MACHINING OF MADRONE, CALIFORNIA LAUREL, TANBARK OAK, AND CHINQUAPIN

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MACHINING OF MADRONE, CALIFORNIA LAUREL, TANBARK OAK, AND CHINQUAPIN[1]

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One of the factors that affects the utility of any wood for many uses is its machining properties. Machining data on madrone, California laurel, tanbark oak, and chinquapin, four West Coast hardwoods, are presented here as one means of facilitating their utilization. Machining is, of course, only one of several considerations. It does not appear to be a limiting factor with these woods because in general their machining properties are good.

Considerable work on the machining properties of wood has already been done at the Forest Products Laboratory with 24 of the principal native hardwoods. This work is described in U. S. Department of Agriculture Technical Bulletin No. 824, "Machining and Related Properties of Southern Hardwoods." The same general procedure used in that bulletin was followed with the tests described here.

The following machining properties were investigated: planing, shaping, turning, boring, mortising, and sanding. For each of these operations there is given a paragraph or two outlining the test procedure and the results, together with a small table comparing madrone, California laurel, tanbark oak, and chinquapin with several of the better known hardwoods. At the end of the report is a summary table covering planing, shaping, turning, boring, mortising, and sanding for 29 hardwoods (including the four West Coast hardwoods) on which machining tests have been made.

American woodworkers consider smoothness of surface to be the best criterion of machining properties, and it is so used in this report. Among less important factors which are merely touched on in passing are power consumption and rate of dulling of tools.

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

Planing

Planing tests were all made at one moisture content, 6 percent, the approximate moisture content that would be required for exacting work. Six cutting angles were used: 5, 10, 15, 20, 25, and 30 degrees. Runs were made at speeds of 1,800 and 3,600 r.p.m. with a feed of 40 f.p.m. Results were based on the occurrence of such planing defects as raised, fuzzy, or chipped grain.

A comparison of the planing properties of the four West Coast woods with those of four well-known eastern hardwoods follows.

Madrone planed about as well as any of the hardwoods that have been tested. Although tanbark oak and chinquapin did not do quite so well they still belong among the better planing woods. California laurel made a relatively poor showing largely because of interlocked grain and small burls in the material tested that tend to cause chipped grain.

Madrone	produced 90 percent of defect-free test samples
White oak	produced 87 percent of defect-free test samples
Tanbark oak	produced 80 percent of defect-free test samples
Chinquapin	produced 75 percent of defect-free test samples
Yellow-poplar	produced 70 percent of defect-free test samples
Sweetgum (red or sap gum)	produced 51 percent of defect-free test samples
California laurel	produced 40 percent of defect-free test samples
Cottonwood	produced 21 percent of defect-free test samples

Madrone was relatively little affected by cutting angles, the results being uniformly good all the way from 15° and 30°. Tanbark oak gave its best results at 15° and 20° which were about equal. The California laurel was much better at 20° than at any other angle while chinquapin did best at 20° to 30°. In general results were noticeably better in all woods at the higher cutterhead speed of 3,600 r.p.m.

Shaping

Test samples were shaped on a double spindle shaper operating at 7,200 r.p.m. Grading was based on smoothness of surface. Defects such as raised, fuzzy, or chipped grain, which would require additional sanding to make acceptable shaping work, were taken into account. Madrone shaped more smoothly on the end grain than any wood yet tested, and California laurel showed up well also. The tanbark oak shaped fairly well, but chinquapin, owing largely to rough end grain cutting and feather edges, was moderately poor. A comparison of the shaping of these four woods with four well-known eastern hardwoods follows:

Madrone	produced 75 percent of good to excellent shaping
Hard maple	produced 62 percent of good to excellent shaping
California laurel	produced 60 percent of good to excellent shaping

Birch	produced 53 percent of good to excellent shaping
Tanbark oak	produced 39 percent of good to excellent shaping
White oak	produced 28 percent of good to excellent shaping
Chinquapin	produced 25 percent of good to excellent shaping
Sweetgum (red or sap gum)	produced 21 percent of good to excellent shaping

Turning

Turnings were cut by means of a milled-to-pattern knife, which insured uniformity of size and shape. The pattern contained the head, the cove, and cuts at different angles to the grain. Turnings were then carefully graded with special reference to sharpness of detail and smoothness of cut. Madrone and California laurel both turned very well requiring a minimum of subsequent sanding. Tanbark oak and chinquapin may be considered fair turning woods. The latter often showed a tendency toward minute roughness. These woods compared with three well-known eastern hardwoods as shown below:

Black walnut	produced 91 percent of good to excellent turnings
Madrone	produced 88 percent of good to excellent turnings
California laurel	produced 86 percent of good to excellent turnings
Tanbark oak	produced 81 percent of good to excellent turnings
Birch	produced 80 percent of good to excellent turnings
Chinquapin	produced 77 percent of good to excellent turnings
Cottonwood	produced 70 percent of good to excellent turnings

Boring

A series of 1-inch holes was bored using a standard type wood bit driven at 2,400 r.p.m. in a small boring machine. The holes were examined and graded for smoothness of cut, then measured by means of a plug gage for trueness to size. The madrone, California laurel, and tanbark oak were equal to any woods tested for smoothness of cut, and the chinquapin was good. But when it comes to trueness to size the chinquapin and California laurel were no better than fair, while the madrone and tanbark oak were among the more favorable woods. For most uses, however, smoothness of cut is the more important consideration and the comparison which follows is based on smoothness of cut only:

Black walnut	produced 100 percent of good to excellent samples
Madrone	produced 100 percent of good to excellent samples
California laurel	produced 100 percent of good to excellent samples
Tanbark oak	produced 100 percent of good to excellent samples
White oak	produced 95 percent of good to excellent samples
Sweetgum (red or sap gum)	produced 92 percent of good to excellent samples
Chinquapin	produced 90 percent of good to excellent samples
Cottonwood	produced 70 percent of good to excellent samples

Mortising

A series of half inch square mortises was cut using a standard type hollow chisel mortiser. The finished mortises were examined and graded for smoothness of cut, and measured with a steel gage for trueness to size. The California laurel and tanbark oak mortised as smoothly as any of the woods that have been tested. Madrone and chinquapin, although not quite so good, belong among the better woods in this respect. The chinquapin and tanbark oak rate good in trueness to size of mortises, while the California laurel and madrone rate fair. The following comparison is based on smoothness of cut only:

White oak	produced	100	percent of fair to excellent mortises
Tanbark oak	produced	100	percent of fair to excellent mortises
California laurel	produced	100	percent of fair to excellent mortises
Hard maple	produced	95	percent of fair to excellent mortises
Madrone	produced	95	percent of fair to excellent mortises
Chinquapin	produced	90	percent of fair to excellent mortises
Yellow-poplar	produced	63	percent of fair to excellent mortises
Cottonwood	produced	52	percent of fair to excellent mortises

Sanding

Equipment for making sanding tests that are strictly comparable with earlier tests was not available. Some machine sanding tests were made, however, using a small drum and garnet abrasive with different sizes of grit. These tests are believed to be sufficient to answer the chief questions relating to their sanding properties and to permit approximate comparisons with other hardwoods in this respect.

Based on limited tests, tanbark oak, chinquapin, and California laurel showed only slightly scratching tendencies, and would be expected to fall among the best third of the species listed in table 1, which is based on the use of 2/0 grit. Madrone, owing to its much finer texture, would be more subject to scratching and would require 3/0 or possibly 4/0 grit for equally good results.

In freedom from fuzzing tendencies madrone should rank with the very best of the table 1 woods, with tanbark oak and California laurel probably in the top third. Chinquapin has definite fuzzing tendencies, and probably belongs somewhat below the middle of the list.

Specific Gravity of the Test Material

Although specific gravity is not in itself a machining property it has a bearing on such machining factors as power consumption and rate of dulling of tools. As a general rule, the heavier the wood, the more power is required to cut it and the more rapidly it dulls the cutting tools. The amounts dealt with were too small to produce any significant dulling effect, and no actual power measurements were taken. It was very noticeable, however, that an exceptional effort was required to pass any of the heavy ones through a hand-feed machine, such as a jointer or table saw.

Three of the four woods in this study, madrone, California laurel, and tanbark oak, are relatively heavy. The only moderately light one is chinquapin. The following tabulation gives specific gravity figures for the four western hardwoods and four common eastern hardwoods for comparison. Figures are based on oven-dry weight and volume:

Species	Specific gravity
Cottonwood	0.43
Chinquapin	.49
Sweetgum (red or sap gum)	.53
California laurel	.69
Yellow birch	.66
Madrone	.72
White oak	.71
Tanbark oak	.74

Summary

Madrone, tanbark oak, and California laurel are heavier and harder than most of our native hardwoods. They would probably require more power to machine, and they probably dull tools somewhat more rapidly than do lighter and softer hardwoods. On the other hand, they tend to give very good results when it comes to smoothness of cut. Chinquapin is considerably lighter and softer, and does not machine so smoothly as a rule, although it offers less resistance to the cutting action of the tools.

The principal machining properties of 29 hardwoods, including the four West Coast woods referred to above, are shown in table 1. The arrangement of species is alphabetical.

Table 1.--Some machining properties of hardwoods

Species	Planing	Shaping	Turning	Boring	Mortising	Sanding
	Defect-free pieces	Good to excellent pieces	Good to excellent pieces	Good to excellent pieces	Fair to excellent pieces	Good to excellent pieces
	Percent	Percent	Percent	Percent	Percent	Percent
Ash	75	51	79	94	62	75
Basswood	64	9	68	75	51	17
Beech		21	90	99	93	49
Birch	63	53	80	98	97	34
Buckeye		6	58	75	18	
Cottonwood	21	3	70	70	52	19
Chestnut	74	24	87	91	72	64
Chinquapin	75	25	77	90	90	
Elm	33	11	65	94	75	66
Gum, black	48	23	75	82	24	21
Hackberry	74	10	77	99	70	
Hickory		19	84	100	98	80
Laurel, California	40	60	86	100	100	
Madrone	90	75	88	100	95	
Magnolia	65	25	79	69	32	37
Mahogany	80	68	89	100	100	
Maple, hard	54	62	82	99	95	38
Maple, soft	41	22	76	80	36	37
Oak, chestnut		23	90	100	100	75
Oak, red	91	21	84	99	100	81
Oak, tanbark	80	39	81	100	100	
Oak, white	87	28	85	95	100	83
Pecan	88	31	89	100	100	
Sweetgum (red or sap gum)	51	21	86	92	58	23
Sycamore	22	8	85	98	96	21
Tupelo		43	79	62	35	34
Walnut, black	62	34	91	100	98	
Willow	52	5	58	71	24	24
Yellow-poplar	70	12	81	87	63	19