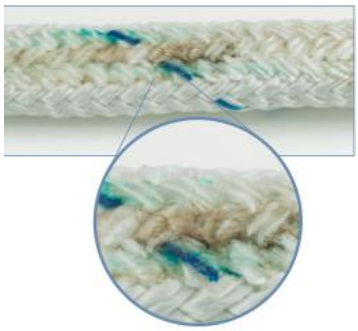
The Myth of Rigging Ropes

While demonstrating a new range of friction devices for a befriended company, I realised the significance of the rope type for rigging applications.

Many arborists consider a rigging rope a rope that is there to be abused. Very little thought is given to the structure of the rope and the actual force it can bear before breaking. Often enough I have seen ropes being abused to their limits without consideration of the structural damage done to the rope. Just because a rope has not broken does not mean it is still safe to use.



Hard sections in the rope core can indicate a melted core that has no or only very little strengths left. Glazing of the mantel of the rope will indicate structure damage to the outer fibres, so choosing the right rope for the job is vital to prevent damage to the rope.

Most commonly we see single braid constructions or old climbing lines being used for the light rigging.

The problem with old climbing lines in rigging is that:

1. We already throw them out of our climbing kit because we don't believe they are safe to climb with.
2. The force produced on a rope while rigging is way greater than the force produced while climbing.
3. Climbing ropes often have a low strengths–weight ratio.
4. There is a good chance that we mix up the climbing ropes and the rigging ropes.

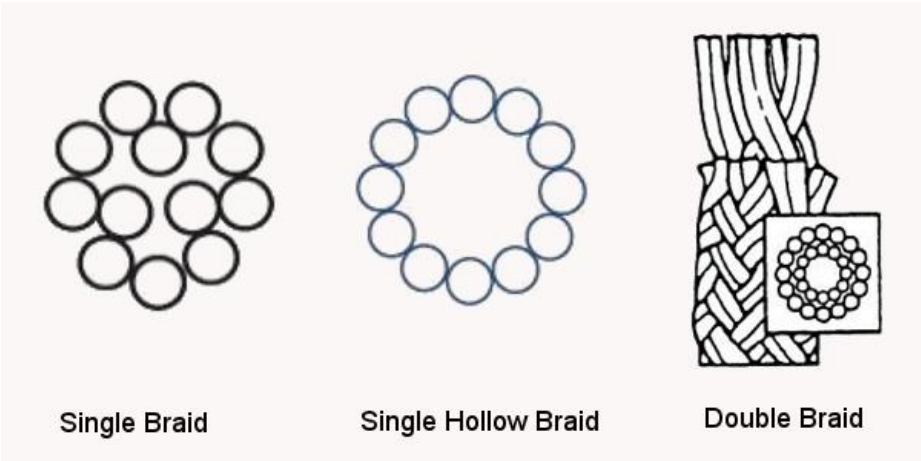
The single-braid rope construction is good for light weight rigging. The more strains are woven into the rope the less stretch it has, so a 3 strand single-braid will have more stretch then a 12 strand single-braid. The single-braid can be used as a rigging rope for natural crotch rigging as well as for technical rigging. I refer to technical rigging when the use of friction devices and pulleys are used. We will always need a greater diameter of a single-braid rope then of a double-braided rope for the same strengths.

The double-braid construction is a much stronger rope construction and when we look at the heavier rigging we often find the stronger double-braid being used. This double-braid construction shares the load between the core and the mantel and so a stronger rope can be produced. For example the ½ inch Samson Arbor-Plex 12 strand single-braid has an average breaking strength of 2700kg. The Samson ½ inch Stable-Braid with a double-braid construction has an average breaking strength of 4700 kg.

Double-braid ropes also perform better with technical rigging, they don't flatten as much under load as single-braid and single-hollow-braid when running through friction devices and pulleys.

The only disadvantage a double-braided rope has is that it should not be used in a natural crotch rigging scenario. When running a double-braid over a branch, the friction slows the movement of the mantel and at the same time the weight of the load pulls on the core of the rope. This uneven loading of the rope changes the properties and can damage it. There are core-dependant double-braid constructions that carry the full load on the core of the rope. This often is done to protect the inner weight bearing fibres from abrasion or damage. These types of rope have only little use in the arboriculture industry since it is harder to check the rope for damage to the weight bearing part.

The single-hollow-braid rope constructions are very strong and light weight ropes, woven in a fashion that they have a hollow core. This design makes them perfect for easy splicing and rope tools can easily be made up. The disadvantage with single-hollow-braid ropes is that under load, they flatten which can cause a malfunction when using friction or lifting devices like a bollard, porter-wrap or winch. This flattening can also lead to damage of the rope when running through a pulley. The single-hollow-braid can be used as tag-lines and guy-lines as well as for rope tools.



As a general rule, all rigging ropes should only be loaded with 10% of their breaking strength. Most knots we use in rigging will reduce the breaking strength of the rope by 40 – 60%. This means that when we have a rope with 3000kg breaking strength and we tie a knot in the rope that reduces the breaking strength by 60%, we will only have a breaking strength of 1200kg left. If we now imagine that something goes wrong when we are rigging out 300kg heavy trunk sections of the tree and the energy absorbing lowering techniques do not work, then the 300kg piece can easily weigh 3 to 4 times its own weight. This would bring the rope to its maximum capacity.

3000kg	→	60% 0f 3000kg	→	1200kg
Breaking Strength		Knot strength loss		Strength left

Using the right knot and using a rope with the right load is essential to work safe and maximise the use of the rope. Once we have abused the rope past its limits, it is useless to us and has to be replaced. It is not safe to work with a rope where we cannot make a judgement on the remaining breaking strength.

Safety Factor vs. Cycles to Failure*

Breaking Strength in lbs (kN)	Safe Working Load in lbs (kN)	Safety Factor	Number of Lifts Before Failure
30,000 (133kN)	5,000 (22kN)	6:1	1,000
30,000	6,000 (27kN)	5:1	750
30,000	7,500 (31kN)	4:1	500
30,000	10,000 (44kN)	3:1	300
30,000	15,000 (67kN)	2:1	100
30,000	20,000 (88kN)	1.5:1	25
30,000	28,000 (124kN)	1.1:1	5

Please take into consideration that when looking at this chart, the safety factor here used is a safety factor where splices are being used for the attachment point. A splice only reduces the breaking strength by 10%. When using Knots a greater safety factor is required to achieve the same cycles to failure.

Ropes for the arboriculture industry today are made out of some sort of artificial fibre. Here is a short listing of the most common fibres and their properties.

	Nylon	Polyester	Poly-propylene	Kevlar1*	Spectra2*
STRENGTH Breaking Tenacity - (grams/denier)	7.0-9.5	7.0-9.5	6.5	18-26.5	30.0
Wet Strength vs. Dry Strength	85-90%	100%	100%	95%	100%
Shock-load Absorption Ability	Excellent	Good	Very Good	Poor	Fair
DEGRADATION: Resistance to UV in Sunlight	Good	Excellent	Poor (black is best)	Fair	Fair
STORAGE: Requirements	Wet or Dry	Wet or Dry	Wet or Dry	Wet or Dry	Wet or Dry
RESISTANCE 3*: Resistance to Acids	Fair	Good	Excellent	Fair	Excellent
Resistance to Alkalis	Very Good	Fair	Very Good	Fair	Excellent
Resistance to Oils and Gas	Very Good	Very Good	Very Good	Very Good	Very Good
THERMAL PROPERTIES: Melts at	420-480F° 215-248C°	490-500F° 254-260C°	330F° 165C°	800F°426C° -Begins to de-compose	297F° 147C°

1* Based on DuPont Kevlar® data
2* Based on Allied-Signal Spectra® data-Type 900
3* Resistance is relative to the length of exposure, percent of concentration and temper
Source: http://www.marlin-associates.com/ropeguide.html
Aramid fibres have similar properties to Kevlar fibres and Dyneema fibres have similar properties to Spectra fibres.

After we had a look at the different properties of the fibres it becomes obvious why we prefer the polyester fibre for rigging ropes. Polyester is strong, stays strong when wet, has good shock loading properties, is UV resistant, and has good heat resistance. Polyester ropes are good for all tree rigging applications. For some rope tools (e.g. balancers) where we do not shock load the rope we can use stronger fibres like Dyneema or Spectra. The problem with these fibres is that they have low shock load absorbing abilities and have low heat resistances. When looking for a new rigging rope it pays off to check that the rope you are buying has been tested to a recognised industrial standard. Often cheap ropes are cheap because they have not been tested properly. Rope suppliers of quality ropes can always provide you with proper data on the rope you intend to buy and the testing method.