U. S. DEPARTMENT OF COMMERCE

BUILDING MATERIALS AND STRUCTURES

REPORT BMS69

Stability of Fiber Sheathing Boards as Determined by Accelerated Aging

by

DANIEL A. JESSUP,
CHARLES G. WEBER, *and*
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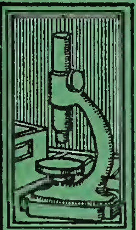
NATIONAL
BUREAU OF STANDARDS



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Foreword

Fiber sheathing comprises fiberboards of a comparatively new type, and it gives considerable promise as a material for house construction. Samples of the boards were tested in connection with the research on building materials and structures for low-cost housing. Particular attention was given to tests of the lasting qualities of the boards, and this report contains data on their resistance to accelerated aging. The changes in the properties of the materials are used as a basis for judgment of stability.

LYMAN J. BRIGGS, *Director.*

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CONTENTS

ABSTRACT

Fiber sheathing boards were aged by exposure to wetting, freezing, drying, and to outdoor weathering. Judgment of stability was based on changes produced in the properties of the boards. The properties tested were weight, thickness, expansivity, thermal conductivity, flexural properties, nail-holding strength, and permeability to air and water. Data were obtained on the resistance of the boards to rot-producing fungi.

In general, the retention of the essential properties under the aging treatments was excellent. Practically no loss of insulating value was noted, and the strength and water resistance of most of the samples after aging were satisfactory. The boards were not readily subject to mold growth even at excessively high humidities.

I. INTRODUCTION

The properties and stability of the ½-inch type of fiber building boards have been previously determined, the data being contained in previous publications.[1 2]

This article presents the results of tests on relatively rigid insulating boards of approximately the same thickness as the lumber usually employed for sheathing, 25/32 inch. These boards are treated with asphalt to improve their resistance to the infiltration of air and water. They are designed to contribute to the rigidity of a structure, to serve as barriers against the infiltration of water and air, and to provide thermal insulation.

Resistance to rot-producing fungi under controlled conditions was observed, and the resistance of the different boards to deteriorative influences was judged by the effects of accelerated aging and outdoor weathering exposures.

Experience at the Bureau with record papers,[3 4 5] roofing materials,[6] sheathing papers,[7] and fiber building boards [8] has demonstrated the usefulness of accelerated aging for predicting the relative stability of fibrous materials.

II. DESCRIPTION OF SAMPLES

The boards tested in this investigation were secured from cooperating manufacturers. No attempt was made to obtain all the commercial brands available, but those tested were considered to be representative of commercial products. Ten different manufacturers submitted samples for test. Three boards were laminated and consisted of two plies of equal thickness. The others were homogeneous boards, one of which had kraft paper cemented to both face and back with asphalt.

III. PROPERTIES AND TESTING

The sheathing of a structure is, in the course of normal events, exposed to a wide range of

[1] NBS Building Materials and Structures Report BMS13 (1939). 10¢.
[2] NBS Building Materials and Structures Report BMS50 (1940). 10¢.
[3] BS J. Research **7,** 466 (1931) RP352.
[4] BS J. Research **11,** 727 (1933) RP620.
[5] J. Research NBS **23,** 405 (1939) RP1241.
[6] J. Research NBS **18,** 669 (1937) RP1002.
[7] NBS Building Materials and Structures Report BMS35 (1939). 10¢.
[8] NBS Building Materials and Structures Report BMS50 (1940). 10¢.

TABLE 1.- *Properties of fiber sheathing boards and effects of accelerated aging*

Laboratory designation	Thickness	Density	Linear expansion (for increase from 50% to 90% RH)	Thermal conductivity before and after aging [a]	Flexural properties [b]								Nail-holding strength (lateral)		Water permeability (time of penetration through board)		Air permeability (rate of flow through board)	
					Breaking load				Deflection at rupture									
					Across long direction		Across short direction		Across long direction		Across short direction							
					Initial	After aging	Initial	After aging	Initial	After aging	Initial	After aging	Initial	After aging	Initial	After aging	Initial	After aging
	in.	*lb/ft*³	%	*Btu/hr / ft²(° F/in.)*	*lb*	*lb*	*lb*	*lb*	*in.*	*in.*	*in.*	*in.*	*lb*	*lb*	*hr*	*hr*	*cm³/sec / m²(g/cm²)*	*cm³/sec / m²(g/cm²)*
1	0.74	17.8	0.32	0.37	13	10	11	10	0.31	0.30	0.28	0.30	98	90	96	70	65	326
2	.74	15.8	.31	.35	13	12	12	12	.75	.90	.71	.81	105	99	24	20	867	943
3	.83	20.0	.10	.39	48	43	45	37	.48	.55	.45	.55	171	147	72	45	125	150
4 [c]	.81	17.0	.30	.38	38	33	28	26	.69	.69	.63	.72	103	80	168	200	0.001	0.006
5	.78	18.2	.39	.39	27	22	25	22	.33	.37	.39	.52	109	96	48	20	141	480
6	.74	19.3	.27	.40	45	38	40	32	.28	.32	.32	.39	135	118	48	48	583	305
7	.80	17.2	.20	.36	52	42	45	40	.48	.43	.51	.44	145	120	45	24	315	363
8 [d]	.77	23.3	.27	.40	33	14	30	14	.29	.30	.29	.30	159	72	72	24	0.001	[e] 2100
9 [d]	.82	19.5	.32	.37	43	18	46	20	.36	.58	.44	.68	144	96	500	240	0.001	[e] 10
10 [d]	.74	21.5	.34	.40	27	18	20	11	.43	.58	.54	.46	156	138	48	24	1.29	[e] 108

[a] The thermal conductivity was not in any instance affected by aging.
[b] For specimens 3 inches wide on supports 12 inches apart, loaded at center.
[c] Kraft paper cemented to each surface with asphalt.
[d] Two-ply laminated boards. The plies separated under accelerated-aging treatment.
[e] Determined on the individual plies of the specimens that had separated during aging.

conditions of temperature and moisture. Accelerated aging was employed to obtain data on the resistance of the fiber sheathing boards to such variations. They were subjected to these influences with the conditions made more drastic in order to speed up their action, and the extreme conditions in much more rapid succession than normally occurs. The treatment consisted in the following cycle: Heating 3 hours at 65° C in dry air; immersing in water at room temperature for 3 hours; and freezing the wet boards at −12° C for 18 hours. This cyclic treatment was continued for a total of 600 hours, 25 cycles.

Although the fiber sheathing boards are not designed for use as exterior finish, they are often considered for such use, particularly on temporary or semitemporary structures. The Bureau receives numerous inquiries regarding the performance of the boards as outside finish. Hence, a number of weathering tests were made. The tests consisted in outdoor exposures, the effects of which were accelerated by spraying with water at regular intervals. The edges of the specimens were sealed against moisture with a coating of spar varnish containing powdered aluminum. Two specimens of each board selected were exposed. In each instance, the exposed surface of one specimen was painted with a linseed-oil–white-lead paint, and the exposed surface of the other specimen was left unpainted.

Data on the properties of the boards before and after accelerated aging are shown in table 1. Inasmuch as the methods of test are the same as those used in testing the ½-inch building boards, and described in detail in previous publications,[9] [10] they are described but briefly here.

1. Thermal Insulation

Insulating value is determined by measuring the rate at which heat is transferred through a board, and is expressed as the number of heat units (Btu), passing through a square foot of board, 1 inch thick, per hour, with a temperature difference of 1° F. Thermal conductivity was determined by the guarded hot-plate method previously described.[11]

The values reported in this article were obtained by H. W. Woolley and J. G. Reid, Jr., in the Heat Transfer Section of the Bureau.

Accelerated aging of the fiber sheathing boards did not result in measurable losses of their insulating values.

[9] NBS Building Materials and Structures Report BMS4 (1938). 10¢.
[10] NBS Building Materials and Structures Report BMS13 (1939). 10¢.
[11] NBS Building Materials and Structures Report BMS 13 (1939). 10¢.

2. Flexural Properties

The fiber sheathing must supply considerable stiffening and structural strength or the structure must be otherwise braced. Hence, resonably high strength is important, and good retention of that strength with aging is essential.

Flexural strength was determined by the method used for insulating boards and previously described.[12] It consists in loading at midspan a specimen 3 inches wide, supported by two parallel rods 12 inches apart, until the specimen breaks. With two exceptions, namely boards 1 and 2, the initial strength was considered high; the average for the two directions ranged from 23 pounds to 48 pounds. Boards 1 and 2 had much lower strengths.

Losses of flexural strength during aging were not large except for boards 8, 9, and 10. These were laminated boards and the plies separated under the accelerated aging treatment, owing to softening of the adhesive during the heating. This would possibly not occur under natural aging, as the maximum temperatures employed here are not encountered.

3. Nail-Holding Strength

The nail-holding strength of fiber sheathing is an essential property. The benefits of high physical strength and rigidity will be lost if the nailing fails, and strength tests at the Forest Products Laboratory [13] of large panels have shown that many of the failures occurred at the point of nailing. Nail-holding strength was determined by measuring the force required to move a 6-penny common nail to the edge of the board from a position ¾ inch from the edge.

Accelerated aging caused some drop in the nail-holding strengths of all of the boards. However, the losses do not appear to be indicative of serious deterioration except for the laminated boards 8 and 9. In these instances, the loss was caused by separation of the plies.

4. Water Permeability

It is generally recommended that where the fiber sheathing boards are used, sheathing paper is unnecessary except to cover the joints. Hence, the boards must be capable of functioning as a primary moisture barrier to prevent infiltration of water. The rate of penetration of water through the boards was determined by the dry-indicator method. An indicator consisting of a mixture of eosin dye, powdered sugar, and starch is sprinkled on one surface of the specimen; a glass cover is sealed over the indicator to prevent evaporation of the transuded moisture; and the edges of the specimen are sealed with wax to prevent water from reaching the indicator except by penetration through the board. The specimen thus prepared is floated on water, and the time of transudation of water in an amount sufficient to develop color in the indicator is a measure of the permeability.

With respect to water permeability, the boards were, in general, superior to most ordinary sheathing papers.[14] The water resistance dropped somewhat under the treatment, but the losses were considered not serious, since all of the boards retained good resistance to the passage of water after aging.

5. Air Permeability

Leakage of air through the walls is a factor affecting heating, cooling, and the general comfort of a building. To function satisfactorily, fiber sheathing must prevent infiltration of air under conditions of wind pressure, because the boards are designed for use without the protection of sheathing paper. The fiber sheathing boards appear to be excellent in this respect. The initial permeabilities were low for most of the boards and were not increased appreciably during aging.

6. Outdoor Weathering

Table 2 contains data on the comparative results of tests after accelerated aging and after 15 months' exposure to outdoor weathering. The results of the outdoor exposures appear to be roughly comparable to those of accelerated aging. Outdoor aging did not cause boards 8 and 9 to split, and their flexural strength and nail-holding strength did not decrease as much as with accelerated aging. The boards which had been painted on the exposed surface were little affected by the exposure.

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[12] See footnote 11.

[13] G. E. Heck, Rigidity and Strength of Framed Walls Sheathed with Fiberboard. U. S. Dept. Agr. Forest Products Laboratory.

[14] NBS Building Materials and Structures Report BMS35 (1939). 10¢.

TABLE 2.—*Comparison of effects of accelerated aging and outdoor weathering*

Laboratory designation	Water permeability (time of penetration)			Air permeability (rate of flow through board)			Flexural strength				Nail-holding strength			
	Initial	After accelerated aging	After outdoor exposure	Initial	After accelerated aging	After outdoor exposure	Initial	After accelerated aging	After outdoor exposure: Unpainted	After outdoor exposure: Painted	Initial	After accelerated aging	After outdoor exposure: Unpainted	After outdoor exposure: Painted
	hr	*hr*	*hr*	$\frac{cm^3/sec}{m^2(g/cm^2)}$	$\frac{cm^3/sec}{m^2(g/cm^2)}$	$\frac{cm^3/sec}{m^2(g/cm^2)}$	*lb*	*lb*	*lb*	*lb*	*lb*	*lb*	*lb*	*lb*
4	168	200	30	0.001	0.006	3.6	38	33	24	32	103	80	90	94
3	72	45	45	125	150	196	48	45	44	55	171	147	163	192
7	45	23	15	315	363	386	52	42	35	55	145	120	164	192
8	72	24	15	0.001	2,100	414	33	14	18	25	159	72	124	144
9	500	240	120	0.001	10	2.9	43	18	36	38	144	96	131	128

7. Resistance to Rot-Producing Fungi

There has been much interest in the susceptibility of the fiberboards to rotting. Tests were made on the sheathing boards in connection with similar work on fiber insulating boards to determine their susceptibility to attack by rot-producing fungi. The selection of fungi was based on a recommendation of the Division of Forest Pathology, United States Department of Agriculture, and the cultures were prepared in the Forest Pathology Laboratory.

Specimens of the sheathing boards were inoculated on the edges and on the protected surface with cultures of rot-producing fungi and stored over water at approximately 95-percent relative humidity and room temperature. The specimens supported fungus growth at the edges, but generally, where the coating produced a relatively impervious surface, there was no visible fungus growth. It was found that growth proceeded most favorably at humidities above 85 percent, and that the fiberboards supported fungus growth to about the same extent as did the woods commonly used in house construction.

IV. SUMMARY AND CONCLUSIONS

The stability of fiber sheathing, a relatively new product in the field of house construction, was determined by measuring the resistance of fiber sheathing boards to accelerated aging and to attack by rot-producing fungi.

The boards had, in general, excellent stability under the aging treatments. Losses of flexural strength were, with few exceptions, not serious, and the nail-holding strength was equally satisfactory.

The materials were excellent with respect to resistance to the passage of water and air and maintained those properties well under aging. They appear to be sufficiently impervious to serve as primary barriers against the infiltration of both water and air when used in a wall without sheathing paper, provided that all joints are covered with waterproofed paper or otherwise sealed.

The fiberboards are apparently no more susceptible to damage from the growth of rot-producing fungi than are the woods commonly used in house construction.

WASHINGTON, October 10, 1940.

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[List continued on cover page IV]

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[Continued from cover page III]