NATIONAL SCHOOL
SAILING ASSOCIATION

TENSION ON A TOWROPE

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TENSION ON A TOWROPE

A project to discover the relationship between the forces applied to boats and the resulting speeds and accelerations.

Careful construction, accurate timing devised and a great deal of patience are needed if the motions of model craft are to be investigated in a testing tank. Some basic principles can, however, be discovered by much simpler methods if the work is done "fullscale". Experiments of the kind suggested here' are well worth carrying out for their own sake as applications of elementary physics and mathematics; they have the further advantage that they may improve performance afloat under sail.

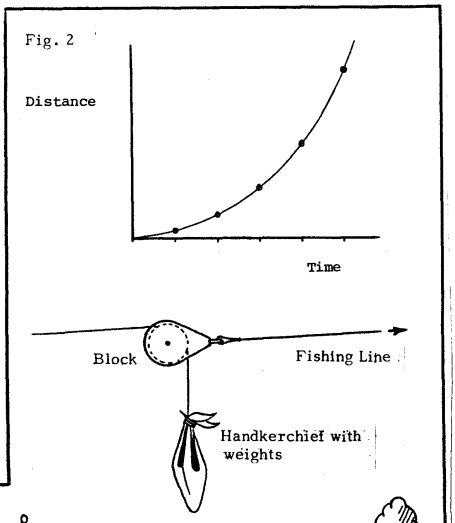
It sometimes happens that, on arrival at a sailing base, there is not a breath of wind: here is the opportunity to experiment. The equipment needed is simple enough: a good length of fishing-line, a few weights, a wrist or stop watch, a tape measure and a single block from a boat's rigging.

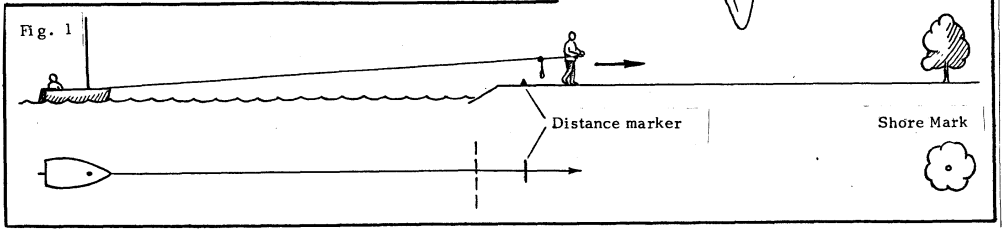
Choose an area where there is no current, where the shore is clear of obstacles and has a good level run-back at right angles to the shore line. Tie one end of the fishing line to the bow. of a boat, reeve the other end through a block and tie a handkerchief on the end-e§ a pocket to hold the weights. (You will need kilos and fractions of a kilo.) The boat is then paddled out to the limit of the fishing line (the longer this is the better) . Three people are needed ashore: one to time operations, one to put down pegs or rocks as markers, and one to act as "tug". Choose a mark inshore to which the boat will be steered and towards which the line will be pulled. Line the boat up and make sure she is without way and that the fishing line is floating straight on the water without tension; if necessary, put some corks on the

line like split-shot. Lift the block off the ground and walk inshore until the weight is suspended. As soon as the weight is off the ground put a marker down under it and note the time. By walking inshore towards the chosen mark put just sufficient tension on the block to keep the weight clear of the ground as the boat moves inshore. After say 20 seconds , put down another marker and continue thus at regular intervals of time until the boat comes ashore (see Fig. 1) . The results could be tabulated thus:

Boat:	Enterprise
Crew:	1 up weighing 50 kilos
Load on tow line:	250 grammes
Time:	11.30.10 11.30.30 11.30.50 etc., etc.
Distance run:	0 m. 4.10m. 9.35 m. etc.

These results could then be graphed to give an acceleration curve for this particular towing force (see Fig. 2). A series of such experiments with different weights on the end of the towing line ranging from perhaps 100 g. to say 5 kilos will have much of value to teach, especially if the fishing line is long enough for steady maximum speed to be reached in each case.





The next step would be to investigate the effect of ballast . By putting first one and then two people aboard in addition to the helmsman, the different effects of the same pulling forces as before can be observed, recorded and graphed . A third simple variable could be to study the effect of lowering and raising the drop keel to different extents.

Well worth studying is another simple variation. By getting the crew to sit on one side, the boat can be heeled over. (A plumb-line and the tape will measure the angle easily enough.) The helmsman will have to give careful attention to his steering in this case, but measuring the loss of speed under a given force compared with an upright boat may well bring home the folly of trying to sail a boat fast "on her ear".

Further experiments could obviously include various types of boats, towing at an angle to the bow, the effect of waxing or greasing a boat's bottom and increasing the towing force to find the maximum speed attainable without planing. For this last, of course, some fairly stout codline will be needed and plenty of room to work . The results , however , are well worth the trouble taken as, if a number of different craft are studied, the relationship between waterline length, wetted surface and maximum speeds can be established by able children and even, perhaps, some investigation of Froude's law.

The major practical lessons to be learned are, however, that though very tiny forces will move a boat slowly, much greater ones are needed to increase speeds appreciably, and_quite small resistances can reduce them considerably. All good helmsmen learn how to get the maximum pull out of their sails; few learn to reduce resistance to the absolute minimum and these latter are the regular winners.

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