Evaluation of Compressive Strength in Various Timbers for Agricultural Implements in Pantnagar, Uttarakhand

Abstract

This study investigates the compressive strength of various wood types, including Red Cedar, Java Plum, Mango, Yellow Teak, Margosa, Eucalyptus, Teak, North Indian Rosewood, Lebbeck, and Sal. The compressive strengths of these woods were measured to be 43.79, 50.42, 78.00, 71.16, 68.32, 69.88, 80.78, 85.50, 65.12, and 81.20 MPa, respectively. North Indian Rosewood and Sal exhibited the highest compressive strengths, suggesting their superior suitability for applications requiring high compressive resistance. Conversely, Red Cedar showed the lowest compressive strength among the woods tested. The standard deviations for these measurements were Java Plum (0.07), Mango (0.28), Yellow Teak (0.36), Teak (0.45), Margosa (0.52), Eucalyptus (6.11), Red Cedar (0.69), North Indian Rosewood (0.79), Lebbeck (0.93), and Sal (0.68), with Mango displaying the lowest variation. The findings indicate that North Indian Rosewood and Sal are particularly robust, while Mango exhibits consistent compressive strength, making these woods preferable for specific structural applications.

Keywords:Compressive strength, material properties, standard deviation, wood performance, high compressive resistance

1. Introduction

Comment [EA1]: Literature reviewed and rewrite this section

The present investigation was carried out to determine theCompressive strengthof various types of Timbers used for agricultural implements in Pantnagar, Udam Singh Nagar, Uttarakhand. This study provides information for selection criteria of wood to make a different component of agriculture implement and tools. This chapter consists of full detailed material and methods used in the study. This study was mainly targeted on utilization of different type of wood for their use to make different components of agricultural implements and tools.

Wood is light weighted, durable and economical. Various samples have been prepared in different proportion considering different properties of wood thereafter tested for different Physical and Mechanical properties and compare which one has best strength sample among the all sample. The testing was conducted by using Universal Testing Machine.

Comment [EA2]: Study area should be included and details of the area

2. Materials

2.1 Wood

Wood is a natural polymer and its molecular structure is established on the cellulose chain whose cell wall comprises cellulose fibers which were laterally arranged to its axis. The wood is the intermediate and in fact the main zone of the tree.Wood subsists of four main chemical groups represented in Table1. The cellulose and hemicellulose groups are the carbohydrates (sugar molecules) which make up the majority of the cell wall. Lignin performs as a "glue" to bind the cells together into a stiff/strong material. The extracts are chemicals that are deposited in the cells and provide unique properties to wood, such as the natural resistance to biological deterioration.Woods with a high degree of natural resistance have approximately high percentage of biocidal extracts (Author). The total extractive content of few species can be as high as 20 to 30%; these species commonly have a high proportion of biocidal extracts.

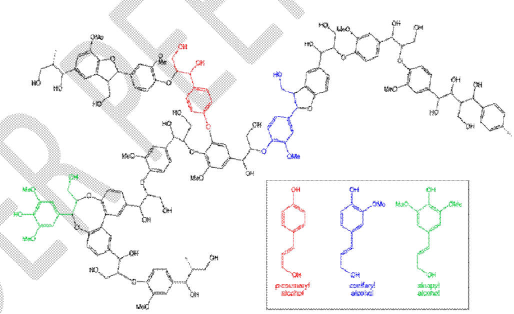


Figure 1: Chemical structure of lignin, which comprises approximately 30% of wood and is responsible for many of its properties

2.2 Collection of various types of wood

Destructive method of sampling was adopted to collect the wood samples. The tree of Sheesham, Sal, Yellow Teak, Red cedar, Teak, Margosa, Java plum, Eucalyptus, Lebbeck and Mango were felled and converted into logs of one meter length which are used for preparation of samples for mechanical property analysis. Mechanical tests were conducted as per the Indian Standard Specification IS 1708 by Universal Testing Machine (AMT-SC, A.S.I make).

Table 1: Chemical Constituents of Wood

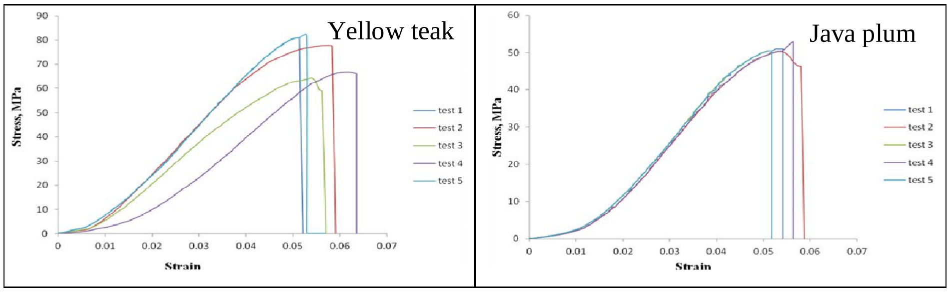
Compound	Description	Amount (Percent of total mass)
Cellulose	Long chain of glucose molecules	40-50
Hemicellulose	Long chains of sugar molecules other than glucose	25-30
Lignin	Complex organic compounds that help bond cells together	15-20
Extracts	Compounds that are not an integral part of the cell wall	< 15
Ash	Inorganic elements in wood	< 1

3. Results & discussion :

The results of the compressive test are discussed in this section. The compressive tests were carried out using controlled Universal Testing Machine (AMT-SC, A.S.I make). Compressive strength plays an important role to provide good strength for agricultural implements. Compressive strength was tested at different types of wood Ultimate compressive strength found from the stress- strain curve. The stress-strain curves of wood were presented in Fig 2.

Table 2:Compressive strength and Parentage reduction in Compressive test

S.No	Types of wood	Compressive ultimate strength (MPa)		(%) Reduction	
		Mean	S.D.	Mean	S.D.
1.	Yellow teak	71.16	0.36	7.05	0.10
2.	Red cedar	43.79	0.69	11.77	0.56
3.	North Indian rosewood	85.50	0.79	7.83	0.92
4.	Teak	80.78	0.45	8.41	0.81
5.	Lebbeck	65.12	0.93	9.15	0.60
6.	Java plum	50.42	0.07	6.67	0.45
7.	Eucalyptus	69.88	6.11	9.33	0.47
8.	Margosa	68.32	0.52	7.63	0.15
9.	Mango	78.0	0.28	6.32	0.38
10.	Sal	81.20	0.68	6.46	0.33


Yellow teak
Java plum
Stress, MPa
Strain
test 1
test 2
test 3
test 4
test 5
0
10
20
30
40
50
60
70
80
90
0.01
0.02
0.03
0.04
0.05
0.06
0.07

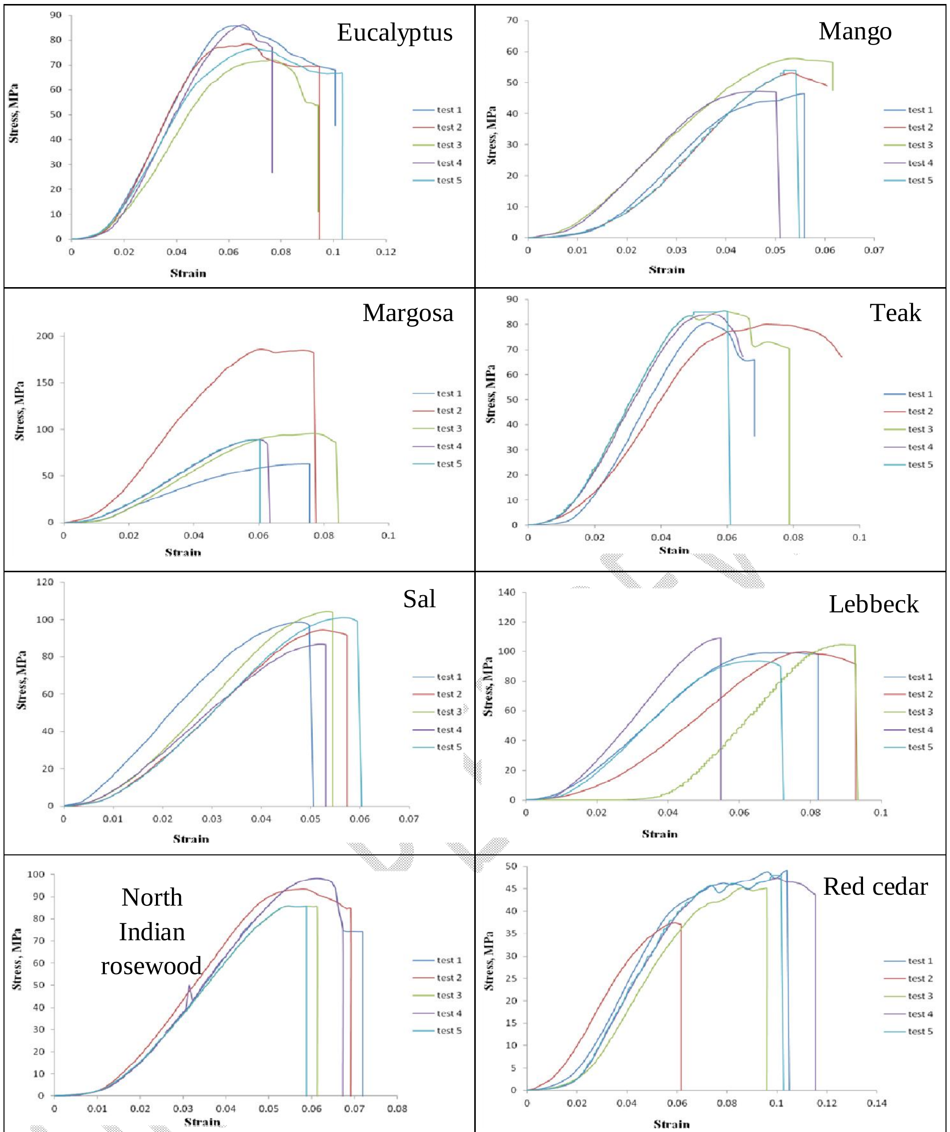


Figure 2: shows the engineering stress-strain curve for different types of wood and strains from zero up to the specimen fracture.

It was concluded from table 2 that the Compressive strength of different types of wood red cedar, Java plum, Mango, Yellow teak, Margosa, Eucalyptus, Teak, North Indian Rosewood, Lebbeck and Sal were 43.79, 50.42, 78, 71.16, 68.32, 69.88, 80.78, 85.50, 65.12 and 81.20 MPa. Similar patterns of compressive strength were observed in the research findings of **Izekor D. N.** and **Fuwape J. A. (2010)**. North Indian rosewood and Sal had a good compressive strength over all types of wood, but red cedar has lower compressive ultimate strength as compared to other types of woods. Hence North Indian rosewood wood proved itself more suitable wood rest of the other types of wood. And their standard deviations were as follows Java plum (0.07), Mango (0.28), Yellow teak (0.36), Teak (0.45), Margosa (0.52), Eucalyptus (6.11), Red cedar (0.69), North Indian Rosewood (0.79), Lebbeck (0.93) and Sal (0.68) respectively. Mango has less standard deviation compared to other types of wood.

Conclusion

The molecular structure of wood, primarily composed of cellulose, hemicellulose, lignin, and extracts, plays a crucial role in its strength and durability. The selected wood species—Sheesham, Sal, Yellow Teak, Red Cedar, Teak, Margosa, Java Plum, Eucalyptus, Lebbeck, and Mango—were analyzed to determine their compressive strength, an essential factor for their application in agricultural implements. The results revealed significant variations in the compressive strength of different wood types, with North Indian Rosewood and Sal demonstrating the highest compressive strength, making them more suitable for agricultural tools requiring high strength. In contrast, Red Cedar exhibited the lowest compressive strength among the tested woods. Furthermore, the study highlighted the importance of standard deviation in evaluating the consistency of the wood's mechanical properties. Mango wood showed the least variation in compressive strength, indicating its reliability. These findings align with previous research by **Izekor D. N. and Fuwape J. A. (2010),** supporting the consistency and reliability of the data. In conclusion, the study provides essential data for selecting appropriate wood for agricultural implements, with North Indian Rosewood and Sal being the top choices due to their superior compressive strength. This research contributes to the efficient and effective use of natural resources in agricultural applications, promoting the use of durable and strong wood materials for enhanced performance and longevity of agricultural tools.

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