

29 September 2011

Hi Eduard,

My thoughts re rig tensions.

All other things being equal, and in the case of the 9ers, they are roughly equal, then Rig tension is firstly all about ForeStay [F/Stay] tension and that in turn is a function of Forestay length.

There are also, secondary, mast bend consideration, more so with the 49er and XX.

And again there are tertiary considerations, also with the 49er and XX re spinnaker loads!

A 49er has a Forestay of approx. 6500mm, a XX about 5250mm and a 29er approx 4700mm.

We also know "empirically" that a 49er F/Stay tension is going to be between 26 (0-5knts) -> 33 (25 & above). We also know empirically that a 29er's tension is going to be between 22 (0-5) -> 25 (25 & above). School is out on the XX but its going to be somewhere in between 25-31 (at a guess)!

(FYI, we are talking numbers on a Loos Gauge, 22 = 130kgs, 24 = 150kgs, 26 = 170kgs, 28 = 190kgs, 30 = 220kgs and 32 = 250kgs)

A far smarter man than I will work out a formula, and it will have a square (to the power of 2) or a cube (to the power of 3) and will have a J factor in there also, "as it should" because its all about F/Stay sag.

Sailmaker's also empirically know that it's foolish to assume that a F/Stay wont sag, it is infact impossible. So they cut "hollow" into the jib luff to compensate for the sag in exactly the same way as they cut luff round into the main to compensate for the mast bend. Same deal!

How much they cut in and where they cut it in, is one of the arts of the sailmaker's trade, too much hollow and the entry to the jib is too flat, too little luff hollow and it will be too knuckle-ly and you will never get any pace.

Ok,

So we know that there is "hollow" cut in a jib luff, we know that this will be effected by rig tension and that rig tension is a factor of the length of the wire. And we also know that the amount of forestay sag will be a function of wind strength, because as it blows stronger, so will the sideways and aft loads on the jib increase, you hick harder or get on the wire, you generate more force in the jib and that in turn deflects the wire further and further.

Now we get into one of those intangible areas, "feel"!

The problem with the word "feel" is it's impossible to quantify. And it's even harder to explain.

The point I want to get across is that different tensions will be right for different people for a given wind strength.

If you're a "pincher", you point the eye out of a needle, and your crew is a human cleat, then you will need less tension, because the mainsheet will provide a lot of the rig tension, so if you are in 10-12 knts, and you're on a 29er, and your crew is a human cleat, then the ratchet block can hold 5:1, you can hold, say 30kgs, and it's a 2:1 Mainsheet, so that's 30kgs x 5 x 2 = 300kgs. If you have set your rig up "correctly" then you probably only have 24 = 150kgs tension in the F/Stay, so the 300kgs mainsheet tension, factored down by as much as 70% (mast bend, sail stretch, etc, etc) is still a significant proportion of static rig tension. And as I just said, that's significant. (the length of the boom is a little greater than the J (mast to jib tack) measurement, so it will almost exactly correlate to a 1:1 increase in F/Stay tension)

Where as if you have a crew who eases before the gust and pulls back on as it hits (after the boat has rolled 5d to windward, all that), then you may need to be running up around 25 and accept you will only get 100-120kgs support from the mainsheet.

*[When I sailed 18teens, one of my boats, Prime Mk3, (photo in Dad's first book) had adjustable hydraulics on everything, F/Stay, Sidestays, D1's & D2's. I taught us many things, one is that too many strings is very very slow, think KISS. But what we did do was put load cells on the lines and actually measure the tensions while we were sailing! While the Shrouds and D1's often exceeded 200% static load, the F/Stay never got above 153%]*

There is no correct tension for everyone, there is a range which you most likely will be in and the rest is up to personnel preference.

- ⇒ So why do we do this, If we over tighten the F/Stay we also over tighten the rig, this dose 2 things, firstly it binds up the rig, makes it less elastic than we want it to be and therefore inhibits the rig from breathing with each gust/lull sequence, which in turn makes it harder for us to make the most from those changes, also it may well physically stop you from achieving cambers you may want in the main but more so in the jib, the second thing is that a bound up F/Stay will inhibit F/Stay sag and therefore stop the luff rounding up and make it very hard to steer the boat. I will destroy the "groove".

Enough of forestay sag.

Lower mast bend, again, in the 49er and XX this is governed by D1's and it will be critical to within ½ turn on a turn buckle. On the 29er it is a function of where you put the wedge.

The lower mast operates in the down wash of the jib. These need to be seen as foils or elements working in unison in the air, the sum of both, working together is many times great than the addition of the 2 parts working independently. If you have you jib set full, by easing off the halyard and spring the sheet 10-20mm then you had better be carrying some camber low down in the sail. If you have pull the halyard on tight and sheeting hard in, you had better ease out the D1's so the lower main complements the exit flow of the back of the jib and dose not block/constrict the slot.

On both the 49er and the XX, lower tensions can vary wildly, again depending on personnel preference and the amount of vang you carry and your crew weight. For the same F/Stay tension, D1's can alter from 17-24.

On a 29er, and to a lesser extent a XX lower mast bend is set by “heel tune” this is the way the mast plug sits in the mast step. In a XX there is a set screw so this can be adjusted, but it tends to just compliment D1 tension.

On a 29er, you are allowed to use a wedge normally under the front between the plug and the step to alter the way the mast leaves the step.

*I have to say that I am quite amused by people going to great lengths to bend spreaders down (which is illegal, BTW, 2004, ISAF and 129erCA rulings) which allows the mid mast to bend, and then go to great lengths to wedge the lower mast back, which in-turn stops the mid mast bending.*

Be that as it may, with a 29er the idea is to get the mast to exit the step with almost no pre-bend.

What I mean by that is that the spreaders will induce the mast to bend fwds, if they don't, they are not doing their job and that could result in mast breakages under spinnaker.

So in its normal setting with 24-25 on the forestay, un-wedged, the mast will naturally sit, with some pre-bend, maybe 10 – 30 mm. There are a number of ways this is measured, the easiest is to arrange that the jib halyard sits on the front of the lower spreader, right at the point, 49er guys have a plastic moulding they do this with, some people put a very small notch with a rat-tail file, not advocating that, but its common place, and then pull the halyard tight, through the notch and down below the lower Gooseneck. Move it in and out and you end up with a parallel line, that's sits 10-20mm off the front face of the mast, visually it's very easy to sight this, and you can pick up, without tools certainly 5 mm of bend, with practice 1mm of bend.

My suggestion is if you like to sail light, so <120 kgs you would want 7-12mm of bend, mid range 120-135kgs you want 3-8mm and if you like sailing heavy then 4 ->to slightly inverted.

Final point on 29ers, the wedge must be fixed, you have to fix it with a screw or glue it in for 2 reasons, firstly it's a requirement of the class rules, secondly, this is a very primary control, you play around with it at your peril, it's a set and forget situation.

Cap shroud tensions.

Again personnel preference, 15-17 is a safe number, anything below that and you have to think about it, but if you have 16-17 on the caps, it's pretty hard (not impossible) to break the mast. Caps do 2 things, their primary function is to stop the mast going fwd under spin load, but as a secondary function, they hold the mast tip to windward, and stop it going sideways.

And I am going to complicate this a little more. If you go for a sail, at the design wind (10-11knts) so the crew is both fully extend on the wire, there is almost no vang but maximum mainsheet tension and you get exactly side on and snap a photo of that.

Then you come back to the beach, take the sails off and tie a string between the mast head and the end of the boom, and you keep on tightening it till you duplicate the bend in the mast, then that tension will be about 55kgs. This is often referred to as leach load or leach tension.

If you now tension the cap shrouds up so at 55kgs of “leach load” they are taught, but at 60kgs they go loose, then drop the load in the leach line to zero, the tension in the caps shrouds will be around

17-18 (for both 49er and XX). This point is sometime referred to as the tipping point, or crease point.

Put it in very simple language, if you set your Cap shrouds at anything below the crease point, so <17 then you will not alter the dynamics of the rig, it will remain responsive, particularly up-range.

If you set it >17 then you will pre-set a trigger point at which the rig goes from semi-dynamic to fully dynamic.

All the above relates to up-wind-setting.

And to just complicate the problem of Caps even further, is you run loose Cap tensions, down wind under spinnaker pulling the mast head fwd, that will increase the camber in the upper main and make it more powerful, pulling you lower and faster earlier.

Unfortunately there is no one correct setting, there are ranges in which people tweak and optimise it so its perfect for their style and technique.

So some starting points for the various classes.

29er, Light airs, 18-19 on the F/Stay. Mid range 22-23 on the F/Stay and up range 24-25 on the F/Stay. Not overly interested in side stay tension as they will be governed by the F/Stay tension.

~~~~~

29erXX, some starting point

Light airs FS 25, Pri 29, Caps 15, D1s 17

Mid range FS 29, Pri 30, Caps 17, D1s 24

Top end FS 31, Pri 36, Caps 16 D1s 28

~~~~~

49er

Light Airs FS 26, Pri 30, Caps, 19 D1s 24

Mid range FS 29, Pri 34, Caps 18 D1s 28

Top end FS 33 Pri 38, Caps 19 D1s 26

Final point, a lot of top sailors, measure F/Stay tension and if they have them Cap Shroud tension and then alter Primary and D1 tension/wedge to achieve a desired mast bend. That should be the priority. Primary Shroud tension and D1 tension follow from mast bend, not the other way around. In compiling these numbers, in most cases Pri and D1 tension's a calculated guesses, because no one at the top of the game knows or cares what they are.

Julian