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Physical and Mechanical Properties of Kanyaung *Shorea argentea* C.E.C. Fisher

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ကညောင်သစ်၏ အရည်အချင်းနှင့် အင်အားကို လေ့လာခြင်း

ဦးစိုးတင့်၊ B.Sc. (For.) (Rgn.), M. Sc. (A.N.U.) ဌာနမှူး
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ကညောင်သစ်ပင်သည် သစ်ပင်ကြီးမျိုးဖြစ်၍၊ ရခိုင်ပြည်နယ်-တနင်္သာရီ နှင့် ဧရာဝတီတိုင်းတို့တွင် ပေါက်ရောက်မှု ကောင်းပါသည်။ သို့ပါ၍-ဌင်းကညောင်သစ်၏ အသုံးဝင်မှု အလားအလာကို သိရှိနိုင်ရန်၊ ဌင်းသစ်၏ အရည်အချင်း နှင့် အင်အားတို့ကို စမ်းသပ်လေ့လာကာ အသုံးပြုနိုင်မည့် အခြေအနေကို ဤစာတမ်းတွင် ပမာဏ အနေဖြင့် တင်ပြထားပါသည်။

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Abstract

Kanyaung is a timber species producing a relatively large usable volume of wood and is growing in fairly large quantity in Rakhine State, Tenasserim Division and Bassein areas. With the object of finding the possible utility of this species, the physical and mechanical properties are investigated and presented in this paper.

Contents

1. Introduction

Kanyaung is a large and tall tree, producing relatively large volume of wood. It attains a height of 100 feet and over and 8 to 9 feet or even more in girth. Its occurrence is confined to the forests of Bassein, Tenasserim and Rakhine. The stocking of this species should be regarded as plentiful in such a tropical forest where many mixed species grow. The stocking per acre of this species 2 and above at breast height in Bassein and Rakhine areas are shown below in township-wise.

Bassein Area - Bassein Township - 0.50 tree/acre
Bassein Area - Thabaung Township - 1.01 tree/acre
Rakhine Area - Gwa Township - 0.90 tree/acre
Rakhine Area - Sandoway Township - 0.81 tree/acre

The information on growing stock mentioned above are supplied by "The National Forest Inventory Project, Forest Department." The data on Tenasserim is not available at the moment.

The timber is used in large scale in the area of occurrence and the volume available is pretty large and yet the properties of this species has never been investigated before. With an intention of exploring a better and efficient use of this timber species, the physical and mechanical properties are investigated as a first step. Later on if conditions are favourable its drying properties, treatability and other properties would be tested by the respective researchers of the Forest Research Institute in Yezin.

2. Literature Review

The genus *Shorea* occurs in India, Burma, Thailand, Laos, Malaysia, Indonesia and the Philippines. The species occurring in individual areas are plenty. As many as 59 species or more in Malaysia, 32 species in the Philippines, 4 species in India, 16 species in Thailand and 11 species in Burma are found. The genus *Shorea* as a whole provides the highest parting of the timber exploited in Malaysia and it is one of the genus commercially importance in the countries of occurrence. Malaysia, Indonesia, Philippines and Thailand are exporting this timber.

The genus *Shorea* has different trade names and the species are grouped according to colour and density in world timber market. In Malaysia, the species are named *Balau* and *Red Balau* for heavy shorea species and *Maranti* for light *shorea* species. This *Maranti* group is again subdivided into *Dark Red Maranti*, Light Red *Maranti*, White Maranti and Yellow Maranti depending on the similarity of structure, weight and colour. In the Philippines, the species is named as *Lauan*, but it includes some Parashorea and Pentacme species. This lauan is again grouped into Dark Red *Lauan* and Light Red or White *Lauan* depending on the colour of the timber. In India the most commercially important species of *shorea* is Sal (*S. robusta*).

In Burma, although it is said that 11 species of *Shorea* occur, Thitya (*Shorea oblongifolia*) is the only species commercially known throughout the country. Thitya is marketed together with Ingyin (*Pentacme siamensis*) and has a common trade name as Thitya / Ingyin. The species studies in this paper, Kanyaung (*Shorea*

argentea), is commercially important in Bassein, Tenasserim and Rakhine local areas only. According to the literature no much information on the species is available and no strength testing has ever been carried out before. According to the literature, S. argentea occurred only in Burma.

3. The Timber

The timber is grey or light brown when freshly cut, but changing colour into light red or greyish brown in drying. Sapwood and heartwood are ill defined and growth rings are also indistinct when green. Radial surface is lustrous with ribben figure. Texture is moderately coarse. The grain is mostly interlocked, occasionally straight. It is a moderately heavy timber (68 lb / c.ft green ; 51 lb / c . ft air dry) and moderately hard (Average hardness 1300 lb).

The timber seasons well and can be seasoned using the solar dryer in the Forest Research Institute. Drying in the month of October, the pieces measuring 2" x 2" x 4' take about 4 weeks to get to a moisture content of 13-15%. Apart from a negligible amount of end splitting, it dries rather rapidly without serious trouble, but care have to be taken to avoid cupping and warping in longer pieces. Air drying may also give good results.

In term of durability it seems to be moderately durable, but no proper test has been done on this species. Presence of tyloses and the density indicates that the wood could be very difficult to treat. Information on the durability and treatability is wanting. According to local information, the wood is durable under protection but not so, if exposed, and is liable to insect attack even in the process of transportation. Pin hole borer is the major cause of damage.

The timber saws pretty easily when green, but becomes harder to saw in dry state. Machining and planing have some problem to get smooth surface as pricking occurs. Manual planing gives a fine smooth surface. It is rather easy to bore and gives a smooth bore-hole, especially in dry condition. The resistance to splitting when nailed is poor, and splitting occurs when nailed at the ends.

4. Materials and Methods

The timber for test was collected from the lot of commercial sale of the Timber Corporation. Two logs were selected and the sizes of the logs were 5' 2" in girth and 16' in length, and 5' 6" in girth and 15' in length respectively. The timber thus collected were compared with the anatomical features described in the literature. The logs at the time of cutting were green.

The logs were cut into 2½" x 2½" sticks and were shipped to Rangoon, and then transported to Yezin. The sticks were then randomly selected for green and air dry tests. The sticks to be tested dry were kiln dried in the Solar Kiln of the F.R.I. Specimens were matched for green and air dry tests and green specimens for immediate tests were temporarily stored in damp saw dust and were planned on four surfaces to the required sizes of 2" x 2". The planed specimens for green tests were keep wrapped with damp cloth to keep them green until the time of test. The solar Kiln dried specimens were stored in the conditioning chamber to obtain a moisture

content nearest to 12% till of the time of test. Care had been taken to use specimens of clear, straight grain and free from defects for both green and dry tests.

4.1 Physical properties

Twelve specimens were taken from the remaining portion of the test specimens for the determination of radial and tangential shrinkage. Six specimens were taken for volumetric shrinkage evaluation. Water displacement method was used in determining the volumes of the specimens. Measurements of the specimens were taken nearest to the thousandth of an inch and nearest to the thousandth of a grain in taking the weight.

The specimens were dried in the oven at 105° C till a constant weight was obtained.

4.2 Mechanical properties

Various dimensions of the test specimens were shown in table (1). Cleavage test, and Impact Bending test were not carried out as proper equipments were not available at the moment. Test on tension parallel to grain was not also done because the result obtained out of such test is normally not precise.

Table (1). **Dimensions of the specimens for various tests.**

Sr. No.	Test	Size of Specimens
1.	Static Bending	2" x 2" x 30"
2.	Compression Parallel to grain	2" x 2" x 8"
3.	Compression perpendicular to grain	2" x 2" x 6"
4.	Hardness	2" x 2" x 6"
5.	Shear	2" x 2" x 2"

The Avery Universal Testing Machine was used for the mechanical tests of the timber. The principal tests made and the properties evaluated are : -

(1) Static Bending Test
- (i) Fibre Stress at Proportional Limit. (FS @ PL).
- (ii) Modulus of Rupture (MR).
- (iii) Modulus of Elasticity (ME).

(2) Compression parallel to the grain
- (i) Fiber Stress at Proportional Limit. (FS @ PL).
- (ii) Maximum Crushing Stress (Max. Cr.)

(3) Compression perpendicular to the grain
- (i) Fibre Stress at Proportional Limit. (FS @ PL).

(4) Hardness
- (i) Radial (Rad.)
- (ii) Tangential (Tan.)
- (iii) End. (End.)

(5) Shear
- (i) Radial (Rad.)
- (ii) Tangential (Tan.)

The temperature of the room where the testing was carried out could not be maintained at the required range of temperature. Therefore testing was done as rapidly as possible after reconditioning the specimens in the controlled cabinet. This was to prevent to the loss or gain of moisture content which is detrimental for getting proper results.

The method of tests was in accordance with the American Society for Testing Material (A.S.T.M.).

5. Results

5.1 Physical Properties.

Results of the physical properties such as the specific gravity, weight, and shrinkage percentage are given in Table (2). The shrinkage percent is the different in dimension resulting from drying from green state to even dry condition. The weight (density) given is the calculated weight based on the specific gravity of the specimen.

The physical property of Kanyaung is shown together with those of other species for comparison. Teak is also indluded, as " The Standard " in comparison. Other species of the genus *Shorea* such as Thitya and Sal are also given. Sal is not the indigenous species of this country, but it plays an important role in India. Two Dipterocarpus species, namely, In and Kanyin which are commercially sold under one common name In / Kanyin, strong timber like *Pyinkado* and other commercial timber such as Binga, Hnaw, Sagawa, Taungthayet and Yemane are presented. Kuthan, Leza and Nabe, which are not yet popular in timber market are also added.

Table (2) Physical Properties of Kanyaung and Other Species.

Species	Seasoning	Specific gravity	Moisture Content %	Weight lb / c. ft	Shrinkage percent			Shrinkage Ratio	Remarks
					Rad	Tan	Vol		
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
	Green	.706	56.9	68	5.5	10.9	16.4	1.98	
Kanyaung	Air Dry	.731	12.7	51	-	-	-	-	
Teak	Green	.586	49.4	55	2.1	3.3	6.8	1.57	
	Air Dry	.568	14.1	40	-	-	-	-	
Binga	Green	.553	58.4	55	3.8	7.3	12.0	1.92	
	Air Dry	.586	12.8	41	-	-	-	-	
Hnaw	Green	.583	81.4	66	2.8	5.6	8.7	2.00	
	Air Dry	.592	12.2	41	-	-	-	-	
In	Green	.726	50.3	68	4.4	9.1	14.0	2.07	
	Air Dry	.755	19.4	56	-	-	-	-	
Kanyin	Green	.655	65.7	68	4.2	8.9	15.0	2.12	
	Air Dry	.689	14.3	49	-	-	-	-	
	Green	.418	114.8	56	2.4	5.6	9.8	2.30	
Kuthan	Air Dry	.441	6.3	31	-	-	-	-	
	Green	.522	92.2	64	4.2	6.4	12.1	1.52	
Leza	Air Dry	.545	10.1	42	-	-	-	-	

Table (2) Physical Properties of Kanyaung and Other Species (Contd).

Species	Seasoning	Specific gravity	Moisture Content %	Weight lb / c. ft	Shrinkage percent			Shrinkage Ratio	Remarks
					Rad	Tan	Vol		
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
	Green	.497	94.0	60	3.0	5.4	8.4	1.80	
Nabe	Air Dry	.497	17.0	36	-	-	-	-	
Pyinkado	Green	.779	48.6	72	3.3	6.7	11.1	2.03	
	Air Dry	.816	10.3	56	-	-	-	-	
Sagawa	Green	.426	112.9	57	3.2	5.2	8.2	1.63	
	Air Dry	.441	8.8	30	-	-	-	-	
Taungthayet	Green	.551	58.5	54	3.2	6.0	10.8	1.88	
	Air Dry	.575	13.7	41	-	-	-	-	
Thitya	Green	.858	46.3	78	5.4	9.7	15.1	1.79	
	Air Dry	.933	10.6	64	-	-	-	-	
Yemane	Green	.419	151.2	66	2.4	4.9	8.8	2.04	
	Air Dry	.432	12.1	30	-	-	-	-	
	Green	.684	60.1	68	4.0	8.4	13.2	2.10	
Sal	Air Dry	.719	9.2	49	-	-	-	-	

5.2 Mechanical Properties

The mechanical properties of Kanyaung are given in table (3). The mechanical properties of other species mentioned in paragraph (5.1.2) are also given. The adjusted strength values for 12% moisture content is not made, because a separate table, viz table (4) where the direct comparison of strength of different species had already been given. Table (4) is an index of suitability of utility for different species, teak being taken as 100% suitable. This index compared the combined strength values of different species adjusted according to the weight of each species. Direct comparison of the individual strength values (Limaye and Seaman) was not made. This index of suitability for different utility given in table 4 provides an easy comparison of Kanyaung with other species and transforms technical data to a simple form of information easy to be understood by non-technical people.

6. Discussion

Shorea argentea is a moderately heavy (sp.gr.731) and strong timber. If compared with the shorea grown in Malaysia, the timber is lighter and weaker than Heavy Balau whose specific gravity is 0.92. It is almost identical to Red Balauin both weight and strength. Red Balau has a specific gravity of .73 and 47 lb/c.ft at 16.9% moisture content. Kanyaung is superior to Dark Red Maranti, Light Red Maranti, Maranti White and Maranti Yellow, whose specific gravities range from .43 to .58 only. The densities of these four Marati range from 30 -40 lb/c.ft. On the other hand, Kanyaung shrinks more compared to Malaysian Shorea species.

Table . 3 Mechanical Properties of Kanyaung as compared to some other species.

Name	Seasoning	Moisture content %	STATIC BENDING			Comp : Parallel to grain		Comp : Per to grain p.s. i	HARDNESS			SHEAR	
			FS @ PL p. s .i	M.R. p .s .i	M.E p.s. i × 10^3	FS @PL p .s .i	Max. Cr p. s .i		Radial lb	Tan lb	End lb	Rad p. s .i	Tan p. s .i
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)
Kanyaung	Green	56.9	5067	12003	2058	4095	6160	921	1320	1300	1300	1280	1475
	A D	12.7	7936	14918	2170	4525	7260	1270	1330	1390	1200	1610	1870
Teak	Green	49.4	6935	11460	1640	3815	5710	930	980	960	910	990	1080
	A D	14.1	9425	11465	1830	5385	8350	1280	960	990	860	895	1390
Binga	Green	58.4	6425	10525	1330	4030	5280	990	1075	1055	1230	1190	1300
	A D	12.8	7695	14030	1603	5710	7525	1345	1165	1255	1580	1460	1445
Hnaw	Green	81.4	5645	9450	1215	3955	4925	1085	1060	1100	1255	1150	1320
	A D	12.2	6535	11325	1362	4175	6550	1475	1165	1295	1440	1505	1490
In	Green	50.3	6990	11595	1754	3670	5640	1220	1420	1420	1455	1195	1345
	A D	19.4	7205	13925	1964	3540	6785	900	1615	1565	1575	1380	1600
Kanyin	Green	65.7	6935	11020	2020	3890	5865	950	1020	1010	1060	885	1055
	A D	14.3	8095	15605	2240	3730	7745	1185	1395	1285	1315	1160	1345
Kuthan	Green	114.8	3325	5585	914	1905	2685	465	505	505	460	815	975
	A D	6.3	6710	9660	1270	3665	6465	940	600	645	630	890	1030

Table . 3 Mechanical Properties of Kanyaung as compared to some other species. (contd)

Name	Seasoning	Moisture content %	STATIC BENDING			Comp : Parallel to grain		Comp : Per to grain p.s. i	HARDNESS			SHEAR	
			FS @ PL p. s .i	M.R. p .s .i	M.E p.s. ix 10^3	FS @ PL p .s .i	Max. Cr p. s .i		Radial lb	Tan lb	End lb	Rad p. s .i	Tan p. s .i
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)
Leza	Green	98.2	6065	11005	1695	4010	5115	955	985	990	1055	1200	1425
	A D	12.4	9280	13265	1940	4895	7145	1245	1125	1076	1120	1315	1325
Nabe	Green	94.0	3290	6065	801	1935	2790	555	700	685	740	740	905
	A D	17.0	4570	8145	940	2555	3805	845	795	770	870	955	1175
Pyinkado	Green	48.6	9635	15555	2265	6445	8015	1700	1925	1915	1825	1525	1965
	A D	10.3	11330	20580	2530	7120	11515	2210	2165	2385	2080	2130	2300
Sagawa	Green	112.9	4795	8010	1194	2985	4020	630	610	640	640	940	1005
	A D	8.8	6215	9250	1387	4250	6420	985	760	840	1005	1070	1225
Taungthayet	Green	58.5	4655	8625	1638	2885	4095	565	750	735	755	1100	1290
	A D	13.7	6085	11435	1853	3460	5590	865	845	860	1030	1325	1530
Thitya	Green	46.3	10225	14305	2339	6075	8220	2645	1865	1865	1845	1635	1785
	A D	10.6	14040	22955	2816	7400	11010	2675	2075	2160	1580	2170	1995
Yemane	Green	151.2	4060	6940	1118	2410	3300	680	755	760	670	890	950
	A D	12.1	6335	9375	1287	3205	4850	685	490	560	525	1035	1050
Sal	Green	60.1	7460	11985	1802	4825	6020	1135	1355	1335	1240	1135	1300
	A D	9.2	9110	15690	2027	5100	8255	1480	1480	1635	1400	1530	1625

Table (4). Relative Suitability of Kanyaung and Other Selected Species as Percentage of Strength of Teak.

Sr. No	Species	Strength as a	Stiffness as a beam	Suitability as a post	Retention of shape	shear	Hardness	Weight
1	2	3	4	5	6	7	8	9
1	Teak	100	100	100	100	100	100	100
2	Kanyaung	92	120	103	50	125	120	125
3	Binga	90	83	92	69	111	107	102
4	Hnaw	77	74	81	88	111	110	102
5	In	104	110	100	57	105	147	140
6	Kanyin	105	125	100	55	90	105	110
7	Kuthan	50	55	50	75	75	50	70
8	Leza	91	103	95	70	110	104	105
9	Nabe	55	51	51	85	76	76	90
10	Pyinkado	128	135	135	170	155	187	130
11	Sagawa	62	72	69	88	83	68	75
12	Taungthayet	73	100	80	74	108	77	102
13	Thitya	135	150	140	55	150	195	150
14	Yemane	60	68	61	85	80	65	85
15	Sal	105	110	105	60	110	120	120

Between the indigenous species, Kanyaung is lighter and weaker than Thitya (same genus with Kanyaung). Within the same family of Dipterocarpaceae, Kanyaung is very similar to in specific gravity but superior to Kanyin. Therefore Kanyaung stands between In and Kanyin (Table 2 and 4). This is true also in strength properties. In term of strength as beam, it is inferior to both In and Kanyin, but superior to both in stiffness as beam, suitability as post, and shear. Nevertheless, Kanyaung is very poor in retention of shape. Its movement is 5 - 7% more than In and Kanyin.

Shorea argentea is inferior to Thitya in every respect. Although these two are of the same genus, Thitya is 25% heavier than Kanyaung, 42 % stronger as abeam, 30 % stiffer, 37 % better for post, 25 % stronger in shear and 75 % harder, In shrinkage, it is not significantly stable than Kanyaung.

Compare to teak, Kanyaung is better in term of strength, but the movement is 50% more, Binga, Hnaw, Kuthan, Leza, Nabe, Sagawa, Taungthayet and Yemane are inferior to Kanyaung in strength. On the other hand, all these species are more stable than Kanyaung. Pyinkado is an exceptional in that it is far better than Kanyaung in all the mechanical properties.

Kanyaung is very much comparable to Sal (Shorea robusta) in all regards. Sal is more stable than Kanyaung, but only by 10%. Apart from that, these two are identical in the physical and mechanical properties. Kanyaung may be suitable for all purposes for which sal is used.

The strength values of Kanyaung, if classified according to the proposal made by the same author in strength grouping of Burmese timbers, will fall in strength Group III. In this Group other species included are Thingan (Hopea odorata), Kanyin, Kashit (*Pentace burmanica*), Thadi (*Protium serrata*), and In (*Dipterocarpus turbinatus*) etc. Other species inferior to Kanyaung like, Binga, Hnaw, Kuthan, Nabe, Sagawa, Taungthayet and Sagawa are in the lower strength groups.

7. Conclusion

Kanyaung is a strong and good timber. It is comparable to other Shorea grown in Malaysia and the Philippines. As mentioned in the discussion it is superior to most of the maranti except heavy Balau. Maranti have been exported by those countries. Kanyaung should therefore be exported after proper extraction and drying. Care should be taken in the extraction to prevent pin hole borer attack and carry out predrying as necessary to minimise the timber from shrinking.

This timber stands between In and Kanyin, or it could be said that it is better. Obviously it is inferior to Thitya (*Shorea oblongifolia*) and Pyinkado. It is therefore, suggested that this timber be used in the same way as In and kanyin.

This species is stronger than most of the species like, Binga, Hnaw, Kuthan, Leza, Nabe, Sagawa, Taungthayet and Yemane. It is therefore, suggested that Kanyaung may be used in place of the above mentioned species.

Sal is one of the most important species in India, and Kanyaung, having a similar strength properties as Sal, could perhaps be promoted to the status of this species.

Kanyaung falls into strength group III, and is therefore suitable as general utility timber.

Judging from the strength properties of Kanyaung this species could be used for general construction purposes as posts, beams, joists, rafter, door and window frames, planking, flooring, ceiling, and battens, Inexpensive furniture, crates, boxes are also another possible use of this species. Sleeper, after treatment is another possibility, but it depends on the feasibility of preservative treatment. Boat and wagon carriage could be made with the species. To conclude Kanyaung is a good utility timber and should be carefully handled to reduce degradation. It is strongly recommended that care should be taken in transportation and drying be done before use to minimise borer attack and shrinkage.

Further investigation on the behaviour of drying and treatability to preservatives should be made on this species.

Botanical Names of Tree Species

Sr. No.	Burmese Names	Botanical Names.
1.	Kanyaung	*Shorea argentea* C.E.F. Fischer
2.	Teak	*Tectona grandis* Linn.f.
3.	Binga	*Mitragyna rotundifolia* O.Ktze.
4.	Hnaw	*Adina cordifolia* Hook.f.
5.	In	*Dipterocarpus tuberculatus* Roxb.
6.	Kanyin	*Dipterocarpus turbinatus* Gaertn.f.
7.	Kuthan	*Hymenodictyon excelsum* Wall
8.	Leza	*Lagerstroemia tomentosa* Presl
9.	Nabe	*Lannea grandis* Engler.
10.	Pyinkado	*Xylia dolabriformis* Benth
11.	Sagawa	*Michelia champace*. Linn.
12.	Taungthayet	*Swintonia floribunda* Griff.
13.	Thitya	*Shorea oblongifolia*. Thw.
14.	Yemane	*Gmelina arborea* Roxb.
15.	Sal	*Shorea robusta.*

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