STRENGTH PROPERTIES OF FINGER JOINTED WOOD FROM FAST GROWING SPECIES

M Rafais M Razip, Wan Mohd Nazri Wan Abdul Rahman & Jamaludin Kasim

Center for Wood Industries, Faculty of Applied Sciences, UiTM Pahang, 26400 Bandar Jengka, Pahang Darul Makmur, MALAYSIA

Corresponding Author: mrafaismrazip@yahoo.com

Abstract

Finger jointing short pieces of lumber has become an increasingly popular method of reducing wood waste and utilizing shorts to realize maximum profit from the steadily rising cost of raw materials.This study was conducted to evaluate the mechanical properties of finger joint from Hevea brasiliensis and Leucaena spp. at three portion (top.middle.bottom), and to determine the effect of species on jointing system. Polyvinyl acetate (PVAc) was used to joint these specimen. This two species and the combination were tested in verticle orientation for bending properties (modulus of elasticity and modulus of rupture) conforming to the European standard (EN 408:2003).The result revealed that the tests specimen from the two species and the combination was strong enough for use as material in funiture making.Thus, it can be concluded that finger joint from Hevea brasiliensis and Leucaena spp. can successfully be produced as the main source of raw materials for finger joint.

Keywords: Finger jointing, Fast Growing Species, Polyvinyl Acetate (PVAc)

INTRODUCTION

Finger joints have been in use in furniture production for more than 50 years, yet it is only with the decline in resource quality that interest in them for furniture has increased. The joints can be made with only one finger, vertical or any in-between orientation wood (Gene, 1998). Finger jointing short pieces of lumber has become an increasingly popular method of reducing wood waste and utilizing shorts to realize maximum profit from the steadily rising cost of raw materials. In some instances, finger jointed lumber is actually preferred to solid, enjoined lumber (Pitcher, 1999).

Polyvinyl acetate (PVAc) is one of the most common adhesives used in non-structural applications. Polyvinyl resin emulsions are thermoplastic, softening if the temperature is raised and hardening again when cooled. PVAc is capable of producing strong and durable bonds on hardwood and hardwood-derived products (Vassilios and Ioannis, 2006). Because of high dry strength and easy of application, they can be used with low clamping pressures (although joints of questionable quality may result. Due to their competitive cost, polyvinyl acetate adhesives are widely used for finger joint assembly and have displaced nearly all other glues for this purpose (Carl, 2010).

Rubberwood is often the most misunderstood species of wood in the furniture industry. The name rubber wood invokes a variety of misconceptions as to it's features and to it's durability. Rubber wood (also called Para wood in Thailand) is the standard common name. Rubberwood is one of the durable lumbers used in the manufacturing of today's home furnishings (Rajan, 2000). *Leucaena leucocephala* is a multipurpose nitrogen-fixing tree of great importance in the tropics (Vietmeyer et al., 1977). According to

Oldfield (1984), *Leucaena* was recognize as a highly plant valued to the ecological remedy. Its capability of nitrogen fixation, rapid growth, and deep root system make it very useful in reforestation, bioremediation, and soil conservation. It suppresses nature's grasses and stabilizes the soils. Under this perspective, the use of *Leucaena* in soil restoration has been studied in several countries (Vanlauwe et al., 1998) and (Sharma et al., 1998). In this study Rubberwood spp. and *Leucaena spp.* are species were selected because of the advantage that they have. This study was conducted to evaluate the mechanical properties of finger joint from Hevea brasiliensis and Leucaena spp. at three portion (top.middle.bottom), and to determine the effect of species on jointing system

MATERIALS AND METHODS

Three *Hevea brasiliensis* trees *and* one *Leucaena spp.* were harvested for the study. All logs were were sawn to produce long planks and then kiln dried to ensure the moisture content (MC) of all samples were below 12%. After drying, the samples were then sized down to the dimension of 20 x 20 x 160 mm (Figure 1). Then, any natural defects such as knots were removed according to EN:385:2001. Small pieces of wood from all trees were taken to measure their specific gravity.

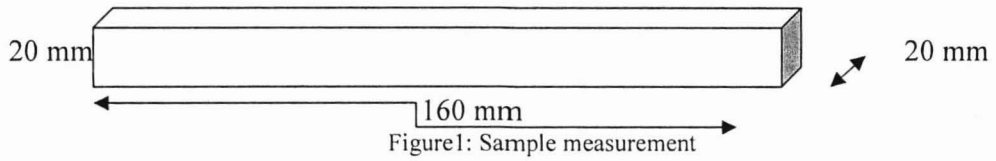

Figure1: Sample measurement

Finger joint was performed to all 360 replicates prepared earlier in Figure1. Then finger joint was performed based on the following characteristic:

I. 12mm length
II. 1 mm tip
III. 4 mm pitch
IV. 12° angle

After cutting the fingers, polyvinyl acetate (PVAc) are used to glue and lock the finger by using the dipping technique. Then, the assembled joints are pressed manually with constant pressure for about 10 minutes with the presure of 44.4 kg/cm^2. After the glue cured, all joint samples were re-cut to their final size, which is 15 x 15 x 300 mm as shown by Figure 2. All samples were remarked as shown in Table 1.

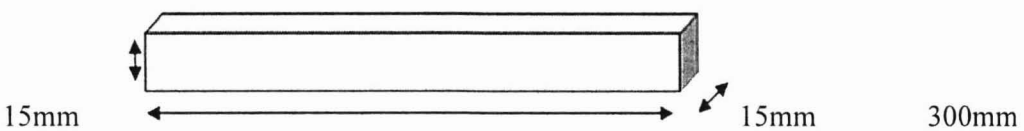

Figure 2: Size measurement of finger joint sample.

Table 1: Configurations of Samples

No.	Group	Configuration	Replication
1.	TH	Top *Hevea brasiliensis*	20
2.	MH	Middle *Hevea brasiliensis*	20
3.	BH	Bottom *Hevea brasiliensis*	20
4.	TL	Top *Leucaena spp*	20
5.	ML	Middle *Leucaena spp*	20
6.	BL	Bottom *Leucaena spp*	20
7.	THL	Top *Hevea brasiliensis*+ *Leucaena spp*	20
8.	MHL	Middle *Hevea brasiliensis*+ *Leucaena spp*	20
9.	BHL	Bottom *Hevea brasiliensis*+ *Leucaena spp*	20

Notes:TH,MH,BH,TL,ML,BL,THL,MHL,and BHL refer for symbols of species.

Bending test are applied to all 180 samples. The bending test are performed according to EN 408:2003. The samples were tested by four point bending. The modulus of rupture (MOR) and modulus of elasticity (MOE) of each sample were measured in this test. All readings were recorded and finger joints quality was evaluated and photographed.

RESULTS AND DISCUSSIONS

Table 2 shows the comparison between Leucaena *spp* and Rubberwood. For moisture content the results showed that rubberwood samples had the highest average. *Leucaena spp* showed higher specific gravity when compared to Rubberwood. Finger jointed samples from *Leucaena spp* showed better MOR and MOE values when compared to rubberwood and the mixed samples.

The ANOVA of the effect of portion, species and their interaction on the finger jointed samples are shown in Table 3. There are no significant differences in MOR and MOE for the portion factor, but the result of SG for the portion are highly significant. Species showed significant effects on all MOR, MOE and SG values. Their interaction showed no significant difference.

Table 2: Properties of Finger Jointed Wood from Rubberwood and *Leucaena spp.* top, middle and bottom portion.

SPECIES	Portion	MOR (MPa)	MOE (MPa)	MC (%)	SG
Leucaena spp	Top	63.7	13427	39	0.70
	Middle	65.5	14986	52	0.78
	Bottom	65.4	14887	51	0.65
Rubberwood	Top	51.5	8535	54	0.55
	Middle	52.6	9126	51	0.55
	Bottom	55.8	9165	51	0.59
Leucaena spp + Rubberwood	Top	53.3	11164		
	Middle	54.4	11414		
	Bottom	55.8	11484		

Note: MOR = Modulus of Rupture, MOE = Modulus of Elasticity, MC = Moisture Content, SG = Specific Gravity.

Table 3: Summary of the ANOVA on Finger Jointed of Rubberwood and *Leucaena spp.* at top.middle,and bottom portion.

VARIABLE	df	MOR	MOE	SG
PORTION	2	$.722^{ns}$	1.392^{ns}	9.197^{x}
SPECIES	1	26.697^{x}	169.181^{x}	74.878^{x}
PORTION*SPECIES	2	$.100^{ns}$	1.122^{ns}	2.108^{ns}

Note: ns-Not significant $p>0.05$, ^{x} - Significant at $p<0.05$,

Figure 4 shows the effect of portion on the MOR value of finger jointed samples. No significant effect of portion was shown on the MOR however the value decreases from bottom to the top of the trunk. This is due to the different distribution of parenchymatic cells which decrease from bottom to top of trunk (Choon and Choon, 1986).

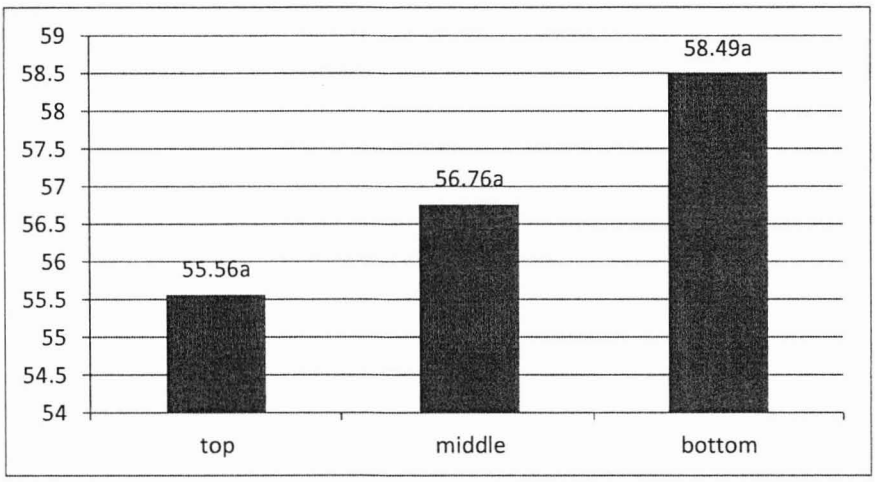

Figure 4: Effect of Portion on MOR

Figure 5 shows the effect of portion on MOE properties of the finger-jointed samples. MOE value was unaffected by tree portion. Top portion has a value of 10896MPa, followed by middle portion with the value 11576MPa and lastly bottom portion with 11592MPa. Xiao, (2007) reported that lowest density of wood achieve the deepest glue penetration and thus more glue requirement to have good MOE.

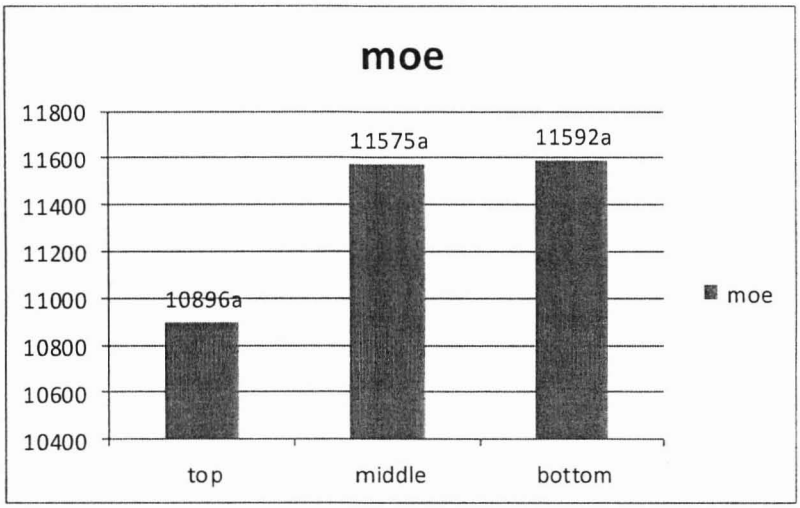

Figure 5: Effect of Portion on MOE

Figure 6 shows the effect of portion on Specific Gravity. SG value of jointed wood samples decreases significantly from bottom towards the upper portion. The bottom portion showed the highest SG value (0.742) followed by the middle portion (0.668) and top portion (0.626).

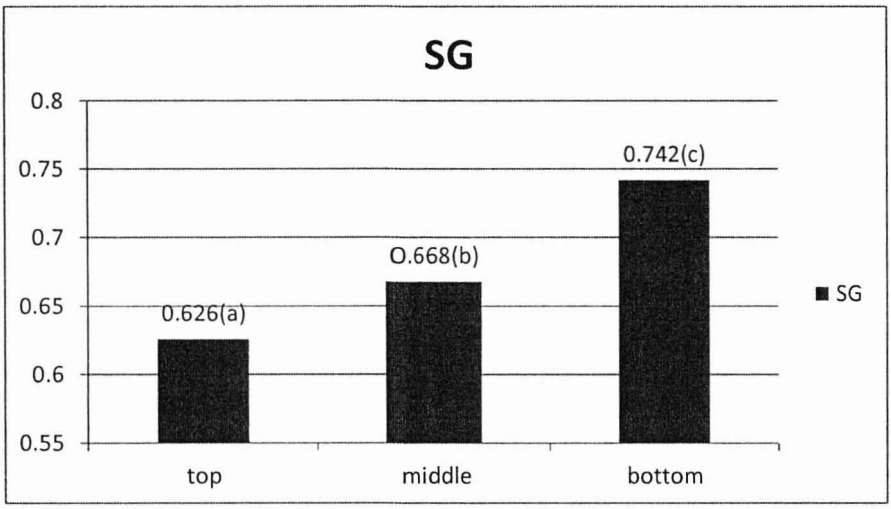

Figure 6: Graph of SG in Different Portion of Finger Jointed

.

Figure 7 shows the effect of species on bending properties. Wood species used show a significant effect on the MOR values. Leucaena spp. having a higher wood density had higher MOR value when compared with Rubberwood and Rubberwood + Leucaena spp.

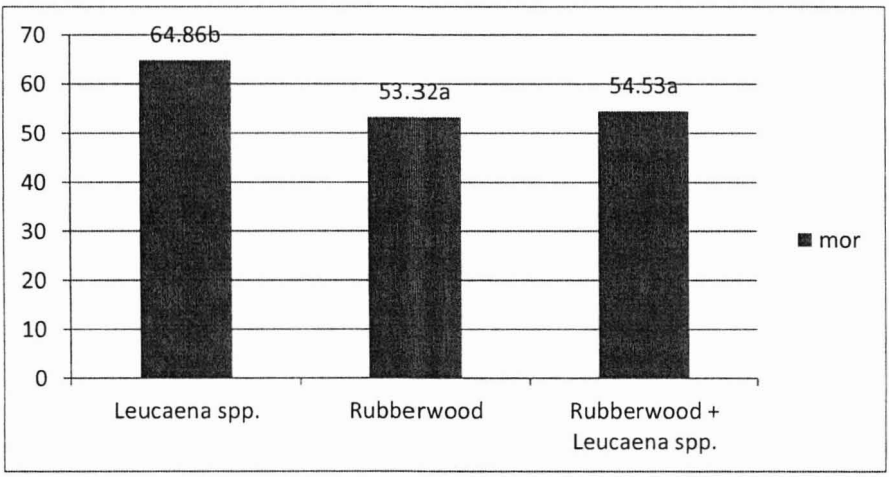

Figure 7: MOR in Different Species of Finger Jointed

Figure 8 shows the effect of species on the MOE of the finger jointed samples. The result showed a significant effect of species towards the MOE value. Similar to MOR, leucaena with a higher wood density had better MOE values compared to rubberwood and their mixture.

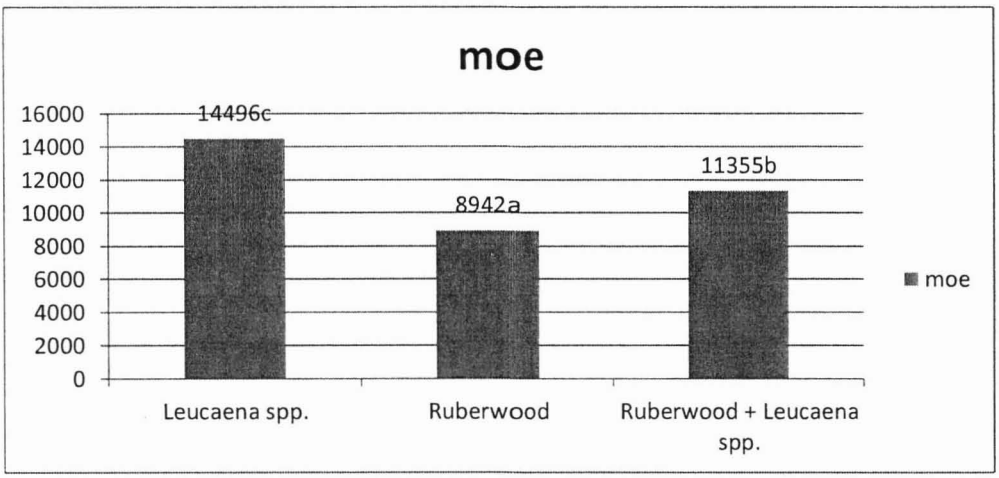

Figure 8: Effect of species on MOE of Finger Jointed wood

CONCLUSIONS

Leucaena spp showed higher specific gravity when compared to Rubberwood. Specific gravity is 0.71 for Leucaena spp. and 0.56 for Ruberwood. Finger jointed samples from Leucaena spp showed better MOR and MOE values when compared to rubberwood and the mixed samples. MOR and MOE value was unaffected by tree portion. SG value of jointed wood samples decreases significantly from bottom towards the upper portion. Wood species used show a significant effect on the MOR and MOE values. Thus, it is recommended that *Leuceana spp.* be considered as alternative materials to support the furniture industry. Hopefully this could solve the problem in shortage of the raw material in the wood industry.

References

BS EN 385:2001. Finger jointed structural timber — Performance requirements and minimum production requirement. BSI 389 Chiswick High Road London W4 4AL.

Carl A. Eckelman,2010. Brief Survey of Wood Adhesives.Pordue university cooperative extension service west Lafayette in.

Choon, L.S., and Choon, K. K., (1986). Characteristics of oil palm trunk and its potential utilization. *The Malaysian Forester*, 49(1):3–22.

EN 408 : 2003. Structural timber and glued laminated timber. DIN Deutsches Institut für Normung e.V., Berlin. Beuth Verlag GmbH, 10772 Berlin, Germany.

Kent Pitcher, (1999). Finger jointing lumber can reduce waste and utilize marginal material - and in depth article.

Rajan S (2000). Rubberwood Industry-Challenges and Prospects, 1-8 p. In: Ahmad Shakri MS, Ho KS, Mohd Dahlan J (Eds.). Proceedings of the national seminar on alternatives to rubberwood. Forest Research Institute of Malaysia, 26 September 2000.

Sharma, N.K., Singh, P.N., Tyagi, P.C., Mohan, S.C., 1998. Effect of Leucaena mulch onsoil–water use and wheat yield. Agricultural WaterManagement 35 (3), 191–200.

Vanlauwe, B., Sanginga, N., Merckx, R., 1998. Recovery of Leucaena and Dactyladeniaresidue 15 N in alley cropping systems. Soil Science American Journal 62, 454–460.

Vassilios Vassiliou,and Ioannis Barboutis, 2006. Effect of PVAc Bonding on Finger-Joint Strength of Steamed and Unsteamed Beech Wood (Fagus sylvatica). Aristotle University, Faculty of Forestry and Natural Environment, Department of Harvesting and Technology of Forest Products, 541 24, Thessaloniki, Greece.

Wengert. (1998). Finger Joints: A Few Whys and Wherefores. The Wood Doctor provides his prescription for effective finger joints in solid stock.

Xiao, H., (2007). Evaluation of Shear Strength and Percent Wood Failure Criteria for Qualifying New Structural Adhesives. Report as part of the Value to WoodProgram funded by Natural Resources Canada: Pages 44.