Portable Apparatus For Measuring Surface Irregularities In Panel Products
Abstract

Explains the apparatus developed at the Forest Products Laboratory to make possible approximate measurement of vertical deformations on wood surfaces.

The portable apparatus uses a shadow-casting technique, directing a slit of bright light at two wires to produce sharply defined shadows on the surface. Distortion of the shadows viewed perpendicular to the surface provides a magnified picture of the vertical distortion at that point.

A fixed-focus camera unit with 3-inch, wide-angle lens and Polaroid back produces photographs of the surface under study. The self-contained apparatus can be used on horizontal or vertical surfaces and in any lighting.
PORTABLE APPARATUS FOR MEASURING SURFACE IRREGULARITIES IN PANEL PRODUCTS

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Introduction

In 1959 a technique\(^1\) for evaluating, comparing, and recording surface show-through of particleboard cores was devised at the Forest Products Laboratory. Later a portable apparatus\(^2\) employing the same basic technique was built to provide a more versatile evaluating tool for furniture. However, the technique did not permit actual measurements of vertical deformations in a horizontal surface.

A new technique\(^3\) was devised at the Forest Products Laboratory to enable an approximate measurement of vertical deformations with the aid of a photograph taken directly from above. The technique consists of a low-angle, narrow slit of bright light directed at a tightly stretched wire to cast a shadow on the surface being evaluated.

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

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Apparatus and Technique

During 1967, a portable apparatus employing the shadow-casting technique was designed and built at the Forest Products Laboratory.

A diagrammatic sketch of the apparatus is shown in figure 1 and the completed apparatus in figure 2. Figure 3 demonstrates its use on a piece of particleboard.

When the slit of light is directed at the two wires, having a diameter of 0.025 inch and spaced 0.10 inch apart, two sharply defined shadows are cast on a surface. The distortion of the shadows viewed perpendicular to the surface is a magnified picture of the vertical distortion proportional to the angle of the light beam to the surface. For example, if the slope of the light beam to the surface of the panel is 1 to 5, then the distortion of the shadow on the surface is five times that of the vertical distortion at that point.

The camera devised was a fixed-focus unit with a 3-inch, wide-angle lens equipped with a 4- by 5-inch Polaroid back. The 3-inch lens reduced the distance necessary from subject to lens and kept the apparatus compact. Two types of Polaroid film were used with the apparatus to date. Type 57, with an ASA rating of 3000, allowed photographing with little light and smaller diaphragm openings. Type 50, which was slower but produced both a positive and negative print, was also used. The camera back was fitted with a ground glass for viewing and focusing.

The camera unit was mounted so that the axis would remain perpendicular to the evaluated surface, regardless of the slope of the apparatus. A hinged leg on the apparatus permitted a slope of 1 to 5 or 1 to 10.

Light was provided by an electronic flash unit with an adjustable output from 50 to 200 watt-seconds and flash duration between 1/400 and 1/1200 second. A cord, connected with the light and lens, synchronized the opening of the lens and flash when the shutter was tripped.

The apparatus, being self-contained, can be used on horizontal or vertical surfaces, at any location, and in any lighting situation.
Figure 1.--Diagram of portable shadow-casting apparatus.
Figure 2. Shadow casting apparatus.
Figure 3.—Apparatus in use on an FPL particle board. Back is removed.

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Samples of Results

To illustrate the sensitivity and application of the instrument, six photographs taken at a 1 to 5 slope on the apparatus are presented. Figure 4 shows straight and almost smooth shadows cast on a flat surface with few vertical irregularities in a study of sanded, unexposed exterior particleboard. The same board, exposed on the Forest Products Laboratory's Madison fence site for 2 years, is shown in figure 5. The shadow lines are straight, but jagged, indicating the panel has remained flat, but developed vertical irregularities of the surface.

Figures 6 and 7 show grain raising in lumber stock as indicated by the shadow lines that project toward the wires. The curved shadow lines in figure 6, a Douglas-fir board soaked and dried, indicate cupping. Some cupping is noticeable in figure 7, a piece of painted pine siding exposed several years on a building.

Figure 8 shows a painted exterior plywood siding. The shadow lines are straight, indicating a flat surface, but jagged, indicating grain raising or other surface irregularities. The photograph shows severe checking, separation around a patch, and paint peeling.

Figure 9 shows shadow lines on a desk top having a lumber core, conventional crossbands, and oak veneer on the faces. Note the crook in the lines near the center indicating a probable sunken glue joint in the lumber core. The two bright lines in the center near the wires are reflections of the wires in the polished surface.

The sensitivity of close photography not only provides shadows that show vertical surface irregularities, but also allows observance of surface details such as planer marks in figure 7, wood and paint checking, and other distortions.
Figure 7.--Shadow lines on painted pine siding showing face checking, grain raising, and planer marks.
Figure 9.--Shadows lines on a lumber core-oak veneer desk top.

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