Ferrocement Boats for Disaster Mitigation In Coastal Orissa

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Summary

This document presents the basic information on ferro-cement boats and makes an argument for promotion of this innovative low cost material and appropriate boat technology for mitigation of recurring disasters in form of floods in coastal Orissa. Ferro-cement is a composite where chicken wire mesh is used as the reinforcement in a dense cement mortar matrix. Its properties make for a good timber-substitute material. It has been used for almost a century in various applications ranging from boats, building components such as sheets. roof, panels, fence etc. Orissa being a perennially flood-prone state of India is subject to this disaster on almost a yearly basis. Due to the slow death of boating in the community because of unavailability and high cost of good quality boat building timber, the population has to often depend on external agencies such as the navy for immediate rescue of marooned people in the aftermath of the floods. This was identified as a critical problem in a survey conducted by Aagamee Orissa – a forum of professionals, activists and volunteer groups[1]. While timber boats are expensive to build, ferro-cement boats are cheaper, relatively uncomplicated technology and versatile with proven track record. This proposal provides the basics of ferro-cement as a material and the construction techniques used for ferro-cement. It seeks funding for the construction of several prototype country style boats of different sizes for trials. It is expected that these boats would be of use in the upcoming monsoon season.

[1] People's Voice on Orissa Floods – 2003, A survey by Aagamee Orissa (to be published).

Introduction[2]

The increasing cost and scarcity of durable boat building timbers have affected the construction of fishing crafts around the world. The developed world has by and large witnessed the transfer from traditional wooden boat building methods to either less conventional wood construction techniques (e.g., plywood or wood laminates) or non-wood materials such as fibre reinforced plastic (FRP), steel, aluminum and ferro cement.

Brief history of Ferro-Cement[3]

Ferro Cement is the name given by English speaking people to a boat building method using steel wires covered with a sand cement plaster, patented in 1855 by the French, who called it Ferciment. Ferciment boats built by the French before 1855 are still in existence and one at least is still afloat, effectively supplying the answer to "what happens to the steel and plaster, when the boat is placed in water."

Ferciment boats built by the Italians in the 1940s are still in use and going strong, but they called the method of construction Ferro-Cemento and the New Zealanders who pioneered the amateur construction of Ferro-Cemento boats called it Ferro-Cement.

These techniques generally favour less labour intensive methods of construction. In the developing world where timber is still the predominant boat building material, the scarcity and high cost of good quality timber have not meant that less wooden boats are being built, but rather that building quality has deteriorated through the use of poor quality timber. At the same time, however, attempts have been made to diversify construction methods with varying degrees of success. The following aspects are critical to the success of any commercial boat building operation.

1. Materials
2. Labour
3. Site
4. Design
5. Cost

[2] Richard O.N. Riley and Jeremy M. M. Turner**, "**Fishing Boat Construction: 3. Building a Ferrocement Fishing Boat", Fao Fisheries Technical Paper, Rome 1995.
[3] From the preface in Hartley's Ferro-Cement Boat building book.

6. Marketing and Sales
7. After Sales Service

In recent years the destruction of forests has now excluded various species of good quality boat building timber from general use, reducing availability and spiraling costs upwards. Plywood offers the chance to achieve strength with lightness and is easily maintained and repaired. However, its flat sheets impose design limitations in small craft and marine grades are not widely available.

GRP (glass reinforced plastic) or FRP (fibre reinforced plastic) construction, whilst having a wide market in developed countries particularly for leisure craft, has been held back in some underdeveloped countries for various reasons including high setting up costs, requiring factory air conditioning, dust, humidity, and quality control.

Despite good weight and strength qualities, aluminum alloy requires greater technical knowledge in its construction to prevent exposure to dissimilar metals and great care whilst welding or bending, as well as taking account of alloy fatigue so as not to affect the materials strength.

Steel presents the builder with an easier material to work with: there is plenty of information to consult; the materials are usually readily available worldwide; setting up costs can be fairly nominal; and good construction provides robust boats. However, in all phases of construction, steel needs to be nurtured against corrosion attack from initial storage to final painting stage, particularly in underdeveloped countries where maintenance, if carried out at all, is very often poorly done, resulting in a reduced life span.

Ferro-cement is a flexible and durable form of construction. It is easy to repair and possesses many features that help produce a well founded fishing boat. It is particularly suitable for moderate to heavy displacement designs with well-rounded sections. However, good supervision in all aspects of construction is desirable, whilst in general the labour can be semi-skilled. Because ferro-cement materials are analogous to the building construction industry, material availability worldwide is generally very good and cheap. Despite some poor construction in various places over the past twenty five years, which has hindered the

acceptance of the material somewhat, there are enough fishing boats constructed in ferro-cement around the world to give substantial claim for ferro-cement to be positively accepted in fishing boat building.

What is ferrocement?

Ferrocement is a technical term, not to be confused with ordinary reinforced concrete. It might be defined as a composite material consisting of a matrix made from hydraulic cement mortar and a number of layers of continuous steel mesh reinforcement distributed throughout the matrix. The basic parameters, which characterise ferro-cement are the specific surface area of reinforcement, the volume fraction of the reinforcement, the surface cover of the mortar over the reinforcement and the relatively high quality of the mortar.

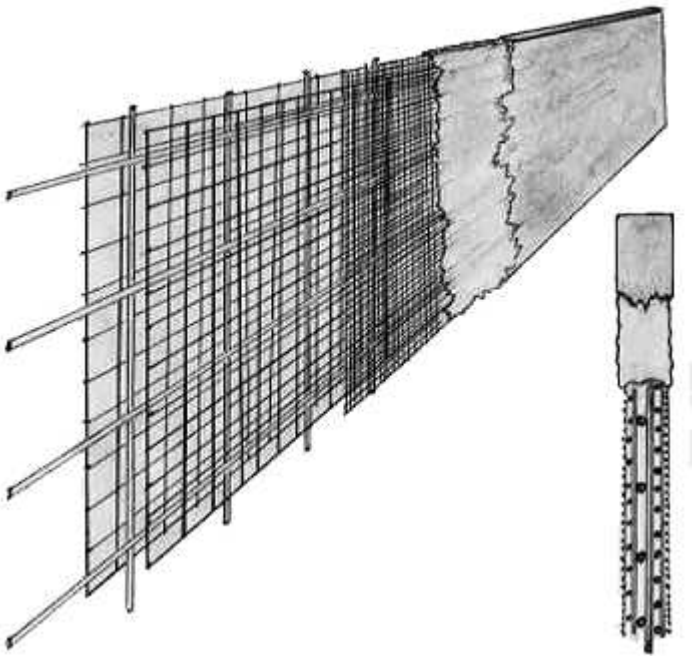

Figure 1. Schematic diagram of typical ferro-cement sheet.

Ferro-cement behaves like reinforced concrete in its load bearing characteristics, with the essential difference being that crack development is retarded by the dispersion of the reinforcement in fine form through the mortar. This makes the material of interest in boat construction and it has been established that when cracking takes place it results in a wide distribution of fine cracks, which, in combination with the high alkalinity of the cement rich mortar, inhibits corrosion in the reinforcing steel.

The main advantages of ferro-cement are low cost, the low level of skills required for hull construction, and reduced maintenance with increased resistance to rot and corrosion when compared to wood and steel. Claims of low cost can only be substantiated where the second advantage of low level of skills required can be exploited, for example, in developing countries with a large unskilled, under-employed and low paid labour force. In industrial nations, where there is little difference between the cost of skilled and unskilled labour, these advantages are less apparent or even disappear, explaining the relatively slow growth in the use of ferro-cement.

The main disadvantages of ferro-cement are its weight and poor impact resistance. However, these disadvantages only restrict the application, of the material, but need not detract from its potential. In the case of heavy displacement workboats over 11 m LOA, the increased weight is of reduced importance; for such craft over 15 ms, the weight will be no more than that of a similar size steel vessel. Poor impact resistance can be largely overcome at the design stage by provision of appropriate hull protection members.

It may well therefore be asked why ferro-cement has not been used more widely? This is due mainly to three factors: bad publicity due to poor amateur and professional construction; publication in the early years of outlandish claims for strength and low cost of construction, which in some cases could not be substantiated; the heavy rise in labour costs in industrialized countries which affected what is generally speaking a labour oriented material. Although today with the range of building techniques for ferro-cement expanding, the labour cost factor need not play such an important part.

Technically, ferro-cement has been a well-researched material with American Concrete Institute having published guidelines and standards on it. There are a number of textbooks that have been written on it. In spite of that, ferro-cement remains more of an art rather than a technology.

Orissa Scenario

Orissa is a coastal state of India known for its abundant natural resources but extremely poor populations. While the numerous waterways of Orissa provide it with a great wealth, it also causes great hardship to the people because of frequent occurrence of floods. In year 2003, vast areas of the state remained inundated due to flooding of several major rivers,

with floodwaters not receding for several weeks together. One of the important learning from visiting flooded areas and what was subsequently captured in a survey was the fast disappearing boats from the community. It is well known that ever-increasing price and lack of availability of good quality timber has affected boat building to a great extent. Traditional country boats made from timber are not considered to be a viable source of livelihood for a whole host of reasons. The consequence is that large numbers of people depend on external intervention for relief and rescue.

Figure 2. J. J. Lambot small reinforced concrete boat (1848).

The Proposal

It is proposed that a number of prototype country boats (3-5 model boats about 4 feet long and 3-4 prototypes about 12 feet) be built in the workshop of Kalinga Institute of Industrial Technology (KIIT) to demonstrate the ferro-cement technology and ferro-cement boats as viable replacements of traditional country boats built from timber. Traditionally it is believed that ferro-cement boats are cost effective only beyond 15 m in length. How ever, it is expected that with low labour costs in Orissa, ferro-cement boats would be viable even in smaller sizes.

The program

The following program is proposed:

- Build prototype timber country boat (12 feet) using traditional artisans.
- Build model ferro-cement boats (4 feet) to test the technique and get a feel for construction.
- Build 12 feet prototype country boat using the timber boat as a model or as a mould.

- Trial the prototype ferro-cement boat.
- Quantify weight, buoyancy, Carrying capacity, speed, ease of handling.
- Estimate durability and robustness against impact damage and ease of repair.
- Publication of a short 'how-to' guide in Oriya on Ferro-cement boat construction.

At the completion of the above program, a decision can be taken with regard to the technical and financial viability of setting up a ferro-cement boat manufacturing facility. Further work can also be done on building of larger fishing boats and recreational boats.

Budget

The following expenditure is envisaged

1.	Timber boat (12 feet)		Rs. 5,000/-
2.	Ferro-cement model boats (4 feet)	5 x 1000 =	Rs. 5,000/-
3.	Ferro-cement prototype boat (12 feet)	4 x 4,000 =	Rs. 16,000/-
4.	Testing and field trials		Rs. 10,000/-
5.	On-board motor and fittings		Rs. 5,000/-
6.	Literature, admin and misc		Rs. 5,000/-
TOTAL PROJECT COST ESTIMATE			Rs. 46,000/-

Progress

The following progress has been made so far –

- Timber 12 feet country boat prototype – complete – Dec 2003. See Figure 3 for a photograph.
- Ferro-cement 4 feet model boat (bamboo and chicken wire mesh reinforcement) – complete – Jan 2004. See Figure 4 for a photograph.
- 2nd 4 feet ferro-cement model boat (gunny bag reinforcement complete – Mar 2004). See Figures 5 and 6 for a picture of the clay mold.

- Skeleton of 12 feet prototype ferro-cement boat with steel rebar and chicken wire mesh reinforcement is under construction – present (see Figure 7).

Concluding Remarks

The ferro-cement boat has an exciting prospect in the context of disaster mitigation in Orissa. While the small country style boats will be ideal low cost approach to the intermittent needs of rescue and relief work during floods, larger more sophisticated boats can subsequently open up commercial opportunities in both boat manufacture as well as potential use in fishing, transport and recreational use.

Figure 3. County boat built from low cost 'chakunda' timber by traditional village artisan at KIIT workshop.

Figure 4. Model ferro-cement boat being constructed using the direct plaster method.

Figure 5. Clay male mold for casting of ferro-cement boat.

Figure 6. Model ferro-cement boat being finished.

Figure 7. Skeleton of the first prototype ferro-cement boat under construction in KIIT workshop.