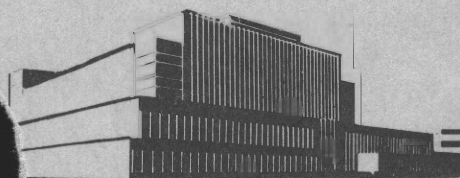
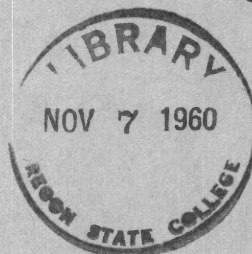


(Report) 2197

IMPORTANCE OF BALANCED CONSTRUCTION IN PLASTIC-FACED WOOD PANELS

August 1960

No. 2197



FOREST PRODUCTS LABORATORY
MADISON 5, WISCONSIN

UNITED STATES DEPARTMENT OF AGRICULTURE
FOREST SERVICE

In Cooperation with the University of Wisconsin

IMPORTANCE OF BALANCED CONSTRUCTION IN

PLASTIC-FACED WOOD PANELS

By

B. G. HEEBINK, Engineer

Forest Products Laboratory,¹ Forest Service
U. S. Department of Agriculture

Requests are frequently received at the Forest Products Laboratory for information on the warping of plastic-faced panels that have cores of plywood, particle board, or paper honeycomb. The Laboratory is asked to explain the causes of the warping and, if possible, to suggest measures to remedy the difficulty.

Examination of many of these panels, and the results of a few tests made over the past years, have led to the conclusion that perfect balance in constructions of this type is seldom obtained. Furthermore, limited observations made on decorative laminates and their so-called companion "balancing sheets" indicate that most cupping and bowing in panels occurs because of inadequate balance between the plastic surfacing sheet and the backing sheet, rather than because of the instability of the core material.

A core of plywood may twist occasionally because of misalinement of the grain in the plies of veneer.² Twisting will seldom if ever be a problem with panels consisting of plastic faces on particle board or honeycomb cores.

¹Maintained at Madison, Wis., in cooperation with the University of Wisconsin.

²Brouse, Don. Some Causes of Warping in Plywood and Veneered Products. Forest Products Lab. Rept. No. 1252. Reviewed and reaffirmed 1956.

Essentially, a balanced construction is one that will not be warped by the forces induced by uniformly distributed moisture changes. The principle holds good for everything from plywood itself to a plastic-faced wood table top.

The dimensional changes that may occur in these plastic sheet materials are considerably greater than those of a thick plywood core; in addition, most of these plastic sheet materials (composed of parallel-laminated sheets of resin-impregnated paper) have a definite machine direction. Figure 1 presents what appears, from limited data, to be typical unrestrained dimensional characteristics of some common sheet materials that are often glued together to form furniture panels. This shows that the unrestrained dimensional movement of decorative laminates and backing sheets associated with a rather large moisture change is roughly two to five times that of thick plywood depending upon the machine direction of the plastic sheets.

Thick plywood, flat-pressed particle board, and hardboard sheets normally do not have machine direction. The use of a hardboard backing sheet, in combination with a decorative laminate face sheet, which has a definite machine direction, can sometimes cause a saddle-shaped warp in the panel (concave in one direction and convex at 90°). A saddle-shaped warp also results from having the machine direction of the decorative laminate face at right angles to that of the plastic backing sheet.

Naturally, the problem is not only one of considering unrestrained dimensional movement. It includes such factors as unequal stresses exerted by the materials on opposite sides of the panel (which might be brought about by unequal thicknesses of sheets with the same unrestrained dimensional change), unequal rates of moisture pickup of the face and back materials, and unequal rates of vapor transmission through the two surfacing materials, thus allowing water vapor to get into the core more rapidly from one side than from the other.

A practical cure for warping is difficult to recommend, especially since warping is particularly troublesome when the panels are relatively long and thin. Making the core twice as thick will theoretically reduce the warp to one-half, and may be a practical cure when using a relatively inexpensive core such as paper honeycomb. Using a stiffer core will also reduce the effect of unbalance. For example, plywood is normally stiffer than particle board of equal thickness, while paper honeycomb core has practically no stiffness without the facings.

One basic solution would be to obtain a suitable backing or balancing sheet of plastic from the supplier of the decorative laminate face. It should be similar to the decorative laminate in composition and machine directional properties, and of approximately the same thickness. This increases cost, but may well be worth it if rejections due to warp have been excessive.

As a second suggestion, the use of a somewhat elastic adhesive, such as some of the polyvinyl emulsion adhesives or the rubber-base contact cements, might be considered. These adhesives permit a slight adjustment at the glue line so that stresses from unbalance tend to be relieved before they can result in appreciable warp. For example, if a contact bond adhesive is used, it is possible to bond a decorative laminate on one side of 3/4-inch plywood, with no backing, and have it remain satisfactorily flat for such applications as kitchen cabinet tops. If these tops are self-edged, however, there is likely to be a slight edge projection of the decorative laminate at certain times of the year.

One general recommendation, regardless of the materials that are used, is that all materials, before assembly of the panel, be brought to equilibrium in an atmosphere of about 40 to 45 percent relative humidity. This is exceedingly important, particularly for the facing materials and the balancing sheets. For example, if the core and backing material for a table top are in equilibrium at this relative humidity at the time of gluing, and the decorative laminate is considerably drier, the top will warp when all of the materials come to their respective moisture contents in equilibrium with an atmosphere of 40 to 45 percent relative humidity. This type of unbalance is one that is most likely to be noted by the manufacturer of the top, because the warp becomes noticeable shortly after the top is pressed.

Sometimes tops are glued with all of the component materials at the proper equilibrium moisture content, but are unbalanced in construction because the face material can exert or resist more stress than the backing. In this case the tops seldom warp until the entire panel changes in moisture content, as during the first winter exposure in a northern climate. By this time the top is probably in the hands of the consumer and therefore, unless he registers a complaint through the proper channels, the manufacturer of the top may not be aware of the difficulty.

The Forest Products Laboratory has underway a broad, basic evaluation of the warping of panels of many types. When this work is completed, it will make available basic data that can predetermine the

performance of composite panels of most combinations of faces, cores, and backs, if the conditions under which they are to be used are reasonably well known. Use of these basic data (the unrestrained dimensional movement, modulus of elasticity, vapor transmission, rate of dimensional change with change in moisture content, and creep properties of adhesives) should make possible the design of tops with a known degree of unbalance; this known unbalance would be counteracted by certain other factors, such as stiffness of the assembly, to make the construction suitable for the specific application.

In the meantime the importance of balanced construction cannot be overstressed, unless one is prepared to take a calculated risk on the results of offering unbalanced panels.

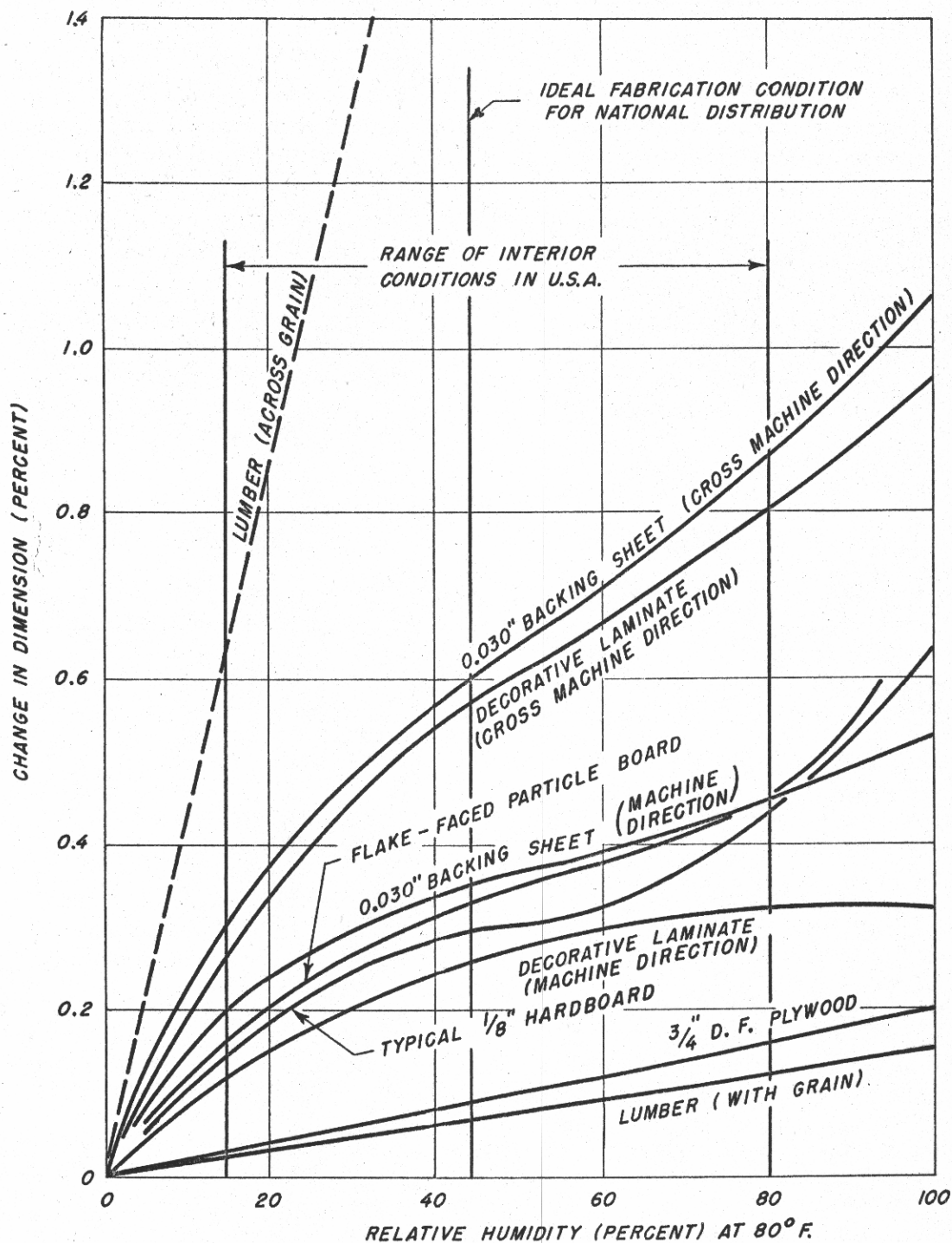


Figure 1. --Typical unrestrained dimensional characteristics of some common sheet materials.

SUBJECT LISTS OF PUBLICATIONS ISSUED BY THE

FOREST PRODUCTS LABORATORY

The following are obtainable free on request from the Director, Forest Products Laboratory, Madison 5, Wisconsin:

List of publications on
Box and Crate Construction
and Packaging Data

List of publications on
Chemistry of Wood and
Derived Products

List of publications on
Fungus Defects in Forest
Products and Decay in Trees

List of publications on
Glue, Glued Products
and Veneer

List of publications on
Growth, Structure, and
Identification of Wood

List of publications on
Mechanical Properties and
Structural Uses of Wood
and Wood Products

Partial list of publications
for Architects, Builders,
Engineers, and Retail
Lumbermen

List of publications on
Fire Protection

List of publications on
Logging, Milling, and
Utilization of Timber
Products

List of publications on
Pulp and Paper

List of publications on
Seasoning of Wood

List of publications on
Structural Sandwich, Plastic
Laminates, and Wood-Base
Aircraft Components

List of publications on
Wood Finishing

List of publications on
Wood Preservation

Partial list of publications
for Furniture Manufacturers,
Woodworkers and Teachers of
Woodshop Practice

Note: Since Forest Products Laboratory publications are so varied in subject no single list is issued. Instead a list is made up for each Laboratory division. Twice a year, December 31 and June 30, a list is made up showing new reports for the previous six months. This is the only item sent regularly to the Laboratory's mailing list. Anyone who has asked for and received the proper subject lists and who has had his name placed on the mailing list can keep up to date on Forest Products Laboratory publications. Each subject list carries descriptions of all other subject lists.