Plywood Exposure Tests. (Sixth Progress Report)

by

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SUMMARY

This report covers the results of tests and observations on red lauan and bagtikan plywood bonded with melamine-type adhesive after two years of exposure to outdoor conditions.

The study showed that the adhesive was not durable and therefore could not be considered suitable for use in the manufacture of Type I plywood.

INTRODUCTION

The study presented in this report is a continuation of a previous study[1] conducted on a melamine-type adhesive submitted by a certain chemical company. As per original agreement, the adhesive was to be tested in accordance with the requirements for Type I plywood bond.

This investigation was conducted to evaluate the performance of this adhesive as it is exposed to the changing weather conditions in the Philippines. Its performance would indicate the extent to which it can be considered serviceable for exterior use.

MATERIALS

Laboratory-prepared panels, made of red lauan and bagtikan heartwood, were used. They were of the three-ply constructions, consisting of 1/16-inch veneer for faces and backs, and 1/8-inch for cores.

The melamine-type adhesive used has the following components:

COMPONENTS	PARTS BY WEIGHT
Liquid	100
Powder	46
Total	146

EXPERIMENTAL PROCEDURE

A panel was randomly taken from each of the triplicate panels previously manufactured under the following experimental variables:

1. Spread: 30 and 40 lbs/M sq. ft. SGL
2. Pressing time: 2 and 4 minutes
3. Assembly time: 10, 30 and 90 minutes
4. Moisture content: 6 and 12 per cent.

Thus, a 2 x 2 x 3 x 2 factorial design was used, with each variable represented in the 24 panels that were studied.

All the panels were nailed at two selected points on the center of each panel to a veritcal test fence facing south. The lowest row was 24 inches above the ground. A distance of 2 inches separated each test piece.

The test panels were removed after two years. It was observed that delamination was present in nearly all the test specimens. Delamination was measured. Bond strength was evaluated by means of the dry shear test.

Analysis of results

1. The shear strength and wood failure (bond strength) obtained after two years was compared to the corresponding shear

[1] Manzo, P. M. and I. M. Laroya. 1962. A study on melamine-type adhesive for Type I plywood.

strength and wood failure after fabrication. The comparison was expressed quantitatively as the per cent reduction in bond strength given in the following formula:

$$\text{Bond strength reduction, per cent} = \frac{\text{Original bond strength} - \text{bond strength after two years}}{\text{Original bond strength}} \times 100$$

The formula was based on the assumption that the original bond strength was the maximum value that could be attained under the combination of variables used. The values obtained are tabulated in Table 2.

2. An analysis of variance was employed to test the hypothesis that the variables used have an effect on the amount of shear strength reduction. The F-test values are shown in Tables 3 and 4.

3. Delamination was evaluated by classifying the panels as either failed or have not failed. Failure was attained when the total delamination exceeded four inches in length, or 4 per cent of the glue line. The delamination presented in Table 1 was expressed as a per cent of the total glue line.

RESULTS AND DISCUSSIONS

The comparison between the panels which were originally fabricated and those exposed after 2 years showed that there was a significant reduction of bond strength after two years. On the average, the shear reduction of red lauan and bagtikan was 24 per cent and 18 per cent, respectively. The average reduction in wood failure was 77 per cent for red lauan and 69 per cent for bagtikan. This reduction in bond strength indicates that tension and compression stresses, set up on the width and thickness of the plywood panels, were sufficiently great to cause degradation of the glue line.

The analysis of variance showed that the main variables used during the fabrication of the panels have no effect on the reduction of shear strength. This also includes their first order and second order interactions. The result shown by the analysis of variance could be interpreted in two ways. The first interpretation assumes that the effect of the variables has been confined only to the manufacturing operation and that the variables have no more effect as far as the service performance of the plywood is concerned. The second interpretation assumes that the effects of other factors, such as weathering, stressing of the glue line due to moisture content changes, were far greater than the effects of the variables used in the study, in degrading the glue line. The latter interpretation is believed to be better because of the physical and chemical changes that is inherent in weathering which probably occurred simultaneously with mechanical degradation.

Wood failure was not treated statistically in the same manner as the shear strength because of the semi-subjective method of evaluating it from the shear specimens. No conclusion as to the effect of the processing variables on the reduction of wood failure could therefore be made.

The evaluation of delamination showed that 17 out of 24 or about 71 per cent delaminated in red lauan. In bagtikan, 16 out of 24 or 67 per cent delaminated. The specimens which failed were 10 out of 24 or about 42 per cent for red lauan and 9 out of 24 or about 38 per cent for bagtikan. These results show that there was excessive delamination after only two years of exposure to outdoor conditions.

CONCLUSIONS

In assessing the performance of an adhesive, both its strength and durability must be taken into consideration. In most cases, durability is considered as the better criterion.

The results of the exposure test showed that the service performance of the melamine-type adhesive submitted by the chemical company concerned was not satisfactory The reduction in bond strength is moderate, but the excessive number of delaminated panels and the number of specimens that failed because of delamination within a span of only two years, pointed out that the adhesive was not durable. Hence, the adhesive is considered not suitable for use in the manufacture of Type I plywood based on the aforementioned findings.

Table 1. *Bond strength and delamination of red lauan and bagtikan panels after two years outdoor exposure.*

TREATMENTS	RED LAUAN			BAGTIKAN		
	Shear strength (psi)	Wood failure (per cent)	Delamination (per cent)	Shear strength (psi)	Wood failure (per cent)	Delamination (per cent)
$M_1A_1S_1t_1$	169	4	3.1	249	20	1.0
$M_1A_1S_1t_2$	231	44	1.0	280	23	13.5
$M_1A_1S_2t_1$	172	10	None	274	25	4.2
$M_1A_1S_2t_2$	189	10	None	241	32	None
$M_1A_2S_1t_1$	179	8	5.7	245	12	1.0
$M_1A_2S_1t_2$	236	18	None	240	12	0.5
$M_1A_2S_2t_1$	209	14	None	242	38	None
$M_1A_2S_2t_2$	179	10	None	266	60	1.0
$M_1A_3S_1t_1$	156	23	0.5	256	34	9.4
$M_1A_3S_1t_2$	181	18	2.1	236	26	26.0
$M_1A_3S_2t_1$	210	31	None	283	39	1.0
$M_1A_3S_2t_2$	211	43	None	274	35	None
$M_3A_1S_1t_1$	240	41	26.0	238	17	14.5
$M_3A_1S_1t_2$	172	11	26.0	273	28	14.5
$M_3A_1S_2t_1$	204	18	18.2	270	59	None
$M_3A_1S_2t_2$	225	34	19.8	280	36	None
$M_3A_2S_1t_1$	215	27	26.0	266	12	15.6
$M_3A_2S_1t_2$	254	25	9.4	274	14	6.2
$M_3A_2S_2t_1$	203	21	3.1	250	22	None
$M_3A_2S_2t_2$	192	22	12.5	236	19	None
$M_3A_3S_1t_1$	160	6	26.0	275	51	7.0
$M_3A_3S_1t_2$	165	9	7.3	242	29	2.6
$M_3A_3S_2t_1$	206	26	0.8	262	16	3.1
$M_3A_3S_2t_2$	203	19	1.5	279	40	None

Legend:

M_1 = 6 per cent moisture content
M_3 = 12 per cent moisture content
A_1 = 10 minutes assembly time
A_2 = 30 minutes assembly time
A_3 = 90 minutes assembly time
S_1 = 30 lbs. spread, MSGL
S_2 = 40 lbs. spread, MSGL
t_1 = 2 minutes pressing time
t_2 = 4 minutes pressing time

Table 2. *Reduction in bond strength after two years exposure.*

Panel No.[1]	RED LAUAN		BAGTIKAN	
	Reduction in shear strength (per cent)	Reduction in wood failure (per cent)	Reduction in shear strength (per cent)	Reduction in wood failure (per cent)
1	35.5	95.9	25.4	78.9
2	8.7	55.6	15.2	74.7
3	36.8	89.9	19.6	72.8
4	22.2	89.6	26.5	63.6
5	26.0	91.9	21.5	87.6
6	16.9	81.8	21.0	87.8
7	21.4	85.8	27.3	57.8
8	26.0	89.8	18.4	37.5
9	39.3	76.0	11.7	64.2
10	27.6	81.6	27.2	71.7
11	20.4	67.7	6.9	59.8
12	14.2	56.6	17.7	62.0
25	0	40.6	22.2	81.5
26	38.3	87.8	18.8	70.5
27	28.4	77.5	12.3	37.2
28	18.5	63.4	9.1	63.2
29	19.5	70.6	11.9	87.2
30	8.3	70.9	13.8	85.1
31	23.7	78.4	20.9	77.3
32	31.4	76.1	22.4	80.2
33	38.9	93.9	18.6	45.7
34	28.6	90.0	22.7	67.8
35	16.2	64.9	15.2	83.0
36	24.0	80.0	17.0	58.8

[1] Panel numbers designate the same treatments as shown in Table 1.

Table 3. *Analysis of variance of red lauan.*

Source of Variation	D. F.	Sum of squares	Mean square	F
M	1	9.88	9.88	N.S.
S	1	14.72	14.72	N.S.
t	1	34.08	34.08	N.S.
A	2	99.07	49.53	N.S.
M x S	1	46.93	46.93	N.S.
M x T	1	224.48	224.48	N.S.
M x A	2	37.04	18.52	N.S.
S x T	1	2.16	2.16	N.S.
S x A	2	535.57	267.78	N.S.
A x T	2	41.94	20.97	N.S.
M x S x T	1	43.58	43.58	N.S.
M x S x A	2	134.00	67.00	N.S.
M x T x A	2	431.58	215.79	N.S.
S x T x A	2	277.50	138.75	N.S.
Error	2	473.67	236.83	
Total	23	2406.20		

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₱45,000.00 worth of fancy articles made of ipil-ipil seeds every month. She said that these articles have become a craze among the American ladies. Necklaces, earrings and bracelets sell like hot cakes at $10.00 to $20.00 a set.

The cones of Mindoro pine and Benguet pine can be painted and sold as decorations. These are good substitutes for mistletoes for Christmas trees. There is indefinite number of articles and novelties that can be made out of these seeds. Perhaps, the only limit to this is the inventive ingenuity and resourcefulness of man.

The profitableness of seed collection has been proven in Arayat, Pampanga and Mount Makiling, Laguna. There are persons who would prefer to collect seeds rather than be employed temporarily at ₱4.00 a day. These people claim that they are earning much more in seed collection and on top of this, they are not under the command of anybody. In other words, they are their own boss.

Those who are interested to make additional income by collecting seeds of forest tree species, they are welcome for consultation at the Reforestation Administration in Diliman, Quezon City, or any of the Reforestation projects which is nearest their place. They will be told what to do, what seeds to collect, and how much they are going to be paid for the seeds that they will be able to collect. They will also be instructed how to treat, dry and store these seeds so that what they will collect will be fresh and viable.

This coming dry season, many people will have nothing to do. At the same time, many economic trees will also be bearing fruits. They could make their spare hours profitable by collecting forest tree seeds. It will not only be financially rewarding but they will also feel a sense of accomplishment in the thought that they are also doing their share in helping restore the forest that have been destroyed by unthinking people.

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Table 4. *Analysis of variance of bagtikan.*

Source of Variation	D. F.	Sum of squares	Mean square	F
M	1	44.01	44.01	N.S.
S	1	10.27	10.27	N.S.
T	1	9.75	9.75	N.S.
A	2	23.56	11.78	N.S.
M x S	1	1.76	1.76	N.S.
M x t	1	4.09	4.09	N.S.
M x A	2	83.71	41.85	N.S.
S x T	1	0.27	0.27	N.S.
S x A	2	142.43	71.22	N.S.
T x A	2	138.23	69.11	N.S.
M x S x T	1	2.33	2.33	N.S.
M x S x A	2	102.82	51.41	N.S.
M x T x A	2	73.10	36.55	N.S.
S x T x A	2	50.88	25.44	N.S.
Error	2	40.20	20.10	
Total	23	727.41		