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COMPARATIVE STUDY OF SETTLEMENT OF PRECAST DEFORMED MINI PILES WITH THREADED AND PLAIN AGAINST MANGROVE WOOD PILES BASED ON PILE SETTLEMENT AS DEEP FOUNDATION REINFORCEMENT

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Abstract

Foundation is one of the essential elements that cannot be avoided in the world of construction, whether in roadwork, bridges, buildings, or other structures. Bengkalis Island is one of the islands that has inadequate soil bearing capacity for construction, like other areas, so it requires piles to support the foundation. Increasing development will increase the demand for these piles as a supporting material for foundations, where concrete has the potential to be an alternative material used as a substitute for mangrove piles. Concrete is shaped like a mini pile and made into two types: plain and threaded. The results will show which type is best suited for use on the soil of Bengkalis Island. The concrete has a design quality of f'c 15 MPa, with a diameter of 5-8 cm and a length of 1 meter. Testing is carried out by applying a gradual load, starting from 5 kg, until the concrete is unable to withstand the load it supports. The results show that concrete with threads has the potential to be an alternative material, as it exhibits a smaller decrease compared to wood and plain concrete, with a decrease of approximately 0.81 mm under a given load of 125 kg. Based on this research, threaded concrete can become an alternative material to reduce the excessive demand for pile wood in the future.

Keywords : Mini Pile, Plain Mini Pile, Threaded Mini Pile, Peat Island, Pile Settlement

1. INTRODUCTION

Foundations are one element that cannot be avoided in the world of construction, whether in roadwork, bridges, buildings, or other structures. It can happen because the foundation is an important element that receives the load from the structure above it and transfers it into the ground. Based on their depth, foundations are divided into two types: shallow foundations and deep foundations.

A foundation with a depth of 0 to 3 meters is used to support light structures such as simple homes, low-rise buildings, or structures that do not carry heavy loads. Deep foundations, on the other hand, are foundations with a depth of more than 3 meters and are used for high-rise buildings, commercial buildings, or extensive infrastructure that require strong and stable supports to withstand heavy loads and reach deeper, more solid soil layers.

Bengkalis Island is an island located in Riau Province, composed mainly of peat soil, which has poor bearing capacity. Soil bearing capacity is the ability of the soil to support a structure and prevent it from sinking or collapsing. A lower soil bearing capacity increases the risk of structural failure, while a higher soil bearing capacity increases the potential for structural failure.

The majority of people on Bengkalis Island use 5-8 cm mangrove stakes as supporting material, installed in the structural column foundations and along the sloof beams. This supports the soil's bearing capacity, preventing the structure from sinking under the loads above it. However, the increasing number of developments on Bengkalis Island has led to an increase in the need for mangrove stakes, which has an impact on abrasion around Bengkalis Island.

Concrete is a synthetic material with the potential to serve as a substitute for mangrove stakes, as it can be shaped to resemble them, thereby reducing demand for the natural

material. These concrete stakes, known as mini piles, are believed to be resistant to termite attack, weather, and decay, especially in extreme environments.

Based on the issues, research is needed to determine whether mini piles have the potential to be an alternative material to mangrove stakes, in terms of their settlement rate under load. Switching to this method will not only improve construction quality but also preserve the coastal environment.

2. METHOD

According to Tjokrodimuldjo (1997), concrete is a mixture of cement, water, coarse aggregate, and fine aggregate with or without additional materials. The cement used is PCC cement produced by PT. Dynamix Cement is the main binder. Coarse and fine aggregates come from Tanjung Balai Karimun, Riau Islands. There are 2 (two) types of mini piles, namely plain and threaded, with a diameter of 8 cm and a length of 1 meter, which are expected to have different settlement rates with a curing age of 28 days. The test carried out is a gradual loading test method, with 5 kg applied at each stage. The composition of the concrete Mixture required in this study is presented in Table 1 below.

Table 1. Concrete Mixture in $1m^3$

Mixture Fractions	Cement (Kg)	Water (Kg)	Coarse Aggregate (Kg)	Fine Aggregate (Kg)
Plain Concrete Piles	326	215	1029	760
Threaded Concrete Piles	326	215	1029	760

The method used for driving precast plain and threaded mini piles is manual, involving the use of a weight as the primary load to drive the piles into the ground. This piling process is carried out in stages and carefully to ensure that the lowering of the piles takes place smoothly and that the piles are adequately embedded and stable in the ground. Each stage of piling is carried out by monitoring the depth and position of the piles to ensure compliance with the predetermined plan. Monitoring settlement during piling is crucial to ensure that the position and depth of the piles align with existing calculations, thereby ensuring the strength and stability of the piles in supporting the structure's load above them. In addition, to ensure that the piles work optimally in supporting the loads received, careful quality testing and accurate settlement measurements are carried out. The form of testing carried out is illustrated in Figure 1 below, which describes the procedures and results obtained during the piling process.

Fig. 1 Testing Models of Mini Pile Settlements

3. RESULT & DISCUSSION

Loading tests were conducted in stages, starting with a load of 5 kg, with each pile type exhibiting a different response to the soil. This test model uses water that is gradually introduced into the tower to apply the load and observe the changes that occur slowly. Based on the test results, at an initial load of 5 kg, the three types of materials (plain mini piles,

wooden piles, and threaded mini piles) exhibited no settlement, indicating that all three can withstand the load without significant changes in settlement depth.
However, at a load of 20 kg, the plain mini piles began to show a decrease of 0.02 mm, indicating a response to the increased load. Furthermore, at a load of 25 kg, the wooden piles exhibited a settlement of approximately 0.03 mm, whereas the plain mini piles experienced a settlement of 0.06 mm. On the other hand, the new threaded mini piles started to show a decrease of 0.04 mm when the applied load reached 30 kg. The different settlements for each type of pile driving reflect the different abilities of each material to transmit loads into the soil.
For more details, the test results are presented in Table 1 below, which contains information on the settlement that occurs in each type of pile at various loading levels.

Table 2. Results of Testing the Settlement of Wooden Piles, Plain Concrete, and Threaded Concrete

Loads (Kg)	Wooden Piles Settlement (mm)	Plain Concrete Piles Settlement (mm)	Threaded Concrete Piles Settlement (mm)
5	0	0	0
10	0	0	0
15	0	0	0
20	0	0.02	0
25	0.03	0.06	0
30	0.04	0.08	0.04
35	0.05	0.12	0.06
40	0.1	0.16	0.08
45	0.15	0.16	0.12
50	0.23	0.24	0.14
55	0.31	0.35	0.16
60	0.38	0.47	0.17
65	0.45	0.56	0.23
70	0.48	0.63	0.27
75	0.53	0.71	0.31
80	0.6	0.79	0.33
85	0.72	0.87	0.35
90	0.84	1.05	0.41
95	0.89	1.2	0.42
100	0.94	1.44	0.48
105	1.01	1.62	0.54
110	1.08	Loss	0.59
115	1.12	Loss	0.69
120	1.18	Loss	0.75
125	1.23	Loss	0.81

According to the Table above, the test results show some interesting findings. At a load of 125 kg, the wooden piles experienced a settlement of approximately 1.23 mm, while the threaded mini piles showed a settlement of 0.81 mm. However, plain mini-pile concrete piles yield different results. These piles could only support a load of up to 110 kg, after which they could no longer support the load and experienced significant settlement. This shows that plain concrete mini piles have a lower resistance capacity compared to wooden piles and threaded mini piles at greater loads. For a more precise comparison between the three types of piles, the graph in Figure 2 below shows the differences in settlement that occur in each type of pile at a given load level.

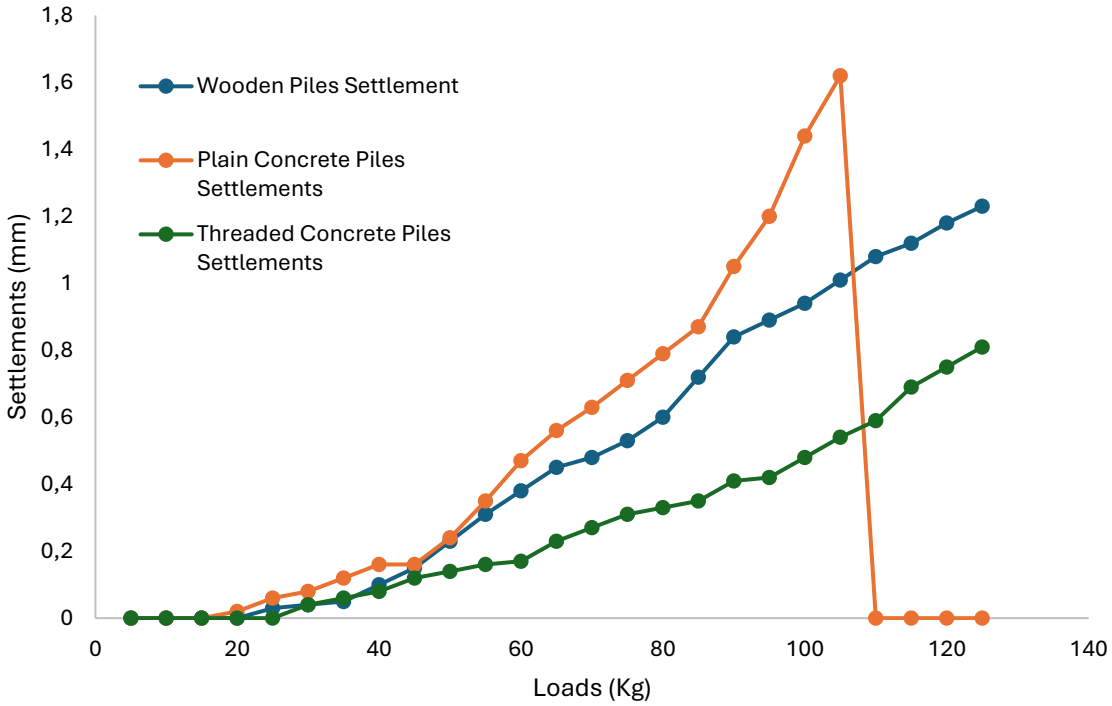

Fig. 2 Comparing Graphs: Settlements of Wooden Piles, Plain Piles, and Threaded Piles

Based on the graph above, we can observe the comparison of settlement in the three types of piles tested against the applied load. The settlement of the wooden piles shows a consistent increase as the load increases. The settlement begins to be clearly detected after the load reaches about 25 kg, and the greater the load, the greater the settlement, reaching about 1.23 mm at a load of 125 kg. The settlement of the plain mini piles shows the most significant response. At a load of about 110 kg, there is a sharp increase in the settlement of the pile, which indicates that this pile can only withstand that load. After reaching 110 kg, the plain mini piles can no longer support the load, and settlement accelerates, reaching more than 1.6 mm at a load of around 125 kg.

4. CONCLUSION

Meanwhile, the settlement of the threaded mini piles appears to be more stable than that of the other two types. The settlement is more controlled and continues to increase linearly, even as the load continues to increase. At a load of around 125 kg, the settlement of threaded mini piles was recorded at around 0.81 mm, which is lower than that of wooden piles and plain mini piles. Overall, this graph shows that although threaded mini piles have lower settlement than the other two types, timber piles and plain mini piles begin to experience significant settlement at higher loads. This illustrates that the type of material has a significant influence on the bearing capacity of the pile against the given load.

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