COMPARISON OF METHODS FOR PREPARATION OF MOISTURE CONTENT GRADIENT SECTIONS

Michael R. Gorvad and *Donald G. Arganbright*

Research Associate and Project Leader

Timber Physics Project, University of California Forest Products Laboratory,
47th and Hoffman Blvd., Richmond, CA 94804

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ABSTRACT

A comparison is made of the effect of sawing and slicing on the moisture content of wood sections used to assess moisture content gradients in lumber. Thin, small-diameter (0.020 inch × 2.75 inch and 0.031 inch × 4.00 inch) (0.508 mm × 6.98 cm and 0.794 × 10.2 cm), commercially available metal slitting saws and a modified commerical horizontal wood slicer were used to cut sections ranging in nominal thickness from 1/32 inch (0.79 mm) to 7/32 inch (5.56 mm) from air-dry Douglas-fir (*Pseudotsuga menziesii* (Mirb.) Franco) and tanoak (*Lithocarpus densiflorus* (Hook. & Arn.) Rehd.). In both species, moisture content loss in cut sections increased with decreasing section thickness for both slicing and sawing. Above 3/32 inch (2.38 mm) section thickness, the larger diameter saw produced moisture content losses that were less than or equal to losses in sliced sections.

Keywords: Moisture content gradients, moisture sections, metal saws, slicing, Douglas-fir, tanoak.

INTRODUCTION

It is sometimes desired to assess moisture content gradients in dried or partially dried lumber. Such assessments are usually accomplished by subdividing a sample into successive sections and determining the moisture content of the individual sections.

Methods used to section wood in which moisture gradients are being assessed include slicing, planing (with chip recovery) (Pfaff 1978), and sawing. Each method offers certain advantages and presents certain problems. Presumably, slicing least affects the moisture content of the sections obtained. However, if the slicing is done in a plane parallel to the longitudinal direction, the tendency of the wood to split or cleave, rather than be cut by the slicing knife, often leads to irregularly shaped slices. This may cause problems, for instance, if specific gravities are to be determined on the individual sections. Because of the generation of heat from friction, both planing and sawing would appear to possess the potential for lowering the moisture content of individual slices, particularly as slice thickness decreases. However, since the amount of heat required to drive off moisture increases as the moisture content of wood decreases, heat generation by the cutting tool may not be a problem at moisture contents below the fiber saturation point, although, conversely, frictional forces may increase. Sawing offers an advantage in that uniformly shaped slices may be easily obtained, an aid when specific gravities of individual slices are to be determined.

This report summarizes the results of tests that compared sectioning methods of slicing and sawing with regard to their effect on slice moisture content.

EXPERIMENTAL

Equipment

Slicing was done using a modified commerical wood slicer of the type found in professional cabinet shops.

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Both circular and band saws were tested, but were of an unorthodox nature. In an attempt to minimize kerf, thin saws with unswaged teeth were used. The choices were a band knife, normally used to cut fibrous materials such as fiberglass bats, and two metal slitting saws, usually mounted in a milling machine for cutting keyways, screw slots, and the like. In more detail, the band knife was 0.020 inch (0.508 mm) thick and had a scalloped cutting edge with a single bevel. One metal slitting saw was 4 inches (10.2 cm) in diameter, $^1/_{32}$ inch (0.794 mm) thick, and had 40 teeth, while the second was 2¾ inch (6.98 cm) in diameter, 0.020 inch (0.508 mm) thick, and had 72 teeth. The metal slitting saws were mounted in a conventional metal-milling machine.

Test material

One softwood, Douglas-fir (*Pseudotsuga menziesii* (Mirb.) Franco), and one hardwood, tanoak (*Lithocarpus densiflorus* (Hook. & Arn.) Rehd.), were selected for test material.

Douglas-fir source material consisted of 2 × 4 (50 × 100) studs that had been stored indoors for approximately two years. Cross-sectional dimensions of the studs were 3⅜ inches × 1½ inches (85.7 mm × 38.1 mm). The tanoak had also been stored indoors for several years, and was jointed and planed to cross-sectional dimensions of 3$^9/_{16}$ inches × 1 inch (90.5 mm × 25.4 mm). Parent blocks, from which the moisture content sections were to be cut, were taken from this source material by successive transverse cuts. Unsound material or that with irregular grain patterns was discarded.

Design

A two-phase approach was used. The first phase was conducted to obtain reasonable (not necessarily optimal) feed and spindle speeds to be used with the metal slitting saws. Such speeds would not cause large reductions in section moisture contents when these saws were used for sectioning. The second phase compared slicing with sawing.

In the first phase, spindle speeds bracketing rotational speeds of readily available low horsepower electric motors were selected. This was done with an eye toward later construction of a small-scale table saw to be used for cutting moisture gradient sections. Feed speeds were largely determined by those available on the milling machine used in the study, although an attempt was made to include approximate feed rates that would occur if specimens were moved by hand through a table saw.

In the event that wet cores or pockets are encountered in sawing wood specimens to determine moisture content gradient, it is desirable to know the effect of sawing on high moisture content material. To that end, brief tests were conducted with saturated Douglas-fir and tanoak.

A fixed nominal section thickness of 0.10 inch (2.54 mm) was used throughout the first phase. In the second phase where sectioning techniques were compared, sections of nominal thicknesses ranging from $^1/_{32}$ inch (0.79 mm) to $^7/_{32}$ inch (5.56 mm) in $^1/_{32}$ inch (0.79 mm) steps were cut using each of the different techniques. It was hypothesized that heat generated by the cutting process would lower the moisture content of the thinner sections more than that of thicker sections. Thus, the relative effects of the different sectioning methods would be reflected in sec-

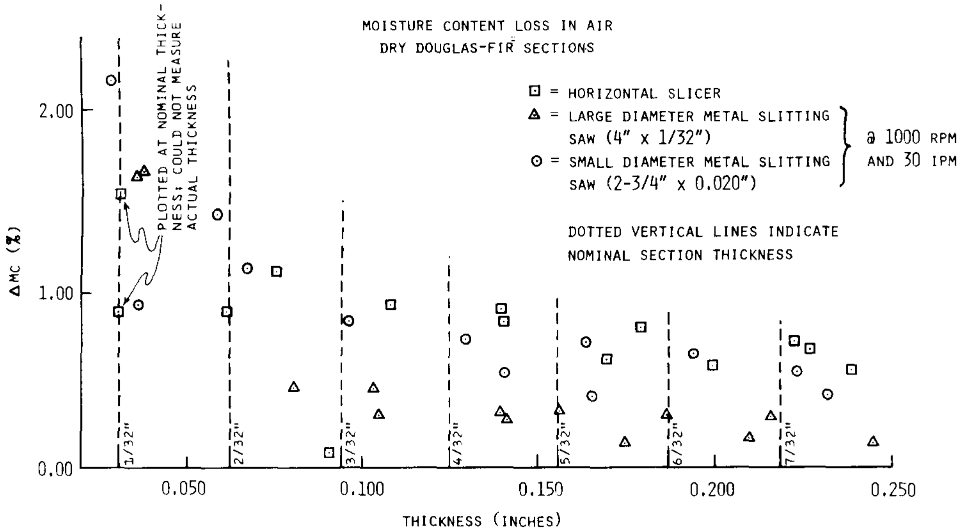

FIG. 1. Moisture content loss in air dry Douglas-fir sections.

tion moisture loss as a function of section thickness. It should be noted that in all cases, only one section was cut from each parent block.

Preparation of parent blocks

No particular effort was made to condition the air-dry parent blocks used in Phase I, but it was felt they were fairly well equilibrated since the source material had been stored indoors for long periods of time. The first phase included tests on saturated as well as air-dry material. Air-dry parent blocks used in Phase II were conditioned in a controlled environment room at 12% wood EMC for over two months in an effort to eliminate moisture content gradients in the material.

Technique

Sections were cut parallel to the original longitudinal edge face of the board. Immediately upon cutting of a section (by any of the considered methods), it was wrapped in aluminum foil and the parent block placed in a plastic bag. Sections and blocks were then weighed as soon as possible, oven-dried for approximately 24 h at 103 C, ±2 C, and reweighed, and moisture content of section and block was determined. The effect of cutting on section moisture content was measured by calculating ΔMC = parent block moisture content − section moisture content.

RESULTS

Phase I indicated that the use of spindle and feed speeds of 1000 rpm and 30 ipm (76.2 cm/min), respectively, would not greatly affect the moisture content of sections cut with the large diameter metal slitting saw. While there was some variation in specific gravities for Phase I material, it is felt that the differences had no effect on the results.

In the Phase II comparison of sectioning by slicing and sawing, both large and small diameter metal slitting saws were used at a spindle speed of 1,000 rpm and

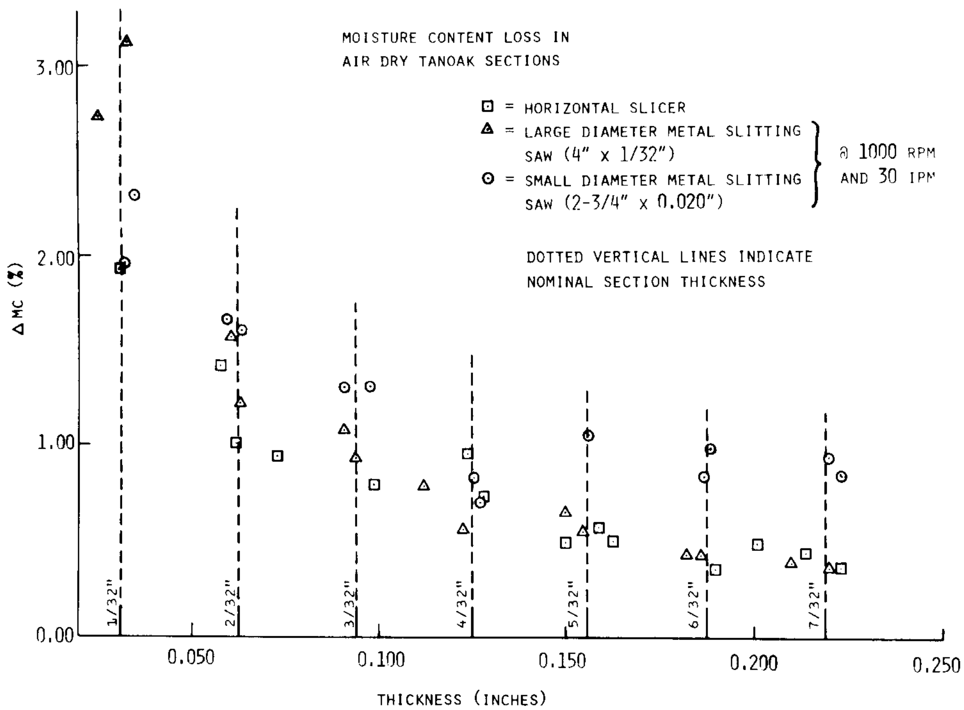

FIG. 2. Moisture content loss in air dry tanoak sections.

a feed speed of 30 ipm (76.2 cm/min). Figures 1 and 2 (for Douglas-fir and tanoak, respectively), plot values of ΔMC against actual slice thickness for the methods of slicing and sawing with large and small diameter metal slitting saws. No points are given for the band knife since this method proved to be a spectacular failure, primarily because the saw was unable to make a complete cut and had a pronounced tendency to follow the grain. Also, there was considerable burning of the wood by the band knife, which apparently generated large amounts of heat from friction.

Figure 1 indicates the following results for air-dry Douglas-fir:

1. ΔMC increased with decreasing section thickness for both slicing and sawing; from approximately 7/32 inch (5.56 mm), to around 3/32 inch (2.38 mm), this trend was less pronounced for sawing with the large diameter metal slitting saw than for either slicing or sawing with the small diameter metal slitting saw.
2. Except for the thinner sections (below approximately 3/32 inch (2.38 mm)), the values of ΔMC for roughly corresponding thicknesses when sawing with the large diameter metal slitting saw were smaller than those for either slicing or sawing with the small diameter metal slitting saw. For roughly corresponding thicknesses above 3/32 inch (2.38 mm), sawing with the small diameter metal slitting saw often produced smaller values of ΔMC than did slicing.
3. For all thicknesses above 2/32 inch (1.59 mm), sawing with the large diameter metal slitting saw produced less than a ½% moisture content loss in the section.

Similarly, Figure 2 indicates that for air-dry tanoak:

1. ΔMC increased with decreasing thickness for all three sectioning methods, the trend being stronger than for Douglas-fir.
2. For roughly corresponding thicknesses above 3/32 inch (2.38 mm), sawing with the large diameter metal slitting saw and slicing created about the same moisture loss. Sawing with the small diameter metal slitting saw produced somewhat larger moisture losses.
3. Above 3/32 inch (2.38 mm) section thickness, moisture loss caused by sawing with the large diameter metal slitting saw was less than 0.8% in the sections.

As in Phase I, variations in estimated specific gravities existed, but these were felt to be of little or no consequence.

CONCLUSIONS

This study indicates that readily available metal slitting saws can be used to cut moisture content sections of the type described without unduly lowering the moisture content of the machined sections and with a very small kerf (approximately 1/32 inch (0.79 mm)). For sections ranging in approximate thickness from 3/32 inch (2.38 mm) to 7/32 inch (5.56 mm), moisture content losses in machined sections were less than 0.5% for air-dry Douglas-fir and less than 0.8% for air-dry tanoak. These losses were at least as small as losses incurred in slicing sections. These results were deemed acceptable but not necessarily optimal, and further work might reduce such section moisture content losses even further.

REFERENCE

PFAFF, F. 1978. Moisture content testing of kiln-dried spruce-pine fir. Can. For. Ind. 98(10):37–45.