Protection of Traditional Wooden Fishing Canoes

Leela Edwin, Saly N. Thomas and B. Meenakumari

Central Institute of Fisheries Technology
P.O. Matsyapuri, Cochin-682 029, Kerala, India
E-mail: leela@ciftmail.org

Wood is the best-known traditional material for boat construction. However, the shrinking forest resources restricts its widespread use. The scarcity of this versatile natural resource has led the Central Institute of Fisheries Technology to conduct studies on the utilization of less durable species for construction of fishing canoes and methods for protecting them. This communication discusses the methods for protection of wooden canoes from degradation in the tropical aquatic environment. The upgradation of secondary species of wood can be brought about through chemical preservative treatment. The use of oil-borne and water-borne preservative (dual preservative treatment) has been found successful for increasing the service life of less durable species like rubber wood (*Hevea brasiliensis*). Alternatively, reinforcement through use of sheathing materials like Fibreglass Reinforced Plastic (FRP) can also be adopted. The costs involved for the chemical treatment and sheathing with FRP are worked out. The materials used and the method for sheathing small canoes, both old and new, with FRP has been discussed.

Key words : Wood preservatives, FRP sheathing, rubber wood canoe

India has rich timber resources with nearly 5000 species of Indian trees known to yield timber. Out of this, only 400 species are actually used for boat building and only 200 of them are put to commercial use extensively. Teak is widely used for fishing boat construction in Gujarat, Maharashtra, Andhra Pradesh and Orissa. The second choice is 'aini' (jungle jack) particularly in Kerala, Tamil Nadu, Karnataka and Pondicherry. Timber for log raft should have lightness, low absorption of water, rot resistance and good weathering properties. Species best suited are siris (*Albizzia chinensis*), 'semul' (*Bombax ceiba*), Malabar neem (*Melia composita*), *M. dubia*, 'maharukh' (*Alianthus malabarica*), 'murukku' (*Erythrina indica*) and rain tree (*Samanea saman*). Timbers recommended for mechanized boat construction are teak (*Tectona grandis*), 'aini' (*Artocarpus hirsuta*), 'chaplash' (*A. chaplasha*), sal (*Shorea robusta*), 'shisham' (*Dalbergia sissoo*), 'padauk' (*Pterocarpus dalbergioides*), 'laurel' (*Terminalia alata*) and 'kindal' (*T. paniculata*).

When timber was plentifully available, the accent was on the use of very durable traditional timbers like teak. Majority of the artisanal craft are made of wood and a loss of millions of rupees is incurred annually due to biodeterioration of these boats. It is estimated that the fishing industry uses about 20,000 m^3. of timber for annual replacement alone. The total requirement of timber for marine use may be 0.1 million m^3 (Kumar, 1985) in the context of the increased fishing activity and replacement of other marine structures like pilings, fenders etc.

In India, according to the estimates made by the Department of Animal Husbandry and Dairying, Government of India, there are 2,80,491 fishing craft. Of these, 1,81,284 are traditional craft, 44,578 are motorized craft and 53,684 are mechanized craft (Anon, 2000). Of the total 66,659 fishing craft operating along the coast of Andhra Pradesh, 53,853 belong to the traditional sector. Timber is still the most favoured material for boat building among the rural fishing communities. There is a need for the use of preserved wood over untreated non-durable species of wood or even durable wood and to improvise adequate measures for protecting craft made of less durable species of wood. This communication deals with the agencies causing biodeterioration of small wooden fishing canoes and methods of preventing it. Chemical preservation of wood through single and multiple treatments are described. Alternatively, using physical barriers like a sheathing of Fibreglass Reinforced Plastic (FRP) can also protect small craft from biodegradation.

Agencies of biodeterioration

The beach landing wooden traditional craft is usually hauled up after the day's operation. This causes intermittent wetting and drying of the wood surface favouring the growth of fungi, which requires moisture, warmth, air and organic material to grow. The wood is susceptible to fungal growth when its moisture content is between 27 and 100% or above. The optimum moisture content for the growth of most wood rotting fungi lies between 35% and 75% and the absolute minimum is about 22% (Findlay, 1985). Drying the wood to moisture content of 18-20% in the humid tropics generally protects the wood against fungal infection and against internal development of any fungi already present inside the wood. The fungal growth is maximum at temperature between 15 and 30°C. All decay fungi has optimum development at about pH 6. The parts of the fishing vessel above waterline are more liable to fungal decay than water exposed surfaces. Based on the type of deterioration caused to wood, two types of fungi are distinguished - wood staining fungi and wood decay fungi. These fungi fall under the groups Ascomycetes, Dereteromycetes and Basidiomycetes.

Marine woodborers that cause the greatest amount of damage are categorized into two: bivalve molluscs and crustaceans. Molluscs come under two groups: Teredenidae and Pholadidae. The important genera of wood boring molluscs are *Teredo, Bankia, Nausitoria* and *Martesia*. Among shipworms *Teredo elongata, T. manni, T. furcifera, T. milleri, Bankiella carinata, B. liliobankia* and *Nausitoria hedlei* are species important to India. Of *Pholas* and *Martesia* which represent Pholadidae, *Martesia* is widespread in India. *Martesia striata* and *M. fragilis* are common species. Among crustacean borers, the three major genera are *Limnoria, Sphaeroma* and *Chelura* of which the latter is of minor importance to India. *S. terebrans , S. annandeli, S. walkeri, L. tripunitate, L. bombayensis, L. insulae* and *L. andamanensis* are active in Indian waters.

The marine fouling organisms do not destroy materials like wood, steel, FRP, aluminium or ferro-cement in which they settle. Bacteria, fungi, diatoms and algae are the most common vegetable organisms while hydroids; bryozoans, tunicates, serpulids and barnacles are some of the animal groups that have been recorded. Of these, the barnacles, most commonly represented by the genus *Balanus* are the most aggressive of the fouling organisms in Indian coast. The fouler increases the roughness of the hull and increases fuel consumption of the fishing vessel. Bacteria form part of the microflora that causes degradation to the wood submerged in seawater. Degradation by bacteria is most common in softwoods and is often found in hardwoods that are resistant to soft rot attack. Besides wood species with high lignin content and timbers treated with CCA show this type of bacterial degradation (Findlay, 1985).

Chemical preservation of boat building timbers

Making the condition inside the wood unsuitable for development and growth of wood destroying organisms can prevent the deterioration of wood. Chemical wood preservatives can be used for this purpose. The choice of the chemical preservative depends on the end use to which the wood is to be put and the length of service required. The preservative can be incorporated into the wood in the green condition or air-dried condition.

Single preservative treatment

Of the oil type preservatives, creosote is the most important. Creosote has been in use in wood preservation for more than 150 years. Creosote may be defined as those fractions of the distillates from coal tar that boils between 200 and 400°C. Recommended minimum retention levels in European waters are about 320 $kg.m^{-3}$ (Barnacle, 1976). The efficacy of oil type preservative against

fungal decay and insect attack is well established. They are easy to apply by brushing, spraying or steeping. Brushing or spraying of oil type preservative does not impart sufficient protection and it has to be repeated at regular intervals. Pressure treating the wood scantlings before boat building is the most thorough and consistent procedure for applying preservatives. The preservative penetrates deep into the wood in this process. In situations where pressure creosoting is not possible, steeping of the wood scantlings in the preservative in an open tank can be adopted. Experiments conducted in CIFT have shown that complete penetration of the preservative occurs in rubber wood planks of 25 mm thickness in 10 days. Several studies conducted in the tropical areas showed that in creosote treated tropical woods, retention below 160 $kg.m^{-3}$ did not confer protection. It is reported that the *Limnoria* sp. is tolerant to creosote. Two modified creosote formulations, *viz.*, arsenical creosote and copper creosote were subjected to field trials by treating small rubber wood panels and exposing the panels to estuarine, atmospheric and soil conditions. It was observed that treated panels remained free of attack at the end of five years exposure to soil and atmospheric conditions and three years under estuarine conditions (Edwin and Pillai, 2004).

The variable performance of creosote treatments in warmer waters has led to multi-stage treatments. In India, several researchers conducted series of tests on the effectiveness of CCA. In a general comparison, CCA treatment was rated more effective than creosote, especially against *Martesia* sp. However, two species of the genus *Sphaeroma*, *viz.*, *S. terebrans* and *S. triste* are also tolerant to CCA treated timber. The AWPA recommends a retention of 40 $kg.m^{-3}$ for pilings used in salt water. The Bureau of Indian Standards recommends CCA retention of 32 $kg.m^{-3}$. It is observed that CCA treatment brings about a reduction in mechanical strength of treated wood (Edwin & Thomas, 2000; Thomas *et al.*, 1998).

Multiple preservative treatments

Single preservative treatments involving both oil and water borne preservatives have inherent drawbacks. The effectiveness of multiple preservative treatments began to gain attention in the 1970s. Multiple preservative treatments involve dual treatment, double treatment and combination treatments. Dual treatment is the pressure impregnation of timber with copper based preservative followed by pressure treatment with creosote with an intermittent drying stage. Double treatment refers to CCA treatment followed by creosote in one complete cycle without intermediate drying while combination treatment is a double diffusion treatment followed by pressure creosoting.

Studies conducted at CIFT on dual treated *Mangifera indica* panels exposed to estuarine conditions showed better resistance to biodeterioration (Edwin *et al.*, 1993). Thomas *et al.* (1998) studied the effect of CCA and creosote on the compressive and static bending timbers, *viz.*, *Artocarpus hirsuta, Antiaris toxicaria, Mangifera indica, Lagerstromia lanceolata* and *Terminalia tomentosa*. The change in mechanical strength was minimum in dual treated panels.

In areas where pressure treatment facilities are limited combination treatment using copper based preservatives and creosote have proved better than single treatments. Adequate retention is necessary to give satisfactory protection against marine borers. Steeping in the water-borne preservative followed by oil-borne preservative with an intermittent drying period has been found to give adequate protection to planks to be used for boat building.

The cost of chemical preservative treatment is much less when compared to the traditional treatment using sardine oil, cashew nut shell liquid, etc. The cost of brush treatment with CCA followed by creosote was estimated to be Rs. 548 per annum (Nair *et al.*,1985). More effective penetration of the preservative can be brought by steeping the planks in the preservative solution prior to the construction of the canoe. The cost of incorporation of CCA and creosote in a two-stage treatment procedure is between Rs. 3,000 and 3,500, for treating scantlings for a canoe of 6.5 m in length.

Sheathing with FRP

The use of fibre laminates for protection, repair and strengthening of timber structures drew attention in the past decade. The primary function of the FRP sheathing is to provide strength and dimensional stability to the rubber wood and also to keep away moisture. Besides providing water proofing, the sheathing reduces maintenance, provides resistance to impact and abrasion, prevents attack of marine borers and other decay causing organisms, provides an extended service life and improves appearance of wooden fishing vessels. In the case of the rubber wood canoe, since FRP sheathing was given, the use of preservatives was minimized. It is observed that sealants can reduce exposure to the leaching of arsenic up to 75%. The construction is simple and can be taken up by traditional boat builders once a basic training is received.

The main material components can broadly be divided into reinforcement and resin. The primary function of the reinforcement is to strengthen the resin film and create a new structural element possessing properties, which neither component has. The most popular reinforcement is glass mat, the two main types being chopped strand mat and woven roving mat. The chopped strand mat is more

Table 1. Comparative cost of preservative treatment and sheathing for 6.5 m rubber wood canoe

Item	Preservative treated rubber wood canoe (Rs.)	FRP sheathed rubber wood canoe (Rs.)	Traditional *Aini* wood canoe (Rs.)
Cost of 15 cu.ft. wood	2,250.00	2,250.00	9,750.00
Cost of water-borne preservative	350.00	350.00	Nil
Cost of oil-borne preservative	2,600.00	-	Nil
Cost of FRP sheathing	-	6,500.00	-
Cost of traditional treatment	Nil	-	1,000.00
Labour cost	2,800.00	5,400.00	2,800.00
Total	8,000.00	14,500.00	13,550.00

commonly used for boat building because of its multi-directional strength. The surface mat is used for surface finishing. The glass mat is marketed in rolls similar to bolts of cloth. The thickness of the cloth varies with the weight of the glass in grams per m^2. Mats weighing 300 g and 450 g are locally available. The two major types of resins are the polyester and the epoxy resins. The polyester resin used here is a thermosetting resin made from unsaturated polyester. Polyester resins used for boat work usually contain 30-50% styrene. The catalyst used is methyl ethyl ketone peroxide (MEKP). Curing is usually initiated at room temperature by the addition of about 1-2% of the catalyst by weight. This is for activating the resin and allowing it's early thermosetting. An accelerator is usually used to increase the speed of the chemical reaction of the resin and the catalyst used. Cobalt acetate or cobalt naphthanate is used as accelerator. Both these agents cause the resin to set hard in a predetermined time.

Once the setting of the scantlings are over, the surface is cleaned and prepared very carefully. It is ensured that the wood is dry. According to experts, the adhesion bonding between wood and FRP is mainly by mechanical interlocking and chemical bonding. Dry wood contains 5-12% moisture. The surface is smoothened using a planing machine or sandpaper. Rough edges are made smooth. Care is taken to ensure that the surface is free from moisture, dirt and grease. The holes and perforations, if any, on the hull are closed using a mixture of fine saw dust and activated resin. It sets and covers the hole to form a smooth and firm surface. A coating of activated resin is applied on the degreased and cleaned surface. If presence of small perforations is noticed again, they are filled with putty. Immediately after application of the resin on the surface of the hull, a layer of chopped strand mat is laid over it. Two such coats are applied on the outside of the hull and one coat on the inside. This

continuous laying of the FRP sheath on the inside and the outside prevents the peeling away of the sheath. Skilled labourers are required for carrying out the sheathing work speedily to prevent setting of the resin and to prevent the formation of air bubbles. The comparative costs of the different types of canoes in Table 1. The cost of FRP sheathed rubber wood canoes of 6.0 m is approximately Rs. 15,000. This compares well with the cost of a traditional canoe of the same size made of conventional wood like *Artocarpus hirsuta*, which costs between Rs. 12,500 and 13,500. Use of FRP sheathing, thus, enables the fishermen to make efficient use of the under-utilized rubber wood for construction of small canoes.

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References

Anon (2000) *Handbook on Fisheries Statistics*, Dept. of Animal Husbandry and Dairying, Ministry of Agriculture, New Delhi: 153 p.

Barnacle, J.E. (1976) Wood and its preservation in the sea- a resume. In: *Proc. of the Fourth International Congress on Marine Corrosion and Fouling*, France: 57-67

Edwin, L and Thomas, S.N. (2000) Creosote and copper-chrome-arsenic (CCA) treatment on the compressive strength of *Adina cordifolia* (Haldu). *Fish. Technol.* 37 (1):1-4

Edwin, L., Thomas, S.N., Nair, N.U.K. and Ravindran K. (1993) Dual preservative treatment for small fishing vessels - observation on the biodeterioration of mango wood. In: *Low Energy Fishing*, Fishery Technology (Special Issue) Society of Fisheries Technologists (India), Cochin: 98 - 102

Edwin, L. and Pillai, A.G.G.K. (2004) Resistance of preservative treated rubber wood *(Hevea brasiliensis)* against marine wood borers, *Holz als Roh-und Werkstoff* 3: 303-306

Findlay, W.P.K. (1985). Agencies of destruction in preservation of timber in the tropics, p.15-43, Martinus Nijhoff / Dr. W. Junk Publishers, UK

Kumar, S. (1985) Wood preservation for marine use. In: *Harvest and Post Harvest Technology of Fish*, p. 151-159, Society of Fisheries Technologists (India), Cochin

Nair, N.U.K., Pillai, A.G.G.K., Ravindran, K. and Balasubramanyam, R. (1985) Wood Preservation –an appropriate technology for the use of small scale fishermen. In: *Harvest and Post Harvest Technology of Fish*, p. 160- 165, Society of Fisheries Technologists (India), Cochin

Thomas, S.N., Edwin, L. and Ravindran, K. (1998) Effect of single and dual preservative treatments on the strength of boat building timbers in *Advances and Priorities in Fisheries Technology* (Balachandran, K.K., Iyer T.S.G., Madhavan P., Joseph J., Perigreen, P.A., Raghunath, M.R. and Varghese M.D., Eds.), p. 117-120, Society of Fisheries Technologists (India), Cochin