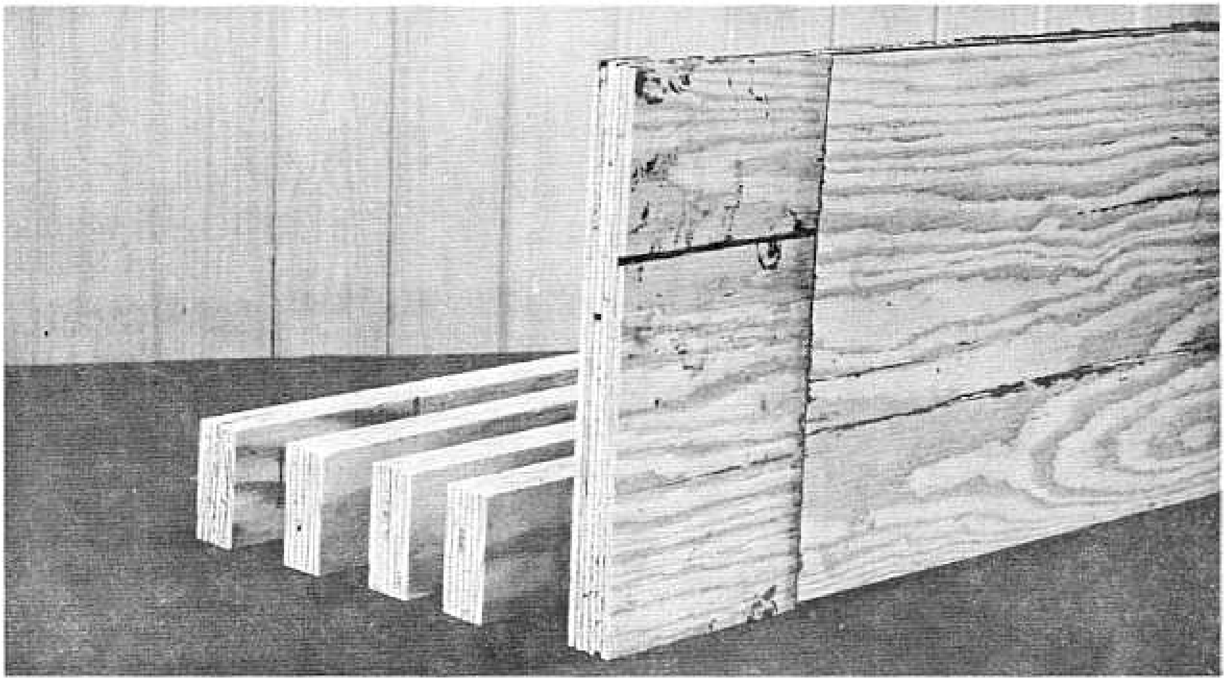

Planks comprised of six parallel-bonded, ¼-in-thick, butt-jointed veneers were smooth-ripped to yield four pieces with net widths of 3.5 in. Faces were neither sanded nor planed, and edges were left as ripped. Butt joints were set in a repetitive stepwise pattern. In production, slabs would be 4-ft-wide, rather than 15-1/8-in pictured.

Structural lumber promising from 1/4-inch southern pine veneer

Laminated lumber may represent a more profitable use than plywood from peeler blocks

By PETER KOCH, Southern Forest Experiment Station, USDA Forest Service

PINEVILLE, LA.–The possibility of laminating lumber from sliced or rotary-cut veneer has interested researchers and industrialists for many years because of the potential for increased yield and uniformity of strength. Some data on such lumber are now available.

The study reported here is the latest in a series aimed at evaluating the properties of structural wood laminated from thick southern pine veneers. The work began in 1963, and much of it was summarized in *Research Paper SO-30*, published in 1967 by the Forest Service, Southern Forest Experiment Station, New Orleans, La.

The author is in charge of the Southern Station's wood utilization lab at Pineville, La. Recently published by the Forest Service was the two-volume definitive work, "Utilization of the Southern Pines", by Dr. Koch.

Central to the current study are three conclusions drawn from the earlier work:

- If laminae are thin, butt joints do not seriously weaken laminated wood.
- In joists or beams loaded with gluelines vertically arranged, modulus of elasticity is about average for the species when low- and high-grade laminae are mixed and placed randomly.
- Allowable bending stress averages highest if laminae are thin.

From this research, it became evident that there would be substantial advantages from making southern pine structural lumber by parallel lamination of wide sheets of rotary-cut veneer into slabs 1½ inches thick. The slabs could then be ripped to the net widths required for 2 by 4's, 2 by 6's, or larger members. In 1965 I manufactured a number of 12-in joists in this manner. They had 8 plies and were very strong and stiff.

Six-ply structural lumber formed

In the current experiment, nine 17-ft southern pine logs were randomly selected from a pile in central Louisiana and bucked into pairs. Grade of resulting 8-ft logs ranged from 1 to 3 by USDA Forest Service rules and averaged 1.5. Diameters ranged from 9.9 to 14.1 inches inside the bark at the small end and averaged 12 inches. Log specific gravity averaged 0.5 (ovendry weight, green volume).

One of each pair was sawn by band headrig and linebar resaw into 2 by 4's (net green thickness 1-13/16 inch). The other was peeled into 1/4-in-thick veneers clipped to widths of 15-1/8 inch. The veneers were air-dried to

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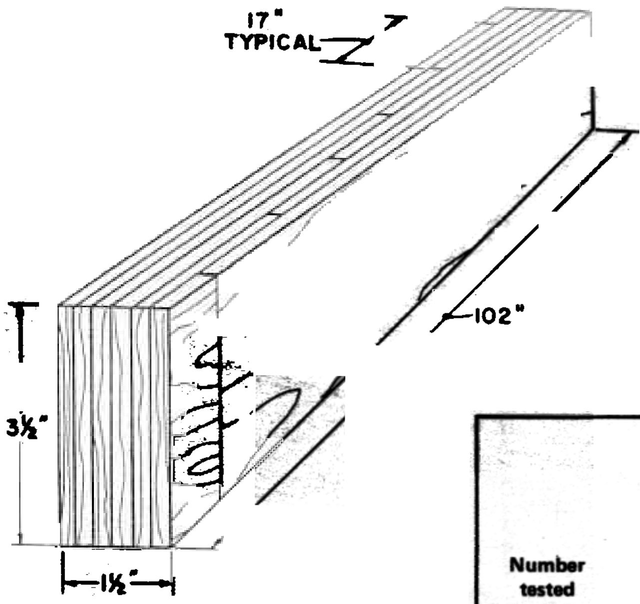

Butt joints were arranged in stepwise pattern designed to be repetitive every 102 inches, should lumber be fabricated in long lengths.

COMPARISONS—2 by 4's from three sources

Number tested	Source of joists	Modulus of elasticity (corrected for shear)	Modulus of rupture	Allowable fiber stress in bending
		------	p.s.i.	------
92	Laminated from ¼-inch veneer	1,950,000	9,310	2,660
57	Sawn from sawlogs	1,790,000	9,220	1,270
18	Sawn from veneer cores	1,500,000	6,260	910

(All values adjusted to 12% moisture content. Allowable stresses in bending are based on Natrella's 95% exclusion limit for modulus of rupture divided by a factor of 2.1.)

10% moisture content and cold-pressed with resorcinol glue into 6-ply slabs 102 inches long. Butt joints in each ply were spaced 17 in from joints in adjacent plies (see above). A pair of 2 by 4's was also sawn from each of the nine 5-1/4-in veneer cores to yield 18 studs from cores. All the sawn 2 by 4's were kiln-dried to 10% moisture content and planed to 1.5 by 3.5 inches.

The laminated slabs were smooth-ripped to 3.5-in width (see photo); thickness was that resulting from the pressing operation (1.40 inches). All 2 by 4's that were free of wane and rot were loaded on edge as joists and broken in bending. Most failed in tension, none in horizontal shear.

Yields and strengths are high

Lumber cut from the sawlogs scaled 117% of log scale (International ¼-in rule). Forty-one percent of the cubic volume in the logs ended as kiln-dry, end-trimmed, sized product.

Yield from the peeler logs (including the two studs cut from each core) was significantly higher, with lumber scaling 185% of International log scale. Moreover, 60% of the cubic volume of the logs ended as dry, trimmed, sized product.

The laminated 2 by 4's averaged stronger than the sawn 2 by 4's and were more uniform in strength. Average values for modulus of elasticity and modulus of rupture, together with allowable stress in bending, are shown in the boxed tabulation.

The 2 by 4's sawn from cores had strength values somewhat greater than required for SPIB Stud grade. Those from sawlogs had modulus of elasticity approximately equal to the species average for loblolly pine and an allowable bending stress corresponding to SPIB No. 2 Common. For laminated 2 by 4's, the modulus of elasticity was 1,950,000 p.s.i., a value exceeded only by the requirement for SPIB Dense Select Structural and No. 1 Dense grades (2,000,000 p.s.i.). Allowable fiber stress in bending for the laminated 2 by 4's (2,660 p.s.i.) equalled the values recognized by SPIB for the strongest structural grade of southern pine (2,650 p.s.i.).

Is it practical?

I propose that 6-ply laminated lumber be manufactured by a procedure that calls for no major innovation in equipment. All components in the process (except the layup equipment and charger for the hot press) have been proven in production.

Briefly, 3-ply panels would be built up from 8-ft lengths of ¼-in veneer. The panels would be formed with conventional phenol formaldehyde glues in an 8-opening hot press 32 feet long and 4 feet wide. The 8-ft veneers would be arranged with staggered butt joints to achieve the pattern shown in the drawing.

Pairs of these ¾-in panels would then be batch-pressed cold into slabs 1½ inches thick; a single phenol-resorcinal glueline would be required in each slab.

The slabs, 32 feet long and 4 feet wide, would be crosscut to desired lengths and smooth-ripped to standard lumber widths. A one-shift operation would turn out about 2,560 cu ft of dry, sized product daily. This cubic footage corresponds to about 45M bd ft of 8/4 structural lumber.

Cost of glue in the laminated lumber would be about $5.50/M bd ft, which compares to about $4/M sq ft for ½-in plywood of sheathing grade.

A thousand board feet of sized, dry dimension lumber (2 by 6, for example) contains about 57 cu ft of wood, while 1,000 sq ft of ½-inch plywood contains only 42 cu ft. If ½-in sheathing plywood is priced at $100/M sq ft, the laminated lumber would have to sell for $136/M bd ft to achieve equality in price per cubic foot.

Since the market price per M bd ft for most favored lengths, widths, and grades of southern pine structural lumber is usually about 50% higher than the price per M sq ft of ½-in sheathing plywood, it would appear that manufacture of laminated lumber might be more profitable than manufacture of sheathing plywood. ■