Talkin'bout the downhaul

This is the second in a series on Paper Tiger control systems for newcomers to the class, or for those who are isolated from the main fleets. The aim is to describe the variations in PT rigs and the possible advantages and disadvantages of the different systems used. It is intended as a guide only. This time we'll examine the downhaul.

What does it do?

The downhaul can be used to affect the performance of the sail in a number of ways, depending on the sail cloth used and the way the panels have been cut and assembled. For example, woven cloth panels in crosscut sails can distort diagonally under load, which can be a mixed blessing, depending on the skipper you talk to. Radial cut sails, or sails made from solid sheet, are less likely to distort, or will develop nasty creases if they do.

Generally, with crosscut sails, applying pressure to the downhaul may:-

- Make the luff of the sail tighter than the leach, resulting in the leach falling away to leeward.
- Move the point of maximum draught (depth of curvature of the sail) closer to the mast.
- Apply tension to the rear edge of the mast (via the sail boltrope) causing the mast to bend forward in the middle.

Radial-cut (and solid sheet) sails are intended to hold their designed shape under load. Therefore, the effects of similar downhaul pressure on a radial sail will be different to that on a crosscut. Depending on the layout of the radial panels, the sail's draught may move only slightly (if at all) under downhaul pressure, and although mast bending and leach lay-off will still occur, they may not do so to the same degree as with a crosscut sail.

So what does all this achieve?:-

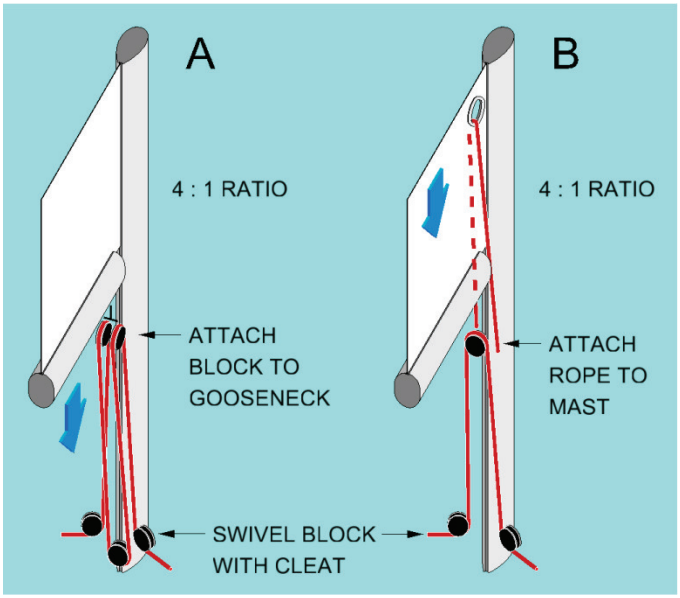
- Leach layoff (sail twist) is an effective depowering tool and may also help to maintain power in rough water when apparent wind direction is constantly changing up the height of the sail as the boat pitches in the waves.
- Wind pressure can move the draught aft in some sails, so being able to bring it forward again to its designed position can be beneficial.
- Bending the mast flattens out the sail draught, which depowers the sail and reduces drag in strong winds.
- Tensioning the downhaul on a run may help to hold the mast reversed and will bend the mast , thus increasing the sail area presented to the wind without having to use the vang.

It is worth a chat with the maker of your sail to understand how he designed it to respond to the downhaul, as using the system at the wrong time or in the wrong way could slow you down.

The configuration

The class rules state that: **"Downhaul control fittings shall be mounted on the mast and/or the spanner"**. This limits the variation in the systems that will be seen on PTs. Generally the systems used tend to fall into two categories:-

- Those that pull directly on the boom (system A).
- Those that pull directly on the sail (system B).



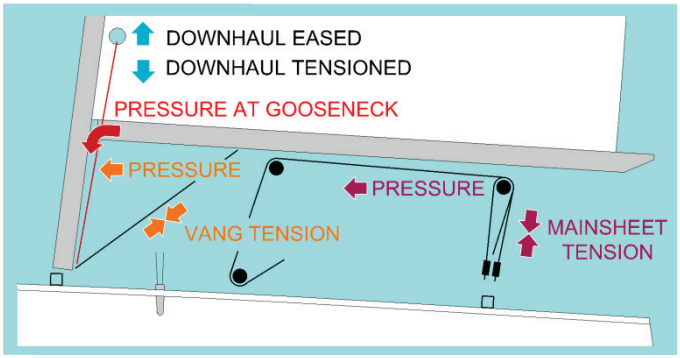
Basic system types - boom attachment and sail attachment

There are variations that combine elements of both, but I'll stick with the more basic setups here.

Boom-attached systems usually have the upper downhaul blocks attached to the gooseneck. The lower blocks and the cleats are attached to the base of the mast.

Sail-attached systems usually pass a rope, which is attached to the mast below the gooseneck, through an eyelet in the sail above the boom (called a cunningham eye) and attach the upper downhaul blocks to the end of this. The lower blocks and the cleats are mounted the same as for the boom attached systems.

When the sail is sheeted on hard upwind, or the vang is pulled on tight off the wind, the forward pressure on the gooseneck can prevent it from sliding freely.



Because the sail-attached system doesn't have to move the gooseneck in order to tension the luff, it may be possible to lock the gooseneck in place, or at least limit its range of movement, with a pin through the sail track for example. This will depend on the stretchiness of the sail luff and how high above the boom the Cunningham Eye is located. If the sail stretches more than the distance between the eye and the boom, the two will hit before the sail luff is fully tensioned. Radial cut sails have less stretch than crosscut sails, so are more likely to suit a fixed gooseneck. When this system is correctly set up, the luff can be easily tensioned and eased, even when the gooseneck is under full mainsheet or vang pressure.

Cut away luff

A common variation of the system (as shown opposite) has the sail luff cut away above the boom and a block attached to the cunningham eye to reduce friction losses and wear on the rope. The sail tack may be attached to the gooseneck or a fitting on the top of the boom, depending on the shape of the cutout.

Advantage of attachment to the boom:-

- Simplicity and little chance of the upper and lower downhaul blocks meeting when the system is fully tensioned.

Disadvantage of attachment to the boom:-

- Pressure at the gooseneck may prevent the boom rising to ease the luff tension when the system is released.

Advantages of attachment to the sail:-

- The gooseneck may not need to move when tensioning or easing the luff, therefore the system adjusts readily under all conditions.
- It is easier to install more powerful systems.

Disadvantages of attachment to the sail:-

- The cunningham eye may pull down onto the boom before the luff is fully tensioned.
- If a long length of travel is required in the downhaul block system because of a stretchy luff, the upper block may have to be located above the gooseneck to allow for this to occur. It may then snag on the boom or gooseneck when the system is tensioned.
- Some sail area will be lost along the foot of the sail as it bunches up on the boom when the system is tensioned.

The gooseneck

Unfortunately there are currently no sliding goosenecks on the market that are suitable for PT operation without some modification. This is due to the light section, rotating masts that we use. Goosenecks that hang off the rear edge of the sail track can rip out when the mast is rotated upwind in strong conditions, damaging the mast in the process.

The goosenecks that are available can be modified to transfer the load to the rear web of the sail track by adding a reinforced resin slug, as in these examples from the PT Shop.

Goosenecks to suit either boom or sail attachment of downhaul (PT Shop)

Another method is to weld a stainless steel plate to the gooseneck, then attach a Teflon or nylon pad to this instead of the slug.

It is important that the gooseneck is able to slide easily, especially if the downhaul system is attached to the boom.

Welded plate and Nylon slide

When using system B, if the sail allows the downhaul to be fully tensioned without the gooseneck having to move from its "untensioned" position, a fixed gooseneck can be used. There are suitable versions of fixed goosenecks readily available. A sliding gooseneck can be stopped from moving down the mast by inserting a clevis pin through the mast sail track below it.

The image opposite shows a custom made, low friction gooseneck, which allows limited gooseneck movement.

When using a fixed gooseneck, the forward end of the foot of the sail will bunch up against the boom when the system is tensioned. To allow this, the bolt rope has to be cut away up as far as the cunningham eye.

The ratio

The selection of the number of purchases (runs of rope between the boom or sail and the base of the mast) to operate the system may be influenced by the following factors:-

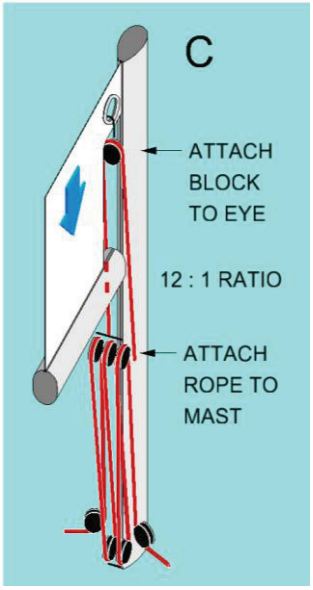
- How easily you want the system to operate.
- How often it is to be used. e.g. a lighter skipper may make more use of the system upwind to depower the sail than a heavier skipper will.
- Ball bearing blocks have less friction than standard blocks and therefore will require less effort to operate under load.
- The more purchase in the system, the easier it is to release from a cleat when under load whilst hiking.
- A crosscut sail may require less effort to apply the desired tension than a radial-cut sail will.

The minimum purchase used should be at least 4 to 1 (see systems A & B on first page). However, it will require a lot of effort to pull this system on tight, especially if a block isn't used at the cunningham eye in system B, and neither system is recommended.

System A can be modified to provide a 6 to 1 system by substituting a triple block at the top and double block at the bottom instead of those shown. This will provide more power but is still not ideal. A system with more than a 6 to 1 purchase, which is attached to the gooseneck, requires more blocks and may be harder to ease off due to friction in the system, especially if standard blocks are used.

System B is very simple to make but will be hard to operate for the reasons mentioned above. Attaching the block system shown in system A to the end of the rope through the cunningham eye (instead of the single block shown) will double the power to 8 to 1. Attaching the 6 to 1 system described above for system A, to the rope, will triple the power of the system to 12 to 1.

Combining the 12 to 1 system with a cut-away sail luff, and cunnigham eye block (system C) creates a system which is powerful and easy to operate under any conditions, and is used by many of the top skippers.



Optimal system

Advantages of low purchase system:-

- Less rope to pull or release to make a required adjustment.
- Less loose rope on the deck when the system is fully tensioned.
- Less likelihood of running out of rope if the system isn't tailless.
- Less blocks required, therefore less friction in the system.
- Less weight.
- Cheaper to make.

Disadvantages of low purchase system :-

- Greater effort required to tension the system.
- Harder to release the system when under load.

Advantages of high purchase system:-

- Easy to apply maximum luff tension.
- Easy to release cleat from maximum tension.

Disadvantages of high purchase system :-

- More rope has to be played to make adjustments.
- More loose rope on the deck when the system is tensioned (unless rope tail retrieval system fitted).
- Heavier.
- More expensive to make.

The rope

The rope used on PT downhaul systems generally ranges from 3mm to 6mm. 6mm will usually be seen on older boats that are using larger sized blocks and/or low purchase systems, or if the skipper has hand issues. Since the advent of small diameter, ball bearing blocks, 4mm or 5mm rope is more common. 3mm rope may be used on high purchase systems to save weight and reduce friction, but it is harder on the fingers.

A pre-stretched braided polyester rope is adequate for the downhaul system as the loadings don't require super strength or anti-stretch characteristics and they run more freely than equivalent thickness high strength "Spectra" type ropes.

If running a rope through a cunningham eye, 5 to 6mm diameter is advisable. 'Spectra' doesn't like friction, so is not a good choice for this job unless you are prepared to replace it regularly.

The blocks

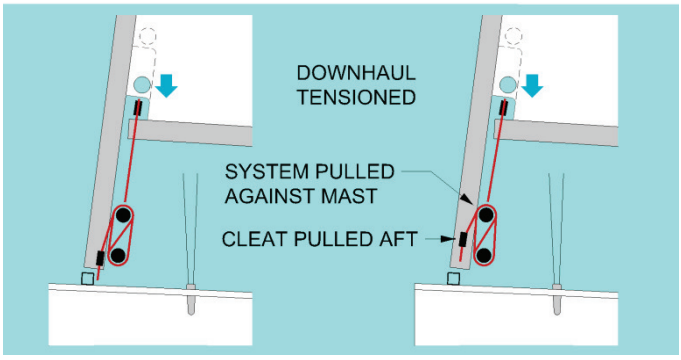
As mentioned previously, older boats may be seen with downhauls using 25+mm diameter blocks. On newer boats, 20mm diameter (or less) blocks are more common as they are lighter, create less wind resistance and are more than capable of handling the loads involved. The ball bearing types operate more freely, reducing friction in the system, but are more expensive than basic blocks.

The cleats

As the system has to be cleated on the mast, and the mast rotates, a combined swivelling block and cleat has

to be used to enable the system to be operated from any position on the boat. Most boats use two cleats, one either side of the mast to avoid conflict with the vang/mast rotation system.

The position of the cleats varies on different PTs, but they can be mounted as far to the rear of the mast as you like with little chance of accidentally rotating the mast to windward when the system is tensioned. The lower and further aft the cleats are positioned on the mast, the better the operating angle for the rope will be through the system's blocks. If they are located high and forward on the mast they tend to be swung aft by pressure from the rope, and the upper block can be pulled against the mast.



Cleats low and aft **Cleats high and forward**

As the downhaul cleats are just one of the systems that may be operating at the mast base (the vang, rotation control and lower forestay being others), arranging the components of your systems so that there is no conflict at any angle of operation is important .

Block attachment

A boom-attached downhaul usually has the upper block attached to a shackle on the gooseneck (if it has one) or a saddle attached to the end of the boom.

The lower block can be attached to the custom made plate that comes with some mast bases, or to a fixture attached near the base of the mast. A block hanger can be used for this, but it must be strong enough to take the considerable load that can be applied to it.

The lower block should be held away from the mast to stop friction from the rope rubbing against it.

Rope tails

It is permissible (and desirable) to be able to adjust the downhaul whilst hiking upwind, or when sitting aft on a reach. If a single cleat is used, or the rope tails are short, it will not be possible to do this. To create a system that can be readily adjusted, two cleats are used on the mast, and the tail ends of the downhaul rope are extended to a place near both gunwales where they can be easily reached. This is usually the rear chainplates. Some skippers tie the ends of the rope to the shrouds or chainplates; others attach rings to the shrouds and lead the ropes through them, joining the ends together in the centre of the boat. If joined together, a rope can be cleated from the opposite side of the boat if necessary. If tied to the shrouds, there needs to be enough slack in the rope to allow the system to be eased from the opposite side of the boat to that from which it was tensioned.

Combination of tails tied to chainplates and an endless system

More complex systems lead the rope through eyelets near the inner gunwales to elastic take-up gear below the trampoline, which removes loose rope from the deck. These system can be made endless, meaning they never run out of adjustment. However, the additional components add weight and cost and may make it a more complex exercise to dismantle the boat -- if travelling to the Internationals in N. Z. for example.

Example of endless systems for the downhaul (white), outhaul (black), vang (red to rear) and lower forestay(red forward) below the trampoline, with elastic take-up in the centrebeam.

Next time we'll talk about **the outhaul and leechline**.

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