THE ANATOMICAL, PHYSICAL AND MECHANICAL PROPERTIES OF *CEDRELA TOONA* ROXB.

Iqbal Mahmood[1] and G.M. Nasir[2]

Abstract

This paper is one of the series being prepared on the properties and utilization potential of home-grown timbers. For this purpose, the anatomical, physical and mechanical properties of *Cedrela toona* were determined in accordance with standard methods. The results indicated that the wood of *Cedrela toona* is good in all the physical and mechanical properties both in green and air-dry conditions and meet the standard requirements. More diversified and extensive use of the wood can be contemplated in addition to its traditional uses.

Introduction

Pakistan is scarce in timber resource. There are few wood species which have commercial value and they do not meet the demand of wood consumers because of short supply. Therefore, it is necessary to pay consideration for other commercially less important timbers to evaluate them for utilization.

Cedrela toona is also one of the commercially less important timber generally known as toon. It is found in India, Burma, Java, Australia and Pakistan in foot hills and plains up to an elevation of 1000 m. In Pakistan the trees are found in Hangu (Kohat), Abottabad (Hazara), Mirpur and Muzaffarabad (Azad Kashmir), Murree, Rawalpindi, Gujar Khan and Lahore (Abdullah, 1972). It is a large deciduous tree with heavy crown, 18 to 20 m in height, attains a length 3.6 to 4.2m of clear bole and a girth of 1.5 to 2.4m or more (Pearson and Brown,1932).

Cedrela toona wood has not been tested in Pakistan so far, for its properties and consequently no technical information is available. Traditionally,

---

[1] Assistant wood Seasoning Officer, Pakistan Forest Institute, Peshawar.
[2] Assistant Wood Technology Officer, Pakistan Forest Institute, Peshawar.

it is used for furniture, carvings and cigratte boxes (Abdullah, 1972). This study was carried out to compare the wood properties of locally grown toon with the reported values and to find out its suitability for different uses other than the traditional.

Material and Methods

The material was collected in log form from Pakistan Forest Institute, Peshawar. In order to study the anatomical features, wood samples were removed at a height of 1.2 meter from the butt log of the tree and permanent slides of cross, radial and tangential sections were prepared by standard laboratory procedure. Small portion of wood was also macerated in 20% nitric acid and Potassium Chlorate to measure the fibre dimensions (Johansen,1940). About 50 to 100 observations were taken for each microscopic feature and the data was analyzed for average values, standard deviation and co-efficient of variation.

For physical and mechanical properties the material was converted into about 7cm thick planks. Half of the material was tested in green condition and the remaining was seasoned properly to about 12% moisture content in an air-seasoning shed. The test specimens were prepared from the planks in accordance with the standard methods (ISO standards). Some samples had a moisture content slightly higher or lower than this level. For this reason, the air-dry strength values were adjusted to 12% moisture content. The test specimens of the following sizes were prepared from each plank for determination of different physical and mechanical properties:

- Shrinkage	3cm x 2cm x 2cm
- Density	6cm x 2cm x 2cm
- Static bending	30cm x 2cm x 2cm
- Impact bending	30cm x 2cm x 2cm
- Maximum compression parallel to grain	6cm x 2cm x 2cm
- Tensile strength perpendicular to grain	7cm x 2cm x 2cm
- Cleavage	4.5cm x 2cm x 2cm
- Hardness	10cm x 2cm x 2cm

- Shearing strength parallel to grain — 6.25cm x 5cm x 5cm. ~~2.5 inch x 2 inch x 2 inch~~
- Compression perpendicular to grain at elastic limit — 5cm x 5cm x 5cm

All the strength tests were made in accordance with ISO and BSI 373 (standards) except the shear test which was made according to procedure given in ASTM 143-52.

Results and Discussion

Cedrela toona grown in Peshawar, Pakistan was first time tested to evaluate its technological wood properties. The results of the study are discussed below:

General characteristics

The sapwood is pinkish or greyish white, heartwood is light brick red when first exposed changing to a rich reddish brown colour with the passage of time, usually with darker streaks on the radial surface. The wood is somewhat lustrous, with dry feel, fragrant with cedary scent and acrid taste. Moreover, the wood is straight grained, moderately close and somewhat uneven textured and is of medium density (0.603 gm/cm^3).

Wood Anatomy

Growth rings are distinct but not conspicuous, delimited by a zone of large and numerous springwood vessels. Average ring width is 1.25 cm.

The wood is ring porous. Springwood vessels are not appreciably large in size than summerwood vessels, but numerous (12/mm^2), occur singly or mostly sub-divided forming radial rows of 2 to 6 or more. The largest vessels are about 377u in diameter. Summerwood vessels are comparatively smaller in size and less numerous (8/mm^2), occur singly or in radial rows of 2 to 3. The Vessels are thin walled with simple, nearly horizontal to oblique perforations and are sometimes plugged with gum.

Both paratracheal and metatracheal parenchyma are present. Paratracheal parenchyma is relatively scanty i.e forming incomplete sheath around the vessels and generally grading to diffuse condition. Metatracheal parenchyma is diffused or several celled and is abundant in latewood portion.

Fibers are non-libriform and non-septate,average length is 1.42mm (1.4 to 1.7mm) long, 12u (8 to 18u) in diameter and 4.41u (3.8 to 4.8u) in wall thickness. Their radial alignment is distorted due to the presence of large size vessels and are often occluded with reddish brown deposits.

The rays are broad, visible to the naked eye in cross surface, 1 to 4 seriate in width and are 2 to 3/mm in number. In tangential section they are about 12/mm^2. The largest rays are about 21 cells (588u) in height and 4 cells (81.6u) in width. The rays are also well conspicuous on radial surface and are heterogenous to homogenous. The ray cells are frequently filled with reddish brown gummy deposits.

Average values, standard deviation and co-efficient of variation for all the microscopic features are given in table 1.

Physical and mechanical properties

Green condition

The term green condition means that the wood containing excessive moisture required to wet it up to the fibre saturation point. Generally all the growing trees have moisture content well above the fibre saturation point and the strength functions are not affected by the differences in moisture content above fibre saturation point. Results from the green material provide better basis of comparison than that from the air-dry material as indicated above.Moreover, these properties are also not affected influenced by the difference in moisture content. Moreover, they are also not affected by seasoning defects (Limaye, 1933).

Like other woods, toon has also the tendency to contract and expand anisotropically because of variation in relative humidity. Volumetric shrinkage of the specimens of the wood was found to be less (10.90%) than the reported value (11.30%).

Furthermore, average value of basic density (the ratio of oven dry weight to green volume).

Air-dry condition

In contrast to green wood, the physical and mechanical properties of air-dry wood are also necessary because the wood species do not increase in strength to a uniform extent by seasoning (Limaye, 1933).

Air-dry density of locally grown toon wood was calculated as 0.603 gm/cm^3 (table 2) which is higher than the reported value (0.480 gm/cm^3) for Indian toon and on the basis of this density it can be classed as medium dense wood (Findlay, 1974).

Mechanical properties are directly influenced by density. Higher the density, better will be the mechanical properties of wood (Findlay, 1974). Results of this study also showed the same relationship. Because of higher value of air-dry density , all the mechanical properties of local toon wood were found better than given in literature (Table 3).

Table 1. Anatomical properties of toon (*Cedrela toona*) wood.

Microscopic feature	Average	S.D ±	C.V %
No. of earlywood vessels /mm^2	12.07	0.187	1.556
No. of latewood vessels /mm^2	8.43	0.361	4.28
Diameter of spring- wood vessels (u)	290.32	48.25	16.62
Diameter of latewood vessels (u)	127.40	32.05	25.16
Diameter of paratra- cheal parenchyma (u)	25.14	5.62	22.38
Diameter of metatra- cheal parenchyma (u)	19.57	3.94	20.13
No. of rays in cross section /mm	2.74	0.215	7.841
No. of rays in tang. section /mm2	12.84	1.25	9.79
Height of ray (cells)	10.89	5.22	47.91
Height of ray (u)	310.12	118.01	38.05
Width of ray (cells)	3.37	1.390	41.20
width of ray (u)	52.68	19.41	36.84
Fibre length mm	1.42	0.15	10.73
Fibre diameter (u)	11.99	2.32	19.39
Fibre wall thick- ness (u)	4.41	0.383	8.671
Lumen width (u)	3.17	-	-

Table 2. Physical and mechanical properties of toon (*Cedrela toona*) wood.

Property	Green condition			Air-dry condition		
	Ave.	S.D ±	C.V%	Ave.	S.D ±	C.V%
Volumetric shrinkage (%)	10.90	0.54	4.95	7.81	0.43	5.51
Density	0.505*	0.018	3.56	0.603**	0.028	4.64
Modulus of rupture (kg/cm2)	735.00	64.80	8.82	783.00	82.76	10.57
Modulus of elasticity (kg/cm2)	65663.00	6102.00	9.29	78939.00	5714.00	7.23
Maximum compression parallel to grain (kg/cm2)	255.00	26.84	10.53	321.00	30.31	9.44
Compression parallel to grain at elastic limit (kg/cm2)	173.00	22.35	12.92	223.00	21.33	9.57
Shear parallel to grain (kg/cm2)	78.00	5.31	6.81	120.00	13.98	11.58
Compression perpendicular to grain at elastic limit (kg/cm2)	54.00	7.96	1.47	68.00	3.47	5.10
Impact bending (m-kg)	1.82	0.455	25.00	1.42	0.325	22.89
Cleavage (kg/cm)	24.00	1.17	4.88	26.00	2.80	10.77
Tension perpendicular to grain (kg/cm2)	24.00	3.47	14.46	25.00	3.06	12.24
Hardness (kg)						
Side:	325.00	20.50	6.31	430.00	31.61	7.25
End:	333.00	23.76	7.14	533.00	40.07	7.52

* Basic density
** Air dry density

Table 3. Comparison of some physical and mechanical properties of toon (*Cedrela toona*) wood.

Property	Green condition		Air-dry condition	
	Actual value	Reported value	Actual value	Reported value
Volumetric shrinkage (%)	10.90	11.30		
Density	0.505*	0.424	0.603**	0.480
Modulus of rupture (kg/cm2)	735.00	436.00	783.00	562.00
Modulus of elasticity (kg/cm2)	65663.00	63981.00	78939.00	78535.00
Maximum compression parallel to grain (kg/cm2)	255.00	215.00	321.00	311.00
Compression parallel to grain at elastic limit (kg/cm2)	173.00	162.00	223.00	184.00
Shear parallel to to grain (kg/cm2)	78.00	63.00	120.00	94.00
Hardness (kg)				
Side:	325.00	293.00	430.00	352.00
End:	333.00	315.00	533.00	376.00

* Basic density

** Air dry density

Conclusion

Cedrela toona grown in Pakistan can be classed as moderately dense and strong timber. It has attractive colour, straight grain and medium strength. These properties enable the wood not only suitable for furniture but also for cabinet work and paneling. It can also be used for packing cases and crates because of its medium weight and better cleavage value. Moreover, as the timber is moderately hard, it is suitable particularly for toys, models and turnary wood articles.

References

Pearson, R.S and H.P. Brown. 1932. Commercial timbers of India, Central Publications Branch Calcutta.

Abdullah, P. 1972. Meliaceae, No.17. Flora of West Pakistan. Editors: E.Nasir, National herbarium (Stewart Collection) and S.I. Ali, Department of Botany, University of Karachi, Karachi.

Donald Alexander Johansen. 1940. Plant microtechnique. first edition, Mc Graw-Hill Book Company, Inc. New York and London.

Organization for International Standards. 1975. Wood-Sampling Methods and General Requirements for Physical and Mechanical Tests ISO: 3129.

Limaye, V.D. 1933. The Physical and Mechanical Properties of wood grown in India. The Indian Forest Records, Third Interim Report on Project No.1.

Findlay, W.P.K. 1974. Timber: Properties and Uses. Crosby Lockwood Staples, London.