A Brief Review on Physical and Mechanical Properties of Indian Subcontinent Timber and their Measurable Characteristics

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Abstract

In India, Agriculture developed in the inaccessible areas and got a rank among the ranking table of some developed countries of the world after the 18th century. At that time basic and well-designed suited needs of the farmers were homegrown tools. Normally, Farmers were using many types of tools for their everyday life, even for household purposes as well as for agriculture operations. Appliances used for Agricultural in 18th and 19th centuries were mostly hand operated and animal drawn. Around the time of independence (1947), new designs and developments in the appliances came into the notice. Local woods were used in most of the wooden tools – different types of woods needed for particular tools and strings (used for various works) came from different plants. The mechanical as well as measurable characteristics of wood or timber are important aspects used for the determination of suitability and utilization of wood material.

Keywords

Physical and Mechanical Properties; Woods; Agriculture

1. Introduction

Due to steep and hilly terrain comprising of shallow and stony soils, it is required the use of some traditional or popular technique which may include the tools or appliances in the agriculture activities. Present study is come into the use so that the locally generated agriculture tools and appliances can be used for agriculture activities during the harsh or severe condition. In addition to these agricultural ingredients, the author documented the traditional knowledge of local people about the use of plants in the operation of cutting tools based on their preference and choice. Traditional farm equipment and tools were made locally or made from locally available materials such as stone, wood and iron made from locally made or standardized factories. These tools and appliances were economically financial in the term of labor, money and time saving [1]. Apart from this, they are easily operated and did not require any special skills. Each of these tools and appliance is usually used in connection with the specific operation in the sequence of agricultural operations; land preparation, sowing, weeding, irrigation, harvesting, post-harvesting operations and transportation.

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Measurable characteristics of woods are quantitative characteristics and behave for external influence other than applied efforts. Due to the influence on the performance and strength of woods used in structural utilization; one should be familiarize with its physical properties. Mechanical properties are characteristics of materials in response to externally applicable forces. It has elastic properties, which mark resistance to deformation and deformity, and have strength qualities, which mark the resistance of the applied load. The value of mechanical property is given in terms of stress (per unit area force) and stress (distortion from applied stress). Strength properties mean that how much resistance a material can produce ultimately against the applied loads. In the case of wood, there is considerable variation in the strength on the basis of species, loading conditions, duration of load and mixed content and the number of environmental factors. Since wood is an anisotropic, and the mechanical properties are different in the three principal axes. Property values in the longitudinal axis are generally much higher than those in tangent or radial axes. Bending stress get induced when a material is used as a beam, such as in the floor or rafting system. The density of the material is the mass in each unit volume on certain condition. In the case of hydroscopic materials such as wood, density depends upon two factors: the weight of wood structure and the moisture retained in the wood. There is considerable variation in wood density in different moisture materials and in order to keep a practical meaning, it should be given in relation to any specific situation. Density is important for indicating strength in the wood and can assume some characteristics as hardness, easy machining and best resistance. Specific gravity is similar to density and it is defined as the proportion of the water density of the density of the wood. Thus, the specific gravity is an excellent index of the amount of wood content contained in a piece of wood; It is a good index of mechanical properties, as long as the wood is clear, straight grained and free of impurities. However, specific gravity values reflect the presence of gums, resins, and extractive, which contribute very little to the mechanical properties. Some property relationships are almost linear and other exponential. Dimensional changes with shrinking and swelling of wood, both used in the use and use of wood and materials are major sources of visual and structural problems. Moisture in the form of shrinking and swelling wood changes In response to atmospheric humidity in response to daily as well as seasonal changes, that is, when the air is moist, wood filters the moisture and snuffs; When the air is dry, the loss of wood leads to moisture and shrinkage.

The research and development work on physical and mechanical properties has been executed in matured countries and a few developing countries. This chapter includes a review of the various properties of Teak, Yellow teak, Java plum, Margosa, Mango, Eucalyptus, Lebbeck, Sal, Red cedar and North Indian rosewood.

2.1 Physical Properties of Wood

Bali and Singh [2] examined the physical properties of Teak which was collected from the Vilonia range of Gorakhpur Forest division of Uttar Pradesh (Currently in Uttarakhand). The measurable characteristics like specific gravity, moisture content and density of Teak were 0.578, 42.1% and 821 kg/m³ respectively. Shukla et al. [3] studied the physical properties of Quercus dilatata collected from Chachpur range, Jabal forest division Himachal Pradesh. The average specific gravity of Quercus dilatata was 0.760 and percent moisture content was 56.9 and density was 1192 kg/m³. The radial, tangential and volumetric shrinkage was 6.0, 10.2, and 19.6% respectively. Josue [4] investigated for nine-year-old trees and Xyliaxy locarpa were taken from a small plot at Luasong, Tawau, and Sabah. The average basic density, oven-dry density and green moisture content of Xyliaxy locarpa were 0.72 gm/cm³, 0.78 gm/cm³ and 49.8%, respectively. Total shrinkage from green to oven-drought circumstances for radial and tangent directive was 3.35% and 5.76% respectively. The wood density drop from the bottom to the top and heightened from the interior to the exterior sector of the branch within tree. The moisture content, heightened with height, and drop from the interior to the exterior sector of the stem. There was higher shrinkage at the exterior sector of the branch and down from the bottom to the top of the branch.

Shanavas et al. [5] studied wood properties of three fast flourishing tree species “Acacia auriculiformis, Acacia mangium, and Grevillea robusta” appearing as distributed and barrier sown trees in the agricultural fields of Kerala. Specimens and sample locations exerted a profound domination on the wood mechanical properties. Essential wood density of A. Auriculiformis was greater than that of A. Mangium and G. Robusta, while the moisture content goes after a reversal sequence: G. Robusta A. Mangium A. Auriculiformis. Wood density further increased from interior to exterior positions forward the radial direction, excepting for G. Robusta. Although moisture content down
from the interior to exterior location of the specimens for *A. Mangium*, no certain arrangement was apparent in this consideration for the other two specimens. Most toughness properties, however, followed a pattern related to that of wood density. Hence, the physical of and, excepting shrinkage, were *A. Mangium, G. Robusta* inferior to teak. Izekor et al. [6] studied the density variation of plantation grown *Tectona grandis* wood. Wood density determination was carried out using sample sizes of 20×20×60 mm according to BS373. The mean values were oven-dried to a constant weight at 103±20 °C. The mean density values, based on oven-dry weight and volume were 480, 556 and 650 kg/m³ for 15, 20 and 25 year old Tectona grandis wood. Izekor and Fuwape [7] studied the modulus of rupture values obtained for Sagun for the three age classes were 76.86, 103.95 and 134.69 N/mm². The mean values of Modulus of rupture in the longitudinal positions ranged from 65.29 to 88.31, 90.49 to 117.46 and 121.13 to 148.46 N/mm². The Modulus of elasticity values obtained for the three age classes of 15, 20 and 25 years old Sagun wood were 6846.92, 9915.7 and 12845.57 N/mm² respectively. The mean values for Modulus of elasticity in the longitudinal positions ranged from 5771.47 to 7864.62, 8861.05 to 11017.33 and 11373.90 to 14382.98 N/mm². The interaction between age and height were significant at 0.05 % probability level. The mean values obtained for compressive strength were 43.74, 58.47 and 75.36 N/mm² respectively. The mean values of compressive strength in the longitudinal positions ranged from 36.98 to 50.42, 50.77 to 66.84 and 86.68 N/mm² and the interaction between age and height, radial position and height were also significant at 0.05 percent probability level.

### 2.2 Mechanical Properties of Wood

Yoshizawa et al. [8] examined about the radial fluctuation of wood properties in 11-years old Acacia uriculiform which was cultivated in Bangladesh with width 222.38 mm. There was the advancement in following properties such as basic density, fiber length, and fiber length, which, has a radial distance of 80 mm in correspondence to pith and then constant to the bark. The compressive strength increased up to 50 mm from pith and then became nearly constant to the bark. Conversely, the specific compressive strength of air dried density was almost constant from pith to bark, indicating positive conjunction. Although, there was only 50% deviation in compressive strength which was interpreted by air dried density. The boundary of core wood and outer wood could be depicted at 70-90 mm from pith in accordance with radial deviation in basic density. The outline from the pith was noted to be 60-90 mm which was depicted in accordance to fiber length and length increment curves. The properties of wood vary significantly except Compressive strength, potential of characterizing and selecting trees for betterment in wood quality by tree breeding methods. Andrade [9] researched about the woods mechanical properties which mainly incorporate an assortment of harmful wood, with moderate theists that usage broad amount of sauce. The intention of this job is to use the Near-interred spectroscopy producer to earn adjustment for mechanical characteristics of Eucalyptus wood. At the age of 7th, a natural Eucalyptus hybrid was used as achieved from V&M Florestal Crop. Sphere was measured precisely in strong wood and field wood, in diffuse reflecting mode, using a broker spectrometer in the 800 to 1,500 mm range. The Near-infrared spectroscopy (NIRS) technique verified applications to measure factors of elasticity in strong wood, with values r=0.91 and RPD=2.6, and in field wood with values r=0.87 and RPD=2.0. Modulus of rupture and compressive strength displayed the value of r below 0.9. Arrangement of contrasting plank faces did not current a defined change pattern. Equal correlation value provided for solid and ground wood for all properties. Majid Kiae [10] studied the wood mechanical properties of five hardwood plants such as oak, beech, hornbeam and alder and ash. These trees are important plant species for wood production in Iran. Five common trees of each plant species were chosen in the Northern part of Iran and log samples were cut between 2-4 m of stem heights to determine the mentioned properties. Results of analysis of variance indicated that the types of plant species had a significant effect on the different wood properties. The highest, breakdown modulus of wood density, the modulus of flexibility and the likelihood of grain values were found in hornbeam, beach, ash and oak, respectively. The least of mechanical strength was found in alder wood.

Sapari et al. [11] investigated the bending strength properties of half cut *Yellow meranti* wood by using finger jointed techniques, the variety was secured with polyvinyl acetate. The modulus of rupture and modulus of elasticity of off-cut *Yellow meranti* wood in three point test method at horizontal, vertical and control orientation were 21.26, 24.49 and 66.84 MPa and 7611, 8814 and 9060 MPa respectively. The modulus of rupture and modulus of elasticity of off-cut *Yellow meranti* wood in four point test method at horizontal, vertical and control orientation were
26.30, 28.91 and 81.47 MPa and 11221, 11668 and 13605 MPa respectively. Hossain et al. [12] Studied physical properties, strength and endurance of few timber species financially used in Bangladesh. Seven timber species, namely Teak, Sal, Sil korai, Rain Tree, Jam, Jackfruit, and Mango were tested for physical and mechanical properties following ASTM standards. Four contrasting types of chemical climate subsists of ordinary water, sodium chloride (5%), sodium sulfate (10%) and hydrochloric acid (5%) were formed and tested for endurance in condition of strength defeat over a period of 90 days. The test results admitted that Sal, Teak and Jam were the perfect species of applying as a compression member while Sal and Teak showed the good achievement in tension. In static bending Sal, Sil korai, Teak and Jam have been established convenient. With respect to endurance acidic climate has been advertised to be the most combative assistant. Saline water was approximately protected from all types of wood species. Overall, the Rain Tree presented finest achievement in all chemical climates having 6 less loss of strength, and Sil korai has been formed to be the most accessible one of the same climate amid all the wood species. Jamala et al. [13] studied the mechanical properties like modulus of rupture and modulus of elasticity for five types of species by using spontaneous wood bending strength frame with analog dial gauge at the wood workshop. The samples selected for study are Iroko, Mahogany, Obeche, Apa and Ita in the tropical rainforest ecosystem, Ondo State, Nigeria. The modulus of rupture of Ita, Apa Mahogany, Iroko and Obeche is 149.94, 136.71, 94.82, 90.41 and 30.87 N/mm2 respectively and the modulus of elasticity of Ita, Apa Mahogany, Iroko and Obeche is 7088.69, 6313.58, 8192.54, 5765.63 and 3937.5 N/mm2 respectively.

Elzaki et al. [14] investigated the mechanical properties of wood of 20-year old Lusitanica from Jebel Marra field Western Sudan to resolve its mechanical properties as a probable different wood. The end results for the mechanical properties were correlated with the aspect of the equation cypress species from India and Costa rica. The results displayed that the moderate value the modulus of rupture “693.0 kPa/cm” was reduced than that of the Indian cypress “763.0 kPa/cm” but higher than for the Costa rica cypress. The elements of elasticity were 142.7 kg/m2 express good rigidity properties. The shear stress was decreased than that of the Indian cypress, but comparable to a Costa rica. Thulasidas et al. [15] studied Mechanical properties of teak wood mature in homegrown arboriculture and the objective factors affecting timber strength were reviewed in correlation with that of a typical woodland orchard. No significant inequality was realized in modulus of elasticity and modulus of rupture with respect to wet, dry and orchard sites and the values are balanced correlated along the basic teak. Though, dry site home-garden teak displayed bigger compressive strength parallel to grain (60.6 N/mm2) and alter extremely among wet and plantation sites (P B 0.05). The greater compressive strength value was correlated with greater air-dry density (691 kg/m3) reported connected with the wide fiber wall and minor fiber laymen as explicated by objective application. The micro fibrillar angle also presented non-significant contrast, among the three localities (P=0.05) and the value 12.50 was absolutely limited to, changing the timbre toughest negatively in its usage potential. The results of the current study admit that growers preferred to drop apartment teak at short revolution of 35-years have in no way changed the wood quality attributes acting as density and strength. Hanns et al. [16] investigated the mechanical properties as elasticity and strength of green wood, particularly as measured in the axial direction; influence the stability of trees across static loads and dynamic loads. Comprehensive selection of data on mechanical properties is listed in three contrasting cartulary rearranged in Canada, Great Britain and the United States. A statistical analysis shows that the wood density was a major predictor for the mechanical characteristic as measured in the axial direction. In this respect, conifers from temperate zones and long tresses, both from temperate and hot zones do not alter incomparably from each other. A familiar, approximately straight relation along the element of elasticity and the density at 50% moisture content was formed. Relationships between durability in bending, compression, and shear and green wood density have normal least squares mounting exponents approximately 1.2 but can almost equally well be approximated by linear functions of wood density. Therefore, if the density of stem wood of a given tree is known from direct measurement and differs from the tabulated value, the values tabulated for mechanical properties can be reformed for by a simple law of proportion. Drawing of tests in the form of devices for tree control is discussed that this method is based on the knowledge of the mechanical characteristic of green wood. Mmolotsi et al. [17] studied the physical properties of wood of four indigenous tree species. Samples were collected at irregular from the blocks at a timber and wood preparing courtyard. Acacia burke and S. africans acquire hardwood that is surely contracting in color from the
sapwood. *Acacia burke* a presented much darkened color in the Hardwood, although that of *Spirostachys africana* was darkening grayish in color. Wood of *P. africanum* and *Termineliaserecia* displayed no distinctly disparate colors between the sapwood and the Hardwood. Density further buried in various woods with the maximum density values registered at 0.97 g/cm³ in the A. Burke and the minimum were 0.70 g/cm³ in *P. africanum*. There were significant differences in densities between wood of all these species. The maximum change in dimensions was entered on the tangent side of all words except for A. Burke. The maximum dimensional modification was reported at 9.02±4.02 % in the tangent side of *P. africanum*. The minimum dimensional modification was entered at 0.41±0.08 % in the long-term part of the *P. africanum* wood. Overall the lowest changes were recorded in the longitudinal side of the wood.

**References**


