

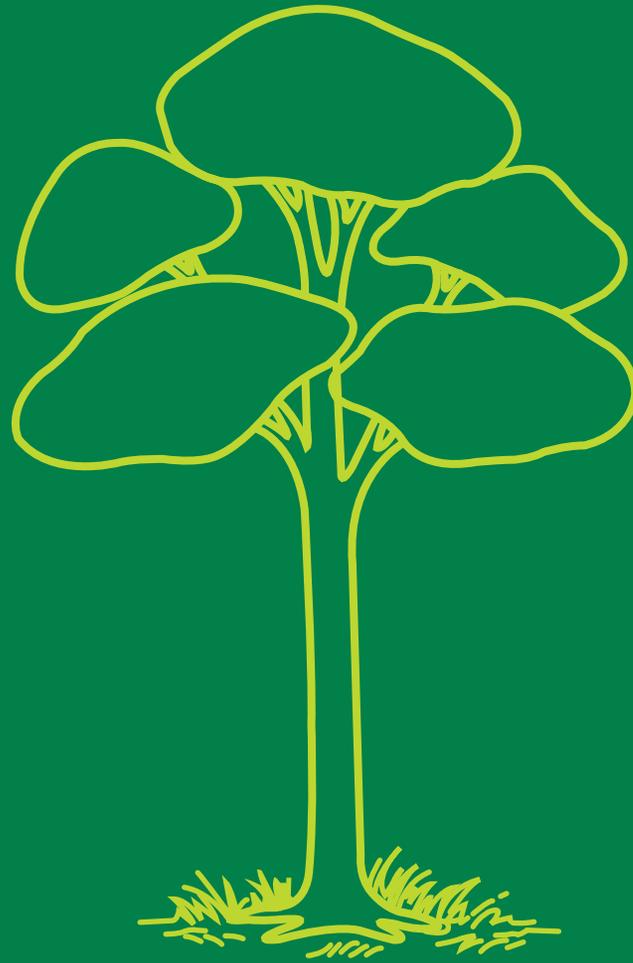
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**Utilization Potential of Mahogany (*Swietenia macrophylla*
King) Wood in Bangladesh – with Respect to Its
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Abstract

The strength and seasoning properties of timber species, *Swietenia macrophylla* King were studied. *S. macrophylla* is found moderately strong. The volumetric shrinkage is higher and the specific gravity is lower than that of Chittagong teak which was recommended as standard for comparison of other timber species of Bangladesh. The species can be seasoned properly in the solar kiln and in air-drying yard. The species is found suitable for making furniture and other household articles as far as Seasoning and strength properties are concerned.

সারসংক্ষেপ:

মেহগনি প্রজাতি কাঠের শক্তি ও শুষ্ককরণ সম্বন্ধীয় গুণাগুণ পরীক্ষা করা হয়েছে। এই প্রজাতিটি মাঝারি শক্তি সম্পন্ন। এর আয়তনিক সংকোচন আদর্শ কাঠ হিসেবে বিবেচিত সেগুন কাঠের চেয়ে বেশী ও আপেক্ষিক গুরুত্ব সেগুন কাঠের চেয়ে কম। সৌরচুলী ও এয়ার ড্রাইং ইয়ার্ডে সঠিকভাবে এই প্রজাতির কাঠ শুকানো যায়। উক্ত প্রজাতির কাঠের শক্তি নিরূপণ ও শুষ্ককরণ গুণাগুণ সম্পর্কের সাথে আসবাবপত্র ও গৃহস্থালির কাজে ব্যবহৃত বিভিন্ন কাজের জন্য উপযুক্ত।

Keywords: Strength properties; *Swietenia macrophylla*; Shrinkage; Modulus of elasticity; Solar kiln

Introduction

Mahogany (*Swietenia macrophylla* King) is a native of Peru, Brazil and Central America where it thrives in tropical climatic conditions and at low elevations having a rainfall of 1500-5000 mm (Hensleigh, 1955). Later on, the species was introduced in other places over the world including South –East Asian countries, Philippines and Indian Sub-continent. In India, it was first introduced in the Royal Botanic Garden at Calcutta in 1872 (Troup, 1921). Due to its fast growth and a wide range of end uses it has since then been cultivated and planted in many places of the sub-continent. It has become part of major afforestation programme in Bangladesh (Baksha and Islam 1997).

Mahogany is a large tree growing 10-14m high and more with a straight cylindrical bole. Tree morphology and macro and micro anatomical features of Mahogany wood have made it an

important timber wood species (Soerinegera and Lemmens 1993). It is extensively used in making highly expensive and quality furniture, interior wood works, e.g. door and wall panel, cabinet works, decorative wood, precision works like making components of musical instruments and various specialty and novelty items. For a wide range of end-uses, the species has come to be known as the premier cabinet wood of the world (Rocafort, 1965). It is valued also for its good dimensional stability, lack of distortion, high degree of natural luster and good finishing properties (Mahew and Newton, 1998). In Bangladesh, it has a high demand mostly for making furniture because of its lower price than teak and its good polishing and finishing properties.

Mahogany is an important addition to inadequate timber resources of Bangladesh. To

ensure efficient utilization of the wood for various end uses, it is necessary to know its physical strength properties as well as drying behavior, in addition to studying the anatomical features. The present study is aimed at investigating the strength properties and drying characteristics to evaluate and compare with this teak.

Materials and Methods

Three representative trees of *Swietenia macrophylla* were collected from homestead area in Patiya region, Chittagong. The age of trees were 20-23 years with 10-14m height and 80-100cm girths. Three samples per bole were selected randomly from each of trees consecutive 2.50m bolts above the stump height of each tree. All the bolts were fairly straight and free from natural defects. One disk was taken from each bolt for determination of moisture content (MC), specific gravity and shrinkage. The sample size for MC and Specific gravity was 2.54×2.54×5.08cm and for shrinkage was 5.08×5.08×15.24cm. The samples were taken from butt, middle and top portion.

For determination of mechanical properties the bolts were marked into 6.35cm squares according to the standard sawing diagram and sawn to 6.35cm ×6.35cm×2.50m sticks. The sticks were prepared in pairs. One stick was taken from each pair for conducting tests in green condition

and the other for air-dry condition. The sticks for air-dry test were stacked using suitable stickers inside a drying shed and allowed to attain the equilibrium moisture content of 12-14%.

All the test sticks were dressed to 5.08cm×5.08cm×2.50m strips and clear specimens were prepared from these strips according to the sizes specified by ASTM standards (Anon, 1971). The specimens were tested in accordance with the ASTM specifications except toughness. The mechanical tests were carried out in a Riehle screw power type universal testing machine. The toughness tests were performed in a toughness-testing machine.

For determination of seasoning properties, four planks of 2.5cm×20cm×2m dimension were taken from each tree totaling twenty four planks as samples. Twelve samples were used for air-drying and another twelve for solar kiln drying. The air-drying samples were stacked in an open shade using 2.5cm×3.7cm stickers. A heavy weight from the top of the air-drying stack was placed to prevent the distortion. For solar kiln drying, the samples were placed in the solar kiln in stack followed by operating schedule of the kiln developed by Sattar, (1993).

Results

The average values of physical properties

Table 1. Physical and Seasoning Properties of *Swietenia macrophylla* compared to teak

Species	Locality of timber with age	Seasoning condition	Moisture content (%)	Specific gravity *		Shrinkage % **		Drying time (days) from green condition to 12-14% MC		Grouping	
				Volume at test	Volume at oven dry	Volumetric		Solar drying	Air-drying	Specific gravity	Shrinkage
						12%	OD				
Chittagong teak (<i>Tectona grandis</i>)	Kaptai, Chittagong Hill tracts Age 40 years	Green	155.0	0.58	0.61	4.50	5.00	15	38	Moderately heavy	Stable
		Air -dry	12.0	0.59	-	-	-	-	-		
Mahogany (<i>Swietenia macrophylla</i>)	Patiya, Chittagong Age 22 years	Green	54.0	0.51	0.55	5.10	7.01	13	60		
		Air- dry	14.0	0.53	-	-	-	-	-		

* based on oven dry weight ** from green to oven dry condition based on green dimension

volumetric shrinkage of *S. macrophylla* wood were determined in green and air-dry conditions. The results are presented in table-1. The values of physical properties of Chittagong teak (*Tectona grandis*) having 40 years age group are also included in the table 1 for comparison (Yakub *et al.* 1978). The table shows that the wood seasons well with minor defects. The drying time of 2.5 cm

thick planks in a Solar Kiln from the initial moisture content of 54.0% to 12-14% final moisture content (MC) level took 13 days in post winter season. The air-drying time from the initial MC of 54% to final MC 14% is 60 days in a shed (Table 1). Minor defects were found in air-dry samples during drying.

Table 2. Comparison of strength properties of Mahogany (*S. macrophylla*) with teak (*T. grandis*)

Properties	Species/ Seasoning conditions/Values				Grouping	
	Mahogany (<i>S. macrophylla</i>)		Chittagong teak (<i>T. grandis</i>)			
	Green (CV%)	Air dry(CV%)	Green	Air dry		
Static bending:						
Stress at proportional limit (kg/cm ²)	339(18.1)	394(26.5)	514	628	Moderately Strong	
Modulus of rupture (kg/cm ²)	494(11.6)	615(22.6)	867	1008		
Modulus of elasticity (1000 kg/cm ²)	59(10.7)	67(11.7)	120	131		
Work in (kg/cm ³):						
To proportional limit	0.115(40.5)	0.134(42.5)	0.124	0.170		
To maximum load	0.438(25.2)	0.513(38.8)	0.747	0.622		
Total	0.727(23.4)	0.810(42.4)	1.613	1.225		
Compression parallel to grain:						
Stress atproportional limit (kg/cm ²)	209(10.4)	254(9.7)	288	374		
Maximum crushing strength (kg/cm ²)	273(9.1)	349(8.7)	383	513		
Compression perpendicular to grain:						
Stress atproportional limit (kg/cm ²)	86(13.1)	115(23.3)	67	119		
Hardness (kg):						
Side (kg)	414(20.2)	470(20.7)	506	495		
End (kg)	443(19.4)	460(19.6)	541	532		
Nail holding capacity:						
Side (kg)	146(18.5)	116(33.1)	138	95		
End (kg)	155(21.3)	94(21.4)	79	68		
Shear parallel to grain(kg/cm ²):						
Shearing stress, Radial	102(16.5)	109(16.2)	86	197		
Shearing stress,Tangential	101(10.3)	116(14.0)	103	115		
Cleavage load to cause splitting :						
Radial(kg/cm) of width	36(26.3)	65(23.6)	68	66		
Tangential(kg/cm) of width	36(34.2)	62(17.0)	77	79		
Tension perpendicular to grain (kg/cm ²):						
Tensile strength(Radial)	40(25.0)	40(24.7)	44	41		
Tensile strength(Tangential)	38(25.4)	42(22.2)	49	47		
Toughness (cm-kg/specimen):						
Radial	320(25.4)	216(26.1)	387	381		
Tangential	279(21.5)	179(31.0)	419	326		

Table 3. Physical and strength properties of *S. macrophylla* relative to teak expressed as percentage

Properties	Species/seasoning conditions/values <i>Swietenia macrophylla</i>	
	Green	Air-dry
Specific gravity based on oven dry weight and Volume:		
At test	88	90
At oven dry	90	-
Volumetric Shrinkage (%) from green to oven dry condition based on green dimension	113	-
Static bending:		
Stress at proportional limit	66	63
Modulus of rupture	57	61
Modulus of elasticity	49	51
Work to proportional limit	93	79
Work to maximum load	59	82
Work Total	45	66
Compression parallel to grain:		
Stress at proportional limit	72	68
Maximum crushing strength	71	68
Compression perpendicular to grain: Stress at proportional limit	127	97
Hardness:		
Side	81	82
End	95	86
Shear parallel to grain:		
Shearing stress, Radial	119	55
Shearing stress, Tangential	98	101
Cleavage, load to cause splitting:		
Radial	53	98
Tangential	47	78
Tension perpendicular to grain:		
Tensile Strength, radial	91	97
Tensile Strength, Tangential	77	89
Nail withdrawal:		
Side	106	195
End	122	138
Toughness:		
Radial	83	57
Tangential	67	55

The average values of various properties in both green and air-dry conditions and the suitability of mahogany relative to teak (Yakub *et al.* 1978) is presented in table-2. Co-efficient of variations (CV%) of the wood properties are shown in the parenthesis. The sapwood and heartwood were distinct. The heartwood of mahogany is dark reddish and sapwood is yellowish brown in colour. The ratio of sapwood to heartwood is great in fast growing trees. The grain tends to be interlocked, but there is a reasonable proportion of plain, straight-grain timber. The values of physical and strength properties were also compared in Table-3 with the Physical and strength properties of teak to find out the suitability of *S. macrophylla* expressed as percentage.

Discussion

S. macrophylla is a medium dense timber with specific gravity of 0.53 in air dry condition. It exhibits volumetric shrinkage of 7.0% from green to oven dry condition (Table-1). It is evident from data that the specific gravity and volumetric shrinkage of earlier mahogany is 0.52 and 5.1 respectively (Sattar 1997). On the other hand, the specific gravity and volumetric shrinkage for *T. grandis* is 0.59 and 5.00% in air dry condition respectively. Report in the Philippines, shows that the specific gravity of 10 and 20 years old *S. macrophylla* wood were found 0.44, 0.54 respectively, volumetric shrinkage were found 8.31%, 7.26%; respectively (Marina *et al.* 2003). This reveals that the mean specific gravity of 10 years old Mahogany trees was lower than that of 20 years old trees. Data Table 1 also indicate that the specific gravity of *T. grandis* is higher than that of *S. macrophylla*.

Table 2 shows that Mahogany is a moderately strong timber with Modulus of rupture (MOR) is 615kg/cm²; Modulus of elasticity (MOE) is 67kg/cm². Modulus of Rupture and Modulus of Elasticity of earlier Mahogany is 597 Kg/cm² and 100 Kg/cm² (Sattar. 1997). Modulus

of Rupture less than that of 22 yrs present Mahogany Modulus of elasticity is greater than that of 22yrs present Mahogany. MOR of 10 and 20 years of philippines *S. macrophylla* are found 501kg/cm² and 595kg/cm²; respectively and MOE are found 59kg/cm², 64kg/cm² respectively (Marina *et al.* 2003). The strength properties of 10 years old mahogany tree was lower than that of 20 years old Philippines Mahogany trees. (Marina *et al.* 2003). The air dry strength values are found higher than in green condition. However, toughness value are found higher in green condition.. It is a medium dense timber having specific gravity 0.51 at green condition that is less than that of Chittagong teak and the relative value varies from 88-90%. Data shows that all the strength properties of the species are lower than those of teak in most of the cases except nail holding capacity where higher values are observed. It has a very good nail holding capacity with values 106 to 195 percent relative to teak (Table 3).

The present study indicates that Philippines Mahogany and Mahogany of Chittagong regions of 20-23 years were almost similar. The similar results are found in Chittagong teak. Considering physical properties of specific gravity and shrinkage strength properties of modulus of rupture (MOR), modulus of elasticity (MOE) in static bending and maximum crushing strength (MCS) parallel to the grain values of 20 years old Chittagong mahogany timber is moderately heavy, moderately strong and stable. Therefore mahogany timber is found suitable for furniture, cabinets and other purposes requiring moderate strength.

Conclusion

Mahogany is one of the valuable and economically important tropical timbers. It is moderately heavy and moderately strong timber. Investigations of strength and seasoning properties of *s. macrophylla* from Patiya, Chittagong, indicate that the wood can be used for musical

instruments, jeweler's box, printing block, novelty and turnery articles. It is an excellent timber for furniture, paneling and cabinet works because of its graceful colour and moderate weight. It is valued for its small dimensional movement, lack of distortion and good finishing qualities.

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