The Shock of the Old

Part 10: ON THE WIRE.

After his excursion into 3D printing for boatbuilders in W151, Moray MacPhail continues his series on refining traditional boat rigs

So far we have made reasonable estimates of the sizes needed for spars and stays. The task now is to connect them all together in an effective and practical way, consistent in terms of the strengths and functions of the various components.

However, there is one thing I must get off my chest first. I'm asked: Is it a good plan to increase your wire sizes by a notch or two 'just for good measure'? I think not, because you then increase:

- The cost of your rigging
- Weight, just where you don't want it
- Windage, which is rarely useful
- The impact of not-designed-for loads on the rigging which may result from a collision or accidental gybe. In these cases, it is better for the wire to break than for it to be so strong as to snap spars or tear bits out of the hull.

So, in my view increasing the size of the wire beyond what is actually required and what the attachments are designed for is a thoroughly bad idea. Rant over.

Standing Rigging Materials

What kinds of rigging wire are available? Figure 4.1 – across the page – shows the three most common constructions for wire rope.

Stainless steel wire rope is virtually maintenance free but is fairly expensive and does have limitations. Chief amongst these is that it often gives little or no warning of failure, principally because stainless tends to corrode out of sight or more correctly, out of oxygen. This means that visual inspection may not give a complete assessment of the state of the wire, though if splinters or other surface defects are visible the wire should be replaced. Insurance companies tend to insist that stainless standing rigging is replaced every 10 years or so.

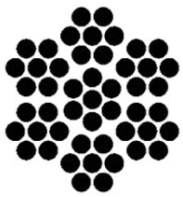
Galvanised wire frequently seems to be regarded, sometimes unfairly, as a poor relation to stainless. Certainly it is cheaper, some 50-60% of the cost and it does require some maintenance. Every six months or so a 'gloop' of boiled linseed oil – not raw; it will stain your sails, hands and anything else – and paraffin wiped on with a rag will be needed to keep rust at bay. Varnish and/or tar are sometimes suggested for protecting galvanised. wire but these can crack and let in water. If you prefer a modern concoction, Waxoyl is reputedly very good. Whichever you choose, the maintenance load is hardly onerous by comparison with the things you need to do.

Besides cost, galvanised wire has one great advantage over stainless: steel requires oxygen to corrode, so it will deteriorate more obviously than

Figure 4.1: Construction of Wire Ropes Most Used for Standing Rigging

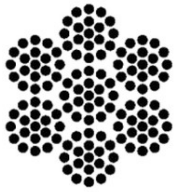
1×19

Size for size the strongest simple wire you can get and by far the most common for standing rigging. It does not like being bent, so is not suitable for running rigging and is weakened if kinked. It is only available in stainless. In sizes above about ¼" (5-6mm), so it does not form a very neat eye and swaged or swageless terminals are more commonly used. It is just – but only just – possible for ordinary mortals to splice this construction.



7×7

Fairly stiff and fairly strong but much more tolerant of abuse than 1×19. So it can be used if you need to form a loop, maybe to attach a wire to a spar or for stays which often come into contact with things – for example, a bobstay which spends at least some time fending off anchor chains or dinghies. Also good for craft which are regularly rigged and unrigged like trailer-sailers. Can be spliced.



7×19

Less strong than 1×19, but much more flexible and thus used for halyards, running backstays, gaff spans etc. It should run over sheaves at least eight times the diameter of the wire – not usually a problem except for centreplate winches where space is always tight. Galvanised wire is often 6×19 with a fibre core often soaked in oil, replenished by a bi-seasonal soak.

stainless and will almost always give warning of failure by dribbling rust streaks or splintering. This means that a visual examination, combined with bending or twisting the wire to see the core, will give a good idea of its condition. You may have to remove some serving to get a complete check. One area where stainless wins over galvanised, however, is when used for forestays carrying hanked-on foresails. Hanks sliding up and down can quickly remove the protective zinc on galvanised wire, so exposing the bare steel and allowing corrosion.

In recent years what were once exotic materials have come into the mainstream, so we need to consider how High Modulus Polyethylene – HMPE – ropes such as Dyneema and Vectran fit into the scheme of things

The strength of these ropes is listed in Table 4.1, which you will find over the page. I have included 2.5mm (3/32") since it is used on some small boats for halyards but I would not recommend fitting it to a non-racing boat. Thin rope can act like a cheese-cutter on cold wet hands, so 3mm (1/8") is probably a sensible lower limit, even though it may be too strong for your needs on a small boat. I have included data for braided HMPE which is the variant that looks like pyjama cord. The table also shows a 'factor' for each type which when multiplied by the square of the diameter in mm will give a quick approximation of the breaking load in kilograms.

Table 4.1 Breaking Loads (kg) for Standing Rigging Materials							
	Stainless			Galvanised			HMPE
Diameter (mm)	1x19	7x19	7x7	7x7	7x19	6x19	Braided
2.5	500	360					570
3	730	510	550	629	580	500	1000
4	1300	900	1000	1120	1040	890	2060
5	2000	1420	1500	1750	1630	1390	2400
6	2800	2050	2000	2330	2350	2000	3980
7	3550	2835					
8	4650	3630	3900	4136	3820	3550	5360
10	7250	5700		6310	5910	5750	
Factor	77	57	60	67	63	56	100

In terms of strength modern fibres look really good. But the main point of standing rigging is to keep the spars in the right place, so what is needed is stiffness – meaning low stretch for a given load. You can pay for that in terms of weight or size – windage – as you can see from Table 4.2.

If you start with 1×19 wire – or similar such as Dyform – as the benchmark there is no question that the best size for stretch is steel wire rope, so if you reckon windage to be the critical thing, then that is the one to go for. HMPE rope has a larger diameter for a given stretch. But if you worry more about weight than windage – you want maximum strength for a given weight – then the braided HMPE will be better than stainless wire rope by quite a margin. It will weigh maybe 10% of the steel equivalent – that's not 10% less but 90% less – but it will stretch more.

So how come top racing boats use small diameter modern fibre rigging? Well, the stuff they use is a league above braided HMPE and is stronger, stiffer and lighter than steel based wire rope. The snag is that it is very expensive and has about as much resistance to sunlight as Count Dracula, so it doesn't last very long.

Remember that HMPE is stronger size for size than stainless wire rope, so substitution of HMPE for a given size of 1×19 steel wire rope will be quite safe; there will be plenty of strength in hand but it will stretch more.

Following from this, another point is that matching either size or stretch will mean that working loads in the fibre will be low, so splices or knots can be used even though they may weaken the rope. Splices, knots and terminals for these ropes will be considered in the next article.

If however your start point is 7×7 wire, the picture is a bit different as shown in Table 4.3. Braided HMPE of about the same size as the 7x7 will only weigh about 17% of it for the same stretch. More weight saving is available if you could live with extra stretch. So you could quite credibly change – or use it from the outset. Equally you could make a good argument for not doing so. On the one hand is the lower weight of the HMPE; on the other, the higher cost and reduced robustness.

Certainly carrying a length of braided HMPE as an emergency stay would seem to make sense, but I'm not convinced of the need to get rid of my wire stays. In round numbers I would recommend 1×19 if you are using terminals on the wire – see next article – and 7 x7 if you are planning to loop the wire over the spars or on a trailer-sailer where the rigging tends to get chucked into the boat in a heap with all the other gear.

To sum up

For standing rigging, braided HMPE is a perfectly credible substitute for 7×7 wire – and great as emergency rigging because it is so easy to splice and store – but is either bigger or stretchier than 1×19. I'm not sure it is really worth it. You never use the full strength of HMPE if you want to maintain the stiffness of the rig and stiffness is the main aim. Me, I'll stay with stainless.

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Table 4.2 How HMPE Compares with 1×19 Stainless Steel Wire				
1×19 wire as benchmark	Diameter for a given stretch	Weight for a given stretch	Diameter for a given load	Weight for a given load
1×19	1	1	1	1
Braided HMPE	1.68	0.35	0.84	0.09

Table 4.3 How HMPE compares with 7×7 Stainless wire rope				
7x7 wire as benchmark	Diameter for a given stretch	Weight for a given stretch	Diameter for a given load	Weight for a given load
7×7	1	1	1	1
Braided HMPE	1.08	0.15	0.74	0.07