# A NOTE ON PHYSICAL AND MECHANICAL PROPERTIES OF WALNUT (*JUGLANS REGIA* LINN.) WOOD GROWN IN PAKISTAN

K. M. Siddiqui and Iqbal Mahmood*

**Abstract**

This paper presents the results of a study on physical and mechanical properties of walnut wood grown in Kaghan Valley, Hazara Division. The results are compared with reported values of the same species in the literature. The strength properties of locally available walnut wood are somewhat better than those reported in India for the same species and in Canada and West Germany for *Juglans nigra* and *J. regia* respectively. The testing was done in air-dry condition in accordance with standard procedures.

## Introduction

The Walnut (*Juglans regia* Linn.) is locally known as Akhrot or Akhor. It is a large and deciduous tree, with spreading branches. It ranges from 24–30 m and even grows up to 37 m in height and 6 m in girth. Generally the girth ranges between 3–3.5 m with about 9 m clear cylinderical bole. The species is indigenous in the Himalayas and in Pakistan, it is naturally found between 1370–3350 m elevation in Hazara and Kashmir regions growing either in pure groups or in mixture with other temperate broad-leaved and coniforous species. It is also grown as a fruit tree on the farm lands in hilly areas. The wood is straight-granted, semi-ring-porous and greyish-brown in colour which is often figured or mottled with darker streaks (1). It is durable, especially under covered conditions. It saws easily and few timbers stands up better to high speed machine work than walnut. It lends itself to a marked degree to carving. It finishes to a smooth shiny surface and takes polish very well. A noticeable feature of walnut wood is that if heavily oiled, as when preparing rifle stocks, both lighter coloured and darker varieties tone down to a uniform dull-brown-red, the darker markings turning nearly black. It peels well on a rotary veneer cutter, finishing to a smooth and lustrous surface, after the logs have been soaked for 12 hours in water heated to 120 $F^{o}$ (49 $^{o}C$). The timber is extensively used for gunstocks, furniture, carvings and cabinet making.

## Material and Method

The material was obtained from Kaghan Valley, Hazara region in log form. Six planks of about 7 cms thickness were plain-sawn from the heartwood portion of each log in two mutually perpendicular directions according to ISO standard (2). The planks were stacked for about 6 months to dry them to atmospheric conditions. These were subsequently converted into standard-size test specimens, which were kept under the normal laboratory conditions for about a week before actual testing to allow them to attain equilibrium with the surrounding

*The authors are Director and Assistant Wood Seasoning Officer, Forest Products Research Division, Pakistan Forest Institute, Peshawar.

atmosphere. The testing was done in air-dry condition. The strength data was adjusted for small clear specimens at moisture content of 12 per cent. Test specimens of the following sizes were cut from each plank for determination of different strength properties.

| | | |
|---|---|---|
| (i) | Static bending: | 2 cm x 2 cm x 30 cm |
| (ii) | Impact bending: | 2 cm x 2 cm x 30 cm |
| (iii) | Crushing strength parallel to grain: | 2 cm x 2 cm x 6 cm |
| (iv) | Tensile strength perpendicular to grain: | 2 cm x 2 cm x 7 cm |
| (v) | Cleavage: | 2 cm x 2 cm x 4.5 cm |
| (vi) | Hardness: | 2 cm x 2 cm x 10 cm |
| (vii) | Shear strength: | 2 inch x 2 inch x 2.5 inch |
| (viii) | Crushing strength perpendicular to grain: | 2 inch x 2 inch x 2 inch. |

All these strength tests were made in accordance with the BS 373 except the shear test which was performed according to ASTM standards. The average values of different properties in the literature were converted into standard units to compare the same with observed values.

**Results and Discussion**

The following table gives average values, standard deviations and coefficients of variation of different properties of walnut wood grown in Kaghan Valley. The results show that it is a heavy, hard and strong timber. On the basis of density it is comparable to mulberry timber grown under local condition, but its strength properties are superior than those of the latter (5). On the other hand the densityof walnut is lower than those of other local hardwoods e.g. shisham (*Dalbergia sissoo*) and babul (*Acacia arabica*) with consequent low strength properties except for modulus of rupture and shear parallel to grain. These two properties are 14 and 28% higher in walnut as compared to those of shisham. The shear strength of walnut and babul woods are however, similar inspite of differences in their wood density.

All strength properties of local walnut were found to higher than those reported earlier in the Indian literature for walnut wood from Kashmir (6). The density, modulus of rupture, maximum crushing strength parallel to grain and crushing strength parallel to grain at E.L. are 20%, 26%, 7% and 15% respectively higher than reported values. The crushing strength perpendicular to grain at E.L; maximum shear parallel to grain and side hardness are 42% greater than the latter. The end hardness is about 39% higher. However, modulus of elasticity is less than the reported value. The strength values of local walnut wood in respect of density, modulus of rupture, maximum crushing strength parallel to grain, curshing strength parallel to grain at E.L.; crushing strength perpendicular to grain, shear parallel to grain and hardness (side and end) are 6–39% higher than the reported values for the species in Canda and Germany (7, 8).

**Conclusion**

From the results of mechanical tests carried out it has been found that, on strength basis, local walnut is superior in most of its' properties as compared to same wood grown in India,

Canada and West Germany. The timber is known to have excellent working and finishing properties. It is an ideal wood for gun and riflestocks, bearing blocks, frames, joints panelling, cabinet making, furniture, mallets, etc. as well as bolted, notch and nailed timber. The results of this study would enable more efficient utilization of scarce resource of walnut timber in Pakistan.

## LITERATURE CITED

1. Siddíqui, K.M., Ayaz and Iqbal Mahmood 1984. Properties and uses of Pakistani timbers. Bulletin No. 9, Forest Products Research Division, Pakistan Forest Institute, Peshawar.

2. International Standards Organization. 1975. Wood-sampling methods and general requirements for physical and mechanical tests. ISO 3129–1975 (E).

3. British Standards Institution. 1957. Methods of testing small clear specimens of timber, B.S. 373.

4. American Society For Testing Materials. 1957. Methods for evaluating mechanical and physical properties – Small clear specimens of timber (D 143–52).

5. Siddiqui, K.M. and Iqbal Mahmood. 1985. Suitability of mulberry wood for different localities in Pakistan for sports goods manufacture. Bulletin No. 8. Forest Products Research Division, Pakistan Forest Institute, Peshawar.

6. 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.

7. Kennedy, E.I. 1965. Strength and related properties of wood grown in Canadà. Department of Forestry Publication No. 1104, Canada.

8. Kollmann, Franz, F.P. 1968. Principles of wood science and technology Vol. 1, solid woods. Springer Verlag Berlin Heidelberg New York.

Physical and mechanical properties of Walnut (*Juglans regia* Linn.) wood at 12% moisture content.

| Property | Actual values | | | Reported values from | | |
|---|---|---|---|---|---|---|
| | Average | Standard deviation | Coefficient of variation % | India (Kashmir) | Canada (*J. nigra*) | Germany (*J. regia*) |
| Density = $\frac{\text{A.D.Wt}}{\text{A.D.Vol.}}$ = g/cm$^3$ | 0.700 | 0.028 | 4.0 | 0.560 | 0.656 | 0.600 |
| Shrinkage % green to Oven dry = Volumetric | 11.4 | – | – | 12.0 | – | – |
| Modulus of rupture N/mm$^2$ | 129 | 14.6 | 11.3 | 96 | 104 | 105 |
| Modulus of elasticity N/mm$^2$ | 10271 | 606 | 5.9 | 11769 | 13300 | – |
| Max. Crushing strength 11 to grain N/mm$^2$ | 60.0 | 3.7 | 6.1 | 55.9 | 54.1 | – |
| Compressive strength 11 to grain at E.L. N/mm$^2$ | 39 | 2.5 | 6.4 | 33 | 30 | – |
| Crushing strength to grain at E.L. N/$^1$mm$^2$ | 14.8 | 1.0 | 6.7 | 8.6 | 9.03 | – |
| Max. Shear 11 to grain N/mm$^2$ | 17.3 | 1.3 | 7.5 | 10.1 | 14.9 | – |
| Impact bending m-N/test | 0.195 | 0.030 | 15.3 | – | – | 0.190 |
| Tensil strength 1 to grain N/mm$^2$ | 2.4 | 0.23 | 9.5 | – | – | 2.9 |
| Cleavage N/mm | 38 | 2.0 | 5.2 | – | – | – |
| Hardness = N x 100 Side | 68.5 | 3.8 | 5.5 | 40.1 | 60.2 | – |
| End | 81.4 | 6.8 | 8.3 | 49.2 | 74.6 | – |