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Study on Bearing Capacity of Galam (*Melaleuca sp.*) as a Pile Foundation in Peat Soil: A Laboratory Test Model

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ABSTRACT : *Central Kalimantan Province has a wide distribution of peat soils. Development on peat soil is often carried out and causes soil bearing capacity problems, due to the nature of peat soil which has a low bearing capacity. To overcome this the solution that is often used is the use of galam wood, this is considered to increase the bearing capacity of the soil by the local community. A study was conducted to prove that galam wood can increase soil carrying capacity by using 2 research methods. Laboratory modeling method for the foundation of the galam wood pile with 3 types of galam wood samples from a length of 10 cm, 20 cm and 30 cm. Calculation of the bearing capacity of the foundation varies the length of galam wood using the chin method. The validation of the calculation results is carried out by numerical modeling using an application. After calculating the bearing capacity of galam wood with a length of 10 cm, it is obtained 104 g/cm^2 for numerical modeling and 94 g/cm^2, 20 cm is obtained 213 g/cm^2 for numerical modeling and 213 g/cm^2 and 30 cm, it is obtained 417 g/cm^2 for numerical modeling and 370 g/cm^2.*

KEYWORDS *Bearing capacity, Peat, Galam wood.*

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I. INTRODUCTION

Apart from settlement, construction failure on peat soil can also be caused by low soil bearing capacity. Because of this, the type of foundation commonly used in peat soil areas is a pile foundation. The wood that is generally used as a pillar foundation is galam wood (Melaleuca sp.). This type of wood is used because until now it is still easy to find in the Central Kalimantan area. This galam wood pile foundation is very suitable for conditions in peat areas that are always watery (submerged) because it has the unique property that if it is always submerged it will always maintain its strength as proven by the old building with a galam wood foundation that was dismantled and it turns out the galam wood is still intact. The condition is very good even though the building is more than 20 (twenty) years old (Yudiawati and Marzuki, 2008).

The foundation of galam wood which is considered local wisdom needs to be researched, especially with its use on peat soil. In several studies that have been carried out, analysis of the bearing capacity of galam wood was carried out based on the results of the Cone Penetration Test (CPT) and using empirical data. Field experiment research using galam wood has also been conducted by (Rifky, Ahmad. 2014) in a scientific article entitled Shallow Foundations on Soft Soils with Galam Stud Reinforcement Based on Field Experiments, but the research conducted did not specifically mention the soil used in the study was peat soil. So it is necessary to conduct research that proves the increase in the bearing capacity of peat soil by using galam wood pile foundations..This research tested the bearing capacity of galam wood poles in peat soil using laboratory modeling. Then, the carrying capacity data is also used for numerical analysis. So that the parameters of the numerical model of interaction between galam and peat are obtained.

II. FOUNDATION MODEL DECLINE AND SUPPORT CAPACITY

Numerical validation using Plaxis was conducted. Data on soil and wood materials that have been tested in the laboratory were collected. These data are useful for inputting the material properties of soil and wood in the plaxis numerical application. The results of laboratory testing of soil and wood used are contained in table 2.1 and table 2.2. Testing using the 2D plaxis numerical application, after inputting geometry, soil parameters and wood material has been carried out. The next stage is the calculation process and displaying the results of the plaxis numerical application program itself.

Table 2.1 Material Data of Peat soil

Type of soil	Models	Type	ɣ sat (kN/m^3)	ɣ unsat (kN/m^3)	E (kN/m^2)	ν	Cohesi (kN/m^2)	ϕ	ψ
Soil Peat	Mohr Columb	Undrained	10,199	3,334	300	0,3	17,26	28,27	0

Table 2.2 Material Data of Galam Wood

Materials	Materials Models	Materials Type	Diameter (m)	Gref (kN/m^2)	E (kN/m^2)	ν
Wooden Poles Galam	Linier Elastic	Non Porous	0,01	5,4x10^4	1,08x10^5	0,2

The following are the results of geometric drawings from numerical analyses on 2D Plaxis tests.

- Galam wood modelling 10 cm

After modelling, the model is obtained as shown below, the results of the modelling obtained the decline that occurs against the working load. These results will be used to calculate the decrease vs load to determine the ultimate bearing capacity that can be held by wood with a length of 10 cm diameter of 1 cm.

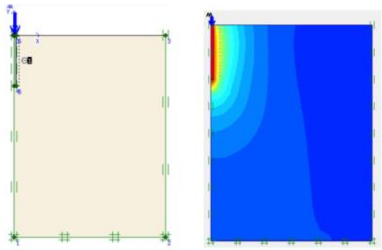

Fig 2.1 Galam wood modelling 10 cm Foundation Using Numerical Application

- Galam wood modelling 20 cm

After modelling, the model is obtained as shown below, the results of the modelling obtained the decline that occurs against the working load. These results will be used to calculate the decrease vs load to determine the ultimate bearing capacity that can be held by wood with a length of 20 cm diameter 1 cm.

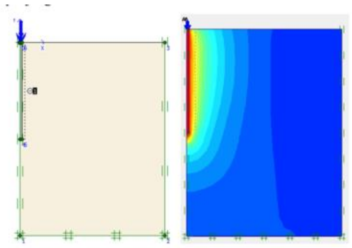

Fig 2.2 Galam wood modelling 20 cm Foundation Using Numerical Application

- Galam wood modelling 30 cm

After modelling, the model is obtained as shown below, the results of the modelling obtained the decline that occurs against the working load. These results will be used to calculate the decrease vs load to determine the ultimate bearing capacity that can be held by wood with a length of 30 cm diameter 1 cm.

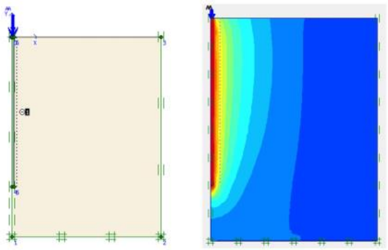

Fig 2.3 Galam wood modelling 30 cm Foundation Using Numerical Application

After testing the load and decline using laboratory calculations as well as laboratory modelling, a recapitulation of the results of the two methods was carried out. The recapitulation was carried out for three types of galam wood from diameters of 10 cm, 20 cm and 30 cm. The results of the recapitulation of the two methods are in the table and figure below.

Table 2.3 Recapitulation of galam wood modelling 10 cm

	Test Data		Laboratory tests	Plaxis
Load (g)	Load (kN)	Load Levelling (kN/m^2)	Decrease (m)	Decrease (m)
0	0	0	0	0
1	9,80E-06	0,12	0,0001	-0,000048
2	1,96E-05	0,25	0,0001	-0,000100
4	3,92E-05	0,50	0,0003	-0,000205
8	7,84E-05	1,00	0,0005	-0,000415
16	1,57E-04	2,00	0,0008	-0,000838
32	3,14E-04	3,99	0,0015	-0,001702
64	6,27E-04	7,99	0,0055	-0,003559

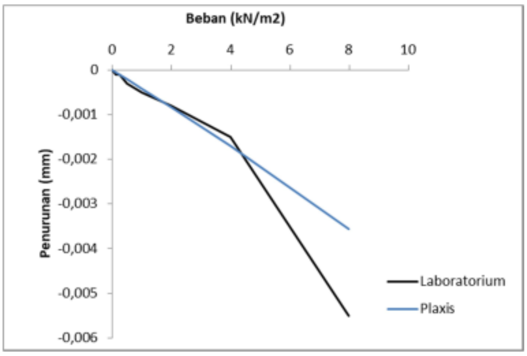

Fig 2.4 Recapitulation Curve of galam wood modelling 10 cm

After testing using laboratory modelling and validated using numerical modelling, the maximum test results were obtained based on laboratory modelling of 0.005 m and numerical modelling of 0.003559 m. The maximum load that can be withstood is 64 grams.

Table 2.4 Recapitulation of galam wood modelling 20 cm

	Test Data		Laboratory tests	Plaxis
Load (g)	Load (kN)	Load Levelling (kN/m^2)	Decrease (m)	Decrease (m)
0	0	0	0	0
1	9,80E-06	0,12	0,0001	- 0,000025
2	1,96E-05	0,25	0,0001	- 0,000055
4	3,92E-05	0,50	0,0002	- 0,000116
8	7,84E-05	1,00	0,0003	- 0,000237
16	1,57E-04	2,00	0,0005	- 0,000480
32	3,14E-04	3,99	0,001	- 0,000968
64	6,27E-04	7,99	0,002	- 0,001955
128	1,25E-03	15,98	0,004	- 0,003990

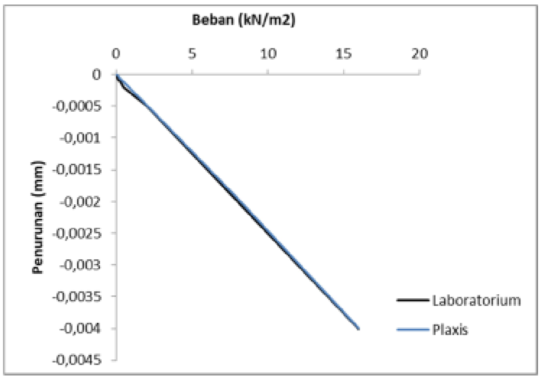

Fig 2.5 Recapitulation Curve of galam wood modelling 20 cm

After testing using laboratory modelling and validated using numerical modelling, the maximum descent test results based on laboratory modelling were obtained at 0.004 m and numerical modelling at 0.003990 m. The maximum load that can be held is 128 grams.

Table 2.5 Recapitulation of galam wood modelling 30 cm

Test Data			Laboratory tests	Plaxis
Load (g)	Load (kN)	Load Levelling (kN/m^2)	Decrease (m)	Decrease (m)
0	0	0	0	0
1	9,80E-06	0,12	0,0001	-0,000035
2	1,96E-05	0,25	0,0001	-0,000077
4	3,92E-05	0,50	0,0002	-0,000159
8	7,84E-05	1,00	0,0003	-0,000325
16	1,57E-04	2,00	0,0005	-0,000655
32	3,14E-04	3,99	0,001	-0,001317
64	6,27E-04	7,99	0,002	-0,002647
128	1,25E-03	15,98	0,005	-0,005332
256	2,51E-03	31,96	0,01	-0,010875

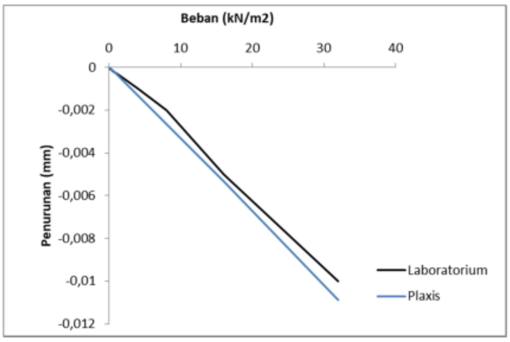

Fig 2.6 Recapitulation Curve of galam wood modelling 30 cm

After testing using laboratory modelling and validated using numerical modelling, the maximum test results were obtained based on laboratory modelling of 0.01m and numerical modelling of 0.010875 m. The maximum load that can be withstood is 256 grams.

III. CALCULATION OF SUPPORT CAPACITY OF GALAM WOOD FOUNDATION BASED ON CHIN METHOD

The Chin-Kondner method assumes that the load and settlement relationship curve will form a hyperbolic curve when the load reaches the limit load or collapses. In this method, the amount of settlement is divided by the load and plotted against the amount of settlement. The magnitude of the limit load or collapse is the inverse of the straight curve of the relationship. The carrying capacity calculated is the carrying capacity based on laboratory modelling and numerical modelling. The calculation of bearing capacity is also carried out for 3 different types of galam wood lengths of 10 cm, 20 cm and 30 cm. The results listed in the table 3.1

Table 3.1 Support Capacity Based on Chin Method

Mast Length	Support Capacity	
	Plaxis Modelling (g/cm^2)	Modelling Laboratory (g/cm^2)
10 cm	104	94
20 cm	213	213
30 cm	417	370

It can be seen from the results of the bearing capacity of numerical modelling and laboratory modelling that the larger the diameter of the galam wood used for testing, the more the bearing capacity is increased.

IV. CONCLUSION

The results of peat soil testing obtained soil characteristics. It was found that the type of soil used in the research was peat soil with the Sapric-peat soil classification (mature peat). After calculating the bearing capacity of galam wood with a length of 10 cm, it was obtained 104 g/cm^2 for numerical modeling and 94 g/cm^2, 20cm obtained 213 g/cm^2 for numerical modeling and 213 g/cm^2 and 30 cm obtained 417 g/cm^2 for numerical modeling and 370 g/cm^2. Based on the results of carrying capacity calculations based on numerical modeling and laboratory modeling, it was found that each time an increase in the length of the galam wood pole used as a foundation was directly proportional to the increase in soil bearing capacity that occurred. Several suggestions can be made for these improvements, including: Further research needs to be conducted regarding strengthening wood against other types of soil materials and carried out on a larger and more complex scale (full scale analysis). For further testing, a more in-depth analysis is needed to overcome differential settlement and analysis for wooden poles using the Plaxis 3D Foundation program.

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