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Wood Utilisation Research Centre

STABILITY OF FURNITURE PANELS MANUFACTURED FROM JARRAH

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SUMMARY

The dimensional changes of edge-jointed panels (blanks) made from 20 mm thick boards of jarrah (*Eucalyptus marginata* Donn ex Sm.), and any changes in spring, bow, cup, and twist under varying environmental conditions were compared in this trial. Three adhesives (urea formaldehyde, melamine urea formaldehyde and resorcinol formaldehyde), moisture content variations in boards, board width, and storage conditions were assessed.

The dimensional change for width was statistically significant, which is expected from wide flat panels, but should not cause problems in use provided the furniture is designed to allow for this movement. There were negligible changes in thickness. Spring, bow, cup and twist showed some variation, but again would not be a problem if designs made allowance for minor movement.

The results confirm that the edge-jointed flat panels used for furniture vary in dimension in differing equilibrium moisture content (E.M.C.) conditions, but show consistent variation. Panels must be allowed to equilibrate to that E.M.C. before manufacture and design of furniture should allow for movement in the panels.

INTRODUCTION

Solid wood panels (blanks) have many and varied applications in the furniture and joinery industry with possible use for table tops, bar tops, or for cutting multiple curved components with greatly reduced wastage. These panels are manufactured by edge-jointing boards to make a wide panel, as discussed by Araman *et al*. (1982) and Bowyer *et al.* (1986). The adhesives used depend on the end use, e.g. urea formaldehyde is currently recommended for interior use and resorcinol formaldehyde for external use. Wood used where atmospheric conditions fluctuate continually alters in dimension

(Newby and Brennan 1990) and this dimensional change increases with wide, thick blank panels.

The amount of dimensional alteration in width and thickness may be affected by the moisture content of the wood used to construct the panel. Adhesives used to construct the blank panels can also affect the dimensions of blank panels because most adhesives contain water, and increase the moisture content of the wood when panels are constructed.

This study was conducted at the Wood Utilisation Research Centre (W.U.R.C.) at Harvey. The effects of adhesive type, moisture content of boards used in the panels, board width, and subsequent storage effects, on dimensional change and stability of panels (spring, bow, dry and twist) were assessed.

METHODS

The 20 mm thick boards used in the trial were standard production from regrowth jarrah logs from thinning operations in Kent Block, near Harvey, from trees of varying diameter and age. The logs were milled into standard boards at the W.U.R.C. sawmill using a 'Forester 150' horizontal breakdown bandsaw and 'Jonsered' bandsaw resaw bench. The sawn boards were strip stacked and dried in a solar kiln to average moisture contents of 8 per cent or 14 per cent.

The dried boards were dressed to 40 mm, 60 mm or 80 mm widths and 20 mm in thickness. Three adhesives were used to construct the panels - urea formaldehyde, melamine urea formaldehyde and resorcinol formaldehyde. Three moisture content treatments were used - 8 per cent, 12 per cent or random. Four 1.2 m long panels of five boards, i.e. four gluelines per panel, were constructed using each combination of adhesive and board width. Two panels per treatment were then placed in cyclic humidity conditions of 6 per cent or 20 per cent E.M.C. and two panels per treatment stored in normal E.M.C. conditions. The former panels were moved weekly from 6 per cent E.M.C. to 20 per cent E.M.C. for four weeks and then placed under normal conditions for one week. Assessment for spring, cup, twist and dimensional variation were carried out once a week for five weeks.

The statistical analysis of each parameter measured (thickness change, width change, spring, bow, cup and twist) used the following design:

Treatment	Degrees of freedom
Adhesive type	2
Moisture content	2
Board width	2
Environmental conditions	1
Replication	1
Error	99
	107

RESULTS AND DISCUSSION

The mean effects of adhesive type, moisture content of boards used in the panels, board width, and subsequent storage effects on dimensional change and stability are given in Table 1.

Table 1

Effect of adhesive type, board moisture content and board width on dimensional changes and stability of jarrah panels (mean values in mm)

	Thickness	Width	Spring	Bow	Cup	Twist
Adhesive type						
Urea formaldehyde	.003	.039	.017	.049	.032	.043
Resorcinol formaldehyde	.003	.045	.021	.050	.040	.069
Melamine urea formaldehyde	.004	.042	.020	.043	.035	.049
Moisture content						
High	.004	.041	.020	.043	.040	.057
Low	.003	.045	.023	.055	.034	.049
Random	.004	.041	.014	.043	.033	.055
Board width						
40 mm	.002	.019	.024	.044	.017	.063
60 mm	.006	.053	.021	.053	.035	.055
80 mm	.002	.058	.013	.043	.056	.041
Environmental conditions						
Cyclic storage	.001	.005	.029	.032	.056	.050
Normal E.M.C. storage	.005	.057	.016	.053	.028	.055

The small values result from the cyclic storage effects in particular, because moisture uptake and losses result in swelling or shrinkage of the wood fibre, and subsequently in movements.

The statistical analysis of the data indicated that there were significant differences caused by some of these variables (Table 2). Because of the large numbers of variables and interactions, the non-significant variables are not listed in the Table.

Table 2

F-values relating adhesive type, board width and board moisture content to dimensional changes and stability of jarrah panels.

Parameter	Source	F-value	Probability
Thickness	Panel	43.6	***
	Panel and moisture	3.7	*
	Board width	25.0	***
	Panel and board width	4.5	*
Width	Panel	125.4	***
	Moisture	5.4	**
	Panel and moisture	15.0	***
	Board width	23.5	***
	Panel and board width	8.9	***
Spring	Panel	10.5	**
	Board width	3.6	*
	Panel and board width	5.3	**
Bow	Panel	8.6	**
Cup	Panel	13.6	***
	Board width	16.9	***
	Panel and board width	6.3	**
Twist		No significant effects	

*** Significant at $p<.001$
** Significant at $p<.01$
* Significant at $p<.05$

The following major points came from the analysis:

(i) there were no significant differences produced by the three different adhesives (urea formaldehyde, resorcinol formaldehyde, and melamine urea formaldehyde) in thickness or width changes, or in spring, bow, cup or twist.

(ii) with moisture, the only major significant difference was in thickness, but these amounts were small in absolute figures and would not affect utilization.

(iii) none of the factors produced any significant difference in twist.

The individual factors - changes in thickness and width, spring, bow, cup and twist - are discussed below.

Thickness changes

The interactions (panel by board width and panel by moisture content) were much smaller in magnitude than board width and panel replication. The large differences in the latter variables ($p < .001$) were not entirely consistent between moisture levels, and similarly the large differences attributed to board widths were not consistent between panels.

Because there were two panels (replicates) for each treatment, the variation between panels may be attributed to differences in material and minor differences in construction. The panels were constructed by edge-gluing boards of uniform thickness and the significant changes in thickness are difficult to explain. However, they should not cause any problems in utilization.

Width changes

The significant changes in panel width attributed to board width ($p < .001$) and panel and board width ($p < .001$) were expected, because with an equal number of edge joints in each panel, the overall width of panel is greater. This factor must be considered in utilizing the product, because the gap between flush doors on a piece of furniture would decrease or increase as moisture was either absorbed or desorbed. The significant differences in width resulting from variations in moisture content ($p < .01$) and the panel moisture content interaction ($p < .001$) are difficult to explain because any moisture absorption or desorption should be uniform. There were very large differences between panels.

Spring

There were significant differences in spring which were attributed to panels ($p < .01$), board width ($p < .05$), and panel and board width ($p < .05$). However, the effect on utilization of the panels should be negligible.

Bow

The major variation in bow ($p < .01$) was between the two replicates, which could be explained by differences in material and perhaps construction. As with spring, the effect on utilization of the panels should be negligible.

Cup

The same variables that affected spring were involved in cupping. As expected, board width had the major effect ($p < .001$) because with equal numbers of edge joints in the panels, gluing wider boards produced wider panels. The overall cupping consequently increased with increasing panel width, which would affect utilization. The panel and board width interaction ($p < .01$) and panel variation ($p < .001$) similarly contributed, with the latter variable based on data from two panels only.

Twist

There were no significant differences in twist resulting from any of the variables, and it would not be a problem in utilization.

In general, the stability of these blanks or panels, based on the assessment of spring, bow, cup and twist, could be regarded as satisfactory. Any dimensional changes with varying environmental moisture contents would be similar to those experienced by any solid timber. Panels should be allowed to equilibrate to the relevant E.M.C. before furniture manufacture, and design of furniture must allow for any movement.

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