

Raft Buoyancy and Working Capacity

I suppose now is the time to confess up that I did Naval Architecture as a supplementary subject during my ONC/HNC back in the sixties...however, apart from checking out the design criteria of the steel boat that I am building, I haven't used this knowledge for thirty years or more, so please feel free to challenge, correct or ignore my jottings.

My understanding is that the raft is 'supported' by thirty six barrels, each measuring 0.6m diameter and 0.9mtres long, and firmly secured in cradles beneath the main deck of the raft. They are retained by tensioned webbing straps. This translates into 254.4litres/barrel or a total of 9,160kgs of positive lift - when the barrels are totally submerged. In practice, the raft floats with 0.2m of their diameter submerged. At this level, each barrel displaces 74.3 litres (by volume) - which suggests that the raft has a weight approaching 2,670 kgs. Theoretically, there will be 6,490kgs of reserve buoyancy, but this should be reduced by one third to compensate for possible distortion in barrel shape due to changes in operating conditions and temperature. The centre of buoyancy (CoB) rests at the mid-level of the submerged part of the barrels and at the mid-position along their length (i.e. between barrels 3 and 4). It has a working lift of 4,526kgs. The centre of gravity (CoG) of the raft rests approximately at deck level, having regard to the high elevation of the winch/tabernacle and the heavy-duty guard rails. Longitudinally, the CoG rests slightly aft of the CoB due to the weight of the engine, winch and mounts etc. It would be further aft but for the offset introduced by the bow overhang. It should be remembered that the barrels are cylindrical and that the amount of buoyancy that they generate will increase towards the 50% immersion level then decrease thereafter, for each additional centimetre of immersion.

It is very difficult to be precise about the actual figures involved when lifting a load. Suffice to say that, if the deck can be retained in a horizontal plane then the full reserve buoyancy can be utilised. In the past, barrels of water have been used for this purpose, but this assumes that the scantlings are rigid and no flexing of the structure occurs. Using the figures generated above, the raft will have slight nose up attitude as shown in Fig (a). As the load on the bow increases, the aft end of raft tends to lift, reducing the available buoyancy margin and causing the CoB and the combined CoG to migrate towards the bow. I have tried to give some indication of how the stability of the raft is maintained and also exceeded !!

In Fig (b), I have assumed a load about 1tonne. The centre of buoyancy (CoB) is still good at this point having migrated only a few centimetres towards the bow. The combined load of the raft and mooring block has, however, moved considerably further forward. We are still within the positive margin of the stability curve at this point. As the mooring load is increased (2 tonnes), there is a significant shift in the CoB towards the bow and its level also rises as the bow barrels become totally immersed. The combined weight of the raft and load moves the resultant CoG'' forward of the CoB and a potential capsized situation exists - Fig (c). Although we have some reserve buoyancy, the dynamics operating on the raft could precipitate a capsized situation.

In Fig (d), the situation is getting well out of hand. The buoyancy at the bow, is falling as there are now only two sets immersed. The load is up to 3.5tonnes and the COB and CoG are well overlapped. The only thing to say at this point is that, assuming the webbing straps hold, you should be able hang on to a perfectly stable, inverted raft !!

There have had to be a lot of assumptions made in trying to get a working model. Ideally, every piece of bar, plate and angle should be measured, its individual CoG worked and plotted in order to arrive at a true static position of the total CoG for the raft. There is no account taken of the working gear that will be needed on board (viz...anchors, chain, tools etc etc). In fact the only real way of checking the stability curve of an 'in-service' vessels is an 'inclination test' whereby weights are added to (in this case – the foredeck) and the inclination angle measured. As there have been several changes to the weldments and new fittings have been added, I would recommend a 'practical test'. My understanding is that the maximum capacity for the winch is 1.7tonnes and my 'back of the envelope' calculations suggest that this will induce a bow depression of around 15degs. I think that this should be the maximum load that the raft should be subjected to - bearing in mind its age and the 'dynamics' that will be encountered in use.

Keep smiling and wear a survival suit!!

'Val'

Fig A - 0°

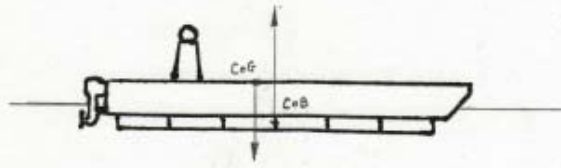


Fig B - 10°

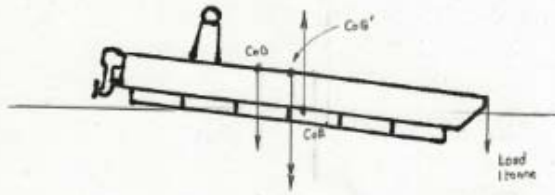


Fig C - 20°

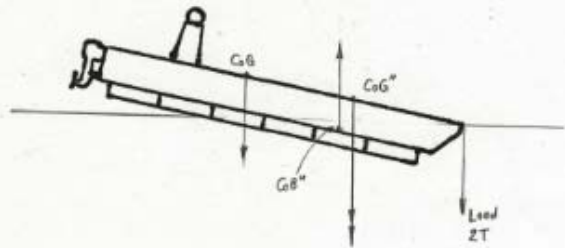


Fig D - 30°

