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Properties of Few Lesser Known Timbers of Mizoram, North East India

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Abstract Mizoram is a North East India hilly state with rich forest cover. Due to poor stocking and difficult terrain limiting lateral growth, quality timbers for structural and commercial use are very limited. The present study is an attempt to find suitable replacements for mainstream timbers by studying the wood properties *vis a vis* utility. About 5 commonly available tree species selected were *Schima wallichii, Anogeissus accuminata, Callicarpa arborea, Castanopsis tribuloides* and *Duabanga grandiflora.* Some important properties are discussed in this paper namely density, static bending strength, compressive strength and hardness. Results shown few of the selected species have comparable strength to that of teak. *S. wallichii, A. accuminata* and *C. tribuloides* showed good bending strength and hardness; *C. arborea* and *D. grandiflora* showed comparatively lower strength owing to their lower densities. Further, all the strength properties were positively correlated with their respective densities.

Keywords Wood properties, Static bending, Compression strength, Hardness.

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Introduction

North eastern part of India is unique in its biogeography. All the north eastern states are predominantly hilly. Mizoram is the southernmost located hilly state in this part of the country. As per the latest state of forests report, Mizoram has 86.27% forest cover, one of the highest among Indian states. But it is important to note that out of 18,186 sq. km. of forest, only 131 sq. km. area is under very dense forests which indicate the poor stocking of forests as reported by the Indian state of forests report (FSI 2010).

Structural and commercial timber requirement of the state is mainly met by bamboo and few timbers like Teak, *Michelia, Gmelina* and few more albeit insufficiently. Official extraction from natural forests in the state of Mizoram is on an average 6670 m^3 for the last 10 years which is second lowest among the neighboring hilly states(ICFRE 2010). Indian timber import is almost equal to that of domestic extraction. Mainly imports are from Malaysia (57%) and Myanmar (18%) (Yadav and Basera 2013). Myanmar is the bordering country with Mizoram; therefore Mizoram also is dependent on huge imports of Teak wood from neighboring country.

Under this scenario, it is wise to look at alternative options from the locally available underutilized timber species to reduce the pressure on mainstream species. Bamboo is the backbone of north eastern hilly states but certain utilities require timber as an irreplaceable structural material. Research on wood properties has in most cases contributed to creation of better products (Kauman 1990). Therefore, in this study some lesser known timber species were selected to test certain strength properties. The criteria for selection were availability of the species and some local household utilities the species were subjected to. Also, there are no reports on properties of these timbers so far. Similar studies were conducted by Bhat et al. (2008),Shukla et al. (2007) and Tulasidas and Bhat (2012).

Materials and Methods

Description of species selected

Following species of timber were selected for testing of wood properties.

Schima wallichii (DC.) Korth. is an evergreen tree belonging to family Theaceae. Commonly available throughout the state. Heartwood is reddish brown in color. The tree is distributed in North East India, Bangladesh, Bhutan, Nepal, South West China, Myanmar, Thailand, Laos and Vietnam. It grows up to about 10-20 m tall.

Castanopsis tribuloides (Sm.) A. DC. belong to family Fagaceae. The tree is found in China, India, Nepal, Bangladesh, Myanmar, Thailand, Laos and Vietnam. It grows up to 12-18 m tall.

Anogeissus acuminata (Roxb. ex Candolle) Guillemin et al. of family Combretaceae. The tree is dominant in Vietnam and has its range of distribution in India, Bangladesh, Myanmar and Yunnan.

Callicarpa arborea Roxb. Lamiaceae family. Distributed in China, Pakistan, India, Sri Lanka, Nepal, Bangladesh, Myanmar, Thailand, Cambodia, Laos, Vietnam, Malaysia, Indonesia, Philippines, New Guini. The tree can grow up to 20 m tall.

Duabanga grandiflora (Roxb. ex DC.) Walpers family Lythraceae. The tree is found naturally in southern China, India, Myanmar, Malaysia, Laos, Thailand, Cambodia, Vietnam. The tree grows up to 25-30 m tall. (Sawmliana 2013).

Sample collection

Logs / blocks were collected from 3 different trees in each species of timber and allowed to air dry in shade for 6 months to attain equilibrium moisture content. Further, these blocks/logs were converted to scantlings and billets and made free from bark, sapwood and any minor defects. The billets were obtained considering outer, middle and inner part of heartwood to get the representative sample. These billets were then oven dried till attaining constant weights. For testing of different properties small clear specimens of different dimensions were cut as mentioned in the IS 1708 (1986). Detailed dimensions of the test specimens are as mentioned below.

Basic density the sample: 2 cm × 2 cm × 6 cm; Static bending: 2 cm × 2 cm × 30 cm; Compression strength parallel to grain: 2 cm × 2 cm × 8 cm; Compression strength perpendicular to grain: 2 cm × 2 cm × 10 cm; Hardness test under static indentation 2 cm × 2 cm × 10 cm.

All the above tests were conducted on the Shimadzu Universal Testing Machine in the Institute of wood science and technology. Bangalore following the standard procedures mentioned in the IS 1708 (1986). Results of the strength properties were compared with the properties of teak as reported by Shekhar and Rawat (1966) and Shanavas and Kumar (2006) as standard.

Results and Discussion

Density

Moisture content of all the species at the time of estimation of density ranged in between 12% to 14% with respect to the oven dry weight. *Anogeissus*

Table 1. Some strength properties of lesser known timber species.

Species properties	*A. acuminata*	*C. arborea*	*C. tribuloides*	*D. grandiflora*	*S. wallichi*	*Compare* (teak)
Density (kg/m^3) @12% MC						
	849.61 ± 25.45	526.57 ± 24.04	651.10 ± 21.89	482.84 ± 30.94	734.95 ± 28.06	650-700
Static bending						
MoR	96.99 ± 9.00	85.18 ± 7.58	77.73 ± 3.27	71.87 ± 3.22	102.05 ± 11.16	95.9
MoE	8060.66 ± 981.75	6223.36 ± 797.88	8652.42 ± 513.51	7505.67 ± 567.61	8824.18 ± 1321.18	11906
Compression strength parallel						
CS at LP (N/mm^2)	59.93 ± 4.78	33.87 ± 2.61	52.77 ± 3.38	33.79 ± 3.82	54.68 ± 5.63	36.83
CS at ML (N/mm^2)	72.75 ± 4.10	39.98 ± 4.83	59.17 ± 5.17	40.83 ±4.49	61.77 ± 4.90	
Compression strength perpendicular						
CS at LP	14.69 ± 1.83	8.86 ± 0.69	13.53 ± 1.25	9.17 ± 1.07	10.74 ± 1.95	9.90
CS at ML	16.07 ± 3.14	11.49 ± 1.37	15.60 ± 1.07	11.42 ± 1.32	11.74 ± 1.67	
Hardness						
End grain	8424.67 ± 244.65	4717.37 ± 151.37	5303.81 ± 154.85	5129.01 ± 130.57	6531.87 ± 130.03	4785.65
Tangential	7079.47 ± 186.28	2480.91 ± 111.24	4647.57 ± 133.09	4058.05 ± 273.94	4583.73 ± 183.72	5138.68
Radial	7970.88 ± 178.94	3550.50 ± 158.16	4935.72 ± 287.85	3908.05 ± 98.53	6176.37 ± 111.5779	4922.94

latifolia recorded highest average density among the species (849.60 kg/m^3) followed by *Schima wallichii* (734.95 kg/m^3), *Castanopsis tribuloides* (651.10 kg/m^3) and *Callicarpa arborea* (526.56 kg/m^3) and least in *Duabanga grandiflora* (482.84 kg/m^3).

Static bending

Table 1 shows the strength of lesser known timbers under static bending. Among the tested timbers Modulus of Elasticity (MoE) under static bending was found to be highest in *Schima wallichii* followed by *Castanopsis tribuloides, Anogiessus acuminata, Duabanga grandiflora* and *Callicarpa arborea.* All these timber species showed comparatively lesser MoE compared to teak. Modulus of Rupture (MoR) was also found to be higher in *S. wallichii* followed by *A. acuminata* and *C. arborea.* However, MoR values of other 2 species were less than teak. The variations in these properties within the species are dependent on the amount of mature wood present in the different trees of same species.

Compression strength

Compression strength property is useful in applicability of timbers in structural elements. Compression parallel to grain is particularly applicable in columns

Table 2. Correlation of strength properties with density. *Significant @ p=0.05, **Significant @p=0.01.

Species properties	*A. acuminata*	*C. arboria*	*C. tribuloided*	*D. grandiflora*	*S. wallichii*
Bending (MoE)	0.675*	0.670*	0.626	0.367	0.675*
Bending (MoR)	0.747*	0.722*	0.440	0.977**	0.533
CS Parallel	0.807**	0.491	0.684*	0.861**	0.662
CS Perpendicular	0.767*	0.437	0.865**	0.723*	0.764*
Hardness	0.704*	0.739*	0.864**	0.684*	0.561

Table 3. Regression for strength properties with density. *Significant @ p=0.05, **Significant @ p=0.01, NSN on-significant.

Species Properties	*A. acuminata*	*C. arboria*	*C. tribuloides*	*D. grandiflora*	*S. wallichii*
Bending (MoE)	y = 28.536x - 16300 R^2 = 0.4561*	y = 20.322x- 4277.6 R^2 = 0.4494*	y = 0.1038x -14.591 $R^2 = 0.4679^{NS}$	y = 6.8602x + 4218.7 $R^2 = 0.1347^{NS}$	y = 32.219x-14961 R^2 = 0.4561*
Bending (MoR)	y = 0.2894x - 150.08 R^2 = 0.5582*	y = 0.2626x - 51.939 R^2 = 0.5216*	y = 0.0644x + 35.93 $R^2 = 0.1933^{NS}$	y = 0.1035x + 22.303 R^2 = 0.954**	y = 0.2146x - 56.386 $R^2 = 0.2837^{NS}$
CS Parallet	y = 0.166x - 81.779 R^2 = 0.6512**	y = 0.0614x + 1.8206 $R^2 = 0.2415^{NS}$	y = 0.1038x + 14.591 R^2 = 0.4679*	y = 0.1084x - 18.15 R^2 = 0.7407**	y = 6.8602x + 4218.7 $R^2 = 0.1347^{NS}$
CS Perpendicular	y = 0.0603x - 36.777 R^2 = 0.588*	y = 0.0144x + 1.3509 $R^2 = 0.1913^{NS}$	y = 0.0487x - 18.062 R^2 = 0.7485**	y =0.0255x - 3.0635 R^2 =0.523*	y = 0.0539x - 29.035 R^2 = 0.5843*
Hardness	y = 4.7333x + 3758.8 R^2 = 0.4957*	y = 2.0773x + 2502.3 R^2 = 0.5461*	y = 5.455x + 1448.5 R^2 = 0.7463**	y = 2.0213x + 3171.7 R^2 = 0.4673*	y = 1.6332x + 4572.7 $R^2 = 0.3147^{NS}$

or pillars whereas compression perpendicular to grain in sleepers and flooring materials. Compression strength parallel to grain at limit of proportionality was found to be highest in *S. wallichii* followed by *A.acuminata.* However, all 5 species selected showed values higher than tesk (Table 1). Results were slightly different in compression perpendicular to grain. *A. acuminata* showed highest crushing strength at LP followed by *C. tribuloides* and next was *S. wallichii.* These 3 species showed higher strength than teak. *D. grandiflora* and *C. arborea* showed lowest strength among the 5 species (Table 1).

Hardness

Hardness indentation test for the lesser known timber species on 3 different surfaces namely and grain, tangential and radial surfaces are summarized in Table 1. *A. acuminata* is the hardest among the species in all the 3 surfaces and is remarkably harder than teak. It is worth notable that *Anogiessus latifolia* and *A. pendula* are also well known for their hardness (Meena et al. 2018). All the species were harder than teak in end grain except *C. arborea,* which is also the least hard species in all the surfaces. *C. tribuloides* and *S. wallichii* have also showed greater values of hardness compared to teak.

Correlation and regression of properties with density

It is a well known fact that wood density directly and positively affects most of the strength properties (Niklas and Spatz 2010). In this study all the strength properties studied were positively correlated with density of the timber species (Table 2). However, correlation of compression strength in *C. arborea,* static bending in *C. tribuloides* and hardness in *S. wallichii* were insignificant. Regression equations for MoE. MoR, Compression strength hardness with density are given in Table 3.

Conclusion

First choice timber resources are shrinking day by day and have become unaffordable for common man. Even though the utilization of waste wood is given stress in the form of composite woods, the demand for the solid wood products is irreplaceable. Hence the optimum utilization of locally available timbers is necessary. The results have shown that with conparatively good static bending strength and compression strength *S. wallichii, A. acuminata* and *C. tribuloides* can be tried for variety of uses such as construction, flooring and furniture. Further, with higher hardness *A. acuminata* can be very useful in tool handles and implements. *D. grandiflora* and *C. arborea* having comparatively lower density and strength can find their utility in packing cases and composite wood products. There is lack of knowledge about the properties of lesser known timbers which would suggest their specific utility. In all the regions where quality timber supply is scarce, these lesser known timbers should be tested and explored as an alternative for various purposes of structural utilization and product manufacture.

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