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Effect of the Joint Form on the Strength of the Ulin (Eusideroxylon Zwageri T Et B) Wood's Spread

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Abstract:- The study aimed to determine the effect of joint forms on the Ulin (Eusideroxylon zwageri Tet B) wood spread on its strength. The type of wood used in this study is the Ulin type (Eusideroxylon zwageri T et B), which is a beam with a standard market size that is traded 8 cm x 8 cm x 400 cm. The Ulin beam is wrinkled to four sides so that it gets a uniform size (wide and thick). Beams are made various forms of connection, namely straight edge joints, sloping edges and tilted edges related to each other..

Testing includes the mechanical properties of MoE and MoR using Panter MPK-5 test equipment in the laboratory of the physical and wood mechanics properties of Samarinda State Agricultural Polytechnic. The data analysis used was a Complete RandomIzed Design with 10 repeats, and further tests using LSD (Least Significant Difference). Based on the results of the research obtained it was found that;

The defect-free Ulin wood used in the study had an average MoE value of 318,846.52 kg/cm2, MoR 1,049.66 kg/cm2 classified as wood with strong grade I, with an average test water content of 19.57% and a wood density of 1.00 g/cm3.

The connection in wood results in a decrease in stiffness (MoE) between 23 - 57.04% of the rigidity (MoE) of wood without a connection, when the rigidity of wood without a connection is considered 100%. The form of the connection, greatly affects the rigidity (MoE) of the wood connection. From each treatment the shape of the sloping edge connection and the sloping edge joint produces the highest rigidity value (MoE)..

Keywords:- *Ulin Wood, Connection form, MoE and MoR.*

I. INTRODUCTION

Wood is a material that is very often used for certain purposes of use. Sometimes as a certain item, wood cannot be replaced with other materials because of its distinctive properties. We as users of wood whose each type has different properties, need to know the properties of the wood so that in the selection or determination of the type for a specific purpose of use must be exactly in accordance with what we want[1]

The need for wood as a building construction material, today is increasing. Wood for building construction materials must meet technical requirements, among others, strong, hard, large in size and have high natural durability[2]. The type of wood commonly used for construction materials one of which is ulin wood.

In Kalimantan, Ulin wood has been used as the main material to make a house, especially among the Dayak tribe. Ulin wood is good to be used as raw material of Ulin wood has a special specialty that is in addition to hard, heavy, also not weathered by water even more durable. Ulin is among the wood that is quite resistant to termite attacks[3].

Wooden buildings in terms of structures are safer against earthquake hazards and in terms of architecture, wooden buildings have a high aesthetic value. Along with the development of the construction world demanded the availability of wood that has long-size dimensions that suit the needs in construction[4]

Sawn wood as a building construction material generally has a certain size (length, width and thickness) according to market standards, although there is also a size based on demand (order) but this is not common. To make a building there are times when the size of the building made is longer than the size of the length of the wood as a building material. One of the above problem solving alternatives is the wood splicing technique, so that structural components will be obtained according to the needs. The existence of this connection technique allows the results of long-sized wood according to needs.

Splicing technique is a technique of combining materials that have a short and limited span so that it becomes a long-handled material. This technique is used to form the dimensions of building materials needed as construction materials[5]. The connection is the weakest part, so many structural failures or damages are caused by the failure of the connection. Therefore, connecting techniques are very instrumental to get a good structure.

In wood construction, the place of connection or connection, calls great attention, because the connection is the weakest point in construction. The strength of the wooden construction joint is highly dependent on the mechanical and physical properties of the wood, in addition to the nature of the connective and its shape[6].

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According to Sulistyawati[7], as the basis for determining the quality class of construction wood is modulus of elasticity (MoE) and modulus of repture (MoR). Modulus elasticity is a measure of wood's ability to withstand changes in shape and bending that occur up to the limit of proportion. The greater the load that works, the higher the voltage that arises and the greater the form of shape change that will occur to the limit of proportion. The voltage and strain relationship forms a straight line. The limit of proportion is that when the working load is released, the object will return to its original form, but when the load crosses this limit, it will not go to its original form even though the load has been released[8]. A broken voltage is a voltage calculated from the maximum load (load when broken). Modulus when broken (MOR) is a mechanical property of wood related to the strength of wood that is a measure of the wood's ability to withstand the load or external force that works on it to the maximum and tends to change the shape and size of the wood, in other words the strength of the bending of the broken is the nature of the strength of the wood in determining the load that can be borne by a beam or girder[9].

Based on the description above, it is necessary to analyze the strength of ulin wood on the shape of the wooden joint.

The study aimed to determine the effect of joint forms on the Ulin (Eusideroxylon zwageri Tet B) wood spread on the strength of the wood. Indicators of the strength of wood used are MoE (Modulus of Elasticity) and MoR (Modulus of Repture).

From the results of this study is expected to provide technical data information about the mechanics (basic stress) of wood, which is what percentage of wood strength loss due to connections from various forms of connection.

II. METHODOLOGY

A. Research Place and Data

The study was conducted at the laboratory of Samarinda State Agricultural Polytechnic in Samarinda. Research time of 3 months, including research preparation activities, testing test samples.

B. Research Object

The object of this study is traditional forms of connection using bolt connects on Ulin wood beams, so that mechanical strength data is obtained.

C. Tools and Material

The equipment used in the study was: hand saw, circular saw, sprinkler, chisel, hammer, axe, english key, hand planner, planner (stationary), electric drill, meter, caliper and Panter MPK-5 test machine. The materials used are: Bolts (which are equipped with rings and nuts) and Ulin type wood beams (Eusideroxylon zwageri T et B) with a size of 8 cm x 8 cm x 400 cm (market size).

D. Research Procedure

- Choose a sawn wood (beam) type Ulin is free of defects, which measures 8 cm x 8 cm x 400 cm.
- Perform sharpening on all four sides of the Ulin beam surface to obtain a neat, flat, thick and wide wooden surface (see Figure 1).

Fig 1. Wood Ordering

- Wood (beam) that has been neat and elbows of the sides are made connections in accordance with the shape that has been set, the forms of the connection used can be seen in Figures below:

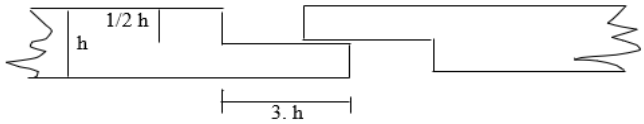

Fig 2. Straight edge connection

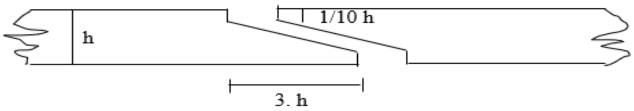

Fig 3. Oblique Edge Conncetion

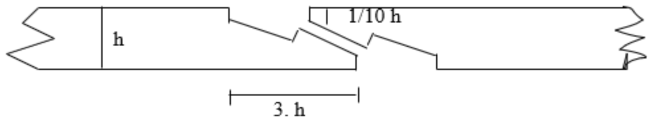

Fig 4. Angled Edge Connection is Linked (Wiyomartono 1977)

- Each form of connection is made 10 pairs, then combined using bolts. Determination of bolt points as much as 2 points per connection that is 1/3 and 2/3 of the length of the connection in the middle of the width of the beam. Wood that has been spliced bolts is an example of a test.

III. TESTING

A. Examples of tests are placed (presented) on a device where the radial cross-section is placed face up and down (which is given a load, then gives the load right in the middle of the spread above the deflectometer rod.

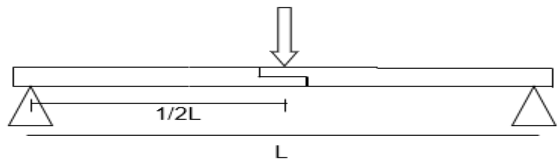

Fig 5. Laying Examples of Test Location of Wood Joints Right at Loading Point (1/2 length of spread)

B. The wooden joint that has been unfurled, given an initial load of 5 kg, by setting the deflection pointer needle at the number 2, then the load coupled with a weight of 20 kg, the needle that shows on the bar is a deflection that occurs. As in Figure 6.

Fig 6. Laying Load on Spread Connections in the testing process

Determination of the quality of wood voltage with PANTER MPK - 5 machine is based on measurement of bending stiffness (modulus elasticity) of wood. The machine works on the principle of simple beams, so that the bending stiffness is calculated based on the formula[10].

$$MoE = \frac{P.L^3}{4.\Delta y.bh^3} \cdot fk$$

Where:

MoE	= Modulus of Elasticity
P	= Standard load
L	= Length of span
y	= Deflection or bending due to standard load
b	= Width cross-section of wood
h	= Thick or high cross-section of wood
fk	= Calibration factor

Based on the relationship between the broken modulus (MoR) and the Panter elasticity modulus (MoE) then obtained the broken modulus (MoR) as follows: MoR = 109 + 0.00301. MoE.

IV. DATA ANALYSIS

The experimental design used to determine the effect of the form of the connection, on the strength of the ulin wood connection, with a statistical model using complete random[11] with a repeat of 10 times is as follows:

$Y = \mu + Ƭ + \varepsilon$

Where:

μ	= Average population value
Ƭ	= Effecr of Trearment (Form of connection)
ε	= Effect of errors of the experimental unit

The data on the treatment in the experimental design is then tabulated into the Anova table (variant analysis) or diversity fingerprint.

If the diversity fingerprint test shows different influences (F calculates > F table) at the test level of 5% and or 1%, then to find out the influence between treatments is further tested using Least Significance Different (LSD), with the following mathematical formulas:

$$\textbf{LSD}_{0,05} = \boldsymbol{t(db; 0,05)\sqrt{(2.KTG/n)}}$$
$$\textbf{LSD}_{0,01} = \boldsymbol{t(db; 0,01)\sqrt{(2.KTG/n)}}$$

where:

LSD	= smallest real difference value
t	= values on table t
db	= freedom degrees
n	= number of samples
0,05 & 0,01	= level of trust

V. RESULT AND DISCUSSIONS

Data obtained from the ulin beam bending test using the panther tools is the following reason:

No	Span length (cm)	Weight (kg)	Width (cm)	Height (cm)	Deflection (cm)	FK	MoE (kg/cm^2)	MoR (kg/cm2)
1	300	20	6.62	6.48	24.20	47.32	147,156.16	551.94
2	300	20	6.55	6.43	22.30	47.32	164,512.70	604.18
3	300	20	6.62	6.59	21.30	47.32	158,301.37	585.49
4	300	20	6.63	6.49	37.20	47.32	94,751.90	394.20
5	300	20	6.62	6.44	25.30	47.32	142,804.66	538.84
6	300	20	6.62	6.53	32.20	47.32	107,627.96	432.96
7	300	20	6.39	6.36	27.60	47.32	140,798.24	532.80
8	300	20	6.63	6.50	27.10	47.32	129,465.97	498.69
9	300	20	6.64	6.45	28.20	47.32	127,139.99	491.69
10	300	20	6.62	6.46	26.40	47.32	135,587.31	517.12
Average							134,814.63	514.79

Table 1. Value Of MoE and MoR on Straight Edge Connection Shape

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No	Span length (cm)	Weight (kg)	Width (cm)	Height (cm)	Deflection (cm)	FK	MoE (kg/cm^2)	MoR (kg/cm2)
1	300	20	6.62	6.61	18.80	47.32	177,792,00	643,96
2	300	20	6.55	6.52	15.80	47.32	225,564.02	787.95
3	300	20	6.62	6.70	19.40	47.32	165,384.34	606.81
4	300	20	6.63	6.59	21.30	47.32	158,062.60	584.77
5	300	20	6.62	6.64	16.70	47.32	197,378.48	703.11
6	300	20	6.62	6.66	18.70	47.32	174,685.24	634.80
7	300	20	6.39	6.52	14.30	47.32	252,231.21	868.22
8	300	20	6.63	6.60	17.30	47.32	193,725.62	692.11
9	300	20	6.64	6.63	18.10	47.32	182,385.90	657.98
10	300	20	6.62	6.58	17.10	47.32	191,368.11	685.02
Average							191,851.45	686.47

Table 2. Value of MoE and MoR on Oblique Edge

No	Span length (cm)	Weight (kg)	Width (cm)	Height (cm)	Deflection (cm)	FK	MoE (kg/cm^2)	MoR (kg/cm2)
1	300	20	6.62	6.60	13.50	47.32	248,630.81	857.38
2	300	20	6.55	6.55	12.90	47.32	269,044.18	918.82
3	300	20	6.62	6.61	13.70	47.32	243,890.88	843.11
4	300	20	6.63	6.62	14.70	47.32	225,929.88	789.05
5	300	20	6.62	6.62	15.90	47.32	209,194.10	738.67
6	300	20	6.62	6.60	13.30	47.32	252,369.62	868.63
7	300	20	6.39	6.39	15.50	47.32	247,197.10	853.06
8	300	20	6.63	6.62	15.20	47.32	218,497.98	766.68
9	300	20	6.64	6.62	13.20	47.32	251,224.81	865.19
10	300	20	6.62	6.61	14.30	47.32	223,657.70	812.31
Average							293,963.70	831.29

Table 3. Value of MoE and MoR on Related Oblique Edge

No	Span length (cm)	Weight (kg)	Width (cm)	Height (cm)	Deflection (cm)	FK	MoE (kg/cm^2)	MoR (kg/cm2)
1	300	20	6.62	6.65	10.50	47.32	312,511.70	1,049.66
2	300	20	6.57	6.62	11.20	47.32	299,241.03	1,009.82
3	300	20	6.63	6.63	10.79	47.32	308,987.29	1,039.05
4	300	20	6.64	6.63	10.90	47.32	302,860.99	1,020.61
5	300	20	6.62	6.63	11.30	47.32	293,022.85	991.00
6	300	20	6.63	6.62	11.20	47.32	296,532.97	1,001.56
7	300	20	6.34	6.63	11.40	47.32	289,577.62	980.63
8	300	20	6.61	6.60	10.30	47.32	326,368.33	1,091.37
9	300	20	6.38	6.39	10.40	47.32	368,996.22	1,219.68
10	300	20	6.42	6.41	11.10	47.32	340,366.19	1,133.50
Average							313,846.52	1,053.68

Table 4. Value of MoE and MoR on No Connection

From the table of test results bending the strength of ulin wood (Eusideroxylon zwageri T et B..) with different connection shapes can be the average values of MOE and MOR of each form of connection as presented in Figure xx.

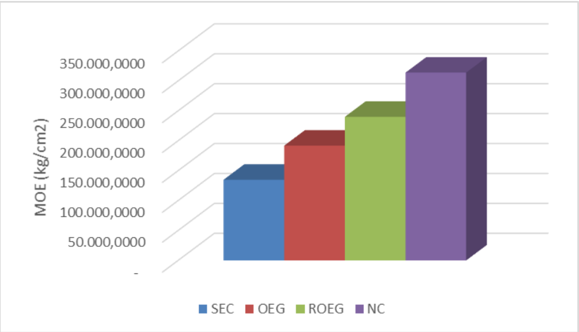

Fig 6. Histogram Average Value MoE Straight Edge Connection Shape, (SEC), Oblique Edge (OQ), Related Oblique Edge (ROE) and No Connection (NC).

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Wood without a connection will automatically differ in the value of its firmness when compared to wood that has a connection, but to know the decrease in the value of its firmness due to the connection it is necessary to know the magnitude of its firmness (MoE).

From the results of testing using a panter tool, the beam without a connection obtained an average bending firmness value (MoE) of 313,846.52 kg / cm^2. Then calculated an average MoR value of 1,053.68 kg / cm^2, according to PKKI standards – 1961 including strong class I.

Based on the SKI C-bo-010:1987 standard Ulin wood has a quality class with a Fiber Voltage (TS) above TS 35, and based on the calculation of the allowable bending voltage of □ ˥t = 458.12 kg / cm^2 and according to SNI – 2002 the Ulin wood has a wood quality class above E26 and based on calculations obtained the allowable bending voltage is □ ˥t = 301.37 kg / cm^2

A wooden connection is the weakest part or point of a construction when compared to wood without a connection. Similarly, the form of connection has different strengths with each other. The average MoE value obtained from the test results, it can be known the quality class, MoR and allowable stress of each form of connection with various standards, as seen in Table 5.

Sambungan	SKI C-bo-010: 1987			SNI – 2002		
	Kelas Mutu	MoR kg/cm^2	$\bar{\sigma}_{lt}$ kg/cm^2	Kelas Mutu	MoR kg/cm^2	$\bar{\sigma}_{lt}$ kg/cm^2
SEC	TS30	685,19	297,91	E20	470,00	214,60
OEG	>TS35	812,15	353,11	E24	590,00	269,41

Table 5. Value of Each Connection Shape

SEC = Straight Edge Connection.
OEQ = Oblique Edge Connection.
ROEC = Related Oblique Edge Connection.

Based on the table above can be seen the ratio of firmness (MoE) between wood without a connection with wood that uses a connection, where there is a difference in the average value of firmness (MoE) wood without a larger connection when compared to wood that has a connection (SEC, OEG, ROEC).

Based on the average value of MoE against the connection form in Tables 1, 2, 3 and 4 there is a difference in firmness values, where the shape of the straight edge connection is smaller / lower when compared to the other two forms of connection, namely the tilted edge connection and the related sloping edge connection which is the form of connection with the highest MoE value. However, in the process of making it, straight edge type connections require a shorter time because it is easier when compared to sloping edge joints let alone the type of related sloping edge joints. In the histogram it can be clearly seen the difference in the firmness of these three forms of connection, and as a comparison is shown the firmness of wood (MoE) without a connection in Figure 7.

Based on statistical testing using RAL the form of the connection is very influential on the strength of the wood as seen in the analysis for its variants.

Source of Variation	SS	df	MS	F	F crit
Between Groups	1563280	3	521093.1783	104.2722**	2.866266
Within Groups	179907.5	36	4997.429366		
Total	1743187	39			

** significant difference

Table 6. Analysis on its Variants

To get more detailed results on the difference, continue with follow-up tests using advanced LSD tests with the following results:

LSD (0.05) = 85.9918
LSD (0.01) = 64.1208

Treatm ent	SEC	OEG	ROEC	NC
Averag e	134,814. 6253	191,851, 4523	239,963. 7048	313,8846. 5181

The underline mark between the ROEC and OEG connection forms indicates that the two average values compared are not real and the difference in strength to the SEC connection. The three forms of connection when compared to wood without a connection provide very significant strength.

This confirms that the connection can decrease the firmness of the wood, or lose the strength of the wood which ranges from 23 - 57.04% of its original strength, this depends on the form of the connection, to the loading.

VI. CONCLUSION

Based on the results of the discussion above, conclusions can be drawn as follows:

- The connection is the weakest point in a construction, resulting in a decrease or loss of strength (Modulus of Elastisity) due to connections ranging from 23 - 57.04% of the wood is defect-free without a connection (intact) when the wood is intact and free of defects in strength is considered 100%.
- The shape of the connection greatly affects the rigidity of the wooden connection. The related sloping edge joint has a higher rigidity (MoE) property compared to the oblique edge joint and the lowest rigidity is the straight edge joint.

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