



The SHOCK of the OLD

Part 21: Knowing the Ropes

In W163, Moray MacPhail looked at the variety of modern ropes available; here he considers where their different qualities might best be used.

Table 1 Properties of various types of rope (using 6mm diameter for comparison)				
	Weight	Strength	Stiffness	Load Bearing
Item	Density – relative to water	Break Load (kg) for 6mm dia	Extension at 50% Max Load (%)	Extension at 500kg (%)
7x19 stainless wire rope	7.0	2040	1.13	0.28
Braided HMPE	0.98	3980	2	0.25
Racing HMPE	1.2	1800	2	0.56
Cruising HMPE	1.2	1520	4	1.32
Braid-on braid polyester	1.4	1230	5.5	2.24
Buff braided polyester	1.4	590	12	10.17
3-strand Pre-stretch	1.4	1020	7	3.43
3-strand buff polyester	1.4	550	17	15.45

Table 1 above starts us off by listing modern ropes and wires and what their properties offer.

- **Density**, so weight can be compared
- **Strength** – breaking load in kg for a 6 mm diameter rope/wire; useful though strength is not always crucial.
- **Stiffness**. The extension – in percent – at 50% of the rated breaking load. For a new rope or wire rope you also have constructional stretch in addition. This is what happens as the fibres or strands settle down together under load and where splices or knots take up slack. The figure quoted here assumes this initial shaking down has happened, and so describes the amount of stretchiness you will be left with, inherent in the material itself.
- **Load bearing** – a comparative figure to give a feel for how much stretch there is for a given load. This relates the strength and stiffness of the rope.

What it boils down to is that steel wire rope is heavy, strong and stiff, HMPE-based ropes are light, very strong and quite stiff and polyester-based ropes are fairly strong, not very stiff, and not very heavy.



Table 2 What you want rigging to do or be

	Semi-standing rigging	Running rigging
Attribute	Halyards, running backstays, sail controls and outhauls	Sheets
Strength	paramount	important
Stretch	important	relevant
Weight	important	relevant
Cost	relevant	relevant
Size	relevant	relevant
Ability to cleat/hold	important	important
Ease of handling	relevant	important
Flexibility	relevant	important

Table 2 ranks the desirable attributes from the viewpoint of ordinary mortals rather than bleeding edge racers – so, for example, cost is always relevant! You may have different priorities, in which case you will need to put your own slant on what follows. Whichever, now the task is to compare the needs with the available materials.

For semi-standing rigging 7 x 19 wire can be used to good effect. But you can match the stretch with the same size of braided HMPE and get a big weight saving. If you are not much fussed about the amount of stretch and in this area it is classed as important but not paramount, then the extra strength of fibres like HMPE can be brought into play, to use even smaller diameters and weights. Just to give you the flavour of it, if you are using say 6mm 7x19 wire as a halyard, then you could match the stretch of that by using 6mm braided HMPE, or 10mm racing HMPE, with weight savings of 90% and 70% respectively. If you allow a bit more stretch you could use 4mm braided HMPE or 6mm racing HMPE. The weight savings are 94% and 83%. Yes you read that right. See Table 3 below.

Table 3 How HMPE compares with 7x19 Stainless wire rope

7x19 wire as benchmark	Diameter for a given stretch	Weight for a given stretch	Diameter for a given load	Weight for a given load
7x19	1	1	1	1
Braided HMPE	0.95	0.11	0.72	0.06
Racing HMPE	1.42	0.31	1.05	0.17

If your benchmark is braid on braid then a different set of factors comes into play. Say you wanted to replicate the stretch you get with a given polyester rope. The polyester stretches about 2.5 times as much as the modern fibres, so for a given stretch – meaning lots! – you could have tiny diameters of HMPE. You are looking at 33% of the diameter and 6.25% of the weight. That really is spectacular. There's only one slight snag here and that is that the HMPE-based rope of that size would not be strong enough. That is as good an example as any to show the difference between the stiffness primarily needed for standing rigging to keep the spars in the right place – see W152 – and the strength which is important for running rigging.

Table 4 How HMPE compares with Braid-on-braid polyester rope					
Braid-on-braid as benchmark	Diameter for a given stretch	Weight for a given stretch	Diameter for a given load	Weight for a given load	Stretch at that dia & load factor
Braid-on-braid	1	1	1	1	1
Braided HMPE	0.34	0.08	0.56	0.22	0.36
Racing HMPE	0.5	0.21	0.83	0.59	0.36
Cruising HMPE	0.77	0.5	0.9	0.69	0.73

A better approach might be to match existing strengths. Even though you may not know exactly what your factor of safety is, if your current arrangement works, then so will the new one. How does that play? Well for a given size of braid on braid – and I'm assuming the good sort here – your braided HMPE can be 60% the diameter, and racing HMPE about 80%. In both cases the resulting stretch will be about 33% of what it was and the weight saving between 40% and 80%. Beyond that the blocks used could be smaller, cheaper or lighter. Cruising HMPE offers savings in stretch and weight but not much in size.

What happens if the start point is ropes other than braid-on-braid polyester? The table below summarises how racing HMPE and cruising HMPE compare with other types of rope commonly used in traditional craft today.

Table 5 How Racing and Cruising HMPE compares with other ropes								
Replaced by Racing HMPE					Replaced by Cruising HMPE			
Start	diameter	weight	stretch	cost	diameter	weight	stretch	cost
Braid-on-braid	0.83	0.59	0.36	2.56	0.9	0.69	0.73	1.37
3-strand pre-stretch	0.75	0.49	0.29	1.77	0.82	0.58	0.57	0.94
Buff braid	0.57	0.28	0.12	1.12	0.62	0.33	0.24	0.6
Buff 3-strand	0.55	0.26	0.12	0.95	0.6	0.31	0.24	0.51

With racing HMPE you are looking at around 75% of the diameter and 50% the weight. But you may have to change the hardware; this is where trad boats with cleats, belay pins can win over modern ones with jammers and clutches sized for a particular rope. The savings in size, weight or stretch which can come from the replacement of buff braided and 3-strand ropes are quite compelling. The replacement may even cost less, though costs need to be treated with caution. All that said, where stretch and weight are the important factors, it is hard to see why anyone would choose 3 strand rope for reasons of practicality. But when even cruising HMPE offers lower size, weight and stretch at lower cost for everything except the best braid-on-braid, what is there not to like? For semi-standing rigging – halyards, bobstay tackles, runners – I think this is where these new ropes really come into their own.

Is the same true for sheets? Assuming the actual size of the rope you currently use as sheets is OK – comfortable to hold, strong enough, and the right size for your hardware – for running rigging size is at least as important as any other attribute. Size for size, racing HMPE is about 4 times the cost of polyester, and cruising HMPE about double. Sure the weight will be reduced by about 15% and the stretch by a good deal more than that but is that critical for a piece of rope which you can trim? Well it is your call, but for my money I'll stay with polyester.

In conclusion I reckon the best route is as follows:

- **Standing Rigging** (to re-cap W152): stainless steel wire rope – 1×19 for larger craft and 7×7 for smaller craft such as trailer-sailers where the ability to coil it up and throw it into the trailer is useful.
- **Semi-standing rigging**: high-modulus rope, particularly on gaffers where there is string everywhere, so the saving of weight and windage, not to mention the possibility of even saving money, are pretty compelling.
- **Running rigging – sheets etc**: braided polyester. If you are constrained by hardware or handling to a particular size of rope then the cost of high modulus ropes is a good deal more, and the benefits hard to identify. I know 3-strand rope looks the part but unless the boat demands it, braided rope is much better behaved. Next time – blocks, tackles and friction.