Cheaper Boats, Cleaner Waters

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Wood has always been the first preference of traditional fishermen for their boat building for centuries. Initially the type of wood that was used for marine applications included highly durable varieties like teak *(Tectona grandis)*, and aini *(Artocarpus hirsuta)*. In the tropics, due to the hot and humid environmental conditions prevailing, only 10% of the available wood happens to be durable for building boats. Towards the end of 20th century, the availability of wood from forests, which is durable in nature, declined and it became necessary to opt for non-durable varieties. According to Kumar (1986), in India, about 20,000 m^3 of wood is required for replacement of boats in marine sector alone. In a recent report, Kumar (2005) estimates that the current use of wood is at a level of 39.5 million mt, out of which nearly 22.5 million mt is used in adverse conditions requiring protection against biodegradation. In the harsh marine environment wood is always under the threat of attack by marine biodeterioration agents like bacteria and fungi and marine wood boring organisms like marine crustaceans and molluscs.

The serviceability of wood in marine conditions therefore relies on preservatives applied on wood. Initially the traditional fishermen used plant and animal based preservatives for increasing the service life of wooden boats. These indigenous preservatives include crude fish oils (sardine oil and shark liver oil), ground-nut oil, cashew-nut shell oil, *poon* (*Calophyllum* sp.) seed oil, neem (*Azadirachta* sp.) oil, castor oil, coal tar, plant resins and extracts like 'chandrus' (a solidified plant resin), *dammar-batu* (oleo-resinous substance obtained from trees of family Dipterocarpaceae, imported from Malaya) etc (Balasubramanyan, 1967; Santhakumaran & Jain, 1983). The preservatives are applied either alone or in combinations. But the effect of these preservatives was observed to be limited as they could only provide a hydrophobic surface without any prophylactic activity (Nair *et al*, 1985). This superficial protection provided was seen to last only for a short duration and the experience was that maintenance of the wood to keep it protected was costly and labour intensive. A scientific approach on the formulation and application of preservatives was initiated in early 1950s when studies were focused on the physiological requirements of the wood boring organisms and the characteristics of the surrounding environment. These studies resulted in the recommendation of chemical wood preservatives like CCA (Chromated Copper Arsenate), CCB (Copper chrome borate), ACZA (Ammoniacal Copper Zinc Arsenate), ACQ (Ammoniacal Copper Quat) etc. Among these preservatives, CCA proved to be very efficient in protecting the wood against marine borers, as explained hereunder.

Chromated Copper Arsenate (CCA): CCA was first formulated and patented under the trade name ASCU in 1933, by an Indian Scientist Sonti Kamesam, working in the Forest Research Institute, Dehra Dun (Patent no. 19859, 1933) (Aston, 1985). In India, from 1938 onwards it was extensively used for preservation of wood for railway sleepers and electric posts. Large-scale production of CCA first started in U.S in 1938. CCA was in use for the last 70 years in countries like United Kingdom, U.S.A., New Zealand, and Japan where it has been a major preservative for applications above ground. It was widely accepted in marine construction purposes for pilings, poles, wooden jetties etc. In India, rough estimates available show that about 400 metric tons CCA preservative is used per annum (Kumar, 2005).

It was only in the last decade, the problem of leaching of constituents from CCA treated wood on exposure to aquatic environment came into focus. Research is being carried out at University of Miami, USA, University of Florida, USA, Forest Products Laboratory, USA, CSIRO Forestry and Forest Products, Australia, and Western Wood Preservers Institute, Washington. In India, the studies on the wood preservation are being conducted at the Institute of Wood science and Technology and on aspects of preserved wood for boat building at Central Institute of Fisheries Technology, Cochin. It was argued that the preservative being water borne, the possibility of leaching of its constituent elements *i.e.*, copper, chromium and arsenic from the treated wood could not be ignored. The constituents of CCA are considered to be hazardous if they accumulate in natural waters in large quantities and they can act as potential toxicants to the organisms. Rising concerns about pollution caused by chemicals of CCA made U.S. Environmental Protection agency to reevaluate safety standards of CCA and announced regulatory ban on residential use of CCA. The growing awareness about pollution caused by the chemicals called attention for research on eco-friendly wood preservatives. The result is that, as an alternative, protection of wood in the aquatic environment has been achieved using physical barriers, based on sheathing and coating that can prevent leaching.

FRP as Sheathing Material: Fibreglass Reinforced Plastic (FRP) is a composite product made from Fiberglass Reinforcement in a plastic (polymer) matrix, which can act as an effective barrier to protect wood from biodeterioration. Historically, the development of FRP can be traced to 1940s when FRP for coating the hull of boats was first used in USA. The technological developments later brought in catalysts that made the FRP resins to cure much faster and that imparted certain improved characteristics. Different types of FRPs can be designed to suit various applications by changing the chemical composition of the resin and varying the reinforcement. The physical characteristics of the resin get completely changed, as they attain resistance to water absorption, resistance to UV radiations and acquire an increase in strength. The principal reason in opting for FRP for boat building in developed countries are lower production cost and faster and less skilled production systems. The position however is that large scale use of FRP is yet to be adopted in developing countries (Venugopal, 1979; 1980). The dependence on other countries for raw materials, relatively higher costs involved in adoption of technology for quality production are some factors that act as constraints for the wider use of FRP by small fishing communities. The primary function of providing sheathing of FRP on wooden boats is to protect wood from attack of marine woodborers and from the biodeteriorating agents. The thickness of one layer of FRP sheath is approximately one mm. The quantity of water entering the wood is a major factor that leads to deterioration. FRP prevents the entry of water into the wood, thereby reducing the possibility of fungal growth. FRP sheath can also improve the appearance of the structure. It does not increase the strength but it reduces maintenance costs. FRP sheath should have an elasticity same as that of wood to prevent the cracking of sheath under impact forces.

Laboratory and Field Studies: The Central Institute of Fisheries Technology has been carrying out elaborate studies on the efficacy of FRP in protecting wood (Edwin and Meenakumari, Unpublished). Laboratory and field oriented experiments were conducted to evaluate the leachability of the CCA preservative constituents to the surrounding water. The effectiveness of FRP in preventing leaching of the preservative was also evaluated.

Rubber wood was used for the experiments. Rubber wood panels were cut from a freshly felled tree and after an initial seasoning the panels were treated with 7.5% solution of CCA. The panels were treated under high pressure in a pressure impregnation chamber so that maximum penetration of the preservative takes place into the wood. A preservative retention of 16kg/m^3 was obtained. After 4 weeks of seasoning, selected panels were sheathed with FRP.

Chemical: Leaching studies were conducted at CIFT by simulating natural conditions in the laboratory. They provided a constant motion to water using magnetic stirrers. The panels were allowed to leach for 336h as per prescribed standard methods. Results show that FRP is successful in reducing leaching. Studies were conducted to compare the difference in the quantum of preservative leached from panels without any sheathing. Leaching was negligible from the FRP sheathed wood treated with CCA whereas that it was cognisibly high in the unsheathed wood. The results show that sheathing the wood with FRP after preservative treatment is a practical method to reduce the challenge posed by the constituent chemicals, which may leach into the aquatic environment.

Table 1: The quantity of copper, chromium and arsenic leached (in mg) from the wood with and without FRP sheathing during 14 days (AWPA E-1 1, 97)

Metal	Sheathing	6h	24h	48h	96h	144h	192h	240h	288h	336h
Cu	Nil	0.06	0.19	0.40	0.17	0.74	0.68	0.52	0.63	0.68
	FRP	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Cr	Nil	0.71	0.13	1.04	0.40	1.07	1.14	1.02	1.12	1.10
	FRP	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
As	Nil	0.22	0.22	0.43	0.35	0.99	1.02	0.98	0.87	1.01
	FRP	0.16	0.14	0.09	0.16	0.14	0.04	0.09	0.06	0.00

Biological: Investigations carried out for a period of eight months have shown that, while CCA preservative treatment reduces the attack of wood borers, FRP sheath aids in enhancing resistance against such attacks. The CCA treated and FRP sheathed panels were exposed along with a set of untreated control panels in racks, in the Cochin estuary at one mt below the low tide level. The panels were periodically examined for presence of borer holes. After six months of exposure the panels were returned to the laboratory. The fouling organisms were scraped off from the panels and the borer attack was assessed. The observations show that CCA preservative treatment reduces attack of marine wood boring organisms. The high abundance of fouling organisms on the FRP sheathed panels may be due to the reduction in leaching of copper, chromium and arsenic from the CCA treated panels through FRP. No borer holes were observed on FRP sheathed panels while CCA treated control panels showed presence of borer holes. The marine wood boring organisms were unable to bore through the FRP sheath.

FRP sheathing of CCA treated wood will improve the longevity of canoes in the marine conditions that even when water enters through the cracks the preservative will prevent the fungal attack and biodeterioration. Prototype canoes were constructed using rubber wood, an agricultural waste, treated and sheathed with FRP. As such, rubber wood is cheap but is non-durable both in terrestrial and aquatic conditions. Therefore it is treated with CCA and seasoned properly before the construction of the canoes. The canoes were later sheathed with FRP. These canoes are given for experimental fishing to artisanal fishermen. Three such prototype canoes are presently

Table 2: Evaluation of woodborer attack on wood in estuarine condition after a period of eight months (ASTM 2481)

Type of panel	Number of borer holes	Condition of the panels	Rating
Control (without any treatment)	30	Light attack	10
CCA16kg/m^3	4	Not more than trace attack	9
FRP sheathed panel	Nil	No attack	0

being operated on experimental basis, of which two are used for lime shell collection. The canoes were visually inspected periodically for physical and biological damage. Any damage due to weathering like fibre blooming (emergence of fibres on the surface), abrasion, cracking, blistering and change in colour due to ultraviolet radiations are being monitored. Signs of biodeterioration of the underlying wood can be found out by gently tapping the surface. After 27 months of continuous operation in the estuarine condition there were no biological or physical damages to the fishing canoes. The cost of raw materials for sheathing a 6.4 m long wooden fishing canoe is given in the Table.3.

Table 3: Type, quantity and cost of raw materials used for making FRP sheathing for 6.4 m wood craft (Edwin, 2003)

Description	Quantity required	Cost in Rupees
Chopped strand mat (300g/m²)	13 kg	1,625.00
Surface mat	10 m²	400.00
Polyester resin	40 kg	3,480.00
Acetone	0.51	37.00
Brush - 2"	4Nos	80.00
Chalk powder	5 kg	60.00
Colour	1kg	310.00
Miscellaneous		500.00
Total		6,492.00

Source: CIFT special bulletin no. 13

Conclusion

In the present scenario of deteriorating wood supply and the rising demands, the introduction of less durable wood but fortified with chemical treatment and FRP sheathing will be is a major step in fisheries sector towards conservation of forests. Studies are still to be made in the use of CCA treated planks for catamarans and then sheathing it with FRP to prove effectiveness. Preservative treatment followed by FRP sheathing is certainly a cost effective and technically feasible method. The fisheries sector in India has to go a long way in popularising the technology among traditional fishermen.

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Fish Outlets in Bangalore

The Karnataka Fisheries Development Corporation (KFDC) is planning to set up retail fish outlets in various parts of Bangalore. Mr B. Nagaraj Shetty, Karnataka Minister for Fisheries and Endowment, revealing this said that he had discussed with the Commissioner of Bangalore City Corporation to provide some stalls for this purpose. It was mentioned by him that the State Government was keen to provide fresh fish, fish fry and fish curry to the people of Bangalore at such stalls. It was also added that the State Cabinet had approved to release Rs. 4 crores for the purpose.