

FRP sheathed rubber wood canoes – A cost effective technology for the artisanal fisheries sector

Leela Edwin and B. Meenakumari

Central Institute of Fisheries Technology, Cochin, India

E-mail : leela@ciftmail.org

Abstract

Wood of the rubber tree (*Hevea brasiliensis*) is an under- utilised agricultural by product, which can be upgraded through preservative treatment for the construction of fishing canoes. Two such canoes of length 6.4m and 6.05m were constructed. The canoes have been given for experimental fishing to artisanal fishermen operating in the backwater sand in the sea for the past 29 months and are now being operated successfully by fishermen in the sea and in backwaters.

Keywords : Rubber wood, FRP, Canoes

Introduction

The best-known traditional material for boat construction is wood but the shrinking forest resources the world over restricts its wide spread use. As a construction material wood offers many advantages like good strength to weight ratio, workability, load bearing capacity, tensile, elastic strength etc. But its disadvantages like its high susceptibility to wood destroying organisms, anisotropy, non-homogeneity compounded by the wide variations in the material properties necessitates its sufficient protection under adverse natural conditions. Though timber is in short supply but 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. 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 in India uses about 20,000 cu. m. of timber for annual replacement alone whereas requirement of timber for marine purposes have been estimated to 0.1 million m³ (Kumar, 1985).

Utilisation of Rubber wood

Wood of the rubber tree (*Hevea brasiliensis*) is an under- utilised agricultural by product, which can be upgraded through preservative treatment for the construction of fishing canoes. According to the FAO statistics of 1999 India was the 6th largest producer of rubber

wood in the world with 374000 ha under rubber cultivation. Being naturally non-durable, rubber wood is not economically usable without preservative treatment. However its good working properties makes it suitable for a number of applications. From the studies conducted on rubber wood it is seen that the mechanical strength properties of the wood compares well with that of teak, which is classified as one of the best timbers for boat building. Preliminary studies were conducted by treating rubber wood with three different wood preservatives viz. copper creosote, arsenical creosote and dual preservative and exposed at the test site at Cochin harbour. The untreated panels were destroyed within 6 months whereas it was found that the preservative treatment prevented biodeterioration of experimental panels under marine conditions as assessed through visual observations, X-ray photographs and mechanical strength testing (Edwin and Pillai, 2004). Treated rubber wood panels were also exposed to soil and atmospheric conditions and assessed for loss in strength after 60 months. It was found that there was no significant difference in strength when compared to treated panels that were not exposed to field conditions. The dual preservative treatment technology ie pressure treatment with water borne preservative (CCA) followed by pressure treatment with oil borne preservative (creosote) was found best suited for marine purposes (Findlay 1985). This was suitably modified to suit the conditions in the field and a treatment technology involving the steeping of wood in the preservative for a longer period was employed for the construction of the canoes. Two such canoes of length 6.4m and 6.05m were constructed. The canoes have been given for experimental fishing to artisanal fishermen operating in the backwater sand in the sea for the past 29 months and are now being operated successfully by fishermen in the sea and in backwaters. Periodic monitoring shows that there is no deterioration by biological or physical agencies (Edwin *et al*, 2003 & 2005).

Fibre glass reinforced plastic timber structures

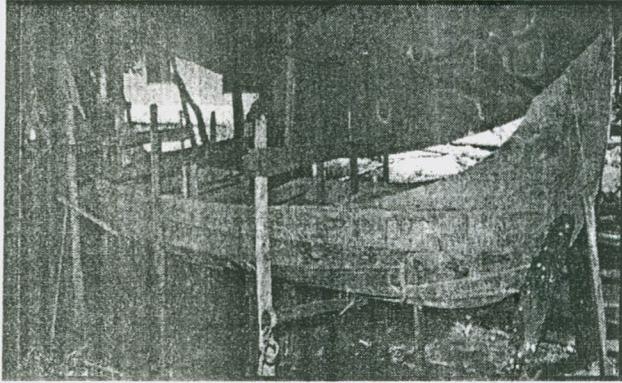
Historically, FRP as a boat building material was developed for military purposes in North America in the late 1940s. Studies on using fibreglass to reinforce timber structures started in the 1960s. The thermosetting resin provides chemical, moisture and temperature resistance while fibreglass reinforcement increases strength and provides good performance over a wide temperature range. Wangaard (1964) and Biblis (1965) studied the effect of bonding fibreglass and epoxy reinforced plastic to the compression and tension faces of the wood cores of a number of wood species. In the nineties research on wood beams reinforced with fibreglass reinforced plastic and other materials have been initiated. The benefits of reinforcing glulam beams of eastern Hemlock, an under utilized species of wood with fibreglass reinforced plastic was also studied (Dagher *et al*, 1996). The U Maine Advanced Engineering Wood Composite Centre has been researching and perfecting the use of FRP wood structures for bridge decks and other purposes. Studies have been conducted on the properties of sheathing materials, the fibres and fabrics used in the sheathing process, evaluation of the sheathing materials and has briefly reviewed the hull sheath interactions (Schindler). Anido

and Xu, 2002 Studies have also been conducted on the physical properties such as water absorption, glass content, abrasion resistance and mechanical properties like static bending test and compression parallel to grain test of FRP sheathed rubber wood experimental panels in the laboratory (Edwin and Meenakumari, unpublished)

This paper describes an experimental study on reinforcing small canoes made of Chromated -copper- arsenate (CCA) treated rubber wood with fibreglass-reinforced plastic (FRP). The main aim of the experiment is to provide a cost effective material and technology to build a fishing craft for the artisanal sector.

Construction procedure

As a logical sequel to the construction of canoes made of treated rubber wood, canoes were made out of rubber wood and sheathed with FRP. The difference between the two types was that scantlings were given only a single preservative treatment. The preservative used was copper-chrome-arsenic (CCA). Planks of 2.0 cm thickness were sawn from the rubber wood about 25 years old. The freshly sawn planks were given a dip treatment for less than 5 minutes in the water borne preservative solution, as a prophylactic treatment to avoid sap stain and during air (copper-chrome-preservative 2 are then kept for stacking them about 0.5 m a about 2.5 cm. attaining below 25% was according to the canoe. The kept immersed in

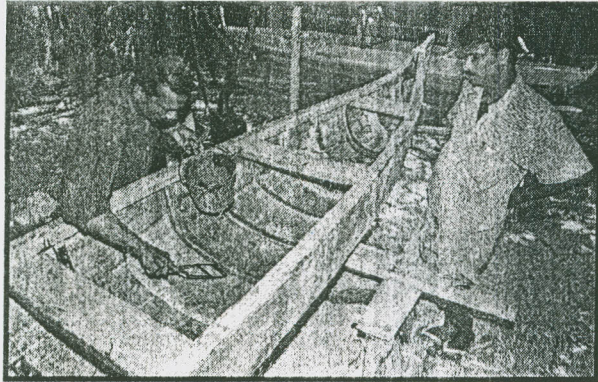


insect attack seasoning arsenic %). The planks air seasoning by horizontally part with gaps of The planks on moisture content set and shaped shape of the scantlings were 7.5% solution of

CCA in a cement tank constructed for this purpose. They were kept weighted to prevent them from floating in the preservative solution. After a period of 10 days the scantlings were retrieved and again allowed to air season as described earlier. Once the scantlings have achieved moisture content of 25% the scantlings were screwed to the hull frames with copper tacks. In the traditional method of construction of plank built canoes in the southwest coast of India the planks are held together by stitching with coir/ polypropylene strands and the joints caulked using coconut fibre and cotton. The major difference in the construction procedure, as compared to the method of construction of the rubber wood canoes made earlier, was the elimination of one stage of the preservative treatment. The second stage of treatment involving the immersion in the oil borne preservative is eliminated as the FRP

sheathing provides the necessary protection. This also saves nearly ten days for preservative treatment and subsequent drying period. Stitching of the planking has been avoided in this method of construction. Instead the rivetting holds the planks edge to edge tightly. Cotton and putty (mixture of chalk powder and resin) seals the gaps between planks. Once the setting of the scantlings are over the surface is cleaned and prepared very carefully. It is ensured that the wood is dry. 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. Thus the surface is carefully prepared for application of the sheathing.



The three main components of FRP sheathing are resin, the glass reinforcement and the wood substrate. The major types of resins for sheathing are polyester and epoxy. Since of these two types, the epoxy resins exhibit much greater adhesion, superior flexibility, resilience, resistance to impact and less shrinkage they are more

suited for sheathing wooden boats. The reinforcement used is chopped strand mat because it offers multidirectional strength. Surface mat is used for a smooth finish of the sheathed surface. The holes/ 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- off of the sheath. Sometimes in this type of construction, a projecting rim of a flat wooden piece of about 2.5 cm in width is screwed to the body of the hull along the entire length of the sheathing, after one layer of fibreglass has been laid. A layer of chopped strand mat is applied on top of the rim. This beading ensures that the sheathing remains in tact even under rough conditions of operation. 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.

Cost of Construction

The cost of FRP sheathed rubber wood canoes of about 6.05 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 aini (*Artocarpus hirsuta*), which costs Rs. 13,550.

The cost of a canoe made of rubber wood treated with water borne and oil borne preservative is Rs.8000/ only. The FRP sheathed rubber wood canoe is expected to give a maintenance free life unlike the conventional canoe for which Rs. 1000/ is incurred annually on maintenance using traditional wood preservatives like sardine oil, cashewnut shell liquid, animal fats, plant resins etc. Greater durability is expected for these types of canoes. A comparison of the cost of construction of treated rubber wood canoe, conventional aini

Table 1 Comparative cost of construction of treated rubber wood canoe, conventional aini wood canoe and FRP sheathed canoe

Item	Rubber wood canoe (in Rupees)	Conventional canoe (in Rupees)	FRP sheathed canoe
Cost of 15 cu ft. wood	2250.00 @ 150/cu.ft	9750 @ 650/cu.ft	2250 @ 150/cu.ft
Cost of CCA	350	-	350
Cost of creosote	2600	-	-
Traditional treatment / FRP sheathing	-	1000	7500
Labour	2800	2800	4500
Total	8000	13,550	14,600

wood canoe and FRP sheathed canoe is given in table. 1.

Performance monitoring

As the first FRP sheathed rubber wood canoe proved to be popular among fishermen operating gillnets at sea in Kannur. In north Kerala two more such prototype canoes were fabricated and given for experimental fishing. The second is being operated in the backwaters for gill netting and the third is being used for lime shell collection in the backwaters. These canoes were distributed through fishermen co-operative societies. The canoes are periodically checked by visual



inspection. The sheath is checked for localized cracks, blistering and wear and tear due to abrasion. After nearly 20 months the canoes have been found in good condition. Slight abrasion has been noticed in areas where the paddles abrade against the side of the craft. In these areas one layer of sheath would provide enough abrasion resistance.

Conclusion

The primary function of the FRP sheathing is to provide strength and dimensional stability to the rubber wood. Besides providing waterproofing, 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 FRP sheathing was given to minimise the use of chemical preservatives. The construction is simple and can be taken up by traditional boat builders once a basic training is received. Thus FRP enables the fishermen to make efficient use of the under utilised rubber wood for small canoe construction.

Acknowledgement

The authors wish to extend their deep sense of gratitude to Dr.K.Devadasan, Director CIFT for the unstinted support and encouragement.

References

- Anido, Robert Lopez and Han Xu (2002). Structural characterization of hybrid fibre reinforced polymer -glulam panels for bridge decks *Journal of Composites for Construction* Vol.6 No.3
- Biblis, E.J (1965). Analysis of wood fibre glass composite beams within and beyond the elastic regions *Forest Products Journal* 15 (2): 81-88
- Dagher, H.J., Tod E. Kimball and Stephen M. Shaler (1996). Effect of FRP reinforcement on low grade eastern hemlock glulam in Ritter, M.A., Duwadi, S.R., Lee, P.D.H. ed(s) National Conference on wood transportation structures October 23-25 Madison, Gen-Tech. Rep FPL-GTR-94
- Edwin Leela and A.G. Gopalakrishna Pillai (2004). Resistance of preservative treated rubber wood (*Hevea brasiliensis*) to marine borers. *Holz Roh Werkst* 62 : 303-306
- Edwin Leela, Saly N. Thomas and B. Meenakumari (2003). Rubber wood, can it replace other hardwoods in boat building? *Infofish International* 5
- Edwin Leela, Saly N. Thomas and B. Meenakumari (2005). Utilisation of rubber wood for fishing canoe construction *Fishery Technology*, Vol. 42 (1) pp 47-54

Edwin Leela and B. Meenakumari (unpublished). FRP sheathed rubber wood – a structural material for construction of small fishing canoes

Kumar, S (1985) Wood preservation practices for marine applications in Harvest and Post Harvest Technology of Fish (Ravindran, K., Nair, N.U., Pergreen, P.A., Madhavan, P., Gopalakrishna Pillai, A.G., Panicker, P. A. and Mary Thomas Eds.) Society of Fisheries Technologists (India), Cochin

Wangaard, F (1964). Elastic deflection of wood –fibreglass composite beams Forest Products Journal 14(6):256-260

Windorski, Daniel, F., Lawrence A.Soltis, Robert J. Ross. Forest product Laboratory Research Paper FPL-RP-562 9p