JIBSTAY SAG

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EFFECT

The jibstay always sags to some degree. Its sag affects the jibs fullness, the position of its maximum draft, and its twist. The precise effects depend upon the jib design, the jibsheet tension, the amount of sag, the wind velocity, and the position of the head relative to the top of the jibstay (the length of the halyard pennant).

These factors determine whether the sag is aft or forward, to what extent the sag is to leeward, and to what extent the position of the leech is simultaneously altered.

THE JIB DESIGN AND THE JIBSHEET TENSION

The weight of the jibstay and the jib causes the jibstay to sag aft ("basic sag"). Tension in the jibsheet transmitted through the sail also pulls the jibstay aft. This effect will be increased if the jib is flat and particularly if its leading edge is flat. It will also be increased if its luff is cut with a curve greater than the basic sag and vice versa.

AMOUNT OF SAG

Factors Increasing Jibstay Sag: decreasing the aft tension on the mast, decreasing permanent backstay or running backstay tension, decreasing mainsheet tension, lowering the site of jibstay attachment to the mast (bending the lower mast puts the jib attachment point forward), "prebend" - chocking or pulling of the mast forward at the deck (or aft at the butt), shroud/spreader relationships which pull the spreader tips and the mid—mast forward, trapeze attachment offset above the site of jibstay attachment which bends the mid—mast forward, boomvang tension – which drives the boom and the lower mast forward at the gooseneck, lateral mast bend - sags the mid- mast to leeward and makes the mainsail fuller or bends the mid-mast to windward and makes it flatter stiffening of the upper mast (jumper stays, etc.) causes the lower mist to bend more, increasing the innate flexibility of the mast.

Factors Decreasing Jibstay Sag: Increasing the aft tension on the mast, increased permanent backstay or running backstay tension, increased mainsheet tension, raising the site of jibstay attachment to the mast (straightening the lower mast), reducing "prebend" - chocking or pulling of the mast aft at the deck (or forward at the butt), shroud/spreader relationships which pull the spreader tips and the mid—mast aft, strut pressure (from the deck) which pushes the lower mast aft at the gooseneck, trapeze attachment at the site of jibstay attachment (diminishes "prebend"), straightening the mast decreases lateral bend, leading the lower shrouds aft, and increasing their tension decreases forward bend, stiffening the lower mast (jumper stays, added external tracks, internal sleeves, etc.) and increasing the flexibility of the upper mast diminishes lower mast bend, increasing the innate stiffness of the mast.

The Wind Velocity

Increased wind velocity increases jibstay sag and determines the direction of the sag by increasing the tension in the jib luff. In strong winds the luff tension pulls the jibstay chiefly to leeward. Aerodynamic lift tends to pull the luff forward (diminishing the "basic sag" aft). In very strong winds with excessive sag, the jibstay may actually sag forward. Decreased wind velocity permits the "basic sag" effects to become more evident, i.e., in light air sag is chiefly aft, in heavy air chiefly to leeward.

The Position of the Jib Head: If the jib head is hoisted right to the mast, jibstay sag has very little effect upon the leech. But, if the jib head is well down the stay (On a long halyard pennant), as the jibstay sags, the jib head drops aft and to leeward and the leech is eased (opened) and twisted.

Consequences of Jibstay Sag: Depending upon the net movement of the stay and the leech, the jib may become fuller or flatter, its draft may shift forward or aft, and its leech may either open or close. Presuming that the jib design and the length of the jib halyard pennant are fixed, control of jib shape with variations in wind velocity requires modification of jibstay sag (and jibsheet tension). Because the optimal jib shape varies with the wind velocity, the optimal amount of jibstay sag also varies with the wind velocity -- too much or too little will diminish the desired effect.

The purposes of controlling jib - stay sag are to:

1. Control jib fullness (which determines power and balance)

2. Control the distribution of maximum draft (which deter mines adaptation to dirty air and pointing)

3. Control the flexibility of the luff and leech (which deter mines adaptation to waves, irregularity of the airflow, and gusts)

INITIAL SETTING

Use a jib whose luff is cut to match the jibstay sag considered to be optimal and achievable in the expected wind velocity. The main must, of course, be designed to accept the mast bend required to maintain this amount of jib- stay sag. (Usually this means In light air, a main with very little luff curve, requiring very little mast bend, and permitting significant jibstay sag and in heavy air, a main with marked luff curve, requiring marked mast bend, and through In creased aft tension on the mast, limiting jibstay sag).

Set the jibstay to sag the optimal amount and to match the jib luff curve. This usually means that in light air jibstay sag must be induced, that in mode rate air/smooth water, jibstay sag is inherently appropriate, that in heavy air, jibstay sag must be decreased, and in waves and dirty air, jibstay sag must be increased.

ADJUSTMENTS

Light Air

In light air when the jibstay sags, it sags aft, pushing the luff back into the sail. This increases the total fullness of the jib and particularly increases the fullness of the luff. The leech shifts aft and

but minimally to leeward. The net effect is that the sail is made fuller and that its draft is shifted forward. This trim facilitates attached flow (light air conditions are characterized by slow, erratic airflow which attaches with difficulty) and increases the power from the sail.

In the absence of significant pressure on the sail the rig tension required in most boats results in an excessively straight jibstay. Techniques which will increase jibstay sag must be applied. Usually decreasing aft tension on the mast (backstay and mainsheet tension) is in— sufficient or results in an inappropriate, draft forward, mainsail shape. The most satisfactory solution is to bend the mast below the site of jibstay attachment.

"Pre-bend", achieved by chocking, mast pulling, or by the shroud-spreader relationship, is the best technique because it permits the jibstay to sag without adversely affecting the mainsail shape, i.e., leaves the main sail flat (which is essential in very light air).

The next best technique is the application of yang tension which sags the jibstay but, in very light air, produces excessive main leech tension (i.e., undesirably increases mainsail fullness). The third best technique is the creation of lateral mast bend (sag to leeward) but this only works when the wind is strong enough to sag the mast and it increases mainsail fullness.

0—3 knots — Use prebend — flattens mainsail

3—6 knots — Use prebend + yang tension— changes mainsail minimally as in creased wind velocity opens leech

6-12 knots - Use lateral mast sag and discontinue "prebend" and vang tension to permit mainsail to become full.

In some boats lateral mast sag should be maximal (to attain mainsail fullness and increase jibstay sag) at 4-6 knots, in others at 6—8 knots, in others at 8-10 knots. When pointing becomes more important than power, jibstay sag and lateral mast sag should be diminished. Maximum lateral sag can be in place in lighter air, 0—3 knots (with little effect), but should be progressively reduced above 8—10 knots (in smooth water).

Moderate Air

In moderate air, because the pressure on the sail is but moderate and the jib tension (to keep the leech closed) is high, when the jibstay sags, it sags aft, making the jib fuller and shifting its draft forward. This shape is inappropriate to smooth water conditions. Once near maximum hull-speed speed has been reached, pointing becomes more important than additional speed. Pointing requires a fine entry, a flat jib luff, a relatively flat jib with its draft aft. This must be attained by restricting the jibstay sag to an amount which matches the jib luff curve. If the sag can be reduced further, the jib luff will be pulled forward and beneficially become even flatter.

A decrease in jibstay sag in moderate air is best achieved by mainsheet tension which tenses the jibstay (by pulling the mast aft) and closes the main leech (i.e., achieves the two essentials of pointing). At the same time the lower mast should be straightened; chocks, pullers, struts, and shroud/spreader relationships should be set for a straight mast, yang tension eliminated, and lateral mast sag progressively reduced. The mast should be absolutely straight, with the least backstay tension, the fullest mainsail, and the straightest jibstay at the wind velocity which, despite maximum hiking, just begins to produce heeling. Above this wind speed, increased backstay (mainsheet! yang tension) must be used to flatten the mainsail, preserve or at least not increase jibstay sag, diminish heeling, and facilitate pointing.

Heavy Air

In heavy air the aerodynamic lift generated by the sail is high therefore the jibstay sags to leeward and, with excessive sag, may be blown forward, If the head is on a long halyard pennant, the leech will be eased and, as the head shifts aft and to leeward, will twist open. With moderate jibstay sag this easing and opening of the leech compensates for the aftwards shift of the draft due to sail stretch. But with excessive jibstay sag the luff flat tens and the stay shifts forward, increasing the aftwards shift of the draft.

In heavy air, particularly in waves, with pitching, rolling, and yawing, a shift of the draft aft and a flat leading edge impair the initiation and maintenance of attached flow. A shift of the draft aft also results in a particularly deleterious gust response: The bow will be blown down, the angle of incidence will increase, and the boat will lie over and wallow instead of accelerating. Excessive jibstay sag must be decreased to shift the draft forward and permit the jib and the boat to adapt to waves and gusts.

The jibstay can be tensed, while the main is flattened, by permanent or running backstay tension (if available), pulling the mast aft. However, as the mast-bend increases, the aft tension has less and less effect upon the jibstay sag and the bending of the lower mast more and more. The mainsheet is also less effective in heavy air because, to provide adaptability and flattening of the lower mainsail, much of its load must be transferred to the yang. The lower mast (unless it is unusually stiff) cannot be prevented from bending, but its flexibility must be limited and the benefits of flattening the lower mainsail, through low mast bend, compromised. It should be stiffened to reduce the jibstay lowering and jibstay sag increasing effects of compressive bending, backstay loading, and vang tension—by whatever means are available including:

Negative prebend - chocking, pulling, or strut use, shroud/ spreader relationships which pull the spreaders aft, lower shrouds led aft and under increased tension, stiffening the lower mast or making the upper mast more flexible.

Dirty Air

In moderate air the optimal amount of sag depends upon the dirtiness of the air. In clear air/smooth water (as indicated above), when pointing is both desirable and feasible, the jibstay sag should be reduced - usually to the bare minimum, but at least to match the jib luff curve. However, in mode rate but dirty air — disturbed by other boats, innately erratic, or affected by waves - jibstay sag must be increased proportionate to the degree of disturbance (relative to its clear air/smooth water optimum).

In moderate air increased jibstay sag increases the fullness of the jib and shifts the draft forward. These modifications are useful in initiating attached flow (difficult in dirty air) and in increasing power and speed (more important than pointing when speed is reduced and leeway is in creased). In addition, moderate jibstay sag provides flexibility, permits the jib to adjust better to marked variations in the angle of incidence, the positions of its leech and luff, and its shape. In waves an excessively tight or an excessively loose jibstay, will jerk, changing the jib shape dramatically, and destroy the attached flow. In disturbed air an excessively tight jibstay with its rigidly positioned air foil is unable to accommodate marked variations in the angle of incidence and therefore stalls readily.

A flexible jibstay and jib responds appropriately to variations in wind velocity and direction. The leech shifts off the center line and decreases the angle of incidence whenever the wind velocity

or the angle of incidence increases and shifts towards the centerline and increases the angle of incidence whenever the wind velocity or the angle of incidence decreases. Transient increases in aerodynamic force are produced by the “pump effect’ as the leech closes. Attached flow is maintained for a greater proportion of the total time; stalling is far less frequent.