# WEIGHT AND DIMENSIONAL STABILITY OF THREE LOW-DENSITY CORE MATERIALS

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UNITED STATES DEPARTMENT OF AGRICULTURE
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# WEIGHT AND DIMENSIONAL STABILITY OF THREE LOW-DENSITY CORE MATERIALS[1]

By

E. A. MRAZ, Laboratory Aid
and
W. F. HUTCHINS, Technologist

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The purpose of this study was to obtain information on the weight and dimensional stability of three low-density core materials used in sandwich constructions, when immersed in certain liquids used in the maintenance of aircraft. The test was carried out in general accordance with method No. 7011 of Federal Specification L-P-406a, "Plastics, Organic: General Specification, Test Methods."

## Materials

The core materials were balsa wood, Hycar, and cellular cellulose acetate.

The chemical test liquids used were iso-propyl alcohol; ethylene glycol; 3580 oleo fluid, hydraulic (light petroleum base) Specification No. 3580-c; 3586 oleo fluid, hydraulic (castor oil base) Specification No. 3586-c Grade A - heavy; 100 octane gasoline; used crankcase oil; and distilled water.

## Selection of Test Material

Twenty-one pieces, 1/2 by 1 by 3 inches in size, were cut from each lot of core material. The balsa selected was within the range of 6 to 9 pounds per cubic foot when in equilibrium with air at 65 percent relative humidity and 80° F. It was cut with the grain parallel to the 1/2-inch dimension.

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[1] This is one of a series of progress reports prepared by the Forest Products Laboratory relating to the use of wood in aircraft. Results here reported are preliminary and may be revised as additional data become available.

## Test Procedures

The core specimens were first conditioned for 7 days in a room maintained at 75° F. and 50 percent relative humidity. They were then weighed to the nearest milligram on an analytical balance kept in the same room under the same conditions, and their length, width, and thickness dimensions were measured with a micrometer caliper to the nearest 0.001 inch. Two measurements were made of both width and thickness, one on each end of the specimen, and the average was recorded. Of the 21 specimens of each core material, three were selected at random for immersion in each of the seven liquids.

The specimens were layered in quart cans, three layers per can, each layer composed of three specimens of a single core material laid edgewise upon wire screen of 1/4-inch mesh. The cans were filled with enough liquid to cover all specimens completely. A maple block 1 inch thick was placed upon the top layer in each can to insure that the specimens would remain submerged, and the can was closed with a lid.

The core materials were allowed to soak for 7 days in a room maintained at approximately 75° F. Each day the liquids were agitated by shaking each can gently. At the end of the 7-day soaking period, the specimens were removed from the containers, one specimen at a time, wiped with a dry cloth, weighed in a closed weighing bottle, and measured as before in each dimension to the nearest 0.001 inch.

Because of the possibility that soluble constituents might be removed from the core materials by the liquid, all specimens were dried for 7 days in the conditioning atmosphere and then re-weighed. As a final check, all specimens were conditioned for 32 days more and then weighed and measured again. Loss of weight in the volatile liquids might thus be detected.

## Results

Table 1 shows the average changes in weight of the specimens of balsa, Hycar, and cellulose acetate after 7 days of immersion in the liquids, after immersion followed by 7 days of conditioning, and after immersion followed by 39 days of conditioning. Also shown in the table are the average changes in thickness, width, and length after 7 days of immersion and after immersion plus 39 days of conditioning. The changes are expressed as percentages based upon the weight and dimension of the specimens after the initial conditioning.

The percentage increase in weight of balsa, after 7 days of immersion in the liquids, was higher than that for the other core materials. Water was absorbed by balsa to a greater extent than were the other liquids. The core materials appeared to have lost no solid matter while in the solutions, except perhaps the Hycar in the alcohol and gasoline.

The Hycar showed only slight dimensional change in any of the seven liquids tested.

The balsa specimens showed but slight dimensional change in the petroleum oleo fluid, gasoline, or crankcase oil. They did show appreciable changes in width and length in the alcohol, glycol, castor oil oleo fluid, and water, and in these cases the percentage change in width was greater than the percentage change in length. The greatest expansion was in water and amounted to about 4.0 percent in width. The longitudinal change of balsa (thickness of specimen) was usually slight.

The cellular cellulose acetate showed only slight dimensional change in the petroleum oleo fluid, gasoline, and crankcase oil. There was appreciable change in the alcohol, castor oil oleo fluid, glycol, and water.

The general appearance of the core materials used in this test did not appear to have been altered by the 7-day immersion in any way except in color. The balsa and cellulose acetate were colored by crankcase oil and the oleo fluids. Hycar was not perceptibly colored. Other physical characteristics of the materials appeared to remain unchanged.

Table 1.--Weight and dimensional changes of core materials in various liquids

| Core material[1] | Liquid | Average gain in weight[2] | | | Average gain in thickness[3] | | Average gain in width[3] | | Average gain in length[3] | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | After soaking for 7 days | After soaking 7 days and conditioning for | | After soaking for 7 days | After soaking 7 days and conditioning for 39 days | After soaking for 7 days | After soaking 7 days and conditioning for 39 days | After soaking for 7 days | After soaking 7 days and conditioning for 39 days |
| | | | 7 days | 39 days | | | | | | |
| | | Percent | Percent | Percent | Percent | Percent | Percent | Percent | Percent | Percent |
| Hycar | Iso-propyl | 29.45 | 0.22 | 0.15 | 0.14 | -0.37 | -0.17 | -0.28 | -0.03 | -0.03 |
| Balsa | alcohol | 181.96 | 2.01 | 2.00 | 0.13 | -0.20 | 1.62 | 0.08 | 0.79 | 0.01 |
| Cel. Ac[4] | | 45.46 | 2.52 | 1.86 | 1.20 | -0.33 | 0.53 | -0.18 | 1.03 | -0.54 |
| Hycar | Ethylene | 10.95 | 0.27 | 0.22 | -0.34 | -0.47 | -0.21 | -0.33 | -0.06 | -0.02 |
| Balsa | glycol | 219.20 | 125.11 | 14.30 | 0.39 | 0.23 | 3.34 | 1.79 | 2.15 | 1.14 |
| Cel. Ac[4] | | 54.34 | 5.22 | 3.31 | 0.86 | -0.53 | 0.56 | -0.48 | 1.00 | -0.48 |
| Hycar | 3580-Oleo | 37.08 | 10.91 | 7.57 | 0.14 | -0.17 | -0.17 | -0.03 | -0.07 | -0.09 |
| Balsa | fluid | 117.26 | 75.11 | 62.68 | 0.46 | 0.16 | 0.33 | 0.13 | 0.30 | 0.06 |
| Cel. Ac[4] | (petroleum base) | 38.52 | 14.52 | 9.72 | 0.13 | -0.36 | 0.03 | -0.21 | 0.11 | 0.02 |
| Hycar | 3586-Oleo | 45.22 | 18.42 | 17.46 | -0.20 | -0.27 | -0.17 | -0.09 | -0.03 | -0.02 |
| Balsa | fluid | 148.05 | 69.29 | 62.73 | 0.34 | 0.33 | 1.85 | 1.22 | 1.18 | 0.73 |
| Cel Ac[4] | (castor-oil base) | 63.91 | 26.75 | 24.34 | 0.19 | -0.36 | 0.46 | -0.48 | 0.55 | -0.54 |
| Hycar | 100-octane | 25.68 | -0.09 | -0.05 | -0.07 | 0.00 | -0.21 | -0.17 | 0.02 | -0.04 |
| Balsa | gasoline | 159.98 | 0.00 | 0.48 | -0.39 | -0.29 | -0.13 | -0.15 | -0.06 | -0.06 |
| Cel Ac[4] | | 28.92 | 0.17 | 0.40 | 0.26 | -0.13 | 0.00 | 0.10 | -0.18 | -0.09 |
| Hycar | Used | 28.82 | 22.93 | 19.47 | -0.41 | -0.68 | -0.14 | -0.23 | -0.03 | -0.06 |
| Balsa | crankcase | 92.48 | 84.26 | 82.83 | 0.07 | -0.26 | 0.00 | -0.43 | 0.11 | -0.03 |
| Cel Ac[4] | oil | 34.48 | 28.50 | 23.55 | -0.07 | -0.40 | 0.13 | -0.16 | 0.00 | -0.01 |
| Hycar | Water | 21.35 | 0.67 | 0.67 | 0.07 | -0.58 | 0.07 | -0.28 | 0.21 | -0.01 |
| Balsa | | 536.55 | 0.96 | 0.78 | 0.07 | 0.00 | 4.00 | 0.61 | 2.44 | 0.31 |
| Cel Ac[4] | | 65.30 | 0.84 | 0.79 | 0.60 | -0.73 | 0.89 | -0.80 | 1.79 | -0.67 |

[1] Dimensions of test specimens - thickness 1/2-inch, width 1 inch, length 3 inches. Balsa 1/2-inch dimension in grain direction (thickness).

[2] Based on weight of specimens, conditioned to equilibrium at 75° F., 50 percent relative humidity before immersion. Each value is the average for 3 specimens.

[3] Based on dimension of specimens, conditioned to equilibrium at 75° F., 50 percent relative humidity before immersion. Each value is the average for 3 specimens.

[4] Cellular cellulose acetate.

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