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Biodeterioration and strength reductions in preservative treated aspen waferboard

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reductions in preservative treated aspen waferboard

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Abstract

Experimental aspen waferboards, bonded with liquid or powdered phenol-formaldehyde resins and treated by various methods with a wide selection of preservatives, were tested for fungal resistance in accelerated laboratory trials. Mold growth on the surface as well as weight and strength losses due to the actions of decay fungi were determined. Testing of board strength after decay in high and moderate hazard exposure conditions required modification of decay tests used for solid wood.

A range of protection was noted with no preservative system exceeding the efficacy of the inorganic salt formulations. Averaged over all treatments, strength loss and weight loss are well correlated. Field exposures of effective treatments are underway.

Waferboard may become increasingly important as a structural panel product for residential and commercial construction. Canada has several waferboard plants, and there presently are several in production in the United States. However, more waferboard/flakeboard/OSB-type plants may be built in the United States in the very near future (27).

Projected demand for aspen waferboard includes many applications where durability against moisture and the deleterious effects of fungi and insects are necessary. Construction practices, paints, or sizings used to minimize moisture problems must be strictly maintained in service to effectively prevent damage by biological agents, and therefore, cannot be completely relied upon as permanent protection. In addition, decay in any portion of a structural sheet of waferboard would involve high replacement costs (16,17). Although preservation of structural wood composites (nonveneered) has received scant attention in Australia and the United States (12, 23), other nations such as the Federal Republic of Germany and New Zealand (9, 17) have developed guides for preservative treatment of such materials.

It is therefore important to evaluate aspen (*Populus tremuloides* Michx.) waferboard, treated with various preservatives, by laboratory and field tests to provide data to assist in assessment of its potential service life in both high and moderate decay hazard usage. Waferboard and other nonveneered structural composites with decay and mold resistance would have potential application in numerous uses such as sheathing or subflooring in mobile homes and recreational vehicles and in the construction of ice-fishing shelters. Treated waferboard would also find use in certain watercraft components and for some exterior uses, such as siding, within the United States. For example, in Puerto Rico 1/4-inch Canadian waferboard is being pressure treated with CCA and used for interior wall partitions. Previous reports have evaluated the weatherability and 1-year

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treated Ghanian hardwood flakes (14, 22).

This study was made to determine the resistance of preservative-treated aspen waferboard to fungi in accelerated laboratory tests, and to determine the effects of fungi on board strength. Biodeterioration testing followed the initial work which examined the effects of preservative, resin type, and treating methods on the mechanical and thickness swelling properties of aspen waferboard (15).

Materials and methods

Board manufacture

As detailed in an earlier report (15), experimental boards (58.4 cm by 70 cm by 1.6 cm thick) were made from aspen wafers, emulsified wax, and liquid or powdered resole phenolic resins pressed at 210°C and 3.5 MPa for 7.5 or 8.5 minutes. Methods of preservation (Table 1) included pretreating wafers, adding preservative to the wax emulsion or resin, and pressure or dip-treating finished panels. Amounts of preservative used were at and above manufacturers' suggested levels.

Deterioration studies

Decay tests for solid wood were modified by increasing sample dimensions to allow strength testing, and prewetting samples to assure decay of untreated board. Without adequate moisture, untreated board may not decay (3, 25, 30, 33).

Soil block testing (ASTM D-1413) is a commonly accepted U.S. standard test. It offers a decay hazard more severe than would be encountered by waferboard in most service situations. However, the value of this test lies in the fact that comparative performances among candidate preservatives can be assessed with reasonable expenditure of time and materials. This method uses weight loss of treated samples for primary evaluation, but, as has been stressed by leading foreign workers in particleboard deterioration (2, 13, 20), evaluation of treatments based on reduction of strength properties is more germane to waferboard's intended structural use. Therefore, both weight loss and on-edge crushing tests reflecting internal bond strength of control and accelerated aged samples were determined.

Square samples (4 cm wide) of test boards were wetted by vacuum impregnation to approximately 40 percent moisture content (MC) (ovendry weight basis). Blocks were then steam sterilized and placed into 0.5 *l* soil block chambers containing cultures of brown-rot fungi [*Gloeophyllum trabeum* (Pers. ex Fr.) Murr. Madison 617 and *Poria placenta* (Fr.) Cooke, Madison 698]. Both ambiently stored controls and accelerated aged (AA; ASTM D 1037) samples were tested (four replicates for each treatment-resin type combination). After weight losses were determined, the blocks were equilibrated at 50 percent relative humidity (RH), 22°C, and crushed on-edge (0.13 cm/min.) to assess the reductions in proportional limit (PL = load at elastic limit/cross-sectional area) as compared to previously wetted but sterile (i.e., no fungus during 3-mo. incubation period in test vessels) samples containing the same preservative treatment.

T-1. No treatment, powdered resin, 3% resin solids.
2. No treatment, liquid resin, 3% resin solids.
3. Preservative mixed with resin and applied during furnish preparation, 2-(thiocyanomethylthio) benzothiazole (TCMTB), 0.11% active solids retention, liquid resin, 3% resin solids.
4. Preservative mixed with resin and applied during furnish preparation, 2-(thiocyanomethylthio) benzothiazole (TCMTB), 0.15% active solids retention, liquid resin, 3% resin solids.
5. Preservative mixed with resin and applied during furnish preparation, CIS-N-[(1,1,2,2-tetrachloroethyl)thio]-4-cyclohexene-1, 2-dicarboximide (Difolatan), 0.25% active solids retention, powdered resin, 3% resin solids.
6. Pretreatment of wafers with gaseous formaldehyde and sulfur dioxide, approximate 1% net weight gain, powdered resin, 3% resin solids.
7. Dip treatment of finished panel, 3-iodo-2-propynyl butyl carbamate, 0.03% solids retention, powdered resin, 3% resin solids.
8. Dip treatment of finished panel, copper-8-quinolinolate, 0.03% solids retention, powdered resin, 3% resin solids.
9. Preservative mixed with wax emulsion and applied during furnish preparation, aqueous copper and fluorine mixture, 0.98% active solids retention, powdered resin, 3% resin solids.
10. Pretreatment of wafers with ammoniacal copper arsenate, 0.98% active solids (0.40 pcf equivalent) retention, powdered resin, 3% resin solids.
11. Pressure treatment of finished panel, ammoniacal copper arsenate, 0.57 pcf active solids retention determined by assay, powdered resin, 4% resin solids.
12. Preservative mixed with wax emulsion and applied during furnish preparation, ammoniacal copper arsenate, 0.61% active solids (0.25 pcf equivalent) retention, powdered resin, 3% resin solids.
13. Preservative mixed with wax emulsion and applied during furnish preparation, chromated copper arsenate, 0.98% active solids (0.40 pcf equivalent) retention, powdered resin, 3% resin solids.
14. Pressure treatment of finished panel, chromated copper arsenate, 0.62 pcf active solids retention determined by assay, powdered resin, 4% resin solids.
15. Preservative mixed with resin and applied during furnish preparation, monochlornapthelene and tributyltinoxide (TBTO), 1.4% stock solution, liquid resin, 3% resin solids.
16. Preservative mixed with resin and applied during furnish preparation, monochlornapthelene and tributyltinoxide (TBTO), 1.0% stock solution, liquid resin, 3% resin solids.
17. Preservative mixed with resin and applied during furnish preparation, aqueous copper and fluorine mixture, 0.70% active solids retention, liquid resin, 3% resin solids.
18. Preservative mixed with resin and applied during furnish preparation, aqueous copper and fluorine mixture, 0.98% active solids retention, liquid resin, 3% resin solids.

In addition, large soil-pan vessels were used to expose control and leached static bending samples to pure cultures of the same decay fungi. Samples were leached by a 2-week submersion with daily water changes. Previous testing with this method has shown that significant strength reductions beyond those due to water alone may occur even in treated particleboard exposed to actively growing fungi (25).

ground use of treated waferboard, a nonsoil test ("contact block test") was designed along published guides for this type of testing (3, 4, 7, 18). The ability of a decay fungus, which is well established on untreated wood, to spread to a treated piece of board in direct contact should reflect efficacy of a preservative to prevent decay in a wet environment out of soil contact. Separate 3-cm squares, 0.5 cm thick, of aspen thoroughly colonized by either of the previously cited brown-rot fungi were affixed to wetted, steam sterilized 4-cm waferboard squares (control or AA) using rubberbands. Four replicate units for each treatment-fungus combination were suspended above water in sealed jars for 3 months. Weight losses were measured as an indication of decay resistance.

Phenolic bonded particleboards that fail in wet conditions of service are often heavily invaded by fungi (10, 22). Also, treated panel materials used in damp conditions may suffer paint failure or develop surface molding which can cause odor and allergy problems. Therefore, any proposed commercial treatment for waferboard should include evaluation of the stain and mold resistance on control and accelerated aged samples.

Squares of treated waferboard (5 cm wide) were surface disinfected by a 2-second dip in boiling water, immersed for 30 seconds in spore suspensions of test fungi [*Penicillium* sp., *Cladosporium* sp., and *Aureobasidium pullulans* (de Bary) Arnaud], and suspended over water in sealed glass jars. After 6 weeks of incubation, samples were removed and rated visually for approximate area of fungal overgrowth on the faces (0 = no growth; 1 = trace to 5%; 2 = 6% to 20%; 3 = 21% to 50%; 4 = 51% to 80%; 5 = 81% to 100% overgrowth). This subjective measurement of visible growth was influenced to some degree by intensity of sporulation and is harder to analyze than data gained by more quantitative methods such as reflectance (11).

Results of fungus and strength testing

Mold and stain test

Penicillium sp. (Fig. 1 A and B) was inhibited (i.e. the obvious area of sample overgrowth remained less than 25% on the fungus rating scale) on non-aged control samples dipped in surface treatments (Table 1: T-7,8) or treated in some fashion by ACA or CCA (Table 1: T-10, 11, 12, 14) with the notable exception of the CCA/wax treatment (Table 1: T-13). The TBTO treatments (Table 1: T-15, 16) outperformed the Cu/Fl additions (Table 1: T-17, 18). The accelerated aging process decreased the efficacy of the surface dip treatments, but certain inorganic salt treatments (Table 1: T-10, 11, 14) and the higher TBTO loading (Table 1: T-15) retained mold inhibition. Mold protection has been reported to increase with increased levels of CCA added to pine chipboard (19).

The *Cladosporium* sp. (Fig. 1 C and D) (previously isolated from molded CCA-treated lumber in MS) was not controlled on any of the accelerated aged materials, and all non-aged materials supported obvious mold growth.

exposed wood caused by *Aureobasidium pullulans* (24) (Fig. 1, E and F) was restricted to less than approximately 25 percent coverage by treatments 5, 6, 7, 8, 10, 11, 12, and 13 on non-aged samples. However, the development of this fungus on accelerated aged materials made from powdered resin was consistently, and in two cases (Table 1: T-1, 14), substantially, lower than on boards made from liquid resins. Also, fungus discoloration was noted to be greater on non-aged boards than on boards subjected to AA. One possible explanation is that the heat and moisture cycles during aging condense some of the free phenols making them more effective in preventing fungal growth on the surface (30). This process may also occur to a greater degree in boards bonded with powdered resin than with liquid resin. Also, the fungicidal phenols may be redistributed to the sample surface during drying to a greater degree with powdered resin systems.

Contact block test

This laboratory test (Fig. 2 A and B) was designed to simulate the resistance of treated materials to decay in aboveground service situations (i.e., no soil). *G. trabeum*, a fungus frequently responsible for decay in wood members not in ground contact, decayed all samples except those with treatments 9 to 18 (Fig. 2 A and B) to levels near those of untreated controls. The dip-treated samples (Table 1: T-7, 8) as well as those containing TBTO (Table 1: T-15, 16) decayed to a greater degree after accelerated aging suggesting loss of treatment during the leaching phase of aging. *P. placenta* decay of samples in this test closely matched that of *G. trabeum*, with the exception of untreated board made with liquid resin (Table 1: T-2) and those containing TCMTB (Table 1: T-3, 4), which were substantially more susceptible to *G. trabeum*.

With many aboveground uses envisioned for treated waferboard, the results of this test may better predict the performance of the preservatives than do the more severe decay tests (soil-block, soil-pan) in which untreated susceptible materials were more severely decayed.

Soil block/on-edge crushing tests

Aspen waferboards with treatments 10 to 18 (Fig. 3 A and B; Fig. 4 A and B) were very resistant to decay by the brown-rot fungi (i.e. < 10% weight loss) whereas untreated board (Table 1: T-1, 2) weight loss averaged 30 percent. Upon accelerated aging, ('A' extension line or side-line tab on bar graph) the protection level was lowered insignificantly in the ACA, CCA samples (Table 1: T-10-14), but decay increased for aged samples with other treatment-resin combinations, notably the TBTO (Table 1: T-15, 16).

The on-edge crushing method has been used to assess decay in solid wood (28, 29) and to study internal strength of nondecayed, preservative-free particleboard (21). It was employed in this study to detect preservatives which might protect the wood in waferboard from decay during fungal testing (i.e., little or no weight loss), but result in large reductions in wood-glue bond strength. Comparison of PL with internal bond (IB)

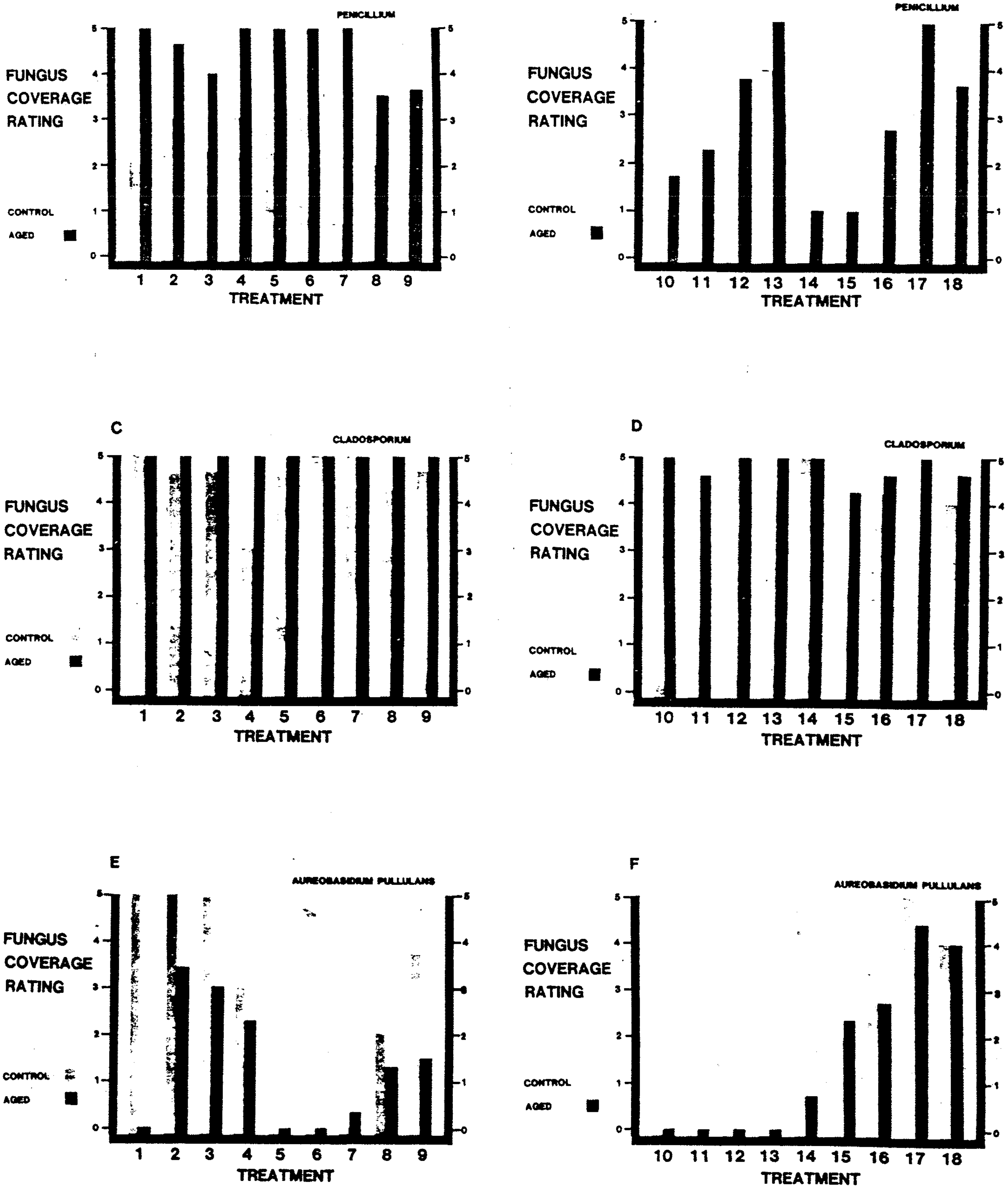

Figure 1. — Mold and stain growth on aspen waferboard: *Penicillium* sp. A, B; *Cladosporium* sp. C, D; *Aureobasidium pullulans* E, F. Fungus coverage rating scale is nonlinear: 0 = no growth; 1 = trace to 5%; 2 = 6% to 20%; 3 = 21% to 50%; 4 = 51% to 80%; and 5 = 81% to 100% of face area overgrown. (Each value is the average of four replicates.)

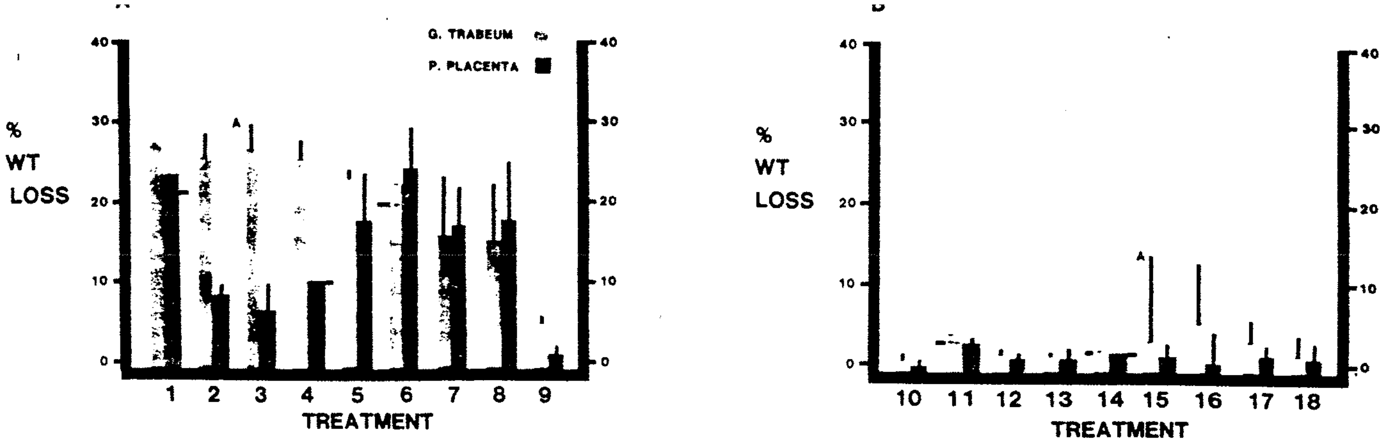

Figure 2. — (A, B) Weight loss of aspen waferboard after a 3-month contact block test. ('A'-extension line marks weight loss of accelerated aged samples; each value is the average of four replicates.)

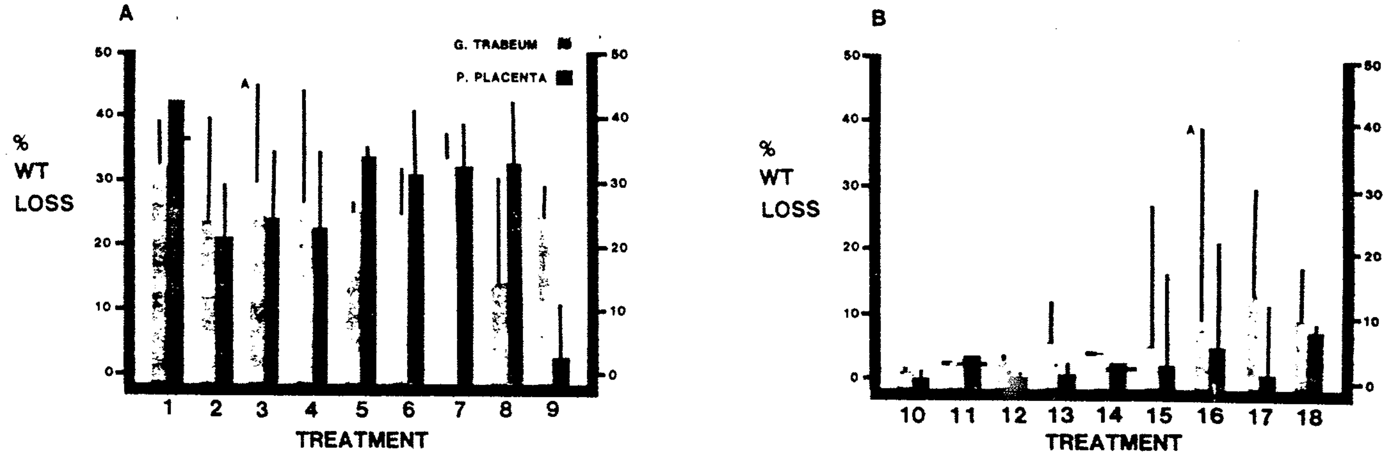

Figure 3. — (A, B) Weight loss of aspen waferboard after soil block testing. ('A'-line or side tab marks weight loss percentage of accelerated aged samples; each value is the average of four replicates.)

values in commercial particleboard has shown a good correlation [$r^2 > 0.8$ (21)]. Face degradation during fungal testing, which may complicate gluing and testing of IB directly, is no obstacle to this method of testing.

Overall regressions and correlations between mean values ($N = 18$) of percentage weight loss and reductions in PL are shown in Table 2. The relationships between weight loss and reductions in PL conform well to the linear curves fitted to the data, with the lowest correlation coefficient, 0.82, found in the aged samples subjected to *P. placenta*.

The effect of aging on PL loss of decayed samples was variable among treatments and fungi. For example, in one-half of the treatments, samples decayed by *P. placenta* showed little or no PL loss, compared to sterile controls, in aged material. Excessive thickness swell, resulting from aging and decay, provides a larger cross-sectional area as a denominator in PL calculations and may explain some of the observed variation. More testing needs to be done with decayed waferboard before on-edge crushing can be recommended as a test method.

Averaged over all treatments, the brown-rot fungi reduced internal strength of waferboard, as reflected in determination of PL loss compared to wetted but sterile samples, proportionately to its ability to decay the samples. This indicated little specific destruction of wood-glue bonding.

Soil pan decay tests and static bending properties

Waferboard samples cut into 43-cm-long by 7.6-cm-wide static bending strips were incubated for 3 months on fungus cultures grown in soil and aspen shavings. After equilibration (50% RH and 22.2°C), weight losses (Fig. 5 A and B) as well as moduli of rupture (MORs) were measured (Fig. 6 A and B). The sample face nearest the fungus culture during incubation was tested in

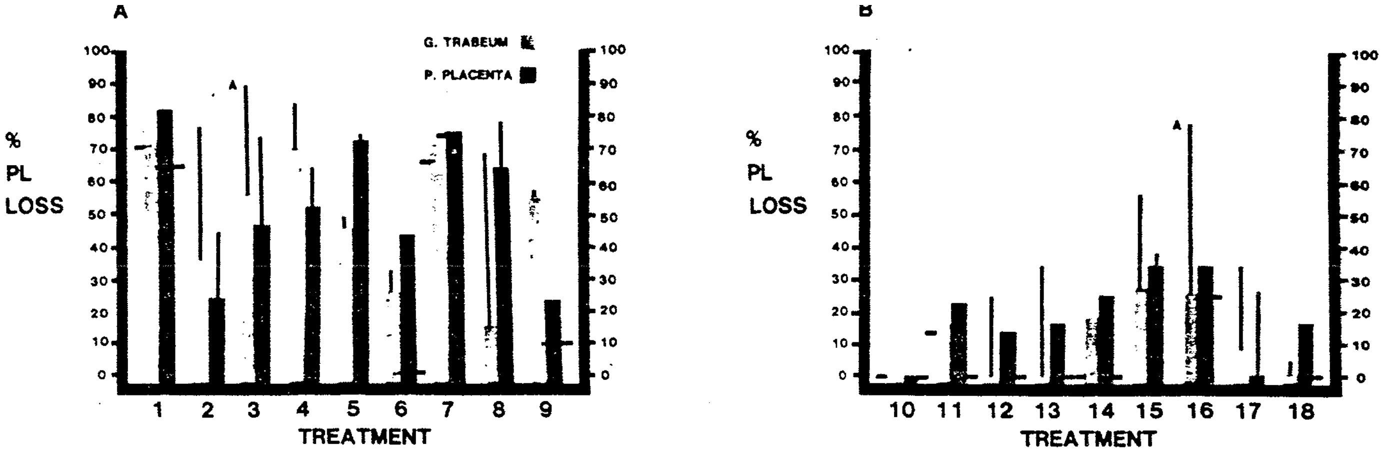

Figure 4. — (A, B) Loss in proportional limit $\left(PL = \frac{\text{load at elastic limit}}{\text{cross sectional area}}\right)$ of aspen waferboard samples crushed on-edge after soil block testing. Values expressed as a percentage of the PL of wetted specimens incubated without fungi for each treatment.

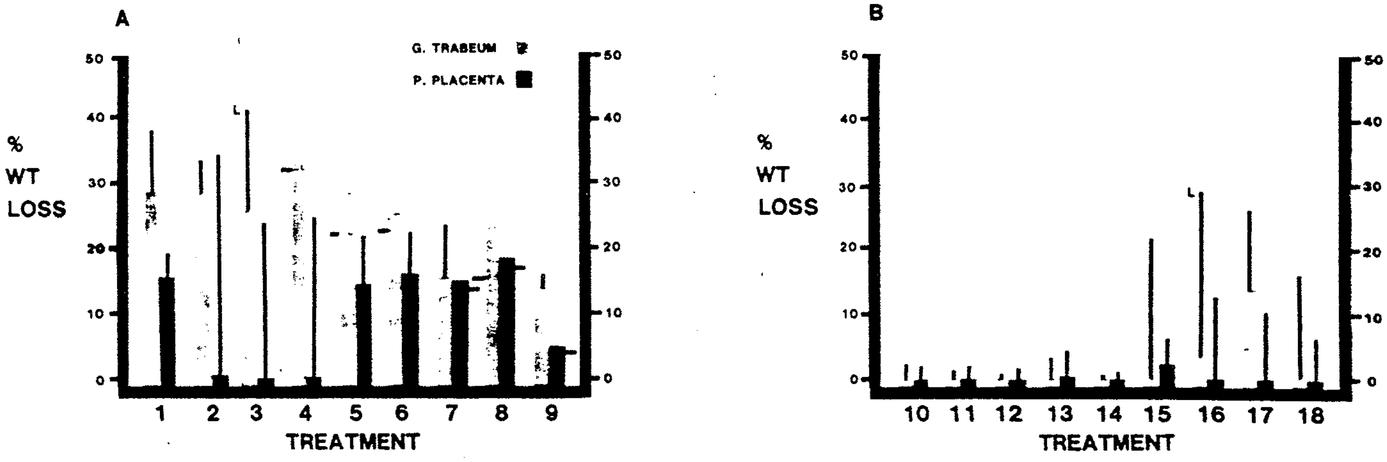

Figure 5. — (A, B) Weight loss of static bending samples in the soil pan decay test. ('L'-line or tab indicates leached sample weight loss; each value is the average of three replicates.)

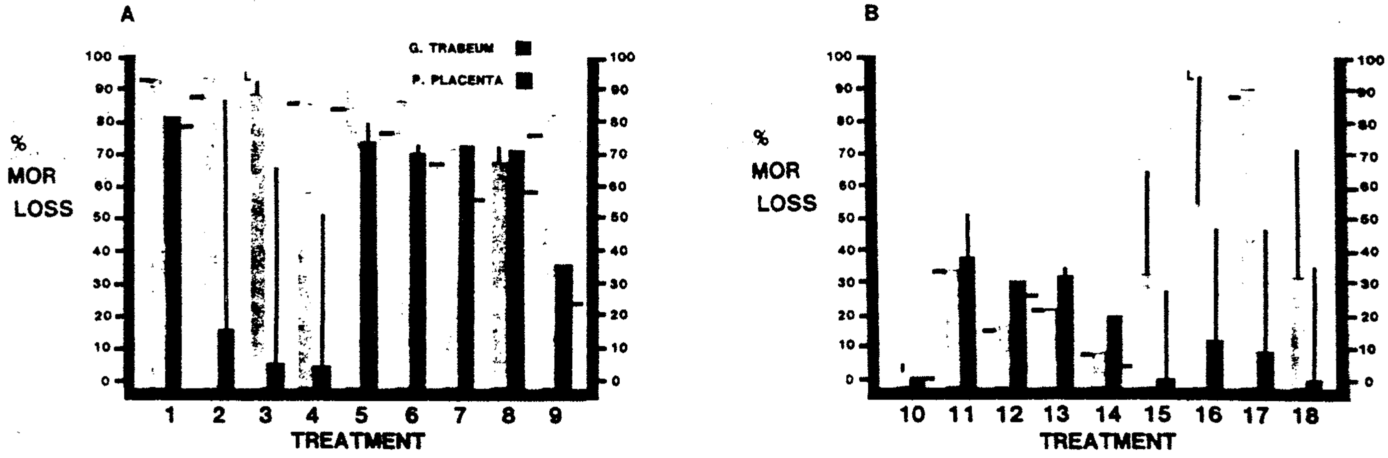

Figure 6. — (A, B) Moduli of rupture losses (as compared to sterile, wet controls) of static bending samples after soil pan decay testing. ('L'-line or tab indicates leached sample MOR loss; each value is the average of three replicates.)

testing was to detect any treatments which might permit substantial reductions in breaking strength after only a small weight loss. The regression equations and associated correlation coefficients are in Table 3. As in the case of the soil block-edge crushing trials, the data in these weight loss/strength loss comparisons also show good fit to the regression lines defined by the equations.

Although there was little or no weight loss in certain treatments (eg., Table 1: T-10 to 18: control samples), MOR losses ranged from 30 to 80 percent as compared to sterile, wet controls. These losses could be partially due to the organic acids given off by the extensive growth of test fungi in the polypropylene trays since it was not uncommon to find small holes, presumably created by acidic condensate, in the aluminum foil covers over these pans after the 3-month incubation period. Such a hydrolytic environment could, conceivably, lower MOR values of waferboard strips even though little weight loss occurs.

Where weight losses of samples exceeded 15 percent (eg., Table 1: T-1 to 9), resulting MOR reductions ran 70 percent or more. Similar strength losses are reported for solid wood at 5 to 10 percent weight loss (32). Such results indicate that in a high decay hazard usage of structural waferboard, it should be well protected against decay (i.e., little or no weight loss permitted) to insure continued strength in service.

Summary

In summary (Table 4), no preservative system tested surpassed the ACA/CCA group (Table 1: T-10 to 14) in overall fungal protection. These salts are known to protect composite board from fungi and insects (5, 19, 22). The CCA added to wax (Table 1: T-13) permitted the greatest fungal attack within this group, with a maximum 13 percent weight loss to *G. trabeum* in aged samples in the soil block test. Also, as reported in an earlier study (15), mechanical properties in aged boards made with the CCA/wax treatment were inferior to those made using other methods of incorporation. Some

TABLE 2. — *Correlation and regression of mean values* (N = 18) *of weight loss (soil block test) and reductions in sample proportional limit (PL as determined by on-edge crushing).*

	Regression[a] equation	Correlation coefficient
1. *Gloeophyllum trabeum* non-aged controls	$y = 2x - 1.8$	$r = 0.86$
2. *Gloeophyllum trabeum* accelerated aged	$y = 1.6x + 10.9$	$r = 0.84$
3. *Poria placenta* non-aged controls	$y = 1.5x + 13.4$	$r = 0.93$
4. *Poria placenta* accelerated aged	$y = 1.6x - 3.2$	$r = 0.82$

[a] %PL loss = y, % Weight loss = x.

TABLE 3. — *Correlation and regression of mean values* (N = 18) *of weight loss (soil pan test) and reductions in modulus of rupture (MOR).*

	Regression[a] equation	Correlation coefficient
1. *Gloeophyllum trabeum* non-aged controls	$y = 2.4x + 26.5$	$r = 0.87$
2. *Gloeophyllum trabeum* leached	$y = 2.2x + 19.9$	$r = 0.93$
3. *Poria placenta* non-aged controls	$y = 3.9x = 12.9$	$r = 0.92$
4. *Poria placenta* leached	$y = 2.1x + 21.3$	$r = 0.84$

[a] %MOR loss = y, % Weight loss = x.

TABLE 4. — *Comparative efficacy of aspen waferboard preservative treatments in laboratory fungal testing (based on data for non-aged materials).*[a]

	Fungal test		
Treatment	Surface mold and stain	High decay hazard (soil block test)	Moderate decay hazard (contact block test)
Untreated (T1, T2)[b]	Poor	Poor	Poor
TCMTB in resin (T3, T4)	Fair	Poor[c]	Poor
Difolatan in resin (T5)	Poor	Poor	Poor
Formaldehyde and sulfur dioxide (T6)	Poor	Poor	Poor
Carbamate dip (T7)	Good[c]	Poor	Poor[c]
Copper-8 dip (T8)	Good[c]	Poor[c]	Poor[c]
Copper/fluorine in wax (T9)	Poor	Fair	Good
Copper/fluorine in resin (T17, T18)	Poor	Good[c]	Good
ACA-pretreated wafers (T10)	Good	Good	Good
ACA-pressure treated panel (T11)	Good	Good	Good
ACA in wax (T12)	Good	Good	Good
CCA in wax (T13)	Poor	Good[c]	Good
CCA-pressure treated panel (T14)	Fair	Good	Good
TBTO in resin (T15, T16)	Fair	Good[c]	Good[c]

[a] Arbitrary separations of performance as follows:

Mold and stain test: (Fig. 1)	Poor = 75% + coverage for 2 of 3 fungi Fair = 25% to 75% Good = <25%
High decay hazard test: (Fig. 3)	(Averaging both fungi) Poor = 20% + weight loss Fair = 10% to 20% Good = <10%
Moderate hazard decay test: (Fig. 2)	(Averaging both fungi) Poor = 15% + weight loss Fair = 10% to 15% Good = <10%

[b] Treatments as described in Table 1.

[c] Substantial loss of protection after accelerated aging.

fluence on the mechanical properties of composite board (5, 14, 19) from the addition of these preservative salts. However, reduced internal bond (6) and significant strength losses after boil-dry weathering (1) have also been reported.

As to integrating one of these waterborne salt treatments into the manufacturing of treated waferboard, the addition of ACA to the wax emulsion provides fungal protection while minimizing the cost increases associated with a separate treatment operation (eg. pretreating or pressure treating). By venting the rotating drum of excess ammonia during the ACA-wax spray addition, pollution problems could be minimized. The ACA solution we used permitted addition levels of only 4 kg/m^3 (0.25 pcf) to the board furnish without adding excess water, which would require redrying of wafers to avoid delamination of boards at pressing due to trapped water vapor. Presumably, work with ACA-wax compatibility systems could develop formulations permitting higher loadings which may be required in ground contact situations.

In terms of moderate decay protection, where the moisture hazard would be occasional (eg. roof decking), the TBTO and Cu/Fl formulations (Table 1: T-9, 15, 16, 17, 18) performed well in the contact block test. The Cu/Fl was somewhat more leach-resistant than the TBTO, and the carrier solvent for the TBTO did have a noticeable odor (even after 3 mo. of testing) which might be objectionable in human habitats.

The surface dip treatments (Table 1: T-7, 8) did provide some mold protection and reduced decay a small amount (about 10% below that of untreated controls) in the contact block test, but this decay protection was lost upon accelerated aging.

The formaldehyde/sulfur dioxide treatment (Table 1: T-6) did not protect boards from the brown-rot fungi, and had deleterious effects on the water resistant nature of the phenol-formaldehyde resin (PF) (i.e., extreme thickness swelling on wetting).

The TCMTB (Table 1: T-3, 4) offered little protection when incorporated into PF resin. This was possibly due to the high pH of such a resin, which may destroy the fungicidal activity of this compound or affect the instability of the compound at the press temperature (Buckman Laboratories, Inc., Memphis, Tenn. — personal communication).

The poor performance of the Difolatan (Table 1: T-5) was unexpected as, in agricultural applications, it is considered an effective fungicide. However, the particular wood species used may influence efficacy since this chemical failed to control fungal stain on susceptible hardwoods such as yellow-poplar (*Liriodendron tulipifera* L.) while performing well on pine (8, 31).

The untreated boards made with liquid PF resin were generally more resistant to decay than those made from powdered resin, but upon leaching, this difference was no longer evident.

Field exposure of untreated panels (Table 1: T-1) and panels protected with dip treatments (Table 1: T-7, 8), ACA (Table 1: T-12), TBTO (Table 1: T-15), and Mississippi. Panels on test fences and half-buried on edge in the soil will be examined for strength reductions and type of biodeterioration after 2-1/2 and 5 years of exposure.

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APA forecasts good structural panel market

Prospects for a 1984 structural panel market that can be at least as good as 1983 are analyzed in the American Plywood Association's (APA) latest regional production and distribution report, which is now available.

Projections for the panel market outlook over the next 5 years are offered, and the rationale for the association's prediction of continued strong demand through 1984 is explained.

The new APA forecast has the rider that should short-term rates remain high through the balance of the year, 1984 housing volume would continue to hover between 1.45 and 1.6 million units and produce about 1.55 million rather than moving to 1.75 million starts (as shown in the forecast).

The association's position is that even at a lower housing level than 1.75 million, the 1984 election year has the potential to at least equal 1983's strong performance by the structural panel industry.

APA's estimates for total U.S. structural panel demand are for 20.3 billion square feet in 1983 and 21.9 billion feet in 1984, based on housing starts of 1.62 million units this year and 1.75 million next year, and on the expected continued growth of several nonhousing markets.

The breakdown of demand estimates by end-use market shows new residential construction claiming 8.1 billion square feet of the total in 1983 and 8.9 billion feet in 1984. Total estimated nonhousing market demand (divided in order of size between homeowner, nonresidential construction, industrial, and international markets) is 12.2 billion square feet this year and 13.01 billion feet next year.

The 34-page report examines production capacity trends nationally and by region. A broad array of opportunities in each major structural panel market is identified. The report also shows the 1982 veneer panel distribution to 50 Rand McNally trading areas from each of the three major producing regions.

Copies of Economics Report E35, "Regional Production & Distribution Patterns of the Structural Panel Industry," are available free to association members and at $15 each for nonmembers by writing the American Plywood Assoc., P.O. Box 11700, Tacoma, WA 98411. ■

Repair of flood-devastated homes boosts lumber sales

Storm and flood devastation in the United States could provide additional stimulus to already-improving sales for Canadian lumber producers.

It is estimated that $240 million (U.S.) will be required to repair housing damage in Louisiana, Texas, and California, with 50 percent expected to go for building materials.

Meanwhile, U.S. housing starts, which are the key to prosperity for Canadian lumber suppliers, have rebounded to 1979 levels.

Starts, after reaching an annualized figure of 1.7 million in both January and February, were maintained at about 1.6 million in March, according to the Washington-based National Association of Home Builders. This is an improvement of more than 50 percent from the depths of last year. ■

American Plywood Association is 50 years old

Fifty years ago on May 16, 1933, the Douglas Fir Plywood Association (DFPA), forerunner to the American Plywood Association (APA), was organized in Portland, Oreg. A month later, on June 13, 1933, the DFPA held its first regular meeting in Tacoma, Wash.

Formed originally to develop consistent quality standards for its member mills, the DFPA rapidly grew as new markets were researched and tapped, product demand zoomed, and more mills added. The Tacoma, Wash. headquartered DFPA became the APA in 1964.

APA has 173 employees located across the United States and in the United Kingdom, West Germany, and Belgium. Its primary objective has remained the same throughout its 50-year history—helping to create demand for member products of known, dependable quality.

Over the years, the residential construction market has provided the bulk of panel demand as structural systems proved economical and durable. More recently, when the nation experienced one of the worst housing recessions in its history, the APA stepped up efforts to develop nonhousing markets and helped the industry survive the storm. In 1982, nonhousing markets accounted for over 70 percent of panel industry demand.

According to APA Executive Vice President Bronson J. Lewis, the association is optimistic about the future. "APA and its members are well equipped to take advantage of numerous opportunities in a resurgent economy," he said.

The association currently represents 147 mills responsible for 78.6 percent of the structural panels produced in the United States. ■