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***RESEARCH ARTICLE***

# Engineering properties of ain (*Terminalia elliptica*) wood

■ **S.P. DIVEKAR,** S. K. JAIN, A. D. RANE, CHANDAN KUMAR, R. B. MAHADIK **AND** V. M. DAWARE

**ABSTRACT**

Wood is one of the earth's most valuable resources and it conforms to the most varied requirement. There are over 1600 different species of woods which are used for various purposes. Wood shows a remarkably wide range of variation in their properties, timber and the type of end use (Rajput and Shukla, 1996). Wood is a multiuse biological raw material with a high economic importance for a number of industrial sectors such as construction, furniture and the packing industry. It is much more variable than that of materials such as concrete or metal (Michael, 2016). Global production of wood is estimated at 3469 million $m^3$ in 2011, of which 1891 million $m^3$ is fuel wood and 1578 million $m^3$ is industrial round wood. Wood is a natural, renewable and valuable construction material. Since being thought of as naturally resistant to wood degrading organisms. Wood has been used as a shelter and has many outdoor applications thought out human history. However, the durability of wood varies depending on its tree species, chemical composition and the environmental condition. Wood biodegradation occurs in different ways such as fungal, bacterial and insect attack. Fungal decay is the most widespread type of wood degradation. The demand for wooden products is continuously increasing day by day. Wood is exposed to both periodic water absorption and desorption process. Understanding water absorption and desorption in wood are of practical importance since they also affect the mechanical properties of the product. In residential building and in industrial application some of the components are often wood (Ostman, 1985). To develop buildings and its components different engineering properties are important. In the present study, the bending stress of ain was found as $5.67 \times 10^7$ kN/m$^2$ and compression stress was found as $1.3 \times 10^7$ kN/m$^2$.

**KEY WORDS :** Ain, Moisture content, Shrinkage, Bending stress, Compression stress

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## INTRODUCTION

The presence of log house in agro-tourism is one of type of attraction to the tourists to come for agro-tourism. The tourists come for tourism and they stay in log house. The main advantage of a log house is a healthy living environment. The log house is made up with the locally available wood or light weight wood.

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The demand for wooden products is continuously increasing day by day. Wood is exposed to both periodic water absorption and desorption process. Understanding water absorption and desorption in wood are of practical importance since they also affect the mechanical properties of the product. In residential building and in industrial application some of the components are often wood (Ostman, 1985).

For the purpose of the study, Agro-tourism for farmers is considered as a range of activities, services and amenities provided by farmers and rural people to attract tourist to their area in order to generate extra income for their businesses. Agro-tourism for tourists is considered as anything that connects tourists with the heritage, natural resource or culinary experiences unique to the agricultural industry or a specific region of the country's rural areas. The Engineering properties are one of the important parameter in building design.

## EXPERIMENTAL PROCEDURE

The materials and the methodology used for the present study were as follows.

### Ain (*Terminalia elliptica*):

Among the popular varieties of wood available in Konkan region of India, ain was selected for project work. Ain is deciduous tree which can grow upto 32 m in height. The leaves of the tree are elliptic to ovate with one or two glands at laminar and petiole junction.

### Machine and instruments :

The following machines and instruments were used for the study.

### Universal testing machine:

Universal testing machine was used for measurement of compressive and bending strength of ain samples. The capacity of the machine is 50 kN (Fig. A and B).

**Fig. A : Ain wood sample**

**Fig. B : Universal testing machine**

**Hot air oven :**

The hot air oven was used for the determination of the moisture content of ain wood sample.

**Weighing balance :**

Weighing balance having capacity 1000g was used for measuring weight of the ain samples. Least count of weighing balance is 0.001g.

**Methodology:**

The methodology adopted for determination of engineering properties of ain was as mentioned below.

**Engineering properties :**

The engineering properties of wood determined were as follows:

**Moisture content :**

The moisture content was determined by using hot air oven. Total 13 samples of 50 ×50 mm in cross-section and 25 mm in length were used to determine the moisture content. The fresh wood sample was weighted in a weighing balance and then dried in oven at temperature of 103 ± 2°C. The weight was recorded at regular intervals. The drying was considered to be complete when the variation between last two weighing, does not exceed 0.002 g. The final weight was taken as oven dry weight Niklewski *et al*. (2012).

$$\text{Moisture content (w.b.), } \% = \frac{W_1 - W_2}{W_2} x100$$

where,

$W_1$ = Initial weight of sample, g

$W_2$ = Oven dried weight of sample, g.

**Shrinkage :**

Total 5 specimens of 20 mm × 20 mm in cross-section and 60 mm in length were used to determined shrinkage of ain. Procedure adopted for shrinkage test are as follows:

– Samples (usually green) were taken with dimensions 60 mm length ×20 mm width ×20 mm thickness.

– Volume of the sample was determined by water immersion method.

– Immerse the specimen completely in water, using needle, then again note down the reading .Thus, the difference of two above reading was the volume of specimen.

– Specimen was taken out from water and was wiped using cloth and was end -coated by immersion in hot paraffin wax, kept under room condition and weighed at periodic interval till moisture content is reached to 12 per cent. Then again determine volume as above.

$$\text{Volumetric shrinkage} = \frac{\text{Initial valume (V1)} - \text{Final valume (V2)}}{\text{Initial valume (V1)}} x100$$

**Compression test :**

An IS code 1708 (part-8)1986 was referred while preparation of sample for compression test. The specification of sample was 80 mm length ×20 mm width ×20 mm in thickness (Fig. C). The procedure used for compression test as follows:

– Wood sample was taken with the sample size as mentioned above.

– Universal testing machine (UTM) of 50 kN was used for compression test of sample.

– UTM machinewas connected with computer for displayed graph of force v/s displacement.

– Wood sample had been kept vertical in between two plates,one plate acting as force and another is stationary.

– Start the button of machine upward plate is acting force until the sample come near to braking point.

**Fig. C : Compression test**

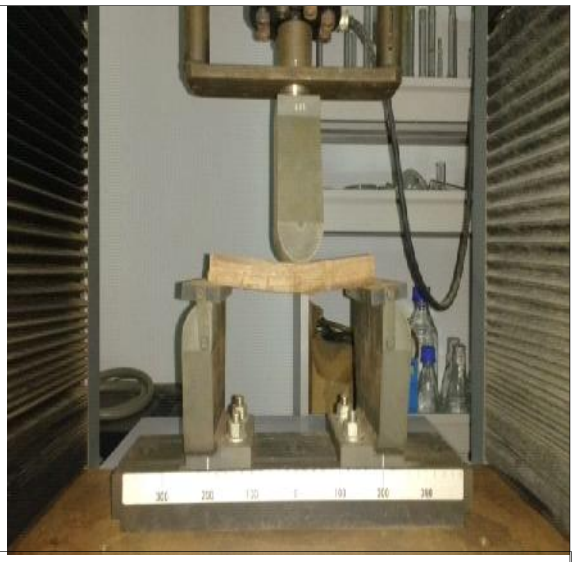

**Fig. D : Bending test**

– The force acting on sample is recoded in computer in term of graph.
– On graph braking point is recorded by computer /machine.

$$\textbf{Maximum crushing strenght} = \frac{\mathbf{P_{max}}}{\mathbf{A}}$$

where,
$\sigma_{ult}$ = Compressive strength, ( N/mm$^2$)
$P_{max}$ = Maximum load at which the sample fails, N
A = Cross sectional areas, mm$^2$.

**Bending test :**

The procedure for bending test are as follows (Fig. D):
Universal testing machine (UTM) of 50 kN was used for bending test of the sample.
– UTM machine was connected with computer for displayed graph of force v/s displacement.
– Wood sample was taken with the sample size 200 mm length ×20 mm width ×20 mm thickness.
– Sample was placed horizontally on supporting plates.
– The force was applied on the upper surface until bending takes place.
– The bending strength was calculated by following formula :

$$\textbf{Bending strenght} = \frac{\mathbf{3 \times P_{max} \times l}}{\mathbf{2bh \times h}}$$

where,
$P_{max}$ = Breaking load, N
l = Distance between the centers of the supports, mm
b = Breadth of the test piece, mm
h = Height of the test piece, mm.

## EXPERIMENTAL FINDINGS AND ANALYSIS

The result of the present study are as follows.

**Engineering properties:**

The moisture content, shrinkage, compression stress and bending stresses of the ain wood samples were determined.

**Moisture content :**

The data of moisture content of ain (Table 1).

**Shrinkage :**

Following table shows the volumetric shrinkage of ain (Table 2).

**Compression test :**

The samples of lengths 80 mm width 20 mm, thickness 20 mm were taken for this test. The compressive strength of ain (*Terminalia elliptica*) for dimension 80 mm length × 20 mm width × 20 mm thickness was found as $1.3 \times 10^7$ kN/m$^2$.

**Bending test :**

The samples of lengths 200 mm, width 20 mm, thickness 20 mm were taken for this test. The bending strength of ain (*Terminalia elliptica*) for dimension 200 mm length × 20 mm width × 20 mm thickness was found as $5.67 \times 10^7$kN/m$^2$.

**Table 1 : Moisture content of ain sample**

| Sample number | Initial weight $W_1$ (g) | Final weight $W_2$ (g) | Moisture content (w.b.) % | Average moisture content (w.b.) % |
|---|---|---|---|---|
| 1 | 78.592 | 49.259 | 37.323 | 36.21 |
| 2 | 77.206 | 48.642 | 36.997 | |
| 3 | 79.018 | 49.802 | 36.974 | |
| 4 | 81.061 | 51.476 | 36.497 | |
| 5 | 80.579 | 50.877 | 36.861 | |
| 6 | 78.056 | 49.057 | 37.151 | |
| 7 | 81.214 | 51.684 | 36.361 | |
| 8 | 81.324 | 51.552 | 36.609 | |
| 9 | 78.146 | 49.967 | 36.059 | |
| 10 | 71.503 | 49.274 | 31.088 | |
| 11 | 80.457 | 51.12 | 36.460 | |
| 12 | 79.066 | 50.162 | 36.557 | |
| 13 | 79.744 | 51.204 | 35.789 | |

It was found that the average moisture content of fresh ain sample was 36.21 per cent

**Table 2 : Shrinkage of ain sample**

| Sample number | Initial volume $V_1$ (cm$^3$) | Final volume $V_2$ (cm$^3$) | Shrinkage (%) | Average shrinkage (%) |
|---|---|---|---|---|
| 1 | 22 | 18 | 18.18 | 20.41 |
| 2 | 21 | 17 | 19.04 | |
| 3 | 19 | 15 | 21.04 | |
| 4 | 20 | 16 | 20.00 | |
| 5 | 21 | 16 | 23.80 | |

It was found that the average shrinkage of ain sample was 20.41 per cent

**Conclusion :**

– The average moisture content of ain was 36.21 % (w.b).
– The shrinkage percentage was 20.41 of ain wood.
– The compression stress of ain was $1.3 \times 10^7$ kN/m$^2$.
– The bending stree was $5.67 \times 10^7$kN/m$^2$ of ain wood sample.

## REFERENCES

BIS (1986). *Methods of testing of small clear specimens of timber*. Test code IS 1708 (Part 1):1996. Bureau of Indian Standards, New Delhi, India, 9.

BIS (1986). *Methods of testing of small clear specimens of timber.* Test code IS 1708 (Part 3):1996. Bureau of Indian Standards, New Delhi, India, 13-15.

BIS (1986). *Methods of testing of small clear specimens of timber*. Test code IS 1708 (Part 6):1996. Bureau of Indian Standards, New Delhi, India, 27-29.

BIS (1986). *Methods of testing of small clear specimens of timber*. Test code IS 1708 (Part 8):1996. Bureau of Indian Standards, New Delhi, India, 35-37.

**Gavanski, E., Kordi, B., Gregory, A. and Kopp, P. J. (2013).** Wind loads on roof sheathing of houses. *J. Wind Engg & Industrial Aerodynamics,*106-121.

**Kunjalata K., Das, N., Boruah, P. K. and Sarma, U. (2016).** Development of a strain measurement system for the study of effect of relative humidity on wood. 265-272.

**Mazzanti, P. (2012).** Drying shrinkage and mechanical properties of poplar wood across the grain. *J. Cultural Heritage,* 85–89.

**Michael, H. R. (2016).** The wood from the trees. The use of timber in construction. *Renewable & Sustainable Energy*, 333-369.

**Niklewski, J., Fredriksson, M. and Isaksson, T. (2012).** Moisture content prediction of rain-exposed wood. Test and evaluation of a simple numerical model for durability applications. *Building & Environment,*126-136.

**Ostman (1985).** Wood tensile strength at temperature and moisture contents simulating fire condition. *Wood Sci.& Technol.*,**19** (2):103-116.

**Rajput, S. S. and Shukla, N.K. (1996).** Timber mechanics, strength, classification and grading timber. Indian Council of Forestry Research and Education.4-32.

WEBLIOGRAPHY

**Kinoshita, S. (1990).** Foundation for wooden house. <*https:// www.google.com/ patents/ US51036133*>.

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