FPJ Technical Note

Further Trials of Roll-Feed, High-Temperature Dryers for 8/4 Southern Pine

Peter Koch

Abstract

Studs cut from veneer cores and dried by four configurations of roll-feeding mechanisms (for a continuous kiln like a roll-feed veneer dryer) were compared to conventionally stickered studs. Roll-dried studs averaged less crook (0.14 in.), bow (0.17), and twist (0.16) than those conventionally stickered (0.22, 0.26, and 0.34 inch, respectively). The data seemed to favor the dryer configuration in which studs were roll-fed on edge and guided by double low-shouldered rings, in that crook averaged least with this arrangement. The major disadvantage of all four of the roll-fed configurations tested is the necessity for accurately sizing each green stud in width and thickness before admitting it to the kiln.

A SUBSTANTIAL PERCENTAGE of 2 by 4 studs cut from southern pine veneer cores or small logs warp excessively when kiln-dried to 9 or 10 percent moisture content (MC). Warp can be significantly reduced by mechanical restraint during the drying process (Koch 1971). One practical way of applying restraint calls for a top load on each kiln stack to impress sharply toothed kiln sticks into each board (Koch 1974a). Another approach is to restrain studs individually between continuously turning pairs of rolls. An earlier report (Koch 1974b) described trials of a prototype continuous kiln with nine pairs of 4-inch-diameter, 34-inch-long, power-driven, smooth rolls spaced 12 inches

The author is Chief Wood Scientist and Project Leader, Southern Forest Expt. Sta., USDA Forest Service, Pineville, La. This paper was received for publication in September 1974.

apart. The studs – separated by fixed steel bars – were reciprocated linearly through an 18-inch stroke by a hydraulic device for reversing roll feed direction. A complete cycle (18 inches of forward and 18 inches of reverse motion) required about 1 minute. Four 5-inch-diameter air cylinders located at the corners of the top roll case applied force between roll pairs.

In this progress report, three additional configurations of roll-feed mechanisms are compared with the one previously tried. As Figure 1 shows, all three incorporated the restraining device in the rolls, thereby eliminating the fixed bars.

Methods

Factors in the experiment were four roll-fed arrangements (see Fig. 1):

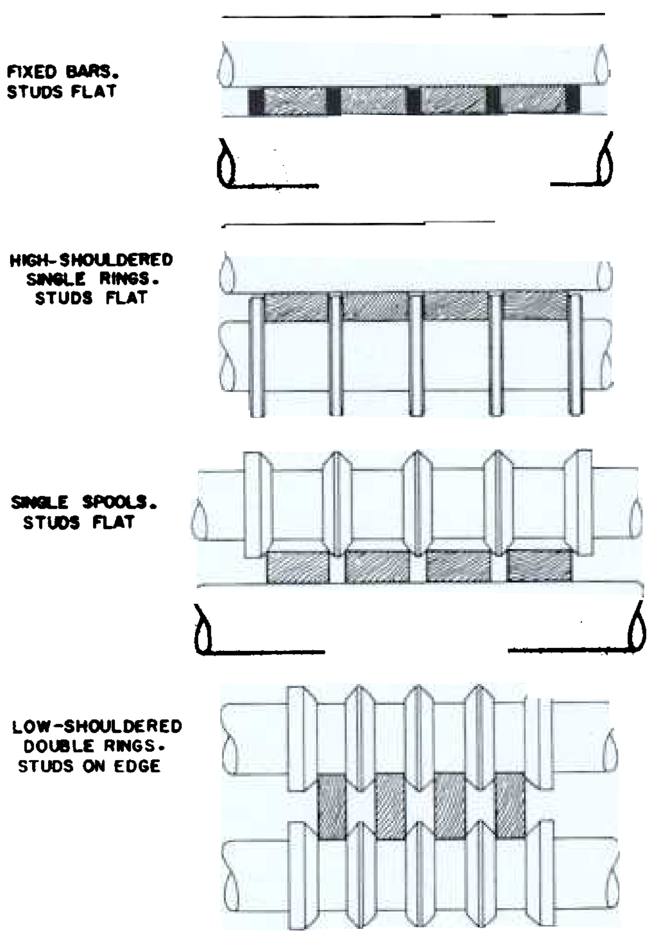

Figure 1. — Four configurations of restraining mechanisms in a continuous roll-feed kiln for studs previously sized green to width (3.82 in.) and thickness (1.74 in.). Rolls are 4 inches in diameter, all power driven, and arranged in pairs spaced 1 foot apart. *Top*: Fixed, cold-rolled steel guide bars measuring 3/4-inch by 1-1/2 inches in cross section and spaced 3.88 inches apart. *Second from top*: Lower rolls furnished with mild-steel rings 7/8-inch thick with outer diameter of 7 inches; rings are 3.88 inches apart. *Second from bottom*: Spool-like rings on upper rolls present a 45-degree beveled surface to top stud corners and thus maintain line contact as studs shrink in width and thickness. *Bottom*: Low-shouldered beveled rings (shoulder height 1/4-in.) fitted on both top and bottom rolls to guide studs on edge; rings are 6 inches in outer diameter and are spaced 1.76 inches apart.

1) Fixed bars, studs flat
2) High-shouldered rings on lower rolls, studs flat
3) Spools on upper rolls, studs flat
4) Low-shouldered rings on both top and bottom rolls, studs on edge

In treatments 1, 2, and 3, air pressure on the four 5-inch cylinders holding down the top roll case was 80 psi; in treatment 4, air pressure was reduced to 10 psi because the studs were fed on edge and had less bearing area in contact with each roll. Actual force per roll pair was difficult to estimate because the chain drive applied vectors additive to the squeezing force delivered by the cylinders.

Twenty-four kiln loads were dried to provide six replicates of each treatment. Loads contained four 8-foot 2 by 4 studs held by the roll-feed mechanism. In each of the first 14 loads, another lumber layer comprised of four 2 by 4's was dried conventionally stickered with a top load of 15 pounds per square foot – i.e., with a total top load of 160 pounds. Thus, 96 studs were dried under restraint between the rolls, and 56 were dried conventionally stickered.

The 152 studs were cut from southern pine veneer cores by a mill in central Louisiana. In preparation for kilning, all studs were trimmed to 96-inch length and surfaced S4S to 1.74-inch thickness and 3.82-inch width. Procedure for high-temperature kiln-drying (240°F), conditioning, and analysis of green and dry studs was identical to that described in a prior experiment with the roll-feed apparatus (Koch 1974b).

The green studs averaged 81.5 percent in MC and 19.0 pounds in weight. Crook, bow, and twist averaged 0.06, 0.11, and 0.08 inch. Specific gravity – on the basis of green volume and ovendry weight – was 0.46.

Results

Dry studs averaged 8.5 percent in MC, with range from 3.8 to 16.0 percent and standard deviation of 2.3 percent. Average weight on discharge was 11.6 pounds, with range from 8.8 to 14.9 pounds. Length shrinkage averaged 0.09 inch.

Studs fed on edge and guided by low-shouldered double rings averaged 9.4 percent MC, about a percentage point higher than those dried flat. This difference is attributable to air circulating across stud edges rather than faces as in the other configurations. Conventionally stickered studs had somewhat greater range in MC (3.8 to 16.0) than roll-dried studs (5.5 to 14.3).

Width shrinkage for conventionally stickered lumber and for lumber roll-dried flat by treatments 1, 2, and 3 averaged 0.12 inch with maximum of 0.20 inch; thickness shrinkage averaged 0.08 inch with maximum of 0.13 inch. For studs fed on edge (treatment 4), thickness shrinkage was least (0.05-inch average, 0.08-inch maximum), but width shrinkage was greatest (0.21-inch average, 0.31-inch maximum).

Warp varied significantly (0.05 level) with treatment. The roll-dried studs had less crook, twist, and bow than those conventionally stickered.

Studs roll-fed on edge had less crook, but more twist and bow, than those fed flat between high-shouldered rolls or fixed bars. Studs fed flat and restrained by single spools had more twist and bow than those dried by the other two roll configurations for flat feeding.

The data are summarized in Table 1.

Table 1. — WARP IN STUDS DRIED CONVENTIONALLY AND BY FOUR METHODS OF RESTRAINT[1].

Treatment	Crook	Twist	Bow
	— — — — —(in.)— — — — —		
Conventionally stickered	0.22 (1.01) *0.15*	0.34 (1.07) *0.25*	0.26 (0.98) *0.16*
Roll-fed			
Fixed bars, studs flat	.15 (.56) *.11*	.14 (.34) *.08*	.17 (.34) *.09*
High-shouldered single rings, studs flat	.15 (.48) *.11*	.09 (.23) *.05*	.11 (.38) *.07*
Single spools, studs flat	.14 (.60) *.11*	.20 (.70) *.14*	.18 (.65) *.12*
Low-shouldered double rings, studs on edge	.12 (.26) *.05*	.21 (.58) *.15*	.23 (.65) *.15*

[1]Maximum observed value is given in parentheses alongside each average, and standard deviation is in italics below.

Damage From Roll Mechanisms

Lumber roll-dried between fixed bars (fed flat) most closely resembled lumber conventionally stickered. Although smeared with resin on top and bottom surfaces, it had no mechanical damage.

The lumber restrained by rings showed varying degrees of mechanical damage. The high-shouldered rings tended to splinter lower corners of a few studs having a propensity to crook.

The spool configuration severely deformed upper corners of each stud, causing an unacceptable degree of bevel.

Double low-shouldered rings, with studs oriented on edge and air pressure to the roll-case cylinders cut from 80 psi to 10 psi (a force reduction of 5,495 pounds over the entire roll case), yielded lumber with minimal mechanical damage. The low shoulders were sometimes indented into the corners of studs that tended to twist or bow, but such damage could usually be eliminated by planing. Because stud faces were not in contact with the rolls, they did not have resin smears.

Feed Force

While feed force was not measured, it appeared to be substantially least when the studs were fed flat with high-shouldered single rings or when fed on edge with double low-shouldered rings.

Discussion

On balance, the results seem to favor the configuration in which studs are roll-fed on edge and guided by double low-shouldered rings. To avoid local crushing of the lumber, normal force exerted by each roll-pair on each stud should be low – perhaps as little as 25 pounds. With this arrangement and at about this force level, no studs had crook in excess of 0.26 inch when rough dry at 9.4 percent MC. Moreover, damage to the corners and surface was minor, and exuded resin was not spread over the surfaces. Power to turn the rolls appeared to be less than for any other configuration except possibly the high-shouldered single rings guiding studs fed flat. For a given length of roll-pair, more studs can be fed on edge than flatwise with corresponding gains in kiln capacity. Finally, with studs fed on edge, thickness shrinkage averaged only 0.05 inch.

Disadvantages of roll-feeding studs on edge between double low-shouldered rings include minor damage to corners of twist-prone lumber, an extra 1/10-inch of width shrinkage, and poorer control of twist and bow than when studs are fed flat. However, the grading rules appear to emphasize crook control since they allow only 1/4-inch of crook but 3/8-inch of twist and 1/2-inch of bow.

Because feed speed was about 180 feet per hour in this experiment, and kiln dwell time was 24 hours, each point on a stud was subjected to over 4,000 passes of the rollers. In a commercial design (assuming 240-foot length and 10 ft./hr. feed speed), each point on a stud would pass only 240 rollers. Damage caused by rollers in a commercial design would, therefore, likely be substantially less than in the experimental apparatus.

The major disadvantage of all four of the roll-fed configurations is the necessity for accurately sizing each green stud in width and thickness before admitting it to the kiln.

Problems of maintaining air circulation vary with the manner in which the studs are fed. With studs flat, further acceleration of drying can probably be attained by impinging air jets – from slotted tubes extending across the roll case – to yield velocities of 3,000 to 10,000 feet per minute in a direction normal to stud faces. This configuration of jet impingement would be less practical with studs fed on edge.

Literature Cited

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