STRENGTH TEST OF MERANTI WOOD LAMINATED WITH BAMBOO AS AN ALTERNATIVE TO WOODEN SHIP SKIN PARTS IN IKN WATERS

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SUMMARY

East Kalimantan is projected as a candidate for the new Capital City of Indonesia, with various superior potentials, one of which is the vast forest area it has. Based on data from the Central Statistics Agency (BPS) in 2020, the total forest area in this region reached 3,802.4 hectares, which includes several types of areas, such as Nature Reserves, Limited Production Forests, Permanent Production Forests, and Convertible Production Forests. This potential makes East Kalimantan an area that is likely to have abundant wood resources. In this analysis, an experimental method was used through a direct bending test in the laboratory, to determine the strength of the component materials used in the construction of traditional wooden ship hulls. Based on the standard regulations for wooden ships from the Indonesian Classification Bureau (BKI), it is known that materials such as bamboo laminates and meranti wood can be classified into strength class II, so they are suitable as alternative raw materials for making wooden ships.

1. INTRODUCTION

Indonesia is one of the countries that produce wooden ships. Where wooden ships are traditional means of transportation which are still widely used by the Indonesian people in their daily lives, both for transportation, commerce and recreation. In the world of shipping, especially wood, where wooden ships require raw materials from ready-to-use mature wood. Usually wooden ships in Indonesia are made of ironwood and teak wood. Ironwood and teak wood are currently difficult to find and the price is very expensive. Therefore, an alternative material was found to replace ironwood and teak wood, namely meranti wood (Nugroho et al., 2017).

Red meranti wood (*Shorea leprosula*) is a woodworking wood that is often traded. Red meranti wood is a hardwood with a light to heavy weight depending on the age of the wood. The specific gravity of meranti wood is between 0.3 and 0.86 with a water content of around 15%. Red meranti wood has a pink or dark red core that is pale and brownish. The nature of red meranti wood which is included in the hard and strong wood group makes this wood used for shipbuilding raw materials. The use of red meranti wood is not only as raw material for making wooden ships, red meranti wood is also used as housing wood, making furniture and crates (Lubis & Supriyanta, 2020).

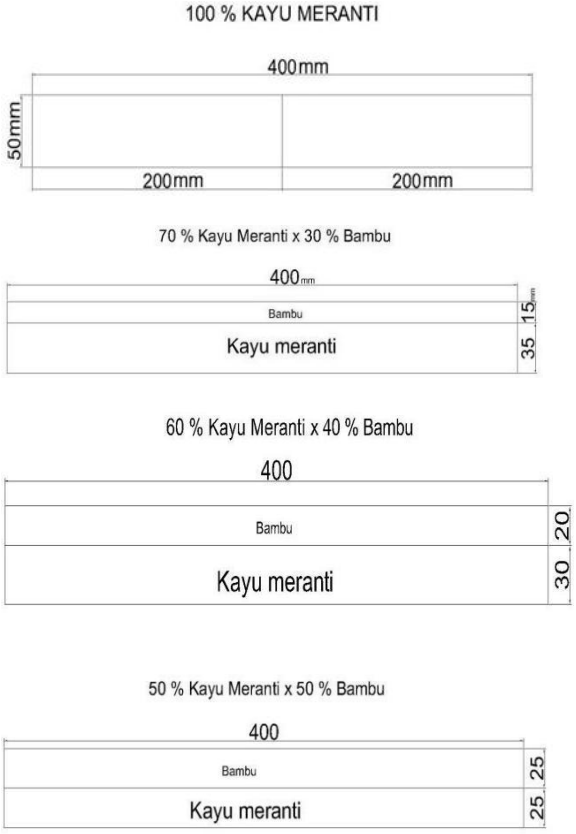
The wood commonly used in making wooden ships is ironwood. In this study, ulin wood was replaced with meranti wood because meranti wood has a much lower price and is easier to obtain than ulin wood. Ulin wood with a price of 250,000 to 750,000 so that ulin wood is categorized as expensive wood due to the scarcity of wood in each region, but the strength of ulin wood is good for material and more sturdy. Meanwhile, meranti wood is priced at 15,500 to 35,600, with an affordable price and the size of meranti wood that is not as heavy as ulin and its economic price, meranti wood can be a choice of material for making wooden ships, (Lubis & Supriyanta, 2020).

Meranti wood is considered not good enough to be used for shipping raw materials because it is easily affected by sea worms and barnacles. Therefore, innovation is needed to replace the wood raw materials that have been used in wooden ships. From various material tests in the laboratory, it is known that bamboo has a very high tensile strength, close to the tensile strength of structural steel. In addition, bamboo is pipe-shaped, so the moment of inertia is large, but light (Nugroho et al., 2017).

In 2012, the production of logs produced on the island of Kalimantan was 7.85 million m^3. Where 7.24 million m^3 (92.24 percent) of this production is one of the meranti wood products. (BPS, 2012).Kalimantan Island is the center of diversity with its timber harvest which is processed as a wood processing product. Meranti wood is widely chosen by wood processing companies to be used as raw material for products because it has quite good quality and minimal natural defects so that it has a high and good production yield level compared to other wood.The development of industry is currently getting more advanced and developing. The business world, including industry, competes and tries its best to utilize resources optimally, including utilizing wood resources with various innovations to create production that has better quality. (Aprianis & Akbar, 2017).

2. RESEARCH METHODOLOGY

This research was mostly conducted using a compression testing machine. In the initial stage, the research started by reading the literature to get information about the research topic. In addition to achieving the objectives of this study, the research has the aim of obtaining Knowing the Bending Strength Value of Bamboo Laminate and Meranti Wood in Traditional Wooden Ship Components. Knowing the Safety Factor Value of Bamboo and Meranti Wood Laminates as Traditional Wooden Ship Components. understanding of the right concepts and methods in solving problems in the previous stage. After that, the process of preparing equipment for tools and materials begins. At this stage, all equipment and materials used for research have been prepared. This makes it easier during the research process. Circular Saw, kneading machine, gergazi, ruler, are used in this research. In this study, 3 specimens were made with different types of variations, namely, 100% meranti wood, 70% meranti wood and 30% bamboo, 60% meranti wood and 40% bamboo and 50% meranti wood and 50% bamboo. In accordance with the standards used in this study, the maximum flexural strength value will be sought, where the results of this study will be compared with the requirements of wooden shipbuilding materials according to the Indonesian Classification Bureau.



After the specimen has been made, three-point testing will then be carried out to obtain the maximum flexural strength value in accordance with the SNI-ISO-3133: 2010 standard. The tests were conducted at the SKAP (Wood Properties and Product Analysis) laboratory of the Kalimantan Institute of Technology using a *Universal Testing Machine.* Tests will be carried out using a support distance in accordance with the standard used, which is 12-16 times the thickness of the specimen.

3. RESULTS AND DISCUSSION

3.1 Compressive Test Result

After testing using the compressive test method using the SNI-ISO- 3133: 2010 standard conducted at the SKAP laboratory (Wood Properties and Product Analysis) Kalimantan Institute of Technology using the *Universal Testing Machine* tool*, the* results are described in tables 1, 2, 3, and 4 as follows:

Table 3.1: Bending Test Results Specimen 100% Meranti wood

N0	Code	Load (N)	Stress (MPa)	Young's Modulus (N/mm^2)	Cross-sectional area (mm)
1	PS 1	15386,677	38,83	373,16	50
2	PS 2	16806,858	42,382	399,93	50
3	PS 3	12886,243	37,5	263,67	50

Table 3.2: Bending Test Results of Specimen 70% wood x 30% bamboo

N0	Code	Load (N)	Stress (MPa)	Young's Modulus (N/mm^2)	Cross-sectional area (mm)
1	PS 1	18345,908	46,725	200,5	50
2	PS 2	13564,316	34,189	216,94	50
3	PS 3	14309,147	36,941	365,7	50

Table 3.3: Bending Test Results of Specimen 60% wood x 40 % bamboo

N0	Code	Load (N)	Stress (MPa)	Young's Modulus (N/mm^2)	Cross-sectional area (mm)
1	PS 1	3632,600	9,190	109,23	50
2	PS 2	7945,658	20,023	137,67	50
3	PS 3	4175,249	10,555	159,49	50

Table 3.4: Bending Test Results of Specimen 50% wood x 50 % bamboo

N0	Code	Load (N)	Stress (MPa)	Young's Modulus (N/mm^2)	Cross-sectional area (mm)
1	PS 1	3221,560	8,134	94,941	50

2	PS 2	6203,984	15,646	77,912	50
3	PS 3	4464,456	11,28	151,53	50

3.2 Comparison of Test Results with Wooden Ship Material Requirements from the Indonesian Classification Bureau (BKI)

The following is a table of wood grade strength from the Indonesian Classification Bureau as a wooden ship material. This table will be a comparison with the results of the flexural strength testing that has been done.

Table 3.5 BKI Wood Strength Class

Strong Class	Specific gravity	Maximum flexural firmness (kg/cm^2)	Maximum compressive strength (kg/cm^2)
I	More than 0.90	More than 1100	More than 650
II	0.60 - 0.90	725-1100	425 - 650
III	0.40 - 0.60	500 - 725	300 - 425
IV	0.30 - 0.40	360 - 500	215 - 300
V	Less than 0.30	Less than 360	Less than 215

After obtaining the comparison value with the requirements of the BKI as a comparison, the results of the *Safety Factor* calculation are obtained as in the following table:

Table 3.6 Calculation of Safety Factor on Specimens

NO	Wood X Bamboo Variation	Maximum Voltage (MPa)	Material Allowable Stress (MPa)	*Safety Factor*	Description
1	100%	19,963	63,75	3,193	Secure
2	70% x 30 %	18,529	63,75	3,440	Safe
3	60% x 40%	4,933	63,75	12,923	Safe
4	50% x 50%	4,721	63,75	13,503	Safe

4 CONCLUSION

In accordance with the PPKI 1996 *rules*, namely 85 and multiplied by 75% because the wood used is quality B wood where the allowable stress used must be multiplied by 75% so that the allowable stress value of the wood material is

63.75 Mpa. From the results of the research that has been carried out, it can be concluded that for the use of Meranti wood material with the type of model 100% meranti wood 19.963 MPa, 70% meranti wood and 30% bamboo 18.529 MPa, 60% meranti wood and 40% bamboo 4.933 MPa, and 50% meranti wood and 50% bamboo 4.721 MPa. With the results obtained, this material is suitable for use as a wooden ship skin material.

5. REFERENCE

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