WESTERN HEMLOCK PLYWOOD

also: Western hemlock

by

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Western hemlock veneer. (Courtesy of Don Brouse.)


QUALITY
BOLT 2-3
D=13½"
M 38427 F

INTRODUCTION

Is it possible to manufacture hemlock plywood as cheaply as Douglas fir plywood? What kind of panel can be made from Hemlock? Is there sufficient supply to justify extensive production? These questions, along with their answers, will be discussed in this paper. Some reasons advanced for and against the manufacturing of this species will be presented, also.

Before long the Northwest plywood industry will be forced to use species other than Douglas fir, because of the diminishing supply of peeler grade logs. Some mills have tried hemlock, some are using it now, some are manufacturing container veneer, but all the mills should realize the importance of utilizing our large stands of hemlock.

Because of the large amount of high quality hemlock timber in Washington, a few mills in that State are taking the lead in solving the technical problems connected with using a new species.

The industry has been negligent in accepting new ideas; hence progress has been relatively slow. The time to present this new product, hemlock plywood, is now, while the demand for plywood is still great.

AVAILABILITY

The supply of western hemlock in the United States and Alaska is exceeded only by supplies of Douglas fir and western yellow pine (6). Moreover, it is the climax species in the Northwest, rather than the much-used species, Douglas fir, which indicates there will always be a supply (13).

The following table is taken from a survey by the Pacific Northwest Forest and Range Experiment Station in 1944. It illustrates the millions of board feet of hemlock and Douglas fir trees in Western Oregon and Washington on unreserved lands (1).

	Western Washington	West. Oregon
Western Hemlock	64,340.5	19,329.4
Douglas fir	69,372.2	210,891.9

There are eleven times as much Douglas fir as hemlock in Oregon, but the two species are almost equal in quantity in the State of Washington. The hemlock grown in Washington is of higher quality than the hemlock found in Oregon. Considering both the supply and quality, one would expect to find more extensive use of hemlock in Washington, and at present that is true. However, there is sufficient standing hemlock timber in both states to supply the plywood mills for many years.

PLANTS THAT HAVE MANUFACTURED HEMLOCK PLYWOOD

Almost all of the plywood mills in the Northwest

have attempted to make plywood from hemlock. Outstanding are five, who have made considerable progress along this line. They are:

Anacortes Veneer, Inc. at Anacortes, Washington
Elliott Bay Mill Co. at Seattle, Washington
St. Paul & Tacoma Lumber Co. at Olympia, Wash.
Bellingham Plywood at Bellingham, Washington
Washington Veneer Co. at Olympia, Washington

USE OF HEMLOCK IN GRAYS HARBOR

The following table compiled from the Grays Harbor Area exclusively, will show successful development of hemlock plywood during the year 1946. (2).

Species of logs used by plywood or veneer plants (in million board feet).

Douglas fir	86.9
Western hemlock	7.3
Sitka spruce	.4
Silver fir	3.3
Total	97.9

The 7.3 million board feet listed for hemlock includes some silver fir as this species was not segregated by all plants.

USE OF HEMLOCK FOR CONTAINER VENEER

One veneer plant, operating at seventy-five per cent of its installed capacity produced 11.5 million

Typical sample of hemlock veneer cut
at room temperature without back bevel.
Courtesy of Don Brouse.


BEST SAMPLE


AVERAGE SAMPLE


WORST SAMPLE
BOLT 4-3

board feet of veneer stock. The species used were included as follows: (2)

Western hemlock	65%
Silver fir	30
Sitka spruce	4
Douglas fir	1
Total	100%

The veneer was used for tops and bottoms of fruit and vegetable containers. Peeler cores were later resawn and used for fruit, vegetable, and egg containers. (2) This proves that hemlock, as well as silver fir and sitka spruce, are acceptable species when the supply of Douglas fir peeler stock is dwindling, or the price of peelers of other species are relatively low. It is of added interest to note that over twice as much hemlock as Douglas fir lumber is cut in the sawmills in this area, other examples of how hemlock is replacing fir when the lack of supply dictates. (2). It is no longer a question of will hemlock make satisfactory plywood, but how much will the mills be cutting in the future?

DISADVANTAGE

In some ways hemlock is superior to Douglas fir for plywood, and in other ways inferior. Disadvantages will be discussed first.

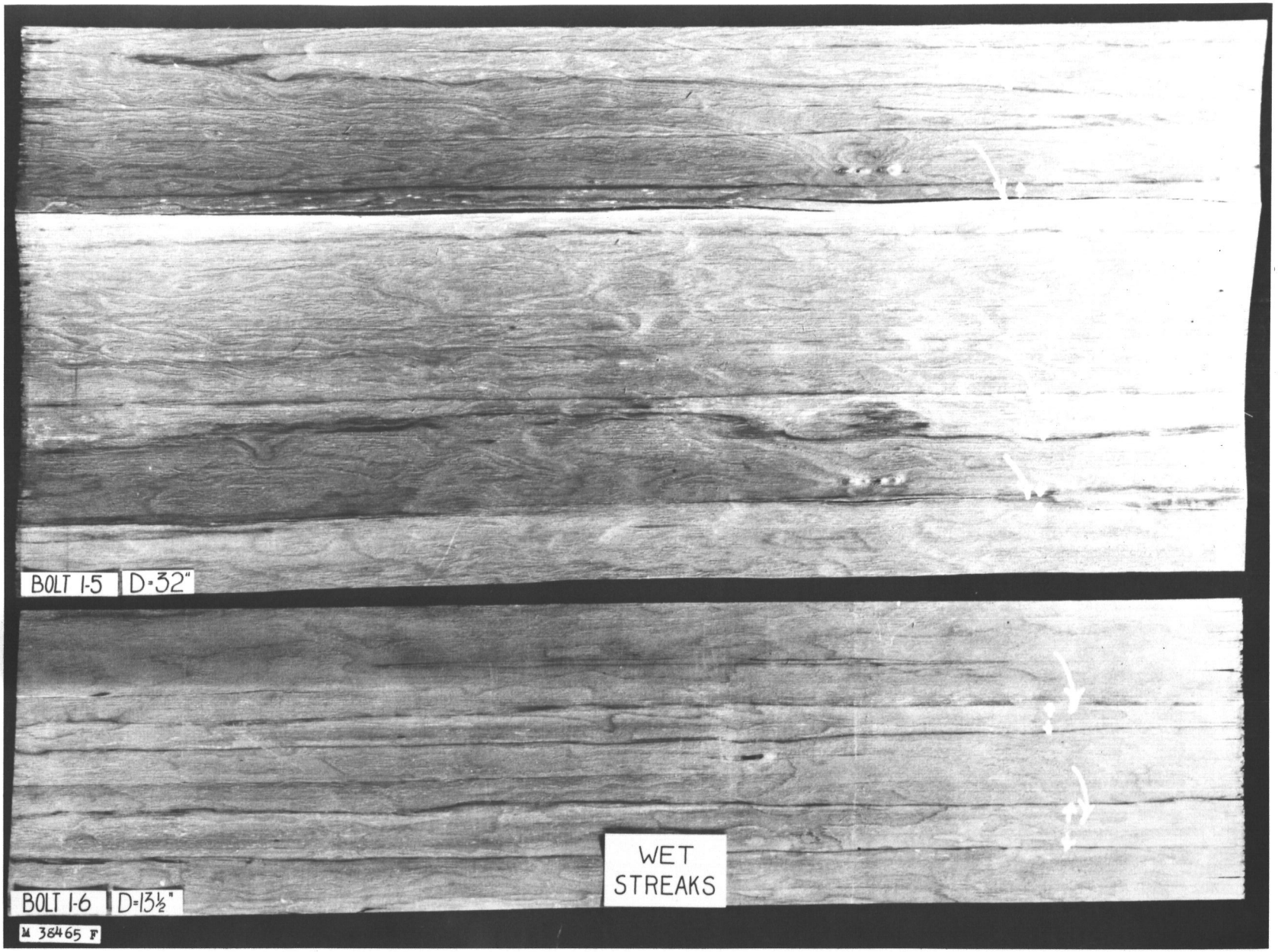
1. Hardness. In end hardness, hemlock is superior

to Douglas fir (15). In side hardness, the reverse is true. The load required to embed a 0.444 inch ball to one half an inch in the end of a piece of dry hemlock lumber is listed at 940 pounds, while the same test for Douglas fir, Coast type is 760 pounds. In side hardness, Douglas fir requires 670 pounds to 580 for hemlock. Side hardness is a more important property than end hardness in veneer. This strength property shows the resistance of wood to indentation, or it is a measure of the capacity of the wood to withstand marring and denting. Both woods are satisfactory for plywood in this respect. (15)

2. Seasoning. It has been said that hemlock veneer takes sixty to seventy percent longer to dry than Douglas fir. (18) Technicians at the St. Paul & Tacoma Lumber Company estimate only fifty percent longer. Naturally, it depends on the moisture content of the logs. The sapwood averages 170% moisture content; the heartwood 42%. Hemlock heartwood can be compared to Douglas fir sapwood for drying purposes.

Wet streaks appear commonly in the wood, but they will offer no serious obstacle in the utilization of this species. (8) Although the wood is very wet when green, it is easy to season without heavy losses, being relatively free from warping, honeycombing, staining, and has less surface checking than fir. (6) There are different opinions concerning collapse. One manufacturer

Appearance of wet streaks in hemlock veneer. Courtesy of Don Brouse.


BOLT 1-5
D=32"
BOLT 1-6
D=13½"
WET
STREAKS
M 38465 F

has had trouble with collapse.

3. Shelling. A common source of complaint is the tendency for the springwood to separate from the summerwood in cutting. This is called shelling.

4. Size. That hemlock is smaller than trees of Douglas fir is a well known fact. At optimum conditions, it grows from 175 to 225 feet tall, and is found to have a diameter between three and four feet, large enough to be economical on a lathe. (6)

5. Column-bending modulus parallel to the grain. After consulting table one in the appendix, one can compare this strength property to that of Douglas fir panels. The value of Douglas fir is slightly larger.

6. Rot. It is seriously affected by Echinodontium tinctorium, brown stringy rot, sometimes causing losses as great as thirty percent or more in a given stand. (3)

7. Insects. The Chiloria alaskensis, or hemlock bark maggot is exclusively a hemlock disease. It is so common, it is one of the means of identification of the wood. (4) Appearing as long black checks or streaks in vertical grain, and as bark pockets in flat grain, it does not degrade the wood as long as the defects are not open, since the strength of the wood is not seriously affected. (6) It may or may not affect the appearance, depending entirely on the taste of the user. The author feels this so-called defect adds beauty to vertical grain faces, but might detract in rotary cuts.

Shelling in western hemlock veneer.

(Courtesy of Don Brouse).

SHELLING

M 38464 F

8. Durability. In general, the lumber made from hemlock is not suitable for conditions favorable to growth of wood destroying fungi, and insects. (1) But neither is Douglas fir; in fact, the latter is listed as only slightly more durable than the former. Western hemlock ties, untreated, last an average of five to six years, while fir ties last six to seven years. (6)

It is possible, by impregnation with creosote, ten percent solution of beta naphthol, or other preservative, to protect both the glue and wood, when outdoor use is expected. (9) Proper construction can prevent deterioration in many cases; therefore, this is not a serious factor in prohibiting its use.

9. Percentage of face stock. An important consideration in the manufacturing phase is whether or not hemlock produces a high or low percentage of face stock. Several companies have agreed that logs yield a lower percent, consequently resulting in a lower grade of plywood.

The experiments carried out at the Madison Laboratory in cooperation with the Douglas Fir Plywood Association on logs from Pierce County, Washington, indicate that the yield compares favorably with that of Douglas fir. The average yield obtained, was close to one-hundred percent based on the Scribner C log scale, which approximates the yield often obtained by Douglas fir mill operators. (8)

In order to make accurate comparisons, one must select logs of the same grade. Too often hemlock receives unfavorable criticism because logs of poor quality were selected. In the statistics compiled from the St. Paul & Tacoma Lumber Company, a normal run would yield eighty percent sheathing, and twenty percent sound on one side. This is a lower percentage than would be expected from good Douglas fir logs.

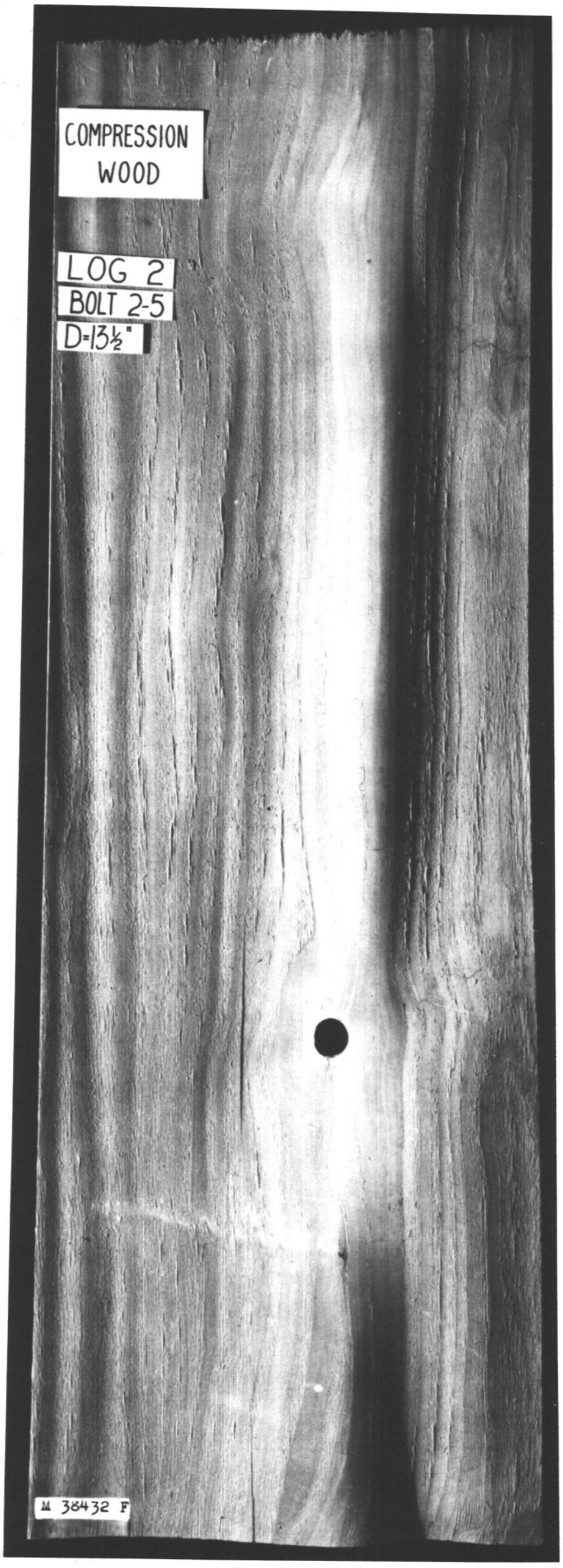
10. Compression wood. This defect occurs occasionally. It presents no difficulty in cutting and it is doubtful whether it would cause trouble in the drying process, but it may cause severe warping due to endwise shrinking. (8) Compression wood also occurs in Douglas fir. The only thing to do if compression wood causes difficulty, is to discard the sheet it is found in, or cut the section out.

11. Splitting of sheets. It has been reported that the sheets are harder to handle in any offbearing operation, because of the panels splitting when picked up. Actual strength tests show Douglas fir and hemlock are equal in splitting resistance. (12)

12. Knots. At room temperature some knots will nick or turn the edge of the lathe knife. How to deal with this problem will be discussed at length later. Small black knots with loose centers give more trouble than others. (8)

13. Sinkers. In the mill pond, some hemlock logs

Compression wood in western hemlock plywood. (Courtesty of Don Brouse.)


COMPRESSION
WOOD
LOG 2
BOLT 2-5
D=13½"
M 38432 F

with very high moisture content are unable to float, and are called sinkers.

14. Appearance. It is difficult to compare with Douglas fir in appearance, but both flat grain and vertical grain hemlock make good looking panels, both painted and in natural colors. There are differences of opinions on this subject, too. At any rate, it can always be used for cores and backs. The Weyerhaeuser Company thought so highly of vertical grain hemlock panels, that they ordered it for their new pulp mill office at Springfield. A beautiful panel was constructed, and can now be seen in their office.

15. Knot holes leaving impressions. When the panels are pressed two to a caul, an unpatched knot hole will cause an impression on the other panel. Because hemlock has a lower density than Douglas fir (.44 and .51 for oven dry specific gravity) this impression will be greater. The common practice is to patch only the knot holes over one inch in diameter, but they are measured by eye and subject to error. This impression becomes much greater as the knot hole increases over an inch. A remedy would be to develop better presses which can press fast enough to handle one panel per caul.

16. Sanding. Hemlock is more difficult to sand (11). According to J. J. Conners of the Washington Veneer Company, there is a fuzzy appearance of the face of the panel after sanding.

Vertical grain hemlock plywood, slightly magnified. Notice the black streak caused by the hemlock bark maggot.

17. Patching. Hemlock is more difficult to patch (11).

18. Glue staining. There is more glue staining in hemlock than Douglas fir (11).

19. Slivers. Hemlock has been reported to sliver more than fir when the glued panels are sawn.

ADVANTAGES

1. Price. This is a very decided advantage in favor of hemlock. In the Puget Sound area (F.O.B.), in February, 1948, Douglas fir peelers, number one, two, and three were priced at 65 to 80, 55 to 70, and 45 to 60 dollars per thousand board feet respectively, while the price of hemlock number one was 40 dollars.

2. Tensile strength. The results of tests at the Madison Laboratory show that hemlock is superior in both parallel and perpendicular tension (see table two in the appendix).

3. Column bending modulus perpendicular to direction of the grain of the faces. Hemlock proved slightly superior in these tests (12).

4. Gluability. Hemlock showed a higher percentage of wood failure with vegetable glue and animal glue. With casein glue, hemlock and Douglas fir wood failures are equal (7). How they compare when synthetic-resin adhesives are used it is not known.

5. Sustained yield. Because of its prolific

seeding, and rapid growing rate, sustained yield is very possible (6). This is becoming increasingly important as some of the mills are beginning to practice sustained yield, and are managing their stands a little more carefully than before.

6. Grain texture. The annual rings are uniform; the grain is soft and straight (6). Being more uniform in grain than Douglas fir, would make better plywood flooring, where uniform wear within an annual ring is required.

7. Spiral grain. Spiral grain occurs less in this species than in those found growing with it (6). As the result there would be less twisting and warping.

8. Paintability. Holds customary base paints well (6). There is not much flaking around knots and summer wood, nor is there any trouble with paints being discolored from the resin in the wood. It is superior to Douglas fir in paintability.

9. Grain raising. There is less raising of grain, which is important in plywood manufacturing.

10. Shrinking. The shrinking values are so nearly identical, that it is listed under the heading of advantages rather than disadvantages. The following table gives the percentages of shrinking and swelling for air dried hemlock lumber, from the green condition (9).

	hemlock	Douglas fir
Volumetric shrinkage	11.9%	11.8%
Radial shrinkage	4.3	5.0
Tangential shrinkage	7.9	7.8

11. Resin ducts. Normal hemlock wood is free from resin ducts (6).

12. Weathering. Flat grain hemlock panels weather less than Douglas fir panels (6).

13. Fomes pini. Although hemlock has the brown stringy rot, it is little affected by the red ring rot which occurs so often in mature fir (3).

The following pages are a discussion of the commercial aspects of hemlock plywood.

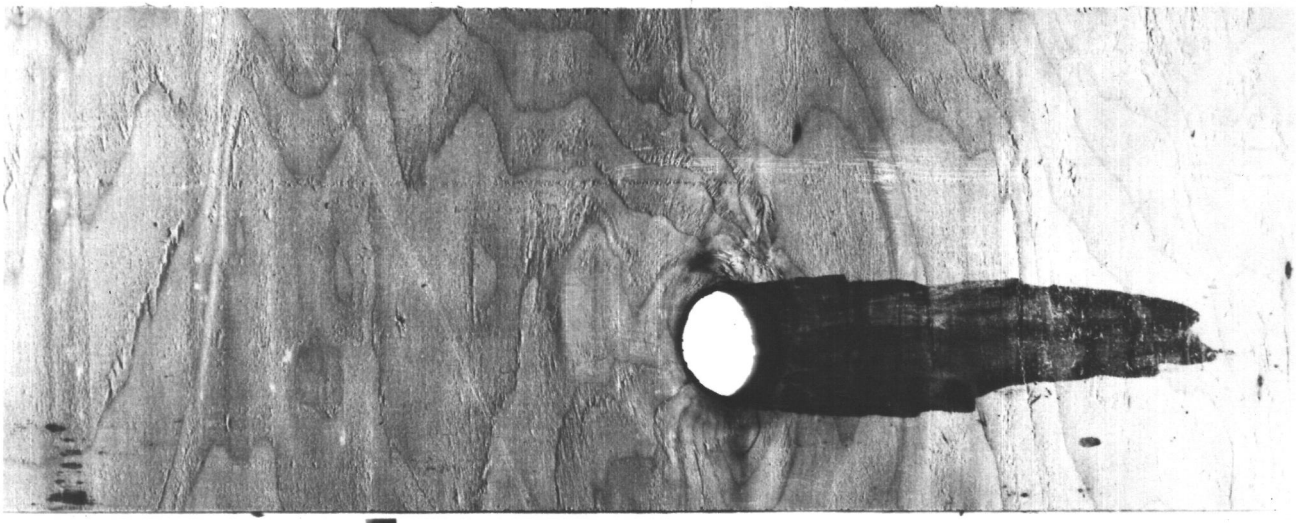
LOG SELECTION

The first consideration is the proper selection of logs. Naturally, the growth characteristics are more important than the method of cutting the bolt. Low density logs of smooth texture will produce smoother and tighter veneer. The uniformity of thickness, the firmness, and in part, the smoothness of the veneer can be controlled by the operator (8). For face stock peelers or "peelables" (twenty to thirty inches in diameter) should be used.

CUTTING KNOTS

Is it economical to steam the logs? That is a

Example of red discoloration developing behind the knots when the veneer was cut at 200 F. (Courtesy of Don Brouse.)



KNOTS
SHOWING
STREAKING

BOLT 4-4

U 38460 F

question often discussed in plywood circles. It is done with some hardwoods. As the industry on the Coast is set up for rapid production, many think it would not be practical.

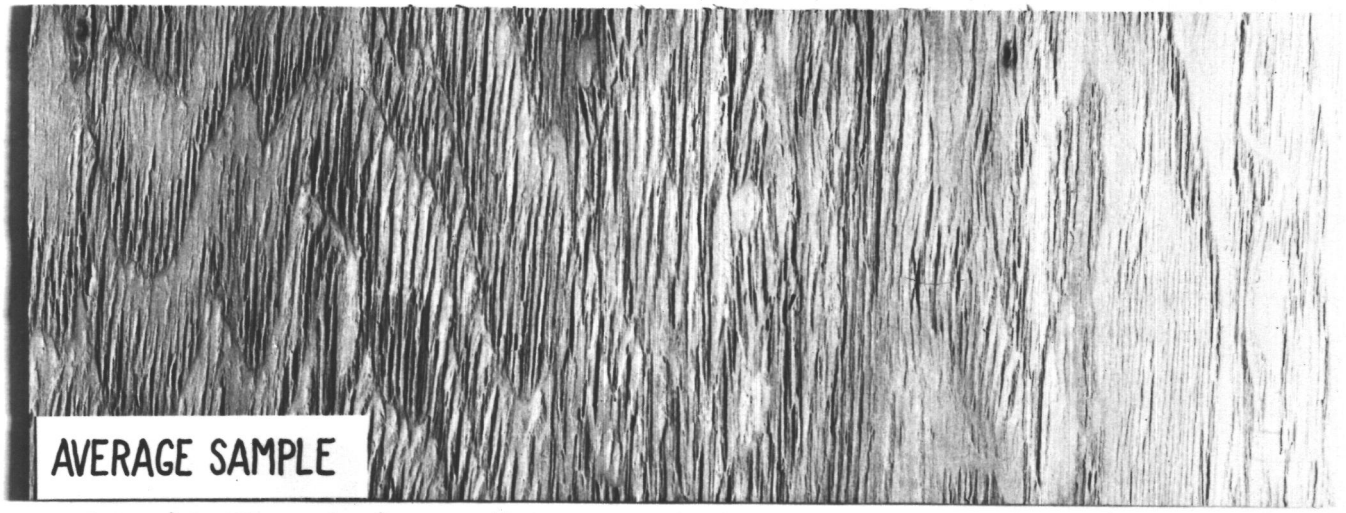
At the Springfield Plywood Corporation in Springfield, Oregon, the peeler cores of Douglas fir are dropped into hot water, and allowed to soak for an hour or so. Then they are easily cut on a small lathe. If necessary, this could be done with hemlock logs that have tough knots. The quality of the veneer would be higher, but it would add to the production costs. If the bolt is heated to 200 degrees Fahrenheit, the radial checks in the log will be extended, and a red stain in the wood results from a soluble extractive material in the knot. For the best results, the logs should be heated, or steamed from 120 to 160 degrees (8). If this process were carried out there would be no damage to the knives at all.

Another alternative would be to cut the logs with tough knots at the end of the day, or previous to changing the knife. Dulling or chipping the knive would not be so important. The knives are usually changed every eight hours or less.

There are other methods of handling the knots. Back beveling, which is filing the straight edge of the knife to a slight angle to facilitate cutting, could be used. However this must be done with caution, since it

Hemlock veneer cut at room temperature with a back bevel on the knife. (Courtesy of Don Brouse).


BEST SAMPLE


AVERAGE SAMPLE


WORST SAMPLE
BOLT 4-7

tends to produce rough, open veneer (8). A proper balance should be met. Not all logs would require back beveling of the knive; therefore, it should be done only when necessary.

Still another method would be to improve the knife quality, and there is room for improvement here. Cooperation with knive manufacturers is recommended (8).

Don Brouse, Engineer for the Forest Products Laboratory, suggested cutting or boring the knots out of the hemlock log before the lathe operation (8).

Thus, the different suggestions for cutting the knots are as follows:

1. Heating the logs.
2. Cutting at the end of the day.
3. Back beveling the knife.
4. Cutting or boring out the knots first.
5. Improving the knife quality.

It must be understood that knots in Douglas fir bolts often are so hard they nick the knife, and slow down production, and need to be chopped or bored. However, hemlock knots generally give more trouble.

No information is available on the frequency of the knots in the two species.

LATHE OPERATION FOR HEMLOCK

Knife pitch. This is the angle between the face of the knife and the line joining the edge of the knife

and the center of the spindle. The diagram on the next page illustrates the pitch (8).

About ninety degrees of pitch give the best results according to the Forest Products Laboratory (8). In actual practice the operator has no way of accurately measuring the pitch, so it is done by eye.

PRESSURE BAR ADJUSTMENT

In cutting Western hemlock, the horizontal distance between the pressure bar (leading edge) and the knife should be approximately twenty-five percent under the nominal thickness of the veneer to be cut. Too much pressure causes excessive shelling (8).

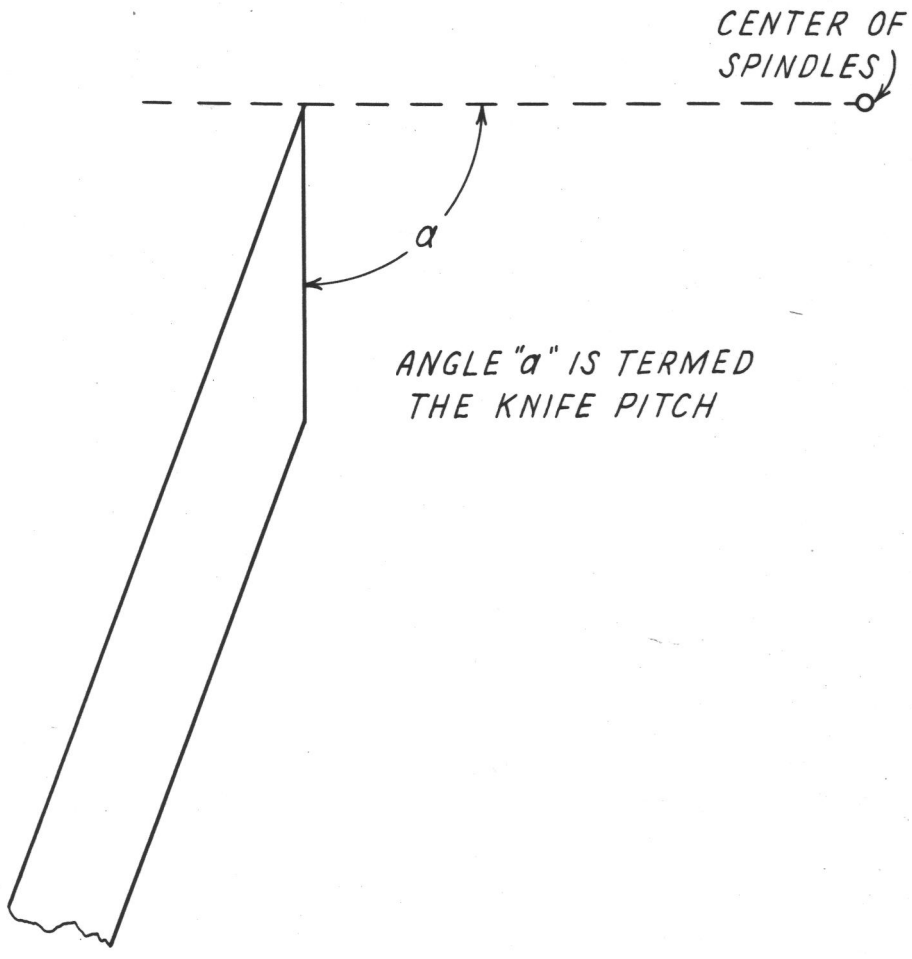
LATHE SPEED

Slower speeds are recommended for bolts with many hard knots in order not to nick the knife.

SEASONING

This has been one of the main problems since hemlock was first introduced in the plywood industry. It has been stated that hemlock takes longer to dry, but since peelers are becoming scarce, it will be better to have sheets of hemlock going through the driers than nothing nothing in them at all.

The drier department has often been the "bottleneck" in factories, and many must work three shifts, sometimes



L 37504 F

Sundays and holidays to keep abreast of the other departments. Ih these plants extra drier space or decreased production might be necessary if large quantities of hemlock were manufactured into plywood.

Some plants could operate with another shift in the drier department, or slow down their driers a little bit for hemlock, and still keep up production. Another thing to remember is if logs have been steamed or heated, the drying time is decreased.

Cold press gluing should be mentioned here, as some mills still employ the cold press. With this method, higher moisture content is permitted; hemlock would fit in better here.

GRADING RULES

Since Western hemlock has become increasingly important, standard grading rules have been adopted to facilitate the procurement of the proper grade for its varied uses, and to provide a closer relationship between buyer and seller (9).

The widespread adoption of these rules proves that Douglas fir plywood manufacturers who neglect considering hemlock as a possible raw material are behind the times. The general requirements listed below will give the reader what kind of product to expect (9).

1. Western hemlock plywood is not intended for exterior use.

2. [illegible]

2. Unless otherwise specified, it shall be smoothly sanded on both sides.

3. It shall be well manufactured, free from blisters, laps, and defects (except those permitted).

4. The entire area shall be bonded with moisture resistant type adhesive, and is suitable for construction where it will be subject to occasional deposits of moisture by condensation through walls or leakage.

5. No tape shall be admitted in the glue line.

6. It should retain its original form and practically all its strength when occasionally subjected to a thorough wetting and drying.

7. No veneer shall be thicker than three-sixteenths of an inch, measured before sanding.

8. All hemlock plywood shall be securely loaded or packed to insure delivery in a serviceable condition.

There are four grades of moisture resistant type plywood covered by rules (9).

1. Sound two sides (S02S) (sanded 2 sides).
2. Sound one side (S01S) (sanded 2 sides).
3. Sheathing (unsanded).
4. Industrial (unsanded).

The product is graded according to both sides of the panel. There are different tests which the space will not allow to describe. With the grading rules rigidly enforced, a good product can be expected.

A page from "Western Hemlock" showing grades.

GRADE MARKING AND CERTIFICATION

23. In order to assure the purchaser that he is getting plywood of the grade specified, producers may individually or in concert with their trade association or Inspection Bureau, issue certificates with each shipment; or grade mark each panel as conforming to the standard.

24. The following sets forth the grade marks adopted by the Douglas Fir Plywood Association to preserve the high standard of quality herein recorded and to insure distributors and ultimate consumers receiving the proper kind of plywood for specific needs. All standard size panels are stamped or branded with the following symbols which indicate compliance with the respective grades of this standard.

(a) *Sound 2 sides* panels are stamped or branded on the edge:

So2S ★ SILVALOCK ★ 00

(b) *Sound 1 Side* panels are stamped or branded on the back:

(c) *Sheathing* panels are stamped or branded on the face:

(d) *Industrial* panels are stamped or branded on the edge:

IND ★ SILVALOCK ★ 00

In answer to the question how does it compare with Douglas fir on the market, two leading plywood mills say it is comparable, and is acceptable at the present time.

SUMMARY

Statistics show almost as much standing hemlock as Douglas fir in the State of Washington today (on unreserved lands). Plywood companies, the Forest Product Laboratory, the United States Forest Service, and the Douglas Fir Plywood Association have studied its utilization, and although it is inferior to Douglas fir in some respects, hemlock plywood has proven to be an acceptable product. Some of the mills in Washington are cutting it at this time.

Hemlock has some lower strength properties, and some superior strength properties to Douglas fir. The drying time is longer. As far as shelling, durability, and percentage of fact stock are concerned, it is inferior. The knots might prove to be a drawback, but there are ways to eliminate this trouble.

Some points in its favor are its lower cost of peeler logs, paintability, absence of resin ducts and less weathering.

The knife pitch should be around ninety degrees; the pressure bar distance should be twenty-five percent under the nominal thickness of the piece to be cut. Steaming some logs at 120 to 160 degrees F. is

recommended. The grading rules issued by the Commerce Department indicate that a fine product can be manufactured.

CONCLUSION

Because of the greater manufacturing costs resulting from smaller logs with higher moisture content, hemlock cannot be manufactured as cheaply as Douglas fir of the same quality. Soon industry will be forced to use hemlock, it is believed. In the last ten years, the logs entering the mill ponds have decreased in quality. Small knotty, decayed logs that were formerly never considered as plywood stock, are now being utilized. Therefore, it is only a matter of a few years that widespread use of hemlock for plywood is expected.

It is strongly recommended that all mills in the Northwest study the technical problems associated with this species in order that they will be able to go into production of hemlock plywood immediately when the quality and supply of Douglas fir logs reach a point that extensive use is economically possible.

APPENDIX

Table 1

COLUMN BENDING MODULUS OF THREE-PLY PANELS*

	Parallel to grain of face	Perpendicular to grain of face
Coast type Douglas fir	9340 p.s.i.	1940 p.s.i.
Coast type Western Hemlock	9250 p.s.i.	1960 p.s.i.

Table 2

TENSILE STRENGTH OF THREE-PLY PANELS*

	Parallel to grain of face	Perpendicular to grain of face
Coast type Douglas fir	6180 p.s.i.	3910 p.s.i.
Coast type Western Hemlock	6800 p.s.i.	4580 p.s.i.

* The above data was taken from tests made by the U. S. Forest Products Laboratory (12).

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