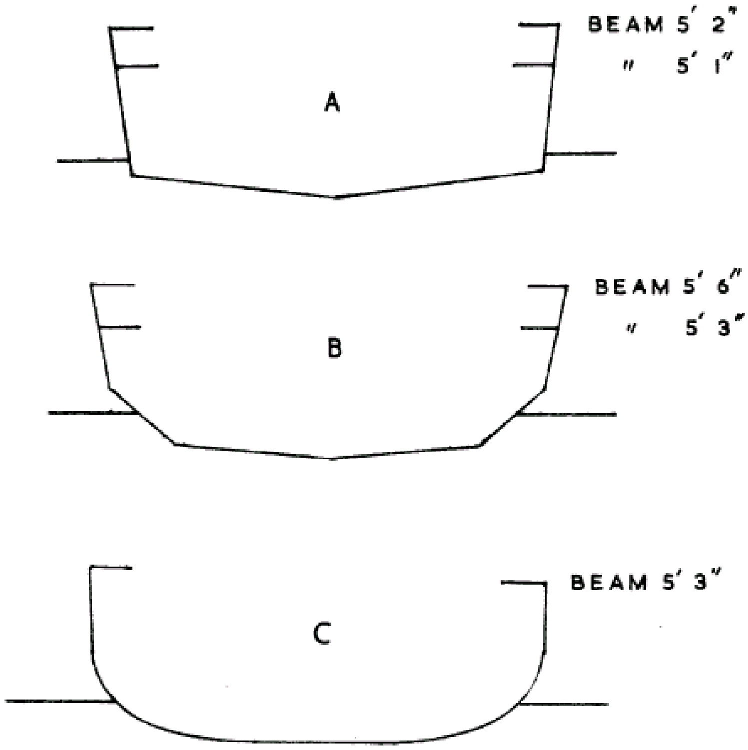
A Self-Righting Uncapsizable Cruising Dinghy – Part II

by **Eric Coleman**

Hull Form



Three types of hull section are chosen for purposes of comparison, which I hope will be representative regarding their relative characteristics. It is assumed that 6" side decks are provided and that boats are laden with a full range of cruising gear. Hull C is that of the traditional clinker built dinghy.

FIGURE 1

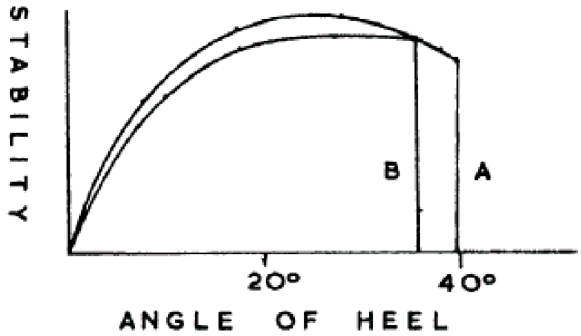
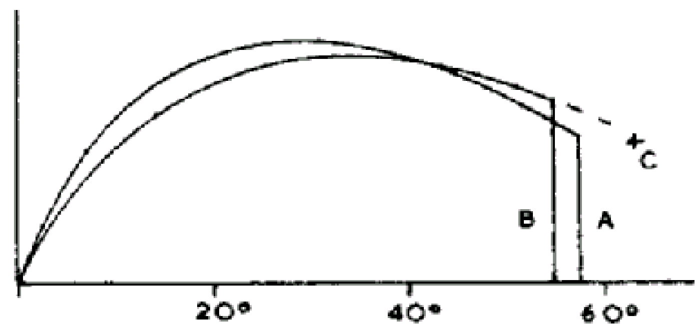


Figure 1 shows the stability curves of hulls A & B with the low freeboard which is representative of many modern dinghies. A stability curve is the stability plotted against the angle of heel. Stability is obtained by multiplying the weight of the boat by the horizontal distance between the centre of gravity and the centre of buoyancy. The curves are approximate in shape to save work and based on the assumption that displacement at the centre section does not change appreciably. The sharp termination to these curves is due to the boat filling. Hull B appears to be inferior to Hull A at virtually all angles of heel. This is the reverse of the generally accepted belief that a single chine hull is more dangerous than double chine because, although the single chine hull is initially more stable, there is a sharp fall off at large angles of heel which can take a crew unawares resulting in a capsize. This reasoning is fair enough in the case of a lightly built boat sailed with minimum gear as in racing but in the case of a fully loaded cruising dinghy which floats lower, Hull B at 40 deg. with its chine panel now horizontal has a less buoyant immersed section and this, combined with the greater deck beam, results in the side deck dipping under before the superior stability characteristic has a chance of showing itself. Increased topside flare will worsen the effect.

<u>FIGURE 2</u>



If the freeboard is now increased 6" as shown, the stability curves are greatly extended as in Figure 2. The C.G. will be raised slightly but this has been allowed for. Hull B now has greater stability at angles of heel beyond 42 deg. but Hull A can still heel farther without filling. If the side decks of Hull B are now increased to 8" to give the same room in the boat as Hull A then the stability curve is extended as shown by the dashed line. It is interesting to note that Hull C with 6" side decks will fill at the point 'C'. Stability at large angles of heel is the best way of dealing with squalls because, at these angles, much of the wind is being spilt off the top of the sails which robs the squall of much of its strength.

So far I have not considered the effect of crew weight on the lateral position of the centre of gravity which will, of course, be moved towards them. Hull B, having the largest beam, will benefit most, particularly if they sit on the side deck which one can reasonably expect them to do in normal sailing conditions with a strong breeze.

People who prefer to sit 'in' a boat may object to such 'gymnastics' but I am not talking of sitting 'out' - i.e. horizontal. In a strong breeze, there will be less angle of heel when sitting on the side deck with bottom slightly outboard and one can sit upright and relaxed with feet under toe straps for security. Sitting in a boat requires muscular effort to maintain one's position and, if the seats are set low, one is forced into an uncomfortable bent forward attitude. A boat of generous beam and narrow side decks can, of course, incorporate side benches so that one has a choice of seating position. Consideration of crew weight may lead one to increase the flare of the topsides because the disadvantage of so doing as pointed out earlier may be more than outweighed by the increased leverage of the crew to windward. On the other hand this means that, with the boat at a critical angle, the crew must be in the correct position and for purposes of this design I prefer to assume that the crew is too inexperienced to deal correctly with an emergency.

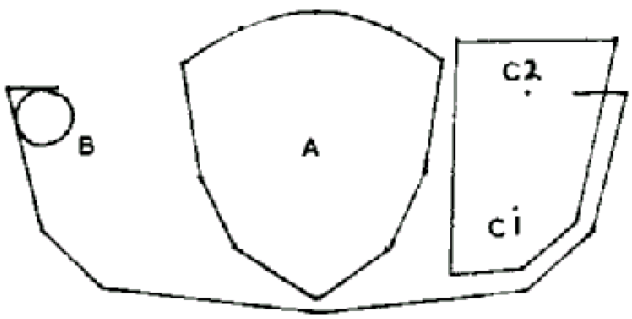
Another advantage of Hull B is that it has the narrowest waterline beam when upright. Water displaced sideways from a boat travels away in the form of bow waves which represent lost energy. The greater the W.L. beam therefore, the greater the resistance. In a light wind Hull B can be sailed upright to give the best light weather performance.

Finally there is the question of survival when struck by beam seas. For seas which do not come aboard green, Hull B is of excellent shape for riding over them. For large seas which are curling over just as they strike the boat, information is somewhat scanty; I wonder why. The boat will, of course, be flung to leeward and Hull A is likely to capsize because the lee chine will dig in and help to trip the boat up. With the boat at a large angle of heel, say 55 deg., the force of the wave on the Hull will depend, amongst other things, on the amount of angular deflection.

With Hull C the deflection will be relatively small and the water will be spilt off the topsides in the same way that a squall is spilt off the sails when a boat heels to a large angle. In the case of Hull B the wave will be deflected upwards through a greater angle and the resultant force on the hull will be greater. What happens after the water gets up there is anyone’s guess but my own limited experience with Hull C is that the water is likely to clear the lee gun’l so that very little comes aboard. This is another argument for not having excessive flare on Hull B although, of course, such waves are rare.

Bearing in mind all the above factors in addition to ease of construction I have chosen a similar hull section to B for the Roamer.

Buoyancy for Self-Righting



If self-righting from 180 deg. of heel is required then buoyancy of shape similar to 'A’ is required. This comes into action after the boat floods, so narrow or no side decks are required to keep this angle of heel reasonably small. When upright and flooded, the boat may be low in the water and rather tender so that bailing out may be difficult. The old self-righting R.N.L.I. lifeboats used this principle and water ballast was used to keep the C.G. low. The rowing boat “English Rose” was designed in exactly the same way. This buoyancy is placed at the ends of the boat which involves some difficulty with a 14' sailing dinghy. For instance, with a cockpit about 7' long, where can one stow the 8' 6" oars? One could, of course, use short or no oars and make up with an outboard but I am trying to design a boat that will not irritate people who like peace and quiet.

If the boat is designed to be self righting from about 120 deg. then the buoyancy and stability when flooded can be increased.

FIG.1

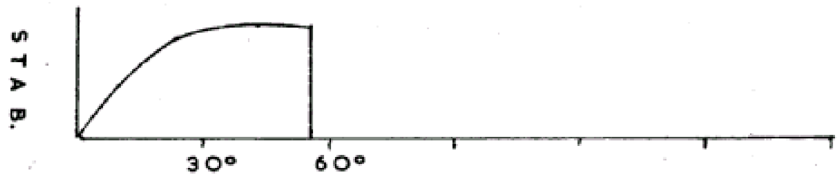


FIG.2

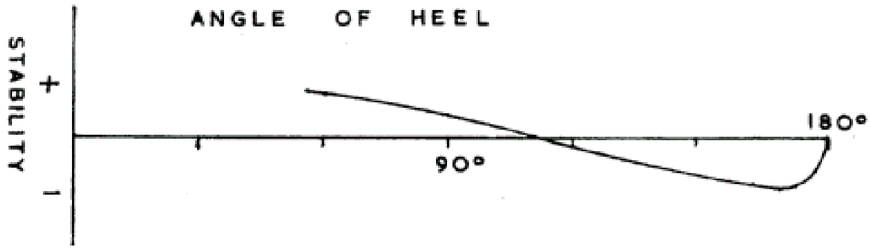
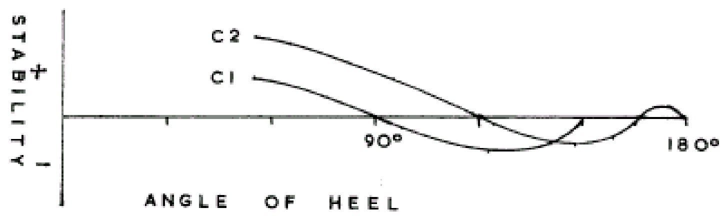


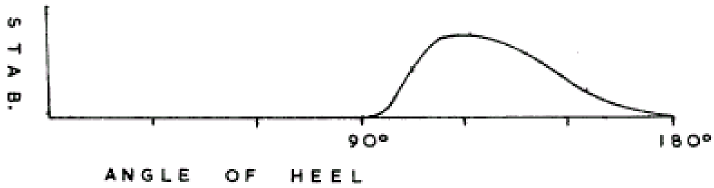
Figure 1 shows the stability curve of the hull itself. Figure 2 is the curve for 6" buoyancy bags 'B' under the side decks. It assumes that the bags are just awash when the boat is inverted i.e. side decks 6" below the surface. Beyond 110 deg. the stability is negative (holding the boat inverted) reaching a maximum around 170 deg. so the size of these bags should be the minimum required to give stability when the boat is upright and flooded. Their small diameter allows the side of the boat to be pulled down for climbing aboard but they help to stop the boat from being pulled over. Buoyancy low down at the ends of the boat is required to give reasonable freeboard, say 10", but there is no attempt to provide a double bottom because it is essential to have a lot of water in the boat to prevent it from blowing away from the crew should they lose contact.

FIG.3

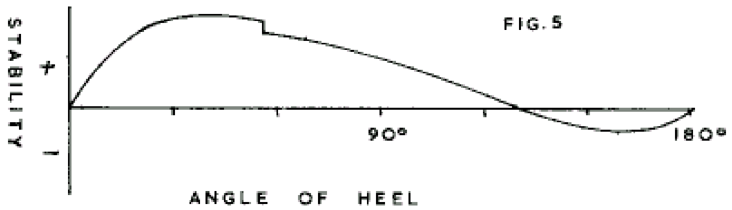


The effect of buoyancy 'C' can be roughly estimated by taking two points 'C1' and 'C2' and plotting their curves as in figure 3. The curve for 'C1' stops at 150 deg. because, at larger angles, it comes out of the water. Curve 'C2' shows positive stability beyond 165 deg. because both points are submerged at this angle and the resultant buoyancy is at a point midway between them giving a righting moment. If these curves are combined, there will be a lack of stability at 120 deg. so the mast is made buoyant and the curve is shown is figure 4.

FIG. 4



The mast has a section 2 3/4” x 2 1/4" and is I7’ 6” long. If fully submerged and horizontal, it would have a buoyancy of 40 lbs. at about 10’ above the C.G. of the boat, giving 400’lb righting moment, equivalent to the righting effect of a crew member sitting out. If the mast curve is now added in, the overall curve for the boat plus buoyancy is as figure 5.



The negative stability beyond 120 deg. could be eliminated with a masthead float but this would complicate the design and seems hardly necessary bearing in mind that the chances of a capsize are small anyway.

At this point I think I should emphasize that my stability curves are estimates. To calculate them would be more work than I am prepared to do. Estimates are not necessarily inaccurate. When the lines of the Roamer were drawn, I ruled a waterline which I judged would give 800 lbs. displacement. On analysis, it was found to give 803 lbs. When the stern buoyancy structures limited the swing of the tiller, I decided that 35 deg. would be sufficient. Later I found that the efficiency of a rudder falls off above 35 deg. and it is big ship practice to limit the rudder travel to this angle. I have calculated the centre of buoyancy at 90 deg. of heel and this, combined with an estimated position for the C.G. at 5” above the W.L. indicated self-righting action. The C.G. is as low as I can get it without excessive ballast and the buoyancy is as high as possible without, I hope, the boat looking too freakish.

Roamer lies before me now (January 1972) immaculate in her new paint, with only the rigging and awning to finish. The next article will be a description of the boat.

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