VOLUME LOSS FROM INACCURATE SAWING

December 1959

No. 2174

FOREST PRODUCTS LABORATORY
MADISON 5, WISCONSIN

UNITED STATES DEPARTMENT OF AGRICULTURE
FOREST SERVICE
In Cooperation with the University of Wisconsin

VOLUME LOSS FROM INACCURATE SAWING[1]

By

L. H. REINEKE, Technologist

Forest Products Laboratory[2] Forest Service

U. S. Department of Agriculture

What does inaccuracy in the sawing of lumber cost the operator in terms of extra material? The answer, baldly stated, is "Much." The wide variation in thickness of boards produced by mills has been demonstrated (fig. 1)[3] with data showing the number of nominal one-inch boards of various actual thicknesses produced by circular and sash gangsaws. The sawyer obviously must saw a thickness sufficiently great to prevent any inaccuracies from reducing the thickness to such an extent that the board becomes undersized. When the error is on the plus side, there is no gain in net footage; material is merely wasted and requires extra power in planing, the weight per board increases, and the size irregularities make for poor piling in the yard or kiln and irregularities in rough construction. When the thicknesses vary widely, as they do with poor circular mills, the extra thickness to allow for sawing inaccuracies may run as high as 20 percent of a one-inch board. This is far too much. With no improvements in the mill some loss can be avoided, as has been pointed out by the author,[4] by a slight reduction in the size aimed for, which could give a net gain in the number of boards of acceptable thickness even though a few rejects occurred. Partial salvage of these rejects, or their use around the mills, could make further savings possible. For example, for the mills represented by the curve for circular mills in figure 1, decreasing the aimed-at thickness by 3/32 inch will save 9-3/8 inches in every 100 boards. Allowing for kerf, this is enough to produce 6-2/3 extra boards. There will, however, be three rejects per hundred, so that a net gain of 3-2/3 boards per hundred results, even if no part of the rejects is used. For the much more accurate sash gangsaw, less gain can be expected; but a reduction

[1] This report originally published in Southern Lumberman, Sept. 15, 1954.

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

[3] From data of C. J. Telford, and E. M. Davis, U. S. Forest Products Laboratory.

[4] Reineke, L. H. Sawteeth in Action. Proceedings, Forest Products Research Society 4: pp. 36-51, 1950.

of 1/32 inch in aimed-at thickness will yield a net gain of 1-1/4 boards per hundred if the five undersized boards can be recovered as 3/4-inch lumber, or if 75 percent of the length is thick enough to make one-inch boards.

The gain obtainable from small changes in thickness is real. The argument is often advanced that small gains per board are lost if they do not add up to another board in a single log; thus, it is argued, a saving of 1/16 inch per board is lost if the log produces less than the 20 to 22 boards required to accumulate the 1-1/4 to 1-3/8 inches required for an additional board plus kerf. This argument fails to recognize the three ways in which volume yield may be increased.

How Volume Yield is Increased

Volume yield may be increased, first, by adding to the thickness of a final board that is somewhat scant in thickness. If this is, say 1/4 inch scant, a saving of 1/16 inch on each of four boards is sufficient to make the last board a full-sized one, instead of a reject. Second, in the second half of a log being sawed through and through, the accumulated reduction in thickness brings the last half of the boards nearer the center, thus increasing their widths. As with thickness, some boards may be scant in width, and the increase in width of the slightly thinner boards may be sufficient to permit edging them one inch wider. The third source of increased yield is the occasional increase in trimmed length of short outside boards. Such boards may be slightly scant in length, so that nearly two feet of length for softwoods, or nearly one foot for hardwoods, must be trimmed off. Any increase in width of the last board may not be sufficient to increase the edged width by a full inch, but it may increase the length enough to trim to the next longer length class.

The ways in which yield is increased with a reduction in board thickness operate similarly when kerf is reduced. Thus, any reduction in the total amount removed at each cut, whether the reduction is wholly in the kerf or in the board, or partly in both, will frequently yield an extra board, or one or more boards that will edge or trim to the next larger size.

The volume actually lost in the extra thickness required to take care of sawing irregularities is not hard to determine. In studies such as the one above, where the purpose is to determine the frequency of undersized boards (rejects) or to determine the thickness to aim at to avoid rejects, measurement of the thinnest point on the board is appropriate, as this determines whether or not the board will "clean up" in planing. When the thinnest point on the board exceeds the minimum thickness for 100 percent planed surfaces on both sides, the excess thickness represents a waste of material. The total waste for a number of boards, however, is not the sum of the excess thickness at the thinnest points of the boards; it is somewhat more than this. If the excess thickness were uniform over the length and width of the board, the difference between actual and minimum permissible thickness would give the excess volume correctly. Such uniformity does not occur in practice, and the true volume excess is not indicated by measurements at the thinnest points, as may be seen from figure 2.

In this figure, a cant is shown sawed into four boards of irregular thickness. The irregularities appear large because the scale for thickness is expanded for the sake of clarity. Kerf is also omitted to simplify the drawing. The boards, numbered 1 to 4, have thicknesses of t_1, t_2, t_3, and t_4 at their thinnest points. Although board No. 3 is curved, its thickness is the same at all points.

Assume that the minimum permissible thickness is 1.0 and the board measurements are as given in the figure. Then if the excess thickness (t - 1.0) at the thin points of these four boards is totalled, an excess of 0.1 + 0 + 0.2 + 0.4 = 0.7 will be gotten, indicating a cant thickness of 4.7. This value is too low, however, as it includes none of the zones over which the cuts wander, 0.3 for the cut between boards 1 and 2, 0.2 between boards 2 and 3, and 0.2 between boards 3 and 4. The sum of these "wander" or deflection-zone widths is 0.7, and adding this to the 4.7 indicates a cant thickness of 5.4. This value, however, may be high if the deflection in one cut happens to be in the same direction as the deflection in the preceding cut, as is the case with the cuts between boards 2 and 3, and boards 3 and 4. Nor does the total of the average of maximum and minimum thickness of each board properly indicate the cant thickness, as $\frac{1.1 + 1.4}{2}$ for board 1, plus $\frac{1.0 + 1.3}{2}$ for board 2, plus $\frac{1.2 + 1.2}{2}$ for board 3, plus $\frac{1.4 + 1.6}{2}$ for board 4 equals 5.1. The actual cant thickness, by adding intervals along the section A-A', is 1.1 + 0.3 + 1.0 + 0.2 + 1.0 + 0.2 + 1.4, or 5.2, the correct cant thickness. The total excess is, therefore, 5.2 - 4.0 = 1.2, or 0.3 per board.

The correct cant thickness, necessary to obtain the total excess volume due to inaccuracy in sawing, can be computed from board measurements only when enough measurements on each board are made to give reliable averages of thickness, from which the average excess thickness of each board can be computed. The aggregate average thickness of all boards from a cant will give the correct cant thickness, omitting kerf.

Determining Excess Thickness

The fairly large number of measurements per board entailed by this procedure would be rather laborious, but a simple alternative is available for determining excess thickness. Setworks are accurately graduated, even though they may not uniformly deliver the set-over indicated by the scale or stops; therefore, the nominal set-over minus the kerf gives the average board thickness from which the minimum permissible thickness may be subtracted to find the excess per board. With rack saws or saw benches using a fence for regulation of thickness, the distance from fence to the near-side saw points is the average thickness per board, and subtraction of minimum permissible thickness gives the average excess. Similarly, the gap between sash gangsaws, measured between the planes of the tooth points, will give the average board thickness.

Studies of sawing accuracy intended to determine the thickness to aim for to get the highest net yield will, then, require only the measurement of the thinnest point on each board in the sample, while studies to evaluate losses in volume require merely a notation of nominal set-over, kerf, and the minimum thickness required to surface to the standard thickness.

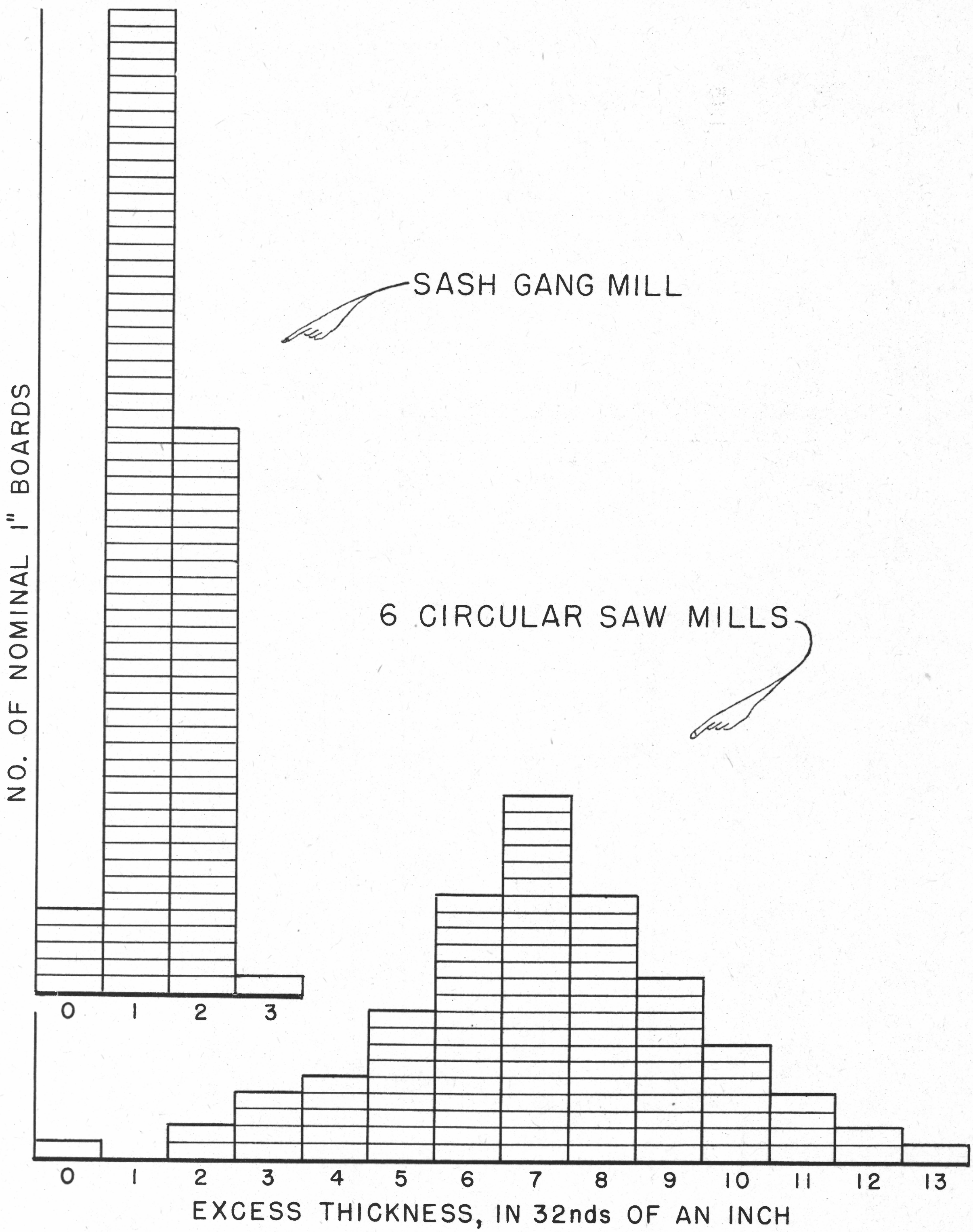
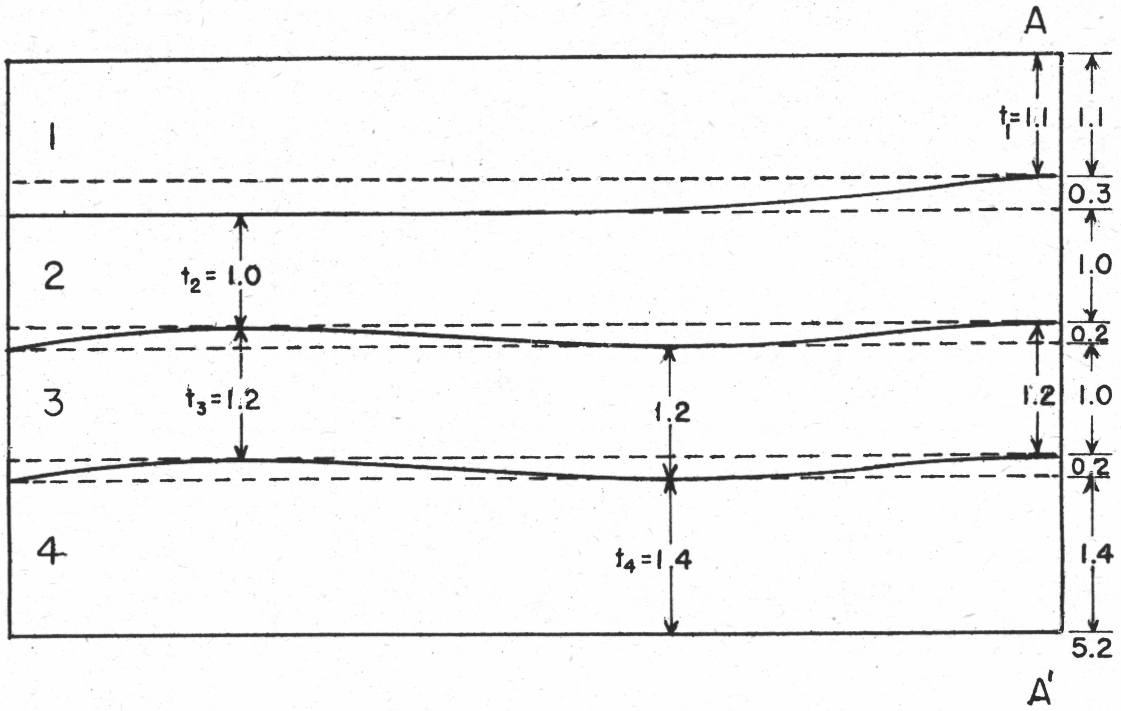


Figure 1. --Typical thickness variations in boards cut by two types of mills. For every 100 boards produced by the circular mills, a 3/32 inch reduction in thickness would make 3 boards undersize, but the accumulated savings would yield 6-2/3 boards per hundred, a new increase of 3-2/3 boards per hundred.

ZM 84455



THICKNESS

Minimum	Deflection Zone	(Max.+Min.)/2
1.1		1.25
	0.3	
1.0		1.15
	0.2	
1.2		1.20
	0.2	
1.4		1.50
4.7 0.7 5.4	0.7	5.10

Figure 2. --Inaccurate saw cuts producing four boards from a cant. (Saw kerf omitted and thickness scale expanded for clarity.) For computing excess volume, the correct cant width, neglecting kerfs, is not obtainable from simple board measurements. See text.

ZM 96919