CEMENT BONDED PARTICLEBOARD FROM EUCALYPTUS CAMALDULENSIS WOOD

by

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Abstract

For determining the suitability of Eucalyptus camaldulensis wood for the manufacture of cement-bonded particleboard, panels were made from the flakes before and after extraction with cold and hot water separately and by mixing portland cement at the rate of 66% of air-dry weight of the board Physico-mechanical properties of different panels indicated that the dimensional stability of panels containing cold water extracted flakes was poor as compared to those containing hot water extracted flakes. The modulus of rupture, nail and screw withdrawal resistance of panels containing hot water extracted flakes were better than the panels of cold water extracted flakes.

INTRODUCTION

Panel products consisting of wood particles and synthetic binder provide an effective way of using low grade hardwoods as well as residues from wood processing industries. The limited resistance of these products against weather and other wood deteriorating agencies has confined their use to indoor applications (9). However, the use of portland cement instead of resin binder forms an exterior quality panel which is resistant to fire, fungi, termites and weather elements. Cement- bonded particleboard produced by mixing wood flakes with the portland cement has found many applications both in pre-fabricated buildings and conventional constructions such as schools, hospitals and low cost housing. In some countries, industrial production of this product has also been reported (3,7,8). The major handicap for the development of this industry in the different parts of the world is that not all wood species react favourably with portland cement (2). The effects of wood on cement are governed by a variety of factors, including tree species, season of felling of trees and quality of wood from different parts of the tree. The varying

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degrees of incompatibility in different wood species are mainly related to such wood components as soluble sugars, carbohydrates, and other extractives etc. The proportion of these components varies in hardwood and softwood species (5,6).

In Pakistan, commercial production of wood cement composites has just been started. The industry needs information on the suitability of hardwoods especially fast growing species like poplars and eucalypts which are expected to provide potential raw material in future. This study was carried out for studying the performances of E. camaldulensis wood in cement-bonded particleboard, in relation to different manufacturing parameters.

MATERIALS AND METHODS

Materials

The materials for this study consisted of wood and portland cement. The wood was obtained from a five years old tree of E. camaldulensis harvested from the Silviculture Research Garden of Pakistan Forest Institute, Peshawar. The wood of branches and stem upto 5 cms diameter including bark was used. Portland cement was obtained from the local market.

Methods

Flake preparation

The wood containing bark was converted into 0.25 mm thick flakes by using German made " Small Shredding Machine K-20". The moisture content of wood before disintegration into flakes varied from 40-50%. The flakes were extracted with cold water for 48 hours and with hot water for one hour separately. Both cold and hot water extracted flakes were dried to about 10-15% moisture level before they were soaked for five minutes in 3% (weight/volume basis) aqueous solution of calcium chloride. Calcium chloride treated flakes were dried to 15-20% moisture content before mixing with cement.

Test Panels Manufacturing

Test panels were made from flakes before and after extraction with cold or hot water. In each case the flakes were prepared as stated above. Calcium chloride treated flakes were mixed with cement in a locally made concrete mixer. The moisture of wood-cement mixture was adjusted to 50% by spraying water during mixing. The wood-cement mixture was spread into a mat in a wooden framing device manually. The mat was pressed in a hydraulic press at room temperature. After pressing, the mat was allowed to cure for four weeks before it was tested for its various physical and mechanical properties. The particulars of board and compression variables are given as under:

- Board density = 1250 Kg/m^3
- Board dimensions = 50 x 55 x 1.25 cm
- Wood cement ratio = 1 : 2 (cement @ 66% by weight of board)
- Pressure = 30 Kg/cm^2
- Pressing time = 24 hours
- Pressing temperature= Room temperature (15-19°C)
- Curing time = 4 weeks

Evaluation of test panels

The test panels after curing for four weeks were tested for their various physical and mechanical properties according to the procedures outlined in ASTM D: 1037-78 (1). The values were compared with the standard requirements given in FAO Portfolio (4).

RESULTS AND DISCUSSION

The panels made from flakes before and after extraction with cold or hot water were labelled as BWE, CWE and HWE panels respectively. The properties of different panels are discussed below and given in the appendix.

Properties of BWE Panels

Wood-cement bonding in BWE panels was very poor. The board surface was not very smooth and showed delamination when scratched with nail or any hard tool. The poor bonding was caused by the improper curing of cement. The curing of cement is affected by the presence of tannins and low molecular weight sugars which act as cement "poisons" (4). Because of poor wood-cement bonding dimensional stability and strength properties of BWE panels were also extremely poor. For these reasons, their strength properties were not determined.

Properties of CWE and HWE Panels

CWE panels showed better properties as compared to BWE panels. In CWE panels because of removal of water solubles, wood-cement bonding was improved which resulted in compactness of surface and improvement of strength.

A comparison of CWE panels and HWE panels shows that the later have better properties than the former (Table 1). The linear

Table 1 Physico-mechanical properties of cement-bonded particle board made from <u>Eucalyptus camaldulensis</u>

Properties	Water Soaking Time (hours)	Type of Panels: CWE Panel			HWE Panels			Standard Requirement
		Mean	SD	Cov	Mean	SD	Cov	
- Thicness Swelling (%)	2	1.80	0.002	1.40	1.0	0.200	2.00	0.8-1.3
- " "	24	2.50	0.019	0.76	1.8	0.013	0.70	1.2-2.0
- " "	672	2.90	0.019	0.66	1.9	0.018	0.95	1.2-2.0
- Linear Expansion (%)	24	0.29	0.009	3.21	0.20	0.013	6.50	0.3-0.4
- Modulus of Rupture Kg/cm2	-	90	1.47	1.64	111	2.60	2.30	90-150
- Screw Holding resistance (Kg)	-	80	1.60	2.0	100	2.14	2.14	90-120
- Nail Holding Resistance (Kg)	-	35	1.68	4.8	50	1.66	3.34	40-80

* Each value is a mean of ten values

expansion of CWE panels is 45% higher than HWE panels. This is because 3.24% water solubles were removed during cold water extraction and 6.19% of the water solubles were removed during hot water extraction (10). In HWE panels because of removal of greater quantity of water solubles, wood cement bonding was improved. The properties of CWE panels is below acceptable limits.

Effect of Water Solubles On the Physical and Mechanical Properties of CWE and HWE Panels

CWE panels showed better properties as compared to BWE panels. In CWE panels removal of water solubles improved curing of cement which in turn improved wood-cement bonding, surface compactness and the strength. Because of good wood-cement bonding the water penetration and linear expansion of the board was reduced. Therefore, HWE panels had greater dimensional stability as compared to CWE panels. This is evidenced by the fact that linear expansion and thickness swelling in HWE panels are lesser than those in CWE Panels (Fig. 1).

The CWE panels after 2 hours, 24 hours and 672 hours soaking in water, exhibited higher thickness swelling of 80%, 39% and 53% respectively as compared to HWE panels. In HWE panels, as indicated by the rate of thickness swelling, the moisture pick up was maximum within 24 hours of immersion in water. After 24th hour of soaking, moisture uptake was slowed down considerably (Fig. 2). On the other hand, in CWE panels even after 24 hours of water soaking, the moisture uptake rate is quite high. This is probably caused by the poor wood-cement bonding caused by the remaining water solubles in wood flakes i.e. 47.7% of total water solubles (10). In general HWE panels have greater dimensional stability as compared to CWE panels. This is because the dimensional movements in HWE panels are lesser as compared to CWE panels. Further, the dimensional movements in CWE panels are below the acceptable limits whereas those in HWE panels are within the acceptable limits (4). Similarly the modulus of rupture (MOR), nail and screw holding resistance of HWE panels are higher as compared to CWE panels (Fig. 3).

These results indicate that the effect of water solubles on the properties of wood-cement boards is quite prominent. These findings agree with the findings of other researchers (2,5)

CONCLUSIONS

From this study the following conclusions are drawn:

1. The presence of water solubles in *E. camaldulensis* wood retard

cement curing and affect wood-cement bonding adversely in the boards.

2. It is not possible to manufacture cement-bonded particleboard from E. camaldulensis without extraction with cold or hot water.

3. Extraction of E. camaldulensis flakes with hot water for one hour removes greater quantity of water solubles as compared to cold water extraction for 48 hours.

4. For producing acceptable quality of cement-bonded particleboard from E. camaldulensis, the flakes should be extracted preferably with hot water before mixing with cement.

5. Although the effects of wood on cement curing are governed by a variety of factors but the effect of water solubles on wood cement bonding is quite prominent.

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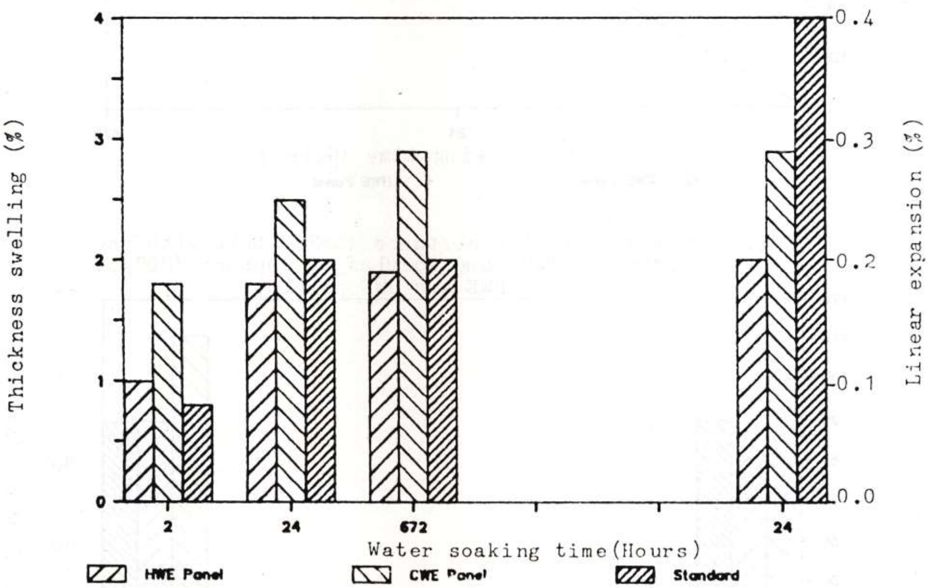
Appendix

Fig.1 Effect of water soaking on the dimensional stability of HWE and CWE panels.



Appendix (Contd.)

Fig.2 Rate of thickness swelling in CWE and HWE panels.

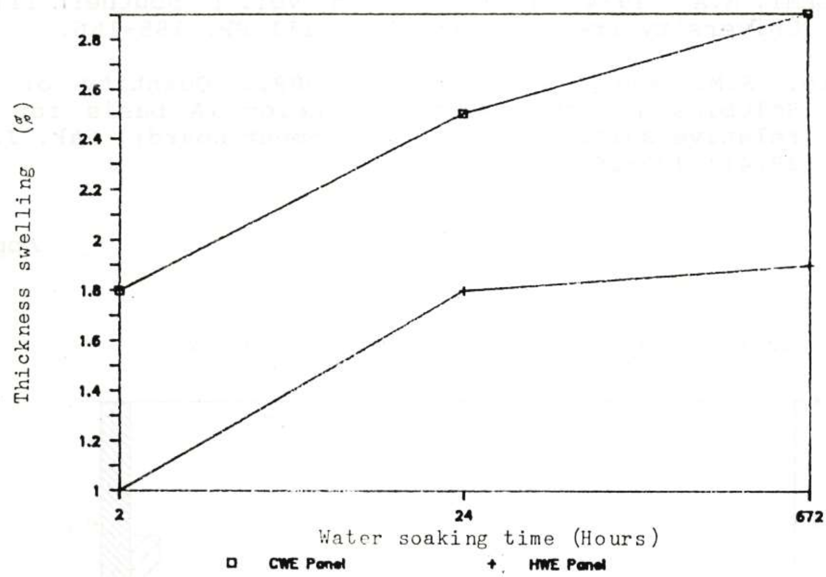


Fig.3 Screw withdrawl resistance (SWR), Nail withdrawl resistance (NWR) and Modulus of Rupture (MOR) of HWE and CWE panels.