# HARDBOARD FROM LODGEPOLE PINE, ENGELMANN SPRUCE, AND DOUGLAS-FIR

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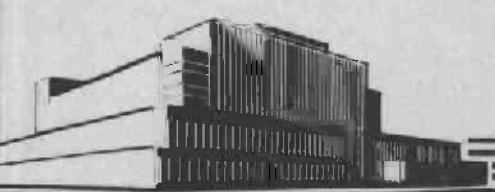

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FOREST SERVICE
In Cooperation with the University of Wisconsin

# HARDBOARD FROM LODGEPOLE PINE, ENGELMANN SPRUCE, AND DOUGLAS-FIR[1]

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## Introduction

This investigation was for the purpose of demonstrating that lodgepole pine, Engelmann spruce, and Rocky-Mountain type of Douglas-fir are suitable for hardboard. The experimental work was limited to one cooking schedule, several degrees of refining, one pressing schedule, and some heat-treating of the hardboards. No resins or other additives other than paraffin size and alum were used.

## Materials

### Wood

The four batches of peeled woods investigated in this study were obtainable from the State of Wyoming. Two of this lot were samples of lodgepole pine, one from the west of the Continental Divide, and the other from the east of the Divide. The former, shipment No. 3327, was from the Bridger National Forest and the latter, shipment No. 3294, was from the Bighorn National Forest. Two other species were included in this group, one, Rocky-Mountain type of Douglas-fir, shipment No. 3326, from the Bridger National Forest; and the other, Engelmann spruce, shipment No. 3297, from the Medicine Bow National Forest.

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[1] This report previously issued as Pulp and Paper Division report of limited distribution.

[2] Maintained at Madison, Wis., in cooperation with the University of Wisconsin.

The wood bolts received were 4 feet long. Random samples of logs from each batch were converted to 5/8-inch chips in a rotary knife chipper. The moisture contents of these woods were less than that of their fiber saturation values; consequently, they were soaked for 1-1/2 hours in water prior to fiberizing.

## Sizing Chemicals

The sizing chemicals were paraffin size, alum, and sulfuric acid. The concentration of these chemicals and the means of preparing them have been previously reported (4).

## Experimental Procedure

Pulps suitable for hardboard stocks were prepared from each of the four batches of chips. A laboratory-model Asplund Defibrator (4) was used to fiberize the chips. Pulping schedules and yield data are given in table 1.

The Asplund pulps were refined in an 8-inch disk refiner, sized, and converted to hardboard (4). Data on stock freeness, sizing, and board pressing schedules are given in table 2.

The heat treating of hardboards was conducted in a forced-draft oven at 175° C. for 4-1/2 hours.

## Methods of Test

The hardboards were tested for modulus of rupture and water absorption (4). In the preliminary investigations in which heat-treated test specimens as well as normal test specimens were tested, the following plan was used: Each board furnished four 5- by 1-1/2-inch test specimens, 2 for normal and 2 for heat-treated strength tests; and four 5- by 1/2-inch specimens, 2 for normal and 2 for heat-treated toughness tests. Water absorption tests were made on the tested modulus of rupture specimens.

## Discussion of Results

One of the objectives of this work was to prepare, for exhibit purposes, good quality hardboard samples from each of the four lots of wood. The preparation of these samples was based on data obtained in the preliminary research, the results of which are given in table 2.

It is apparent from the data in table 2: (1) that sizing improved the water resistance and decreased the modulus of rupture of the board; (2) that the influence of sizing on water resistance and modulus of rupture was related to the amount of size used; (3) that the modulus of rupture was significantly improved by large increases in the amount of alum used to affix the size; (4) that refining increased the modulus of rupture; and (5) that heat treatment improved both the modulus of rupture and water resistance.

The toughness of hardboards is generally affected adversely by heat treatment; however, boards prepared from these woods were only mildly influenced by this treatment. The hardboards produced are without exception tougher than common commercial hardboard.

In the preliminary investigation none of the hardboards prepared from the four lots of wood met class A specifications unless heat treated. Therefore for the concluding experiments, conditions were selected which would, in the opinion of the author, give class A boards without heat treatment. The boards prepared thus were, however, slightly deficient in modulus of rupture.

The concluding experiments showed two glaring weaknesses in the procedure for preparation of hardboard from these woods. The deficiencies of the experiments are attributed to use of a laboratory refiner and to the use of fresh water in place of "white water." The use of a commercial refiner would permit further refining without obtaining excessively high freeness values. The limitations of a laboratory refiner have been investigated by others (1) (2) (3). Reuse of white water would require supplementary charges of alum but in amounts very much less than recorded in table 2. Consequently, these weaknesses should not be attributed to the woods but to the deficiencies of the experimental equipment and experimental conditions which had to be pre-selected.

It has been previously shown that higher molding temperatures produce higher modulus of rupture values and improved water resistance (5). The use of higher temperature pressing schedules would greatly improve flexural strength and water resistance of the boards; however, some reduction in the toughness quality of these hardboards would result.

## Conclusions

Strong, tough, and water-resistant screen-back hardboards can be obtained from lodgepole pine, Engelmann spruce, and Rocky-Mountain type of Douglas-fir. On the basis of the present Interim Federal Specifications (see Appendix) all four woods are suitable for type I, class I, smooth-one-side hardboard.

## Appendix

The Interim Federal Specifications (Fiberboard, Hardboard, Fibrous-Felted) LLL-F-00311 (GSA-FSS) December 1953, has been developed by the General Services Administration. It is based on currently available technical and

quality information, but has not been approved for promulgation as a regular Federal Specification. Though subject to modification, and, pending its promulgation as a regular specification, it may be used in procurement. The physical property requirements for class I, type I, 1/8-inch, smooth-one-side hardboard are as follows: Modulus of rupture (minimum), 5,500 pounds per square inch; water absorption (maximum), 20 percent; and thickness swelling (maximum), 16 percent.

## Literature Cited


(1) Aflenzer, F. A. and McGovern, J. N. Semichemical Fiberizing Variables. Report of Annual Technical Conference Jointly Sponsored by Committee on Coordination of Research of the American Paper and Pulp Association and the Forest Products Laboratory, Madison, Wis., June 2, 1953.

(2) Aflenzer, F. A. Tappi 37, No. 3, March 1954.

(3) Asplund, A. Preparation and Characteristics of Fiber Pulp for Hardboard. Northeastern Utilization Council Bulletin 31, No. 1.

(4) Schwartz, S. L. Tappi 36, No. 10 (October 1953).

(5) Schwartz, S. L. and Baird, P. K. Paper Trade Journal 132, No. 17.

Table 1.--Preparation of Asplund pulps from lodgepole pine, Engelmann spruce, and Douglas-fir

| Defibrator run No.[1] | Species | Moisture content | | Pulp yield | Defibrator freeness |
|---|---|---|---|---|---|
| | | Before soaking | After soaking[2] | | |
| | | Percent | Percent | Percent | Sec. |
| 74 D | Lodgepole pine, Shipment No. 3294 | 15.4 | 47.7 | 79.9 | 15 |
| 75 D | Engelmann spruce, Shipment No. 3297 | 17.5 | 49.7 | 83.0 | 17 |
| 76 D | Douglas-fir, Shipment No. 3326 | 18.7 | 43.2 | 83.5 | 18 |
| 77 D | Lodgepole pine, Shipment No. 3327 | 17.6 | 52.2 | 81.9 | 16 |

[1] Asplund Defibrator runs: 3 minutes presteaming; 2 minutes milling period. Steam pressure, 175 pounds per square inch.

[2] Chips soaked in tap water for 1-1/2 hours.

Table 2.--Experimental hardboards from lodgepole pine, Engelmann spruce, and Douglas-fir

| Board No. | Species | Sizing data: Paraffin | Sizing data: Alum | pH | Defibrator freeness | Molding data: Temperature | Molding data: Schedule[1] | Hardboard properties: Normal boards: Specific gravity | Normal boards: Modulus of rupture | Normal boards: Toughness, flatwise, 1/8-inch basis | Normal boards: Water absorption | Normal boards: Thickness change | Heat-treated boards[2]: Specific gravity | Heat-treated boards: Modulus of rupture | Heat-treated boards: Toughness, flatwise, 1/8-inch basis | Heat-treated boards: Water absorption | Heat-treated boards: Thickness change |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Percent | Percent | | Sec. | °C. | Min. | | P.s.i. | Id.-lb. per in. of width | Percent | Percent | | P.s.i. | Id.-lb. per in. of width | Percent | Percent |
| **PRELIMINARY INVESTIGATIONS** | | | | | | | | | | | | | | | | | |
| 1679 | Lodgepole pine, Shipment No. 3294 | 0 | 0 | 7.8 | 20 | 195 | 1-4-5 | 1.03 | 5,400 | 12.4 | 51.8 | 32.2 | 1.04 | 6,200 | 12.5 | 42.4 | 25.9 |
| 1680 | Lodgepole pine, Shipment No. 3294 | .75 | 2.25 | 4.4 | 19 | 195 | 1-4-5 | 1.03 | 4,500 | 10.0 | 16.6 | 15.3 | 1.04 | 5,400 | 10.3 | 14.6 | 14.1 |
| 1681 | Lodgepole pine, Shipment No. 3294 | .75 | 4.50 | 4.4 | 20 | 195 | 1-4-5 | 1.06 | 5,000 | 10.3 | 16.8 | 15.0 | 1.05 | 5,300 | 11.2 | 14.8 | 13.4 |
| 1682 | Lodgepole pine, Shipment No. 3294 | 0 | 0 | 7.8 | 32 | 195 | 1-4-5 | 1.05 | 6,500 | 13.4 | 45.7 | 27.9 | 1.04 | 7,300 | 11.7 | 30.6 | 19.4 |
| 1683 | Lodgepole pine, Shipment No. 3294 | .75 | 2.25 | 4.4 | 31 | 195 | 1-4-5 | 1.04 | 5,000 | 12.0 | 17.2 | 15.3 | 1.04 | 5,700 | 11.8 | 14.7 | 13.1 |
| 1684 | Lodgepole pine, Shipment No. 3294 | .75 | 4.50 | 4.4 | 31 | 195 | 1-4-5 | 1.05 | 5,100 | 11.9 | 16.2 | 14.8 | 1.05 | 6,100 | 10.9 | 14.6 | 12.7 |
| 1685 | Engelmann spruce, Shipment No. 3297 | 0 | 0 | 7.8 | 26 | 195 | 1-4-5 | 1.05 | 6,200 | 12.1 | 50.5 | 30.8 | 1.05 | 7,000 | 11.1 | 31.1 | 19.9 |
| 1686 | Engelmann spruce, Shipment No. 3297 | .75 | 2.25 | 4.3 | 25 | 195 | 1-4-5 | 1.05 | 4,900 | 11.0 | 20.8 | 17.4 | 1.05 | 5,800 | 10.5 | 17.4 | 15.3 |
| 1687 | Engelmann spruce, Shipment No. 3297 | .75 | 4.50 | 4.3 | 26 | 195 | 1-4-5 | 1.05 | 5,500 | 10.6 | 22.3 | 17.8 | 1.04 | 6,300 | 10.8 | 18.0 | 14.7 |
| 1688 | Engelmann spruce, Shipment No. 3297 | 0 | 0 | 7.8 | 42 | 195 | 1-4-5 | 1.06 | 7,000 | 10.9 | 48.3 | 29.5 | 1.05 | 8,100 | 11.1 | 27.5 | 17.3 |
| 1689 | Engelmann spruce, Shipment No. 3297 | .75 | 2.25 | 4.3 | 38 | 195 | 1-4-5 | 1.04 | 5,700 | 11.0 | 21.1 | 16.7 | 1.05 | 6,400 | 11.1 | 16.3 | 13.1 |
| 1690 | Engelmann spruce, Shipment No. 3297 | .75 | 4.50 | 4.3 | 39 | 195 | 1-4-5 | 1.04 | 6,400 | 10.5 | 22.1 | 17.2 | 1.04 | 7,400 | 10.4 | 16.5 | 13.3 |
| 1691 | Lodgepole pine, Shipment No. 3327 | 0 | 0 | 7.8 | 41 | 195 | 1-4-5 | 1.03 | 6,200 | 13.5 | 49.2 | 29.6 | 1.03 | 7,400 | 12.4 | 33.4 | 20.6 |
| 1692 | Lodgepole pine, Shipment No. 3327 | .5 | 2.25 | 4.3 | 38 | 195 | 1-4-5 | 1.06 | 5,200 | 11.7 | 19.6 | 16.5 | 1.05 | 6,400 | 11.3 | 15.6 | 12.7 |
| 1693 | Lodgepole pine, Shipment No. 3327 | .5 | 4.50 | 4.3 | 39 | 195 | 1-4-5 | 1.05 | 5,800 | 11.5 | 18.4 | 15.5 | 1.04 | 6,600 | 9.9 | 15.3 | 13.1 |
| 1694 | Lodgepole pine, Shipment No. 3327 | .75 | 2.25 | 4.3 | 37 | 195 | 1-4-5 | 1.06 | 4,800 | 10.8 | 18.3 | 16.5 | 1.06 | 5,400 | 10.1 | 15.2 | 13.4 |
| 1695 | Lodgepole pine, Shipment No. 3327 | .75 | 4.50 | 4.3 | 37 | 195 | 1-4-5 | 1.06 | 5,300 | 10.6 | 18.0 | 14.7 | 1.05 | 6,100 | 9.6 | 14.2 | 13.2 |
| 1696 | Douglas-fir, Shipment No. 3326 | 0 | 0 | 7.7 | 42 | 195 | 1-4-5 | 1.01 | 6,300 | 9.7 | 49.7 | 27.3 | 1.01 | 7,100 | 9.2 | 29.0 | 17.5 |
| 1697 | Douglas-fir, Shipment No. 3326 | .75 | 3 | 4.2 | 41 | 195 | 1-4-5 | 1.02 | 5,000 | 7.8 | 14.8 | 14.3 | 1.02 | 5,600 | 8.4 | 14.4 | 13.7 |
| 1698 | Douglas-fir, Shipment No. 3326 | .75 | 6 | 4.2 | 40 | 195 | 1-4-5 | 1.02 | 5,800 | 7.2 | 13.9 | 12.1 | 1.02 | 5,900 | 6.8 | 13.9 | 11.4 |
| 1699 | Douglas-fir, Shipment No. 3326 | .75 | 9 | 4.3 | 41 | 195 | 1-4-5 | 1.02 | 5,900 | 6.9 | 13.8 | 13.0 | 1.01 | 6,400 | 5.9 | 13.8 | 10.8 |
| 1700 | Douglas-fir, Shipment No. 3326 | 1.00 | 3 | 4.3 | 41 | 195 | 1-4-5 | 1.01 | 4,700 | 8.1 | 14.6 | 13.0 | 1.00 | 5,300 | 7.9 | 14.8 | 13.0 |
| 1701 | Douglas-fir, Shipment No. 3326 | 1.00 | 6 | 4.3 | 43 | 195 | 1-4-5 | 1.01 | 5,400 | 7.1 | 13.8 | 12.0 | 1.02 | 6,100 | 6.5 | 14.5 | 11.4 |
| 1702 | Douglas-fir, Shipment No. 3326 | 1.00 | 9 | 4.3 | 42 | 195 | 1-4-5 | 1.03 | 5,600 | 6.3 | 13.7 | 12.1 | 1.02 | 5,800 | 6.0 | 14.2 | 11.4 |
| | Commercial hardboard | | | | | | | | | 4.3 | | | | | | | |
| **CONCLUDING EXPERIMENTS** | | | | | | | | | | | | | | | | | |
| 1709 | Lodgepole pine, Shipment No. 3294 | .5 | 6 | 4.2 | 38 | 195 | 1-4-5 | 1.04 | 5,900 | | 18.5 | 14.8 | | | | | |
| 1710 | Engelmann spruce, Shipment No. 3297 | 1.0 | 6 | 4.4 | 39 | 195 | 1-4-5 | 1.05 | 5,900 | | 15.9 | 13.2 | | | | | |
| 1712 | Lodgepole pine, Shipment No. 3327 | .5 | 6 | 4.3 | 39 | 195 | 1-4-5 | 1.02 | 5,700 | | 13.5 | 10.6 | | | | | |
| 1711 | Douglas-fir Shipment No. 3326 | .6 | 6 | 4.4 | 40 | 195 | 1-4-5 | 1.02 | 5,700 | | 17.6 | 14.1 | | | | | |
| **SPECIFICATIONS FOR 1/8-INCH HARDBOARD[3]** | | | | | | | | | | | | | | | | | |
| | Class A hardboard | | | | | | | [4].96 | [5]5,000 | | [6]20 | | | | | | |

[1] Pressing schedule: The first number is the initial period at a maximum pressure of 500 pounds per square inch; the second number, the breathing period at 100 pounds per square inch; and the third number, the final period at maximum pressure.

[2] Heat-treated for 4-1/2 hours in a forced-draft oven for 4-1/2 hours.

[3] Federal Specification LLL-F-311: Fiberboard; Hard-pressed, Structural. 1940.

[4] Minimum value.

[5] Minimum value, irrespective of specific gravity.

[6] Maximum allowable value.