The SHOCK of the OLD

Part 23: Taking Advantage

Having rocked around the block in 165, Moray MacPhail tackles tackles.

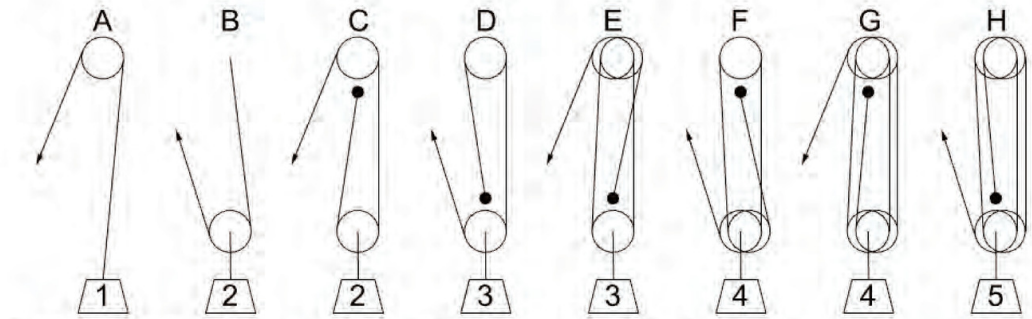
The Arrangements of Blocks

If the load on any part of the rig is too much to handle, we use a tackle – which apparently should be pronounced 'tay-cul' though it always sounds rather affected to me. With every block in a tackle, you gain either convenience or advantage depending on how the tackle is arranged, or 'rove'. In short, if the final part of the tackle – the hauling part – leads to you from the thing you want to move, then the tackle is 'rove to advantage' If not, then it is 'rove to disadvantage', which refers to the power which is added, not necessarily the convenience.

On a two-block tackle, the purchase is given by the number of parts of rope entering and exiting the block attached to the thing which is being moved. Unfortunately with every sheave the rope runs over in a tackle, there is an increase in friction and that reduces the actual power you can gain from any given tackle.

Before we get to frictional losses, please have a look at Figure 1 across the page which shows the most common arrangements of two-block tackles we might consider, their power ratio and their names – probably more often used in boating trivia quizzes than real life.

Figure 1 - Tackles Using 2 Blocks



The number in the load is the theoretical advantage or power ratio.

A. Single Whip
B. Runner
C. Single Purchase
D. Gun Tackle
E. Luff Tackle
F. Reversed Luff Tackle
G. Double Purchase
H. Double Tackle

Frictional Losses

I was once told by a very experienced Thames barge skipper that if you are using a block with three sheaves or more, you are probably wasting your effort – and money. So I thought I'd try to get a handle on the frictional losses you can expect.

To start with I rigged a double tackle – H in Figure 1 above – to give me a theoretical 5:1 purchase using 4 sheaves. The scheme is a double with becket at the lower end with a double block above. I used new wooden blocks of various sizes with acetal sheaves and new braid-on-braid polyester-based rope, again in a variety of diameters.

Then loading a pan with weights totalling 97lbs (44 kg), I measured the actual pull required to keep the load moving slowly and compared that with the theoretical pull. With a few sums I calculated the result as a percentage increase in load per sheave in the system and plotted that against the ratio of the diameter of the sheave to the diameter of the rope. The results are shown below. You may recall the rule of thumb for sheave-to-rope diameter is around 6:1, so from the results in Figure 2 each sheave represents about 10% extra load – in other words with 4 sheaves in the system you have to put in an extra 40% of effort compared with the theoretical amount.

You can reduce that a good deal by using a larger diameter ratio either by using a smaller rope or larger sheaves. Don't blame me if those new smaller cheaper blocks are harder to use.

Figure 2 - Double Tackle

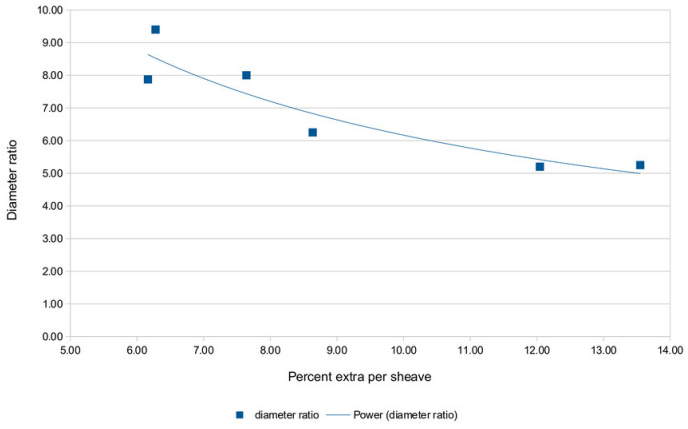


Figure 3 - Gun Tackle

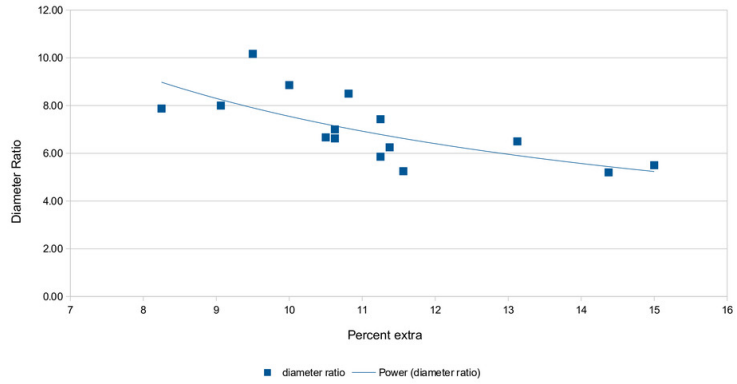


Figure 4 - Dyneema rope in thimbles - Gun Tackle

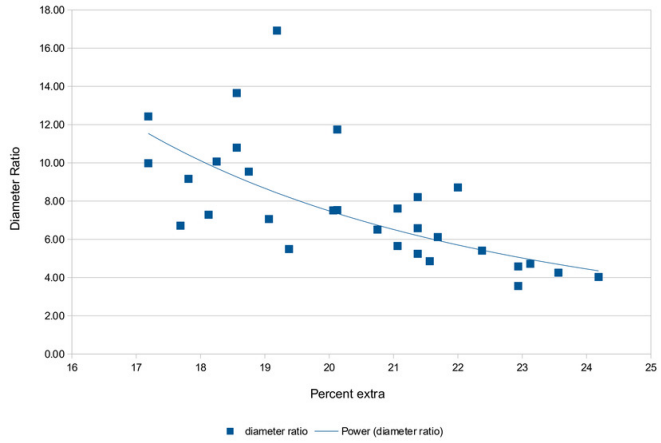
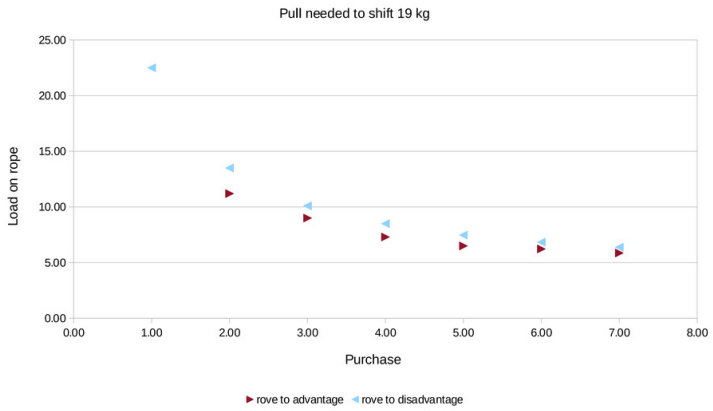


Figure 5 - Diminishing Returns



Now what happens with a different tackle. This time I have used a gun tackle – arrangement D in Figure 1 – so a single with becket below, a single above, rove to advantage with a theoretical 3:1 power ratio and got the results shown left in Figure 3. Again you can see a similar trend with similar values – at 6:1 you are getting something like 10-12% extra per sheave. And again using new blocks, acetal sheaves and braided rope.

So what about those new aluminium low friction thimbles from Holt Marine which I mentioned in W165? Well, see Figure 4 – again a gun tackle, so 2 rings rove to advantage using HMPE braided rope, and in theory a 3:1 power ratio. In this case with the rope running through the ring, the diameter ratio is the width of the ring to the diameter of the rope Instead of the 10-12% friction we saw with conventional blocks, here we have something like 17-19 % at reasonable diameter ratios.

Oh well, that's that then. But just a moment, though. These items won't bind or seize or – within reason – wear out so this initially less attractive performance will last the life of the equipment while the conventional blocks will inevitably deteriorate. Besides the rings will be much more tolerant to misalignment of the rope compared with a conventional block. Combine that with the cost and weight advantages and you can see there might be applications. In particular for semi-standing rigging like outhauls and halyards, this style of rigging could be more reliable.

Now what about that old skipper's assertion that treble blocks are generally a mistake? The following table is taken from a couple of runs right through the permutations in Figure 1 and then on to include treble and in the last case in Figure 5, a quadruple block – well two doubles, actually.

As you read the graph from left to right, you can see the pull on the rope needed to shift in this case just shy of 20lbs (9kg). As the purchase increases so the pull reduces from 25lbs (11.2kg) to 16lbs (7.3kg) and so on along the

Figure 6. Two ways to achieve an 8:1 power ratio

'rove to advantage' line. The 'rove to disadvantage' results always have that extra sheave in the works, so will always require a bit more pull.

In both cases, it is clear that beyond a purchase of 5:1 there is not much more to be had, as any gains are offset by the extra friction. Remember that these were plain acetal sheaves running on stainless axles, with braid-on-braid polyester rope, representative of normal running rigging.

So-called muscle boxes, using thin line and large diameter roller bearing sheaves can get up to 8:1 over a short distance, typically as a hardener for halyards – though I have never measured the losses to see if 8:1 is an optimal level of purchase. Besides that, as the purchase increases so does the amount of rope you need to handle – and buy! Again let me reiterate that these are new blocks and new rope. It gets worse as the rope and the blocks – and the person doing the pulling? – get older.

If you do need a high power ratio, then it might be worth considering a cascade as per Figure 6. You can see that it is a succession of runner tackles each giving a theoretical 2:1 advantage, so 3 of them gives 8:1. I haven't actually done this experiment, but if you reckon that the sheaves in the muscle box are optimal, then a loss of say 7% in each of the 8 sheaves will end up around at 56% losses to friction. The rings lose as found above some 18% each but there are only three of them.

So at a first look both systems would seem to be comparable in terms of performance. There may be other constraints such as layout which influence the choice but both options are credible. It's that old fashioned approach using new materials again.

Before leaving this section, a quick word on double versus fiddle blocks. If you have the space, fiddle blocks can be a better bet since all the parts of the tackle are in line and they tend not to twist. The second sheave of a fiddle block is necessarily smaller in diameter to allow the other part to pass, and so relatively inefficient. And fiddle blocks take up a good deal of room along the line. If you need to use double blocks, you will find life much easier if you arrange your two-block purchase so that the two blocks lie at 90˚ to each other. This ensures that as the blocks approach each other, the parts of the purchase are kept apart and you don't get a massive increase in friction over the last few feet.

So to sum up, some ideas to improve your running rigging include:

- The bigger the block or sheave which will fit into the rig – for a given size of rope – the better.
- The smaller the line that you can handle – including cleating – the better so long as it is strong enough. In terms of weight, cost, windage and ease of handling, ropes of a larger diameter than necessary are a bad deal.
- Sheaves with roller bearings can make a difference for rigging which needs to be adjusted while under load such as peak halyards or which you need to run freely even under light load, like mainsheets.
- For hardeners, outhauls, reefing gear or running backstays which don't have to be continuously adjusted, consider the possibilities of high modulus ropes combined with low friction rings.

I think we have enough tools in the box to look at some examples of rigs. So next time I'm going to start with the simplicity of lugsails and their arrangements.

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