A MATHEMATICAL ANALYSIS OF THE EFFECT OF KERF WIDTH ON LUMBER YIELD FROM SMALL LOGS

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A MATHEMATICAL ANALYSIS OF THE EFFECT OF KERF WIDTH ON LUMBER YIELD FROM SMALL LOGS

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Summary

Recent milling developments, especially in the Southeast, have again raised the question of decreased lumber yields when kerf widths are increased in the sawing of small logs.

Increased yield through decreased kerf can occur in at least three ways: First, through increased length of waney jacket boards; second, through increased width of jacket boards; and third, through recovery of an additional board otherwise left in the slabs because it is less than minimum width.

Most evaluations of these factors in past studies have been based upon diagrammatic interpretation and have been subject to considerable error.

In this study, the procedure has been reversed and "logs" in the diameter range of 5.50 to 12.00 inches have been assembled mathematically from the lumber items and two kerf widths, and their diameters have been determined by formula.

Analysis of results of approximately 300 such "logs" indicates that increased yield ranging from 0 to 33 percent and averaging slightly over 7 percent can be expected when logs in this diameter range are sawn with a 9/32-inch kerf rather than a 12/32-inch kerf. Also, the feasibility of segregating logs by diameter according to lumber items prior to sawing is strongly indicated. In certain diameter ranges, such segregation was found to increase recovery in terms of board feet up to 15 percent.

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

Introduction

During the past 5 years, a circular sawing practice has developed in southern pine mills in which the interrelation of log feed rate and sawtooth cuts per minute is adjusted to obtain relatively large bites--frequently in the range of one-fourth of an inch per tooth. A certain percentage of the sawdust produced under this method is then salable for pulp.

In many mills, this has resulted in a change to saws with wider kerfs, the most common being from 9/32-inch kerfs to 12/32-inch kerfs. The question arises as to whether or not the use of these wider kerfs reduces the potential lumber yield of these logs.

Many mill men, as well as some technical personnel, doubt that it does, particularly from logs under 12 inches in diameter, which constitute a larger percentage of the logs being sawn by the southern mills. They also believe that even from logs 12 or more inches in diameter, significant increases in lumber recovery occur only when the difference in the kerfs being compared is substantial, such as a 5/32-inch-kerf band saw with a 5/16-inch-kerf circular saw.

It can be shown, however, that even a slight reduction in kerf when multiplied by two or more saw lines will frequently move jacket boards into logs far enough so that increases in lumber recovery do result. This occurs in any one of the following three ways, either independently or together, in logs of certain diameter classes:

(1) The first increase occurs in logs that, when sawn, have at least one jacket board requiring trimming to a length shorter than the log as a result of wane from log taper. Even a very slight reduction in kerf width when multiplied by two or more saw lines is sufficient to move the face of this waney jacket board into the log far enough to increase its usable length by one or more feet or in other cases to bring it up to minimum merchantable length.

(2) The second increase occurs in much the same manner in the form of increased width of the jacket boards. Any decrease in kerf width, providing of course that the board thickness remains unchanged, means that the total thickness of the boards plus their kerfs from a given log is reduced. Thus, the result has the effect of moving the outside faces of the jacket boards into the log or nearer to the log center.

(3) A third increase in recovery from decreased kerf occurs in those logs which would yield an additional jacket board of less than minimum acceptable width when sawn with the wider kerf. In this case, the board is usually not

actually sawn but is left in the slab. If this log is sawn with a saw of narrower kerf, the potential board will, in effect, be moved into the log slightly, and in many cases it will be of sufficient width to meet minimum requirements.

Potential gains in lumber recovery occurring in either of the first two ways differ between hardwoods and softwoods because of basic differences in scaling. Softwoods, with some exceptions, are scaled in multiples of 2 inches in width and 2 feet in length, while hardwoods are scaled to the closest board foot random width and to 1-foot multiples in length. If two matched samples of random-width unedged lumber, one hardwood and the other softwood, are edged in accordance with accepted practice, the lumber scale of the hardwood will be in the range of one board foot more per board in 12-foot lumber. A similar, although generally smaller, difference also exists regarding the scale related to length, providing the samples are random in length, which would be the case in jacket boards.

When a large enough random sampling of jacket boards is considered, increases in scale resulting from the effect of decreased kerf on the increased width or the increased length of jacket boards are equal with either hardwood or softwood when expressed in board feet. If expressed in percentage, however, the increase over the original scale would be greater for softwoods than for hardwoods because of the smaller original base scale of the softwood lumber.

A mathematical method of showing how slight reductions in kerf size can result in significant increases in lumber recovery is presented in this report. The procedure used is to take specific combinations of lumber items along with selected kerf widths and assemble them mathematically into "logs." Thus, the minimum diameters (inside bark) that are required to produce these specific combinations when sawn with the different kerf widths can be calculated and comparisons made from the standpoint of lumber recovery.

This method reverses the procedure followed in previous studies in which hypothetical logs were drawn on paper and the drawings were used as an aid to calculate lumber yield for various kerf widths. The results of these studies usually have been inconclusive.

This mathematical approach is more accurate because it breaks down the diameter classes being analyzed into units below one inch; in this case, 0.02-inch increment classes. The results show that for some diameter groups within the 1-inch diameter classes there are marked differences between yields from logs sawn using a 9/32-inch kerf and logs sawn using a 12/32-inch kerf, while for other diameter groups the yields are the same.

Guiding Factors Used

Because completion of this study was stimulated by the trend to 12/32-inch kerfs in southern pine mills, the guiding factors that were selected to serve as the basis of the mathematical analysis were practices now in effect at these mills.

The overall diameter (inside bark) range of the logs to be analyzed, for example, was limited to logs in the 6- through 11-inch (5.50 to 11.50 inches) diameter range because a high percentage of the southern pine logs being sawn fall within this range.

Maximum yields of 8/4 dimension (2 by 4's, 2 by 6's, 2 by 8's) were sought. One inch 4/4 boards (1 by 4's, 1 by 6's, 1 by 8's) were included only to fully utilize the "log." The combinations of dimensions and boards for which the minimum diameters were calculated were predetermined with these objectives in mind.

Only two kerf widths were considered--9/32 and 12/32 inch--and no wane was allowed on the lumber. Minimum rough green sizes used were those recommended in R. R. Cahal's "Sawmilling Practices That Pay."[2] Specifically, minimum rough green thicknesses were calculated on the basis of 31/32 of an inch and 1-7/8 inches for 1-inch 4/4 boards (yard) and 2-inch 8/4 dimension (yard), respectively, while minimum rough green widths used in the calculations were 4, 6-1/8, and 8-1/8 inches for nominal 4-, 6-, and 8-inch lumber, respectively.

Method of Calculations

Two steps were involved in the calculations: (1) All the logical combinations of dimension lumber and boards that can be cut from logs in the 5.50 to 12.00 diameter (inside bark) range were determined; and (2) formulas were derived that made it possible to figure the diameter of the circle that precisely circumscribes the rectangle formed by a cross-sectional plane of the dimension lumber and board combinations and their interior kerfs.[3]

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[2] Sawmilling Practices That Pay: A Production Manual for Sawmill Operations. Published by Southern Pine Inspection Bureau, New Orleans, La. 1947.

[3] Interior kerfs are those that separate lumber from lumber as contrasted to slabbing or edging kerfs that separate slabs or edgings from lumber. The slabbing kerfs were not considered since they have no effect on the lumber recovery but result only in loss of slab or edging volume with increased kerf width.

For obvious practical reasons, the minimum log diameters calculated for a given width of dimension were those which would produce a cant yielding two pieces of 2 by 4, two pieces of 2 by 6, or two pieces of 2 by 8. The minimum log for the 2 by 8's also yields 4/4 lumber. In addition, 38 other combinations of dimension lumber and boards were determined--7 when the logs were sawn to a 4-inch cant; 22 when the logs were sawn to a 6-inch cant; and 12 when the logs were sawn to an 8-inch cant. These 41 combinations are listed in tables 1 and 2.

To calculate the diameters of logs that would yield these combinations, it was necessary to set up formula (1) for those combinations for which the yield was from the cant only, and formula (2) for those combinations for which the yield was from the side lumber in addition to a prescribed cant.

For formula (1), consider figure 1, in which the minimum log diameter required for producing a cant that would yield three 2 by 6's was calculated.

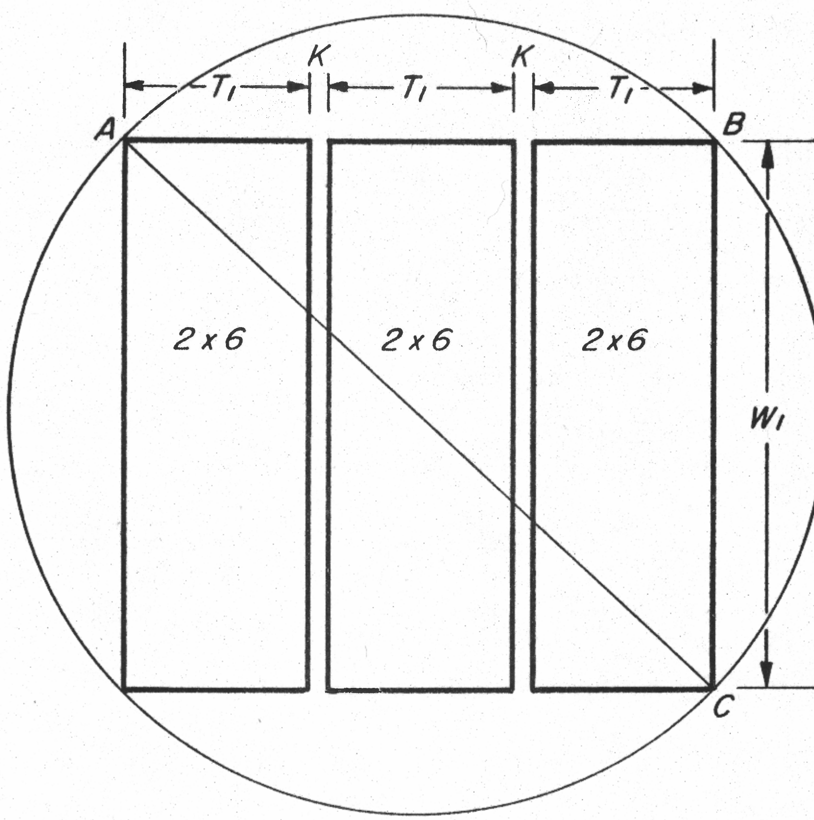

Figure 1.--Drawing from which formula was developed for determining minimum diameter of log developing cants yielding specified lumber items.

AC = diameter of circumscribing circle

T_1 = thickness of pieces of lumber to be sawn from cant

K = width of an interior kerf

W_1 = cant depth or lumber width

Using the proposition for right-angled triangles whereby the square of the hypotenuse is equal to the sum of the squares on the two sides, the formula for the diameter of the circumscribing circles was set up as follows:

$$AC = \sqrt{(AB)^2 + (BC)^2} \tag{1}$$

or for the above example

$$AC = \sqrt{(2K + 3T_1)^2 + (W_1)^2}$$

According to Cahal's "Sawmilling Practices That Pay,"

T_1 = 1-7/8 inches, or 1.875 inches

W_1 = 6-1/8 inches, or 6.125 inches

Using a 9/32-inch kerf, K = 0.28125 inch. Therefore, in substituting

$$AC = \sqrt{[2(0.28125) + 3(1.875)]^2 + (6.125)^2}$$

$$= \sqrt{75.8008}$$

$$\therefore AC = 8.70 \text{ inches}$$

For formula (2), consider figure 2, in which the minimum log diameter required to produce two 1 by 4's from the side lumber and a 6-inch cant is calculated.

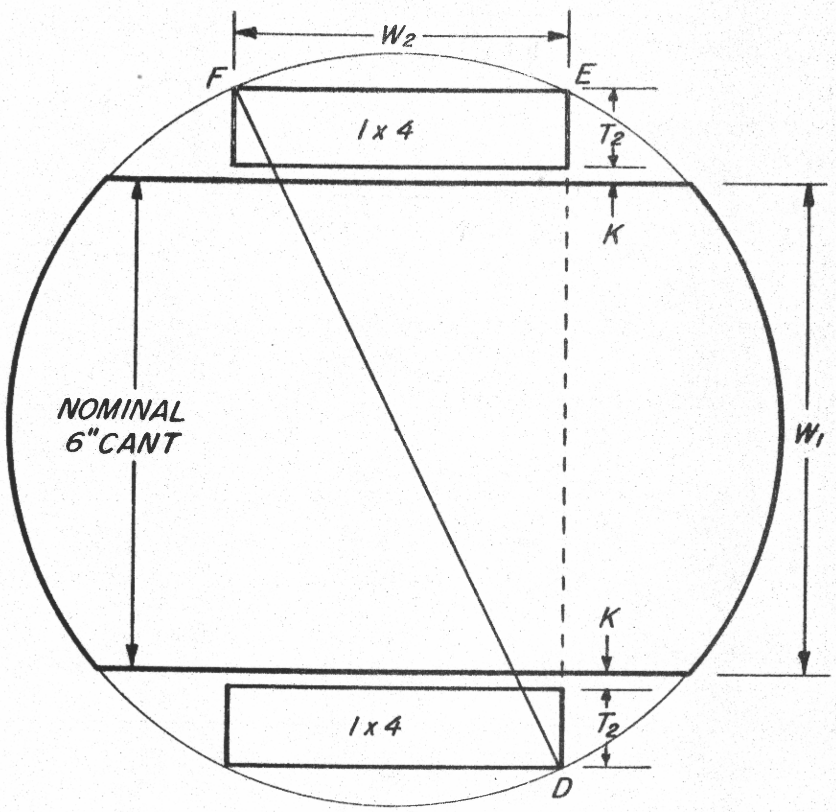

Figure 2. --Drawing from which formula was developed for determining minimum diameter of log yielding specified side lumber in addition to specified cants.

FD = diameter of circumscribing circle

T_2 = thickness of side lumber

W_1 = cant depth or width of cant lumber

W_2 = width of side lumber

K = kerf width

Once again, using the proposition for right-angled triangles, the formula for the diameter of the circumscribing circle was set up as

$$FD = \sqrt{(DE)^2 + (EF)^2} \tag{2}$$

or for the above example

$$FD = \sqrt{(2T_2 + 2K + W_1)^2 + (W_2)^2}$$

Once again, using the sizes specified by Cahal we find that

T_2 = 31/32, or 0.96875 inch

W_2 = 4 inches, or 4.000 inches

with the value for $\underline{W_1}$ remaining the same and using the same 9/32-inch kerf.

Therefore, in substituting

$$FD = \sqrt{[2(0.96875) + 2(0.28125) + 6.125]^2 + (4.000)^2}$$

$$= \sqrt{90.3906}$$

$$\therefore FD = 9.50 \text{ inches}$$

Using these formulas, the minimum diameters required to produce all of the various combinations of lumber products were calculated and tabulated as shown in tables 1 and 2. Logically, logs with diameters falling between two of these required minimum diameters will yield the same as the smaller of the two; thus, it became possible to group all of the diameters within the study range into yield groups as shown in table 3.

The increases in lumber recovery that can be obtained from using a 9/32-inch kerf over what can be obtained from using a 12/32-inch kerf were calculated and compared, as shown in table 4. These increases are shown in percentages as well as board feet.

The results also pinpointed the cant sizes that would most completely utilize logs within its yield class, as shown in table 5.

Discussion of Results

The results that were obtained do not represent the entire gain that might be expected since no factor of log taper is involved. For these calculations, the log, in effect, was considered as a cylinder of a diameter equal to the small end or top diameter inside bark.

The results, furthermore, are applicable only to lumber manufactured under the sizing recommendations contained in Cahal's "Sawmilling Practices That Pay." They do give a fair evaluation for all softwood dimension manufacture, however, since most softwoods are manufactured to similar finished dimension, and shrinkage and planing allowances are about the same throughout the industry.

No direct application of these results can be made to hardwoods because they are generally manufactured and scaled differently. It is logical to assume, however, that the same factors are involved and that gains in recovery from decreased kerf width would result from any sizable sample of hardwood logs.

One of the most interesting facts developed from this study is that for many of the 0.02-inch increment diameter classes within the study range there is no difference in the lumber recovery. For other diameter classes, the increases in recovery that are due mainly to the differences in kerf are substantial, some as high as 33-1/3 percent (table 4 and fig. 1). For example, when sawing to a 4-inch cant, logs with diameters ranging from 7.36 to 7.52 inches yield 24 board feet if sawn with a 9/32-inch kerf and only 20 feet if sawn with a 12/32-inch kerf--an increase of 20 percent. In the next diameter group (7.52 to 7.64 inches), however, the yield using either saw is equal--24 board feet. The difference in yield in the succeeding diameter group (7.64 to 7.88 inches) becomes substantial again--32 feet when sawn with the 9/32-inch kerf as compared to 24 feet with the 12/32-inch kerf for a gain of 33-1/3 percent!

Another interesting and related factor results frequently, especially when developing 6-inch cants. Two or more increases in recovery occur in the logs sawn with 9/32-inch kerf before a diameter is reached in which the first increase in recovery from the same log sawn with the 12/32-inch kerf occurs. This is illustrated graphically in the 6-inch cant section of figure 3 between diameters of 9.24 and 9.68 inches.

The data appear to indicate that (for a given cant size) as log diameter increases a point is reached above which recovery for the 12/32-inch kerf is always lower than for the 9/32-inch kerf. This is indicated for diameters above 10.34 inches in the 6-inch cant section of figure 1. However, the diameter range studied was not sufficient to show this conclusively.

The data also show that as diameter increases the variation in recovery expressed as a percentage tends to level out and approach the mean. This is especially evident in the 6-inch cant section of figure 3.

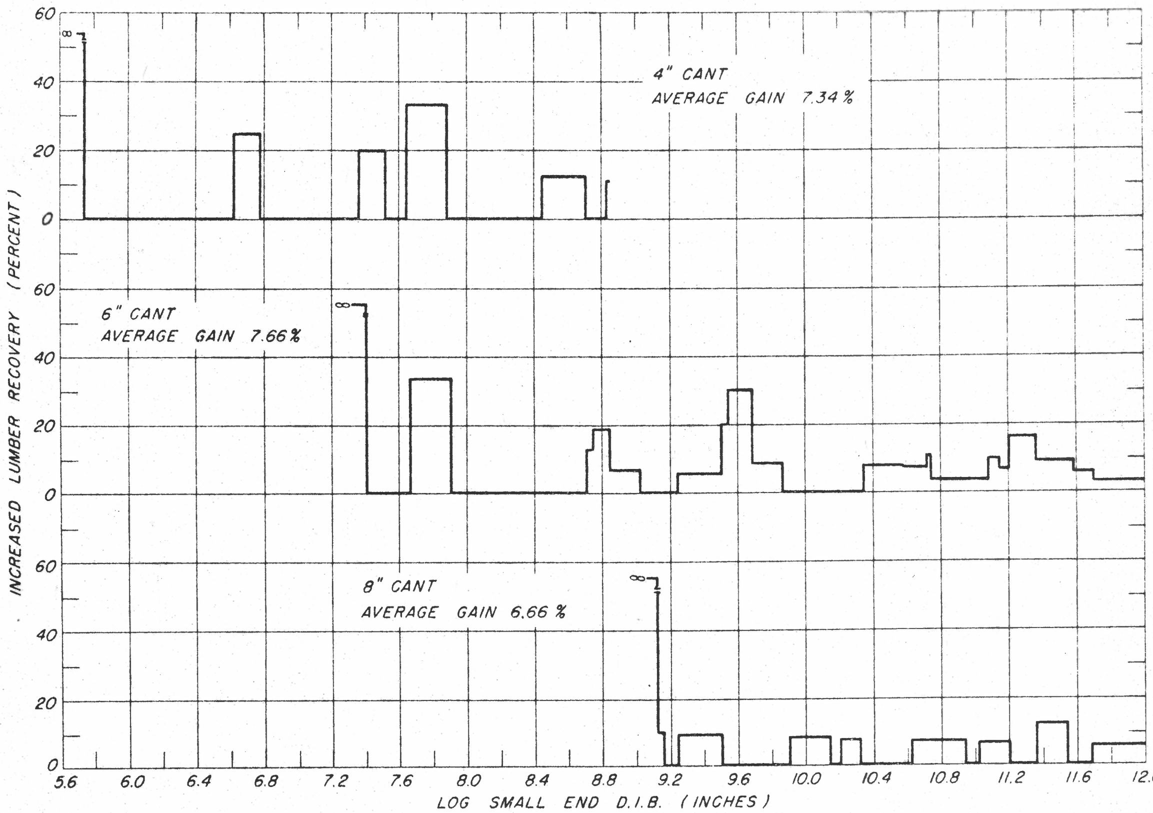

Figure 3.--The percentage increase in lumber recovery resulting from the use of a 9/32-inch kerf saw over that resulting from the use of a 12/32-inch kerf saw for logs similarly sawn into 4-, 6-, and 8-inch cants.

An average increase in recovery resulting for each cant size was computed by assuming a sample containing one log for each 0.02-inch diameter class from 5.50 through 11.48 inches--a total of 300 logs. The largest average increase was 7.66 percent for the 6-inch cant followed by 7.34 percent for the 4-inch cant and 6.66 percent for the 8-inch cant. The weighted average for the three cant sizes was 7.31 percent.

Differences in kerf width alone cannot account for all of this increased recovery. Considering the ratio of 8/4 to 4/4 lumber cut, the kerf difference should account for an increase of approximately 5 percent. The remaining 2+ percent is believed to be the result of two other factors:

First the diameter range potential is slightly greater when using the 9/32-inch kerf than it is when using a 12/32-inch kerf. For example, when considering the 6-inch cant combinations, the minimum-entrance diameter (smallest diameter yielding two 2 by 6' s) is 7.32 inches for the 9/32-inch kerf and 7.40 inches for the 12/32-inch kerf. Thus, yields from four more 0.02-inch-increment diameter classes are included in the recovery increases computed for the 9/32-inch kerf. This does not bias the results of the study since the same condition occurs in practice.

The second and more important factor is that the degree of curvature of the circumferences of the smaller logs being studied was relatively high compared to those of larger logs. Slight differences in the cross-sectional dimensions of the various combinations of lumber items and interior kerfs have a much greater percentile effect on the recovery scale from small logs than from large logs because it is physically impossible to fit merchantable lumber sizes (nothing less than 1 by 4 or 2 by 4) as closely to the circumference or bark in the smaller logs as in the larger logs. A corollary to this is the increase in percentage of slab and edging volume as log diameter decreases.

The data indicate that it should be feasible and economical to segregate logs on the basis of rather precise diameter classes for conversion to a specific cant size before sawing. For example, when a 9/32-inch kerf saw is used to saw a log with a diameter of 9.06 inches, the yield is 44 board feet if the log is sawn to an 8-inch cant and only 38 board feet if it is sawn to a 6-inch cant--an increase in recovery of 15.8 percent. Conversely, at a log diameter of 9.56 inches, the yield from sawing to a 6-inch cant would be 52 board feet as compared to 48 board feet if sawn to an 8-inch cant--an increase of 8.33 percent.

Natural and grading factors inherent in logs and lumber, such as sweep, crook, eccentricity of cross section, and allowable wane, make direct application of these results on an exact diameter basis difficult, but they do not alter the relationships shown to exist in this study. The same general relationships will occur--only the precise diameters at which they occur will change.

Conclusions

The following conclusions based on this mathematical analysis can be drawn:

(1) A definite increase in lumber recovery from logs between 5.50 and 12.00 inches in diameter occurs when the logs are sawn with 9/32-inch kerf saws over the recovery obtained when the logs are sawn with 12/32-inch kerf saws. This increase varies from 2.9 to 33-1/3 percent when considering individual

diameters and averages 7.31 percent for all diameters. At some diameters, no increase in lumber recovery occurs.

(2) The results strongly indicate that the percentile increase to be expected through decreased kerf is greater in the smaller logs than in larger logs; from logs 12 inches and below in diameter than from logs over 12 inches in diameter.

(3) Serious consideration should be given to segregating or marking logs to indicate cant size before they reach the sawyer because a substantial difference between the yields of a given log frequently occurs, depending upon the size of cant to which the log is sawn.

(4) Increases resulting from reduced kerf width are erratic in the lower diameter ranges but tend to level out as diameter increases.

Table 1.--Minimum log diameters (inside bark) required for yielding predetermined combinations of softwood lumber items when 9/32-inch kerf saw is used

Lumber items: From the cant	Lumber items: From side lumber	Minimum[1] diameter (inside bark)	Lumber scale[2]
		In.	Bd. ft.
TO 4-INCH CANT FROM LOGS IN 5.50- TO 9.00-INCH TOP D.I.B. RANGE			
Two 2 by 4	....	5.68	16
Two 2 by 4 + one 1 by 4	....	6.62	20
Three 2 by 4	....	7.36	24
Three 2 by 4	Two 1 by 4	7.64	32
Two 2 by 4 + two 1 by 4	Two 1 by 4	7.66	32
Three 2 by 4 + one 1 by 4	Two 1 by 4	8.44	36
Three 2 by 4 + one 1 by 4	Two 1 by 6	8.82	40
TO 6-INCH CANT FROM LOGS IN 5.50- TO 12.00-INCH TOP D.I.B. RANGE			
Two 2 by 6	....	7.32	24
Two 2 by 6 + two 1 by 4	....	7.66	32
Two 2 by 6 + one 1 by 6	....	8.08	30
Three 2 by 6	....	8.70	36
Two 2 by 6 + one 1 by 6 + two 1 by 4	....	8.74	38
Two 2 by 6 + two 1 by 6	....	8.94	[3]36
Two 2 by 6 + two 2 by 4	....	9.24	40
Two 2 by 6 + two 2 by 4	Two 1 by 4	9.50	48
Three 2 by 6 + two 1 by 4	Two 1 by 4	9.56	52
Three 2 by 6 + one 1 by 6	Two 1 by 4	9.62	[3]50
Two 2 by 6 + three 1 by 6	Two 1 by 4	9.90	[3]50
Four 2 by 6	Two 1 by 4	10.34	56
Two 2 by 6 + one 1 by 6 + two 2 by 4	Two 1 by 4	10.38	[3]54
Four 2 by 6	Two 1 by 6	10.58	60
Three 2 by 6 + two 1 by 6	Two 1 by 6	10.62	60
Three 2 by 6 + one 1 by 6 + two 1 by 4	Two 1 by 6	10.72	62
Three 2 by 6 + one 1 by 6 + two 1 by 4	Two 2 by 4	11.08	66
Four 2 by 6 + two 1 by 4	Two 2 by 4	11.20	72
Three 2 by 6 + two 2 by 4	Two 2 by 4	11.22	[3]68
Four 2 by 6 + one 1 by 6	Two 2 by 4	11.38	[3]70
Three 2 by 6 + three 1 by 6	Two 2 by 4	11.68	[3]70
Four 2 by 6 + two 1 by 4	Two 1 by 8	11.86	72

(Sheet 1 of 2)

Table 1.--Minimum log diameters (inside bark) required for yielding predetermined combinations of softwood lumber items when 9/32-inch kerf saw is used--Continued

Lumber items: From the cant	Lumber items: From side lumber	Minimum[1] diameter (inside bark)	Lumber scale[2]
		In.	Bd. ft.
TO 8-INCH CANT FROM LOGS IN 5.50- TO 12.00-INCH TOP D.I.B. RANGE			
Two 2 by 8 + two 1 by 6	....	9.06	44
Two 2 by 8 + two 2 by 4	....	9.24	48
Two 2 by 8 + one 1 by 8	....	9.68	[3]40
Two 2 by 8 + one 1 by 8 + two 1 by 6	....	9.90	52
Three 2 by 8 + two 1 by 4	....	10.20	56
Two 2 by 8 + one 1 by 8 + two 2 by 4	....	10.38	56
Three 2 by 8 + two 1 by 6	....	10.62	60
Three 2 by 8 + one 1 by 8 + two 1 by 4	....	11.02	64
Three 2 by 8 + two 2 by 4	....	11.22	64
Three 2 by 8 + two 2 by 4	Two 1 by 4	11.36	72
Four 2 by 8	Two 1 by 4	11.64	72
Three 2 by 8 + one 1 by 8 + two 1 by 6	Two 1 by 4	11.68	76

[1]Diameter at small end of log.

[2]Based on 12-foot length.

[3]Lumber item combinations are listed in sequence according to the minimum top diameter of the logs. In a few cases, this results in a deviation from the general orderly trend of increased lumber recovery from increased log diameter.

(Sheet 2 of 2)

Table 2.--Minimum log diameters (inside bark) required for yielding predetermined combinations of softwood lumber items when 12/32-inch kerf saw is used

Lumber items: From the cant	Lumber items: From side lumber	Minimum[1] diameter (inside bark)	Lumber scale[2]
		In.	Bd. ft.
TO 4-INCH CANT FROM LOGS IN 5.50- TO 9.00-INCH TOP D.I.B. RANGE			
Two 2 by 4	....	5.74	16
Two 2 by 4 + one 1 by 4	....	6.78	20
Three 2 by 4	....	7.52	24
Three 2 by 4	Two 1 by 4	7.88	32
Two 2 by 4 + two 1 by 4	Two 1 by 4	7.90	32
Three 2 by 4 + one 1 by 4	Two 1 by 4	8.70	36
TO 6-INCH CANT FROM LOGS IN 5.50- TO 12.00-INCH TOP D.I.B. RANGE			
Two 2 by 6	....	7.40	24
Two 2 by 6 + two 1 by 4	....	7.90	32
Two 2 by 6 + one 1 by 6	....	8.22	[3]30
Three 2 by 6	....	8.84	36
Two 2 by 6 + one 1 by 6 + two 1 by 4	....	9.02	38
Two 2 by 6 + two 1 by 6	....	9.16	[3]36
Two 2 by 6 + two 2 by 4	....	9.50	40
Two 2 by 6 + two 2 by 4	Two 1 by 4	9.68	48
Three 2 by 6 + one 1 by 6	Two 1 by 4	9.86	50
Three 2 by 6 + two 1 by 4	Two 1 by 4	9.86	52
Two 2 by 6 + three 1 by 6	Two 1 by 4	10.14	[3]50
Four 2 by 6	Two 1 by 4	10.58	56
Four 2 by 6	Two 1 by 6	10.74	60
Two 2 by 6 + one 1 by 6 + two 2 by 4	Two 1 by 6	10.74	[3]58
Three 2 by 6 + two 1 by 6	Two 1 by 6	10.94	60
Three 2 by 6 + one 1 by 6 + two 1 by 4	Two 1 by 6	11.14	62
Three 2 by 6 + one 1 by 6 + two 1 by 4	Two 2 by 4	11.36	66
Three 2 by 6 + two 2 by 4	Two 2 by 4	11.58	68
Four 2 by 6 + one 1 by 6	Two 2 by 4	11.70	70
Four 2 by 6 + one 1 by 6	Two 1 by 8	11.98	70

(Sheet 1 of 2)

Table 2.--Minimum log diameters (inside bark) required for yielding predetermined combinations of softwood lumber items when 12/32-inch kerf saw is used--Continued

Lumber items: From the cant	Lumber items: From side lumber	Minimum[1] diameter (inside bark)	Lumber scale[2]
		In.	Bd. ft.
TO 8-INCH CANT FROM LOGS IN 5.00- TO 12.00-INCH TOP D.I.B. RANGE			
Two 2 by 8 + two 1 by 4	....	9.12	40
Two 2 by 8 + two 1 by 6	....	9.16	44
Two 2 by 8 + two 2 by 4	....	9.50	48
Two 2 by 8 + one 1 by 8 + two 1 by 4	....	9.78	48
Two 2 by 8 + one 1 by 8 + two 1 by 6	....	10.14	52
Three 2 by 8 + two 1 by 4	....	10.32	56
Two 2 by 8 + one 1 by 8 + two 2 by 4	....	10.74	56
Three 2 by 8 + two 1 by 6	....	10.94	60
Three 2 by 8 + one 1 by 8 + two 1 by 4	....	11.20	64
Three 2 by 8 + one 1 by 8 + two 1 by 4	Two 1 by 4	11.54	72
Three 2 by 8 + two 2 by 4	Two 1 by 4	11.58	72
Four 2 by 8	Two 1 by 4	11.86	72

[1]Diameter at small end of log.

[2]Based on 12-foot length.

[3]Lumber item combinations are listed in sequence according to the minimum top diameter of the logs. In a few cases this results in a deviation from the general orderly trend of increased lumber recovery from increased log diameter.

(Sheet 2 of 2)

Table 3.--Lumber recovery for all logs between 5.50 and 12.00 inches in diameter (inside bark) using 9/32- and 12/32-inch kerf widths and cutting to basic 4-, 6-, and 8-inch cants[1,2]

Diameter (d.i.b.) groups (by yield)	Using 9/32-in. kerf			Using 12/32-in. kerf		
	4-in. cant	6-in. cant	8-in. cant	4-in. cant	6-in. cant	8-in. cant
In.	Bd. ft.	Bd. ft.	Bd. ft.	Bd. ft.	Bd. ft.	Bd. ft.
5.50 to 5.68	....	....	....	....	....	....
5.68 to 5.74	16	....	....	....	....	....
5.74 to 6.62	16	....	....	16	....	....
6.62 to 6.78	20	....	....	16	....	....
6.78 to 7.32	20	....	....	20	....	....
7.32 to 7.36	20	24	....	20	....	....
7.36 to 7.40	24	24	....	20	....	....
7.40 to 7.52	24	24	....	20	24	....
7.52 to 7.64	24	24	....	24	24	....
7.64 to 7.66	32	24	....	24	24	....
7.66 to 7.88	32	32	....	24	24	....
7.88 to 7.90	32	32	....	32	24	....
7.90 to 8.44	32	32	....	32	32	....
8.44 to 8.70	36	32	....	32	32	....
8.70 to 8.74	36	36	....	36	32	....
8.74 to 8.82	36	38	....	36	32	....
8.82 to 8.84	40	38	....	36	32	....
8.84 to 9.02	40	38	....	36	36	....
9.02 to 9.06	....	38	....	....	38	....
9.06 to 9.12	....	38	44	....	38	....
9.12 to 9.16	....	38	44	....	38	40
9.16 to 9.24	....	38	44	....	38	44
9.24 to 9.50	....	40	48	....	38	44
9.50 to 9.56	....	48	48	....	40	48
9.56 to 9.68	....	52	48	....	40	48
9.68 to 9.86	....	52	48	....	48	48

Table 3.--Lumber recovery for all logs between 5.50 and 12.00 inches in diameter (inside bark) using 9/32- and 12/32-inch kerf widths and cutting to basic 4-, 6-, and 8-inch cants[1,2]--Continued

Diameter (d.i.b.) groups (by yield)	Using 9/32-in. kerf			Using 12/32-in. kerf		
	4-in. cant	6-in. cant	8-in. cant	4-in. cant	6-in. cant	8-in. cant
In.	Bd. ft.	Bd. ft.	Bd. ft.	Bd. ft.	Bd. ft.	Bd. ft.
9.86 to 9.90	....	52	48	....	52	48
9.90 to 10.14	....	52	52	....	52	48
10.14 to 10.20	....	52	52	....	52	52
10.20 to 10.32	....	52	56	....	52	52
10.32 to 10.34	....	52	56	....	52	56
10.34 to 10.58	....	56	56	....	52	56
10.58 to 10.62	....	60	56	....	56	56
10.62 to 10.72	....	60	60	....	56	56
10.72 to 10.74	....	62	60	....	56	56
10.74 to 10.94	....	62	60	....	60	56
10.94 to 11.02	....	62	60	....	60	60
11.02 to 11.08	....	62	64	....	60	60
11.08 to 11.14	....	66	64	....	60	60
11.14 to 11.20	....	66	64	....	62	60
11.20 to 11.36	....	72	64	....	62	64
11.36 to 11.54	....	72	72	....	66	64
11.54 to 11.58	....	72	72	....	66	72
11.58 to 11.68	....	72	72	....	68	72
11.68 to 11.70	....	72	76	....	68	72
11.70 to 12.00	....	72	76	....	70	72

[1]Based on 12-foot length.

[2]Underlined numbers indicate where increases in lumber yield occur.

(Sheet 2 of 2)

Table 4.--Minimum diameters (inside bark) at top end of log at which increases in lumber recovery occur for 9/32- and 12/32-inch kerfs when sawing to obtain maximum yields of 8/4 lumber from logs 5.50 to 12.00 inches in diameter

Minimum d.i.b.	Yield using[1]		Gain from using 9/32-in. kerf	
	9/32-in. kerf	12/32-in. kerf		
In.	Bd. ft.	Bd. ft.	Bd. ft.	Percent
		TO 4-INCH CANT		
5.68	16	0	16	∞
5.74	16	16	0	0.0
6.62	20	16	4	25.0
6.78	20	20	0	.0
7.36	24	20	4	20.0
7.52	24	24	0	.0
7.64	32	24	8	33.0
7.88	32	32	0	.0
8.44	36	32	4	12.5
8.70	36	36	0	.0
8.82	40	36	4	11.1
		TO 6-INCH CANT		
7.32	24	0	24	∞
7.40	24	24	0	.0
7.66	32	24	8	33.3
7.90	32	32	0	.0
8.70	36	32	4	12.5
8.74	38	32	6	18.7
8.84	38	36	2	6.5
9.02	38	38	0	.0
9.24	40	38	2	5.3
9.50	48	40	8	20.0
9.56	52	40	12	30.0
9.68	52	48	4	8.3
9.86	52	52	0	.0
10.34	56	52	4	7.7
10.58	60	56	4	7.1
10.72	62	56	6	10.7
10.74	62	60	2	3.3
11.08	66	60	6	10.0
11.14	66	62	4	6.5

Table 4.--Minimum diameters (inside bark) at top end of log at which increases in lumber recovery occur for 9/32- and 12/32-inch kerfs when sawing to obtain maximum yields of 8/4 lumber from logs 5.50 to 12.00 inches in diameter--Continued

Minimum d.i.b.	Yield using[1]		Gain from using 9/32-in. kerf	
	9/32-in. kerf	12/32-in. kerf		
In.	Bd. ft.	Bd. ft.	Bd. ft.	Percent
		TO 6-INCH CANT--Continued		
11.20	72	62	10	16.1
11.36	72	66	6	9.1
11.58	72	68	4	5.9
11.70	72	70	2	2.9
		TO 8-INCH CANT		
9.06	44	0	44	∞
9.12	44	40	4	10.0
9.16	44	44	0	.0
9.24	48	44	4	9.1
9.50	48	48	0	.0
9.90	52	48	4	8.3
10.14	52	52	0	.0
10.20	56	52	4	7.7
10.32	56	56	0	.0
10.62	60	56	4	7.1
10.94	60	60	0	.0
11.02	64	60	4	6.7
11.20	64	64	0	.0
11.36	72	64	8	12.5
11.54	72	72	0	.0
11.68	76	72	4	5.1

[1]Based on 12-foot length.

Table 5.--Best cant sizes to saw to when using 9/32- and 12/32-inch kerf saws to obtain maximum yields of 8/4 lumber from logs ranging between 5.50 and 12.00 inches in diameter (inside bark) at small or top end of log

Diameter (d.i.b.) groups (by yield)	Using 9/32-inch kerf		Using 12/32-inch kerf	
	Best cant size	Yield[1]	Best cant size	Yield[1]
In.	In.	Bd. ft.	In.	Bd. ft.
5.50 to 5.68	....	....	....	....
5.68 to 5.74	4	16	....	....
5.74 to 6.62	4	16	4	16
6.62 to 6.78	4	20	4	16
6.78 to 7.32	4	20	4	20
7.32 to 7.36	6	24	4	20
7.36 to 7.40	4 or 6	24	4	20
7.40 to 7.52	4 or 6	24	6	24
7.52 to 7.64	4 or 6	24	4 or 6	24
7.64 to 7.66	4	32	4 or 6	24
7.66 to 7.88	4 or 6	32	4 or 6	24
7.88 to 7.90	4 or 6	32	4	32
7.90 to 8.44	4 or 6	32	4 or 6	32
8.44 to 8.70	4	36	4 or 6	32
8.70 to 8.74	4 or 6	36	4	36
8.74 to 8.82	6	38	4	36
8.82 to 8.84	4	40	4	36
8.84 to 9.02	4	40	4 or 6	36
9.02 to 9.06	4	40	6	38
9.06 to 9.12	8	44	6	38
9.12 to 9.16	8	44	8	40
9.16 to 9.24	8	44	8	44
9.24 to 9.50	8	48	8	44
9.50 to 9.56	6 or 8	48	8	48
9.56 to 9.68	6	52	8	48

Table 5.--Best cant sizes to saw to when using 9/32- and 12/32-inch kerf saws to obtain maximum yields of 8/4 lumber from logs ranging between 5.50 and 12.00 inches in diameter (inside bark) at small or top end of log-- Continued

Diameter (d.i.b.) groups (by yield)	Using 9/32-inch kerf		Using 12/32-inch kerf	
	Best cant size	Yield[1]	Best cant size	Yield[1]
In.	In.	Bd. ft.	In.	Bd. ft.
9.68 to 9.86	6	52	6 or 8	48
9.86 to 9.90	6	52	6	52
9.90 to 10.14	6 or 8	52	6	52
10.14 to 10.20	6 or 8	52	6 or 8	52
10.20 to 10.32	8	56	6 or 8	52
10.32 to 10.34	8	56	8	56
10.34 to 10.58	6 or 8	56	8	56
10.58 to 10.62	6	60	6 or 8	56
10.62 to 10.72	6 or 8	60	6 or 8	56
10.72 to 10.74	6	62	6 or 8	56
10.74 to 10.94	6	62	6	60
10.94 to 11.02	6	62	6 or 8	60
11.02 to 11.08	8	64	6 or 8	60
11.08 to 11.14	6	66	6 or 8	60
11.14 to 11.20	6	66	6	62
11.20 to 11.36	6	72	8	64
11.36 to 11.54	6 or 8	72	6	66
11.54 to 11.68	6 or 8	72	8	72
11.68 to 12.00	8	76	8	72

[1] Based on 12-foot length.