2074

FABRICATION OF SMALL CLEAR SPECIMENS OF TIMBER FOR STRENGTH TESTS

(Report)

No. 2074

February 1957

FOREST PRODUCTS LABORATORY
MADISON 5, WISCONSIN

UNITED STATES DEPARTMENT OF AGRICULTURE
FOREST SERVICE
In Cooperation with the University of Wisconsin

FABRICATION OF SMALL CLEAR SPECIMENS OF TIMBER FOR STRENGTH TESTS

By

SIMPLICIO B. BELLOSILLO, Engineer

Forest Products Laboratory,[1] Forest Service
U. S. Department of Agriculture

Introduction

This report presents in detail the methods used at the U. S. Forest Products Laboratory for fabricating small clear specimens of timber as required for tests in accordance with standard methods of the American Society for Testing Materials, ASTM Designation D143-52. The ASTM standard contains complete details for the selection of trees, manner of marking, field descriptions, and storage of logs at destination, but does not give exact fabricating details.

Standardizing of the conditions of test will assure comparable results wherever the tests are made. Many national and world organizations, including the American Society for Testing Materials, have made great progress in such standardization. Proper preparation of test specimens and proper testing techniques are equally important in obtaining valid results. A report on the preparation of specimens for tests of wood in tension parallel to the grain has already been prepared.[2] It is the purpose of this report to provide a basis for standardization for specimen fabrication.

---

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

[2] Method of Fabricating Specimens for Tests of Wood in Tension Parallel to the Grain. Simplicio B. Bellosillo, 1955.

The methods described herein have been developed and used by the U. S. Forest Products Laboratory with good results over many years. These methods are neither mandatory nor the only satisfactory procedures. Other laboratories using different methods and equipment can no doubt produce specimens equally good. It is believed that this report will be particularly useful to newly established laboratories and other laboratories not normally engaged in tests of wood.

Initial Preparation of Test Specimens

Marking the Log

For the purpose of this report, it will be assumed that a shipment of double bolts,[3] about 8 feet long cut from the original log, have been received and are ready for cutting. It will also be assumed that these bolts are properly marked as to butt end and north side. The usual practice is to put a metal identification tag (or a notch) on the butt end and at the north edge of a log.

Preparing the Log for Cutting

The midlength of each double bolt is first marked for crosscutting, and provision is made to take a 2-inch-thick cross-sectional disk from this midlength. The north direction is also marked at the midlength so that after the bolts and disk are sawed there will be a reference mark on all three pieces. The bolt is crosscut by any means available, and the 2-inch disk is then processed for photographing. This is done by surfacing one side with a jointer or by sanding to a smooth surface. The north side of the specimen should be indicated, and a scale placed beside the section to indicate the scale of the photograph. Figure 1 shows a photograph of a section cut from an "E" bolt.

The cutting of the 2-inch disk from the midlength for photographing is a slight deviation from the ASTM provisions which specify[4] that the top

---

[3] Each 4-foot section of a tree is designated as a "bolt." These are assigned letters a, b, c, aa, bb, etc., commencing at the butt of the tree and proceeding upward.

[4] ASTM Standard D143-52. Method of Testing Small Clear Specimens of Timber.

of the d or c-d bolts be photographed. This deviation is dictated by necessity for and methods used in protecting the bolts during shipment; that is, the logs are usually shipped with a protective coating painted on both ends. Because of this and because checks and shakes may have started at the ends, the tops of the d or c-d bolts are not always suitable for photographing. Therefore, this 2-inch disk can more readily be surfaced for photographic purposes than the end of a bolt. The section is later utilized as material for the tangential and radial shrinkage test specimens of the composite bolt. The selection of the disk in this manner will produce test bolts that are slightly less than 4 feet long, which is usually a sufficient length.

The 4-foot bolts are then lined up for marking with the freshly sawn ends facing the marker. The two original ends of the double bolts have usually been painted with end sealers to retard drying; therefore, the freshly cut surfaces at the center are utilized as marking surfaces. Thus, the marking is done on the top end of the lower bolt and the butt end of the upper bolt. The top end of the a, c, e, g, etc., bolts are marked normally, as provided in the ASTM standards (sketch A, fig. 2); the butt ends of the other bolts are marked inversely (sketch B, fig. 2).

A line is drawn across the section from the north passing through the pith of the log, and another line is drawn across the section through the pith and perpendicular to the first line. With a thin wooden template, 2-1/2 inches wide, the other lines shown in figure 3 are then drawn. All markings on the cross section are made with indelible pencil. If the end surface dries too rapidly and marking is difficult, the surface is wetted. The sticks (2-1/2 by 2-1/2-inch squares marked on the bolt ends) are then marked with the tree, stick, and bolt numbers (fig. 3). It is good practice to mark the four quadrants, or pie-shaped pieces that fall outside the marked sticks, with the tree and bolt numbers, as shown in the top log of figure 3. In marking butt ends, it should be remembered that the opposite ends are usually smaller, so that in some instances fewer or smaller sticks than actually marked are obtained for test.

The diameter of each top and butt end and the length of each bolt, together with a sketch of the markings, are next recorded in a cutting diagram. (See form 1, appendix). The log is now ready for cutting into sticks.

Cutting the Log

In cutting each bolt, it is important to follow a cutting plan which will leave the pie-shaped quadrants intact, as these quadrants are frequently

utilized for other test purposes. This can be accomplished by making the three central north-south cuts first, and then making the three central east-west cuts on the remaining two sections.

Figures 4 and 5 show a ponderosa pine test bolt being sawed in the Laboratory experimental sawmill. Test bolts of unusually large diameter are reduced to workable size by splitting the bolts to smaller size by means of wedges. Bolts of small diameter are frequently cut on a medium-size bandsaw. Figure 6 shows the test flitches being reduced to size on a ripsaw. The use of this smaller saw reduces the sawing waste. Because of the loss which occurs in sawing, the test sticks are always smaller in cross-sectional area than the 2-1/2 by 2-1/2 inches marked on the log. Sticks 2-1/4 inches square have proven satisfactory for producing 2-inch-square finished sticks in the air-dry condition. Sticks obtained near the outside of the bolt are sometimes less than 2-1/2 inches square, but are retained for test purposes if they can be finished to a final size of 2 by 1-1/2 or 2 by 1 inches.

Processing the Sticks

After rough sawing, the sticks are sorted to make the two composite bolts.[5] The sticks for the air-dry composite bolt are left in the rough form, with the ends sealed by dipping in paraffin or by painting with a suitable end-grain sealer; they are then stored in an open-sided shed for drying. "Weighing sticks" are selected from the unutilized quadrants or from the air-dry composite bolt, and their weights and sizes are recorded. All stick numbers in the composite bolt are recorded on the back of form 2 for later reference (see appendix). The weighing sticks are periodically weighed to determine the drying progress of the composite bolt. Where adequate facilities are available, sticks may be kiln-dried instead of air-dried, as specified in section 22 (d) of ASTM Std. D143-52.

The specimens comprising the green composite bolt (which is to be tested immediately) are dressed to a finished 2- by 2-inch size by means of a jointer and planer. Two adjacent sides of each stick are dressed on the jointer to assure accurately squared corners (fig. 7). The sticks are then planed to correct size in a planer.

During the processing and dressing of the green specimens, it is advisable to cover all specimens not in use with wet burlap or cloth to retard drying. Green specimens are usually exposed to the air for no longer than 10 to 20 minutes.

---

[5]Refer to sections 19 and 20, ASTM Std. D143-52.

After the sticks have been dressed to size (2 by 2 inches), they are marked for cutting into final test-specimen lengths, with the tree, bolt, and stick numbers, and a code letter indicating the type of test. A convenient tool used in marking the sticks is a 30-inch template, marked to show the various specimen lengths. To distribute the whole 4-foot length of a stick to the different tests and, at the same time, to avoid the various defects present in the piece require ingenuity and skill, which the individual develops as he gains experience in this work. Frequently, because of limitations in the amount of test material, some specimens must be taken from the undamaged portions of the static-and impact-bending specimens. These sticks are marked with instructions on the specimen; for example, "save 6 inches for comp. $\perp$.", which means that a specimen for the compression-perpendicular-to-grain test is desired from the unbroken ends of that piece. It is of prime importance in this phase of the work to follow closely the recommendations of the ASTM standards, especially paragraphs 24 to 40, which deal with the order, selection, and number of tests.

The specimens are cut to length with a fine-cutting saw that will produce an end-grain surface perpendicular to the longitudinal axis of the specimen, a surface which will not require further dressing. When the specimens are cut, they are listed on a distribution sheet (form 3, appendix). The completed test specimens are stored temporarily in a tightly closed tank or framed pit and covered with wet burlap until the time of test. Care should be taken to avoid long storage of green material. No specimen to be tested green should be kept in storage for more than 2 weeks, unless facilities are available for providing high humidities at a temperature of about 35° F.

Green sticks of species that stain readily should be dipped in an anti-stain solution if it is necessary to delay sawing to final dimensions and testing of the specimens for more than a few days. The dipping is thought to have no effect on properties of the specimens, because the treated outer surfaces are removed in the final cutting.

The air-dry specimens should be dried in accordance with paragraph 22 of the ASTM standards. After drying, they should be dressed and cut in a manner similar to that used in preparing the green specimens, and conditioned in a humidity-temperature controlled room at 20° ± 3° C. (68° ± 6° F.) and 65 ± 1 percent relative humidity. This is intended to condition the material to an equilibrium moisture content of approximately 12 percent.

To minimize the possibility of checking at critical areas with consequent effect on the test results it is customary to prepare only a limited number (usually about 12) shear, cleavage, or tension-perpendicular-to-grain specimens at one time.

Preparing the Individual Specimens

Specimens for Static- and Impact-Bending, Compression-Parallel- and Perpendicular-to-Grain, Specific-Gravity, Nail-Pull, and Hardness Tests

Specimens are fully prepared after being cut to the following lengths:

Type of test specimen	Length
Static bending	30 inches
Impact bending	30 inches
Compression parallel to grain	8 inches
Compression perpendicular to grain	6 inches
Specific gravity	6 inches
Nail pull	6 inches
Hardness	6 inches

The Shear Test Specimen

Shear test specimens (fig. 8) are always selected in pairs from a stick, one to be tested in radial shear (surface of failure radial) and the other in tangential shear (surface of failure tangential). A step-by-step procedure for cutting shear specimens is given below.

1. Before cutting, the shearing plane must be determined and marked (together with the tree, bolt, and stick numbers) on the face of the stick which will be the 2- by 2-inch shearing face of the specimen. This final marking should be differentiated from the temporary marking used while the specimens for the different tests are being scheduled. The type of specimen is designated with the letter "R" to denote a radial shear specimen, and the letter "T" to denote a tangential shear specimen. By means of a fine-cutting circular saw, the specimens are then usually cut 2-1/2 inches long from 2-inch-square sticks about 5-1/2 inches in length.

2. A notch 2 inches from the proposed bottom of the specimen is next crosscut across the surface that will be the 2- by 2-inch shearing face. The table of the saw is adjusted to cut this notch to the 3/4-inch depth shown in the drawing, or very slightly deeper; this insures that a clean corner will be obtained when the next cut is made. In cutting this notch, it is important that a shear length as near 2 inches as possible be obtained. The parallel saw guide is carefully adjusted to produce the desired length, as shown in figure 9. If the saw is not equipped with a parallel guide, a block of wood serving the same purpose can be clamped to the crosscut guide, as shown in figure 10. In order to insure that all specimens to be prepared at one time will be as nearly uniform in length as possible, it is recommended that all specimens in a particular group be notched before proceeding to the next step.

3. The parallel saw guide (or the wood block on the crosscut guide) is next adjusted to produce the 3/4-inch-wide notch. It is highly important that the table of the saw be adjusted to cut to the bottom but not beyond the first cut, as shown in figure 11. If this cut is too deep and projects into the shear area, undesirable stress concentration that might seriously affect the test results will occur. After this final cut, the specimens are ready for testing.

It is very important to have a sharp, fine-cutting saw to get smooth surfaces without further finishing. Extreme care must be used in sawing these specimens in order to avoid injury to the operator.

The Cleavage Test Specimen

The cleavage test specimens (fig. 12) are always selected in pairs from a stick, one to be tested in radial cleavage (surface of failure radial) and the other in tangential cleavage (surface of failure tangential).

It is preferable to take the pair adjacent to each other by cutting an 8-inch piece from the 2- by 2-inch stick; however, if the stick is too knotty or defective to yield a clear 8-inch piece, the two specimens can be cut individually from sticks a little over 4 inches in length. The procedure for preparing these specimens is as follows:

1. The direction of the cleavage plane must first be determined and each specimen marked with the tree, bolt, and stick numbers and type of specimen (radial or tangential cleavage). The marking is placed on one of the two faces which do not fracture during test.

2. The hole centers for drilling the 1-inch holes are next marked on the specimens in accordance with the dimensions shown in figure 12. The centers are marked with a light punch mark to facilitate positioning the drill.

3. The holes are bored with a regular 1-inch auger bit for wood with the threads of its lead screw filed smooth and to a conical point (fig. 13). The filed lead screw permits a slow rate of penetration which yields a smooth hole. It also makes possible the use of the bit in a regular power drill.

   The hole is drilled until the bit is nearly through the piece, with only a slight puncture of the bottom face by the conical point.

4. The specimen is next turned over and, with the punctured hole as a guide, the hole is drilled completely through the piece. This procedure eliminates the cutting and tearing of the bottom face of the specimen, which frequently occurs when the drill is forced completely through the piece in one operation.

5. The specimens are then cut to the final dimensions (fig. 12) with a fine-cutting circular saw.

The Tension-Perpendicular-to-Grain Test Specimen

The tension-perpendicular-to-grain test specimens (fig. 14), are also selected in pairs from a stick, one to be tested in radial tension (surface of failure radial) and the other in tangential tension (surface of failure tangential). The specimens are prepared as follows:

1. A pair is taken (adjacent to each other, preferably) by cutting a 6-1/2-inch piece from the 2- by 2-inch stick. If the stick is too knotty and defective to yield a clear 6-1/2-inch piece, the two can be prepared individually from pieces about 4-1/2 inches long.

2. The specimens are marked with the tree, bolt, and stick numbers and type of test (radial or tangential) on either of the two faces which do not fracture during test.

3. The hole centers are marked on the proper faces in a manner similar to that used for marking the cleavage specimens.

4. The holes are bored with the same special bit used in the cleavage test specimen and are drilled in the same manner.

5. Specimens are then cut to the dimensions shown in figure 14 by means of a fine-cutting circular saw.

The Toughness Test Specimen

A pair of toughness specimens, 0.79 by 0.79 by 11 inches (2 by 2 by 28 centimeters), is taken from the uninjured portion or end of each impact-bending specimen or companion static-bending specimen. It is desirable to obtain 32 specimens per bolt and to provide a cross-sectional distribution. One from each group of two specimens from the same stick is tested with the load applied radially, and the other tested with the load applied tangentially. If test material is limited, it is sometimes better to obtain four instead of two specimens from a 2-inch-square stick. This can be accomplished only if the growth rings are approximately parallel to one face of the stick.

Each pair of specimens should be from the same annual rings and should be truly oriented to the radial and tangential directions. These two objectives are difficult to attain, especially in material obtained from smaller diameter trees; a great deal of discretion is therefore necessary in selecting the best orientation. The specimens are prepared as follows:

1. The actual location and orientation of each radial and tangential specimen is marked on the end of the selected stick. A small square template of the proper size is convenient to use for marking.

2. The specimens are next cut to rough size. Because the size of the sticks does not allow for much waste, this cutting must frequently be done on a bandsaw having a thin blade. The ends

of the toughness specimens are too small for legible marking, so the specimen number is written on one of the original faces and later transferred to the first face finished.

3. Two adjacent sides of each stick are dressed on a jointer to assure accurately squared corners. The sticks are then planed to proper size on a planer. Difficulty in planing these short sticks can be overcome by placing a number of sticks to be surfaced on a uniformly thick hardwood board about 3 to 4 feet long and 6 to 8 inches wide, and then sending the entire assembly through the planer.

   Low, upraised edges should be provided on the board in order to hold the specimens in place. It is sometimes possible to obtain a satisfactory specimen surface by using a sharp hollow-ground circular saw instead of a planer. A few trials will usually indicate the best procedures to be followed.

4. The specimen is next cut to proper length and the direction of test indicated.

Fabrication of Specimens for Secondary Method Tests

The secondary cutting plan described in the ASTM specification utilizes specimens of both 1- and 2-inch- square cross section, hence, a revised plan for marking the ends of the bolts must be used. Except for the smaller size of some of the specimens, the same general fabricating procedures previously described in detail can also be used for test specimens used for this secondary method.

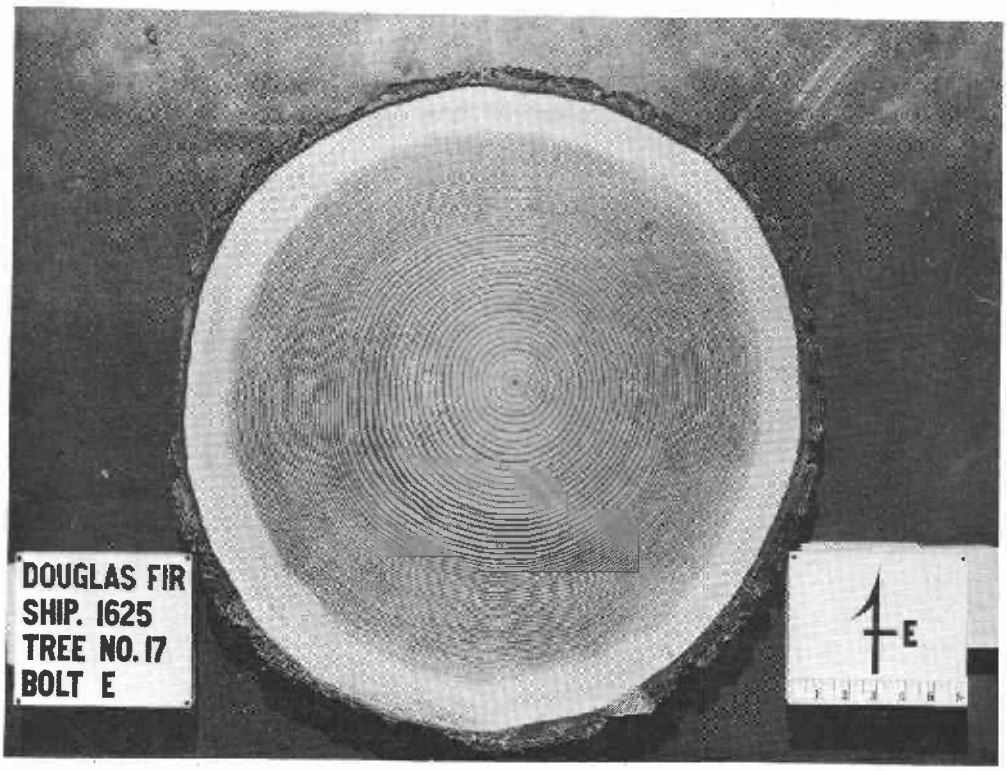


Figure 1.--Two-inch-thick section of an "E" bolt showing method of identification and indication of scale and north point.

Z M 70979

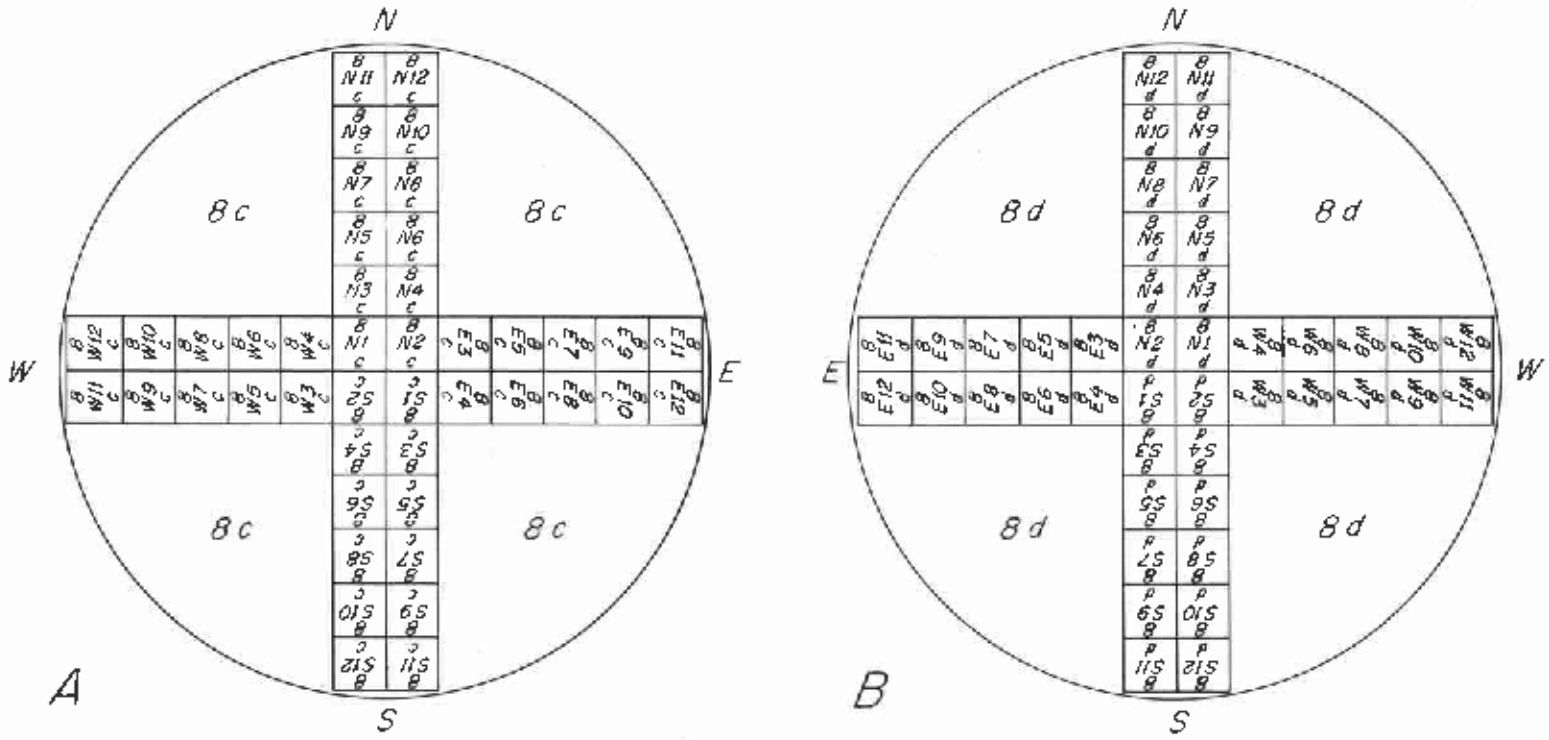


Figure 2.--Method of marking test sticks on the ends of the A and B bolts of tree No. 8. Note the inverse marking of bolt B.

Z M 110 273

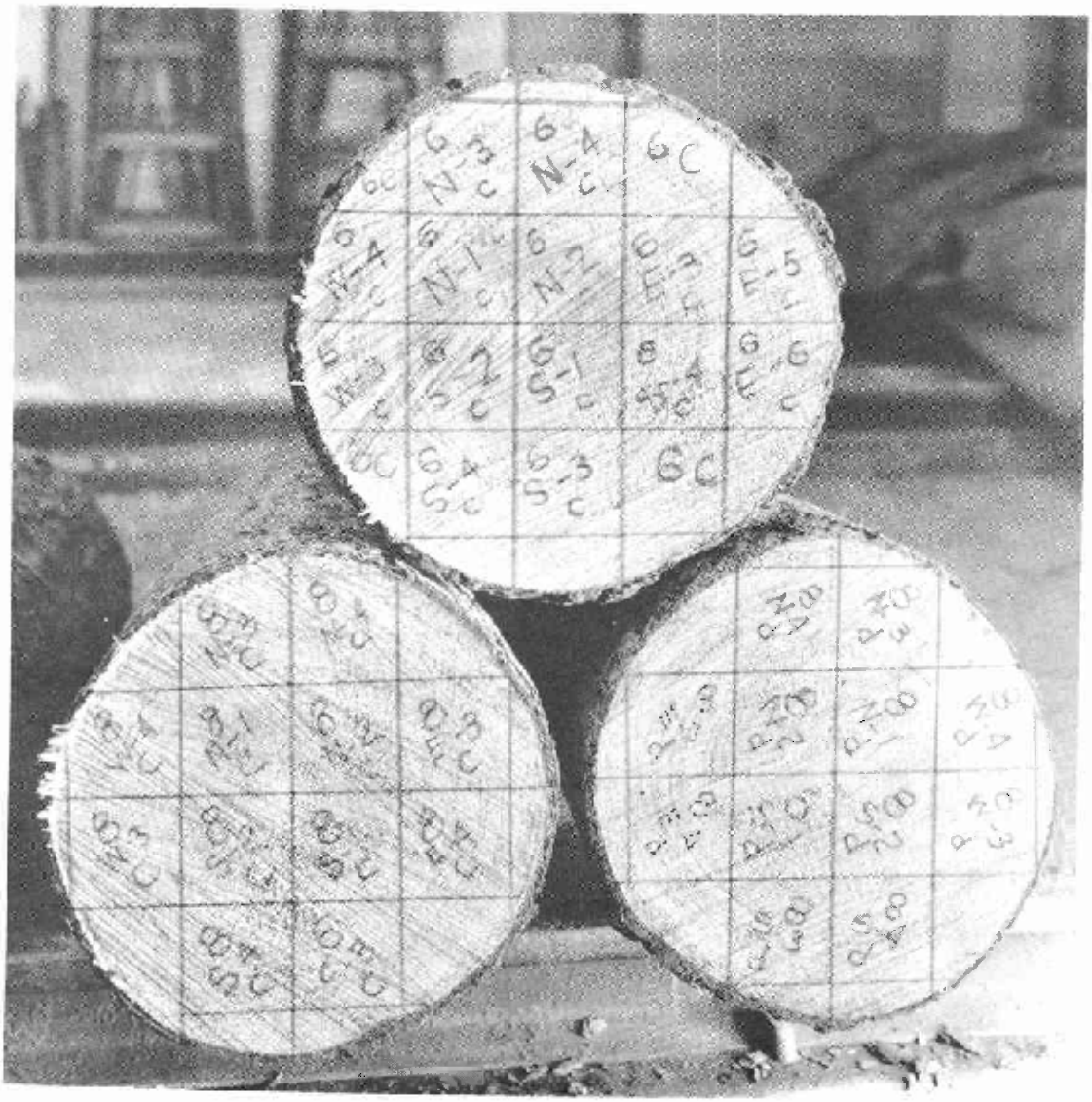


Figure 3. --Ends of three ponderosa pine logs marked in accordance with ASTM cutting plan.

Z M 107 773

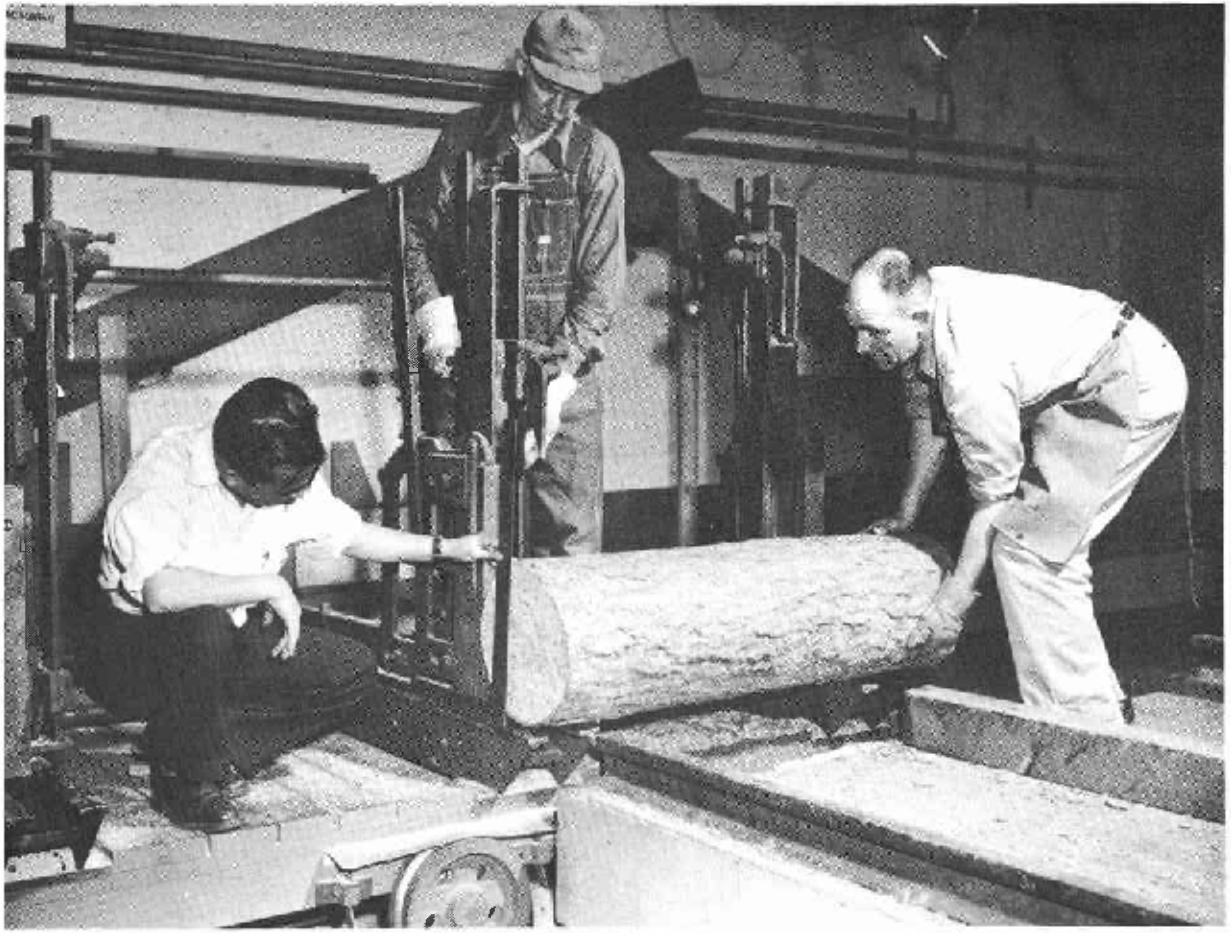


Figure 4.--Test bolt being mounted in correct position on carriage of experimental sawmill. Great care must be taken to orient the initial cutting plane vertically and to keep the pith line parallel to the path of the saw.

Z M 100 325

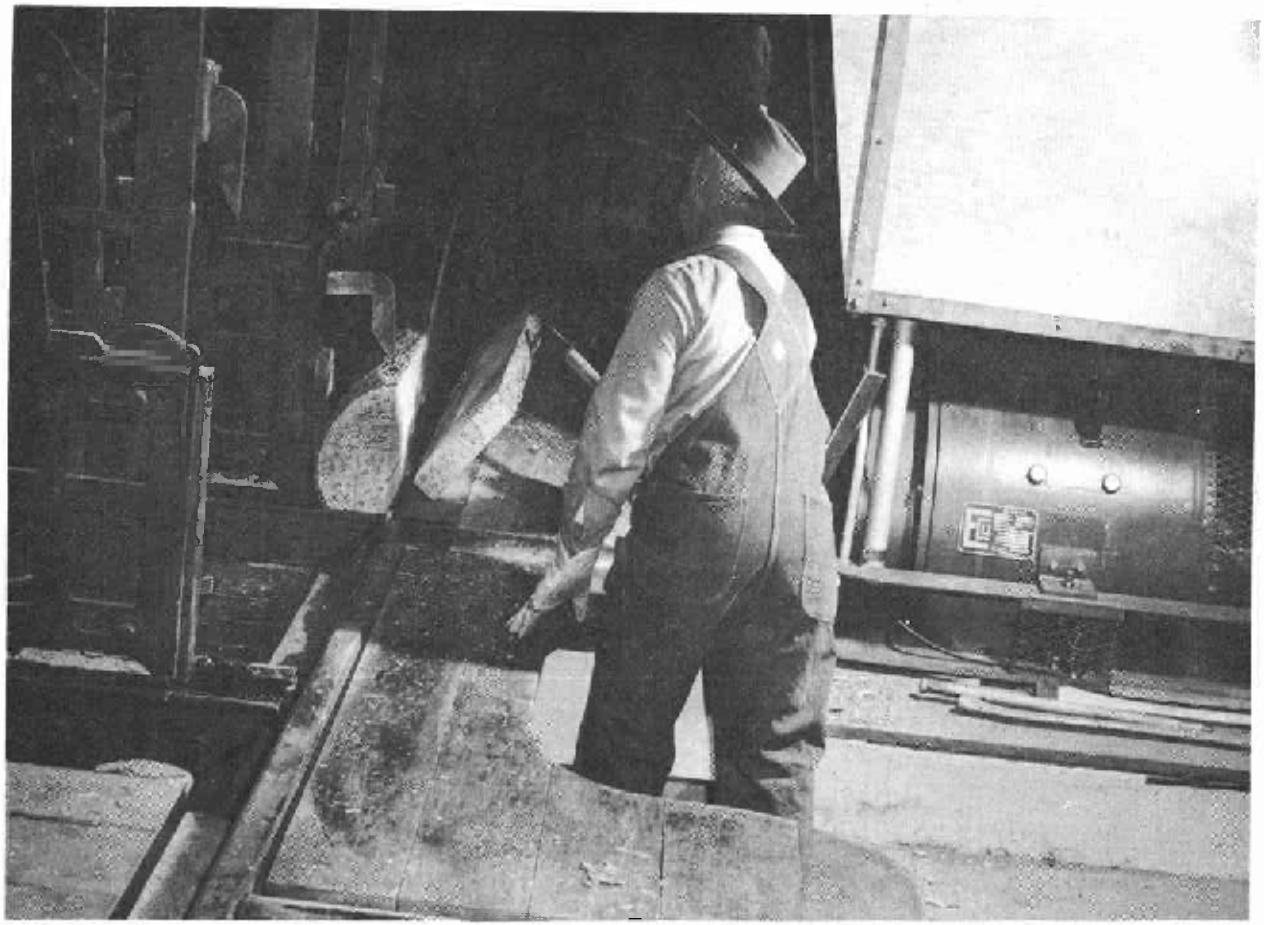


Figure 5. --Test flitch being removed from saw.

Z M 100 326

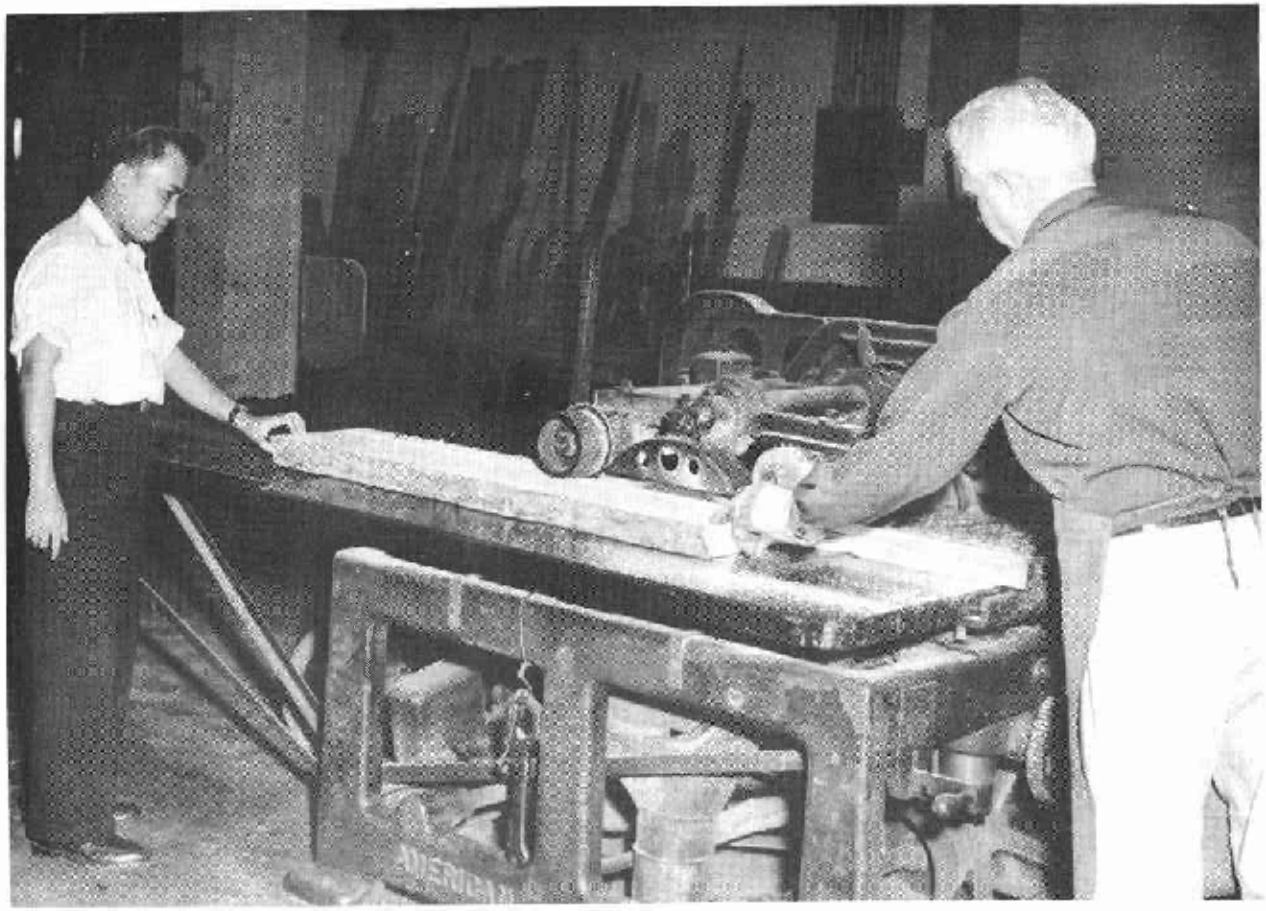
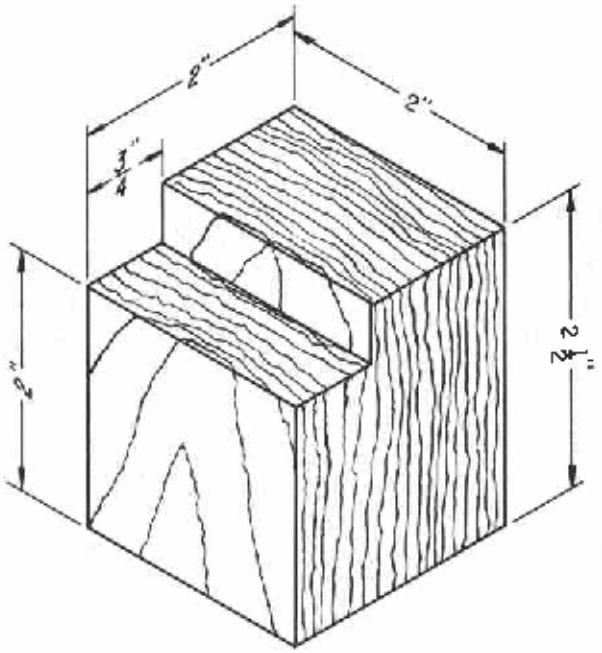


Figure 6.--Flitch being ripped to 2-1/2-inch-square sticks on a ripsaw.

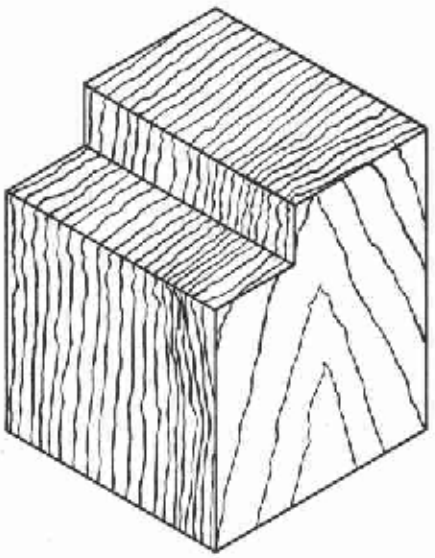
Z M 100 328

Figure 7. --Test stick being surfaced on a jointer, to obtain a 90° angle between the 2 adjacent faces.

7 M 100 329



TANGENTIAL SURFACE OF FAILURE



RADIAL SURFACE OF FAILURE

Figure 8.--Dimensions of block shear specimen and grain orientation to insure tangential or radial surface of failure.

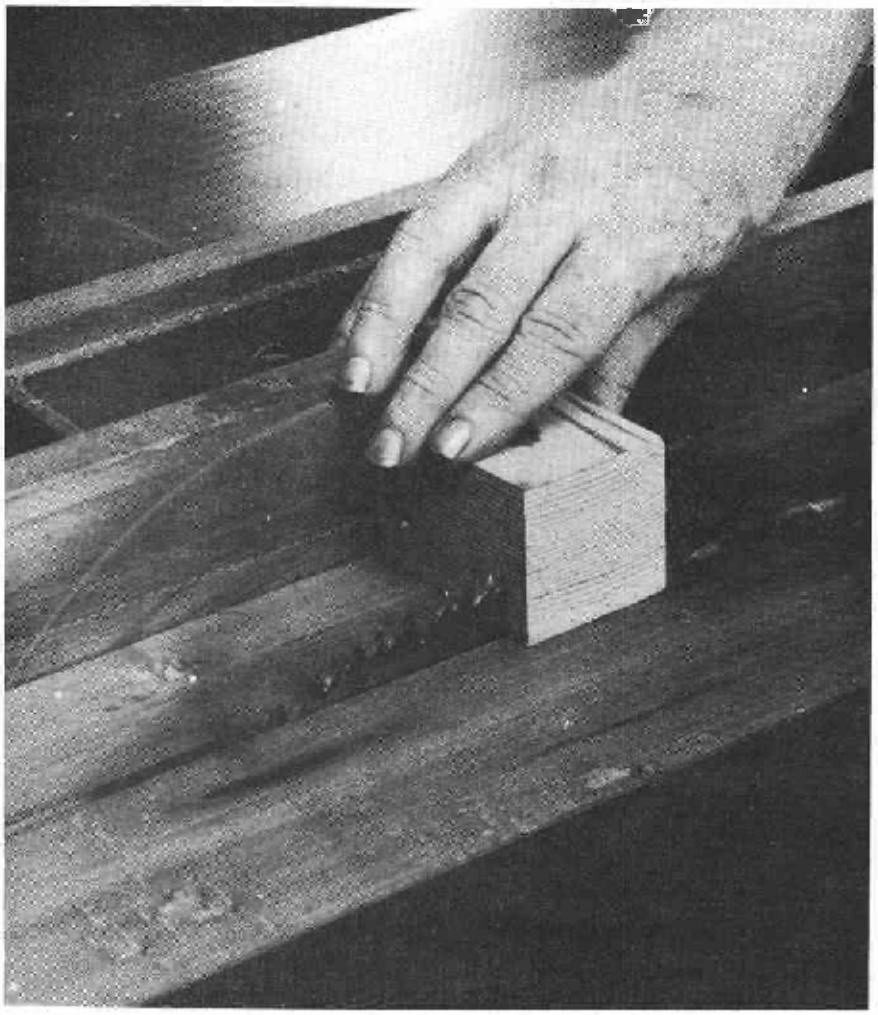


Figure 9.--Initial saw cut being made in preparation of block shear specimen.

Z M 108 991

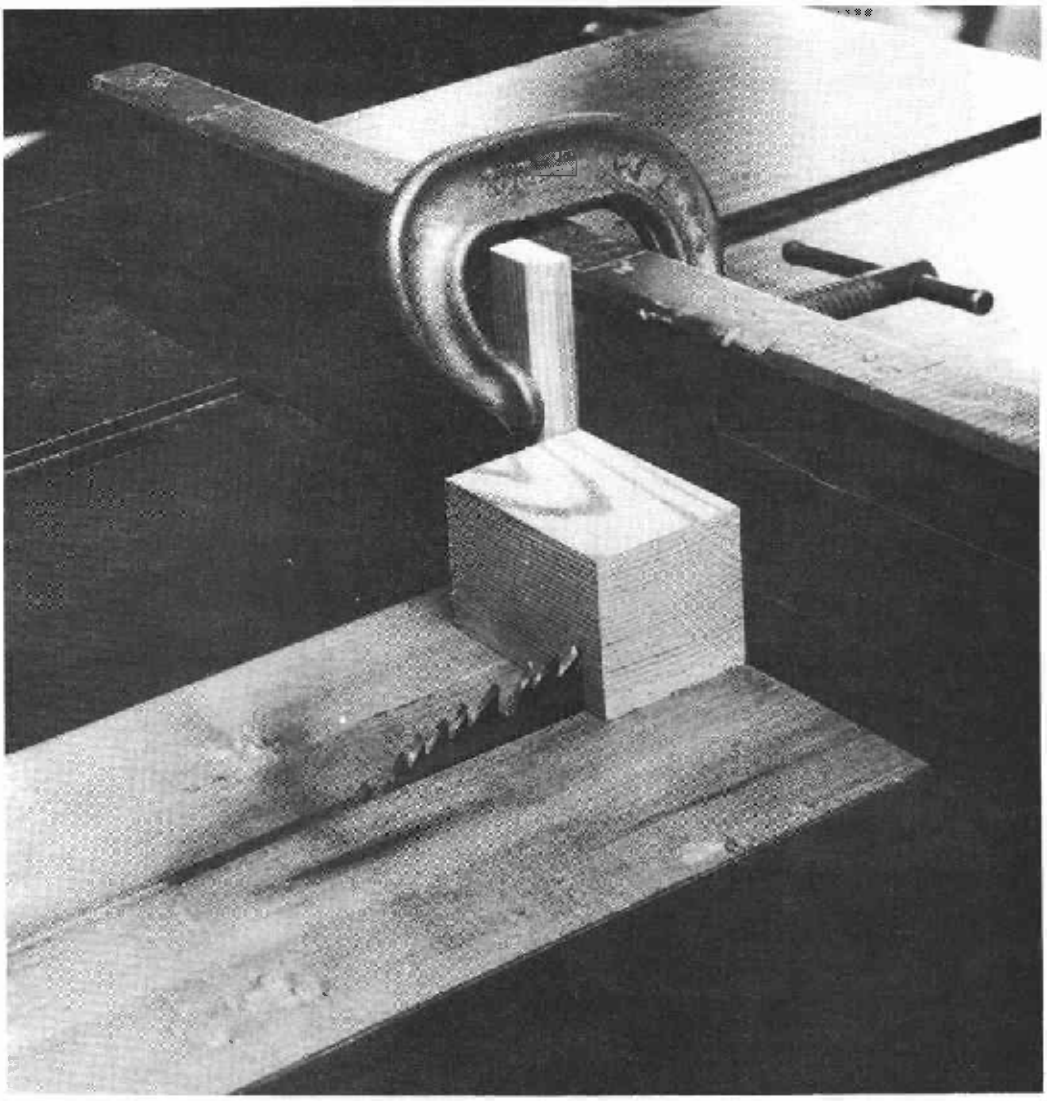


Figure 10.--If saw is not equipped with a parallel guide, a wood block clamped to the cross-cut guide will give satisfactory results.

ZM 108 992

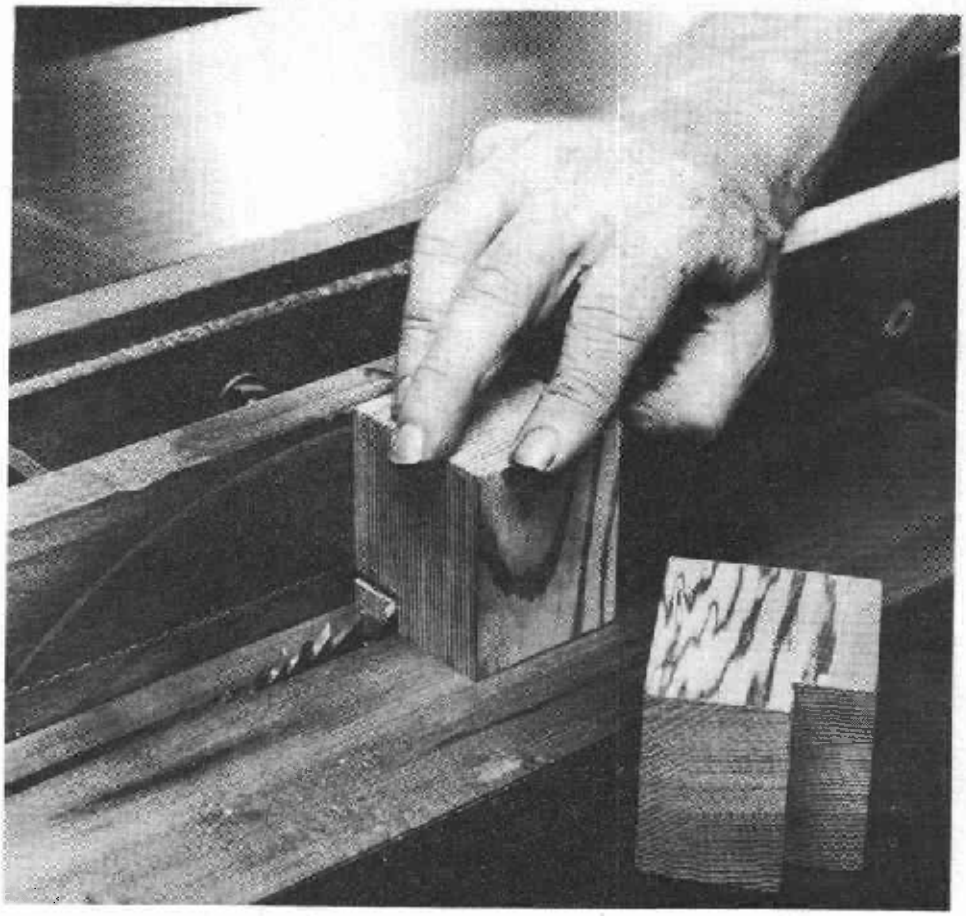
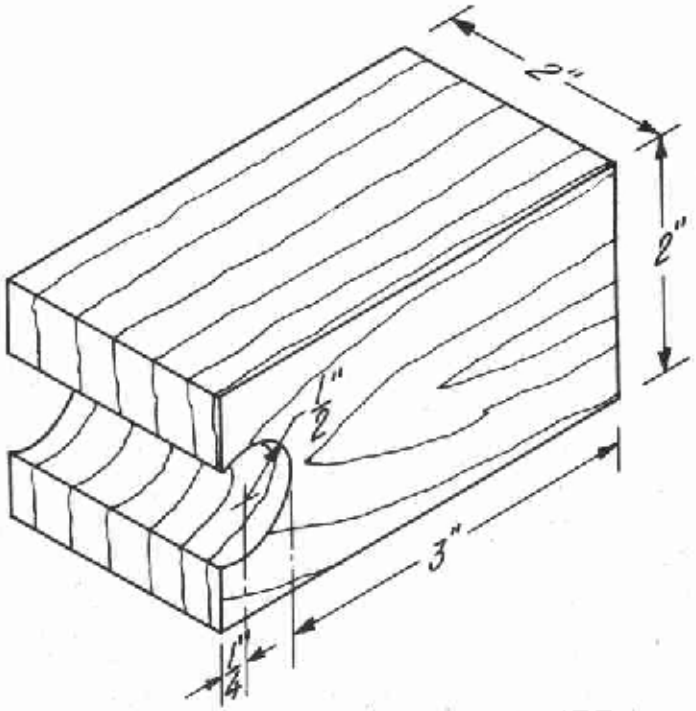


Figure 11.--Final cut being made on the block shear specimen. Saw height is adjusted to cut into but not beyond the first cut.

Z M 108 990



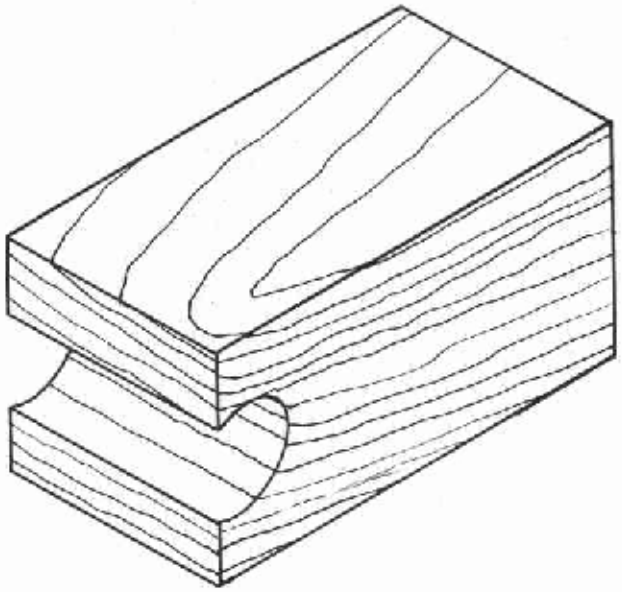


Figure 12.--Grain oreintation and dimensions of cleavage specimens.

2 M 109 039

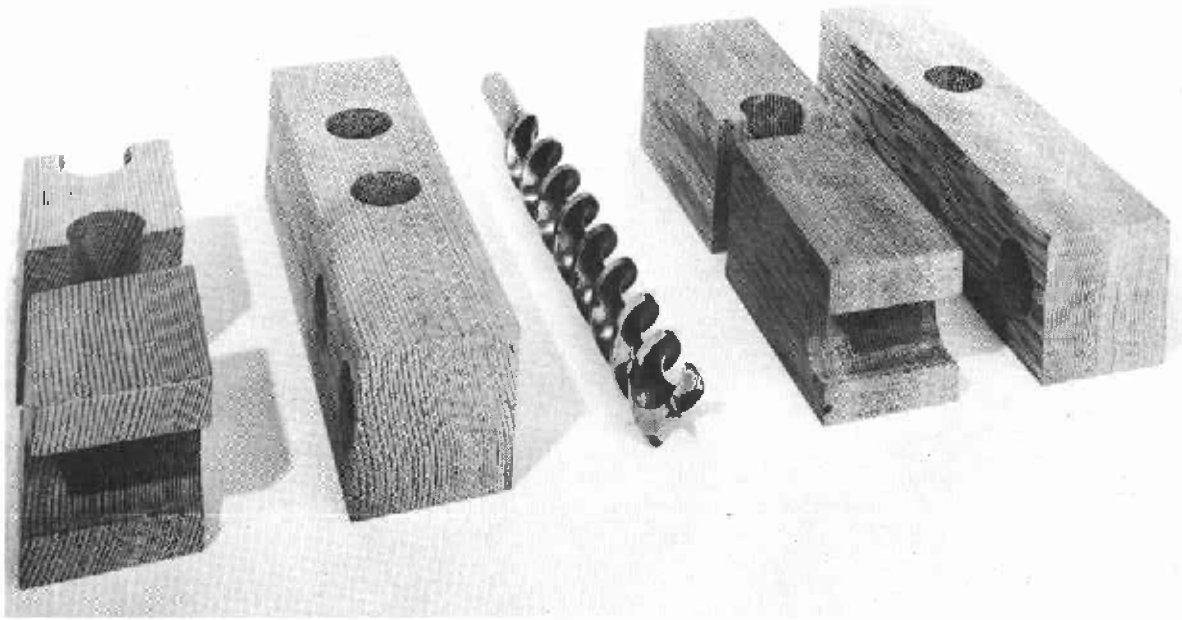
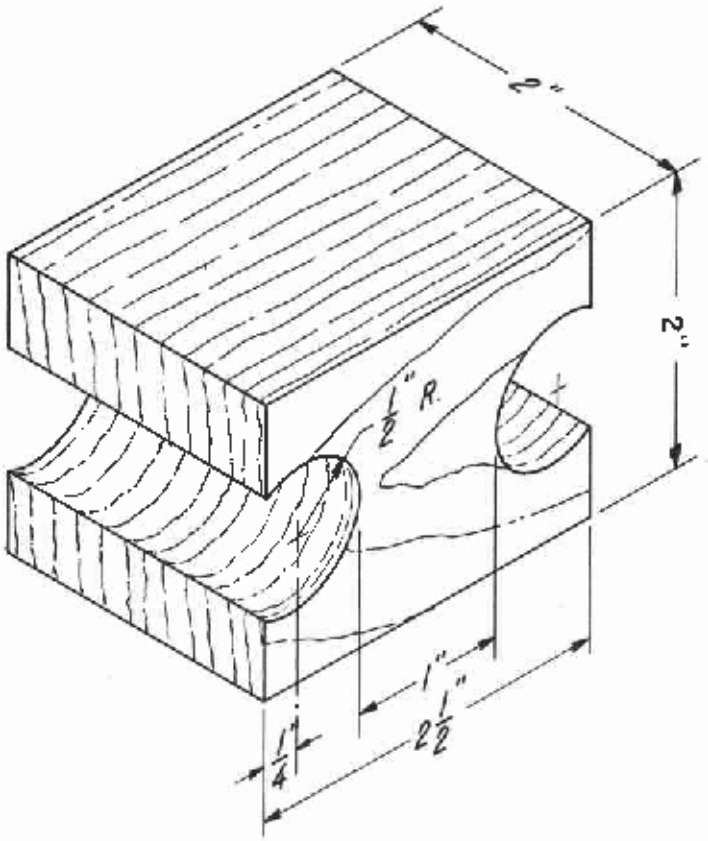
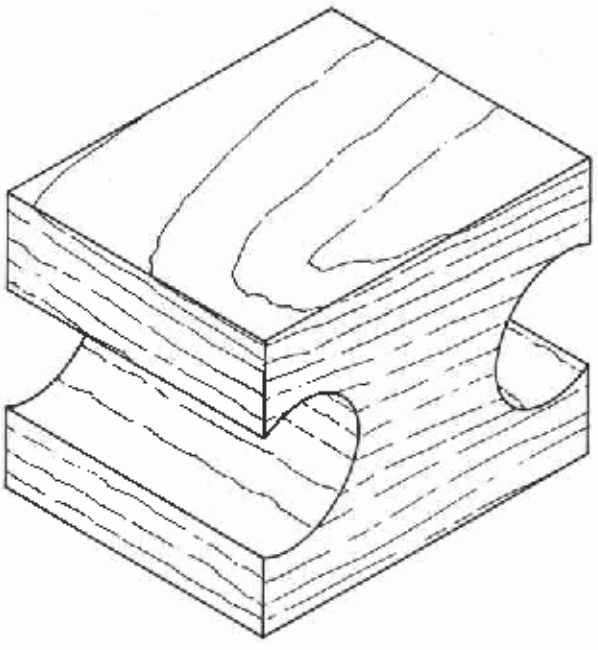


Figure 13. --Completed and partially completed cleavage specimen (right) and tension perpendicular-to-grain specimens (left). Note that the threads have been filed from the lead screw of the bit thus forming a conical point.

Z M 108 989 .



RADIAL SURFACE OF FAILURE



TANGENTIAL SURFACE OF FAILURE

Figure 14. --Grain orientation and dimensions of the tension perpendicular-to-grain specimens.

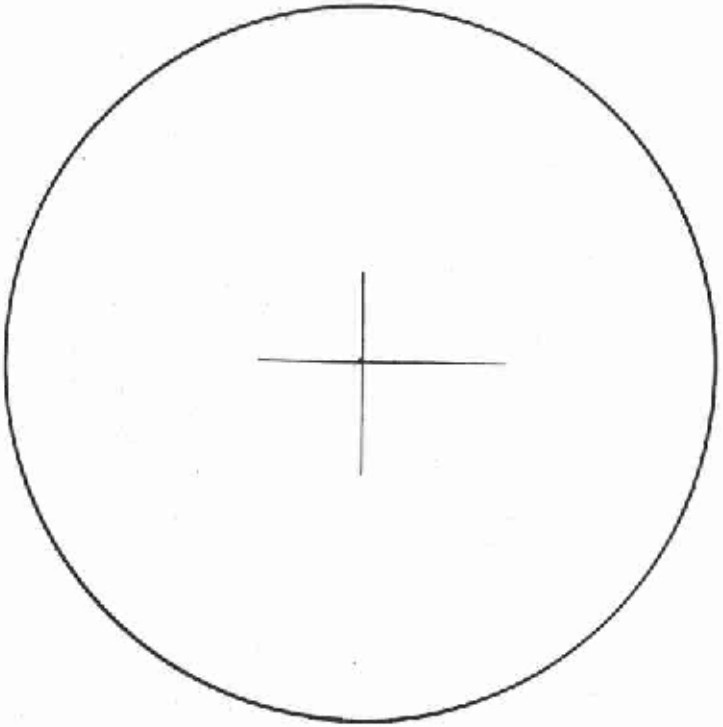
APPENDIX

SPECIES _____

SHIPMENT _____ LOG _____ CONDITION _____

BOLTS _____

Marked by _____ Date _____
Recorded by _____



Diam. top _____ Date _____
Diam. butt _____ Marked by _____
Length _____ Recorded by _____

REMARKS _____

P&E-115

Form 1. --Used to provide a permanent record of the dimensions of the test bolt and the actual cutting pattern used.

Z M 110 27a

FOREST PRODUCTS LABORATORY - DIVISION OF PHYSICS & ENGINEERING

RECORD OF AIR DRYING STICKS

Project _____ Species _____

Date Stored _____ Shipment _____

Number of Sticks Stored _____ Tree Nos. _____

Where Stored _____ Bolts _____ and _____

Tree No.							
Stick No.							
Length (In.)							
Width (In.)							
Height (In.)							
Wt. as Stored							

Subsequent Weight and Moisture	Date							

Form 2. --Used to record data pertaining to sticks selected for each composite air dry bolt.

ZM 110 084

DISTRIBUTION OF TESTS

Project _____
Date _____
Seasoning _____

Species _____
Ship. L _____
Tree No. _____
Bolt _____

Comp. //	Culls
Static	Impact
Shear, etc.	Gravity
Tension //	Recorded by

Form 3. --Used for listing the type and identification number of each test specimen obtained from each bolt.