GLUING OF BORAX AND BORIC ACID TREATED CIVIT VENEER[1]

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Civit (*Swintonia floribunda*) veneer, 1.5 mm thick, both green and dry (10—12 percent moisture content) were soaked in 1 25 percent boric acid and 1.9 percent borax solutions separately at 90°—100°C for 10, 25 and 40 minutes. These were conditioned and glued into three-ply plywood, with a ureaformaldehyde adhesive fortified with melamine, for producing boil-resistant glue-bond. Plywood shear test samples were prepared and tested in both dry and wet (boiled in water for six hours and tested while wet) states.

Dry shear tests show that green veneers treated with both boric acid and borax, and dry veneers treated with borax had the higher bond strength, while the longest treating time (40 minutes) had the lowest bond strength, all the differences being significant at the 5% level. The wet test shows significant differences at the 5% level between the preservatives, borax treatment producing better bond strength However, all the treatment combinations resulted in adequate bond strength for the type of plywood produced.

For manufacturing highly water resistant Civit plywood which will also resist fungal lyctus and drywood termite attack, the veneers can be treated with borax or boric acid solutions without adversely affecting subsequent gluing.

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১·৫ মিলি মিটার পুরু সিভিট ভিনিয়ারকে ভিজা এবং শুষ্ক (শতকরা ১০-১২ ভাগের জলীয় অংশে) অবস্থায় পৃথক পৃথক ভাবে শতকরা ১·২৫ ভাগের বোরিক এসিড দ্রবণে এবং শতকরা ১·৯ ভাগের বোরাক্স দ্রবণে ৯২°—১০০° সেঃ তাপমাত্রায় ১০, ২৫ ও ৪০ মিনিট সময়কালে সিক্ত করা হইয়াছিল। পরবর্তীকালে উক্ত ভিনিয়ারকে কণ্ডিশনিং এর পর মেলামিন রেজিনে উৎকর্ষসাধিত ইউরিয়া ফরম্যালডিহাইড আঠা দ্বারা তিনস্তর বিশিষ্ট স্ফুটন প্রতিরোধক প্লাইউড নির্ম্মাণ করা হয়। প্লাইউডের তলঘষ নমুনা তৈয়ারীর পর নমুনাগুলির উপর শুষ্ক ও ভিজা (ছয় ঘন্টা পানিতে ফুটাইবার পর ভিজা অবস্থাতেই পরীক্ষণ) উভয় অবস্থাতেই তলঘর্ষ পরীক্ষা চালানো হয়।

শুষ্ক তলঘষ পরীক্ষায় দেখা যায় যে বোরাক্স ও বোরিক এসিড দ্রবণ-সিক্ত কাঁচা ভিনিয়ার ও বোরাক্স দ্রবণ-সিক্ত শুষ্ক ভিনিয়ারের যোজনশক্তি অপেক্ষাকৃত বেশী। অপর পক্ষে সর্বাপেক্ষা দীর্ঘ সংরক্ষণ কালে (৪০ মিনিট) ভিনিয়ারের যোজনশক্তি সর্বাপেক্ষা কম পাওয়া গিয়াছে। সকল পার্থক্যগুলি ৫% সমতায় বেশ অর্থমূলক দেখা যায়। ভিজা তলঘর্ষ পরীক্ষায় আন্তঃ সংরক্ষনী পার্থক্য ৫% সমতায় অর্থমূলক পাওয়া গিয়াছে। এই ক্ষেত্রে বোরাক্স দ্বারা সংরক্ষণে অপেক্ষাকৃত ভাল যোজনশক্তি দেখা যায়। যাহা হউক, এই ধরণের প্লাইউডে যতটুকু যোজনশক্তি প্রয়োজন, সকল ক্ষেত্রেই তাহা অপেক্ষা অধিক যোজনশক্তি পাওয়া গিয়াছে।

পোকা ও ছত্রক আক্রমণ প্রতিরোধক উদরোধ সিভিট প্লাইউড নির্মাণে ভিনিয়ারকে নিশ্চিতভাবে বোরাক্স ও বোরিক এসিড সংরক্ষণীদ্বারা সংরক্ষণ করা চলে ; ইহাতে পরবর্তী কালে আঠাদ্বারা ভিনিয়ার সংযোজনে তেমন কোন অসুবিধা হয় না।

INTRODUCTION

Preservative treatment increases the useful life of non-durable timber. Similarly preservative treated plywood has a greater service life. Treated plywood may be manufactured in two ways—veneer may be treated, almost always with water-borne preservatives, and than adhesive-bonded into plywood, or plywood may be manufactured and subsequently treated with suitable preservatives

Toxicity of boron compounds to wood-destroying organisms is well documented. Hunt and Garratt (1953) reported that boron prevents fungal and mold attack in wood treated with it. Carr (1959) gave

a comprehensive review of boron compounds as wood preservatives and had shown these to be effective against decay and sapstaining fungi, wood destroying insects and all dry wood termites. Tamblyn (1957) gave a review of processes, cost, effectiveness and gluing characteristics of boron-treated veneer as practised in Australia. Boric acid and boron solutions are used for treatment of green veneer of Australian hardwoods to prevent *Lyctus* attack. Hot solutions of boric acid (Cummings 1939) have been replaced by cold three percent solution of boric acid or borax (Tamblyn 1949) where green veneer is passed through the solution rapidly and is then stacked for a few hours before drying to appropriate moisture content and glue-bonding into plywood.

In Bangladesh, the major plywood users are the tea-chest manufacturers. Bangladesh Standard Institute (BDS : 18 : 1958/78) (Anon. 1958) specifies that "veneer (of non-durable wood species) shall be treated with 1.25 percent hot solution (200° to 212°F or 93° to 100°C) of boric acid or 1.9 percent hot solution of borax for a period of 10 to 40 minutes according to species and thickness of veneer. They shall then be dried down to a moisture content of not above 10 percent before bonding".

In the present study manufacture of plywood with water-proof adhesive bond was studied using Civit (*Swintonia floribunda*), a non-durable wood (Narayanmurti 1951) and urea formaldehyde adhesive fortified with melamine. Civit is the most widely used species for the manufacture of plywood in Bangladesh and has excellent gluing properties. Veneer was treated with both boric acid and borax solutions separately according to the BDS : 18 both by diffusion of green veneer and soaking of predried (8-10 percent M. C.) veneer. Predried veneer treatment was included in the study as the industry, many a times, finds it more convenient to dry freshly peeled veneer and store these for future use as often preservative chemicals may not be available in time, adequate facilities may not be available, and for other reasons.

MATERIALS AND METHOD

A factorical experiment was designed with one species - Civit, two veneer moisture conditions (M)—green and predried, two preservatives (P)—1.25 percent boric acid solution and 1.9 percent borax solution, and three treatment times (T)—10, 25 and 40 minutes. Four replicate panels were made and five samples per panel were tested each for 'dry' and 'wet' shear tests.

A civit log was cross-cut to 52 in length and heated in water at 65.6°C (150°F) for 72 hours. This was then peeled into 1.5 mm (1/16 in) thick veneer in the experimental Coe Veneer Lathe of the Veneer and Composite Wood Products Division of the Forest Research Institute, Chittagong. The green veneer, so obtained, was clipped to a dimension of 26 in × 26 in. Ninety six pieces of sized veneer were wrapped with polythene sheets to prevent drying. Another 96 pieces of veneer were dried in the Coe Roller Conveyor Dryer of the Division to a target moisture content of eight percent.

A 1.25 percent boric acid solution was prepared. A paste was first made with boric acid and water and then the additional required quantity of water was added and mixed thoroughly. The solution was heated to 92°—100°C and maintained there during the treatment. A 1.9 percent solution of borax was made and used in the same manner.

Forty eight pieces of green veneer were immersed into the hot boric acid solution and batches of 16 veneer pieces were taken out of the solution after 10, 25 and 40 minutes. The treated veneers were then solid-stacked for 3 hours to allow diffusion of the preservative solution into the wood. These were then dried in the veneer dryer to a moisture content of approximately eight percent. The remaining 48 green pieces were treated in the borax solution in the same manner.

Ninety six pieces of dried veneer were treated in the boric acid solution and borax solution for 10, 25 and 40 minutes in the above manner but were not solid-stacked for diffusion. These were dried immediately in the veneer dryer to about eight percent moisture content.

All the treated veneer pieces were conditioned in a room maintained at a dry bulb temperature of 27°C (80°F) and 65 percent relative humidity for attaining an equilibrium moisture content (E.M.C) of 12 percent.

After the veneers were conditioned to a constant weight, they were glued into three-plywood panels using urea formaldehyde resin (Kaurit 285 powder) catalysed with a hardener (700 powder) containing melamine resin for producing boil-proof bond. The adhesive mix was prepared according to the manufacturer's recommendations. The three-ply plywood panels were glue-spread and hot pressed in a 160 ton Williams and White Laboratory Hydraulic Hot Press using the following schedule :

Glue spread	:	36g glue mix double glue line on core
Open assembly time	:	5 minutes.
Closed cold assembly time	:	5 minutes.
Specific pressure	:	200 psi
Press temperature	:	120°C (240°F)
Press time	:	4 minutes.

Four panels were manufactured using each treatment combination. The panels were then conditioned to 12 percent E. M. C. in the conditioning room. Ten standard glue shear test samples, 3 25 in × 1 in (ASTM 1958) (Anon. 1958) were prepared from each panel. Out of these, five samples were tested 'dry' and five were tested 'wet' in the Riehle Electrical Plywood Shear Testing Machine at a rate of loading of 500 lbs per minute. For 'wet' shear tests, the specimens were boiled in water for six continuous hours, transferred to cold water and subjected to shear test while still wet (BS : 1455 : 1948—AX 100 ; DIN 68705—A 100).

RESULTS AND DISCUSSION

The loads at failure in 'dry' and 'wet' plywood shear tests are tabulated in Tables 1 and 2 below :

Table 1, Load at failure in psi in the 'dry' shear test (each value is tne average of 5 samples × 4 panels)

Treatment Time (minutes)	Veneer moisture condition at treatment: Green		Dry	
	Boric acid	Borax	Boric acid	Borax
10	569	582	500	555
25	561	602	495	575
40	531	541	520	542

Table 2. Load at failure in psi in 'wet' shear test (each value is the average of 5 samples × 4 panels)

Treatment Time (minutes)	Veneer moisture condition at treatment: Green		Dry	
	Boric acid	Borax	Boric acid	Borax
10	315	360	312	347
25	307	343	312	302
40	290	344	302	303

Analysis of variance of 'dry' and 'wet' glue-shear tests is given in the Tables 3 and 4 respectively below :

Table 3. Analysis of variance table for 'dry' shear tests

Sources	DF	SS	MS	F
Veneer moisture condition (M)	1	13035	13035	18.4[1]
Preservative (P)	1	16244	16244	22.9[1]
Time of treatment (T)	2	5232	2616	3.7[2]
Panels (R)	3	3125	1062.5	1.5
M X P	1	2714	2714	3.8
M X T	2	4796	2398	3.4[2]
P X T	2	3932	1966	2.8
M X P X T	2	469	234.5	0.3
Error	33	23368	708.1	
Total	47	72915		

[1] Significant at the 5% level [2] Significant at the 10% level

Table 4, Analysis of variance table for 'wet' shear tests

Sources	DF	SS	MS	F
Veneer moisture condition (M)	1	2094	2094	1.34
Preservative (P)	1	8775	8775	5.62[1]
Time of treatment (T)	2	4965	2488	1.59
Panels (R)	3	4319	1440	0.92
M X P	1	3905	3905	2.50
M X T	2	255	113	
P X T	2	1407	704	
M X P X T	2	1048	524	
Error	33	51513	1561	
Total	47	78251		

[1] Significant at the 10% level.

The 'dry' shear test shows that there is a significant difference (at 5% level) between the moisture conditions of veneer at the time of treatment. The glue bond strength was higher when green veneer was treated and subsequently dried than when predried veneer was treated and redried. This might be due to the presence of traces of preservative chemicals on the surface of veneer. In the case of treatment of green veneer chemicals were diffused and better distributed into the veneer. Moreover, predried veneer was dried twice which might have caused some deterioration in the physical and chemical properties of the veneer producing 'case-hardened' veneer thus resulting in poorer bond strength (Northcott *et al* 1959, Pryor 1950, Skeist 1962, Salehuddin 1970, Stevens and Suchsland 1968). It may be noted that in the 'wet' test no difference could be detected. During boiling in the 'wet' test, the 'case-hardening' was relieved, i. e., deactivated 'active points', hydroxyl groups, were reactivated (Salehuddin 1970). The time of treatment was also significant at the 10% level. A soaking time of 40 minutes produced lower bond strength than those of 10 and 25 minutes' soaking. Veneer absorbed more chemical during prolonged soaking and evidently interfered more with adhesion. The type of preservative was significant at the 5% level in the 'dry' test and at 10% level in the 'wet' test. Borax produced higher bond quality as evident in both the 'dry' and 'wet' tests Urea formaldehyde resin cures at a low pH of a stated level produced by the addition of a hardener Boric acid also produces a low pH. The cumulative effect of addition of boric acid and

hardener might have produced a too low pH thus impairing the curing of the resin and produced a lower bond quality. Dost (1971) found that Redwood particle board formed without catalyst was stronger than board formed with catalyst The cause was attribated to the low pH measured for both wood and bark of Redwood However, all the treatment combinations used resulted in glue bond strength well above the minimum prescribed in various standard specifications (ASTM : 1958, BS : 1201, BDS : 18).

Comparison of the bond strength of untreated Civit plywood with the same urea formaldehyde resin (Salehuddin and Azizullah 1977) shows that all the treatment combinations lower the bond quality.

CONCLUSION

Either 1.25 percent boric acid solution or 1.9 percent borax solution may be used for treating Civit veneer for making it more durable in the sense of being resistant to most of the biological decay organisms and subsequently bonded with fortified urea formaldehyde resin for making it highly water resistant. Bangladesh, being a hot and humid country where conditions for the attack of wood by these micro-organisms are very favourable, the importance of such treatment is quite apparent.

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