

Chapter 5 Mechanical Properties of Wood

Table 5–3b. Strength properties of some commercially important woods grown in the United States (inch–pound)^a

Common species names	Moisture content	Specific gravity ^b	Static bending					Compression parallel to grain (lbf in ⁻²)	Compression perpendicular to grain (lbf in ⁻²)	Shear parallel to grain (lbf in ⁻²)	Tension perpendicular to grain (lbf in ⁻²)	Side hardness (lbf)
			Modulus of rupture (lbf in ⁻²)	Modulus of elasticity ^c (×10 ⁶ lbf in ⁻²)	Work to maximum load (in-lbf in ⁻³)	Impact bending (in.)						
Hardwoods												
Alder, red	Green	0.37	6,500	1.17	8.0	22	2,960	250	770	390	440	
	12%	0.41	9,800	1.38	8.4	20	5,820	440	1,080	420	590	
Ash												
Black	Green	0.45	6,000	1.04	12.1	33	2,300	350	860	490	520	
	12%	0.49	12,600	1.60	14.9	35	5,970	760	1,570	700	850	
Blue	Green	0.53	9,600	1.24	14.7	—	4,180	810	1,540	—	—	
	12%	0.58	13,800	1.40	14.4	—	6,980	1,420	2,030	—	—	
Green	Green	0.53	9,500	1.40	11.8	35	4,200	730	1,260	590	870	
	12%	0.56	14,100	1.66	13.4	32	7,080	1,310	1,910	700	1,200	
Oregon	Green	0.50	7,600	1.13	12.2	39	3,510	530	1,190	590	790	
	12%	0.55	12,700	1.36	14.4	33	6,040	1,250	1,790	720	1,160	
White	Green	0.55	9,500	1.44	15.7	38	3,990	670	1,350	590	960	
	12%	0.60	15,000	1.74	16.6	43	7,410	1,160	1,910	940	1,320	
Aspen												
Bigtooth	Green	0.36	5,400	1.12	5.7	—	2,500	210	730	—	—	
	12%	0.39	9,100	1.43	7.7	—	5,300	450	1,080	—	—	
Quaking	Green	0.35	5,100	0.86	6.4	22	2,140	180	660	230	300	
	12%	0.38	8,400	1.18	7.6	21	4,250	370	850	260	350	
Basswood, American	Green	0.32	5,000	1.04	5.3	16	2,220	170	600	280	250	
	12%	0.37	8,700	1.46	7.2	16	4,730	370	990	350	410	
Beech, American	Green	0.56	8,600	1.38	11.9	43	3,550	540	1,290	720	850	
	12%	0.64	14,900	1.72	15.1	41	7,300	1,010	2,010	1,010	1,300	
Birch												
Paper	Green	0.48	6,400	1.17	16.2	49	2,360	270	840	380	560	
	12%	0.55	12,300	1.59	16.0	34	5,690	600	1,210	—	910	
Sweet	Green	0.60	9,400	1.65	15.7	48	3,740	470	1,240	430	970	
	12%	0.65	16,900	2.17	18.0	47	8,540	1,080	2,240	950	1,470	
Yellow	Green	0.55	8,300	1.50	16.1	48	3,380	430	1,110	430	780	
	12%	0.62	16,600	2.01	20.8	55	8,170	970	1,880	920	1,260	
Butternut	Green	0.36	5,400	0.97	8.2	24	2,420	220	760	430	390	
	12%	0.38	8,100	1.18	8.2	24	5,110	460	1,170	440	490	
Cherry, black	Green	0.47	8,000	1.31	12.8	33	3,540	360	1,130	570	660	
	12%	0.50	12,300	1.49	11.4	29	7,110	690	1,700	560	950	
Chestnut, American	Green	0.40	5,600	0.93	7.0	24	2,470	310	800	440	420	
	12%	0.43	8,600	1.23	6.5	19	5,320	620	1,080	460	540	
Cottonwood												
Balsam, poplar	Green	0.31	3,900	0.75	4.2	—	1,690	140	500	—	—	
	12%	0.34	6,800	1.10	5.0	—	4,020	300	790	—	—	
Black	Green	0.31	4,900	1.08	5.0	20	2,200	160	610	270	250	
	12%	0.35	8,500	1.27	6.7	22	4,500	300	1,040	330	350	
Eastern	Green	0.37	5,300	1.01	7.3	21	2,280	200	680	410	340	
	12%	0.40	8,500	1.37	7.4	20	4,910	380	930	580	430	
Elm												
American	Green	0.46	7,200	1.11	11.8	38	2,910	360	1,000	590	620	
	12%	0.50	11,800	1.34	13.0	39	5,520	690	1,510	660	830	
Rock	Green	0.57	9,500	1.19	19.8	54	3,780	610	1,270	—	940	
	12%	0.63	14,800	1.54	19.2	56	7,050	1,230	1,920	—	1,320	
Slippery	Green	0.48	8,000	1.23	15.4	47	3,320	420	1,110	640	660	
	12%	0.53	13,000	1.49	16.9	45	6,360	820	1,630	530	860	
Hackberry	Green	0.49	6,500	0.95	14.5	48	2,650	400	1,070	630	700	
	12%	0.53	11,000	1.19	12.8	43	5,440	890	1,590	580	880	

Table 5–3b. Strength properties of some commercially important woods grown in the United States (inch–pound)^a—con.

Common species names	Moisture content	Specific gravity ^b	Static bending			Impact bending (in.)	Compression parallel to grain (lbf in ⁻²)	Compression perpendicular to grain (lbf in ⁻²)	Shear parallel to grain (lbf in ⁻²)	Tension perpendicular to grain (lbf in ⁻²)	Side hardness (lbf)
			Modulus of rupture (lbf in ⁻²)	Modulus of elasticity ^c (×10 ⁶ lbf in ⁻²)	Work to maximum load (in-lbf in ⁻³)						
Hickory, pecan											
Bitternut	Green	0.60	10,300	1.40	20.0	66	4,570	800	1,240	—	—
	12%	0.66	17,100	1.79	18.2	66	9,040	1,680	—	—	—
Nutmeg	Green	0.56	9,100	1.29	22.8	54	3,980	760	1,030	—	—
	12%	0.60	16,600	1.70	25.1	—	6,910	1,570	—	—	—
Pecan	Green	0.60	9,800	1.37	14.6	53	3,990	780	1,480	680	1,310
	12%	0.66	13,700	1.73	13.8	44	7,850	1,720	2,080	—	1,820
Water	Green	0.61	10,700	1.56	18.8	56	4,660	880	1,440	—	—
	12%	0.62	17,800	2.02	19.3	53	8,600	1,550	—	—	—
Hickory, true^d											
Mockernut	Green	0.64	11,100	1.57	26.1	88	4,480	810	1,280	—	1,440
	12%	0.72	19,200	2.22	22.6	77	8,940	1,730	1,740	—	1,970
Pignut	Green	0.66	11,700	1.65	31.7	89	4,810	920	1,370	—	1,520
	12%	0.75	20,100	2.26	30.4	74	9,190	1,980	2,150	—	2,140
Shagbark	Green	0.64	11,000	1.57	23.7	74	4,580	840	1,520	—	1,460
	12%	0.72	20,200	2.16	25.8	67	9,210	1,760	2,430	—	1,880
Shellbark	Green	0.62	10,500	1.34	29.9	104	3,920	810	1,190	—	1,670
	12%	0.69	18,100	1.89	23.6	88	8,000	1,800	2,110	—	1,810
Honeylocust	Green	0.60	10,200	1.29	12.6	47	4,420	1,150	1,660	930	1,390
	12%	—	14,700	1.63	13.3	47	7,500	1,840	2,250	900	1,580
Locust, black	Green	0.66	13,800	1.85	15.4	44	6,800	1,160	1,760	770	1,570
	12%	0.69	19,400	2.05	18.4	57	10,180	1,830	2,480	640	1,700
Magnolia											
Cucumbertree	Green	0.44	7,400	1.56	10.0	30	3,140	330	990	440	520
	12%	0.48	12,300	1.82	12.2	35	6,310	570	1,340	660	700
Southern	Green	0.46	6,800	1.11	15.4	54	2,700	460	1,040	610	740
	12%	0.50	11,200	1.40	12.8	29	5,460	860	1,530	740	1,020
Maple											
Bigleaf	Green	0.44	7,400	1.10	8.7	23	3,240	450	1,110	600	620
	12%	0.48	10,700	1.45	7.8	28	5,950	750	1,730	540	850
Black	Green	0.52	7,900	1.33	12.8	48	3,270	600	1,130	720	840
	12%	0.57	13,300	1.62	12.5	40	6,680	1,020	1,820	670	1,180
Red	Green	0.49	7,700	1.39	11.4	32	3,280	400	1,150	—	700
	12%	0.54	13,400	1.64	12.5	32	6,540	1,000	1,850	—	950
Silver	Green	0.44	5,800	0.94	11.0	29	2,490	370	1,050	560	590
	12%	0.47	8,900	1.14	8.3	25	5,220	740	1,480	500	700
Sugar	Green	0.56	9,400	1.55	13.3	40	4,020	640	1,460	—	970
	12%	0.63	15,800	1.83	16.5	39	7,830	1,470	2,330	—	1,450
Oak, red											
Black	Green	0.56	8,200	1.18	12.2	40	3,470	710	1,220	—	1,060
	12%	0.61	13,900	1.64	13.7	41	6,520	930	1,910	—	1,210
Cherrybark	Green	0.61	10,800	1.79	14.7	54	4,620	760	1,320	800	1,240
	12%	0.68	18,100	2.28	18.3	49	8,740	1,250	2,000	840	1,480
Laurel	Green	0.56	7,900	1.39	11.2	39	3,170	570	1,180	770	1,000
	12%	0.63	12,600	1.69	11.8	39	6,980	1,060	1,830	790	1,210
Northern red	Green	0.56	8,300	1.35	13.2	44	3,440	610	1,210	750	1,000
	12%	0.63	14,300	1.82	14.5	43	6,760	1,010	1,780	800	1,290
Pin	Green	0.58	8,300	1.32	14.0	48	3,680	720	1,290	800	1,070
	12%	0.63	14,000	1.73	14.8	45	6,820	1,020	2,080	1,050	1,510
Scarlet	Green	0.60	10,400	1.48	15.0	54	4,090	830	1,410	700	1,200
	12%	0.67	17,400	1.91	20.5	53	8,330	1,120	1,890	870	1,400
Southern red	Green	0.52	6,900	1.14	8.0	29	3,030	550	930	480	860
	12%	0.59	10,900	1.49	9.4	26	6,090	870	1,390	510	1,060

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Common species names	Moisture content	Specific gravity ^b	Static bending					Compression parallel to grain (lbf in ⁻²)	Compression perpendicular to grain (lbf in ⁻²)	Shear parallel to grain (lbf in ⁻²)	Tension perpendicular to grain (lbf in ⁻²)	Side hardness (lbf)
			Modulus of rupture (lbf in ⁻²)	Modulus of elasticity ^c (×10 ⁶ lbf in ⁻²)	Work to maximum load (in-lbf in ⁻³)	Impact bending (in.)						
Oak, red—con.												
Water	Green	0.56	8,900	1.55	11.1	39	3,740	620	1,240	820	1,010	
	12%	0.63	15,400	2.02	21.5	44	6,770	1,020	2,020	920	1,190	
Willow	Green	0.56	7,400	1.29	8.8	35	3,000	610	1,180	760	980	
	12%	0.69	14,500	1.90	14.6	42	7,040	1,130	1,650	—	1,460	
Oak, white												
Bur	Green	0.58	7,200	0.88	10.7	44	3,290	680	1,350	800	1,110	
	12%	0.64	10,300	1.03	9.8	29	6,060	1,200	1,820	680	1,370	
Chestnut	Green	0.57	8,000	1.37	9.4	35	3,520	530	1,210	690	890	
	12%	0.66	13,300	1.59	11.0	40	6,830	840	1,490	—	1,130	
Live	Green	0.80	11,900	1.58	12.3	—	5,430	2,040	2,210	—	—	
	12%	0.88	18,400	1.98	18.9	—	8,900	2,840	2,660	—	—	
Overcup	Green	0.57	8,000	1.15	12.6	44	3,370	540	1,320	730	960	
	12%	0.63	12,600	1.42	15.7	38	6,200	810	2,000	940	1,190	
Post	Green	0.60	8,100	1.09	11.0	44	3,480	860	1,280	790	1,130	
	12%	0.67	13,200	1.51	13.2	46	6,600	1,430	1,840	780	1,360	
Swamp chestnut	Green	0.60	8,500	1.35	12.8	45	3,540	570	1,260	670	1,110	
	12%	0.67	13,900	1.77	12.0	41	7,270	1,110	1,990	690	1,240	
Swamp white	Green	0.64	9,900	1.59	14.5	50	4,360	760	1,300	860	1,160	
	12%	0.72	17,700	2.05	19.2	49	8,600	1,190	2,000	830	1,620	
White	Green	0.60	8,300	1.25	11.6	42	3,560	670	1,250	770	1,060	
	12%	0.68	15,200	1.78	14.8	37	7,440	1,070	2,000	800	1,360	
Sassafras	Green	0.42	6,000	0.91	7.1	—	2,730	370	950	—	—	
	12%	0.46	9,000	1.12	8.7	—	4,760	850	1,240	—	—	
Sweetgum	Green	0.46	7,100	1.20	10.1	36	3,040	370	990	540	600	
	12%	0.52	12,500	1.64	11.9	32	6,320	620	1,600	760	850	
Sycamore, American	Green	0.46	6,500	1.06	7.5	26	2,920	360	1,000	630	610	
	12%	0.49	10,000	1.42	8.5	26	5,380	700	1,470	720	770	
Tanoak	Green	0.58	10,500	1.55	13.4	—	4,650	—	—	—	—	
	12%	—	—	—	—	—	—	—	—	—	—	
Tupelo												
Black	Green	0.46	7,000	1.03	8.0	30	3,040	480	1,100	570	640	
	12%	0.50	9,600	1.20	6.2	22	5,520	930	1,340	500	810	
Water	Green	0.46	7,300	1.05	8.3	30	3,370	480	1,190	600	710	
	12%	0.50	9,600	1.26	6.9	23	5,920	870	1,590	700	880	
Walnut, Black	Green	0.51	9,500	1.42	14.6	37	4,300	490	1,220	570	900	
	12%	0.55	14,600	1.68	10.7	34	7,580	1,010	1,370	690	1,010	
Willow, Black	Green	0.36	4,800	0.79	11.0	—	2,040	180	680	—	—	
	12%	0.39	7,800	1.01	8.8	—	4,100	430	1,250	—	—	
Yellow-poplar	Green	0.40	6,000	1.22	7.5	26	2,660	270	790	510	440	
	12%	0.42	10,100	1.58	8.8	24	5,540	500	1,190	540	540	
Softwoods												
Baldcypress	Green	0.42	6,600	1.18	6.6	25	3,580	400	810	300	390	
	12%	0.46	10,600	1.44	8.2	24	6,360	730	1,000	270	510	
Cedar												
Atlantic white	Green	0.31	4,700	0.75	5.9	18	2,390	240	690	180	290	
	12%	0.32	6,800	0.93	4.1	13	4,700	410	800	220	350	
Eastern redcedar	Green	0.44	7,000	0.65	15.0	35	3,570	700	1,010	330	650	
	12%	0.47	8,800	0.88	8.3	22	6,020	920	—	—	—	
Incense	Green	0.35	6,200	0.84	6.4	17	3,150	370	830	280	390	
	12%	0.37	8,000	1.04	5.4	17	5,200	590	880	270	470	
Northern White	Green	0.29	4,200	0.64	5.7	15	1,990	230	620	240	230	
	12%	0.31	6,500	0.80	4.8	12	3,960	310	850	240	320	

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Common species names	Moisture content	Specific gravity ^b	Static bending			Impact bending (in.)	Compression parallel to grain (lbf in ⁻²)	Compression perpendicular to grain (lbf in ⁻²)	Shear parallel to grain (lbf in ⁻²)	Tension perpendicular to grain (lbf in ⁻²)	Side hardness (lbf)
			Modulus of rupture (lbf in ⁻²)	Modulus of elasticity ^c (×10 ⁶ lbf in ⁻²)	Work to maximum load (in-lbf in ⁻³)						
Cedar—con.											
Port-Orford	Green	0.39	6,600	1.30	7.4	21	3,140	300	840	180	380
	12%	0.43	12,700	1.70	9.1	28	6,250	720	1,370	400	630
Western redcedar	Green	0.31	5,200	0.94	5.0	17	2,770	240	770	230	260
	12%	0.32	7,500	1.11	5.8	17	4,560	460	990	220	350
Yellow	Green	0.42	6,400	1.14	9.2	27	3,050	350	840	330	440
	12%	0.44	11,100	1.42	10.4	29	6,310	620	1,130	360	580
Douglas-fir ^e											
Coast	Green	0.45	7,700	1.56	7.6	26	3,780	380	900	300	500
	12%	0.48	12,400	1.95	9.9	31	7,230	800	1,130	340	710
Interior West	Green	0.46	7,700	1.51	7.2	26	3,870	420	940	290	510
	12%	0.50	12,600	1.83	10.6	32	7,430	760	1,290	350	660
Interior North	Green	0.45	7,400	1.41	8.1	22	3,470	360	950	340	420
	12%	0.48	13,100	1.79	10.5	26	6,900	770	1,400	390	600
Interior South	Green	0.43	6,800	1.16	8.0	15	3,110	340	950	250	360
	12%	0.46	11,900	1.49	9.0	20	6,230	740	1,510	330	510
Fir											
Balsam	Green	0.33	5,500	1.25	4.7	16	2,630	190	660	180	290
	12%	0.35	9,200	1.45	5.1	20	5,280	400	940	180	380
California red	Green	0.36	5,800	1.17	6.4	21	2,760	330	770	380	360
	12%	0.38	10,500	1.50	8.9	24	5,460	610	1,040	390	500
Grand	Green	0.35	5,800	1.25	5.6	22	2,940	270	740	240	360
	12%	0.37	8,900	1.57	7.5	28	5,290	500	900	240	490
Noble	Green	0.37	6,200	1.38	6.0	19	3,010	270	800	230	290
	12%	0.39	10,700	1.72	8.8	23	6,100	520	1,050	220	410
Pacific silver	Green	0.40	6,400	1.42	6.0	21	3,140	220	750	240	310
	12%	0.43	11,000	1.76	9.3	24	6,410	450	1,220	—	430
Subalpine	Green	0.31	4,900	1.05	—	—	2,300	190	700	—	260
	12%	0.32	8,600	1.29	—	—	4,860	390	1,070	—	350
White	Green	0.37	5,900	1.16	5.6	22	2,900	280	760	300	340
	12%	0.39	9,800	1.50	7.2	20	5,800	530	1,100	300	480
Hemlock											
Eastern	Green	0.38	6,400	1.07	6.7	21	3,080	360	850	230	400
	12%	0.40	8,900	1.20	6.8	21	5,410	650	1,060	—	500
Mountain	Green	0.42	6,300	1.04	11.0	32	2,880	370	930	330	470
	12%	0.45	11,500	1.33	10.4	32	6,440	860	1,540	—	680
Western	Green	0.42	6,600	1.31	6.9	22	3,360	280	860	290	410
	12%	0.45	11,300	1.63	8.3	23	7,200	550	1,290	340	540
Larch, western	Green	0.48	7,700	1.46	10.3	29	3,760	400	870	330	510
	12%	0.52	13,000	1.87	12.6	35	7,620	930	1,360	430	830
Pine											
Eastern white	Green	0.34	4,900	0.99	5.2	17	2,440	220	680	250	290
	12%	0.35	8,600	1.24	6.8	18	4,800	440	900	310	380
Jack	Green	0.40	6,000	1.07	7.2	26	2,950	300	750	360	400
	12%	0.43	9,900	1.35	8.3	27	5,660	580	1,170	420	570
Loblolly	Green	0.47	7,300	1.40	8.2	30	3,510	390	860	260	450
	12%	0.51	12,800	1.79	10.4	30	7,130	790	1,390	470	690
Lodgepole	Green	0.38	5,500	1.08	5.6	20	2,610	250	680	220	330
	12%	0.41	9,400	1.34	6.8	20	5,370	610	880	290	480
Longleaf	Green	0.54	8,500	1.59	8.9	35	4,320	480	1,040	330	590
	12%	0.59	14,500	1.98	11.8	34	8,470	960	1,510	470	870
Pitch	Green	0.47	6,800	1.20	9.2	—	2,950	360	860	—	—
	12%	0.52	10,800	1.43	9.2	—	5,940	820	1,360	—	—

Chapter 5 Mechanical Properties of Wood

Table 5-3b. Strength properties of some commercially important woods grown in the United States (inch–pound)^a—con.

Common species names	Moisture content	Specific gravity ^b	Static bending				Impact bending (in.)	Compression parallel to grain (lbf in ⁻²)	Compression perpendicular to grain (lbf in ⁻²)	Shear parallel to grain (lbf in ⁻²)	Tension perpendicular to grain (lbf in ⁻²)	Side hardness (lbf)
			Modulus of rupture (lbf in ⁻²)	Modulus of elasticity ^c (×10 ⁶ lbf in ⁻²)	Work to maximum load (in-lbf in ⁻³)	Modulus of rupture (lbf in ⁻²)						
Pine—con.												
Pond	Green	0.51	7,400	1.28	7.5	—	3,660	440	940	—	—	
	12%	0.56	11,600	1.75	8.6	—	7,540	910	1,380	—	—	
Ponderosa	Green	0.38	5,100	1.00	5.2	21	2,450	280	700	310	320	
	12%	0.40	9,400	1.29	7.1	19	5,320	580	1,130	420	460	
Red	Green	0.41	5,800	1.28	6.1	26	2,730	260	690	300	340	
	12%	0.46	11,000	1.63	9.9	26	6,070	600	1,210	460	560	
Sand	Green	0.46	7,500	1.02	9.6	—	3,440	450	1,140	—	—	
	12%	0.48	11,600	1.41	9.6	—	6,920	836	—	—	—	
Shortleaf	Green	0.47	7,400	1.39	8.2	30	3,530	350	910	320	440	
	12%	0.51	13,100	1.75	11.0	33	7,270	820	1,390	470	690	
Slash	Green	0.54	8,700	1.53	9.6	—	3,820	530	960	—	—	
	12%	0.59	16,300	1.98	13.2	—	8,140	1,020	1,680	—	—	
Spruce	Green	0.41	6,000	1.00	—	—	2,840	280	900	—	450	
	12%	0.44	10,400	1.23	—	—	5,650	730	1,490	—	660	
Sugar	Green	0.34	4,900	1.03	5.4	17	2,460	210	720	270	270	
	12%	0.36	8,200	1.19	5.5	18	4,460	500	1,130	350	380	
Virginia	Green	0.45	7,300	1.22	10.9	34	3,420	390	890	400	540	
	12%	0.48	13,000	1.52	13.7	32	6,710	910	1,350	380	740	
Western white	Green	0.35	4,700	1.19	5.0	19	2,430	190	680	260	260	
	12%	0.38	9,700	1.46	8.8	23	5,040	470	1,040	—	420	
Redwood												
Old-growth	Green	0.38	7,500	1.18	7.4	21	4,200	420	800	260	410	
	12%	0.40	10,000	1.34	6.9	19	6,150	700	940	240	480	
Young-growth	Green	0.34	5,900	0.96	5.7	16	3,110	270	890	300	350	
	12%	0.35	7,900	1.10	5.2	15	5,220	520	1,110	250	420	
Spruce												
Black	Green	0.38	6,100	1.38	7.4	24	2,840	240	740	100	340	
	12%	0.42	10,800	1.61	10.5	23	5,960	550	1,230	—	530	
Engelmann	Green	0.33	4,700	1.03	5.1	16	2,180	200	640	240	260	
	12%	0.35	9,300	1.30	6.4	18	4,480	410	1,200	350	390	
Red	Green	0.37	6,000	1.33	6.9	18	2,720	260	750	220	340	
	12%	0.40	10,800	1.66	8.4	25	5,540	550	1,290	350	530	
Sitka	Green	0.37	5,700	1.23	6.3	24	2,670	280	760	250	350	
	12%	0.40	10,200	1.57	9.4	25	5,610	580	1,150	370	510	
White	Green	0.33	5,000	1.14	6.0	22	2,350	210	640	220	270	
	12%	0.36	9,400	1.43	7.7	20	5,180	430	970	360	410	
Tamarack	Green	0.49	7,200	1.24	7.2	28	3,480	390	860	260	380	
	12%	0.53	11,600	1.64	7.1	23	7,160	800	1,280	400	590	

^aResults of tests on clear specimens in the green and air-dried conditions. Definition of properties: impact bending is height of drop that causes complete failure, using 0.71-kg (50-lb) hammer; compression parallel to grain is also called maximum crushing strength; compression perpendicular to grain is fiber stress at proportional limit; shear is maximum shearing strength; tension is maximum tensile strength; and side hardness is hardness measured when load is perpendicular to grain.

^bSpecific gravity is based on weight when oven-dry and volume when green or at 12% moisture content.

^cModulus of elasticity measured from a simply supported, center-loaded beam, on a span depth ratio of 14/1. To correct for shear deflection, the modulus can be increased by 10%.

^dValues for side hardness of the true hickories are from Bendtsen and Ethington (1975).

^eCoast Douglas-fir is defined as Douglas-fir growing in Oregon and Washington State west of the Cascade Mountains summit. Interior West includes California and all counties in Oregon and Washington east of, but adjacent to, the Cascade summit; Interior North, the remainder of Oregon and Washington plus Idaho, Montana, and Wyoming; and Interior South, Utah, Colorado, Arizona, and New Mexico.