Fishery Technology
2000, Vol. 37(1) pp : 1 - 4

Effect of Creosote and Copper-Chrome-Arsenic (CCA) Treatments on the Compressive Strength of Haldu Wood (*Adina cordifolia* Benth & Hook)

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The effect of preservative treatment on a secondary species of wood, *Adina cordifolia* (Haldu) was studied. Panels were impregnated with creosote, an oil borne preservative, and copper-chrome- arsenic (CCA), a water borne preservative, through immersion treatment. The compressive stress parallel to grain of panels at various preservative retention levels was assessed to find out the change in mechanical strength. An average reduction of 14% compressive stress was noticed in CCA treated haldu panels and slight increase of 2 - 6% was observed in creosote treated panels.

Key words: Creosote, CCA, compressive strength, ***Adina cordifolia***

Wood continues to be the material of choice for the construction of fishing boats owing to qualities such as ease of working, retention of shape and high strength. But its dwindling availability and susceptibility to biodeterioration makes wood a costly material for construction of boats. The estimated loss of wood due to wood boring organisms for the fishing industry alone in our country works out to Rs.95 million (Santhakumaran & Jain, 1983; Qasim, 1988). Estimates show that about 20000 m^3 of timber is required in India for annual replacement in the fishing industry (Kumar, 1985) and overall requirement for marine use may be over 0.1 million m^3 (Kumar, 1980). In this context, there arises a demand for secondary species of timber, treated with preservatives for increased service life. The practice of preservation of timber using chemical preservatives is in vogue for quite some time. Copper-Chrome-Arsenic (CCA) and creosote continue to be the two major preservatives used for the long term protection of wood under marine conditions.

Preservatives affect the mechanical, physical and chemical properties of treated wood. An understanding of the change in its mechanical strength is important for purposes such as boat building and construction of marine structures. Studies on the changes in the mechanical properties of Indian timbers due to preservative treatment are not many.

Studies in this regard have been conducted by Kamala *et al.* (1980). Similar studies on the strength properties of treated wood have been carried out by Johnson (1977) and Mitchell & Barnes (1986). The results of a dual preservative treatment (CCA followed by creosote) on the strength properties of mango wood have already been reported (Edwin *et al.*, 1991). Haldu (*Adina cordifolia*) is easily available in the forests of the south-west coast of India and this, after suitable treatment for improving its strength, can be used as a substitute for other costly varieties in boat building. This paper reports the results of a study on the compressive strength of haldu wood treated with creosote and CCA.

Materials and Methods

Seasoned haldu wood (25% moisture content) of specific gravity 0.6 was cut to 30 x 20 x 120 mm size. The specimens were free from knots, checks, splits, decay, sap stains etc and had the grains parallel to their longitudinal axis and the planes at right angles as specified in IS : 1708 (1969). Ten sets of ten panels each were prepared for preservative treatment. Six sets were employed at a creosote loading of 40 - 180 kg/m^3, 3 sets at 4 - 13 kg/m^3 of CCA and one set of untreated panels as control as detailed in Table 1. The first set of panels were soaked in creosote (specific gravity 1.06) and 15% CCA solution for varying periods. They were then taken out from the respective solution and air dried for 30 days to a moisture content of 11 - 13%. The compression strength parallel to grain was determined in a ZWICK 1484 Universal Testing Machine of 200 kN capacity as per IS 1708 (1969). The load was applied continuously throughout the test at a speed of 0.36 mm/min. The compressive stress at maximum force, extent of deformation, deformation at intermediate load of 5 kN, 10 kN, 15 kN and 20 kN were determined to find out the extent of compression at the given loads. Compressive stress at maximum force parallel to grain axis was taken as a measure of strength for assessing the suitability of wood for frames for boat building (Anon, 1970). Moisture content and temperature at the time of testing were maintained at a uniform level for all specimens. The results were analysed statistically using 't-test' at 95% confidence limit.

Results and Discussion

The optimum level of preservative retention for marine piles and structures in high hazard areas is 160-320 kg/m^3 for creosote and 16-32 kg/m^3 for CCA (Johnson, 1977). As this study was aimed at developing treated timber for boat construction, lower retention levels were selected. The compression test data are presented in Table 2. Compressive stress at maximum force did not show any significant difference in the case of creosote treated panels irrespective of preservative retention when compared to control panels (t=2.041, df=5). Panels treated with CCA showed significant difference in strength even at low retention when compared to control panels (t=4.767, df=2). An average reduction of 14% compressive stress was noticed in treated panels when compared to untreated ones. Higher force was required in creosote-treated panels to bring about the same level of compression as in CCA-treated panels. Consequently, work done (force x deformation) was lower in the case of CCA panels. The average deformations at 5 kN, 10 kN, 15 kN, and 20 kN, were found to be lower for creosote-treated panels than the corresponding values for CCA-treated and control panels. It was found that higher retention of creosote increased specific gravity of wood up to 0.87.

Table 1. Duration of immersion in the preservative, retention of preservative and changes in sp. gravity.

Preservative	No. of hours in immersion	Preservative retention kg/m^3	Sp. gravity
Control	–	–	0.60
	24	40	0.63
	48	48	0.73
	72	51	0.74
Creosote	120	112	0.78
	360	156	0.85
	720	180	0.87
	8	4	0.50
CCA	42	8	0.50
	114	13	0.51

Table 2. Compressive stress of treated *Adina cordifolia* panels

Preservative	Retention Kg/m^3	Compression stress at Max. force (N/mm^2)	Compression at max. force (mm^2)	Compression at 5 kN (mm)	Compression at 10 kN (mm)	Compression at 15 kN (mm)	Compression at 20 kN (mm)	Work done at max. force (Nmm)
Control	–	51.10	2.87	1.09	1.43	1.76	2.19	60.27
	40	51.20	2.84	1.08	1.25	1.74	1.63	48.52
	48	50.00	3.02	0.77	1.05	1.29	–	60.20
Creosote	52	53.30	2.71	0.68	1.07	1.12	1.25	66.58
	112	54.30	2.86	0.71	0.98	1.20	1.40	59.83
	156	53.00	2.72	0.65	0.88	1.07	1.25	61.36
	180	53.00	2.85	0.63	0.86	1.06	1.24	59.86
	4	46.03	3.01	1.08	1.40	1.62	1.81	45.44
CCA	8	45.62	3.31	1.50	1.80	1.99	2.17	44.87
	30	40.46	2.37	0.63	0.94	1.15	1.35	46.79

Wood *et al.* (1980) showed that higher levels of retention of CCA produced lower work to maximum load and toughness value. According to them, the reduction in strength was probably due to hydrolysis of the carbonate constituents of the cell walls. Chemical dissolution of the cell walls due to CCA treatment was confirmed by Bariska *et al.* (1988) through scanning electron microscope studies. Johnson (1977) noticed embrittlement in dual treated panels as a result of high salt retention. Edwin *et al.* (1991) observed that the strength of CCA-treated *Mangifera indica* (mango) panels was lower than that of creosote treated panels. Studies by Rao & Kamala (1993) showed that the timber treated with CCA at 16 kg/m^3 had shown improvement in 8 species of timber. In this study, lower levels of CCA retention had no effect on the strength of timber.

It is generally indicated that weakening of timber due to preservative treatment is caused almost entirely by the temperature and pressure to which the wood is subjected during the conditioning or impregnation period, rather than by the preservative used (Hunt & Carrratt, 1953). The results of the present study stand contrary to this general view. It is to be noted that in this study, panels were impregnated only through immersion treatment. Therefore the change in strength in this case was solely due to the characteristic nature of the preservative. At the same time, creosote did not bring about any decrease in strength.

In the present study, slight increase in compressive stress of 2-6% was noted in 80-85% of the panels treated with creosote. This may be attributed to the increase in specific gravity of wood (Table 1) due to creosote treatment. Creosote and creosote mixtures are inert and do not enter into any chemical reaction that would affect strength of wood. This is because the oil based preservatives are restricted to the cell cavities whereas the water based preservatives are taken into the cell wall during treatment (Hunt & Garratt, 1953). Studies by Rao & Kamala (1993) showed that presence of oils or chemicals did not cause deterioration in strength. The preservatives, particularly at high levels of absorption, have improved the compressive stress at the limit of proportionality during compression perpendicular to grain. The reduction in compressive stress and static bending strength due to CCA treatment has been indicated in studies using *Terminalia tomentosa, Artocarpus hirsuta, Antiaris toxicaria, Mangifera indica* and *Lagerstroemia lanceolata* (Thomas *et al.*, 1998).

CCA has high toxicity against agents causing biodeterioration but has a deleterious effect on strength as seen from the present study. On the other hand, creosote-treated panels show better retention of strength. This toxic nature of CCA and the improvement in strength imparted due to creosote treatment can be taken advantage of. If a suitable combination treatment involving CCA and creosote is evolved, advantage can be taken of the toxic nature of the former and improvement in strength imparted by the latter. This would help in utilization of less utilized varieties of wood and ease the pressure on heavily depleting resources.

The authors are thankful to the Director, Central Institute of Fisheries Technology, Cochin, for granting permission to publish this paper. The guidance given by Dr. N.Unnikrishnan Nair, Senior Scientist, CIFT, is gratefully acknowledged.

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