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LABORATORY PERFORMANCE OF A POWERED BACK-UP ROLL FOR
PEELING VENEER(U) FOREST PRODUCTS LAB MADISON WI
S P LOEHNERZ OCT 82 FSRP-FPL-429

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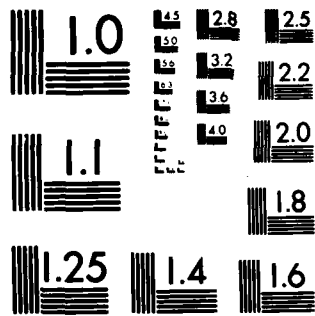
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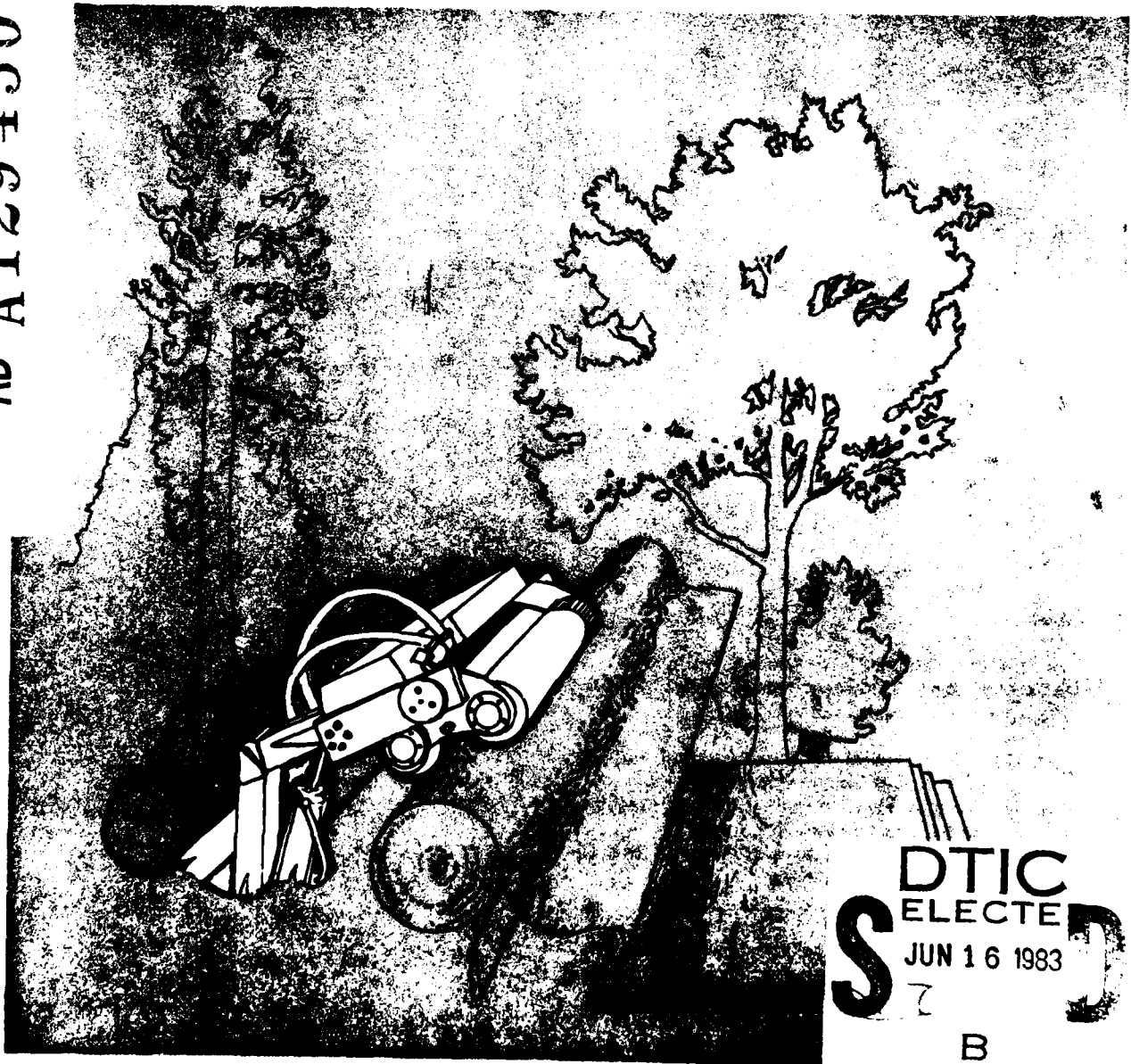
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Laboratory Performance of a Powered Back-up Roll for Peeling Veneer



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Abstract

The performance of a prototype powered back-up roll (PBR) for peeling veneer was evaluated at the Forest Products Laboratory. The torque which the PBR supplied to a veneer bolt was measured while peeling veneer of different species and thicknesses.

The PBR provided up to 100 percent of the required torque for 4-foot bolts and has the potential to virtually eliminate the spin-out problem. The PBR will also allow peeling to smaller cores, and the peeling of logs once thought "unpeelable."

The net result of implementing this new technology will be a significant increase in veneer yield from the timber resource.

Note

This paper is the third in a series of four papers describing the FPL powered back-up roll. The other Research Papers are:

FPL 427 Influence of Chuck Design on Spin-Out Torque
in Softwood Veneer Peeling Blocks

FPL 428 Powered Back-Up Roll—New Technology
for Peeling Veneer

FPL 430 Industrial Performance of Powered Back-Up
Roll for Peeling Veneer

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United States
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Paper
FPL 429

October 1982

Laboratory Performance of a Powered Back-up Roll for Peeling Veneer

By
STEPHEN P. LOEHNERTZ, Research General Engineer

Introduction

Every year an estimated 700 million cubic feet of wood are consumed to produce veneer. This amount is equivalent to 10 million logs averaging 32 feet in length and 20 inches in diameter. If all of the plywood that could be produced from this veneer were stacked in 4-by 8-foot sheets, the stack would be over 4,000 miles high. The magnitude of these numbers underscores the importance of obtaining the maximum yield of veneer from the available timber supply. Actual use of plywood accounts for 13 percent of the total volume of all wood products, and 33 percent of the total value.

In conventional veneer peeling, a log is rotated against a fixed knife by means of chucks embedded in the ends of the log. Three major problems that limit veneer yield are associated with this conventional peeling method: (1) spin-out, (2) large core size, (3) unpeelable logs.

Spin-out occurs when the torque required to turn the log exceeds the amount that can be transmitted by the chucks. The wood at the ends of the log fails, and the chucks spin freely. With dual chucks, spin-out may occur when the large outer chuck is retracted. It is estimated that the spin-out rate is 5 to 8 percent at U.S. veneer plants.

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

²Italicized numbers in parentheses refer to literature cited at end of this report.

The size of the log core remaining is determined by the size of the chucks. Core size can be reduced by using smaller chucks, but only at the risk of increasing the spin-out rate. The use of dual chucks is a compromise solution to the problems of spin-out and core size. It reduces the chance of a spin-out, while providing a smaller core than would be attainable by using a single chuck.

Logs with bad centers are considered unpeelable because they cannot be adequately gripped by the chucks. As a consequence, these logs are relegated to sawtimber, or to the chipper, or are left in the woods. It is estimated that 25 percent of all logs from the woods now fall into this category.

New Technology for Peeling Veneer

The Forest Products Laboratory (FPL) powered back-up roll (PBR) was designed to reduce or possibly eliminate the preceding problems (fig. 1). It provides auxiliary torque for peeling veneer by means of hydraulically powered rollers in contact with the surface of the log (figs. 2,3). The rollers assist the chucks in turning the log and thus reduce the torque that the chucks must provide. A hydraulic cylinder holds the PBR in contact with the log at a constant force (fig. 1). Detailed information on the design of the PBR is contained in a previous report (7).²

Objective

→ The objective of this study was to determine the effectiveness of the PBR in providing auxiliary torque

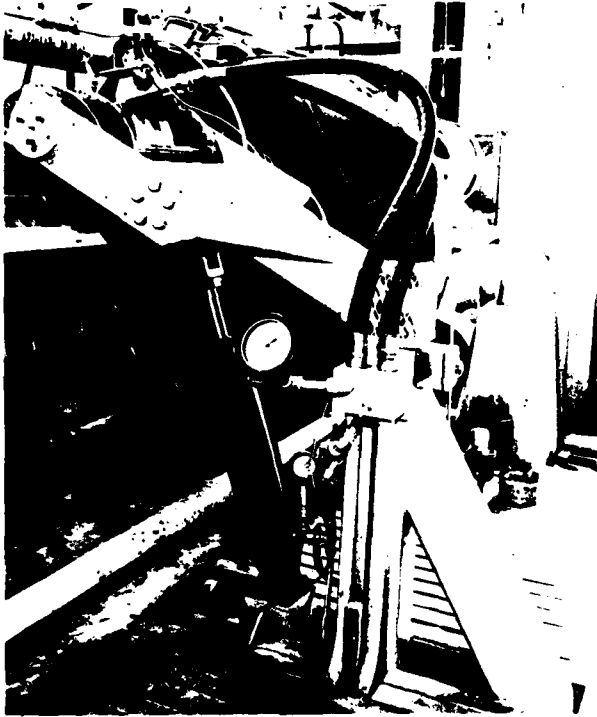


Figure 1.—FPL powered back-up roll—side view showing frame and hydraulic positioning cylinder.

(M150 229-10)

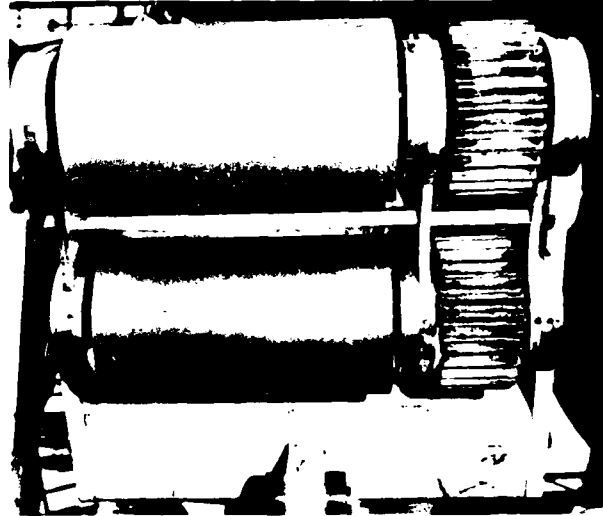


Figure 2.—View of rollers from bottom.

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Figure 3.—View of FPL powered back-up roll resting on log.

(M150 134-5)

to a veneer bolt. Specific goals were to:

1. Measure the torque provided by the PBR in peeling veneer of different species and thicknesses. These were Douglas-fir and red oak, 1/32 inch and 1/10 inch each; and white fir, 1/8 inch and 3/16 inch.
2. Evaluate the quality of veneer peeled using the PBR by examining uniformity of thickness, surface smoothness, and surface appearance.
3. Evaluate roller coating material for friction characteristics, wear, and compatibility with wood.
4. Develop optimum control criteria for the PBR to provide detection and correction for roller slip and deflection of the log. ←

Procedure

Measurements

Torque was measured on the lathe using strain gages mounted on one of the spindles. Gages were installed in such a way that they responded only to a torsional load. The log was driven by one chuck only which was mounted on the spindle with the strain gages. The other chuck freewheeled on bearings and provided no torque to the log, but helped hold the log in position.

By providing all the torque from one spindle instead of two, the output signal from the strain gages was larger in magnitude and less affected by electrical noise.

The measured torque was the torque actually provided by the lathe. A value for the PBR torque was obtained indirectly as the difference in torque readings between regular peeling and peeling with the PBR.

All logs were peeled both with and without the PBR, in an alternating fashion. A typical procedure would be to begin peeling a log without the PBR and get a torque reading, then apply the PBR and get another reading.

alternating back and forth, until the log was used up. The traces then showed the difference in spindle torque for the two methods and this difference was the PBR torque contribution. A position transducer was used to indicate the location of the knife, and thus the log radius at any point during the peeling process.

The pressure drop across the hydraulic motor powering the rollers was measured using a pressure transducer (fig. 4). The torque output of the hydraulic motor is very nearly proportional to the pressure drop. Experimental traces of the spindle torque and motor pressure were produced on a two-channel x-y plotter. The input to the x-axis was log radius. In this way graphs of torque and pressure versus radius were obtained.

Log Preparation

Logs were cut to a standard length of 50 inches, with the cutoffs used for ring counts and specific gravity determination. Information on log properties is summarized in table 1. A notch was made in the end of each log to serve as a revolution marker.

All logs were stored in a cold water tank at about 50° F. The Douglas-fir logs were peeled at this temperature. The red oak and white fir logs were heated at a water temperature of 140° F for 24 and 48 hours, respectively, prior to peeling.

Results

Torque Data

The test results demonstrated that the PBR is capable of providing a substantial amount of the torque required for peeling veneer. Theoretically, the required torque is a linear function of radius, if the cutting forces remain constant. Thus, the required torque at a log radius of 10 inches is double that at a 5-inch radius. Figure 5 shows the general idealized form of the torque curve, measured at the spindle, for peeling with and without the PBR.

Ideal logs with a homogeneous composition would give the smooth line results as shown. Real logs have knots and irregularities that cause the torque to fluctuate about some average value. The torque contribution of the PBR was computed from the change in the average values. Some data for average required torque are given in table 2.

The PBR provided 100 percent of the torque to peel 1/32-inch and 1/16-inch Douglas-fir veneer, and 85 percent for 1/10-inch Douglas-fir veneer. No change in the required torque was observed with respect to the transition from fast growth to slow growth wood.

The PBR contributed 70 percent of the required torque for 1/10-inch red oak, less than required for Douglas-fir but not surprising in view of the differences in density for these species. The PBR easily contributed 100 percent of the torque for 1/32-inch veneer.

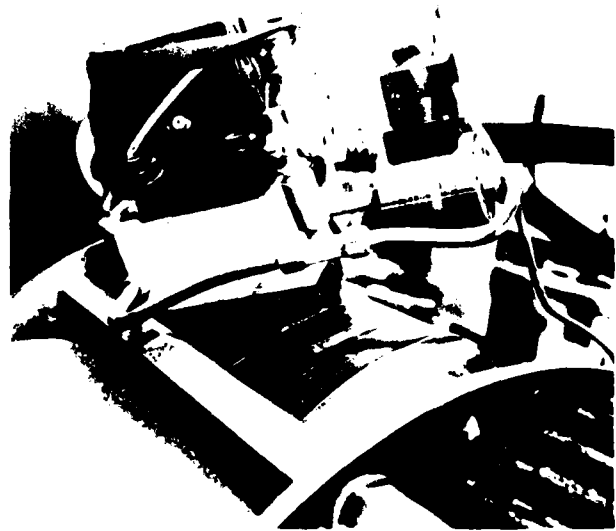


Figure 4.—Top view of motor, showing servovalve and pressure transducer.

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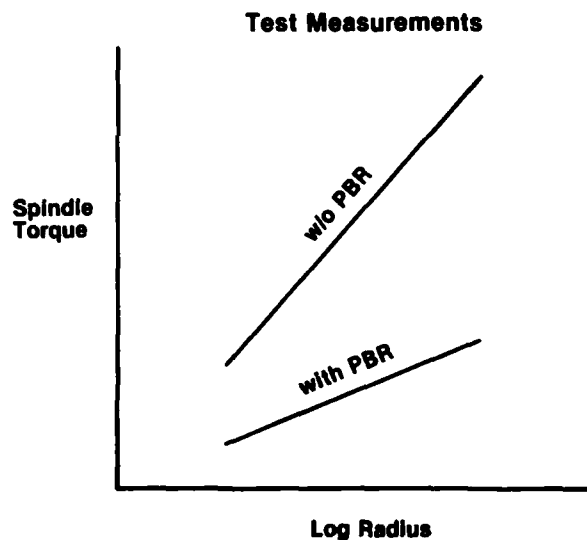


Figure 5.—Generalized torque curves.

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PBR performance with white fir, however, was degraded somewhat by roller slip. The percent of torque contributed was approximately 35 to 40 percent for both 1/8-inch and 3/16-inch veneer. The 3/16-inch veneer was peeled looser than the 1/8-inch veneer so the required torque was approximately the same for both. Normally it increases for thicker veneer. PBR torque results are summarized in table 3.

Roller Coating

The material used for the roller coating was Dupont Adiprene[®], a urethane rubber material. Adiprene[®] bridges the gap between plastic and rubber, and is resistant to water, oil, abrasion, and high temperature. This roller coating proved very compatible with wood, and showed no signs of wear at the conclusion of testing.

Contact area between the rollers and log ranged from 12 to 24 square inches, depending on log size and the pressure between the rollers and log. The static coefficient of friction of the rollers against the log was computed by taking the ratio of the transmitted force to the normal force. This value ranged from 0.5 to 0.8. It is believed that the lower value of the coefficient of friction was caused by the log being dried out on the surface. With a dry log the roller tended to load up with slivers of wood, and slip. This did not occur with a green log. In any case, a small increase in the normal force compensated for the dried log and eliminated the tendency to slip. In comparison, the static coefficient of friction for steel against green wood is approximately 0.17.

Pitch pockets were a minor problem with the old growth Douglas-fir. Pitch collected in patches on the rollers, but did not cause slip. Some slivers adhered to the pitch on the rollers, but no significant buildup occurred. The pitch was easily removed with a soap solution of trisodium phosphate. Solvents however, were not used for cleaning because they would have harmed the coating material.

The roller coating performed very well with the red oak logs, and the rollers stayed very clean during this part of the testing. The computed coefficient of friction for these logs was 0.55.

Roller coating performance was poorest with white fir where slip occurred, at the settings used for Douglas-fir and red oak, due to excess water given off by the logs. This water release was apparently due to the method of conditioning, a hot water soak at 140° F for 48 hours. This soaking time is excessive by industry standards. Plants visited by the author where this species is peeled have relatively dry logs, with no excess water given off during peeling. The coefficient of friction for white fir was computed to range from 0.25 to 0.55. As with the red oak, the rollers remained clean.

Controls

A manual control system was used for testing. The force holding the rollers against the log, i.e., the normal force, was controlled by adjusting the pressure in the hydraulic positioning cylinder. The torque applied to the log by the rollers was controlled by adjusting the pressure to the motor powering the rollers.

Roller Slip

Due to the slow rotational speed of the lathe, slip was detected visually. When it occurred, the pressure

measured at the hydraulic motor dropped instantaneously to almost zero, since the rollers were turning freely without resistance. This instantaneous change in the motor pressure showed up dramatically on the x-y plotter as a vertical line cutting across the entire page, which is a secondary means of detecting slip. In an industrial situation it would be desirable to directly measure and compare the surface speeds of the log and rollers in order to detect slip.

The control logic for dealing with slip is shown in figure 6. This process applies whether the system is in manual or automatic mode. If slip occurs, two corrective actions can be taken. First, the position cylinder pressure, or normal force, can be increased. This change increases the traction between the rollers and the log. Second, the pressure to the hydraulic motor can be decreased, which reduces the roller turning effort and makes them less likely to lose their grip. Both corrections can be made automatically, using a speed error (slip) signal to regulate a valve that controls pressure.

Log Position

There are limits on the magnitude of normal force that the rollers should apply to the log. Excessive force will accelerate wear of the roller coating, and possibly cause indentation of the log surface. More importantly, excessive force could cause bending of the log toward the knife, especially at small core diameters, resulting in nonuniform veneer thickness and irregularly shaped cores. In the same manner, insufficient normal force would allow the log to bend away from the knife, with similar results.

The allowable range for normal force with respect to log deflection was not established during the test program. Due to the experimental setup the minimum core size attainable during testing was limited to a 7-inch diameter. A 7-inch core on a 4-foot bolt is approximately 30 times as stiff as an industrial core 8 feet long and 5 inches in diameter. Thus, any deflection that occurred was not observed. It should be noted that

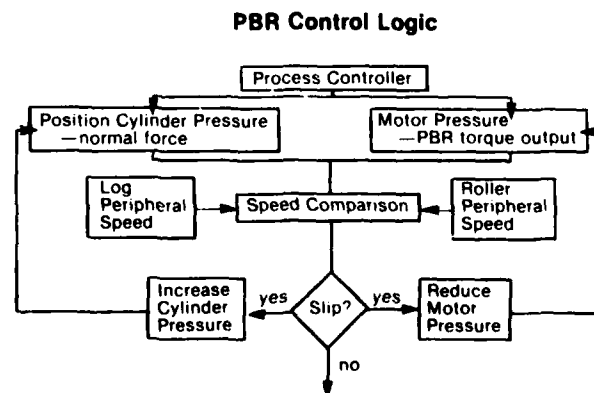


Figure 6.—PBR control logic process.

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because the torque required to peel veneer decreases as the log diameter decreases, the primary function of the PBR could change from providing torque to providing position control. PBR operating variables are given in table 4.

Veneer Quality

Veneer was evaluated for uniformity of thickness, surface smoothness and appearance.

Thickness

A sheet of veneer cut from one revolution of the log was saved for each segment of the peeling of a log. (Each log was peeled with and without the PBR, in alternating segments.) Each veneer sheet was measured in nine locations by a pneumatic actuated dial indicator: at the four corners, along the edges midway between the corners, and at the center of the sheet. Several readings were made in the general vicinity of each location to get a representative value.

Veneer peeled with the PBR tended to be thicker than regularly peeled veneer by 0.001 to 0.004 inch. This difference is shown in figure 7 for two typical logs. In both cases thickness is plotted as the difference between the actual peel and the lathe feed. Apparently the PBR displaced the log slightly and thus affected the veneer thickness. Adjustments in lathe settings could correct for such displacement. There was no evidence of the type of log deflection (bending) discussed previously.

Surface

Veneer peeled with the PBR was indistinguishable in appearance from veneer peeled the regular way. The rollers left no marks on the surface, except when they occasionally slipped. Slip produced slight scuffing and, infrequently, a skid mark. It was determined that light sanding would easily remove any marks.

Discussion

The results of the test program show that the PBR is very effective in providing auxiliary torque to veneer bolts. This success implies that the PBR has the potential to greatly reduce the magnitude of the spin-out problem, and to allow use of smaller chucks. The PBR may also make it possible to peel so-called unpeelable logs, such as those with soft, or partially hollow centers.

The PBR developed by FPL has generated considerable commercial interest. In February 1981 FPL entered into an agreement with the Boise Cascade Corporation to install an industrial version of the PBR in their Yakima, Washington plant. This plant peels a high percentage of white fir logs and spin-out has been a problem. As noted earlier, the PBR provided 35 to 40 percent of the required torque when white fir was peeled in the FPL experiments. Because this work was affected by the excess water released by the logs used, it is expected that actual in-plant performance will surpass 40

Table 1.—Material properties

Species	No. of logs	Roundup diameter, ¹ range in.	Ring count, range	Specific gravity
West Coast Douglas-fir	12	23-27	230-300	0.41
Northern red oak	6	14-15	80-100	.53
White fir	22	10-20	58-222	.36

¹Diameter after peeling off the irregular surface.

Table 2.—Average required torque (ft-lb)

Radius in.	1/10 in. Douglas-fir	1/10 in. red oak	1/8 in. white fir
4	630	760	650
6	1,000	1,380	1,020
8	1,380	1,600	1,380
10	1,760	(1)	(1)

¹These logs were smaller than a 10-inch radius.

Table 3.—PBR performance for 4-foot logs

Species	Veneer thickness in.	No. of logs	Total number torque readings ¹	PBR torque pct
Douglas-fir	1/32	3	38	100
	1/10	9	40	85
Red oak	1/32	3	16	100
	1/10	4	8	70
White fir	1/8	17	56	35-40
	3/16	5	(2)	(2)

¹Readings taken as follows: regular peeling, PBR peeling, regular, PBR, etc., for any log.

²Regular peeling only, continuous readings.

Table 4.—PBR operating variables

Species	Veneer thickness in.	Normal force lb	Motor pressure lb/in. ²
Douglas-fir	1/32	2,100	1,500
	1/10	2,900	2,500
Red oak	1/32	2,100	1,800
	1/10	2,700	2,500
White fir	1/8	2,900	1,500

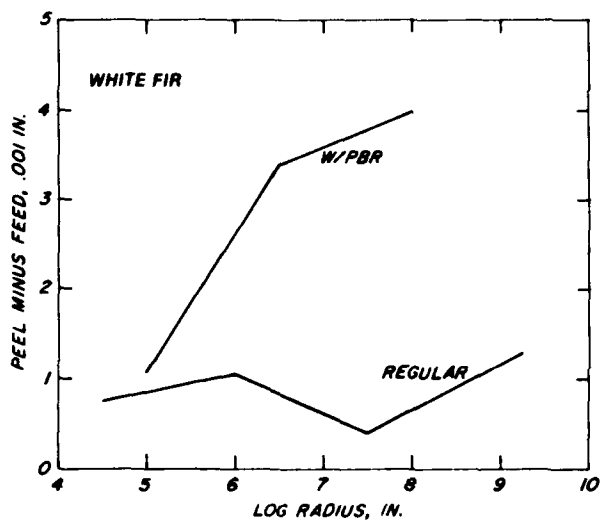
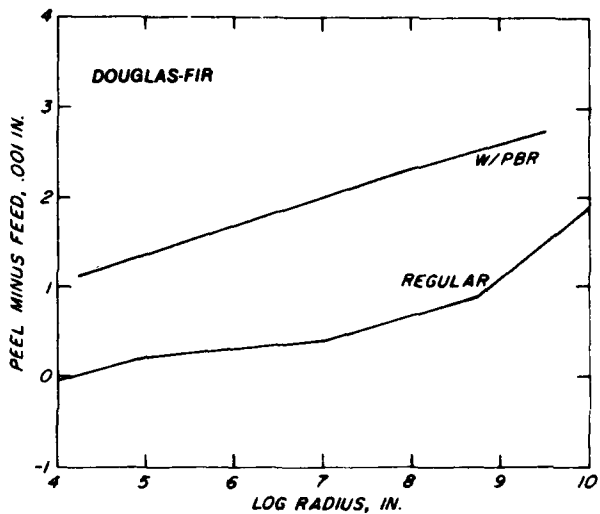


Figure 7.—Veneer thickness for Douglas-fir log No. 3, 1/10-inch veneer and for white fir log No. 13, 1/8-inch veneer.

percent. The Boise Cascade PBR will be designed and built by Premier Gear and Machine Works, Portland, Oreg. The controls system will be developed by Lloyd Controls. Performance of this industrial prototype will be closely monitored by both Boise Cascade and FPL personnel. A joint test program will be conducted, and a report published upon the completion of testing.

Literature Cited

1. Fronczak, Frank J.; Loehnertz, Stephen P. Powered back-up roll—new technology for peeling veneer. USDA For. Serv. Res. Pap. FPL 428, For. Prod. Lab., Madison, Wis.; 1982.
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Laboratory Performance of a Powered Back-up Roll for Peeling Veneer, by Stephen P. Loehnertz, Madison, Wis., FPL 1982.

7 p. (USDA For. Serv. Research Paper FPL 429).

Evaluates performance of a prototype powered back-up roll at the Forest Products Laboratory. The net result of implementing this new technology will be a significant increase in veneer yield from the timber resource.

Keywords: Powered back-up roll, veneer peeling, spin-out, veneer yield, veneer quality, resource recovery, chucks, core size, rollers, torque output.

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