PROPERTIES OF PARTICLEBOARDS FROM *EUCALYPTUS CAMALDULENSIS* WOOD OF DIFFERENT AGE TREES

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Abstract

Particleboards were made with target density of 0.70 g/cm^3 from different age trees of *Eucalyptus camaldulensis* using flakes from 4 years (Class A), 6 years (Class B) and 8 years (Class C) old trees and their mixtures; 50 percent A/ 50 percent B, 50 percent B/ 50 percent C and 50 percent A/ 50 percent C, bonded with urea formaldehyde resin. Static bending, internal bond, screw withdrawal, thickness swelling, water absorption and linear expansion of particleboards for each age class and their mixtures were determined. Boards easily met industry specifications for all properties except linear expansion. Overall, the properties of the panels produced from 100 percent class A flakes were significantly superior to those of 100 percent class C. The properties of the panels produced from class B and C flakes were improved when they were muxed with 50 percent class A flakes..

Introduction

E. camaldulensis is planted on farmlands under social and farm forestry programmes in the plains ~~areas~~ of Pakistan. According to the Forestry Sector Master Plan (1993), the total volume of Eucalyptus trees grown on farmlands is 0.36 million m^3. In an other estimate (Amjad et, al 1992; Amjad 1991), the volume of eucalyptus wood on farmland is 0.57 and 0.16 million m^3 in the provinces of Punjab and NWFP, respectively. Because of high density, a small amount of eucalyptus wood is used as particleboard's raw material.

In general terms the lower density woods produce panels within the present desired specific gravity ranges usually with strength properties superior to the higher-density woods (Foster 1967). The reason for preferential use of relatively light woods is that they can be compressed into medium density particleboards with the assurance that sufficient inter-particle contact area is developed during the pressing operation to achieve good bonding. A partial

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solution to the use of higher density woods is to mix them with low density wood to achieve a medium density blend (Maloney 1978).

Density of wood from young trees of eucalyptus is lower in comparison to the mature trees and may be used for acceptable quality particleboards. Whereas high density mature trees of eucalyptus provide flakes of inferior form, produce heavier boards than available in the market and consume greater quantity of raw material resulting into higher cost (Hillis 1976).

The objective of this study was to assess the influence of ~~wood~~ density variation among *E. camaldulensis* wood of different age classes and their mixtures on the properties of particleboards.

Materials and Methods

Wood selection and preparation

Six trees of *E. camaldulensis* from each of three age classes were harvested from the Research Garden, Pakistan Forest Institute, Peshawar. The classes were 4 year (class A), 6 year (class B) and 8 year (class C) old trees. Trees were cut into 1 meter long bolts and debarked. Two disks were cut from each bolt for basic density (BD) determination. The bolts were next sawn into 15cm x 7.0cm rectangular blocks and converted into flakes by using German made "small shredding machine K-20". From each of the three classes of wood, six flake mixtures were prepared for particleboard study; 100 percent A, 100 percent B, 100 percent C, 50 percent A/50 percent B, 50 percent B/50 percent C and 50 percent A/50 percent C.

Particleboard preparation and evaluation

The flakes were dried to 7 percent moisture content (MC). A liquid urea formaldehyde resin at 50 percent solids content was sprayed on the flakes by air atomization in a rotary blender to 8 percent resin solid (based on OD wood weight). No wax was used. The average MC of the flakes out of the blender was 13 percent.

5 replicate panels with target density 0.7 g/cm^3 were prepared from each mixture at a press temperature of 140^{0}C. Press time was 9 minutes to closing against 1/2 inch stop.

Physical and mechanical tests were conducted on the particleboards produced from the six mixtures of wood. All tests were conducted in accordance with the standard (ASTM D 1037-72). Table contains the average, standard deviation, and number of tests for all panel properties for all mixtures studied. Dunn's multiple comparison test was used to determine significant differences between means of the mixtures for all properties at the 5 percent level of significance.

Results and Discussion

The average basic density of the wood from different age classes A, B and C was determined as 0.49, 0.53 and 0.59 g/cm^3 respectively. Differences were noticeable in the density of wood and ultimately the flakes obtained.

The table shows the results of the particleboard study. All the flake classes and their mixtures produced particleboards which exceeded (2400 psi) minimum modulus of rupture (MOR) requirement for 1-M-3 grade particleboard (ANSI A 208.1-1979). The panels produced from 100 percent A flakes had the highest MOR (3369 psi) while the panels from 100 percent C had the lowest MOR (2757 psi). The panels from 100 percent A had significantly higher MOR values than those with 100 percent C and 50 percent B/50 percent C flakes.

The average modulus of elasticity (MOE) for all panels exceeded the minimum specification for 1-M-3 grade particleboard (400,000 psi). The highest average MOE was obtained from panels with 100 percent A flakes (485,000 psi). However this average and the average MOE of panels with 50 percent A/ 50 percent B and 50 percent A/50 percent C were not significantly different. MOE of panels produced from flakes of 100 percent B were not significantly different from the average for panels produced from their mixtures. Panels produced from flakes of 100 percent C had significantly lower average MOE values than panels with flakes from all other mixtures.

The average internal bond (IB) for all the panels exceeded the minimum specification for 1-M-3 grade particleboard (80 psi). The particleboard from 100 percent C material had the lowest average IB (112 psi) while the highest average (187) was obtained with panels of 100 percent A material. Panels made from 50 percent A/50 percent B, 100 percent A, 50 percent A/50 percent C and 100 percent B had average IB significantly higher than panels from 100 percent C.

Table 1. Physico-mechanical properties of Particleboard from *E. camaldulensis* of different age classes and their mixtures

Board's Properties	Particle mixture						Standard Requirement
	A	B	C	50%A/50%B	50%B/50%C	50%A/50%C	
Density(g/cm³)							
Avg.	0.69	0.68	0.70	0.69	0.70	0.69	
Std. dev.	0.01	0.02	0.02	0.01	0.01	0.01	
n.	10	10	10	10	10	10	
MOR(psi)							
Avg.	3369	3156	2757	3208	2957	3127	2400
Std. dev.	162	143	140	140	107	125	
n	10	10	10	10	10	10	
MOE(10³ psi)							
Avg.	485	446	422	463	434	455	400
Std. dev.	17.9	15.9	15.8	15.6	10.8	13.9	
n	10	10	10	10	10	10	
Internal bond(psi)							
Avg.	187	150	112	163	129	148	80
Std. dev.	17	9	13	19	13	11	
n	10	10	10	10	10	10	
Screw withdrawal(lb)							
(Face)							
Avg.	340	324	295	333	309	315	250
Std. dev.	9.0	8.5	8.7	6.4	8.1	6.00	
n	10	10	10	10	10	10	
(Edge)							
Avg.	290	274	243	283	259	265	225
Std. dev.	13.5	11.8	12.9	13.2	13.5	11.5	
n	10	10	10	10	10	10	
Water absorption(%)							
2 Hours							
Avg.	24.14	26.70	31.60	25.20	28.20	26.3	
Std. dev.	0.56	0.58	0.56	0.51	0.32	0.48	
n	5	5	5	5	5	5	
24 hours							
Avg.	51.00	55.20	62.04	53.1	55.6	56.5	
Std. dev.	0.90	0.75	0.52	0.72	0.54	0.57	
n.	5	5	5	5	5	5	
Thick. swelling(%)							
2 Hours							
Avg.	4.6	5.1	5.6	4.9	5.4	5.2	
Std. dev.	0.08	0.06	0.10	0.07	0.06	0.05	
n	5	5	5	5	5	5	
24 hours							
Avg.	12.5	12.9	13.6	12.6	13.2	12.9	
Std. dev.	0.13	0.07	0.17	0.07	0.10	0.07	
n.	5	5	5	5	5	5	
Linear expansion(%)							
Avg.	0.33	0.34	0.39	0.34	0.38	0.37	0.35
Std. dev.	0.007	0.01	0.01	0.006	0.01	0.04	
n.	5	5	5	5	5	5	

The average face and edge screw withdrawal resistance for all the mixtures was higher than the minimum required in the 1-M-3 grade standard (250 lb.& 225 lb.). Panels made from 100 percent A, 50 percent A/50 percent B and 100 percent B material all had significantly higher face and edge screw withdrawal resistance than those made from 100 percent C.

The 2 and 24 hour water-soak test results indicated that panels with 100 percent A, 100 percent B and 50 percent A/50 percent B had average Water absorption (WA) and thickness swelling (TS) significantly better than the panels with 100 percent C, 50 percent B/50 percent C and 50 percent A/50 percent C.

Panels produced with 100 percent C, 50 percent B/50 percent C and 50 percent A/50 percent B exceeded the linear expansion (LE) standard for 1-M-3 (0.35 percent). LE of panels produced from 100 percent A had significantly higher LE than those with 100 percent C. The remaining mixtures produced panels with the LE within specifications. However, there were statistically no difference between the average LE of panels from the various flake mixtures.

Conclusion

This study has shown that 4 to 8 years old trees of *E.camaldulensis* can be used to manufacture commercially acceptable particleboard panels. Particleboards produced from the various mixtures of all the three age classes A, B and C met specifications for 1-M-3 grade particleboard for all properties with the exception of LE for the 100 percent C, 50 percent B/50 percent C and 50 percent A/50 percent C mixture. The properties of particleboard panels from the various mixtures of all these age classes of wood could only be predicted by the density of the wood raw material. It was evident that an increase in the wood density with the maturity of tree had an adverse effect on the particleboard properties. Therefore, lower density woods from class A trees produced particleboard panels with all properties superior to those from class B and C and their mixtures. Mixing 50 percent class A flakes with class B and class C improved the board properties for the 100 percent B and 100 percent C mixtures.

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