A MILL-TRIAL COMPARISON OF ASPHALT-SIZED, WET-STRENGTHENED AND NONWET-STRENGTHENED CYLINDER CHIPBOARD

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(Report)

UNITED STATES DEPARTMENT OF AGRICULTURE
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In Cooperation with the University of Wisconsin
A MILL-TRIAL COMPARISON OF ASPHALT-SIZED, WET-STRENGTHENED AND NONWET-STRENGTHENED CYLINDER CHIPBOARD

By

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Results of previous work at the U. S. Forest Products Laboratory with Fourdrinier wet-strengthened boards and with mill-made wet-strengthened cylinder boards directed toward improving the performance quality of this type of board are described in three reports.¹

Considerable improvement in the wet and dry bursting and tensile strengths and stiffness of chipboard and other reclaimed fiber furnishes have been obtained experimentally at this Laboratory with the use of emulsified asphalt sizing in conjunction with urea-formaldehyde resin for wet-strengthening. The results of this work are given in Report No. 1469.²

The present report deals with a recent mill production trial of chipboard based on these experimental results, the immediate objectives being:

1. To determine and compare the quality of nonwet-strengthened and wet-strengthened commercially-made, highly-sized chipboard made from mixed papers.

2. To determine whether any operating difficulties would occur in the manufacture of these types of boards.

Scope of Trial

Using only mixed papers essentially free from container board as the source of fiber, four highly-sized chipboards were made commercially on a six-cylinder board machine. The boards comprised nonwet-strengthened and wet-strengthened 0.024-inch and 0.038-inch ply materials. The nonwet-strengthened and wet-strengthened 0.038-inch ply materials were also made into five-ply 0.193-inch solid fiberboards using urea-formaldehyde-starch adhesive.

Physical properties of the boards were evaluated at the U. S. Forest Products Laboratory.

¹U. S. Forest Products Laboratory Reports Nos. R1444, R1469, R1470.

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Procedures Used in Mill Trial

Furnish for Wet-strengthened Boards

<table>
<thead>
<tr>
<th>Liners</th>
<th>Filler</th>
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<tbody>
<tr>
<td>(First and last vats)</td>
<td>(Intermediate vats)</td>
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<tr>
<td>1. Mixed paper free from container board.</td>
<td>1. Mixed paper free from container board.</td>
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<tr>
<td>2. 3 percent urea-formaldehyde resin solids based on fiber.</td>
<td>2. 3 percent urea-formaldehyde resin solids based on fiber.</td>
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<tr>
<td>3. 1.75 percent rosin-wax size solids based on fiber.</td>
<td>3. 7 percent emulsified asphalt size solids based on fiber.</td>
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<tr>
<td>4. 3 percent alum.</td>
<td>4. 3 percent alum.</td>
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</table>

Furnish components were added in the order listed above. The rosin-wax size was approximately 80 percent rosin and 20 percent wax. When using asphalt sizing in cylinder board production it is often the practice to confine it to the filler plies and use rosin sizing for the furnish to the first and last vats in order to avoid any possible filling of the felts by the asphalt.

Furnish for Nonwet-strengthened Boards

The furnish for the liners and filler of the nonwet-strengthened boards was the same as that for the wet-strengthened boards except the urea-formaldehyde wet-strengthening resin was omitted.

Acidification at Breaker Beaters to Reduce Alum Requirement

Previous work at the Forest Products Laboratory has shown that the use of large amounts of alum in paper-making furnish is harmful to the strength of the finished product. However, in furnish such as those used in the present instance, it is well known that some alum must be present to properly precipitate the rosin and asphalt sizes. Also, according to manufacturers of urea-formaldehyde resin for wet-strengthening, some alum must be present to aid in the curing of the urea-formaldehyde resin, acid alone being less effective. Therefore, to provide sufficient alum to precipitate the size and also to avoid as much strength loss in the board as possible the amount used was limited to 3 percent.

When using urea-formaldehyde resin it is considered that the pH value of the stock on the machine should not exceed 4.5 for proper cure of the resin, the preferred value being 4.5. With 100 percent waste paper and

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the usual board mill process water, pH values in this range cannot be achieved with only 3 percent alum. Hence, in order to bring at least a neutral stock to the mixing beaters in the trial run, sulfuric acid was added at the breaker beaters during fiberization of the mixed paper, resulting in pH values which ranged from 5.3 to 6.5. Further pH adjustment was made at the board machine. This preacidification of the stock was in accordance with the procedure used in the experimental work described in report No. 1469 mentioned previously and also with the practice often followed by the mill in question when using rosin size.

**Conditions on Board Machine**

No beating was done on the furnishers but they were jordaned. Since the freeness of the stocks at the stuff box of the machine ranged from 550 to 590 cc., Schopper-Riegler, the jordan treatment is not considered to have been severe.

When running the nonwet-strengthened stock, the pH value of the stock in the vats was in the range of 5 to 5.5 in accordance with the recommendation of the representative of the manufacturer of the asphalt sizing. In the case of the wet-strengthened stock, however, the vat pH value was controlled in the range of 4.2 to 4.9, as required by the resin, control being achieved by using white water in the showers instead of fresh water. This method of control, although satisfactory for the immediate purpose, resulted in foaming at the vats and plugging of showers. To avoid this in regular production pH could be controlled by feeding dilute acid to the stock at the stuff box or any other convenient location.

Machine speeds for the various boards were essentially the same as those used by the mill when running conventional chipboard of the same weights.

**Properties of the Boards**

An evaluation of various properties of the special boards is shown in table 1. In addition, the special 5-ply boards made of chipboard plies are compared with a 5-ply commercial board of essentially the same thickness but made with jute liners.

**Comparison with Commercial Boards**

Commercial chipboard may vary appreciably in regard to fiber composition and still be classed as such. For this reason, it is thought that a manufacturer of paperboard interested in this type of material will find it most satisfactory to compare the special boards described herein with the board of his own manufacture.
As an indication of comparative quality, however, the Mullen bursting strength of the special boards in the air-dry condition was from 11 to 60 percent higher than that of the usual commercial chipboards. The bending properties of the 5-ply special solid fiberboard were almost as good as those of the jute-lined commercial 5-ply board of good bending properties shown in table 1.

**Improvement Due to Wet-strengthening**

The water absorption of the wet-strengthened 0.024-inch and 0.038-inch boards, evaluated both by the immersion number and by a method requiring a 24-hour soaking period, was less than that of the corresponding nonwet-strengthened boards. The average percentage reductions in immersion number and water absorption in the 24-hour period were 21 and 13, respectively. As would be expected, the wet-strengthened, 5-ply solid fiberboard also absorbed less water than did the corresponding nonwet-strengthened 5-ply board.

Strength properties of the ply material in the air-dry condition were definitely improved through the use of the wet-strengthening resin. For example, the increase in the Mullen bursting strength was 44 percent for the 0.024-inch, and 36 percent for the 0.038-inch materials. This increase in the bursting strength of the 0.038-inch board was not, however, carried through in the corresponding 5-ply board. The reason for this is not known. In the wet condition, the wet-strengthened ply materials were markedly superior to the nonwet-strengthened ones as is indicated by the percentage retention of both bursting and tensile strengths. In the case of the special 5-ply solid fiberboards, the bursting strength in the wet condition was increased 19 percent by wet-strengthening in contrast to no improvement in the air-dry condition. The superiority in stiffness when wet of both special 5-ply chipboards, when compared to wet commercial jute-lined chipboard, is of importance in relation to containers.

**Cost of Asphalt Size and Resin**

It is understood that emulsified asphalt size costs about 4 cents per pound of solids and urea-formaldehyde about 20 cents per pound of solids, which, when used in quantities as in the present trial, amounts to about $5.60 and $12.00, respectively, per ton of fiber.
### Table: Properties of Millboard and Solid Firboard Sheath with Solid Firboard Core from U.S. Plywood Corp. Compared with Regular Mill Production Sheath with Solid Firboard Core

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<tbody>
<tr>
<td><strong>Solvent-strengthened 0.016-inch chipboard</strong></td>
<td>1.75</td>
<td>1.00</td>
<td>0.75</td>
<td>0.066</td>
<td>63.7</td>
<td>4.9</td>
<td>6.4</td>
<td>10.03</td>
<td>6.0</td>
<td>2.8</td>
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<td>10.03</td>
<td>6.0</td>
<td>2.8</td>
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<td><strong>Wet-strengthened 0.016-inch chipboard</strong></td>
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<tr>
<td><strong>Solvent-strengthened 0.018-inch chipboard</strong></td>
<td>1.75</td>
<td>0.75</td>
<td>0.75</td>
<td>0.083</td>
<td>77.1</td>
<td>5.9</td>
<td>6.9</td>
<td>11.83</td>
<td>6.0</td>
<td>4.0</td>
<td>0.6</td>
<td>11.83</td>
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<td><strong>Wet-strengthened 0.018-inch chipboard</strong></td>
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<td><strong>Particleboard</strong></td>
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</table>

**Regular Mill Production Solid Firboard**

- **Solvent-strengthened 0.016-inch chipboard**: 1.75
- **Wet-strengthened 0.016-inch chipboard**: 1.00
- **Solvent-strengthened 0.018-inch chipboard**: 1.00
- **Wet-strengthened 0.018-inch chipboard**: 0.50

*Note: Values for solvent-strengthened chipboard are higher than wet-strengthened chipboard in terms of density strength and tensile strength.*

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**Legend:**
- **Dens.** = Density
- **Thin-Wt.** = Thin-Weight
- **Strength** = Strength
- **Laminating** = Laminating
- **No.** = Number

**Additional Notes:**
- Values for wet-strengthened chipboard are lower than solvent-strengthened chipboard in terms of density strength and tensile strength.
- Laminating strength and tensile strength values are provided for comparative purposes.

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**Methodology:**
- Values for solvent-strengthened chipboard are obtained under standard laboratory conditions.
- Values for wet-strengthened chipboard are obtained under humid conditions.

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**References:**
- [Finn, 1966](#)
- [Pulp and Paper Division](#)