EXPERIMENTS WITH FIBRE-GLASS SHEATHING AS A PROTECTION AGAINST MARINE WOOD-BORING ORGANISMS

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Wooden test panels of different species of wood sheathed with fibre-glass reinforced plastic were subjected to immersion tests along with corresponding controls in Cochin Port area and the effect of the protective coating studied.

INTRODUCTION

Wooden hulls of fishing boats that are constantly in contact with sea-water (hull below water-line) are subject to rapid destruction by the attack of many marine wood-boring organisms on them. The indigenous timbers that are now in use in fishing boat construction are not able to resist the borer attack for a considerable length of time unless they are adequately protected (Balasubramanyan 1963). Sheathing the wooden hull below water-line either with copper or aluminium alloy plates is the well known conventional protective measure that is now being adopted.

British Patent No. 824301 describes a protective sheathing process for wooden vessels wherein treated nylon cloth and resorcinal resin form a tough impervious coating on the hull which becomes completely resistant to marine borers. The use of fibreglass in boat-building industry has

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increased considerably over the last few years. Though fibreglass is extensively used as an insulant in fish-holds and cold rooms, practically no effort has so far been made to evaluate the exact resistance of fibreglass reinforced plastic sheathing on wooden hulls as a measure of protection against the marine organisms.

Investigations on the use of fibreglass sheathing as a substitute for the conventional copper or aluminium alloy plates on the hulls of the modern mechanised fishing boats and the extent of protection that could be obtained by this new sheathing material against the marine wood boring and fouling organisms in the tropical warm waters of India are presented in this paper.

Materials and Methods

Well seasoned wooden test blocks measuring 15cm × 6cm × 3.75cm each were selected for the purpose of sheathing them with fibre-glass material. *Aini* ro *Anjili (Artocarpus hirsuta)*, Mango *(Mangifera indica)* and Haldu *(Adina cardifolia)* were the different boat building timbers chosen along with marine grade plywood panels manufactured to Indian Standard \$pecification using White Cedar *(Dysoxylum malabaricum)* for the face and 'Pali' *(Palanquim ellipticum)* for the core. The sheathing material for the reinforcement was the indigenous fibre-glass chopped strand mat weighing approximately 1½oz per sq ft. (450g./m²). The resin used was a polyester variety with Methyl ethyl ketone peroxide as the catalyst and Cobalt naphthenate as the accelerator.

The bare wooden surfaces of the test boards were first thoroughly wetted with resin and a layer of fibreglass chopped strand mat of the above specification was laid and pressed with a paint brush with a further quantity of the resin. After partial drying of the surface, a second layer of fibre glass mat was also fixed and the surface wetted uniformly using a resin soaked brush (Fig 1). Each wooden test board was completely sheathed on all sides including the narrow ends. Post curing for a period of 4 weeks under room temperature was allowed before the panels were properly marked for easy identification. One set of wooden test blocks without sheathing was used as control for comparison.

Results

The test boards prepared were fixed in specially fabricated racks and immersed at suitable depth at different locations in the Port of Cochin (Kerala, India) where the marine organisms were predominant and at a time when they showed maximum amount of settlement. The exposed panels were lifted for inspection once in thirty days for a period of one year during 1962-63 and the general conditions of the test boards as well as the quantity and quality of the marine organisms that settled on them and more particularly the surface borer holes were carefully noted and recorded. The fouling organisms were scraped off the panels at the end of every inspection so as to accelerate further borer attack without any possible impediment due to fouling.

Hydrographical data mainly comprising of water temperature, salinity, pH and dissolved oxygen at the test site for the entire period of observation were recorded

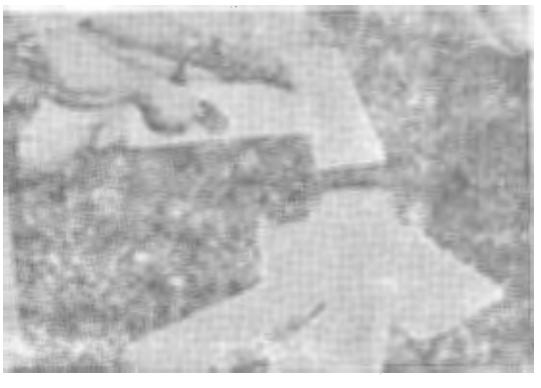

Fig 1. Wooden test panels being sheathed with fibreglass reinforced plastics (FRP)

TABLE I MONTHLY AVERAGES OF THE HYDROGRAPHICAL FACTORS AT THE TEST SITE DURING 1962–1963.

Hydrographical details	Sept 1962	Oct 1962	Nov 1962	Dec 1962	Jan 1963	Feb 1963	March 1963	April 1963	May 1963	June 1963	July 1963	Aug 1963
Water temperature O°C	29	29.5	31.0	30.2	28.2	28.7	31.1	31.4	31.4	29.1	28.6	28.4
Salinity ‰	2.65	3.58	12.1	28.7	29.0	31.0	30.5	29.9	27.0	15.7	2.8	2.1
pH	7.5	7.5	7.6	7.9	7.4	7.6	7.4	7.5	7.5	7.6	7.5	7.5
Dissolved oxygen ml/l	6.0	6.1	8.0	5.8	4.5	5.2	6.0	4.9	5.0	5.5	5.9	6.9

(Table 1). and all the marine organisms encountered were listed. At the end of an year's continuous exposure, the panels were withdrawn and the condition of each was critically examined with a view to assessing the damages caused by the marine organisms and the efficiency of the new protective sheathing material.

The surface borer holes were carefully noted by actual counting and the external damages expressed as % of the total area exposed (Balasubramanyan, *loc cit*). By scraping the surface and peeling off the sheathing material, further examination was made to record their conditions. The marine plywood was carefully de-laminated to ascertain internal timber damage caused by the different wood borers. The observations on the control panels are presented in Table II. It is seen from the table that none of the controls survived beyond 11 months of immersion. But all the sheathed panels were in tact with no external or internal damage even after one year of continuous immersion. The attack on control panels was mostly by *Martesia striata*, *Nausitora hedleyi*, *Teredo furcillatus* and *Sphaeroma terabrans*.

At the final inspection at the end of 360 days of continuous immersion to the free attack of the marine organisms, all the fibre glass sheathed wooden panels provided a normal settling surface to most of the common fouling organisms as the unsheathed controls did.

TABLE 2 MARINE WOOD BORER ATTACK ON CONTROL PANELS OF DIFFERENT SPECIES OF TIMBERS

(Value expressed as % of total area attacked)

Month of observation	*Artocarpus hirsuta*	*Mangifera indica*	*Adina cardifolia*	Marine plywood
Sep '62	Nil	Nil	Nil	Nil
Oct. ,,	10	20	20	15
Nov ,,	25	35	30	25
Dec ,,	35	45	40	30
Jan '63	40	55	50	35
Feb ,,	45	60	55	45
Mar ,,	50	75	65	55
Apr ,,	55	100 (removed)	80	70
May ,,	70		90	85
Jun ,,	85		100 (removed)	100 (removed)
Jul	100 (removed)			

The chief marine wood borers of India are 2 species of *Martesia*, 28 species of ship-worms, a variety of *Sphaeroma* including 4 identified species and 9 species of *Limnoria*, of which all the 2 species of *Martesia*, 11 species of ship-worms and 3 species of *Sphaeroma* have been reported to be present in the Cochin waters (Nair 1964). At the Central Institute of Fisheries Technology test site where the present exposure studies were conducted, the author has reported that *Nausitora hedleyi*, *Martesia striata* and *Sphaeroma terebrans* were the most devastating wood borers

that often show a maximum density of occurrence (Balasubramanyan 1963). During the current observation, the presence of *Teredo furcillatus* at the test site has also been recorded in addition to the above mentioned organisms.

The unsheathed controls exhibited the first evidence of borer attack during the second inspection in the month of October as revealed by the presence of surface holes. The borer attack appears to have been initiated on the unprotected controls roughly between 40 and 45days of immersion. At every inspection it was observed that the attack of the marine wood borers on the unprotected controls were on the increase and before 6 months were completed, more than 50% damages were noted on them (Figs, 2 & 3). The fibre glass sheathed wooden test panels were however free from any damage. The timber damages were caused mostly by *Martesia striata* (80%) and to a lesser extent by *Nausitora hedleyi* and *Teredo furcillatus* (20%). As regards the hydrographical features at the test site, salinity of the water appears to have the greatest influence on the marine boring and fouling organisms. From November onwards till May the salinity of the water was steadily increasing and simultaneously the quality and quantity of the marine organisms were on the increase as observed previously by Balasubramanyan *(loc cit.)* and Nair (1965). It was interesting to note that the acorn barnacles, *Balanus amphitrite,* which are known to plough into paint coatings with the sharp growing edges of their shells could not do so with the fibre-glass sheathing though they were settling on them in large numbers.

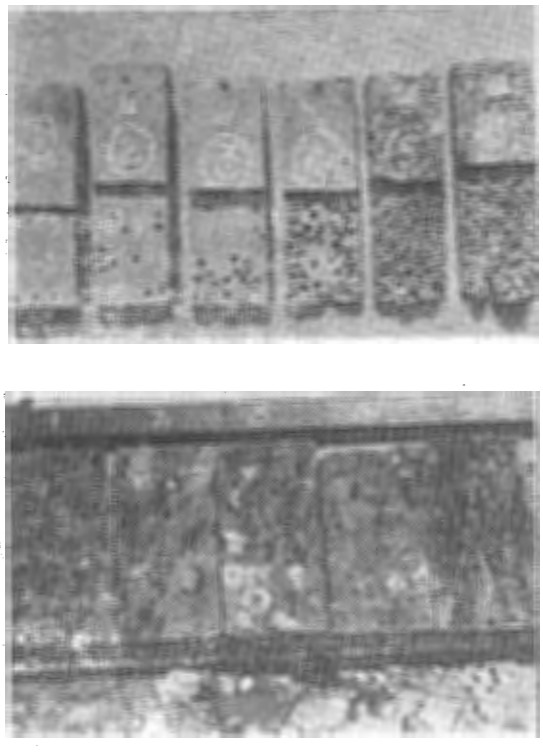

Fig 2 & 3. Pattern of marine borer attack on unprotected wooden test blocks (contrel) at the C. I. F. T Test Site, Cochin.

Discussion

Ply-wood specially fabricated and recommended for the construction of marine crafts in an untreated condition is liable to be severely damaged by marine wood borers under prolonged immersion as witnessed during the present investigation. Both the species of timbers 'White cedar' *(Dysoxylum malabaricum)* and 'Pali' *(Palanquium ellipticum)* like the other varieties do not possess adequate natural resistance against marine borers.

The fibre glass reinforced plastic should undoubtedly be credited for its special characteristics as a sheathing material as it withstood the continuous immersion without being attacked by *Martesia striata* (Fig 4) which is considered to be notorious for its boring habits. This pholadid is capable of boring into stones, coral rocks, lead sheathing, brick works and concrete structures, (Annandale, 1923, McGlashan, 1924, Springer *et, al* 1960). An instance of *Martesia striata* repeatedly attacking plastic sheets (PERSPEX - Methyl methacrylate) of 1/8" thickness in the Port of Cochin has been reported by the present author (1965).

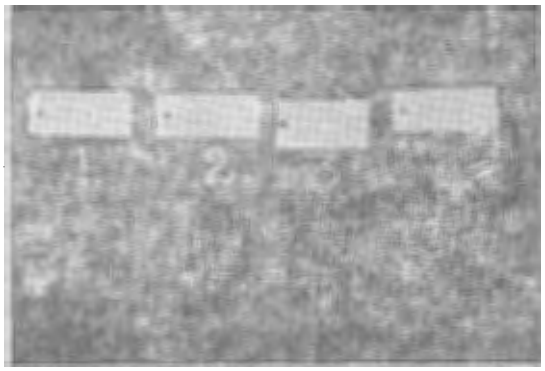

Fig 4. Wooden panels at the end of an year's marine exposure test. FRP sheathed (No. 4) panel is free from both external and internal damages due to marine wood borers.

Apart from being tough, rigid, resistant to abrasion and impervious to the effect of salt water even under continuous immersion, fibre-glass sheathing in combination with polyester resin has shown promise of protecting timber structures against marine borer attack for an extended period. It has been reported not to rot, nor leak or open up at seams, corrode, or absorb water and become heavier, (Fabre 1954). The wood below the sheathing has been safe and sound. The present observations suggest that the non-metallic sheathing materials should be finished with a top-coat of suitable anti-fouling paint so as to reliably ward off the marine borers and foulers. Nylon fabric has also been successfully employed as a sheathing material elsewhere. Tests conducted at the Tropical Testing Establishment have revealed that the African Mahogany *(Khaya ivorensis)*, a timber very susceptible to ship worm attack has been successfully protected by nylon fabric sheathing for 49 weeks at Port Harcourt, Nigeria, while the unprotected controls were completely destroyed in less than half this period (Anon 1958). The Baltic Red-wood *(Pinus sylvestris)* sheathed with nylon fabric has been free from the marine wood borers like *Teredo* sp. and *Limnoria* sp. in Shoreham Harbour (Oliver 1961).

Whatever material is tried and recommended as the non-metallic sheathing for hull protection, it must very reliably resist all the marine wood boring organisms in Indian waters more particularly the erratic attack of *Martesia striata*. The problem of successfully protecting the wooden hulls of fishing boats with non-metallic sheathing materials like fibre-glass and nylon fabric still offers a virgin field for further research in India.

Summary

In the Port of Cochin in India where most of the timber destroying marine wood borers (*Teredinids, Pholadids* and *Crustaceans* except *Limnoria)* are present in large numbers, wooden test panels and marine ply wood test boards protected with a sheathing of fibre-glass re-inforced plastic have been free from all borer attacks for a period of 52 weeks while unprotected controls were all attacked heavily within 25 weeks during a marine exposure test.

Acknowledgement

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