**Have you ever been dismasted?**

We can all learn from one another, so why not share your experiences with other readers? Contact us initially at letters@sailingtoday.co.uk We look forward to hearing from you.

Fig 1
**Because stainless corrodes from the inside out, close inspection is essential.**

# How safe is your mast?

**They may seem OK, but the shiny-looking wires that hold your mast up could be dangerously inadequate or harbouring hidden weaknesses. To find out more, Rodger Witt talked to the experts.**

Never pick a fight with a rigger, because riggers are tough. They also understand physics, as well as three-dimensional geometry, can work out difficult sums in their heads and do clever things with twine, which keeps them one step ahead.

In short, these guys are smart and multi-talented, so we should treat them with respect and listen to what they have to say.

By watching the way they work, we can also, perhaps, gain a little of their insight, which, at the very least, will stand us in good stead and may even prevent a major disaster.

Essentially, riggers are the way they are because they know that if things can go wrong they will and that in the end, everything has a life and nothing lasts forever. That's why they aren't afraid to ask awkward questions and are always looking for trouble (in a purely professional capacity of course). We should adopt a similar approach.

Let's start with the obvious: those nice, shiny shrouds, for example. What on earth could go wrong with them? Plenty, I'm afraid. For a start, even the best quality marine grade 316 stainless steel wire can suddenly fail without warning. For that reason, insurers usually insist you renew your standing rigging every 10 years or so.

To make that job easier, on the Continent, some riggers stamp the date on their swaged end fittings so you know when the stay was assembled.

The reasons for such caution are pretty straightforward. First, stainless is an unstable mixture of mild steel and chromium, the outer surface of which reacts with oxygen in the atmosphere to form a protective layer of chromium oxide. Without oxygen that reaction simply won't take place, leaving the metal vulnerable to attack. The easiest way to displace oxygen, and encourage corrosion at the same time, is to introduce water, particularly salt water, which may simply nestle into the strands of the wire. This combination of oxygen starvation and crevice corrosion is extremely powerful and may also be found wherever stainless wire is concealed – behind a shroud roller or inside a fitting – or merely on any convenient spot where droplets can gather – where a wire enters a terminal for example. Simply washing your rigging in fresh warm water to remove the salt at the end of each season, then drying it thoroughly and storing it indoors will help extend its life. It also pays to take stainless fittings apart, wherever practicable, to see what's going on inside and hidden from view.

A further life threatening problem for stainless wire is work hardening, which is really just another way of describing the general ageing process, which can be accelerated by vibration fatigue. Your standing rigging is constantly being pulled and stretched and, even worse, where it's held in the vice-like grip of a terminal, twanged back and forth. The ultimate result is the breakdown of individual strands of wire, which, though broken, may not stick out in an obvious way, but cunningly remain in place. Hence the need for extremely close inspection. Again, areas around terminal fittings are the obvious places to start looking. As you might expect, a broken strand or strands dictates instant replacement; the really unpalatable aspect to all this is that there's no obvious way to determine when a strand may be just about to break. Even fancy ultrasonic or X-ray tests will only tell you when it's already happened – though, I concede, that may be worth knowing, particularly on newish rigging that may have been involved in an accident.

To add to our worries, work hardening can be accelerated by the aforementioned crevice corrosion – as well as our final adversary, the galvanic action of dissimilar metals. Zinc has a particularly vicious reaction with stainless – which is why you should never attach it to a galvanised shackle – but aluminium is unfriendly too. Which, bearing in mind that most of us have alloy masts these days, seems somewhat unfair. The trick is to avoid direct contact wherever possible.

## Old ways best?

Having listed this brief, but disturbing catalogue of potential problems, it's perhaps understandable that some purists favour good old fashioned galvanised rigging. Sure, size for size the stuff's not as strong, so it needs to be a bigger diameter, but at least it provides clear, visible warnings before it breaks, giving you an obvious sign it's in trouble. When galvanised wire loses its coating of zinc, it first darkens, then rusts, then finally breaks down altogether. Even before you spot the telltale signs of degradation, however, you should periodically open up some of the strands to see what's going on inside.

The real snag is the upkeep.

In the old days, greasing the rigging with regular and distasteful concoctions, which could well include pig's fat, linseed oil and/or varnish, was all part of the fun, even if it left unsightly stains on sails and emitted pungent vapours or attracted the odd fly or two. These days, however, even earthy creatures with the most basic instincts will find this too much to stomach. There's another drawback too: unless your boat has a traditional timber spar, as we've seen already, aluminium alloy and zinc are best kept apart. One other thought: galvanised forestays are particularly prone to wear if your headsails have old fashioned piston hanks that can quickly rub away the zinc coating – but chafe in general is bad news.

Stainless rod rigging is another option, which, at first sight, seems highly attractive. It's undoubtedly stronger, which means it doesn't have to be so thick, which, in turn helps keep the weight and windage down. It's also smooth and shiny and easy to clean – so there are fewer places for water to hide – and less stretchy that conventional wire. The snag is its much higher cost and the fact that you have to be ultra careful to keep it absolutely straight to avoid kinks, which can both encourage crevice corrosion and seriously weaken it. Apart from anything else that involves the use of specialised terminals. Rod rigging



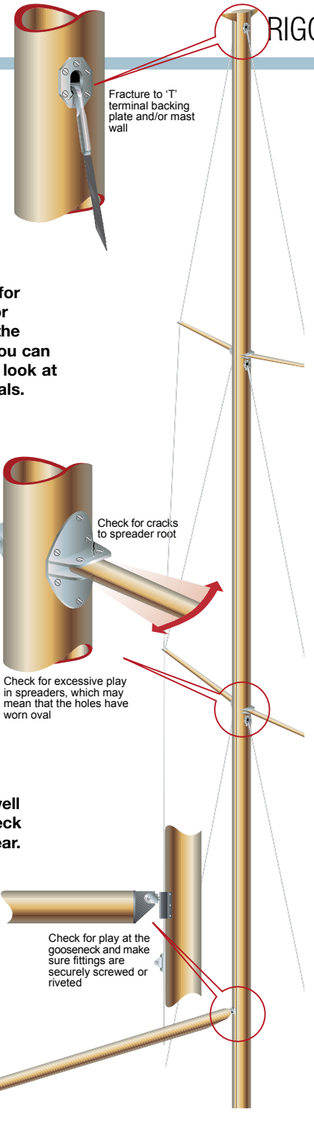
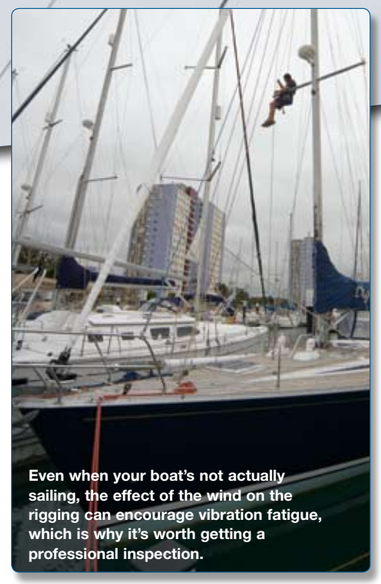



Fig 1
**One reason for going aloft or unstepping the mast is so you can take a close look at the T-terminals.**

Fig 2
**Don't forget to check the spreaders as well as the gooseneck for wear and tear.**

You can't leave anything to chance. That's why professional riggers insist on examining every single component.



Even when your boat's not actually sailing, the effect of the wind on the rigging can encourage vibration fatigue, which is why it's worth getting a professional inspection.

also tends to work harden more easily. On the other hand, as technology improves, these drawbacks are becoming less obvious, so, while rod rigging was once almost exclusively found on racing boats, it's gradually finding favour with cruising skippers too.

For most of us, however, the standing rigging of choice is 1x19 stainless, which as the name suggests, consists of 19 strands of wire twisted together to make a single unified component. It's simple, strong and relatively inexpensive. Fine for keeping your mast up, it prefers to be kept straight, which is why as a rule you won't find it wrapped round blocks or used for running rigging. The obvious choice here is for 7x19 stainless, which is made up of seven wires each of which contains 19 strands. More strands simply make it more flexible.

## Made in a die

There's one other obvious contender for standing rigging. It's pulled through a die and, for that reason, called Dyform. It has an even tighter lay-up than 1x19, making it stronger and less stretchy, so in some cases you might get away with a smaller diameter, reducing windage and weight, though for cruising skippers that's less of a priority and its advantages are outweighed by its considerably higher cost.

Our next priority is attaching the rigging to the boat and the mast, which, in turn, brings us to the subject of end fittings. Old timers like the idea of splicing the ends, because it distributes the loads more evenly. In reality, splicing a piece of 1x19 stainless is a difficult and time consuming operation that few can manage and even fewer are prepared to pay for. Also, while it undoubtedly eliminates obvious hard spots, it's a sad fact of life that other alternatives are stronger. The most popular method is swaging, a term that is sometimes used loosely – and inaccurately – to include crimped Talurit or Nicopress collars or ferrules, which have two holes and can be squeezed onto the end of a piece of wire with a big, macho hand tool that looks like a huge pair of nutcrackers. Copper ferrules and stainless thimbles are used on stainless wires, while galvanised wires use aluminium ferrules and galvanised thimbles. It's important to make sure that only new wire is used, because any deposits can act as a barrier, preventing the ferrule from getting thoroughly squeezed into the individual strands. Even then, crimped terminals such as these, have no place as part of the standing rigging on any decent boat and are vastly inferior to proper rotary-swages, which are made on highly expensive machines. Here, using hydraulics, the fitting is held between two split dies, which bang away at it with an interference-fit rolling hammer. The force they exert is simply awesome, so, as you might imagine, there's always a slight risk of overdoing it – in which case the fitting could potentially be weakened and subsequently develop cracks. The other point already made, but worth repeating, is the way they produce hard edges where the wire enters, leaving places for moisture to lodge. That's more likely to happen at the lower end, near the water, which is why some people only use them higher up, where the wire meets the mast.

To confuse you further, some riggers use a hand tool called a roll-swager, which can produce a perfectly acceptable result – but only on wires up to about ¼in diameter. You can usually spot a roll swage by looking for the two, telltale raised flash lines on either side of the end fitting. Some operators make the mistake of 'rolling' the fitting several times to get a nice smooth finish, but, as before, that runs the risk of weakening the structure and encouraging cracks sometimes even after just a couple of years of use.

The final system is arguably the best of the lot. Swageless fittings, which use a cone or wedge that jams everything up tight, can be assembled or disassembled fairly easy – which means you can fit them yourself or take them apart for cleaning or maintenance – with nothing more than a couple of spanners. Swageless fittings, made by Norseman or Sta-lok are also immensely strong, stronger even than swaged terminals, which, in my book, makes them almost irresistible.

You can expect them to last longer than the wire, but experts recommend you renew the cone in the middle every time you change the rigging.

The next important components are your turnbuckles or rigging screws. At their simplest they divide into two types, open-bodied types – which should be wired to prevent them undoing themselves – and closed or barrel types that are usually fitted with locknuts. In either case, it's important not to over tighten them or adjust them too often when they're under load, because that may cause unnecessary wear, particularly on the threads. In any case, the experts advise replacing rigging screws roughly every six years or so, just to be safe. To reduce the damaging effects of vibration fatigue it also makes sense to attach them to toggles at both ends – to allow movement in two planes.

Even so, it's worth making sure that chainplates and U-bolts are aligned with the angle of the shroud or stay, so all the tension comes in a straight line. Even a slight angle can cause problems. With that in mind, you should also find out exactly how U-bolts are anchored. Some go down onto bulkheads, others are joined to tie rods, which, in turn, may be attached to plates bonded onto the topsides. But unless all the loads have been adequately catered for, after time, things can, and will, come adrift. In some cases, before that happens, you might see bumps or distortions in the relevant trouble spots – in the deck or on the topsides, for example. At the very least, misaligned loads will accelerate wear on the wire and may even induce kinks that can seriously weaken it.

## Look aloft

Problems can arise at the other end too. T-terminals, which may be used to attach the shrouds to the mast, are ideal candidates for crevice corrosion and, ultimately, cracks. For that reason, some professionals prefer to fit more conventional tang attachments, partly because it's easier to see what's going on. Naturally, though, when fixing stainless fittings to alloy masts it's vital to guard

Corrosion may go undetected beneath shroud protectors.

# 20 TOP TIPS

**1.** Remove your mast every three or four years. After fitting new rigging, carry out a visual check for the first three years then commission a professional for an annual inspection.

**2.** Clean out plastic bottle screw covers and protective fittings every year.

**3.** Never use crimped-on end fittings. Apart from anything else, 1x19 wire was never designed to go round sharp corners.

**4.** Always fit toggles to your turnbuckles so they articulate towards the angle of pull. Fit two, top and bottom on the forestay to give 360° movement. It's especially important where furling gear is fitted.

**5.** Use split pins (never rings) to secure closed turnbuckle barrels unless they rely on locknuts. (Some riggers use both locknuts and split pins on the forestay just to be safe, though, with chrome/bronze bottlescrews split pins alone, rather than locknuts are recommended). Open bodied turnbuckles also need split pins on the threads. In either case, make sure the pins themselves are inserted from the outside in and then taped over to prevent them snagging sheets or sails.

**6.** Make sure chainplates are aligned with the pull of the rigging.

**7.** Closed turnbuckles are less easy to inspect, so pack them with lubricant every year. Use white spirit to clean off the excess, which could otherwise stain your sails.

**8.** With open turnbuckles, make sure there's some thread visible to allow subsequent adjustment – particularly important when you want to slacken them off to step the mast.

**9.** Inspect fittings for corrosion and cracks.

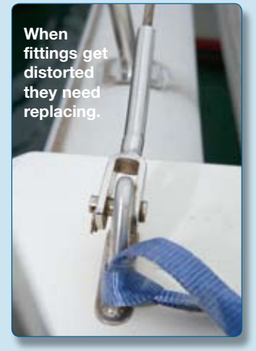
**10.** Look for rust stains and broken strands of wire, especially where they emerge from swaged or mechanical terminals. (See picture on following page.)

**11.** Take components apart for inspection, if they can be stripped down easily, clean with white spirit, then regrease.

**12.** Check mast backing plates around shroud attachments and T-terminals.

**13.** Don't forget to examine the mast step for corrosion. Before removal, use a straight edge to highlight any for and aft distortion loads caused by the rigging.

**14.** Check your spreaders. The shroud should bisect them at equal angles. If the spreader droops, it can fail and you can easily lose your mast.



When fittings get distorted they need replacing.

**15.** Take the spreader ends apart to check for corrosion and make sure they're attached to the shroud. When reassembling, use a touch of silicone on the shank of the bolt.

**16.** Spreaders are also designed to maintain a reasonable angle of pull where the shroud meets the mast. Anything less than about 10° is asking for trouble.

**17.** Check for white powder and pockmarks on the mast.

**18.** Replace bedding compounds such as zinc chromate paste between fittings every three or four years.

**19.** Examine welds and rivets on mast and boom.

**20.** Replace your rigging every 10 years or so. (Check required frequency with your insurers.)

# IS YOUR RIG SET UP CORRECTLY?

**Mark the settings** on your turnbuckles or rigging screws at the end of the season so you can achieve roughly the same tension when you set them up in the spring. However, remember that even wire stretches, so you'll need to check them again.

**On the moorings** start by checking the shortest wires – normally the lower shrouds – to make sure they're taut, and progress to the longest ones. The idea at this stage is simply to keep the mast straight and well supported, so have a look from every angle. You can even lie on your back and sight up the mast track.

**Final tuning may** be best left to an expert, but, again, at its simplest, in most cases, you're merely trying to keep the mast in a straight line and to take up the stretch in the wire. To get some idea of what's going on, assuming your boat has a masthead rig, go sailing in a decent breeze and make sure the windward shroud is tight enough to keep the mast straight when she's hard on the wind.

**If the leeward** shroud is obviously slack and doing no work at all, tighten it until you feel some resistance, then go about and check the other side.

**If the mast** is bent over to leeward, start by reducing the tension in the lowers to see if that helps before tightening the cap shrouds again.

**Unless you know** that your boat sails best with a certain amount of rake, adjust forestays and backstays to keep the mast as straight as possible and minimise headsail luff sag. On a typical 30-footer, about 6in of play in the forestay is about right when you're sailing to windward.

**In real life,** different boats have different characteristics and riggers have different ideas about what constitutes the 'right' amount of tension. At the end of the day, it's largely a matter of trial and error.

**Fractional rigs are** more 'highly strung' and demand even more care. For a start, the after lower shrouds must generally be wound up between three and five times as tightly as the forestay. That's because, even with swept-back spreaders, the angle of pull is usually so acute.

This, in turn, puts the rigging wire under greater stress, which may shorten its life. The same applies to the lower shrouds, which have to counteract the resultant forward thrust. There's another potential drawback. Having tensioned the backstay and bent the mast aft to tighten the forestay on a beat, if you forget to release it off the wind, there's a real risk of snapping the top of the mast. As a rule, therefore, tweakable rigs like these may be fine if you want extra performance, but are less suited to the rigours of long distance cruising.


Checking the wires for tension.

against the possibility of galvanic corrosion by using a barrier of zinc chromate paste where the two surfaces would otherwise come into contact with each other.

## Take it down

What else can we do to make sure nothing goes wrong? Well, for a start, it makes sense to remove the mast and rigging every few years when the boat's laid up ashore. Just because your boat's no longer in commission doesn't mean it's not being subjected to wear and tear. The effect of the wind in your rigging can accelerate fatigue, which does it no good at all. Taking your mast down also gives you the chance to look for signs of rust, cracks, corroded fittings or broken strands. It's a really good idea to use a magnifying glass for this sort of work, though there's no substitute for a thorough professional inspection at some stage, which might well include a die penetration test to assess the internal condition of your swages.


Stainless is most likely to fail where it emerges from a swaged fitting.

As further insurance you should coat your fittings with a lanolin-based waterproof grease – particularly where dissimilar metals are involved. Some riggers recommend protecting against crevice corrosion with beeswax. Otherwise, it makes sense to treat the threads of your turnbuckles with a dry lubricant that contains Molybdenum Disulphide, and use a self-amalgamating tape to prevent chafe. After that, it's a matter of getting used to making regular and frequent checks whenever you get the chance.

As I said at the start, the price of security is eternal vigilance. ■

With special thanks to the rigging experts at XW Rigging Ltd whose helpful advice and practical insight was absolutely invaluable.
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