WEIGHTY PROBLEMS

Ballast for a GRP hull

Many people are now completing GRP hull mouldings at home, primarily as a way of saving money. One item which is often simply accepted as an unavoidable major item of expenditure is the ballast keel. In this article JOHN CAMPBELL advances some cost-saving ideas.

THE MAJORITY OF BOATS at the present time use a single lump of cast iron, cast to the shape of the keel. Such a casting is extremely expensive — in the area of £300 per ton. This puts the cost of ballast for a 36ft sailing hull in the region of £750. When an iron casting is used, it is either bolted on the outside, as was common with wooden boats, or encapsulated within the GRP keel. Except for the more extreme racing designs where there is not room inside the keel for a casting, the encapsulated method has become more popular. When the ballast is totally enclosed, it should be impossible for the ballast to rust; also there are no keel bolts to leak, corrode, or require replacement.

If the builder chooses one of the more extreme designs, he is perhaps more concerned with performance than absolute cost. He should use the external casting on the bottom of the slender fin keel, and perhaps should even consider mortgaging the house to buy a lead casting.

For those of us more interested in cruising, who have chosen a hull with reasonably long keel, there is a choice in the matter of ballast. Most professionally built boats use castings because they are quickest to fit and the supply of castings can be reasonably certain.

Any job for the professional, which keeps the hull longer in the mould, or even just in the yard, is avoided. Any delay in the building time of a hull sends the cost soaring, as the cost of the overheads rises. The professionals always seek to save time, which is money to them. The home boatbuilder can seek to save material costs, which are money to him.

When the professional fits encapsulated ballast, the casting is lowered into the keel of the hull. A slow catalised resin can then be poured in beside the casting to fill the air gaps between it and the hull. This is essential to stop the casting from rusting. Should it rust, it will tend to expand and could burst through the hull. A slow catalised resin must be used to prevent a heat build up, to avoid possible damage or even setting fire to the hull. Once the resin is cured, the top of the ballast is glassed over to protect it from bilge water and to make sure it cannot fall out, should the boat ever find itself upside down.

The home boatbuilder can cast his own ballast weight *in situ*. Obviously, he cannot pour molten iron into the hull, so what is the alternative?

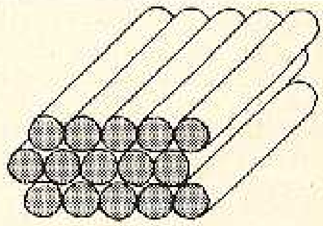
The ideal material must be heavy and must be able to be compacted to reduce air spaces to a minimum. Possible materials are lead, cast iron, and steel. The comparative weights and costs are:

Material	Weight per cubic foot	Cubic feet per ton	Cost per ton
Lead	710 lb	3.15	£300
Cast Iron	450	4.98	£300 ready cast
Steel	490	4.57	£30-£50 as scrap

If iron castings are rejected because of cost, then lead can also be rejected. Unless lead can be obtained cheaply (perhaps the boat is being built in a derelict church), that leaves steel as the choice.

The right sort of steel must be found. It is no use dropping in a few old pieces of engine: the steel must be in a suitable form to be easily compacted. Air spaces must be filled to prevent the steel from rusting. The air spaces can be filled with resin, or more cheaply with cement. If resin is used, a cheap grade such as that used for industrial flooring is ideal. Any resin must be slow setting to give time to work, and to prevent heat build-up.

Figure 1



Cement is perhaps better, as it is rather heavier than most resins (183 pounds per cubic foot), and will bond to the steel better, reducing the danger of rusting. The ballast will effectively be a mixture of steel and cement, and it is important to get the steel content of the mixture as high as possible. High-alumina cement should be used to reduce any possible reaction with the GRP keel.

Material	Weight per cubic foot	Cubic feet per ton
Steel	490 lb	4.57
Cement	183	12.25
70% steel (by volume)	398	5.63
80% steel (by volume)	429	5.22

Figure 2

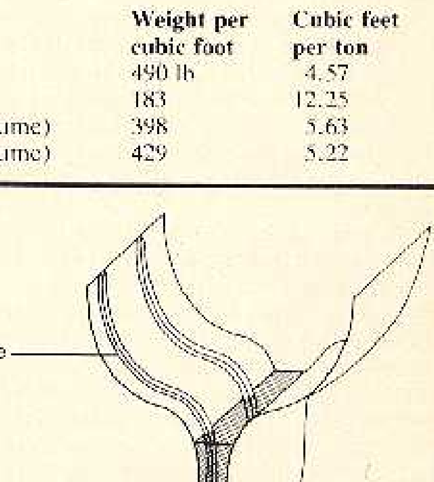


Figure 3

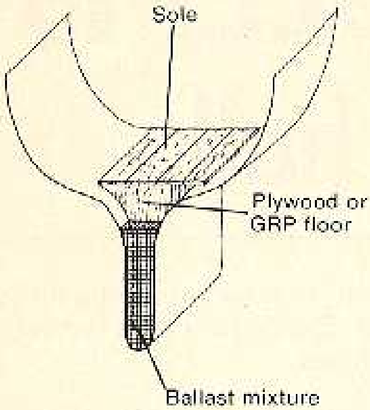
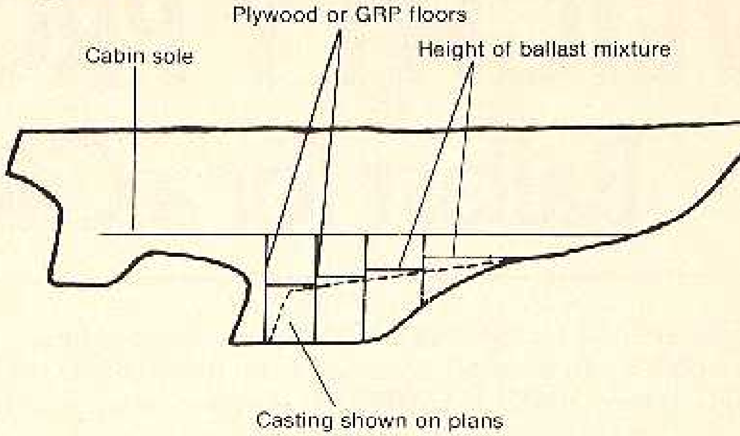


Figure 4



If a 70 per cent mixture of steel can be achieved, then the volume of the ballast will be 0.65cu ft per ton greater than the iron casting. Provided the keel of the hull is reasonably wide, this extra volume should not cause the height of the ballast to rise excessively.

The percentage of steel in the mix depends on the form that the steel is in. Steel rods, up to about ½in in diameter, will pack with almost no air spaces, provided the sides of the keel are parallel (Figure 1). Unless bought at scrap prices, such rods will be fairly expensive — over £100 per ton.

Perhaps the easiest form of steel to pack is shot, as used in shot blasting. Balls around ¼in diameter will pack almost as tightly as the rods. Shot is difficult to buy at scrap prices, but low grade new shot is easily bought at about £95 per ton from shot blast suppliers. To get even cheaper steel is possible, but requires patient searching. People have glibly talked of boiler punchings, but it seems that not too many boilers are being punched now. However, many other steel things are having holes punched in them: for example, the steel shelving made of slotted angle iron. It is often possible to buy these 'holes' by the ton, at very low prices, down to about £30 per ton. Steel in these forms will not pack as tightly as shot or bars, but will pack well enough with care to achieve a 70 per cent mix.

It is possible to mix different types of steel. Sections of scrap railway line, cut to length, can be laid in the keel. Gaps between adjacent rails can be filled with fine shot. This could result in a very high percentage mix. Any odd bits of lead can be thrown into the mixture to increase the weight to volume ratio; the lead will not react with the steel at all. It is, however, essential to keep track of the weight of everything going in as ballast so that the weight is as close as possible to that intended by the designer. The bathroom scales can be brought into use to weigh buckets of ballast mixture. Choose a small, strong bucket, as a gallon of mixture will weigh about 64 pounds.

If shot or similar is used, it can be mixed with cement outside the boat then tipped into the keel, or it can be mixed *in situ* in the keel. Either way, do not try to mix too much at a time, as every piece of steel must be coated with cement to prevent rusting. Once the mixture is in the keel, it must be thoroughly stamped down to remove any air. This is most easily done in thin layers, rather than with a couple of tons all tipped together. The cement mixture should be made very sloppy, and not too much, if any, sand added.

If a ballast keel is made in this way, there is an opportunity to strengthen the hull in a way not possible with a cast iron keel. The hollow keel can be strengthened with foam/GRP frames running up from the bottom of the keel (Figure 2) to the turn of the bilge, or the keel can be divided into compartments by bonding in plywood floors to the height of the cabin sole (Figure 3). Either way, the load of the ballast is spread further up the hull, making it less likely to bend and flex along the garboard area.

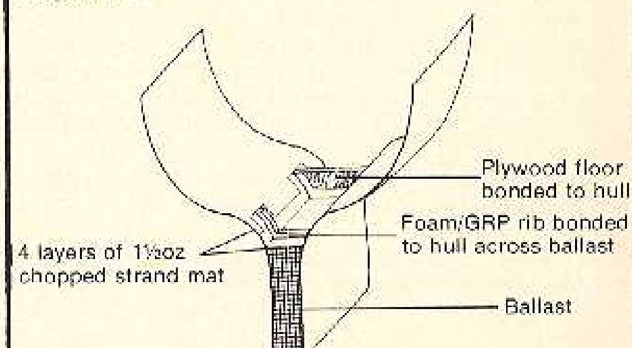
If the hollow keel is split up into compartments, then the amount of ballast in each compartment can be varied. Often on the plans, the top of the ballast casting is shown sloping. A similar weight distribution can be followed by varying the height of ballast in each compartment (Figure 4). Limber holes must be cut between each compartment to allow bilge water to flow through.

Once the ballast mixture is thoroughly set and dried out, it can be covered with glass mat and resin. This covering layer should be bonded to the hull, which must be cleaned and ground down first (Figure 5). Four layers of 1½oz chopped strand mat will protect the ballast from the bilge water, make certain the ballast cannot come loose if the boat is knocked down, and it can also effectively act as a double bottom should the keel of the boat be damaged.

Once the ballast is covered by the GRP layers, foam/GRP ribs should be bonded across the ballast, between the plywood floors, at 300mm centres. These ribs help to tie together the sides of the hull, and further spread the load imposed by the keel.

This method of ballasting a boat enables the amateur to complete a hull, in some ways better than the professional, yet saves a considerable amount of money. <>

Figure 5



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