BUILDING MATERIALS
AND
STRUCTURES
REPORT BMS77
Properties and Performance of Fiber Tile Boards
by
DANIEL A. JESSUP,
HERMAN BOGATY, and
SAMUEL G. WEISSBERG

NATIONAL BUREAU OF STANDARDS
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BUILDING MATERIALS and STRUCTURES

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DANIEL A. JESSUP, HERMAN BOGATY and SAMUEL G. WEISSBERG

ISSUED AUGUST 8, 1941

The National Bureau of Standards is a fact-finding organization; it does not "approve" any particular material or method of construction. The technical findings in this series of reports are to be construed accordingly.
Foreword

Fiber tile board offers considerable promise as a finishing material for installations where much more costly materials are ordinarily used. Samples of this type of board were tested as a part of the research program on building materials and structures.

Lyman J. Briggs, Director.
Properties and Performance of Fiber Tile Boards

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ABSTRACT

Performance tests have been made on fiber tile boards by subjecting them to conditions which they might possibly meet in service. The properties examined were resistance to abrasive cleaning powders, resistance to staining by household chemicals, and stability of the boards when subjected to cycles of steaming and drying. In addition, data were obtained on the density, expansivity, and flexural properties of the boards, and on the thickness and impact resistance of the finish coatings.

The resistance of most of the boards to staining, to impact, and to abrasive cleaning powders was good. Most of the surface coatings were damaged by the changes of steaming and drying, especially at the edges, where moisture had direct access to the base material, and at the score marks, where the coatings in some of the boards were very thin. The density, expansivity, and flexural properties were satisfactory.

I. INTRODUCTION

In connection with research at the National Bureau of Standards on building materials and structures relative to low-cost housing,\(^1\) it was considered desirable to include a study of the properties of fiber tile boards. This material is made of vegetable-fiber boards in large sheets, and has on one side a dense, hard coating, either white or colored. The coated surface is frequently scored to resemble the ceramic wall tile commonly used in more costly structures than those for which the fiber tiles are primarily intended.

II. DESCRIPTION OF SAMPLES

The samples were commercial products furnished by manufacturers. They consisted of compressed wood-fiber board, coated on one side with a synthetic plastic. Some of the coatings were homogeneous, and others had a top layer over a priming coat. Two of the products had a resinous binding material in the base boards. There was no added material in the other base boards.

III. PROPERTIES AND TESTING

The samples were tested in their normal condition for the physical properties commonly measured on fiberboards, and for resistance to impact, steam, abrasion, and various liquids since structural tile in use frequently encounters one or more such deteriorative influences. The data are contained in tables 1 and 2, respectively.
1. **Thickness and Density**

The density of the tile board is the weight per unit of volume. It was computed from measurements of dimensions and from determination of weight. In most cases specimens about 18 by 18 inches were used. The weight was determined on a torsion balance reading to 0.1 gram, and the thickness was determined by means of a micrometer caliper reading to 0.001 inch.

2. **Linear Expansion With Change in Humidity**

The change in dimensions with a change in the relative humidity of the surrounding atmosphere is an important characteristic of interior finishing materials. Low expansivity minimizes the difficulties encountered with waving, buckling, and opening of seams when extreme humidity conditions occur.

The linear-expansion tests were made in accordance with the Federal Specification for fiber insulating board. Test specimens measuring about 12 by 2 inches were conditioned in an atmosphere at 50-percent relative humidity and then conditioned for 48 hours in an atmosphere at 95-percent relative humidity. The changes of length were determined from the displacement of reference marks placed about 8 inches apart on the specimen.

3. **Flexural Properties**

Although tile boards are not naturally generally required to contribute to the strength of a structure, the boards must be of sufficient strength to withstand, without undue breakage, handling incidental to installation, and to resist damage after installation. The strength of fiber building boards is generally determined in terms of flexural properties. These were determined by placing a specimen 1 inch wide across two parallel supports 3 inches apart and loading at the midspan. The load is conveniently applied by means of a tensile testing machine with suitable fixtures. The rupturing load and the deflection at instant of rupture are recorded. This method is one developed at the Bureau for use with binders board.  

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1 Federal Specification LLI-F-321a Fiber Boards; Insulating.
3 Tensile Testing Machine with Suitable Fixtures.
4. Thickness of Coating

The thickness of the coating was determined by an adaptation of Mesle’s chord method. This method has been used successfully for the measurement of the thickness of plated metal coatings. A precision grinding wheel of known radius, \( R \), is lowered upon the surface of the tile board with the axis of the wheel parallel to the plane of the board, as illustrated in figure 1. The surface of thickness, \( T \), is ground through until the wheel reaches the base material along a line through \( P \). The width of the cut, \( C \), is related to the thickness, \( T \), and the radius of the grinder, \( R \), as follows:

\[
R^2 = (R - T)^2 + \left( \frac{C}{2} \right)^2 \quad \text{or} \quad 2RT = T^2 + C^2.
\]

As \( T \) is about 0.01 inch, \( R \) about 4 inches, and \( C \) about 0.5 inch, \( T^2 \) may be neglected, making \( T = (C^2/8R) \).

In practice the plane of the specimen is tilted so that it makes an angle of about 1° with the axis of the wheel. This gives a cut with a semielliptical plan (fig. 2). Tilting has the advantage that, when there is more than one layer of coating, all are exposed for measurement with but one grinding operation. Moreover, there is no uncertainty as to the endpoint of the grinding operation. The width of the cut, \( C \), for a particular coating is measured at the apex of the ellipse formed by the intersection of the wheel with the plane separating the coating under consideration from the next lower layer.

5. Effect of Steam

A test was devised whereby the surface of the fiber tile was exposed to the action of condensing steam for 7 hours and then allowed to dry for 17 hours. Changes in appearance and properties were determined after five such cycles of steaming and drying. The changes produced in some of the boards as a result of this treatment are shown in figures 3, 4, and 5.

Warping was determined by means of a cylinderometer. This device consists of two rigid feet fixed 12 inches apart and a movable foot attached to a dial micrometer at the center of the span. A zero reading is obtained by holding the instrument on a plate-glass surface. The difference between the micrometer reading on the warped board and the zero reading gives the degree of warping.

The warping was extreme in only two of the samples. The base material of these was compressed wood fiber with a resinous binder.

The resistance of the coating to change of gloss and color after steaming was rated as follows: Good, no change; fair, slight but not objectionable; poor, considerable change.

Most of the boards became less glossy on steaming and many of the colored boards faded (fig. 3). In general the color of the white boards was unaffected by steam.

The coatings of most of the boards underwent some surface change. Steaming caused wheels or blisters to form, generally at the edges, near score marks, or at places where the coating had
been scratched or broken (fig. 4). In two instances the coating loosened and tended to separate from the base (fig. 5).

6. Impact Tests

Impact tests on the coated surfaces of tile boards were used as a measure of the resistance to chipping by hard blows. Specimens were placed in a metal frame at an angle of 30° with the horizontal, to simulate glancing blows, and weights were allowed to fall on the surfaces. The shortest distance of fall required to break the surface was recorded. The weights were hardened steel cylinders, $\frac{3}{8}$ inch in diameter, with the edges rounded to a radius of 0.025 inch. The cylinder axis at the moment of impact was vertical. Tests were made with 1- and 2-ounce weights on both the original and the steam-treated boards.

The surface in most cases showed no deterioration after steaming with respect to resistance to impact. The coatings in many instances appeared to be toughened by steaming.

7. Resistance to Abrasion

The surface was tested for resistance to abrasion by mechanically scrubbing it with a cloth-faced pad moving with a reciprocating motion. A device was constructed whereby a number of specimens could be tested simultaneously. The scrubbing pads were composed of wood blocks 2½ inches square covered with a piece of wool blanket over which was fastened a piece of sturdy twill cloth. A load of 1½ pounds was applied to the pads. The stroke of the pads was 4 inches, and the rate of scrubbing was 2,500 cycles per hour. The specimens, fixed in place beneath the moving pads, were moistened from time to time with a 1-percent soap solution.
to which a mild household cleaning powder had been added.

Change in gloss could not be used as a measure of resistance to abrasion, because the polishing effect of the scrubbing prevented change of gloss. The best indication of resistance to abrasion appeared to be the number of cycles necessary to cause the coat to wear completely through to the base. This criterion was used since, in practice, the board tiles might not have to be replaced until this occurred. As might be expected, there is a fairly good correlation between the resistance to abrasion and the overall thickness of the coat.

8. RESISTANCE TO STAINING

The resistance of the coating to staining by common household materials was tested by placing ½ milliliter of the following liquids on the surfaces: a 5-percent solution of washing soda, 5-percent solution of acetic acid, commercial tincture of iodine, commercial writing ink, hot bacon grease. The drop was allowed to stand for ½ hour and then wiped with a clean cloth, using soap and water, if necessary, for thorough cleaning. Most of the boards were stained by dilute acid and iodine. The other compounds had no appreciable effect on the coatings.

IV. SUMMARY AND CONCLUSIONS

The tests of the fiber tile boards studied showed that they are very dense, have a moderate degree of expansion with change in moisture content, and are strong and rigid. The thickness of the coating varies considerably.

The resistance of the coatings of the boards to abrasion was excellent, particularly for those having double coatings.

Steam did not adversely affect the resistance

Figure 4.—Blistering at score marks, caused by swelling of base material when subjected to steam.
of the coatings to impact, but the gloss of most of the coatings was dulled and the colored ones faded. The steaming in general did not affect the color of the white coatings. All coatings treated with steam were blistered, this generally occurring at the edges of the board, near score marks, or where the coating had been scratched. Steam produced excessive warping of two of the boards. The coatings were resistant to staining by writing ink and hot grease, but most of them were stained by weak acetic acid and by tincture of iodine.

Washington, May 20, 1941.
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