A POTPOURRI OF WORK IN THE TREATMENT OF LUMBER AND PLYWOOD

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DURABILITY OF CCA-TREATED PLYWOOD HAVING NON-CONFORMING PENETRATION PATTERNS

One of the most important developments in recent years for generating a new market for preservative treated lumber and plywood is the Preserved Wood Foundation (PWF) system. Because the plywood in the PWF is to be used below grade, it must be protected against attack by decay organisms and insects. Separate standards specifically for this use were developed by the Canadian and American standard creating organizations. These standards cover the pressure-preservative treatment of both lumber and plywood with the waterborne salts chromated-copper-arsenate (CCA) and ammoniacal copper arsenate (ACA).

In 1972, a detailed study was undertaken on one 4 ft. x 8 ft. x 5/8 in. piece of Douglas-fir plywood commercially treated with CCA-B preservative for foundation use. This was a five-ply construction with the face, back, and center plies being nominal 1/10-inch Douglas-fir and the two crossbands approximately 3/16-inch spruce (probably Engelmann spruce). This piece was selected because the thin veneers were well treated, but when an edge surface of a saw cut down the center of the panel was sprayed with Chrome-Azurol S reagent to determine copper penetration in accordance with American Wood Preservers Association (AWPA) Standard A-3, Section 3 (AWPA, 1983) for copper, it was very obvious that the thick crossbands appeared to be poorly treated.

Lathe checks were plainly visible at approximately 1/4 inch intervals and the surfaces of each check were treated, leaving an apparent gap of 1/4 inch of untreated wood. Spraying matched surfaces with ammonium molybdate reagent for arsenic penetration showed only a slight improvement in penetration of the crossbands. Contrary to the evidence of poor preservative distribution, chemical analysis of complete cross sections of the plywood showed an excellent preservative retention of 0.60 to 0.70 pcf.

The major question being addressed was, "What effect does this type of treatment, i.e. poor distribution but excellent retention, have on the performance of the treated plywood under very adverse, ground contact exposure conditions?" Therefore, it was decided to use this specific piece of plywood for test stakes to be placed in the ground and observed annually to determine the degree of protection obtained.

Materials and Procedure

From one quadrant of the panel, ten 1 inch x 48 inch strips were cut consecutively from the interior portion of the panel, with the face and back grain direction running in the longitudinal dimension. A one inch piece was cut from the interior end of each strip for chemical analysis. Each strip was then cut in half to make 20 test plot stakes 5/8 inch x 1 inch x 23-1/2 inches. One-half of the stakes, selected alternately, were exposed without any supplementary treatment whatsoever while the other half were brush coated on both saw cut edges with a nine percent solution of CCA preservative. Stakes were installed to one-half their length in the ground at a test site in the Austin Cary Forest at the University of Florida, Gainesville, Fla. in February 1973. They have been inspected annually since that time.

In addition, chemical analysis of preservative distribution throughout the panel was made. A one inch wide strip, 24 inches long, was cut from an outside edge to the center of the panel. Starting from the outside edge, 1/2 inch complete cross sections of the strip were taken for chemical analysis.

Results and Discussion

After nine years of exposure, not one of the 20 test stakes showed the slightest attack by either decay fungi or insects (termites). Untreated Douglas-fir or southern pine plywood stakes similarly exposed showed significant attack by both decay and termites after one year with failures occurring at two years and thereafter.

It now appears possible that CCA treatment of western species of softwood plywood, even with the lathe check penetration pattern described in this study, provides adequate protection to the plywood.

From the analytical results of preservative distribution in the panel (Table 1), the edge effect on retention is limited to the outer two

Table 1

CCA Preservative Distribution and Retention in Douglas-fir Plywood

Zone (inches from edge)	CCA Retention (pcf)	Zone (inches from edge)	CCA Retention (pcf)
zero to 1/2	1.08	13 to 14	0.68
1/2 to 1	0.87	15 to 16	0.71
1 to 1-1/2	0.81	17 to 18	0.67
1-1/2 to 2	0.71	19 to 20	0.63
4-1/2 to 5	0.72	21 to 22	0.61
7-1/2 to 8	0.63	23 to 24	0.70

inch zone. The absence of a retention gradient from two to 24 inches indicates that preservative solution is impregnated through the entire panel surface rather than the edges. The lathe check penetration pattern was similar throughout the 24 inches length of the analytical strip with the possible exception of the outer 1/2 inch.

Conclusions

a) The excellent performance of this material after nine years has been surprising.

b) No effect of edge treatment is evident after nine years of testing.

c) The results suggest that the CSA Standard for treatment of PWF lumber and plywood (CSA 080.15-M 1983), which requires complete penetration of 90 percent of plies in plywood, may be overly conservative.

d) At the very least, this study suggests that there is some margin for variable penetration in CCA-treated plywood designed for use in the PWF system or other ground contact exposure.

EP TOXICITY - CCA-TREATED WOOD

Background

In May, 1980 the Environmental Protection Agency published rules and regulations pertaining to the identification and listing of hazardous waste. These rules and regulations became effective in November, 1980.

Among the criteria for listing a waste product as a hazardous waste is the characteristic of EP Toxicity. Based on the known properties of K-33-C treated wood, it was proposed that it did not possess the characteristic of EP Toxicity. In order to support this position, the need for confirming data was apparent.

In November, 1980, EPA agreed to temporarily exclude from the regulations arsenical treated wood waste generated by end users of the wood product. Although this exclusion was welcomed, it did not apply to the treating plant and was only temporary. Therefore, development of test data was still necessary.

Method

The following method was used to prepare the specimens for the EP Toxicity Test.

Four each (1-1/2 in. x 3-1/2 in. x 30 in.) southern yellow pine and hem/fir boards were treated with various concentrations of CCA to obtain retentions of approximately 0.5 and 1.0 pcf CCA. The hem/fir was incised in accordance with the CSA standard (CSA 080.2-M 1983). The treating cycles consisted of a 30 minute vacuum (27 inches Hg.) with pressure periods (130-150 psi) of one hour for southern yellow pine and five hours for hem/fir.

treatment, all the samples were air dried in the laboratory for s. Following drying, four six inch long pieces were cut from 0 inch sample to provide a total of 32 (16 of each species with per retention) samples to be tested.

n (eight of each species with four per retention) samples were ed for exposure to weathering. The samples were placed on a .n Buffalo, New York, such that all sides of each sample were d to weathering. The weathering tests were started in December, ind were continued for six months. At the completion of the ring cycle, the samples were evaluated by the EP Toxicity Test l, as described below.

maining 16 samples were allowed to air dry in the laboratory for ditional 45 days, at which time they were tested by the EP ity Test Method.

ollowing procedure was used for the EP Toxicity Test:

eight the sample of wood and place in a container with 16 times s weight in deionized water.
djust the pH to 5.0 ± with 0.5 N acetic acid.
xtract the sample by leaching for 24 hours, supplying sufficient gitation to the liquid to insure that all surfaces are ontinuously leached.
t the end of the 24 hour period, deionized water in the amount of our times the weight of the sample will be added to the ontainer. A sample of the liquid is taken at this time.
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he liquid phase will then be analyzed for arsenic by the silver iethyldithiocarbamate method, and chromium by the iphenylcarbazide method.

lts and Discussion

reatment results are given in Table 2. The industry treatment rements are 0.25 pcf for above ground use, 0.40 pcf for ground ct and fresh water use, and 0.60 pcf for the PWF material and ty poles. As can be seen in the treatment results, all samples treated to retentions greater than those required to meet stry specifications. For the 0.40 pcf specification, the samples d from 0.42 to 0.50 pcf. For the 0.60 pcf specification, the es ranged from 0.80 to 1.43 pcf.

EP Toxicity Test results are given in Tables 3 and 4. As can be , all test samples were well below the maximum concentration blished for both arsenic and chromium (VI). Several of the nic levels were below the drinking water standard of 0.05 ppm.

hould be noted that these data support the results of accelerated ning studies which show that arsenic fixation is enhanced by er retentions (treatment with stronger solution concentrations).

Table 2

Results of Treating Wood With CCA-C for EP Toxicity Test

Sample No.	Species	Dimensions (inches)	% Solution Concentration (by assay)	Retention Solution (pcf)	Retention Oxide (pcf) (by assay)
1046-1	Hem/Fir	1-1/2 x 3-1/2 x 30	2.9	31.61	1.07
1047-2	Hem/Fir	1-1/2 x 3-1/2 x 30	2.9	32.71	1.43
1046-3	Hem/Fir	1-1/2 x 3-1/2 x 30	2.9	17.12	0.48
1046-4	Hem/Fir	1-1/2 x 3-1/2 x 30	2.9	13.39	0.42
1047-1	S.Y. Pine	1-1/2 x 3-1/2 x 30	1.7	38.09	0.50
1047-2	S.Y. Pine	1-1/2 x 3-1/2 x 30	1.7	41.16	0.49
1048-6	S.Y. Pine	1-1/2 x 3-1/2 x 30	1.2	43.69	0.98
1048-7	S.Y. Pine	1-1/2 x 3-1/2 x 30	1.2	44.02	0.80

Table 3

Results of EP Toxicity Test for Unweathered CCA-C Treated Wood

Sample No.	Species	Exposure	Retention Oxide (pcf) (by assay)	EP Toxicity Test Results* Cr (ppm)	As (ppm)
1046-2A	Hem/Fir	Unweathered	1.43	1.35	0.12
1046-2B	Hem/Fir	Unweathered	1.43	1.46	0.14
1046-2C	Hem/Fir	Unweathered	1.43	1.48	0.09
1046-2D	Hem/Fir	Unweathered	1.43	1.54	0.14
1046-3A	Hem/Fir	Unweathered	0.48	1.33	0.41
1046-3B	Hem/Fir	Unweathered	0.48	1.20	0.34
1046-3C	Hem/Fir	Unweathered	0.48	1.10	0.32
1046-3D	Hem/Fir	Unweathered	0.48	1.21	0.40
1047-2A	S.Y. Pine	Unweathered	0.49	0.81	0.25
1047-2B	S.Y. Pine	Unweathered	0.49	0.91	0.28
1047-2C	S.Y. Pine	Unweathered	0.49	0.82	0.22
1047-2D	S.Y. Pine	Unweathered	0.49	0.99	0.28
1048-7A	S.Y. Pine	Unweathered	0.80	0.87	0.05
1048-7B	S.Y. Pine	Unweathered	0.80	0.92	0.05
1048-7C	S.Y. Pine	Unweathered	0.80	1.07	0.05
1048-7D	S.Y. Pine	Unweathered	0.80	0.96	0.05

*The maximum concentration of contaminant allowed is as follows:

Arsenic: 5.0 ppm
Chromium (VI): 5.0 ppm

Table 4

Results of EP Toxicity Test for Six Month Weathered CCA-C Treated Wood

Sample No.	Species	Exposure	Retention Oxide (pcf) (by assay)	EP Toxicity Test Results* Cr (ppm)	As (ppm)
1046-1A	Hem/Fir	Weathered	1.07	0.01	0.65
1046-1B	Hem/Fir	Weathered	1.07	0.01	0.31
1046-1C	Hem/Fir	Weathered	1.07	0.01	1.13
1046-1D	Hem/Fir	Weathered	1.07	0.01	0.31
1046-4A	Hem/Fir	Weathered	0.42	0.01	0.91
1046-4B	Hem/Fir	Weathered	0.42	0.01	0.61
1046-4C	Hem/Fir	Weathered	0.42	0.01	0.86
1046-4D	Hem/Fir	Weathered	0.42	0.01	0.97
1047-1A	S.Y. Pine	Weathered	0.50	0.01	0.76
1047-1B	S.Y. Pine	Weathered	0.50	0.01	0.19
1047-1C	S.Y. Pine	Weathered	0.50	0.01	0.52
1047-1D	S.Y. Pine	Weathered	0.50	0.01	0.41
1047-6A	S.Y. Pine	Weathered	0.98	0.01	0.12
1047-6B	S.Y. Pine	Weathered	0.98	0.01	0.17
1047-6C	S.Y. Pine	Weathered	0.98	0.01	0.30
1047-6D	S.Y. Pine	Weathered	0.98	0.01	0.53

*The maximum concentration of contaminant allowed is as follows:

Arsenic: 5.0 ppm
Chromium (VI): 5.0 ppm

The hem/fir samples yielded higher leaching levels, as was expected, due to the surface incising.

Conclusion

Based on these test data, it is our opinion that CCA-treated wood waste is not a hazardous waste.

TREATABILITY AND FIELD TEST DURABILITY OF ASPEN

From time to time, we are asked about the treatability and durability of aspen and why this species of wood is not listed in recognized wood preserving standards such as those of the Canadian Standards Association and the American Wood Preservers' Association.

Treatability

Aspen is classified as a species with readily treatable sapwood and moderately difficult to penetrate heartwood. Lumber cut from this species is believed to contain significant amounts of treatable sapwood. Cooper (1976) investigated the treatability of balsam, poplar and trembling aspen with both creosote and ACA preservatives and concluded that the high permeability of these woods suggests their suitability as preservative treated lumber where high durability is required. However, a caution was attached to this conclusion in view of the early failure of other preservative treated hardwood species, particularly Eucalyptus in Australia, and it was recommended that field testing be done by preservative treated aspen to insure that it was not susceptible to early degradation by soft-rot fungi.

Field Test for Durability

Small stakes, 1/4 in. x 1.5 in. x 10 in., as described by Fahlstrom (1975), were cut from the sapwood of samples of aspen lumber. These stakes were vacuum pressure impregnated in a small laboratory cylinder with various concentrations of CCA-B to retentions of 0.21, 0.41, 0.62 and 0.92 pcf (oxide basis). Each treatment was replicated in 10 stakes. In addition, 10 stakes of southern yellow pine sapwood were treated in the same manner to retentions of 0.18, 0.41 and 0.62 pcf (oxide basis) with CCA-C.

All stakes were air dried after treatment, labeled and randomly placed in a test plot of the Austin Cary Forest, Gainesville, Florida in 1976. Annually, all stakes were inspected and evaluated to decay and termite attack using the following rating system:

10	no attack
9	slight attack
7	moderate attack
4	severe attack
0	failure

The average decay results for both CCA treated aspen and southern pine are given in Table 5. Termite attack was negligible so this data was not included.

After five years of field exposure in Florida, CCA treated aspen stakes showed moderately severe decay attack at retentions as high as 0.62 pcf and evidence of some attack at retentions as high as 0.92 pcf. CCA treated southern pine sapwood showed slight attack at retentions of 0.41 pcf and virtually no attack at retentions of 0.60 pcf. The small size of each sample and the high surface to volume ratio of these stakes allowed for much faster biological attack than would be expected for full size dimension lumber. In addition, the large surface to volume ratio of the small samples enhances the detection of soft rot as this type of decay generally begins at the surface of wood and proceeds inward. From visual observation, it is believed that soft rot was the cause of deterioration of the aspen stakes.

Table 5

Average Decay Rating of Aspen and Southern Yellow Pine Stakes at Yearly Intervals in a Florida Test Plot

Species	Retention CCA, pcf	Years Exposure One	Two	Three	Four	Five
Aspen	0.92	10.0	10.0	10.0	9.3	8.2
Aspen	0.62	9.9	9.9	9.2	8.6	6.0
Aspen	0.41	10.0	9.6	8.1	7.0	5.3
Aspen	0.21	8.9	6.0	6.7	3.4	2.0
S.Y. Pine	0.62	9.9	9.9	9.9	10.0	9.9
S.Y. Pine	0.41	9.8	9.5	9.0	8.8	8.7
S.Y. Pine	0.18	9.1	9.0	8.1	6.7	6.6

In summary, aspen is a wood species that appears to be readily treatable with wood preservatives. However, the field test durability of treated aspen is not equal to the durability of the treated sapwood of softwood species as found in field tests and experienced in actual service. Since significant deterioration of aspen treated to quite high retentions of CCA is observed in a short period of time, the use of preservative treated aspen is not recommended for ground contact exposure, particularly for structural purposes. Until positive data on the field performance of preservative treated aspen is obtained, it will probably not be included in recognized wood treating standards.

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