International Journal of Innovative Technology and Exploring Engineering (IJITEE)
ISSN: 2278-3075 (Online), Volume-9 Issue-4, February 2020

Bending Strength Analysis of Durian and Coconut Timber Laminated Beam

Sri Handayani, Muhammad Farid Najih, Suriyanto

Abstract: ***Durian timber grows well in the Gunungpati area, although its use is still limited to the needs of light construction. Lamination (glulam) is a combination of one or more kinds of materials and the materials are made into relatively thin layers glued together to form a larger dimension. Timber engineering experiment was conducted by creating a laminated beam made of Durian and coconut timber, with a composition of coconut - Durian – coconut.***

The purpose of this study was to determine the bending strength of a composition of coconut – durian – coconut laminated beam in strengthening the weak side of the durian timber. Coconut timber was used to reinforce durian timber because the weight of coconut timber is relatively larger compared to Durian timber.

Durian laminated beam with coconut timber reinforcement on the top and bottom can be used as an alternative material to improve the bending strength durian timber. Lamination technology was able to increase the bending strength of Durian timber with laminated beams by 12.6% from the average bending strength of 36.68 MPa durian timber, laminated beams into bending strength of 41.30 MPa.

Keywords:Timber Durian, Coconut Timber, Lamination, Ben ding strength

I. INTRODUCTION

Timber is a renewable natural resource which has potential value for building materials. Timber has several advantages over other building materials such as steel, concrete and others, such as lightweight, earthquake resistant, easy in the process of implementation, easy to recycle and relatively economical. While the weaknesses of timber are: flammable, easily shrink, cannot withstand termites, the limited number of structural timber size, more expensive and more difficult to obtain.

Many hardtimbers are known to be strong enough. However, their use is still limited to only a few applications in the construction industry. Therefore, a timber processing technology that can overcome the problem is necessary.

In regional district of Gunungpati in Semarang, has many kinds of timber species are widely grown such as sengon, rambutan, durian, jackfruit and coconut timber. Most people on Gunungpati are use the different of timber for the construstion building material for the price is relatively cheap and can be accessed easily.

Durian Timber with Latin name *Durio Zibhetinus* is included into timber class with E21 quality code with an average weight of 0.57 and bending strength of 54 Mpa. In general, durian timber has a low shrinkage value, medium hardness and slightly coarse texture, and integrated straight fibrous.

Coconut timber is one of the by-products of coconut plant used as building material or timber fuel. In order to be used as a building material, the coconut tree stem should be taken from the coconut plant which is old enough. Based on the parameter of compressive strength parallel to the grain whose class can be categorized in I to IV, the natural durability of coconut timber is very low (class IV-V).

With regard to the use of durian and coconut timber. This study is aimed to apply the lamination technology by utilizing as durian and coconut timber as laminated beams (glulam beams) for construction needs. The purpose of this study was to determine the bending strength of laminated beam of durian and coconut timber as a substitute for the beam structure.

Structural Glued laminated timber is a timber processing technology which has already been known. The lamination is the integration of several layers of timber with glue on both sides then pressed. The process of gluing is achieved following the length of timber. Laminated timber materials are plytimber that has been formed and prepared in such a way that it can be incorporated into the desired timber shape. The permissible timber thickness reaches 50 mm. However, laminated timber is made of timber with thickness between 25 to 50 mm.

The types of lamination can be applied to bending structures and column / press structures. Lamination technology on the timber used in this study are timberen beams, where some timber with dimensions individual sections are combined into a new cross section by glued together.

Abdurachman dan Nurwati H (2009). The results showed that based on the density value, MOE and MOR of lamina timber of mixture of mangium and sengon with 6 layers of B1 form reached the highest value compared with other forms of 0.0048 N/ cm³, 9,189 MPa and 44.1 MPa.

Pramudito Jihannanda (2013) shows that the maximum bending strength of Sengon and coconut laminated beam was 22.172 Mpa and the minimum was 21.276 MPa. and the average bending strength was 21.838 MPa.

Revised Manuscript Received on February 28, 2020.
***** Correspondence Author
Sri Handayani*, Department of Civil Engineering, Universitas Negeri Semarang, Indonesia.
Muhammad Farid Najih, Department of Civil Engineering, Universitas Negeri Semarang, Indonesia.
Suriyanto, Department of Civil Engineering, Universitas Negeri Semarang, Indonesia.

Sri Handayani (2015) The strength class of laminated product increased from IV into III, with an increase of in 25.403 MPa or 59.72%. The initial strong class was IV with 42.533 MPa became 67.935 MPa (class III).

Wan Hazira Wan Mohamad, Mohd Azran Razlan, Zakiah Ahmad (2011) , This study is discussing about the behavior of the bending strength of glulam produced from tropical Malaysian timber showed that the bending strength of glulam was compared with the permissible strength of the timber under bending in accordance with MS 544 Part 3. The results shown that the glulam produced passed the required allowable strength value.

R. Brandner Æ G. Schickhofer (2008). The bending, tensile, and compressive strengths of the glued laminated timber were measured. The average bending, tensile, and compressive strengths were 33.4, 24.5, and 35.9 MPa, respectively, and these values are almost equal to those of glued laminated timber composed of karamatsu single-piece lamina.

II. EXPERIMENTAL WORK

A. Material Properties

Experimental method was used in this study which was aimed at creating laminated durian wood beam with coconut wood as its reinforcement. The laminated beam was then analyzed to determine its bending strength. The data were gathered using observation method. The test results were observed by using observation sheet. The descriptive analysis was used to calculate the mean score from the bending strength test results of the laminated wood. T test was used to analyze the difference between the bending strength test results of the laminated beam (durian-coconut wood) and the non – laminated durian wood

Comparative analysis of bending strength was conducted to compare the non – laminated durian wood as control beam and the laminated durian wood. The durian wood had lower bending strength than coconut wood. Therefore, coconut wood was used as a reinforcement on the weak side of the beam. The lamination was expected to increase the bending strength of the durian wood. The lamination was intended to maximize the utilization of wood materials which had higher strength to increase the strength of the wood with the lower strength.

The object of this research was durian wood and coconut wood as lamination materials and epoxy glue was used as the adhesive.

Three specimens were used on the bending strength test. The size of each specimen was 50 mm x50 mm x 760 mm according to ASTM D143 primary test method. Meanwhile, five specimens of coconut wood and durian wood with the size of 50 mm x50 mmx50 mm were used in water content test. Five specimens of coconut wood and durian wood with the size of 10 mm x 10 mm x 50 mm were used in the specific gravity test.

Chainsaws, cooling equipment, Universal Testing Machines (UTM), oven and scales were used. 3 pieces of test specimens were made with size 5 cm x 5 cm x 76 cm. Laminate test object in stacking with composition ratio of 1.5: 2: 1.5. On the middle side is durian timber, with 2 cm thick, which is wedged on the top and bottom with coconut timber, with each thickness of 1.5 cm. Fig. 1 shows the laminated beam.

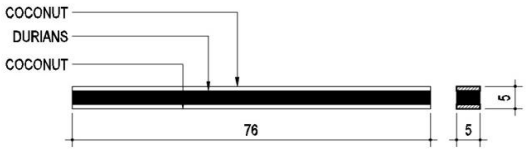

Fig. 1 shows the laminated beam.

Testing Water content in the test based on reference SNI 03-6850-2002 on Test Method Measurement of Timber Water Content and Timber Materials issued by Center of Research and Development- National Standardization Agency.

Bending Test and modulus of bending elasticity are tested based on reference SNI 03-3959-1995 on Strong Test Methods of Strong Timber Strengthening and SNI 03-3960-1995 on Test Methods of Timber Bending Modulus of Elasticity in laboratories issued by Center of Research and Development- National Standardization Agency

III. RESULT AND DISCUSSION

Results of compressive strength test and modulus of rupture/flexural tensile strength test are as discussed below.

A. Water Content

Table 1. Water Content of Durian and Coconut Timber

No of Test objects	Water content (%)	
	Durian Timber	Coconut timber
1	17.21	18.86
2	18.85	15.90
3	16.65	15.89
4	17.29	16.33
5	16.59	16.77
Average	17.32	16.62

The water content test results of durian and coconut timber are shown in Table 1. The water content test results of durian and coconut timber are shown in Table 1. The average water content of durian timber was 16.62% and the average water content of coconut timber was 17.32%. The average water content of durian timber was relatively larger than that of coconut timber.

B. Spesify Gravity of the Timber

The specific gravity is the ratio of timber density to the water density at the same volume. The results of the specific gravity of the durian and coconut timber can be seen in Table 2.

The results of this test showed that the average specific gravity of coconut timber which was 0.53 greater than durian timber which was 0.43. The results correlationof water content and specific gravity of timber were shown on the Fig. 2 and 3.

The results showed an inverse association relationship between timber water content and its specific gravity; higher water content of timber lead to the lower specific gravity, or vice versa. The specific gravity of the wood influenced its bending strength. Higher specific gravity leads to the higher bending strength.

Table 2. The Specific Gravity of Durian and Coconut Timber

No	Specific gravity	
Test objects	Durian timber	Coconut timber
1	0.42	0.52
2	0.46	0.51
3	0.41	0.52
4	0.41	0.56
5	0.43	0.56
Average	0.43	0.53

3.3 The Analysis of Bending Strength of DurianTimber, Coconut Timber and Laminated Beam

According Dumanauw (1984), bending strength can be defined the strength to withstand the force that tried to bend the timber or to withstand the dead load and live load in addition to the blow load borne by the timber, for example a beam.

Table 3 and 4 show the bending strength testing of Durian and Coconut timber. Table 3 shows, the average bending strength of Durian timber is 36.68 MPa and that of coconut timber is 44.94 MPa.

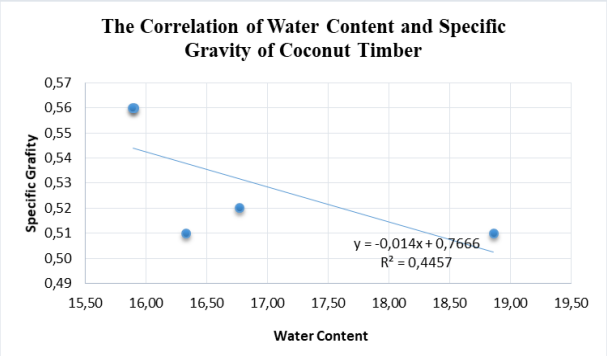

Fig. 2 The Correlation of Water Content and Specific Gravity of Coconut Timber

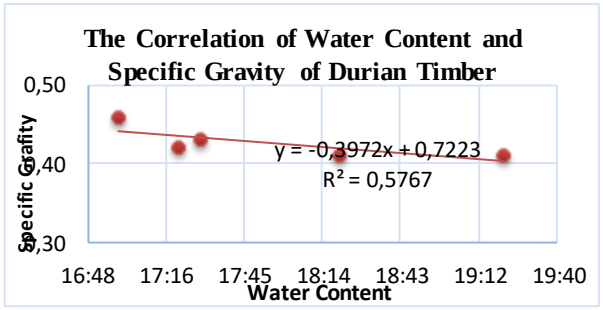

Fig. 3 The Correlation of Water Content and Specific Gravity of Durian Timber

The results of the bending strength above showed that coconut timber had a higher bending structure compared with durian timber. These results are supported by the test data which found that specific gravity of coconut timber was higher than that of durian timber.

Table Bending Strength of Controlled Beam of Durian and Coconut timber

Table 4. Bending Strength of Controlled Beam of Durian Timber and Laminated Timber

No	Bending Strength (MPa)	
Test objects	Durian Timber	Coconut Timber
1	35.28	43.68
2	38.64	44.94
3	36.12	46.2
AAverage	36.68	44.94

The results of the analysis showed that the mean score of the durian wood's bending strength was 36.68 Mpa and 44.94 Mpa for coconut timber. Meanwhile, the mean score of the laminated beam's bending strength was 41.30 Mpa.

The modulus of elasticity and the modulus of rupture of the laminated during and coconut was 67,456.67 Mpa dan 41.30 Mpa. These results were greater than those of the durian wood which were 59,910.67 Mpa dan 36,68 Mpa. Fig. 4 shows bending testing

Fig.4 Bending Testing

The results of the analysis showed that after being laminated, the bending strength of the beam increased by 12.6%, 36.68 MPa into 41.30 MPa. The results of the bending test explained that the lamination technology with the use of epoxy glue on the reinforcement of laminated beam of Durian timber with coconut timber could provide reinforcement to the durian timber in terms of bending strength.

The increased strength was caused by the lamination technology of coconut timber to the durian timber. The reinforcement of laminated beam using a timber with a higher strength class as the outer layer could provide a higher bending strength than the one without lamination.

The difference of bending strength after the lamination was significant as indicated by the mean difference between the bending strength of durian timber with that of the laminated timber. The result of the analysis showed that t_{count} = -5.28423, $t_{count} > t_{table}$, with ttable = - 4.30. Therefore, the analysis result showed a significant difference between the average bending strength of durian timber and laminated timber. Furthermore, the result of the mean difference analysis between coconut timber and laminated beam showed that tcount = 2.3636, $t_{count} < t_{table}$, with t_{table} = 4.30.The result of the test analysis showed that there was no significant difference between the bending strength of coconut timber and laminated beam. Therefore, using the coconut timber reinforcement on top of the weaker durian timber was able to provide significant strength.

IV. CONCLUSION

The coconut timber can be used as a reinforcement for durian timber using lamination technology. The average bending strength of durian timber was 36.68 MPa. The average bending strength of coconut timber was 44.94 MPa. The bending strength of laminated timber was 41.30 MPa. The result showed that there was a significant difference between bending strength of durian timber and laminated timber timber and an average increase of bending strength between Durian timber and laminated timber was 12.6%.

The laminated beam of durian timber with coconut timber as its reinforcement can be used as an alternative material to increase the strength class of durian timber.

REFERENCES

1. ASTM.1995. *American Standart For Testing and Method.Standart for testing of evaluaty timber preservation by field test with stakes*. Philadelpia.1995
2. Abdurachman dan Nurwati H. 2009. *Sifat Fisik Dan Mekanik Kayu Lamina Campuran Kayu Mangium Dan Sengon*. 27(3) : 87-100. Pusat Penelitian dan Pengembangan Hasil Hutan. Bogor
3. Berglund, L., and Rowell, R.M., 2005,*Handbook of Timber Chemistry and Timber Composites*
4. Brandner R. & Schickhofer G. (2008). *Glued laminated timber in bending: new aspects concerning modeling*. Competence Centre holz.bau forschungs gmbh, 8010 Graz, Austria
5. Dumanauw, J.F. 2001. *Mengenal Kayu. Yogyakarta:* PIKA - Kanisius.
6. Fakhri. 2001. *Pengaruh Jumlah Kayu Pengisi Balok Komposit Kayu Keruing-Sengon terhadap Kekuatan dan Kekakuan Balok Kayu Laminasi (Glulam Beams).* Universitas Pascasarjana UGM.
7. Handayani, Sri. 2003. *Pengujian Sifat – sifat Mekanik lentur dan Geser Kayu Sengon dan Kayu Suren dari Daerah Bagian Utara Jawa Tengah*, Semarang. Teknik Sipil FT UNNES.
8. Handayani, Sri. 2009. *Metode Perekatan Dengan Lem Pada Sambungan Pelebaran Kayu*. Semarang. Teknik Sipil FT UNNES.
9. Handayani, Sri. 2015. *Structural Characteristic Laminated Timber of Indonesian Timber*. IJIRAE. Vol 2 Issue 12.
10. Iskandar, 2006. *Pemanfaatan Kayu Hutan Rakyat Sengon (Paraserianthes falcateria (l) nielsen) untuk Kayu Rakitan*. Prosiding Seminar Litbang Hasil Hutan.
11. Jihannanda. Pramudito. 2013. *Studi Kuat Lentur Balok Laminasi Kayu Sengon Dengan Kayu Kelapa Di Daerah Gunung Pati Semarang* [skripsi]. Semarang. Jurusan Teknik Sipil FT UNNES
12. SNI 03-6850-2002. *Metode Pengujian Pengukuran Kadar Air Kayu dan Bahan Berkayu*. PUSLITBANG-Badan Standarisasi Nasional.
13. Sulistyawati, Indah. 2008., *Kekakuan dan Kekuatan Lentur Maksimum Balok Glulam dan Utuh Kayu Akasia*. Universitas Trisakti. Jakarta.
14. Mulyo Wicaksono, Teguh. 2009. *Analisis Kekuatan Lentur Kayu Laminasi dalam Perkuatan Kayu Sengon Sebagai Pengganti Balok*. [skripsi]. Semarang. Jurusan Teknik Sipil FT UNNES.
15. Zakiah Ahmad. 2013.*Laminated Veneer Lumber Made From Tropical Forest Trees. Mechanical Properties*. Malaysia. Penerbit Press University Teknologi Mara.
16. Wan Hazira Wan Mohamad, Mohd Azran Razlan, Zakiah Ahmad (2011), *Bending Strength Properties of Glued Laminated Timber from Selected Malaysian Hardtimber Timber*. International Journal of Civil & Environmental Engineering IJCEE-IJENS Vol: 11 No: 04
17. Zakiah Ahmad. 2013. *Laminated Veneer Lumber Made From Malaysian Tropical Timber Manufacturing and Design*. Malaysia. Penerbit Press University Teknologi Mara.