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Utilization of Rubber Wood for Fishing Canoe Construction

Leela Edwin, Saly N. Thomas and B. Meenakumari
Central Institute of Fisheries Technology
Cochin - 682 029, India

The wood from the rubber tree (*Hevea brasiliensis*) comes as a by-product from the commercial plantations. The highly perishable nature of the wood makes it unsuitable for use such as boat building without chemical preservative treatment. This communication deals with the chemical preservative treatment of rubber wood with copper- chrome- arsenic (CCA), a water borne preservative and creosote an oil borne preservative through immersion in an open tank for the purpose of fishing canoe construction. The fabrication of the canoes was as per the method of construction of plank built canoes. Two canoes were made, one for use in brackish water and the other for use in the sea. The cost of construction was found to be lower than that of the conventional canoe. The performance monitoring shows that the canoes are free from physical damage and deterioration caused due to weathering and biological agencies.

Key words : Rubber wood, fishing canoes, wood preservative, CCA, creosote

In India, the conventional forest species of timbers used for the construction of fishing craft are becoming scarce and costlier. The artisanal fishermen still prefer wood because of the familiarity of this raw material and the expertise available locally in the fishing villages. In the search for alternative wood for indigenous boat building, rubber wood has come to find a place in the fishing industry too. The wood from the rubber tree (*Hevea brasiliensis*) comes as a by-product from the commercial rubber plantations after a useful life of nearly twenty-five years when they become uneconomical for latex production. The rubber plantations of the world are confined to the tropical and sub tropical regions and approximately 9 million hectares are under rubber cultivation of which 90% is located in Asia (Hong, 1995). In India about 0.57 million hectares are presently under rubber cultivation as per the estimates of the Rubber Board of India. The production of rubber wood in the country for the year 2001-2002 is 2073000 cu.m. and the current yield of rubber wood per hectare is 150 m^3 from small holdings (Anon, 2002). The stem wood, which forms 60% of the total yield, goes for industrial uses whereas the rest 40% (branch wood) is used for firewood especially for the brick industry. 62.5% of the stem wood is used by the packing case industry, 22.5% by the plywood veneer sector, 10% for the secondary processing industry and 3% for the match industry.

The favourable physical and mechanical properties of the wood have made rubber wood popular for furniture making and wood working in the recent years. The highly perishable nature of the wood, due to its susceptibility to the attack of fungi and borers makes it less suitable for uses such as boat building without proper chemical preservative treatment. Although systematic data on the natural durability of most commercial timbers for land use are available the same is not the case with marine use (Kumar, 1985). The physical and mechanical properties of untreated rubber wood has been studied earlier (Gnanaharan & Dhamodaran, 1993, Gnanaharan, 1996, Edwin & Pillai, 2004). The working qualities of the wood and its suitability indices were worked out by Shukla & Lal, (1985) Gnanaharan (1996). The scope of upgrading this timber through chemical preservative treatment for land use has also been studied by Hong *et al* (1982), Gnanaharan & Mathew, (1982) and Dhamodaran & Gnanaharan (1994).

Studies on the performance of rubber wood under aquatic conditions are not many. Preliminary studies have been conducted on the resistance of rubber wood to marine borers (Cheriyan *et al.*, 1979, Tewari, *et al.*, 1984, Rao, *et al.*, 1993, Edwin & Pillai, 2004). The durability of dual preservative treated rubber wood under marine conditions has been established by studies conducted in CIFT (Edwin & Pillai, 2004). These studies reveal the potential of preservative treatment for increasing the durability of this timber and utilizing it even in the rigorous marine environment.

The main objective of this study is to find out the feasibility of constructing small canoes out of preservative treated rubber wood and to evaluate the performance of these canoes under actual field conditions.

Materials and Methods

The rubber wood used for the construction of the canoes was from a plantation grown tree twenty years old. The wood had a pale creamy yellow colour with medium texture. The planks were sawn to a length of approximately 210 cm with a thickness of 3 cm as against the usual thickness of 2.5 cm for the planks of conventional wood. The biocides used for preservation of the rubber wood were Copper-Chrome-Arsenic (CCA) and light creosote oil of 1.06 specific gravity.

A cement tank of size 700cm x 0.75cm x 0.75cm was used for preservative treatment. The freshly sawn planks were given an initial dip treatment for about five minutes in 2% CCA solution and kept for air seasoning. The seasoned planks were shaped into scantlings before the actual preservative treatment. The period of immersion of the rubber wood planks in CCA and creosote was standardized through trial and error method in the laboratory. The first stage of the actual treatment procedure consists of the steeping of the scantlings in 7.5% CCA solution at atmospheric temperature for 10 days. The scantlings were kept weighted from floating. Drying of the planks followed this. On reaching moisture content of approximately 25% the planks were kept immersed in the creosote for seven days. Stabilization of the moisture content of freshly sawn planks and the treated planks were achieved through standard air seasoning techniques. The planks were placed on crossers approximately 0.5m apart to prevent warping. Care was taken to keep the planks 10cm off the ground. Gaps of about 2.5cm were left between planks in all layers to allow vertical movement of air. Moisture content of the wood during pretreatment was monitored using a portable moisture meter.

The preservative retention of the scantlings was calculated as per ASTM 2481-81. The extent of penetration of CCA into the wood was found out by the spot test (Anon, 1970). In the traditional method of construction, coir/polypropylene ropes and strands are usually used for tying the planks. The effect of the preservative on the tensile strength of the coir and polypropylene was also studied. The ropes were kept immersed in CCA and creosote separately for 15 days each. One set of CCA treated material was again immersed in creosote after drying and the tensile strength of all samples found out in the Universal Testing Machine (1kN, Shimadzu). The effect of the preservatives on the treated and unexposed samples of rubber wood was studied earlier (Edwin & Pillai, 2004). The change in the compressive stress of dual preservative treated rubber wood samples after exposure to atmospheric and soil conditions for five years were studied. The results of the studies on the effect of the environment on the compressive stress of dual preservative treated samples exposed to marine conditions (Edwin & Pillai, 2004) also helped in the present project. The results obtained from these laboratory and the field studies led to the construction of two prototype canoes for use in the backwaters and the sea.

The canoes were constructed as per the traditional method of plank built canoe construction by carvel planking. The workability of the treated wood was studied during the construction period. The floatation and buoyancy characteristics were also tested after construction. The cost of construction was also worked out with the prevailing cost of materials and accessories for boat building and compared with the cost of construction of a conventional *aini* (*Artocarpus hirsuta)* canoe. The monitoring of the performance of these canoes is done on a monthly basis using a schedule to assess physical damage and deterioration caused due to weathering and biological agencies.

Results and discussion

It was observed that the dip treatment given to freshly cut planks helped in preventing fungal attack. The moisture content of the freshly cut planks was more than 70%. The air seasoning of the planks through horizontal stacking did not cause warping of the scantlings. The moisture content of approximately 25% could be achieved through this seasoning method. Sharma & Kukreti (1981) have observed that the moisture content of kiln-dried planks of rubber wood of 28mm thickness reduced from 64.8 - 90.3% to 9.2 - 11.8% within 4 days. Gnanaharan (1996) has reported that rubber wood can be dried free from surface and end cracking within reasonably short periods.

The rubber selected had a specific gravity of 0.51. The basic density of the wood is reported to be 435-626 kg/cu.m (Gnanaharan, 1996). The rubber wood is classified as a moderately refractory timber (BIS, 1993). The wood was amenable to treatment and absorbed the preservative on immersion in ten days. It has been found that preservative treatment of even non-durable timbers improves its life in marine waters and their behaviour was better than naturally durable timbers used without any treatment. CCA and creosote are the most commonly used preservatives in the water borne type and the oil borne type respectively. CCA is the most widely used wood preservative in current use due to its excellent fungicidal and insecticidal properties. Retention level of 16 kg/cu.m in the case of CCA has been found to be quite effective in resisting borer attack in seawater (Kumar, 1985). As for creosote the long-term performance as a preservative in ground contact and for use in marine waters has been well established.

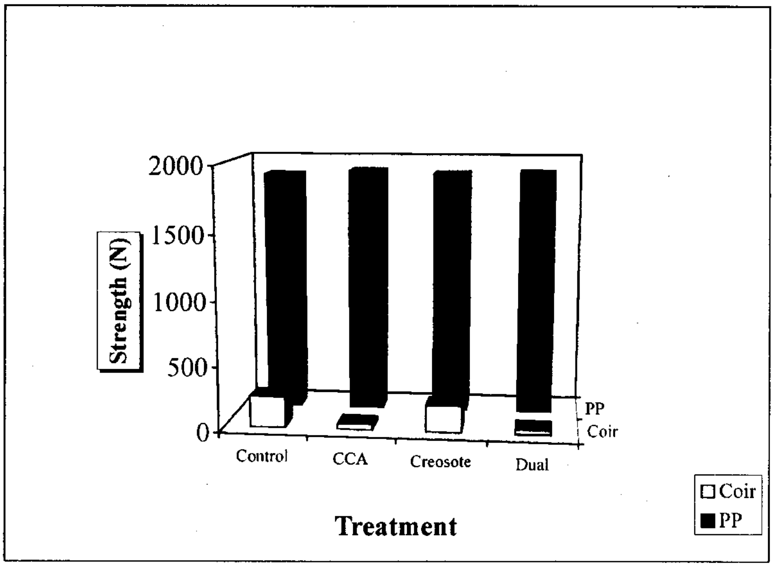

Fig. 1. Tensile Strength of treated coir and polypropylene ropes

The preservative concentration of 7.5% was arrived at for marine purposes after many studies conducted on secondary species of timber. Lesser concentrations of CCA when used along with creosote were not found to affect the strength of wood (Edwin *et al*, 1993, Thomas *et al*, 1998). Immersion of the scantlings in 7.5% CCA solution for ten days brought about an average CCA retention of 8.4 kg/m^3. The average creosote retention of the panels kept immersed in creosote was 136 kg/m^3. The pressure impregnation of rubber wood panels by CCA and creosote at 5.2 kg/m^3 pressure for 90 min yielded retention of 16 kg/m^3 and 160 kg/m^3 respectively (Edwin and Pillai, 2004). The additional plank thickness ensured that the slightly less density of rubber wood would not affect the total weight of the vessel. The preservative requirement of processed rubber wood as advocated by the Rubber Board of India is a dry salt retention of 8.0 kg/m^3 of CCA /CCB for timber not in direct contact with the ground but exposed with a minimum penetration of 19mm (Anon, 2003). Since a combination treatment of CCA and creosote was envisaged the retentions obtained were found to be suitable. In the case of planks used for canoe construction complete penetration through the depth of the plank could be obtained. This was indicated by the development of a pale purple colour over the entire cross section of the planks.

Since pressure impregnation of preservatives for boat building timbers is a technology that is not easily accessible to the poor artisanal fishermen, absorption of both CCA and creosote into the wood was brought about by immersion treatment by steeping the planks in the preservative solutions. The absorption of the CCA preservative followed by creosote brought about an increase in specific gravity of rubber to 0.645.

The dual preservative treatment technology involving the pressure impregnation of a water borne preservative followed by oil borne preservative with an intermittent drying period was used in the treatment of the experimental panels also. The dual treated panels showed no signs of biodeterioration at the end of 33 months of exposure in seawater (Edwin & Pillai, 2004). The superior performance of dual treatment over single treatment under field conditions has been reported earlier (Johnson1977, Edwin *et al.*, 1993, Thomas *et al.*, 1998). The dual preservative treatment technology was modified to suit the conditions in the field and a treatment technology involving the steeping of the wood in the preservative for a longer period was employed in the construction of the canoes.

The work conducted by Gnanaharan & Dhamodaran (1993) showed that the mechanical properties of rubber wood compare well with that of teak and other commonly grown timbers of Kerala. Compressive stress at maximum force did not show any significant difference between treated control panels and treated panels exposed to seawater for 33 months at 5% and 1% level (Edwin & Pillai, 2004) in this study. The working qualities of the wood were found to be good as observed during the different stages of construction. Sawing, machining and planing, are easy but turning was slightly difficult and mortising and boring did not give a clear surface (Shukla *et al*, 1985, Gnanaharan 1996, Anon, 2003). The working quality index of rubber wood reported in this study is 131 as against 100 for teak (Anon, 2003). It is also seen that rubber wood offers good resistance to screw and nail withdrawal forces.

The impact of wood preservatives on the strength of coir and polypropylene ropes kept immersed in CCA solution, creosote and in creosote and CCA solutions one after another are shown in Fig 1. Results of the tensile test showed that when CCA is incorporated into coir only 17% of the original strength was retained whereas in the case of creosote there was 90% retention of strength. However in the case of coir subjected to both treatments strength retention of only 14% could be observed. In the case of polypropylene tensile strength did not show any significant difference between control and ropes treated with CCA, creosote and with both CCA and creosote. Studies on the preservation of coir showed that for coir that are to be used under water for a long period tannin – coal tar treatment is better and prolongs the life of the gear by almost three times (Nayar & Naidu, 1962). The effect of preservatives on different natural fibres including coir show that treatment with copper compounds is not effective (Kuriyan, *et al*, 1962). Hence untreated ropes were used for the construction of the rubber wood canoe.

The backbone of the vessel was shaped from a single plank. Two planks attached on the fore and aft of the backbone give the characteristic curvature to the canoe. Three planks are used on either side of the keel. Another feature of this deckless craft is the presence of cross planks for the fishermen to sit. Holes are made near the edges of the side planks for tying them together. This is a prerequisite for the construction of plank built canoes of this area. This presetting and shaping of the planks ensures minimum carpentry work after preservative treatment. The planks were then dismantled for the preservative treatment. Caulking of the seams was done by coconut husk fibre sprinkled with coconut oil as in the traditional method of construction. Although the traditional method of construction of plank built canoes was adopted no traditional method of treatment of wood was used before or after construction. Two canoes were made one for marine fishing and the other for backwater fishing. The elevation and plan of the canoe (6.47 m LOA) for marine fishing are given in the figure 2 and the important dimensions of the canoe are given in Table 1.

Table 1. Important dimensions of the canoes

Specification	Canoe for marine fishing	Canoe for back water fishing
Length (m)	6.4	6.05
Breadth (m)	0.83	0.77
Depth (m)	0.42	0.39
Plank thickness (cm)	3.18	3.18
No. of cross planks	6	5
No. of ribs	4	3

The wood of jungle jack (*Artocarpus hirsuta*, local name: *aini*) is commonly used for traditional craft construction in this part of the country. The comparison of the cost of treated rubber wood canoe with that of the *aini* wood canoe shows that the cost of the former is about 40% lesser than an aini canoe of the same size. The costs of construction of both types of canoes are given in table 2. The expenditure involved for the traditional method of wood preservation is also taken into account in the case of the *aini* canoe as these forms an inevitable stage in the construction of any artisanal craft. In an earlier study, the annual expenditure involved for the chemical preservative treatment of a *thanguvallom* (plank built canoe) of 15m length using CCA and creosote was estimated to be Rs.548 in 1985 (Nair *et al*, 1985).

Table 2. Construction cost of rubber wood canoe and *Aini* wood canoe

Item	Rubber wood canoe (in Rupees)	*Aini* wood canoe (in Rupees)
Cost of 15 cu.ft. wood	2250.00 (@ 150.00/cu.ft.)	9750.00 (@ 650.00/cu.ft.)
Cost of water borne preservative	350.00	Nil
Cost of oil preservative	2600.00	Nil
Cost of traditional treatment	Nil	1000.00
Labour cost	2800.00	2800.00
Total	8000.00	13550.00

The canoes have been given for experimental fishing to artisanal fishermen operating gillnets in the backwaters and the sea for the past 26 months. Performance evaluation showed that the canoes are as good as conventional canoes. They are being inspected periodically to find out the resistance to decay by bacteria and fungi, marine borer attack, cracking due to weathering, other physical damage due to abrasion and change

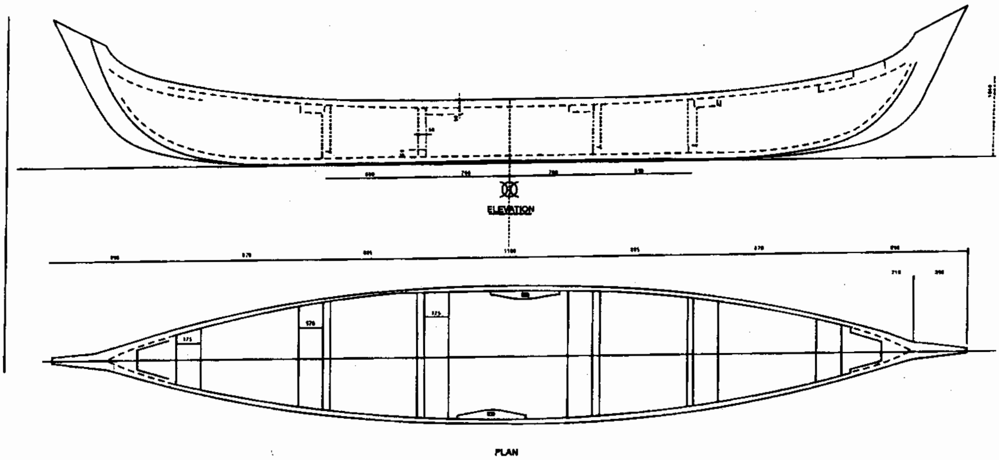

Fig. 2. Elevation and Plan of 6.47 m LOA rubber wood canoe

in colour. It is found that the canoes are performing well and there is no deterioration by biological or physical agencies.

Rubber wood, which comes as a by-product from the rubber plantations, can be efficiently utilized after upgrading by chemical preservative treatment. This would bring an extra income to the cultivators or rubber, who often face difficulties due to the fluctuating prices of latex. It is to be further noted that the forest cover of India is much below the stipulated area. Therefore there is an imminent need to lessen deforestation. The utilisation of rubber wood for marine purposes may to a modest extent reduce deforestation and thus help in maintaining the ecological stability and help in conserving our fast deteriorating environment in the long run. Further studies are being taken up at the Central Institute of Fisheries Technology on the efficient utilization of this environment friendly timber for marine applications.

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