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LIMITED EVALUATION OF PHYSICAL AND MECHANICAL PROPERTIES OF NEPAL ALDER GROWN IN HAWAII

LIMITED EVALUATION OF PHYSICAL AND MECHANICAL PROPERTIES OF NEPAL ALDER GROWN IN HAWAII

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Summary

Nepal alder (*Alnus nepalensis*) grown in Hawaii was evaluated for shrinkage, strength in bending, and hardness. This Hawaii-grown wood was comparable in bending strength to wood of the same species grown in Bengal, India, but was lower in modulus of elasticity and exhibited greater hardness and shrinkage. It was also harder than such Mainland species as aspen (*Populus tremuloides*) and ponderosa pine (*Pinus ponderosa*) but softer than red alder (Alnus rubra). It was comparable in bending strength to aspen but was somewhat lower in modulus of elasticity. Shrinkage in radial and tangential directions was less than in red alder and only slightly more than in aspen and ponderosa pine.

Introduction

A number of fast-growing foreign timber species have been introduced over a period of time to rehabilitate damaged watersheds in Hawaii.[2] The wildland research program for Hawaii has in part the objective to investigate those introduced timber species capable of supporting a large timber industry.[3] One species showing promise is Nepal alder (*Alnus nepalensis*). Introduced into Hawaii before 1930, it has done well in certain areas and is thought to be suitable for more extensive planting to provide a future source of furniture and cabinet wood.

[1] Maintained at Madison, Wisc., in cooperation with the University of Wisconsin.
[2] Carlson, N. K. Honaunau forest. American Forests 66(4):16-18. 1960.
[3] Hawaii Department of Agriculture and Conservation. A wildland research plan for Hawaii. State of Hawaii. 71 pp.. illus. September 1960.

The Indian Forest Research Institute has reported physical and mechanical properties of Nepal alder grown near Darjeeling, Bengal.[4] Trees sampled were about 25 years old and averaged 16 inches in diameter at breast height.

Because such properties had not been evaluated for wood of this species grown in Hawaii, research was undertaken at the Forest Products Laboratory in collaboration with the Pacific Southwest Forest and Range Experiment Station and the Forestry Division, Hawaii Department of Land and Natural Resources, to determine those properties important for the intended use. Hawaii-grown trees sampled for this study were comparable in age and size to the trees from India.

Description of Material

Sample trees were part of a 26-year-old Nepal alder plantation located about 3-1/2 miles from Waimea in the Kohala Forest Reserve on the island of Hawaii, where precipitation averages about 129 inches annually, and temperatures range between 40° and 80° F. The site was an undulating ridge at an elevation of about 3,050 feet where clay loam soil of medium-to-poor drainage remained wet and numerous streams were present.

The alder plantation was in medium pathological condition. An unknown butt rot caused partial decay to roots and trunks of some trees. Trees selected for sampling ranged in size from 19 to 21 inches in diameter at breast height and 79 to 101 feet high, of which 28 to 59 feet was merchantable. At Hawaiian Fern-Wood, Ltd. in Hilo, cants 5 feet long and 6 inches thick were cut from logs representing the 10- to 18-foot height of five trees. Cants were brush coated with pentachlorophenol, then coated with an emulsified wax prior to shipment. Representative pictures of the standing trees and a picture of the cants prepared for shipment are shown in figure 1. The cant cross sections are shown in figure 2.

Procedures

Since this study was limited to evaluating properties important for furniture and cabinet. wood uses, only shrinkage, static bending, and hardness properties were studied. Standard methods of selecting radial and tangential shrinkage specimens were used [5] but, because of limited material, specimens for shrinkage

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[4]Sekhar, A. C., and Bhatnagar, S. S. Physical and mechanical properties of woods tested at Forest Research Institute. Report VII, Indian Forest Records (N.S.) Timber Mechanics 1(8): 148-154. 1957.

[5]American Society for Testing and Materials. Standard methods of testing small clear specimens of timber. ASTM D 143-52.

in volume consisted of one 1-inch-thick cross section of each cant. The remainder of each cant was ripped into 2–1/2–inch–square sticks. Alternate sticks from bark–to–bark were designated for strength tests of the green wood and the other sticks for tests of air–dry wood. One static bending specimen and one hardness specimen of standard size were cut from each stick, and a longitudinal shrinkage specimen 1 inch square by 10 inches along the grain was cut from each stick used for green specimens.

Shrinkages from the green condition, other than volumetric, were determined at 80, 64, and 30 percent relative humidity at 80° F. and at the ovendry condition. Volumetric shrinkage was determined from green to ovendry. Testing for mechanical properties followed standard procedures.[5]

Presentation of Results

Data on shrinkage are presented in table 1. Static bending and hardness data for green and air–dry material are presented in table 2. Published data for Nepal alder grown in Bengal, India,[4] and for a few Mainland species[6] are included in both tables for comparison. Data on variation in strength and related properties for green wood are presented in table 3. It may be assumed that these values are also characteristic of the air–dry wood.

Discussion of Results

Nepal alder evaluated in this study generally did not contain interlocked grain typical of some other species from Hawaii that have been evaluated at this Laboratory. However, it did have some distorted grain and probably some reaction wood as evidenced by the irregularity of growth rings. Shrinkage above normal and strength below normal for its specific gravity can be expected for reaction wood. Distorted grain can be expected to affect such properties as longitudinal shrinkage and static bending, as components of perpendicular–to–grain characteristics detract from normal straight–grain characteristics. Because of presence of some distorted grain and the likely presence of some reaction wood, longitudinal shrinkage averaged somewhat higher than is normally expected for straight–grained wood. Shrinkage of wood in the transverse directions would not be appreciably affected by distorted grain, and radial and tangential shrinkage averages were about what could be expected for a species of this specific gravity. Volumetric shrinkage data as determined in this study appear somewhat low in

[6] Markwardt, L. J., and Wilson, T. R. C. Strength and related properties of woods grown in the United States. U.S. Dept. Agr. Tech. Bull. 479, 99 pp., illus. 1935.

comparison to data obtained for individual directions. Since volumetric shrinkage was determined for the full cross section of each cant, the data represent more material than the other shrinkage data; however, the values could be somewhat low because of more restraint during drying.

Several static bending specimens were culled because of failure influenced by knots or distorted grain that might have been associated with growth about knots, but not all accepted specimens were clear straight–grained material. Specimens from tree 2 contained varying amounts of distorted grain.

Normally, shrinkage and strength increase with specific gravity. This was not the case for material in this study. Shrinkages observed for specimens from the tree of lowest specific gravity averaged higher than those observed in specimens from three of the other trees, and strength of specimens from the tree of highest specific gravity averaged lower than that of specimens from three of the other trees except for side hardness in green wood and end and side hardness in air-dry wood. Part of the strength characteristics of the tree of highest specific gravity were probably influenced by grain characteristics.

Nepal alder grown in Hawaii was slightly more dense and showed greater shrinkage than wood of the same species grown in Bengal, India. The green wood was harder, about the same in static bending strength, but was lower in modulus of elasticity. Properties of air–dry wood may be compared with less assurance because only one tree was used for the Indian evaluation. However, modulus of elasticity appeared low in the air–dry wood from Hawaii in comparison to other strength properties.

Wood of Hawaii–grown Nepal alder was as strong as aspen from the Mainland, but modulus of elasticity was less. It was harder than either aspen or ponderosa pine, but hardness and strength were less than those of red alder. It shrank less than red alder, aspen, or ponderosa pine.

Conclusions

Data developed from this limited evaluation of small clear specimens of Nepal alder grown in Hawaii lead to the following conclusions:

(1) Bending strength is comparable to wood of the same species grown in Bengal, India, but flexural modulus of elasticity is lower.

(2) Compared to the same wood, it is harder but also shrinks more.

(3) It is comparable in strength but lower in stiffness than Mainland aspen, harder than either aspen or ponderosa pine, but weaker and softer than red alder. However, it has less shrinkage than red alder, aspen, or ponderosa pine.

Table 1.--Shrinkage and specific gravity of Nepal alder grown in Hawaii and India, and three Mainland species

Tree	Specific gravity[1]	Shrinkage from green condition to--															
		80° F., 80 percent relative humidity				75° F., 64 percent relative humidity				80° F., 30 percent relative humidity				Ovendry			
		Moisture content	Radial	Tangential	Longitudinal	Moisture content	Radial	Tangential	Longitudinal	Moisture content	Radial	Tangential	Longitudinal	Radial	Tangential	Longitudinal	Volumetric
		Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.
Nepal alder (Hawaii)																	
1	0.28	19.7	1.5	3.6	0.04	14.0	2.2	4.8	0.06	6.5	3.3	6.2	0.13	4.1	7.5	0.22	10.4
2	.38	19.6	2.1	3.5	.07	14.1	2.9	4.7	.12	6.6	4.2	6.3	.21	5.2	7.6	.32	11.5
3	.33	19.6	1.3	2.5	.02	14.0	2.0	3.7	.05	6.5	3.1	5.3	.11	3.9	6.4	.19	9.6
5	.35	19.5	.9	2.3	.04	14.1	1.5	3.4	.09	6.5	2.7	5.1	.15	3.4	6.2	.21	8.8
6	.36	19.4	.9	2.6	.05	14.0	1.6	3.9	.08	6.4	2.8	5.5	.16	3.6	6.5	.25	9.2
Average	.34	19.6	1.4	2.9	.04	14.0	2.0	4.1	.08	6.5	3.2	5.7	.15	4.0	6.8	.24	9.9
Nepal alder (India)[2]	.32	....	......	....	....	[3]11.9	[3]1.3	[3]3.6	....	....	......	....	....	2.4	6.0	....	9.3
Mainland[4]																	
Red alder	.37	....	......	....	....	....	......	....	....	....	......	....	....	4.4	7.3	....	12.6
Quaking aspen	.35	....	......	....	....	....	......	....	....	....	......	....	....	3.5	6.7	....	11.5
Ponderosa pine	.38	....	......	....	....	....	......	....	....	....	......	....	....	3.9	6.3	....	9.6

[1] Based on green volume and ovendry weight.

[2] Report VII, Indian Forest Records.

[3] Atmospheric storage conditions not specified.

[4] U.S. Dept. Agr. Tech. Bul. No. 479.

Table 2.--Mechanical properties of Nepal alder grown in Hawaii and India, and three Mainland species

Tree	Bolt No.	Moisture content	Specific gravity[1]	Static bending: Stress at proportional limit	Static bending: Modulus of rupture	Static bending: Modulus of elasticity	Static bending: Work to-- Proportional limit	Static bending: Work to-- Maximum load	Hardness: End	Hardness: Side
				P.s.i.	P.s.i.	1,000 p.s.i.	In.-lb. per cu. in.	In.-lb. per cu. in.	Lb.	Lb.
				NEPAL ALDER (HAWAII)						
1	C-D	120	0.28	2,100	4,100	710	0.37	6.6	390	360
2	C-D	99	.38	2,500	5,200	780	.47	7.3	520	520
3	C-D	103	.33	2,700	5,500	870	.46	10.9	530	440
5	C-D	105	.35	3,200	6,100	870	.67	8.7	580	500
6	C-D	91	.36	2,700	5,600	870	.50	12.1	580	490
	Average:	103	.34	2,600	5,300	820	.49	9.1	520	460
1	C-D	12.8	.33	4,700	7,200	1,010	1.23	5.3	560	410
2	C-D	13.2	.40	5,000	7,900	980	1.44	5.0	880	640
3	C-D	12.8	.34	4,100	8,000	1,040	.93	7.9	690	420
5	C-D	12.8	.38	5,400	9,100	1,010	1.58	7.9	860	530
6	C-D	13.0	.39	4,700	8,800	990	1.23	10.1	810	560
	Average:	12.9	.37	4,800	8,200	1,010	1.28	7.2	760	510
Adjusted to:		12.0	.37	5,000	8,500	1,020	1.37	7.1	780	510
				NEPAL ALDER (INDIA)[2,3]						
		88	.32	3,000	5,200	920	.59	4.6	400	320
		12	.33	4,300	7,400	1,200	1.03	3.7	640	380
				MAINLAND RED ALDER[4]						
		98	.37	3,800	6,500	1,170	.70	8.0	550	440
		12	.41	6,900	9,800	1,380	1.85	8.4	980	590
				MAINLAND QUAKING ASPEN[4]						
		94	.35	3,200	5,100	860	.69	6.4	280	300
		12	.38	5,600	8,400	1,180	1.53	7.6	510	350
				MAINLAND PONDEROSA PINE[4]						
		91	.38	3,100	5,000	970	.59	5.1	300	310
		12	.40	6,300	9,200	1,260	1.85	6.6	550	450

[1]Based on volume at test and ovendry weight.

[2]Green values based on 5 trees, air-dry values based on 1 tree.

[3]Report VII, Indian Forest Records.

[4]U.S. Dept. Agr. Tech. Bul. No. 479.

Table 3.--Variation of strength and related properties of Nepal alder grown in Hawaii (green condition)

Property	Number of specimens	Mean value					Standard deviation					Coefficient of variation	Standard error of mean				
			Pct.	P.s.i.	In.-lb. per cu. in.	Lb.		Pct.	P.s.i.	In.-lb. per cu. in.	Lb.	Pct.		Pct.	P.s.i.	In.-lb. per cu. in.	Lb.
Specific gravity[1]	21	0.34					0.04					13	0.01				
Shrinkage[2]																	
Radial	15		4.0					0.8				20		0.2			
Tangential	20		6.8					1.0				14		.2			
Longitudinal	21		.24					.10				42		.02			
Static bending																	
Stress at proportional limit	18			2,640					790			30			190		
Modulus of rupture	18			5,270					1,120			21			260		
Modulus of elasticity	18			819,000					169,000			21			40,000		
Work to proportional limit	18				0.49					0.23		47				0.05	
Work to maximum load	18				9.1					2.9		32				.7	
Hardness (ball test)																	
End	21					524					106	20					23
Side	21					464					89	19					19

[1] Green volume and ovendry weight.

[2] Green to ovendry.

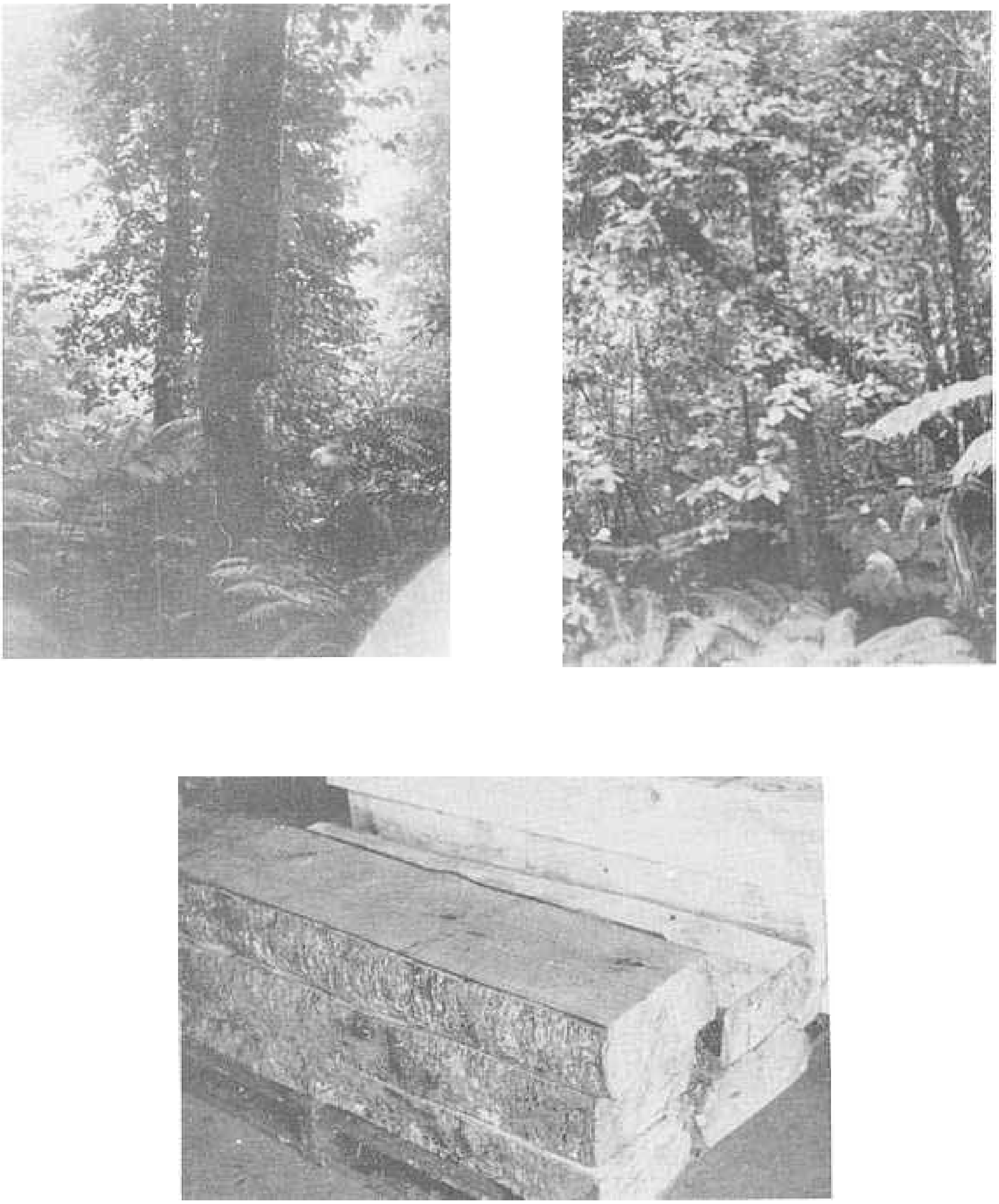

Figure 1. Representative pictures of Nepal alder plantation and cants prepared for shipment.

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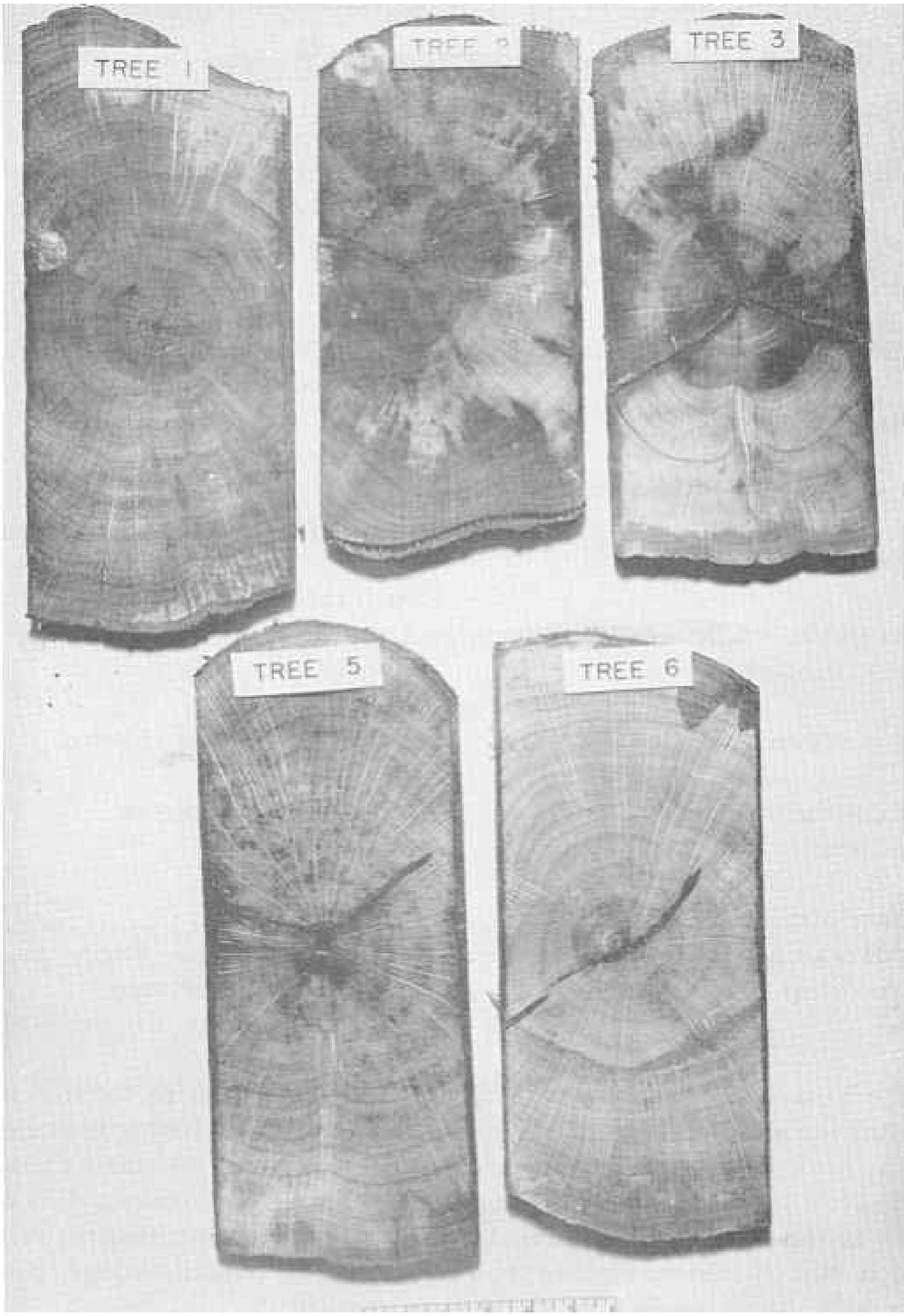

Figure 2.--Cross sections of Nepal alder cants that provided specimens for this study.

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