International Refereed Journal of Engineering and Science (IRJES)
ISSN (Online) 2319-183X, (Print) 2319-1821
Volume 13, Issue 5 (Sep.-Oct. 2024), PP. 01-07

A Comparative Study on Strength Variation of Plywood with Different Thickness

R.M.S.C. Gunasingha, N.F. Aska, B.A.M.K. Batugedara, C.Tharsan and H.A. Tharshanth
Department of Physics, Eastern University, Sri Lanka.
Corresponding Author: hatharshanth@gmail.com

Abstract: *Plywood turns into very important material for various structural purposes in Sri Lanka and used as a substitute of solid wood. Therefore, the objective of this study was to determine and compare the strength variation of plywood of different thickness produced with Teak (Tectona grandis), Ginisappu (Michelia champaca), Mahogany (Swietenia microphyla), Neem (Azadirachita indica) and Jac (Artocarpus heterophyllys). The commercial wood glue was used for fabricating the panels. Bending strength and glue-bond strength by shear strength test was assessed for plywood of different thicknesses was determined and the values of properties were statistically tested. It was found that, the bending strength for Teak, Ginisappu, Mahohany, Neem and Jac plywood are in descending order. The Shear strength of the sample is increase with increasing the number slices of the plywood. When the slices stick together by the glue, the thickness and properties of the plywood is changed. Bending strength and Shear strength are influenced by the glue type, amount of glue applies between two layers and layer thickness of the plywood.*

Keywords: *Plywood, bending strength, shear strength, wood glue, layer thickness*

Date of Submission: 23-08-2024 Date of acceptance: 03-09-2024

I. INTRODUCTION

In 2020, the total forest area in Sri Lanka was approximately about 29.7% of the country's total land area. Timber consumption in Sri Lanka is influenced by various economic activities, including construction, furniture making, and other wood-based industries. Teak (Tectona grandis), Ginisappu (Michelia champaca), Mahogany (Swietenia microphyla), Neem (Azadirachita indica) and Jac (Artocarpus heterophyllys) are typically available species in Sri Lanka and commonly used for wood requirements. Deforestation is a critical environmental issue in Sri Lanka, with significant impacts on biodiversity, climate, and local communities. Perhaps Plywood is a substitute for raw wood and widely used material in Sri Lanka, utilized in various industries including construction, furniture manufacturing, and interior decoration. Plywood plays a crucial role in various industries, contributing to economic growth while also impacting timber resources.

II. RESEARCH METHODOLOGY

The plywood samples prepared like a beam of dimensions 500 mm×50 mm and different samples were prepared with thin plywood sheets of layer thickness 5 mm with Teak, Ginisappu, Mahogany, Neem and Jac samples. The plywood sheets were produced by stick the thin plywood layer sheets together by the commercial available wood-glue. The period of pressing the attached layers with the wood glue was 15 minutes with constant pressure and the same amount of glue was used to attach each layers. The plywood samples were prepared as single layer, two layer, three layer and four layer named as slice 1, slice 2, slice 3 and slice 4 respectively. In sets of plywood samples, effects were assessed on bending strength and glue-bond strength by means of shear strength.

Bending strength is a fundamental property of every material that cannot be changed and calculated as, Stress / Strain. Where Stress = Force / Cross sectional area and Strain = Change in length / Original length. The sample was prepared like a beam so the Bending strength was calculated by end-loaded method. The plywood sample was attached in a table top and a mass was attached to the free end of the sample using a hook and the deflection was measured for different masses. The same procedure was repeated for all samples of plywood and bending strength of the plywood sample was calculated and plotted.

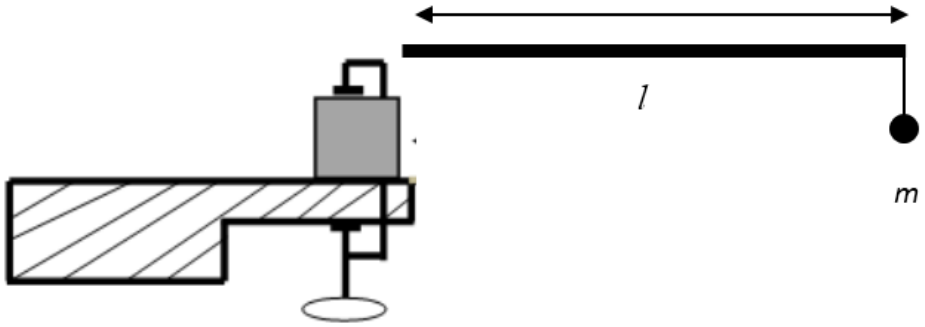

Fig. 1. Experimental set up to find Bending strength by end-loaded method [1]

III. RESULTS

Bending strength for plywood samples corresponds to number of slices is plotted as follows:

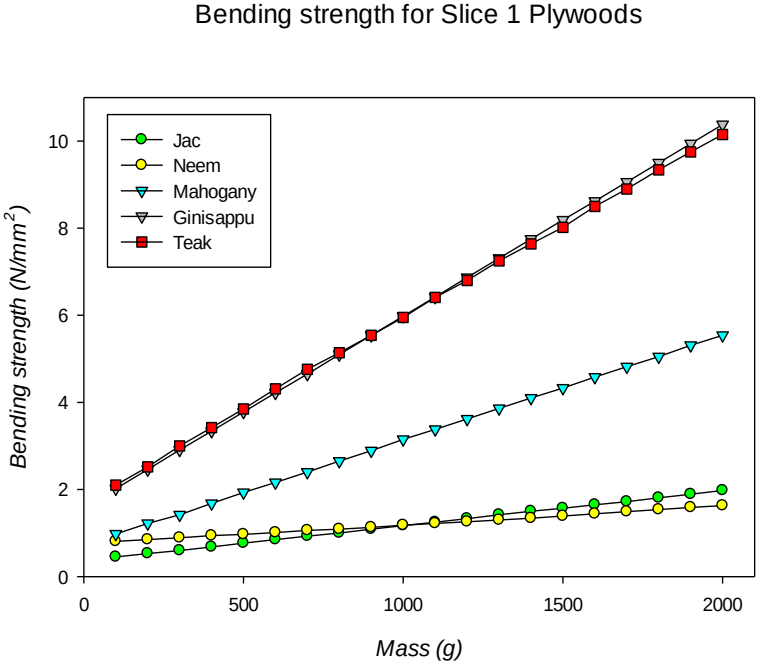

Fig. 2. The mass (g) dependence of bending strength (N/mm^2) for slice 1 sample [2]

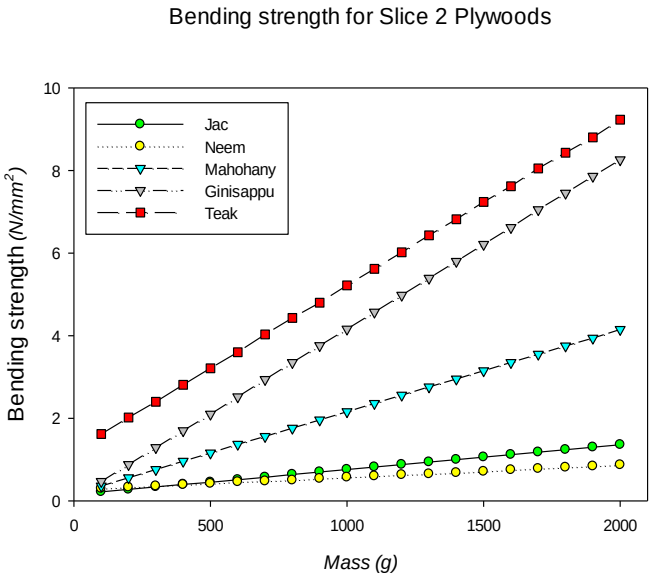

Fig. 3. The mass (g) dependence of bending strength (N/mm^2) for slice 2 sample [3]

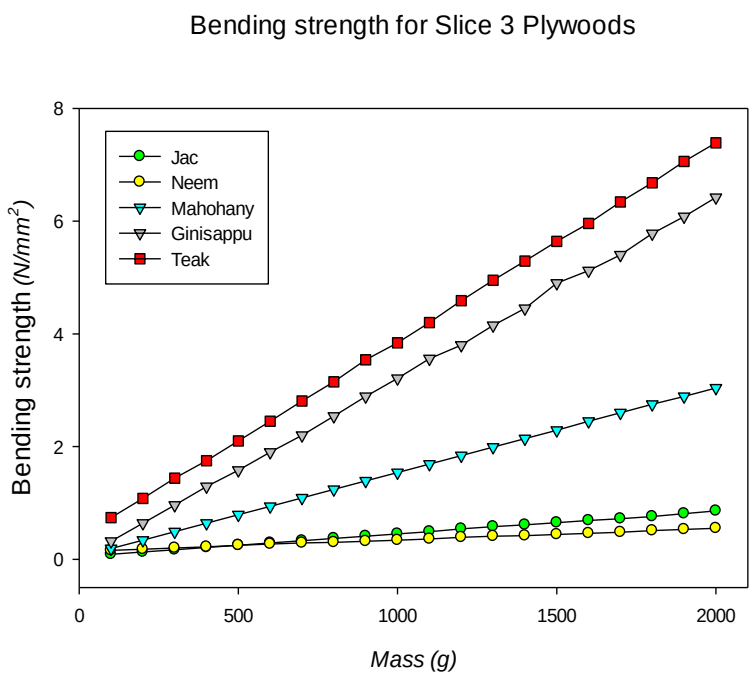

Fig. 4. The mass (g) dependence of bending strength (N/mm^2) for slice 3 sample [4]

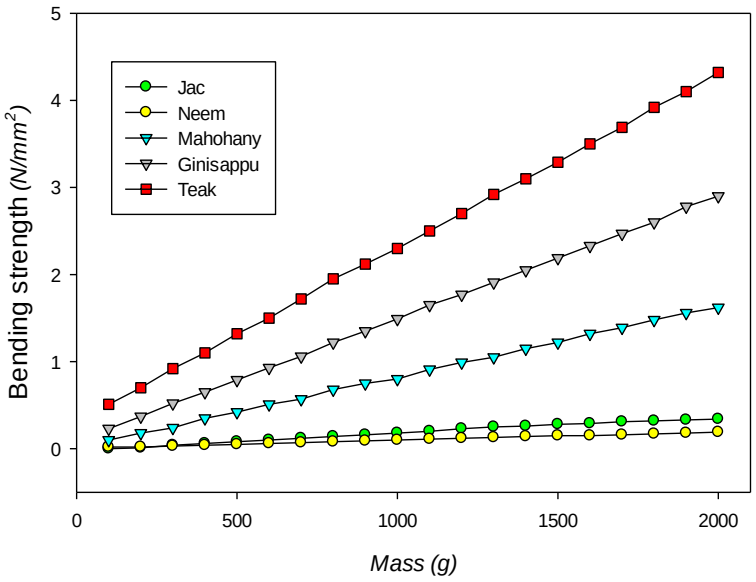

Fig. 5. The mass (g) dependence of bending strength (N/mm^2) for slice 4 sample [5]

Shear strength for plywood samples correspond wood type is plotted as follows:

Shear strength of Teak Plywoods with different thickness

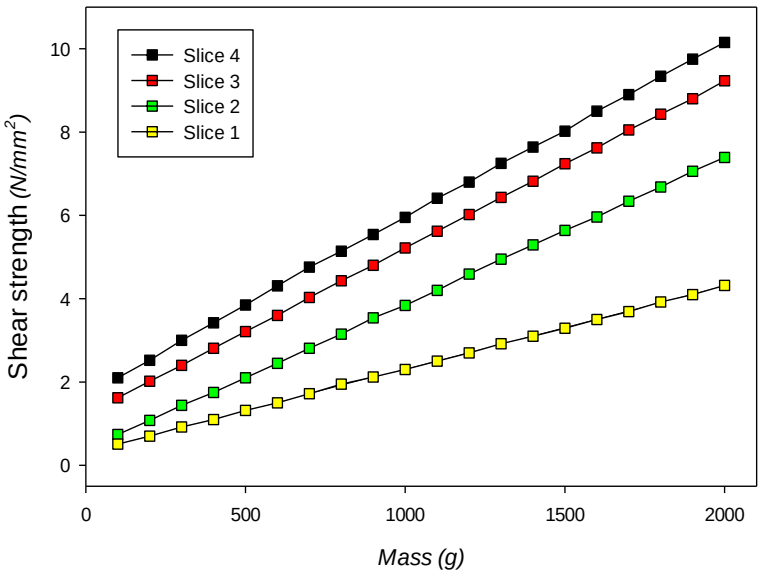

Fig. 6. The mass (g) dependence of shear strength (N/mm^2) for Teak wood [6]

S

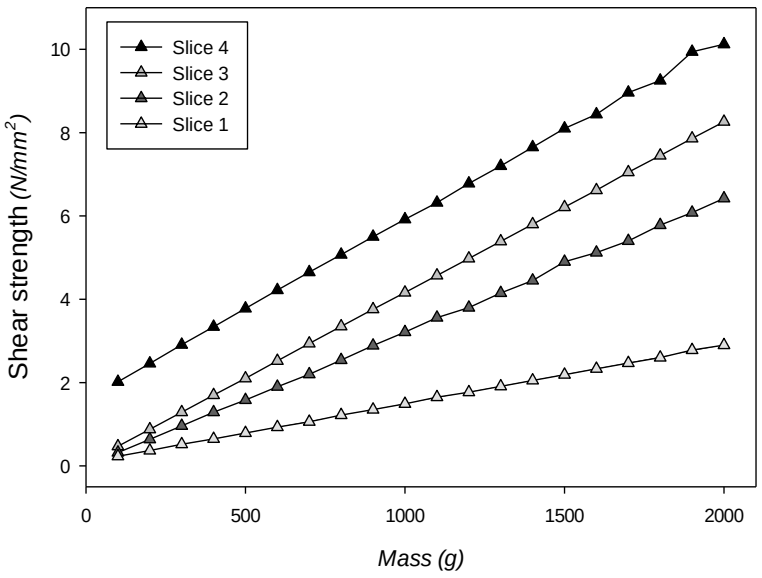

Fig. 7. The mass (g) dependence of shear strength (N/mm^2) for Ginisappu wood [7]

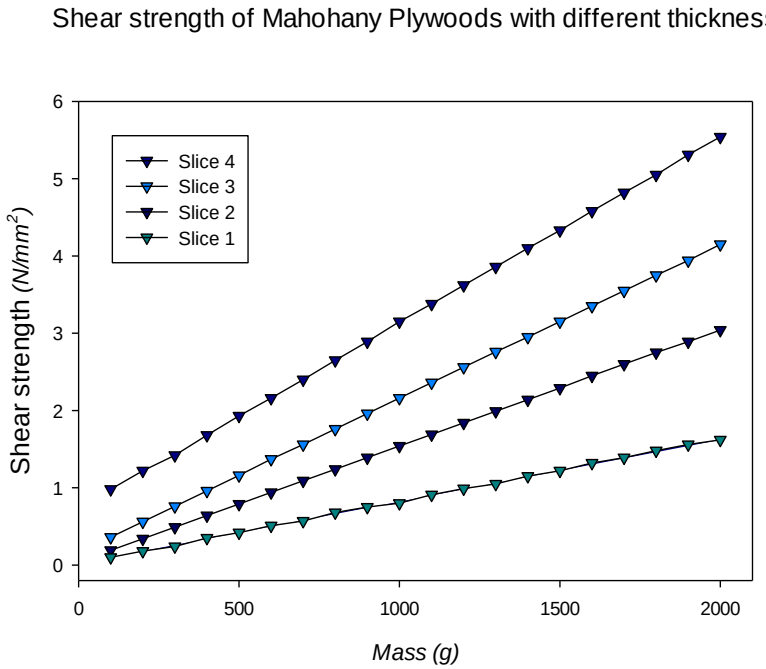

Fig. 8. The mass (g) dependence of shear strength (N/mm^2) for Mahohany wood [8]

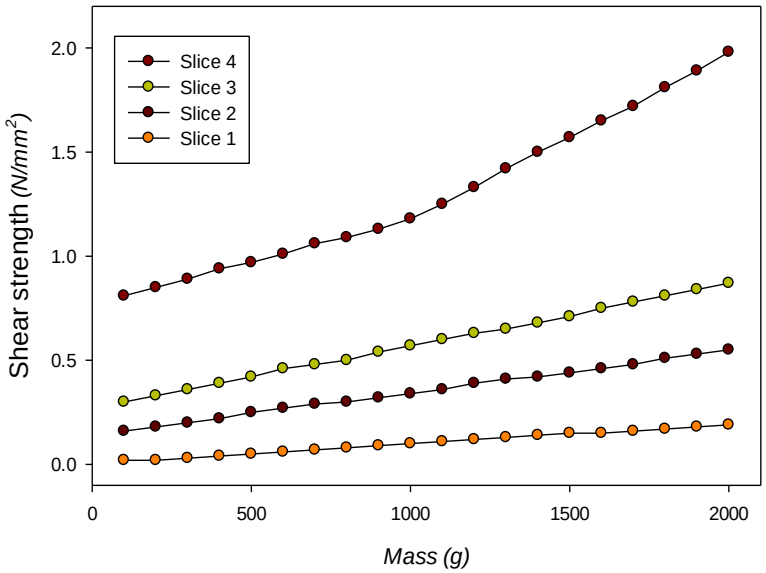

Fig. 9. The mass (g) dependence of shear strength (N/mm^2) for Neem wood [9]

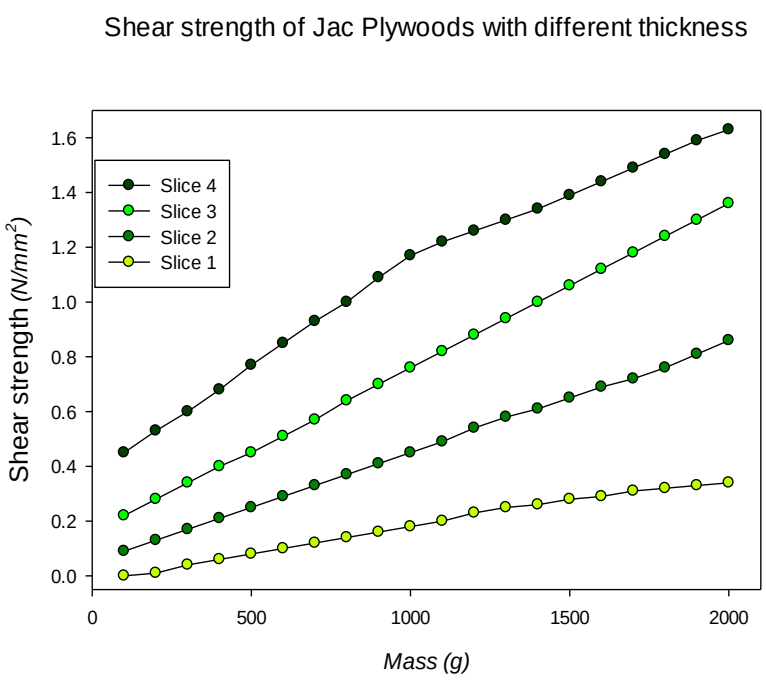

Fig. 10. The mass (g) dependence of shear strength (N/mm^2) for Jac wood [10]

The Bending strength for plywood samples corresponds to number of slices with variation of loading mass has been plotted in [2], [3], [4] and [5] respectively. The Shear strength for plywood samples corresponds to Teak, Ginisappu, Mahohany, Neem and Jac plywood with variation of loading mass for slice number 1, 2, 3, 4 and 5 has been plotted in [6], [7], [8], [9] and [10] respectively.

1. The calculated value of bending strength for Teak, Ginisappu, Mahohany, Neem and Jac plywood are in descending order. According to the results, Teak has high Bending strength, Jac is the lowest and Mahohany is the intermediate.
2. The Shear strength of the sample is increase with increasing the number slices of the plywood. When the slices stick together by the glue, the thickness of the plywood is increased and the mechanical bond between the slices are increases.
3. Also the Shear strength influenced by the glue type, amount of glue applies between two layers and layer thickness of the plywood.
4. In this study it was found that, the bending strength for Teak, Ginisappu, Mahohany, Neem and Jac plywood are in descending order.
5. The Shear strength of the sample is increase with increasing the number slices of the plywood. When the slices stick together by the glue, the thickness and chemical properties of the plywood is changed.
6. The mechanical bonds between the slices are increases and the Shear strength is noticeably increased. Bending strength and Shear strength are influenced by the glue type, amount of glue applies between two layers and layer thickness of the plywood.

REFERENCES

[1]. Islam, M.A., Alam, M.A. and Hannan, M.O. (2012), "Multi response optimization based on statistical response surface methodology and desirability function for the production of particle board". Compos. Part B, 43, 861-868.
[2]. Rahman, K.S., Alam, D.M.N. and Islam, M.N. (2012), "Some physical and mechanical properties of bamboo mat-wood veneer plywood", ISCA J. Biological Sci., 1(2), 61-64.
[3]. Forest Research Institute (FRI) (1970), "Indian Forest Utilization", Forest Research Institute and Colleges, Dehra Dun, India, vol. I.
[4]. Král, P. and Hrázský, J. (2006), "Effects of different pressing conditions on properties of spruce plywoods", J. Forest Sci., 52(6), 285–292.
[5]. Baldwin, R.F. (1995), "Plywood and veneer-based products, manufacturing practices (Wood technology books ser.)". Miller Freeman, San Francisco.
[6]. NazmulAlam, D.M., Islam Md.Nazrul, Khandkar -SiddikurRahman, Alam Md.Rabiul (2012) "Comparative Study on Physical and Mechanical Properties of Plywood Produced from Eucalyptus (Eucalyptus camaldulensis Dehn.) and Simul (Bombax ceiba L.) Veneers", Res. J. Recent Sci., Volume 1, Issue (9), 54-58.
[7]. American Society for Testing Materials (ASTM), (1999), "Standard test methods for evaluating properties of wood-based fiber and particle panel materials static tests of timbers", ASTM, Philadelphia, PA., 1037- 93.

[8]. Abdul H.P.S., Nurul M.R., Bhat A.H., Jawaid M. and Nik N.A., "Development and material of new hybrid plywood from oil palm biomass", Mater. Design, 31, 417–424 (2010).
[9]. Edril Y.Z., Zhang J. and Eckelman C.A., "Holding strength of screws in plywood and oriented strandboard", Forest Prod. J., 52(6), 55-60 (2002).