Overcoming warp in studs produced from southern pine of 38 small diameter is a problem. This wood utilization technologist proposes here a process for a small plant to convert cordwood—8-foot stock—into marketable studs

Straight studs are produced from southern pine cordwood

By PETER KOCH

Southern Forest Exp. Station
Forest Service, U. S. D. A.
Alexandria, Louisiana

A PROCESS for converting southern pine veneer cores into 8-foot 2 by 4's of SPIB Stud grade and better has been developed at the Alexandria, Louisiana, Utilization Laboratory of the Southern Forest Experiment Station. The research leading to this development suggests that a similar process would be practical for converting 8-foot southern pine cordwood into studs—two studs from every stick. (Photo right).

In the interest of simplicity, it will be assumed that cordwood can be procured in a very limited diameter range —from a minimum of 5¼ inches inside bark at the small end for very straight bolts, to a maximum of 6-¾ inches for straight bolts or slightly larger for crooked bolts.

Southern pine in this diameter range probably averages less than 4 rings per inch. The specific gravity is lower than normal. The lumber warps severely during drying, because juvenile wood is always present and there is likely to be considerable compression wood.

Because of the low ring count, 2 by 4's cut from such wood can at best qualify for Stud grade. This grade, as defined by the Southern Pine Inspection Bureau, has stringent warp limitations: The maximum allowable deviations over an 8-foot piece are $\frac{3}{4}$ inch for crook, $\frac{7}{8}$ inch for bow, and ¼ inch for twist.

The objective of the research at Alexandria was to devise a manufacturing process by which bolts containing high proportions of juvenile and compression wood could be made to yield straight studs.

Seven unconventional manufacturing processes were evaluated on southern pine veneer cores, which have most of the characteristics of bolt wood. Three of the processes succeeded in holding all studs within the warp limitations of the Stud grade. One of them appeared most suitable for converting 8-foot boltwood. In this process, warp is controlled by center-ripping the green bolt, then debarking the halfbolts and blanking them oversize on a surfacer-edger that removes excess wood in the form of pulp chips. The oversize stud blanks are then kiln-dried, after which all distortion is removed by face-jointing and thicknessing, followed by straight-line ripping.

Prototype studs were all Stud grade or better. Approximately 12 percent were SPIB #1; 15 percent, SPIB #2; and 73 percent, SPIB Stud. Immediately after machining (at 10-percent moisture content), crook averaged 0.05 inch, and twist and bow averaged 0.06 and 0.17 inch. When moisture content of these studs was reduced to 8 percent after machining, crook twist, and bow increased to 0.16, 0.12, and 0.32 inch. When moisture content was increased to 20.1 percent, crook, twist, and bow were 0.17, 0.11, and 0.22 inch.

When trimmed to 96 inches, the experimental studs weighed 10.23 pounds at 9-percent moisture content. Weight per MBF was 1,920 pounds. The studs averaged 3.8 rings per inch, with about 41 percent having 4 or more rings per inch. Their low specific gravity and low ring count made them somewhat weaker than southern pine studs in general. At 9-percent moisture content average ultimate strengths were 5,790 pounds per square inch in edgewise bending, 4,290 p.s.i. in full-length compression, and 3,500 p.s.i. in full-length tension. Modulus of elasticity averaged 1,280,000 p.s.i.

The sample was limited. More testing might disclose higher average values for specific gravity and strength. In any event, the strengths reported are more than adequate for loads imposed on studs.

ECONOMIC FEASIBILITY

Assessing the economic feasibility of the manufacturing system requires some assumptions about markets and costs. At the outset, it is assumed that studs can be sold FOB mill at an average price of $75 per thousand board feet after all discounts and commissions. Green pulp chips from the chipping headrig should bring $6.30 per ton and dry planer shavings $5 per ton FOB mill. Bark, green sawdust from the bandsaw, and fines from the chipper would be burned or trucked away.

As has been mentioned, the incoming bolts are assumed to cost $0.50 apiece. Gas for the direct-fired kiln, wax emulsion with preservative and dye, and electricity are assumed to cost $1.50, $0.30, and $2.50 per thousand board feet of studs produced.
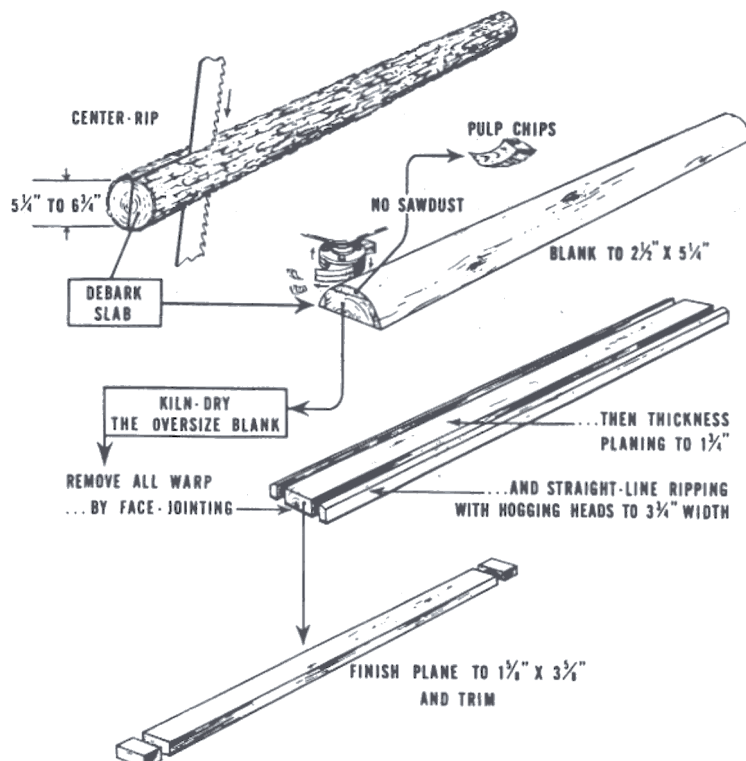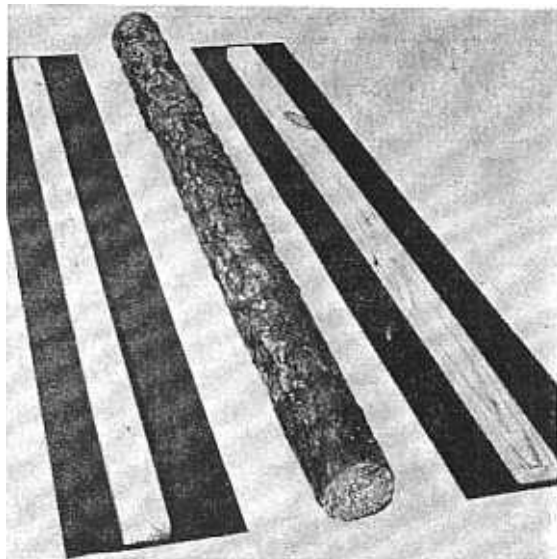
Manpower is estimated as follows: 1 log unloader, 1 bandsaw feeder, 1 barker-blanker operator, 1 stacker operator, 1 forklift operator, 1 facing-planer operator, 1 planer offbearer, 1 roustabout, 1 filer and machine setup man, and 1 maintenance man. Thus, the direct labor requirement is 80 man-hours per operating day. As output is 30,720 board feet per day, approximately 2.6 man-hours are required for the manufacture of each 1,000 board feet of studs. Supervisory staff, clerical help, and watchman would be in addition to this direct labor.

Total capital requirement is estimated at $425,000: $100,000 in working capital and $325,000 in plant and equipment.

In Table 1, the various technological and economic assumptions are organized to indicate the annual operating costs and returns. The table indicates annual sales of $613,763 and annual profits before income taxes of $82,191 or 19.3 percent on the invested capital.

CENTER-RIP

5¼" TO 6¾"

DEBARK SLAB

PULP CHIPS

NO SAWDUST

BLANK TO 2½" X 5¼"

KILN-DRY THE OVERSIZE BLANK

REMOVE ALL WARP ...BY FACE-JOINTING

...THEN THICKNESS PLANING TO 1¾"

...AND STRAIGHT-LINE RIPPING WITH HOGGING HEADS TO 3¾" WIDTH

FINISH PLANE TO 1⅜" X 3⅝" AND TRIM

The tests on veneer cores yielded more data on warp, grade yield, and strength than can be presented in this article. The information has been published as Research Paper SO-25 of the Southern Forest Experiment Station (701 Loyola Avenue, New Orleans, Louisiana 70113), and is available on request.

The production process. The process developed for manufacturing studs from 100-inch cordwood is summarized in the expanded-view drawing, right, above. The plant is planned to operate a single shift 5 days a week. It would have a sustained output of 16 studs per minute for 360 out of the 480 minutes—that is, 5,760 studs (2,880 bolts) per day. In addition to the 30,-720 board feet of studs, 12 tons of green pulp chips and 29 tons of dry wood waste—principally shavings— would be made daily. About 25 tons of bark and 3 tons of green sawdust would be accumulated daily. These quantities are calculated on the assumption that the bolts are 100 inches long and average 6 inches in diameter at the small end, inside bark.

Commercial machinery is available to perform each step of the operation, although the machines have not previously been combined in the sequence described here. The estimated plant cost is $325,000. Estimates of returns and of other costs will be found at the end of this article.

Because the mill value of each 8-foot bolt within the narrow range of acceptability (5¼ to 6-¾ inches) is determined by the pair of studs each will yield, the mill operator could buy at a flat price per stick. For instance, a flat price of $0.50 per bolt would work out to approximately $24 per cord for sticks measuring 6 inches outside bark and $16 per cord for sticks measuring 7 inches outside bark. Since the pair of studs cut from each stick contains 10-⅔ board feet, the price of $0.50 per stick amounts to a raw-material cost of $46.86 per thousand board feet of studs produced.

Scaling and storing. Daily input would be approximately 75 cords. Because payment would be by stick count, a photograph of both ends of each load would permit tallying in the office— and reduced payment for undersize bolts. One man operating a forklift with top tongs would be able to unload incoming trucks and pile the wood in windrows along one side of a log haul designed to move the bolts in endwise procession.

Center ripping. From the log storage piles, one man would manually roll eight bolts per minute into the endwise procession flowing through an unattended self-centering band ripsaw feeding at 80 feet per minute. The log roller would eject the occasional over-

size and undersize bolts into separate storage racks ranged along the side of the conveyor opposite the incoming storage. The bolts would be resold without further processing—the small ones as pulpwood, the large ones to conventional mills for conversion to lumber or veneer.

Debarking and sizing green blanks. On emergence from the ripsaw, each half-bolt would be automatically turned face down and then moved transversely to a planer-type automatic feeding table to again get the half-bolts in endwise procession flowing at 130 feet per minute. The half-bolts would proceed via a self-centering channel to a slab barker and then through a dip-chain straight-line ripsaw (or a modified surfacer-edger) equipped with top infeed rolls capable of accommodating half-bolts ranging in thickness from 2 to 5 inches. A single top chipping head mounted on the saw arbor would profile each core to a thickness of 2-½ inches and a width of 5¼ inches. The profiled cutterhead would carry only two knives and would rotate with the feed at 1,040 r.p.m. to yield chips ¾ inch long. Alternatively, the surfacer-edger could be equipped with three chipping heads— one at the top and two at the sides. Chips would be conveyed into freight cars or vans. One man would monitor this debarking and sizing operation.

Stacking green blanks. Green blanks, 2½ inches thick, 5¼ inches wide, and approximately 100 inches long would be discharged to a sideways conveying table at a rate of 16 per minute and would proceed to a fully automatic stacker capable of building and discharging one 4-foot-square stickered package every 8 minutes. This packaging assumes 9 stud blanks per course, ¾-inch stick thickness (5 sticks per course), and 14 courses per package— i.e., a total of 126 blanks or 672 board feet per package. One man would monitor the stacker operation at all times and would fill the stick hoppers. Each of the 5 hoppers would discharge approximately 98 sticks per hour.

A 75-foot storage chain would be required. It would hold eight packages (approximately 1 hour's production), and would have built-in bunks to enable it to be serviced efficiently by forklift.

Kiln drying. The fork-lift operator would periodically (at least every hour) remove the stickered packages of green stud blanks from the storage chain and would side-charge a series of direct-gas-fired kilns equipped with humidity controls. Each kiln would hold 22,680 board feet—i.e., 36 packages side-loaded 4 deep, 3 high, and 3 long. If the drying schedule is conservatively estimated at 7 days, then 7 kilns would be required.

Face-jointing and straight-line ripping. It is proposed that kiln-dry stud blanks be mechanically unstacked onto a feed table for a 30-inch-wide facing planer. Perhaps half the blanks would go directly through the left side of the planer for facing and thicknessing to 1-¾ inches. Badly bowed blanks would be fed through the right side of the planer for repeated facejointing via a merry-go-round conveyor until within one pass of a complete facejoint, at which time they would be fed through the left side of the machine. On rare occasions the operator might saw a foot or so off a badly warped end to facilitate jointing.

The top thicknessing cutterhead would extend only across the left 12 inches of machine width. The left side of the machine would discharge directly onto a self-centering table feeding a 2-saw dip-chain straight-line rip-saw set for 3¾-inch width. The saws would be integral with cutterheads de-

signed to hog the edgings as produced.

Sixteen stud blanks per minute would be discharged.

Double-end trimming, finish planing, edgemarking, and spraying. The partly machined straight blanks emerging from the ripsaw would be automatically double-end trimmed to 96-inch length. Cutterheads mounted directly on the two trim saws would hog the trim ends. Trimmed blanks would drop automatically into a hopper feeding a 4-head planer and matcher at 130 lineal feet per minute. The man feeding the face jointer would pace himself to maintain a butted flow through the matcher.

Suitable edge markings would be applied to each stud while it was still in control of the matcher feedworks, and a spray chamber at the outfeed end would apply preservative and water repellent emulsion combined with a distinctive dye.

Grading and shipping. The matcher would discharge sixteen 96-inch studs per minute into the top of a hopper feeding a lugged transverse conveyor chain. A grader stationed at the beginning of this conveyor would grade-

mark each stud. Virtually the entire output would be SPIB Stud grade and better, and would proceed through a normally idle double-end trimmer to a fully automatic stacker capable of building and discharging a solid-piled package every 30 minutes. Each package would be stacked 13 wide and 29 high to contain 377 studs (2,011 board feet).

A few studs would have defective ends. Such of these as could be upgraded by trimming a few inches from one or both ends would be pulled by the grader into temporary storage immediately behind the grading station. They would be re-introduced to the conveyor on those days when the double-end trimmer was in operation and would be cut to some specified shorter length for which orders were available—7 feet 6 inches, for example. Each saw would carry its own hogging head to dispose of the trim ends.

Inevitably a few rejects would be produced. These would be stacked by the grader in forklift packages on two wheeled trucks—one for cut-up or factory grade and the other for rip grade from which the customer could recover a 2 by 3. ∎

Table 1

Estimated annual operating results[1]

Net sales		
7,465 M board feet of studs at $75 per M		$559,875
Pulp chips from 699,840 bolts at $0.026 per bolt		18,196
Dry wood waste at $0.051 per bolt		35,692
Net sales		$613,763
Cost of sales		
Raw materials		
699,840 bolts at $0.50 per bolt	$349,920	
Gas for kiln-drying 7,465 M at $1.50 per M	11,198	
Power at $2.50 per M	18,663	
Spray material at $0.30 per M	2,240	
		382,021
Direct labor, 2.6 man-hours per M at $2.15 per hour		41,804
All manufacturing overhead (except depreciation) plus all general and selling overhead at 180 percent of direct labor (1.80) ($41,804)		75,247
Depreciation $325,000 over 10 years		32,500
Cost of sales		531,572
Profit before income taxes		$ 82,191

[1] Assumes 2,880 bolts per shift, 1 shift per day, 243 working days per year.