads are the loads that a rope is subjected to in everyday activity. 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 breaking strength of new and unused rope of current manufacture.

Working load factors vary in accordance with the different safety practices and policies of each user. However, when used under normal conditions, our general recommendation that is fairly well accepted in the industry, is a minimum 5:1 working load factor. Thus, your maximum workload should be approximately 1/5th, or 20%, of the quoted breaking strength. This factor provides greater safety and extends the service life of the winch line.

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 pickups), excessive use, elevated temperatures, or extended periods under load.

Assume that you have seven identical ropes, each with a 30,000 pound breaking strength and you work these ropes daily with each rope lifting a different load, as shown in Table 1.

Table 1 shows that the higher the working load factor, the greater the service life and the lower the replacement factor. Therefore, the working load factor directly reflects the economy of the purchase.

**TABLE 1. WORKING LOADS FOR SEVEN ROPES WITH BREAKING STRENGTHS OF 30,000 LB.**

<table>
<thead>
<tr>
<th>Breaking Strength</th>
<th>Working Load*</th>
<th>Working Load Factor</th>
<th>Number of Lifts</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 30,000 lb</td>
<td>5,000 lb</td>
<td>6:1</td>
<td>1,000</td>
</tr>
<tr>
<td>2 30,000 lb</td>
<td>6,000 lb</td>
<td>5:1</td>
<td>750</td>
</tr>
<tr>
<td>3 30,000 lb</td>
<td>7,500 lb</td>
<td>4:1</td>
<td>500</td>
</tr>
<tr>
<td>4 30,000 lb</td>
<td>10,000 lb</td>
<td>3:1</td>
<td>300</td>
</tr>
<tr>
<td>5 30,000 lb</td>
<td>15,000 lb</td>
<td>2:1</td>
<td>100</td>
</tr>
<tr>
<td>6 30,000 lb</td>
<td>20,000 lb</td>
<td>1.5:1</td>
<td>25</td>
</tr>
<tr>
<td>7 30,000 lb</td>
<td>27,300 lb</td>
<td>1.1:1</td>
<td>5</td>
</tr>
</tbody>
</table>

*Relative values only. The higher the working load factor the greater the service life, and, of course, the lower the replacement factor. Thus, a working load factor also directly reflects an economy factor; if you always lift the same weight, then the stronger the rope, the higher the working load factor, and the longer the rope will last.

IMPORTANT NOTE: It is important to note that many industries are subject to state and federal regulation on work load limits that supersede the manufacturer’s recommendation. It is the responsibility of the rope user to be aware of and adhere to those laws and regulations.

ROPE CLASS
All Samson ropes are categorized for splicing and testing purposes as a Class I or Class II construction.

Class I ropes are produced with non high-modulus fibers that impart the strength and stretch characteristics to the rope, which have tenacities of 15 grams per denier (gpd) or less and a total stretch at break of 6% or greater. Class I ropes are produced with traditional fibers such as olefins (polypropylene or polyethylene), nylon, or polyester.

Class II ropes are produced with high-modulus fibers that impart the strength and stretch characteristics to the rope which have tenacities greater than 15 gpd and a total stretch at break of less than 6%. Typical Class II ropes are produced with HMPE (Dyneema®), HMPP (Innegra®-S), aramid (Technora®), LCP (Vectran®), or PBO (Zylon®).

Both Class I and Class II ropes can be produced in various rope constructions such as 3-strand, 8-strand, 8x3-strand, 12-strand, double braids, or core-dependent braids.
INSTALLING/TENSIONING WINCH LINES
Install lines under proper tension—a minimum load of 100–200 pounds (45–90 kgs). If a controlled method for applying back tension is available at the time of installation it is safe to install lines at higher tensions. However, specific care should be given to assure lines are not running over rough surfaces or slipping around contact surfaces that can cause unnecessary damage in the form of melting or fiber degradation. Install the first 3 layers on winches under tension. A minimum of the first 3 or 4 layers of rope around the winch storage drum should be installed so the rope has a close and tight fit on the drum. Cross winding subsequent layers will help minimize line diving. For new rope installations, the greater the number of wrap layers installed under the suggested tension will minimize or prevent subsequent wraps from diving or burying down into lower wraps.

SPLIT DRUM WINCHES: When determining the length of rope to be installed, allow enough rope that, when working, there is always a minimum of 8 wraps on the working side of the winch drum. This insures that the connection point of the rope to the drum does not undergo a load.

SINGLE DRUM WINCHES: When determining the length of rope to be installed, allow enough rope that, at full extension, there is always a minimum of 2 full layers of wraps on the winch drum. This insures that the connection point of the rope to the drum does not undergo a load.

As the rope is used, the wrap tensions may loosen, it is suggested the rope be re-tensioned at original installation loads to prevent potential downward wrap slippage.

ATTACHING LINE TO A WINCH DRUM
There are various methods of attaching a winch line to a winch drum: using a wedge or plug and set-screw in the main body of the drum, or using a “U” bolt through the side of the flange. Another method involves welding a round plug to the winch drum. The soft eye at the end of the winch line is placed over the plug and held in place with a flat keeper. The attachment method should not have a sharp edge that will cut the line under load. If possible, it is advisable to have an eye splice in both ends of the winch line so that it can be reversed in the event of damage to one end; however, this is not always possible, depending upon the method of attachment to the winch drum and whether or not a closed thimble is spliced into the eye. If an eye is not used at the drum end, then this end should be tightly whipped with a strong twine.

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 and speed. In all cases where any such risks are present, or where there is any question about the load involved or the condition of use, the working load should be substantially reduced and the rope properly inspected before every use.

ROPE CAPACITY OF A WINCH DRUM
Effect of rope diameter on drum capacity.

The formula for determining the length of rope that will fit on a winch drum is:

\[
\text{Length to be stored (feet)} = \frac{A(B^2-C^2)}{15.3 (\text{rope dia.})^2}
\]

(Where A, B, C, and rope diameter are expressed in inches and length (L) is expressed in feet.)

<table>
<thead>
<tr>
<th>Rope Diameter</th>
<th>Feet on Drum</th>
</tr>
</thead>
<tbody>
<tr>
<td>1/2&quot;</td>
<td>510’</td>
</tr>
<tr>
<td>5/8&quot;</td>
<td>325’</td>
</tr>
<tr>
<td>3/4&quot;</td>
<td>225’</td>
</tr>
<tr>
<td>7/8&quot;</td>
<td>165’</td>
</tr>
<tr>
<td>1”</td>
<td>125’</td>
</tr>
<tr>
<td>1-1/8”</td>
<td>100’</td>
</tr>
</tbody>
</table>

(EFFECT OF ROPE DIAMETER ON DRUM CAPACITY)

WINDING ONTO A WINCH

LEVEL WINDING: Using the appropriate amount of tension, wind the rope evenly, without spaces across the drum of the winch. The next level should wind over the previous layer of rope and follow the valley between turns on the previous level. This pattern is followed for all layers of rope, with each layer of turns slightly offset from the layer below.

CROSS WINDING: When the rope is placed under load it can dive, or push into, the previously wrapped level below it. To avoid diving, cross winding is recommended. When cross winding, start with two layers of level wound rope using the appropriate back tension. At the end of the second layer, pull the rope quickly across the drum, allow it to wind one full turn at the side of the drum, then quickly pull it back to the opposite side of the drum. This will force the rope to cross in the middle and form a barrier that will prevent the rope from diving into the lower layers of the drum when placed under load. Follow the cross wound layer with two layers of level wound turns, then form another cross. Repeat this pattern until the length of rope is fully spooled onto the winch.
USE OF SLINGS WITH WINCH LINES
The winch line itself should not be used as a choker to pick up a pole or other objects. The hook attached on the end of the winch line can cut deeply into the rope itself. We recommend a separate line, sling or strap be used as the choker and not the winch line itself.

END-FOR-ENDING
It is recommended that every winch line be rotated end-for-end on a periodic basis. This will vary high stress and wear points and extend useful life. The recommended end-for-ending period is six months, at which time visual inspection and washing can also be done.

SHARP CUTTING EDGES
Samson winch lines should not be exposed to sharp edges and surfaces such as metal burrs on winch drums, sheaves, shackles, thimbles, wire slings, etc. Our winch lines are made from synthetic fibers and, as such, can be cut or damaged by sharp edges. When replacing winch lines, great care must be exercised to assure that the rope is not coming in contact with hardware that has been scored and chewed by previously used wire lines. Sheaves, shackles, thimbles, etc., should be replaced in most cases. Other metal surfaces should be carefully examined and dressed if necessary.

AVOID ALL ABRASIVE CONDITIONS
All rope will be severely damaged if subjected to rough surfaces or sharp edges. Chocks, bits, 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.

MINIMIZE TWIST IN THE LINE
As little twist as four turns per three feet (or meter) introduced into the line can cause as much as 10 to 30% reduction of strength. Another way to help prevent twist is to preset the line. Once these ropes have been loaded, they do not return to their original dimensions. A rope that has been preset is less likely to accept permanent twist. Presetting should be performed only on new and unused rope, and with extreme caution. For lines in use that have not been preset, alternate wrap directions on the bitt to minimize twist each time the line is used.

TEMPERATURE
Friction can be your best friend or worst enemy if it is not managed properly. Friction takes place anytime two surfaces come in contact. Mild friction, sometimes referred to as grip, is a good characteristic, especially in winching applications. However, 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 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 (resistance to slipping) in a new or used state. It is important to understand the operational demands, and take into account the size of the rope, construction, and fiber type to minimize heat buildup.

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

Be aware of areas of heat buildup and take steps to minimize them. 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 often 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.

TABLE 2. THE CRITICAL AND MELTING TEMPERATURES FOR SYNTHETIC FIBERS.

<table>
<thead>
<tr>
<th>FIBER TYPE</th>
<th>CRITICAL TEMP.</th>
<th>MELTING TEMP.</th>
</tr>
</thead>
<tbody>
<tr>
<td>HMPE</td>
<td>150° F</td>
<td>300° F</td>
</tr>
<tr>
<td>Polypropylene</td>
<td>250° F</td>
<td>330° F</td>
</tr>
<tr>
<td>Nylon</td>
<td>325° F</td>
<td>425° F</td>
</tr>
<tr>
<td>Polyester</td>
<td>350° F</td>
<td>480° F</td>
</tr>
<tr>
<td>Aramid</td>
<td>520° F</td>
<td>930° F*</td>
</tr>
</tbody>
</table>

*While the term “melting” does not apply to this fiber, it does undergo extreme degradation in these temperatures, and they char.

STRENGTH DEGRADATION FROM ULTRAVIOLET LIGHT
Prolonged exposure of synthetic ropes to ultraviolet (UV) radiation from sunlight causes varying degrees of strength degradation.

Polyester fibers are the least affected by UV exposure, and the resulting strength degradation of exposed fibers is negligible. Nylon is more susceptible to strength loss due to ultraviolet rays, but with both polyester and nylon, the degree of susceptibility to UV damage is dependent on the type of fiber and the various UV inhibitors with which the fiber manufacturer treats them (i.e., Samthane coating).

Polyolefin and PBO fibers are severely affected by ultraviolet exposure, especially in their natural, undyed, and/or uncovered states.
EYE SPLICES

The standard eye splice cannot be pulled out under tension, however, it can be pulled out by hand when the winch line is in a relaxed state. To prevent such tampering, it is recommended that lock stitching or tight seizing be applied to the base or throat of the splice.

Lock stitching may also prove advantageous on some splices to prevent no-load opening due to mishandling. The material required is one fid length of nylon whipping twine approximately the same size diameter as the strands in the rope you are lock stitching. The strands cut from the rope you are lock stitching may also be used, but whipping twine is preferable.

You may download lock-stitch instructions from our website SamsonRope.com or call customer service to receive them by mail.

Eye splices at the end of winch lines (if not put in at the factory) should be done in strict accordance with the steps and procedures outlined in Samson splicing instructions. These splicing methods can be easily learned and executed by line crews and shop personnel. Splicing instruction assistance is available through the Samson Technical Representative in your area. Splicing Training Kits, manuals, and tools can be ordered through your local Samson Distributor or direct from the factory. Instructions are also available online at SamsonRope.com.

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 approximately 50% of their strength. However, this number can be higher or lower based on rope construction and fibers used. It is vital that the reduction in strength by the use of knots be taken into account when determining the size and strength of a rope to be used in an 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.

AVOID CHEMICAL EXPOSURE

Rope is subject to damage by chemicals. Consult the manufacturer for specific chemical exposure, such as solvents, acids, and alkalis. Consult the manufacturer for recommendations when a rope will be used where chemical exposure (either fumes or actual contact) can occur.
BENDING RADIUS
Any sharp bend in a rope under load decreases its strength substantially and may cause premature damage or failure. In sizing the radius of bitts, fairleads and chocks for best performance, the following guidelines are offered:

Where a rope bends more than 10 degrees around bitts or chocks, or is bending across any surface, the diameter of that surface should not be less than 3 times the diameter of the rope. Stated another way, the diameter of the surface should be at least 3 times the rope diameter. A 4:1 ratio (or larger) would be better yet because the durability of the rope increases substantially as the diameter of the surface over which it is worked increases.

On a cleat when the rope does not bend radially around, the barrel of the cleat can be one half the rope circumference (minimum).

The ratio of the length of an eye splice to the diameter of the object over which the eye is to be placed (for example, bollard, bitt, cleat, etc.) should be a minimum 3:1 relationship and preferably 5:1. In other words, if you have a bollard 2 feet in diameter the eye splice should be 6 or 10 feet in length. By using this ratio the angle of the 2 legs of the eye splice at its throat will not be so severe as to cause a parting or tearing action at this point (thimbles are normally designed with a 3:1 ratio).

BOOM-SHEAVE RECOMMENDATIONS
To assure maximum efficiency and safety, sheaves for braided ropes should be no less than eight times the rope diameter. The sheave groove diameter should be no less than 10% greater than the rope diameter. The sheave groove should be round in shape. Sheaves with “V” shaped grooves should be avoided, as they tend to pinch and damage the rope through excessive friction and crushing of the rope fibers. Sheave surfaces should be kept smooth, and free of burrs and gouges. Bearings should be maintained to ensure smooth rotation.
One frequently asked question 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 are there 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.

**VISUAL INSPECTION**

The load-bearing capacity of double braid ropes, such as Stable Braid, is divided equally between the inner core and the outer cover. If upon inspection, there are cut strands or significant abrasion damage the rope must be retired because the strength of the entire rope is decreased.

Core-dependent double braids such as Ultra-Tech have 100% of their load-bearing capacity handled by the core alone. For these ropes, the jacket can sustain damage without compromising the strength of the load-bearing core. Inspection of core-dependent double braids can be misleading because it is difficult to see the core. In the case of 12-strand single braids such as AmSteel® and AmSteel®-Blue, each of the 12-strands carries approximately 8.33%, or 1/12th, of the load. If upon inspection, there are cut strands or significant abrasion damage to the rope, the rope must be retired or the areas of damage removed and the rope repaired with the appropriate splice.

**ABRASION**

When a 12-strand single braid rope, such as AmSteel®-Blue, is first put into service, the outer filaments of the rope will quickly fuzz up. This is the result of these filaments breaking, which 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. When inspecting the rope, 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.

As a general rule for braided ropes, when there is 25% or more wear from abrasion, or the fiber is broken or worn away, the rope should be retired from service. For double braid ropes, 50% wear on the cover is the retirement point, and with 3-strand ropes, 10% or more wear is accepted as the retirement point.

**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.

**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.

**INCONSISTENT TEXTURE**

Inconsistent 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.

**RESIDUAL STRENGTH**

Samson offers customers residual strength testing of our ropes. Periodic testing of samples taken from ropes currently in service ensures that retirement criteria are updated to reflect the actual conditions of service.

**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.
Single Braids

**Inspection and Retirement Checklist**

Any rope that has been in use for any period of time will show normal wear and tear. Some characteristics of a used rope will not reduce strength while others will. Below we have defined normal conditions that should be inspected on a regular basis.

If upon inspection you find any of these conditions, you must consider the following before deciding to repair or retire it:

- the length of the rope,
- the time it has been in service,
- the type of work it does,
- where the damage is, and
- the extent of the damage.

In general, it is recommended to:

- Repair the rope if the observed damage is in localized areas.
- Retire the rope if the damage is over extended areas.


**ABRASION** Repair or retire

- **WHAT** > 25% reduction
- **CAUSE** > Abrasion
- **CORRECTIVE ACTION**
  If possible, remove affected section and resplice with a standard end-for-end splice. If resplicing is not possible, retire the rope.

**MELTED OR GLAZED FIBER** Repair or retire

- **WHAT** > Fused fibers
- **CAUSE** > Exposure to excessive heat, shock load, or a sustained high load
- **CORRECTIVE ACTION**
  If possible, remove affected section and resplice with a standard end-for-end splice.

**DISCOLORATION/DEGRADATION** Repair or retire

- **WHAT** > Fused fibers
- **CAUSE** > Chemical contamination
- **CORRECTIVE ACTION**
  If possible, remove affected section and resplice with a standard end-for-end splice. If resplicing is not possible, retire the rope.

**INCONSISTENT DIAMETER** Repair or retire

- **WHAT** > Flat areas
- **CAUSE** > Shock loading
- **CORRECTIVE ACTION**
  If possible, remove affected section and resplice with a standard end-for-end splice. If resplicing is not possible, retire the rope.

**COMPRESSION** Not a permanent characteristic

- **WHAT** > Visible sheen
- **CAUSE** > Fiber molding itself to the contact surface under a radial load
- **CORRECTIVE ACTION**
  Flex the rope to remove compression.

**PULLED STRAND** Not a permanent characteristic

- **WHAT** > Strand pulled away from the rest of the rope
- **CAUSE** > Snagging on equipment or surfaces
- **CORRECTIVE ACTION**
  Work back into the rope.

### ABRASION INSPECTION PROCEDURES

Internal abrasion can be determined by pulling one strand away from the others and looking for powdered or broken fiber filaments. (ABOVE)
### Inspection and Retirement Checklist*

Any rope that has been in use for any period of time will show normal wear and tear. Some characteristics of a used rope will not reduce strength while others will. Below we have defined normal conditions that should be inspected on a regular basis.

If upon inspection you find any of these conditions, you must consider the following before deciding to repair or retire it:

- **the length of the rope**, 
- **the time it has been in service**, 
- **the type of work it does**, 
- **where the damage is**, and 
- **the extent of the damage**.

In general, it is recommended to:

- **Repair the rope** if the observed damage is in localized areas. 
- **Retire the rope** if the damage is over extended areas.


### DOUBLE BRAID vs. CORE-DEPENDENT

Double braid ropes consist of a cover or jacket braided over a separately braided core. Samson produces two types of double braided ropes: standard double braids and core-dependent double braids.

The strength of standard double braid ropes is shared between the cover and the core. Damage to the cover also usually affects the core and ultimately the strength of the rope.

In core-dependent double braids, the core is the strength member and carries the entire load. Damage to the cover of a core-dependent double braid may not compromise strength of the rope.

Inspection of both standard double braids and core-dependent double braids is essential to determining whether the rope can be repaired or if it needs to be retired.

---

### Cut Strands

<table>
<thead>
<tr>
<th>CUT STRANDS DOUBLE BRAID: Repair or retire</th>
<th>CORE-DEPENDENT: May not affect strength</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>WHAT</strong></td>
<td>Three or more adjacent cut strands</td>
</tr>
<tr>
<td><strong>CAUSE</strong></td>
<td>Abrasion</td>
</tr>
<tr>
<td></td>
<td>Sharp edges and surfaces</td>
</tr>
<tr>
<td></td>
<td>Cyclic tension wear</td>
</tr>
</tbody>
</table>

### Reduced Volume

<table>
<thead>
<tr>
<th>REDUCED VOLUME DOUBLE BRAID: Repair or retire</th>
<th>CORE-DEPENDENT: May not affect strength</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>WHAT</strong></td>
<td>50% volume reduction</td>
</tr>
<tr>
<td><strong>CAUSE</strong></td>
<td>Abrasion</td>
</tr>
<tr>
<td></td>
<td>Sharp edges and surfaces</td>
</tr>
<tr>
<td></td>
<td>Cyclic tension wear</td>
</tr>
</tbody>
</table>

### Melted or Glazed Fiber

<table>
<thead>
<tr>
<th>MELTED OR GLAZED FIBER Repair or retire</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>WHAT</strong></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td><strong>CAUSE</strong></td>
</tr>
</tbody>
</table>

### Discoloration/Degradation

<table>
<thead>
<tr>
<th>DISCOLORATION/DEGRADATION Repair or retire</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>WHAT</strong></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td><strong>CAUSE</strong></td>
</tr>
</tbody>
</table>

### Inconsistent Diameter

<table>
<thead>
<tr>
<th>INCONSISTENT DIAMETER Repair or retire</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>WHAT</strong></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td><strong>CAUSE</strong></td>
</tr>
<tr>
<td></td>
</tr>
</tbody>
</table>
**TECHNICAL REFERENCE**

**Elastic Elongation | Components of Stretch**

**Elongation (Stretch)**

**ELASTIC ELONGATION (EE):** Refers to the portion of stretch or extension of a rope that is immediately recoverable after the load on the rope is released. This recoverable tendency is a primary result of the fiber (or fibers) used as opposed to the rope construction. Each type of synthetic fiber inherently displays a unique degree of elasticity. Relatively, HMPE fiber has an extremely low elasticity compared to nylon fiber.

**ELASTIC HYSTERESIS:** Refers to a recoverable portion of stretch or extension over a period of time after a load is released. In measuring elastic recovery it is the recovery that occurs immediately when a load is removed; thereafter, a remaining small percentage of elastic recovery will occur slowly and gradually over a period of hours or days. This retardation in recovery is measured on a length/time scale and is known as hysteresis or recovery over time.

**PERMANENT EXTENSION (PE) WHILE WORKING:**
The amount of extension that exists when stress is removed but no time is given for hysteresis recovery. It includes the nonrecoverable and hysteretic extension as one value and represents any increase in the length of a rope in a continual working situation, such as during repeated surges in towing or other similar cyclical operations. The percentage of PE over the working load range is four to six percent for braided ropes and two to three times as much for plaited. However, it will vary slightly with different fibers and rope constructions.

Allowances must be made for this factor in applications such as subsurface mooring or when using devices that demand precise depth location and measurement.

**PERMANENT EXTENSION (PE) AFTER RELAXED:**
That portion of extension which, due to construction deformation (compacting of braid and helical changes) and some plastic deformation of the yarn fibers, prevents the rope from returning to its original length.

**CREEP:** A material’s slow deformation that occurs while under load over a long period of time. Creep is mostly nonreversible. For some synthetic ropes, permanent elongation and creep are mistaken for the same property and used interchangeably when in fact creep is only one of the mechanisms that can cause permanent elongation.

**CONSTRUCTIONAL ELONGATION:** The elongation of a loaded rope that results from compaction as the fibers and strands align and adjust.

**SPLICE SETTING:** The elongation of a spliced rope caused by the adjustment and settling of the strands in the splice.

---

**Components of Stretch on a Loaded Rope**

**Published Elastic Elongation Data:**
All reported percentages are averages based on tests of new rope, where tested ropes were stabilized by being cycled 50 times at each stated percentage of its average break strength.

---

<table>
<thead>
<tr>
<th>New Rope Unloaded</th>
<th>Load Applied</th>
<th>Load Released</th>
<th>After Several Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>Initial Length 30 ft.</td>
<td>Load Length 40 ft.</td>
<td>New length of rope 32 ft.</td>
<td>PERMANENT ELONGATION 2 ft.</td>
</tr>
<tr>
<td>Total Stretch 10 ft.</td>
<td>ELASTIC ELONGATION immediately recoverable 5 ft.</td>
<td>Hysteresis 3 ft.</td>
<td>Non-recoverable</td>
</tr>
<tr>
<td>After released</td>
<td></td>
<td>Recoverable over time</td>
<td>Several hours later...</td>
</tr>
</tbody>
</table>

---

**Elastic Elongation**

**Components of Stretch**

**Technical Reference**
### Comparison of Fiber Characteristics

<table>
<thead>
<tr>
<th>GENERIC FIBER TYPE</th>
<th>NYLON</th>
<th>POLYESTER</th>
<th>POLYPROPYLENE</th>
<th>HMPE</th>
<th>LCP</th>
<th>ARAMID</th>
<th>PBO</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tenacity (g/den)³</td>
<td>7.5 – 10.5</td>
<td>7 – 10</td>
<td>6.5</td>
<td>40 (SK-75)</td>
<td>23 – 26</td>
<td>28</td>
<td>42</td>
</tr>
<tr>
<td>Elongation²</td>
<td>15 – 28%</td>
<td>12 – 18%</td>
<td>18 – 22%</td>
<td>3.6%</td>
<td>3.3%</td>
<td>4.6%</td>
<td>2.5%</td>
</tr>
<tr>
<td>Coefficient of Friction³</td>
<td>.12 – .15</td>
<td>.12 – .15</td>
<td>.15 – .22</td>
<td>.05 – .07</td>
<td>.12 – .15</td>
<td>.12 – .15</td>
<td>.18</td>
</tr>
</tbody>
</table>
| Melting Point     | 425°– 490° F | 480°– 500° F | 330° F | 300° F | 625° F | 930° F* | 1200° F*
| Critical Temperature⁴ | 325° F | 350° F | 250° F | 150° F | 300° F | 520° F | 750° F |
| Specific Gravity  | 1.14 | 1.38 | .91 | .98 | 1.40 | 1.39 | 1.56 |
| Creep²            | Negligible | Negligible | Application Dependent | Application Dependent | Negligible | Negligible | Negligible |

¹ Char temperature — does not melt

² TENACITY is the measurement of the resistance of fiber to breaking.

³ ELONGATION refers to percent of fiber elongation at break.

⁴ COEFFICIENT OF FRICTION is based on the rope’s resistance to slipping.

⁵ CRITICAL TEMPERATURE is defined as the point at which degradation is caused by temperature alone.

⁶ CREEP is defined as a material’s slow deformation that occurs while under load over a long period of time. Creep is mostly nonreversible. For some synthetic ropes, permanent elongation and creep are mistaken for the same property and used interchangeably when in fact creep is only one of the mechanisms that can cause permanent elongation.

### Fiber Elongation at Break

![Graph showing elongation at break for various fibers](image)

**FIBER STRENGTH RETENTION AFTER CHEMICAL IMMERSION**

<table>
<thead>
<tr>
<th>AGENT</th>
<th>HMPE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sea Water</td>
<td>100%</td>
</tr>
<tr>
<td>Hydraulic Fluid</td>
<td>100%</td>
</tr>
<tr>
<td>Kerosene</td>
<td>100%</td>
</tr>
<tr>
<td>Gasoline</td>
<td>100%</td>
</tr>
<tr>
<td>Glacial Acetic Acid</td>
<td>100%</td>
</tr>
<tr>
<td>1 M Hydrochloric Acid</td>
<td>100%</td>
</tr>
<tr>
<td>5 M Sodium Hydroxide</td>
<td>100%</td>
</tr>
<tr>
<td>Ammonium Hydroxide (29%)</td>
<td>100%</td>
</tr>
<tr>
<td>Hypophosphite Solution (5%)</td>
<td>100%</td>
</tr>
<tr>
<td>Perchloroethylene</td>
<td>100%</td>
</tr>
<tr>
<td>10% Detergent Solution</td>
<td>100%</td>
</tr>
<tr>
<td>Bleach</td>
<td>91%</td>
</tr>
</tbody>
</table>
Because our ropes are asked to perform in the real world, our published strengths and test results reflect as accurately as possible the conditions under which they are intended to be used. Since nearly all ropes in actual use are terminated with a splice, publishing unspliced strengths does not allow the customer to select the appropriate size and strength rope for his application, and to assure the utmost in safety and length of service life. Throughout this catalog, and wherever strengths are noted, all published data are for spliced ropes. This ensures that you are selecting sizes and strengths based on real world conditions. When comparing our data to other strengths, please ensure that spliced strengths are used.

**TESTING METHODS AT SAMSON**

Testing is a critical stage in the design and manufacture of new ropes, and in determining retirement criteria for used ropes. Samson has established test methods that comply with industry standard methods like CI-1500, with more stringent specifications and testing instructions to eliminate wide tolerances or generalized procedures. The result is more consistent, reliable data for our customers, and more accurate assessment of retirement criteria.

Samson R&D maintains the largest capacity testing machine for synthetic rope in the industry, capable of testing rope to failure up to 1.1 million pounds. The machine is fully computer controlled, provides automated cycle loading, and precise elongation measurements. All data is acquired, stored, calculations performed, and reports generated automatically.

**SAMSON’S TESTING METHODOLOGY COVERS:**

- Sampling of test specimens
- Determination of diameter
- Determination of lay/pitch, picks per inch
- Linear density
- Breaking force
- Initial elongation (uncycled elongation)
- Cycled elongation/tension fatigue
- Wet testing
- Reporting procedures
- Stiffness
- Abrasion resistance

**SAMSON WAS ONE OF THE FIRST U.S. ROPE MANUFACTURERS TO RECEIVE ISO 9001 CERTIFICATION, A NATURAL PROGRESSION OF OUR EXISTING QUALITY ASSURANCE PROGRAM THAT INCORPORATES:**

- Integrated product development and production software that translates engineering specifications into production orders for manufacturing
- Specialized production documents for processing high modulus fibers
- Standardized procedures for inspection, analysis, and testing of in-process product as well as finished goods
- Individual specifications for all products

Based on our Quality Assurance Program, Samson has received product type approval certifications from:

- ABS – American Bureau of Shipping
- NK – Nippon Kaiji Kyokai
- DNV – Det Norske Veritas
- LR – Lloyd’s Register

Product certifications are available upon request with order placement. As a long standing active member of the Cordage Institute, Samson has been a major contributor in developing standards and specifications on behalf of the Cordage Institute.

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