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Anisotropy Property of Different Types of Wood

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ABSTRACT

The norm of elastic constant tensor and the norms of the irreducible parts of the elastic constants of different types of wood. The relation of the scalar parts norms and the other parts norms and the anisotropy of these woods is presented. The norm ratios are used as a criterion to present the anisotropy degree of the properties of these woods.

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Introduction

The definition of Anisotropy and Isotropy is given in [1,2]. The decomposition procedure and the decomposition of elastic constant tensor is given in also the definition of norm concept and the norm ratios and the relationship between the anisotropy and the norm ratios are given in [3, 4]. As the ratio N_s/N becomes close to one the material becomes more isotropic, and as the sum of N_d/N and N_n/N becomes close to one the material becomes more anisotropic as explained in the details about these woods are given in [3-10].

Data and Calculations

Table 1: Elastic constants in GPA, for 11 woods [10].

Wood	C_{11}	C_{22}	C_{33}	C_{12}	C_{13}	C_{23}	C_{44}	C_{55}	C_{66}
Balsa	3.43	0.06	0.19	0.05	0.09	0.04	0.12	0.18	0.02
Bitch yellow	14.69	1.03	1.62	0.79	1.08	0.74	0.94	1.02	0.24
Douglas Fir (Interior North)	12.68	0.73	0.99	0.54	0.61	0.34	0.95	0.78	0.09
Spruce sitka	11.22	0.53	0.97	0.36	0.54	0.25	0.66	0.69	0.03
Sweet gum	11.75	0.74	1.70	0.47	0.78	0.53	0.69	1.04	0.24
Walnut black	12.94	0.97	1.84	1.02	1.40	0.75	0.72	0.98	0.24
Yellow poplar	11.26	0.62	1.34	0.41	0.63	0.45	0.75	0.82	0.12
Douglas Fir (coast)	13.70	0.77	1.04	0.42	0.44	0.31	1.05	0.86	0.09
Mahogany_African	10.21	0.60	1.32	0.50	0.63	0.37	0.57	0.85	0.20
Mahogany_Honduras	10.85	0.85	1.41	0.61	0.71	0.50	0.89	0.68	0.29
Spruce_Engelmann	10.86	0.72	1.56	0.75	1.15	0.43	1.18	1.22	0.09

By using table 1 and the decomposition of the elastic constant tensor and the norm concept, the norms and the norm ratios of the given materials can be calculated as in the following tables.

Table 2: The norms and norm ratios of woods

Wood	N_s	N_d	N_n	N	$\frac{N_s}{N}$	$\frac{N_d}{N}$	$\frac{N_n}{N}$	$\frac{N_d + N_n}{N}$
Balsa	1.66913	2.41766	1.17444	3.16392	0.52755	0.76414	0.37120	1.13534
Britch yellow	8.87656	9.73848	4.62072	13.9636	0.63569	0.69742	0.33091	1.02833
Douglas Fir (Interior North)	7.07535	8.55677	4.25340	11.8899	0.59507	0.71966	0.35773	1.07739
Spruce sitka	6.09366	7.63201	3.79788	10.47875	0.58152	0.72833	0.36244	1.09077
Sweet gum	7.17044	7.75524	3.61600	11.16398	0.64228	0.69467	0.32390	1.01857
Walnut black	8.41252	8.59845	3.74793	12.59963	0.66768	0.68244	0.29746	0.9799
Yellow poplar	6.55427	7.46480	3.69684	10.59945	0.61836	0.70426	0.34878	1.05304
Douglas Fir (coast)	7.45846	9.20237	4.72436	12.75272	0.58485	0.72160	0.37046	1.09206
Mahogany_African	6.09636	6.84279	3.11953	9.680954	0.62973	0.70683	0.32223	1.02906
Mahogany_Honduras	6.71470	7.03231	3.46644	10.32264	0.65048	0.68125	0.33581	1.01706
Spruce_Engelmann	7.17921	7.22676	3.21182	10.68096	0.67215	0.67660	0.30070	0.9773

Graph 1: Isotropy Degree

Graph 2: Anisotropy Degree depending on N_d/N

Graph 3: Anisotropy Degree depending on N_n/N

Graph 4: Anisotropy depending on the sum of N_d/N and N_n/N

Graph 5: Elasticity Strength

Conclusion

From table 2 and the Graphs (Graph 1 to Graph 5), and analyzing the ratios N_s/N , N_d/N and N_n/N for different types of wood we can conclude by considering the ratio that Spruce_Engelmann (0.67215) is the most isotropic wood and the least isotropic wood is Balsa (0.52755) and we can conclude also by considering the ratios N_d/N , N_n/N , and the sum of them that Balsa (0.76414, 0.37120, 1.13534) is the most Anisotropic wood and the least anisotropic wood is Spruce_Engelmann (0.6766, 0.30070, 0.9773) and also by considering the value of N we can conclude that the most elastically strength wood is Britch yellow (13.9636) and the least elastically wood is Balsa (3.16342).

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