Can Stone Boats Float?

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Stone boats? Well, not exactly. The material is now known as "ferrocement" and as the name implies, the boat is a framework of steel plastered with a cement mixture. Nowadays the thin-shell method gives a light and strong hull which is ideal for hard work, especially for the tropics.

MANY such boats were built and used during World War II, some being as large as 10,000 tons. But even then they were not new. There is one twenty-footer, still afloat on a lake in the Netherlands, which was launched in the 1890's.

Since the war, techniques have improved immensely, largely owing to the work of Professor Nervi of Italy, whose success with commercial and pleasure craft is well known in naval architect circles.

There are several advantages in ferrocement boats—

(1) They are cheap to build, as the main materials are only cement and wire.

(2) Cement burns with difficulty.

(3) Marine borers do not like cement.

(4) A well made ferrocement hull stands up to knocks well, and can often be repaired on the spot.

(5) The type is suited when employing one method to one-off vessels. Further, several people have successfully tackled ferrocement vessels, usually yachts up to 50 feet although they had never built any boat before. One drawback to ferrocement is that for boats under 30 feet, they are heavier than traditional materials. Over 40 feet weights are about equal; with larger boats you may save some weight. This being the case, we look at ferrocement boats as displacement types at present. It is better to stick to round-bilge designs as these are stronger in ferrocement. Hard-chine designs would require extra strengthening at the turn of the bilge. This can be done if required.

Ordinary reinforced concrete, however, is not good enough for boatbuilding, mainly owing to the presence of free lime, which dissolves and creates water channels within the structure. This causes breakdown of the metal inside after a while, and the whole frame becomes weak.

The ancient Romans had it made however, for they knew about pozzolan, which is a natural by-product of volcanic eruptions. Pozzolan eventually sets so well and is so impervious that the old original products are still good today. Luckily, pozzolan is also a by-product of modern industrial furnaces so we can get it at the supermarket without having to pack a mule to the thermal regions. The only drawback is getting pozzolan from Australasia to Papua New Guinea. No comments required!

So, if we mix two parts of the right sand to one part of Type 5 Portland cement but replace 10 per cent of the cement with pozzolan, we get the right plaster. Sand should be a good silica type and it should all pass through a No. 8 sieve. In actual fact, boats have been built without pozzolan and using local sand and the results seem quite good. So possibly the care in application has a lot to do with the final product.

It is advisable to carefully inspect your sand for salt and debris and wash well if necessary. One test which you can do is to put a few ounces of the sand into a narrow jar. After filling with water and shaking, allow to settle and the silt layer on top of the sand should not be more than $\frac{1}{8}$ in.

The framework of the boat can be built several ways. Firstly, one can suspend the frames of the boat from overhead points and build on that. Secondly, one can build a wooden mould, full size, of cheap timber, and go to work on that. A male mould, built upside down on the ground is quite good, but the whole work needs a crane to right it before the mould can be extracted. On the other hand, a female mould, constructed right way up and bolted together in two equal sections, is most handy, for the mould can be split when finished and the boat trundled out, having been built inside.

Most amateurs choose to use the suspended frame method as shown in the photographs.

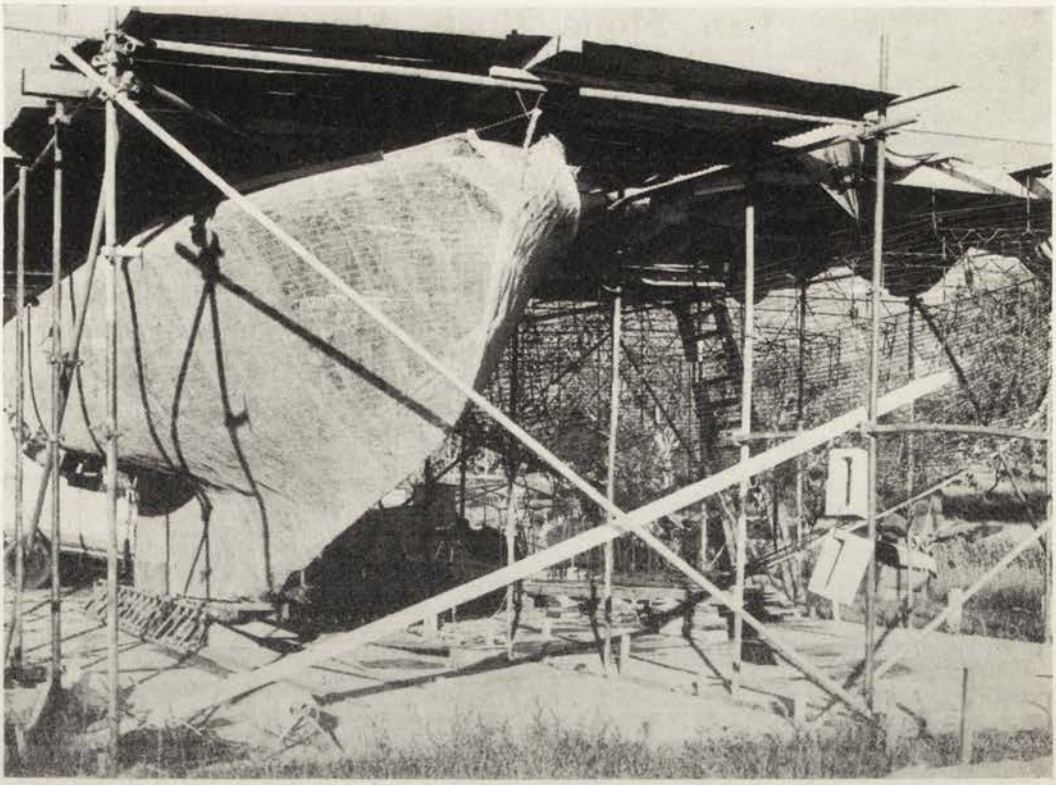

Plate I.—The suspended frame method showing two boats, one partly covered with mesh

This is the obvious choice when only one boat is to be made. Briefly, you should build a temporary structure of timber, or use an existing shed with a strong roof. Each of the vessel's frames, which are cross-sectional shapes of it at equidistant points, is suspended from a matching beam of your shed. A rod can be tack-welded to each frame and if the top end is threaded, then a nut can be used to raise or lower the frames when aligning. The frames will also be tacked to the keel, hornpiece and stem of the boat which has been prefabricated out of water pipe or heavier steel rod. Once the frames are fairly well set up, one then lays stringers of reinforcing rod (about .20 in or .25 in) lengthways from stem to stern at about 2 in centres, from deck level down to the keel. You may tack-weld them at one end, but only there, and the other ties should be made with 16 gauge black wire. If you tack-weld each time the stringers touch a frame, then you will be unable to adjust the frames and true-up the structure, for once you have laid on all the stringers you will invariably have to move the frames slightly to fair up the job. If you do not fair up then the boat will emerge lopsided in the end—a hideous sight.

Once all the stringers are in place, your boat will look very much like a ship, except that she is fairly transparent. Next job is to lace on the $\frac{1}{2}$ in diameter galvanized chicken-mesh. Seven or eight layers are used, some inside and some outside the framework. By passing small staple-shaped pieces of tie wire through the mesh, the mesh can be pinned to the stringers quite nicely. Don't tighten too severely or the mesh shape will be uneven over the whole surface. Do not use strips of mesh more than about 9 in wide, otherwise you will have difficulty in working round the curves encountered. Cut your 36 in wide mesh into four or you can cut it in half and bend each 18 in strip so that you get a double layer. Do not get too enthusiastic with the left-over ends at the stem, stern and keel, for if you get too

much accumulation of mesh there, then the plaster will have difficulty in penetrating unless you use a mechanical vibrator. And of course, if plaster is present elsewhere on the hull, the vibrator will cause it to drop through.

Laying up the materials on wooden moulds is more or less the same but you should put a polythene layer over the timber to prevent plaster sticking to it. The tie wires are replaced with a staple-gun and of course, non-ferrous staples are better. The resulting hull is frameless and there is nothing much inside to fasten on your interior joinery, which is a nuisance. For commercial production in quantity, the wooden mould would provide a quicker method. Some builders spray the plaster mix on with a gun but there have been one or two unfortunate incidents, probably caused by too wet a mix being required for the gun process.

Many builders feel that they are not skilled enough to plaster up the hull. They are probably right in this, especially where skilled people are available. Most people favour a "one hit" method of plastering, so that the entire hull (less deck) can be done in one day. Certainly the employment of one or two skilled plasterers plus some labour for one day is within the means of the would-be owner. Skilled plasterers will do a better job in the surfacing of the plaster, so that it has a beautifully smooth and rounded finish. Nevertheless, experience has shown that where no skilled plasterers are available, then you may as well do it yourself, for the result may be much the same because you, being the fond owner, will take care to prevent air-pockets forming in the hull plaster.

One well-known plasterer in New Zealand favours the "two-stage" method. This means that the outside of the hull is plastered to about half-way through the wire and then left to cure before finishing off inside. A layer of cement grout or epoxy bonding agent is used

Plate II.—Frames, stringers and vertical suspenders

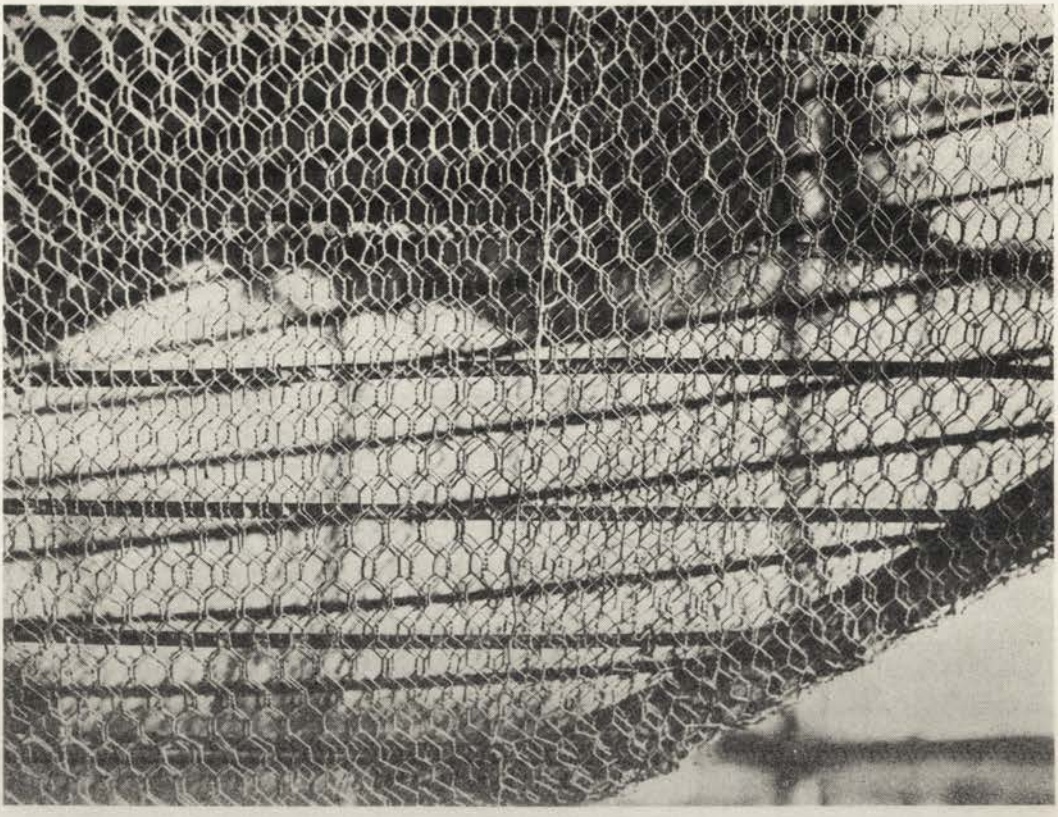

Plate III.—Bow section with three outer layers of mesh not fully tied down

between the two cement layers. The deck should not be attempted until the hull is cured and dried, otherwise the weight of the workmen can spoil the whole show.

Curing the plaster simply means keeping it damp for about 28 days so that the mixture dries out evenly from within and no uneven stresses are set up which may weaken the final result. Alternatively, one may steam-cure the job in as little as 24 hours. Usually the owner will merely put garden hose sprays or sprinklers everywhere and take a well-earned rest. A polythene tent round the whole is an improvement, and you can use less water then as the humidity inside at tropical temperature is amazingly high.

You can build the entire ship, including deck and coachroof in ferrocement, but some people stop at the decks and carry on with marine ply or timber. It is a matter of choice. For hard use and dryness, cement everywhere is recommended even for bunks and bulkheads.

Engine beds are usually of ferrocement and can be included in the original design. Some people suggest water and fuel tanks of ferrocement but this suggestion should be treated with caution. Water tanks should be well lined with epoxy surfaces, and baffle plates will also be required. This also means that large removable sections will be required so that access can be gained when working inside. Diesel fuel penetrates most things in time, so if you have ferro fuel tanks, put them where a little diesel will not matter. Refrigeration and ice boxes should have air spaces between them and the hull.

Tar epoxy paints are most suited to cement and they come in several different colours. Take care to paint the bilges well inside or it

may happen that diesel fuel spillage will penetrate the cement, taking minute amounts of salt with it and thus perhaps affecting the metal work within the hull skin.

With regard to marine surveys, it appears that in some countries, authorities are reluctant to commit themselves, but it seems clear that the main reason for this is a marked lack of data on ferrocement vessels. Even Lloyds, the great marine insuring agency, has little in print on the matter. It is probable that the most authoritative works on ferrocement come from New Zealand, which seems to be the home of this method. The New Zealand marine authorities are in the process of laying down rules for the building of ferrocement craft and their publication should be available in the near future. It is generally accepted that "down-under" is well ahead in this field.

There are two builders of ferrocement craft in the Territory.—Yule Shipbuilders, Central District and D. Wells, Madang Ferroconcrete Products. Three 28 ft extension boats are being built for coastwise fisheries work for D.A.S.F. Since the 24 h.p. diesel engines consume ½ gallon of fuel per hour at full speed of about 8 knots, it will be seen that working range is ample for our coastline. As the boats have bunks, washing and cooking facilities, plus echo sounder and marine radio, it will be realised that a reasonable distance extension tool is now available to us. Less radio and echo sounder, the boats are produced at $6,200 each, which surely is good value for money. A Fisheries Officer could recommend such craft to the general public with a clear conscience as to running costs, spares, and maintenance problems, added to which, in difficult times, fishermen could always do a little cargo work to keep the business going.

When it is known that commercial yards can produce such reasonably priced boats, it can further be realised that the amateur builder can do a very cheap job if he utilises

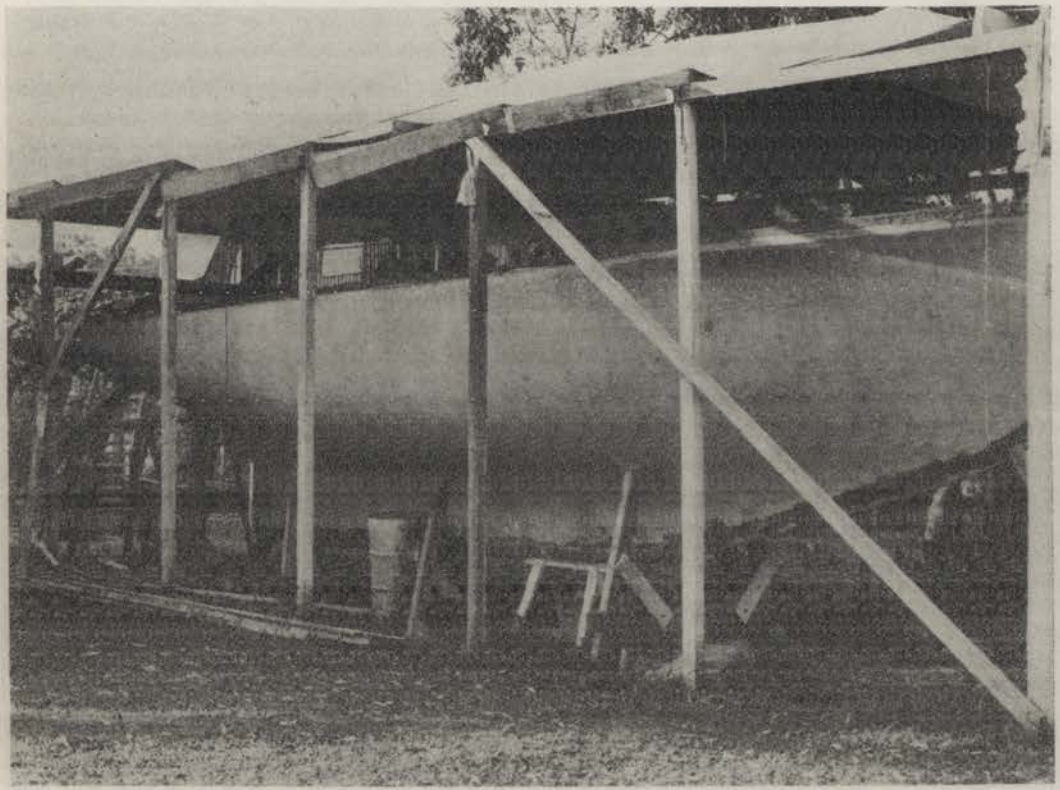

Plate IV.—38 ft yacht built by Mr Peter Williamson of Boroko, amateur with no previous experience. The dark line is glassfibre overlay

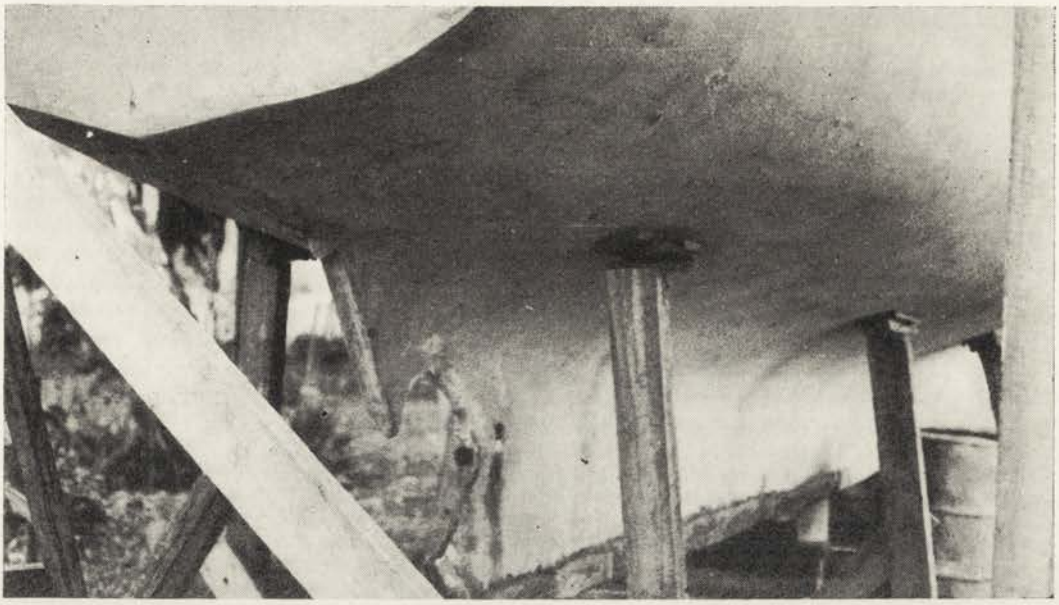

Plate V.—A close-up of the hull before being painted, showing the smooth finish of the cement

his otherwise spare time. One photograph shows an amateur built yacht which, to the stage shown, including all materials and professional plasterers, cost the owner $1,500. For a 38 ft hull, this is very cheap.

You can run a ferrocement yacht onto a reef just like any other boat and the results are worth studying. There have been one or two unfortunate incidents, such as the one where a brand new prawner was caught in a cyclone off Queensland and was lost. This has caused some critics to condemn ferrocement without further ado. There have, however, been too many well authenticated instances of ferrocement boats coming off very well after collision or grounding. The most recent case was off Madang where a 40 ft yacht went on to the reef nearby and for three days was lifted and dropped with each successive wave. A witness stated that each time the boat fell on the reef it seemed enough to split her apart. Actually for three and a half days she withstood the repeated impact without real damage. Unfortunately it was over a long weekend and the message did not get through to the rescue services until the third day. The tug arrived just in time for the boat to finally split along one bilge. Soon afterwards she was not worth saving. The witness, a timber hull man himself, said that he needed no further convincing that ferrocement was an ideal medium.

To repair an eggshell depression in the hull, caused by impact, is fairly simple. In any case the fragments of plaster will remain locked by the wire mesh and no sudden hole will appear. As soon as possible, dry the ship out enough to work on the fracture. With a heavy dolly held on one side of the repair job, gently pulverise the small pieces from the other side with a suitable hammer. Straighten out the mesh remaining and then fill up with plaster or epoxy filler. The epoxy is the quickest and you can be on your way when the tide comes back. The thing to remember is—and this goes for the whole boat—do not plaster more than about 1/16in thicker than your wire mesh. To do so weakens the job considerably. In fact, if you have plastered properly you are bound to have odd meshes showing through the hull when finished. You can just grind them off gently and cover with epoxy filler.

If we can just get the message through, I'm sure that fishermen everywhere will be having a shot at making a ferrocement boat. The thing to do is to make sure that information is available.