Tyson's Ships Riggers Limited

Inspection of Fibre Ropes

Section 1

VISUAL INSPECTION - GUIDELINES General

One of the most frequent, as well as the most important questions asked about ropes, is how to visually inspect the rope in order to estimate the useful residual strength.

There can be no positive method by which residual strength of a used rope can be determined visually as long as there is no actual fibre damage or distortion as described here. A laboratory analysis and tensile test is the best way.

The following guidelines are suggested for use in estimating damage and strength degradation, brought on by normal wear:

SYNTHETIC FIBRE ROPES

In synthetic ropes, the amount of strength loss due to abrasion and/or flexing broadly relates to the percentage of yarns broken in the rope's cross-section.

In 3-Strand Twisted and 8-Strand Plaited Rope constructions, all strands have an intermittent surface exposure, usually referred as the "crowns". Thus, surface damage tends to have a greater effect on total rope strength. Specific guidelines on inspection of these ropes should be obtained from their manufacturers.

12-strand Plaited Ropes are similar to the 8-strand rope mentioned above, however the "crowns" of these strands are less prominent because the cross-section is much rounder than 8 strand (squareline) and therefore surface damage is more evenly distributed.

Double-Braided "Braidline" Rope construction, however, has an independent inner-core, possessing approximately 50% of the total rope strength. This core, since it is not subjected to surface abrasion and wear, tends to retain a larger percentage of its original strength, over a longer period of time. Thus, wear on surface strands does not constitute as large a percentage of strength loss as in other constructions.

"Overbraided" Circular Braided Rope construction is similar to the Double Braided Rope in that it has an independent core but unlike the Double Braid this core represents 100% of the rope strength. The outer braided jacket is therefore an abrasion protection for the strength member and therefore massive damage to this outer braid does not dramatically reduce the overall strength of the rope.

The main fibres in this category are :-

Nylon Polyester Polypropylene Polyolefin

Aramid (Kevlar ® / Twaron ®) HMPE (Dyneema ®) LCP (Vectran ®)

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Section 2:

FACTORS AFFECTING ROPE LIFE

Selecting the correct rope for an application involves the evaluation of all the factors which combine to influence the life of the product.

Rope Strength

Selecting the strongest rope for any given size will reduce the work the rope has to do in service. The load applied to a stronger rope will represent a lower percentage of the overall rope strength and will therefore mean the rope working less hard which in turn will increase its life.

Extension

A rope with a low extension under load can give better control, however shock loading applied to this rope can result in failure without warning, even with a rope which appears to be in good condition.

Ropes, which have a very high extension under load, can lead to problems where the ropes run over guides, as there will be more movement and therefore increased abrasion.

Working Loads

Working Loads are the loads that the rope will see in normal use. These loads are expressed as a percentage of the break strength of the rope when new. The factor by which the break strength is reduced to give the working load will vary according to the application to which the rope will be put. A general rule is that the working load of a rope should not exceed 20% of the new rope break strength.

Ropes, which are greatly overloaded or subjected to high shock loads, can suffer from fatigue damage which is not readily visible and this can lead to the rope breaking under normal working load.

Shock Loads

A shock load is considered to be any sudden change in load from a relaxed or low load situation to a high load situation. Any load which exceeds the normal working load by more than 10% is considered to be a shock load. Synthetic fibres have a memory and can retain the effects of being overloaded or shock loaded. This can result in a later failure of a rope while still within its working load limits.

Bending

Rope strength decreases substantially and can lead to premature damage or even failure if the rope is stressed around a sharp bend.

A very sharp bend will mean that only a small percentage of the rope's fibres will be taking the full load whilst the remainder of the fibres are in compression.

Sheave diameters should always be in excess of five times the rope diameter but in some instances this can be up to twenty times the rope diameter depending on the material and construction of the rope.

Terminations

The easiest way to terminate a rope is with a knot but this is not the most effective since in a knot the rope is bent around a very small diameter of one to one as it is bent around itself. Any knot will reduce the rope strength and with some knots this can be up to a 50% reduction.

Ropes should always be spliced in accordance with the manufacturers recommended instructions. Correct splices will achieve between 90% and 100% of the rope strength when new.

Storage

Ropes should be stored in a clean dry situation out of direct sunlight. The ropes should be stored off the floor to allow a free flow of air. The ropes should be kept clear of direct heat. Never store ropes in the vicinity of chemicals of all types. Never store ropes or run ropes out over concrete or dirty floors or rough ground as dirt and grit picked up by the rope is likely to work its way into the strands and can then cut the fibres as the ropes are worked.

Coiling

Care must be taken in the stowage of 3 strand ropes to ensure that kinks and hockles are not induced. The rope should be coiled with the lay of the rope and uncoiled in the opposite direction. Once a kink has formed it will reduce the strength of a rope by up to 30% and even although, with working, the kink can be removed it will always leave a weak point where the kink can easily occur again.

Although Braided and Plaited Ropes cannot be hockled, they can have excessive twist imparted by improper handling and the best method would be to coil in a figure 8 fashion. This method avoids putting twist into the line in either direction and will ensure that the line runs freely when being deployed.

Section 3

RETIREMENT

When should a rope be retired?

There are no definitive rules for the discard or retirement of Fibre Ropes. Ropes should always be retired before their strength is reduced to a dangerously low level where the rope is likely to break in service.

There are so many variables that affect rope life that only a continuous process of examination, during and after each use by a competent person, will give them the ability to retire the rope before it reaches a critical point.

Many factors affect the life of a rope in service and all must be taken into consideration in assessing the remaining rope life. Factors such as Load History, Abrasion, Bending Radius, Chemical Attack all need to be considered when assessing retirement criteria.

ABRASION

When a rope is first put into service the outer filaments will quickly take on a furry appearance. This is a normal occurrence as the surface filaments break due to slight abrasion in service. This furry surface however acts to protect the underneath fibres in the rope construction.

This surface abrasion needs to be examined regularly to ensure what is a normal occurrence is not mistaken for more serious damage being caused to the rope by other means. A rope left lying in the water for instance will suffer from water wash, this is were the action of the sea works the rope continuously under very low load, which results in flex fatigue which also causes fibre damage and furring. Another cause of abrasion can be from rust build up on untreated surfaces.

Abrasion can also occur between strands and yarns in a rope and therefore a rope should be opened up, where this is practical, to inspect for internal wear. One of the signs to look for is powdered fibre which is indicative of internal wear and will indicate a reduction in rope strength.

GLAZED AREAS

Ropes can be damaged by heat and on the surface this is indicated by glazed areas where the fibres have melted together. The strength loss can be much greater than the surface appearance would indicate.

INCONSISTANT DIAMETER

Ropes should be inspected for inconsistency in diameter which can be either increases or reductions. With ropes which have separate core and sheath constructions inconsistency in diameter can indicate internal damage from overloading or shock loads and can indicate that a rope needs to be replaced.

DISCOLOURATION

All ropes become dirty in use but patches of discolouration along a ropes length need to be investigated in order to determine the cause as this could indicate chemical contamination.

STIFFNESS

Localised areas of stiffness along a rope normally indicate that the rope has been subjected to shock loads and the rope should be considered for retirement.

PULLED AND CUT STRANDS

Especially in Braidline (Double Braided) Ropes an occasional pulled or cut strand will have very little detrimental effect on the strength of the rope. However this damage is usually caused by localised external forces, which very rarely damage only one strand, and therefore the cumulative effect of the damage needs to be assessed.

TEMPERATURE

Heat can be very detrimental to the strength of Man Made Fibre Ropes. Heat can be the result of friction and the greater the friction then the higher the temperature that can be achieved. High temperatures can be achieved when surging rope on capstans or running over non-moving sheaves or rollers. Different rope constructions and fibre types will have different coefficients of friction under new and used conditions and this needs to be taken into account if heat build up is a problem.

Never allow ropes under tension rub against one another as this can result in excessive heat build up and can cause ropes to fail. Never allow ropes to come into contact with hot surfaces or be in the vicinity of welding equipment, as these can be the cause of rope failures.

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For your guidance, we have included an inspection checklist, as below.

INSPECTION CHECK LIST

CONDITION	DISCARD
Rope diameter reduced by abrasion	√
3 strand construction by 10%	√
8 strand construction by 25%	√
12 strand construction by 25%	√
Braidline (Double Braid construction) Sheath by 50%	√
Circular Braid construction sheath by 100%	√
CUT STRANDS	
3 strand one or more adjacent strand cuts	√
8 strand one or more adjacent strand cuts	√
12 strand two or more adjacent strand cuts	√
Braidline (Double Braid) three or more adjacent strands	√
Superline any visible damage to core element	√
INCONSISTANT DIAMETER	
Localised reduction in diameter	√
Localised increases in diameter	√
INCONSISTANT FLEXABILITY	
Localised areas of stiffness	√
HEAT FUSION	
Extended areas of heat fusion	√
DISCOLOURATION	
Areas caused by Chemical Contamination	√