Study of Soft Soil Strength Using Combination of Wood Pile and Woven Plastic Bottle

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Abstract. Roads are needed To connect one location to another, but not all of them can be ascertained to have good land carrying capacity. The construction of a road body on land that has less bearing capacity (soft land) results in a large decrease and lateral movement. Soft soils are soils that if not carefully identified and investigated can cause problems of instability and long-term decline that cannot be tolerated, they have low shear strength and high compressibility.

The method used in this research is experimental method. The test is carried out by looking at the deformation that occurs in soft soils which are not reinforced and in soft soils that are reinforced using plastic bottles woven on a wooden bus and with varying depths of flakes that are 10 cm and 20 cm, with a diameter of 10 cm wood pits. From the results of laboratory testing it is known that the combination of materials from woven plastic bottles and wood buses can reduce the deformation that occurs on soft soil. Deformation that occurs in soils not reinforced with a load of 4 kN is 25.89 mm, while the deformation that occurs in soils that are reinforced using woven plastic bottles on a bus wood pile and with a depth of 10 cm and 20 cm piles with the same load of 4 kN are 8.68 mm, 14.35 mm and 15.62 mm.

1. Introduction

In supporting the development of an area, many factors need to be improved both in terms of supporting facilities and infrastructure. The road is one of the supporting infrastructure for community economic development as well as access to isolated villages and economic development centers at the district level. Therefore, adequate road infrastructure is needed. Roads can be built in various places, but not all places have land with a good bearing capacity to be made as a road.

Various methods have been developed to overcome the problems that occur due to road construction and construction on land that has low bearing capacity. The method of strengthening the soil that is currently developing, generally uses materials sourced from nature and plastic bottle waste. Bus wood is a material that is often found in Merauke Regency, so the price is also relatively affordable. Bus wood has good properties that are used for construction, because it is strong, lightweight, and easy to process. The production of plastic bottles that continues to increase from year to year becomes a problem to be handled. Waste plastic bottles that are not used will accumulate because the material is made of plastic that can not rot, if not utilized or burned it will become garbage that causes pollution and requires a large space.
Various methods of soil improvement can be used, but in choosing the right method, various aspects must be considered, including the location where the work is carried out, the impact on the environment that will be caused, and other factors that must be considered are the economic value and ease of implementation.

2. Methods

2.1. Types of research
This type of research is an experimental study, by testing the material from a combination of wooden bus piles and woven plastic bottles in typical laboratory modeling on soft soils.

2.2. Location of Sampling
The location of this research was conducted at the Civil Engineering Department Laboratory, Faculty of Engineering, Musamus University. The sample soil used came from the Wasur area, Merauke District, Merauke Regency. The bus wood used was a type of white bus wood (Eucalyptus sp) originating from the Sermayam area, District TanahMiring, Merauke Regency. The plastic bottles used are vit / aqua bottles originating from the area around Merauke Regency.

2.3. Method of Implementation
   a. Sample Preparation
      Soil samples were taken from the Wasur area, Merauke District, Merauke Regency. The wood used was bus wood that was often found in Merauke Regency, with a diameter of 4-6 cm. The plastic bottle used is the type of vit / aqua, cut in a circle with a width of 1 cm and then woven into a size of 40 cm x 40 cm.
   b. Preparation of Equipment and Materials
      - Preparation of test equipment for physical and mechanical properties of the soil.
      - Modeling test body: Strengthening the soil model using a tub with dimensions of 120 cm x 60 cm x 50 cm.
      - Hydraulic pump (Hydraulic Jack): to put a load on the plate.
      - Dial indicator (Dial Gauge): to see the value of soil deformation in the test model.
   c. Research Implementation
      - Testing of soil density is adjusted to SNI. [1] The tools used are hot plates, picnometers, ovens, electric scales, spatulas.
      - Testing of water content is adjusted to SNI. [2] The tools used are ovens, cups, electric scales.
      - Testing of grain analysis is adjusted to SNI. [3] The tools used are sieve filters, brushes, electric scales, water hoses, cups.
      - Atterberg boundary testing devices are adjusted to SNI. [3], [4] Test equipment used is casagrande, cup, glass with dimensions of 0.9 cm x 45 cm x 45 cm, spatula, oven.
      - Compaction test equipment adjusted to SNI. [5] The tools used are ovens, standard hammer proctors, standard proctors, electric scales, jacks.
      - We put the subgrade into a basin as high as 35 cm, then add soil to make a 30 x 30 cm road body with a thickness of 3 cm and do a dial installation to see the decline and deformation that occurs in soft soil. After that the testing of scheme 1 is carried out, namely testing the soil without reinforcement of plaits and piles by being loaded using hydraulic tools.
• After completing a loading of 4 KN and the reading of the land dial is dismantled and rearranged for subsequent testing.
• Then in the test scheme 2 the soil is given reinforcement plaited above the soil surface combined with wood pile. First the plaster is plugged into the ground and plaited is placed on it. After that the road body is made, the reading dial is re-installed and tested.
• For testing scheme 3 and scheme 4, the steps are the same as scheme 2, but differ in the depth of the recess. In scheme 3, the tunnel is stuck in a depth of 10 cm and in the scheme of 4 the tunnel is stuck in a depth of 20 cm.

3. Result and Discussions

3.1. Soil Classification
Based on the results of research conducted in the laboratory will be explained data from the results of research on soft soil testing. The soil classification in this test uses the AASHTO classification system. From the test results, the size of the granules that passed the filter no. 200 is 88.38% because it is greater than 35%, it is classified as clay soil, which is the classification of groups A-4 to A-7.

3.2. Soil Properties
   a. Water Content
      From the results of calculations for samples 2 and 3 obtained results respectively 17.65% and 17.50%, so that the average soil water content is 15.22%.
   b. Specific Gravity
      From the calculation results for sample 2, the result obtained was 2.63, so that an average of 2.616 was obtained.
   c. Unit Weight
      From the calculation results unit weights for sample 2 and sample 3 obtained with the results of 1.85 gram / cm3 and 1.85 gram / cm3, so that the average content weight is 1.85 gram / cm3.
   d. Grain size analysis
      The results of the percent lagging obtained are each added to each other so that the cumulative lag percent is obtained and then from the data obtained cumulative passes namely filter no. 4 at 98.6%, no. 8 at 97.54%, no. 10 at 96, 54%, no. 16 is 95.4%, no. 30 is 94.2%, no. 40 is 93.14%, no. 50 is 92.04%, no. 60 is 90.08%, no. 80 at 89.86%, and number 200 at 88.38%.
   e. Atterberg Testing
      From the results of the relationship graph the number of beats and water content obtained liquid limit value (LL) = 44.77%, plastic limit value (PL) = 11.57%. For the plasticity index (PI) values obtained by the formula PI = LL - PL, the Plasticity Index (PI) value = 32.05% is obtained. Looking at the data that has been obtained from the liquid boundary value and the plasticity index value, then using the AASHTO classification, soil types are included in group A-7-6, which is the type of clay soil with the conditions as ordinary to ugly subgrade.
   f. Compaction
      The standard compaction test (proctor standard test) obtained the optimum water content value of wopt = 10.732% and the maximum dry content weight was \( \gamma_d \text{max} = 1.989 \text{ gram / cm3.} \)
3.3. Laboratory Testing Results

From the test results of the land-use model using the force, and by applying the plastic bottle over the bus pile, as well as the variation of pile depths of 10cm, and 20cm, can be seen in the table 1.

**Table 1. Settlement without reinforcement**

| Load (KN) | Deformation Reading (mm) | Settlement Dial (mm) | Deformation Reading (mm) |
|-----------|--------------------------|----------------------|--------------------------|
|           | Dial B | Dial A | Dial 1 | Dial 2 | Dial B | Dial A | Dial 1 | Dial 2 |
| 0         | 0      | 0      | 0      | 0      | 0      | 0      | 0      | 0      |
| 0.5       | 2,40   | 3,50   | -12,19 | 3,45   | 1,47   |
| 1         | 3,05   | 4,84   | -14,50 | 4,84   | 2,00   |
| 1,5       | 3,90   | 5,30   | -17,37 | 5,30   | 2,80   |
| 2         | 4,65   | 6,12   | -19,70 | 6,15   | 3,60   |
| 2,5       | 5,00   | 7,95   | -21,98 | 8,00   | 4,00   |
| 3         | 6,15   | 8,80   | -23,06 | 8,85   | 5,12   |
| 3,5       | 7,00   | 9,61   | -24,57 | 9,63   | 6,05   |
| 4         | 7,93   | 10,22  | -25,89 | 10,20  | 6,89   |
| Distance (cm) | 25 | 20 | 0 | 20 | 25 |

In table 3 above, it can be seen that the deformation that occurs with a 4 kN load on the unweighted soil is -25.89 mm. Deformation that occurs can be seen in Figure 1.

**Figure 1. Graph of soil without reinforcement**

Deformation reading that occur on dial 1 are 10.20 mm, dial 2 deformations that occur at 6.89 mm, dial A deformation that occurs at 10.22 mm, and on dial B deformation that occurs at 7.93 mm.

**Table 2. Settlement with strengthening bottle woven and a wooden pile**

| Load (KN) | Deformation Reading (mm) | Settlement Dial (mm) | Deformation Reading (mm) |
|-----------|--------------------------|----------------------|--------------------------|
|           | Dial B | Dial A | Dial 1 | Dial 2 | Dial B | Dial A | Dial 1 | Dial 2 |
| 0         | 0      | 0      | 0      | 0      | 0      | 0      | 0      | 0      |
| 0.5       | 0,64   | 0,93   | -2,74  | 0,96   | 0,67   |
| 1         | 0,86   | 1,05   | -4,80  | 1,02   | 0,85   |
| 1,5       | 1,05   | 1,81   | -5,95  | 1,80   | 1,04   |
| 2         | 2,32   | 2,37   | -6,12  | 2,65   | 2,30   |
| 2,5       | 2,87   | 3,16   | -7,28  | 3,15   | 2,84   |
| 3         | 3,26   | 3,55   | -7,83  | 3,46   | 3,27   |
| 3,5       | 3,84   | 3,99   | -8,10  | 4,25   | 3,88   |
| 4         | 4,09   | 4,35   | -8,68  | 4,47   | 4,30   |
| Distance (cm) | 25 | 20 | 0 | 20 | 25 |
In table 2 above, it is known that the deformation that occurs with a load of 4 kN on the soil which is given the reinforcement of woven plastic bottles over a wooden pile is -8.68 mm. Deformation that occurs can be seen in Figure 2.

![Figure 2. Graph of soil with reinforced woven bottles on a wooden pile](image)

Deformation reading that occur on dial 1 are 4.47 mm, dial 2 deformations occur 4.30 mm, dial A deformation occurs 4.35 mm, and on dial B deformation occurs 4.09 mm.

### Table 3. Settlement with strengthening bottle woven on wood pile at a depth of 10 cm

| Load (KN) | Deformation Reading (mm) | Settlement Dial (mm) | Deformation Reading (mm) |
|-----------|--------------------------|----------------------|--------------------------|
|           | Dial B | Dial A |                  | Dial 1 | Dial 2 |                  |                  |
| 0         | 0      | 0      | 0                 | 0       | 0      | 0                 |
| 0.5       | 0.83   | 1.15   | -4.74             | 1.18    | 0.85   |                  |
| 1         | 1.12   | 1.96   | -6.80             | 1.97    | 1.15   |                  |
| 1.5       | 1.58   | 2.23   | -7.95             | 2.23    | 1.60   |                  |
| 2         | 2.43   | 2.89   | -10.12            | 2.88    | 2.42   |                  |
| 2.5       | 2.95   | 3.35   | -11.28            | 3.33    | 2.94   |                  |
| 3         | 3.43   | 4.01   | -12.75            | 4.02    | 3.41   |                  |
| 3.5       | 4.02   | 4.61   | -13.88            | 4.58    | 4.00   |                  |
| 4         | 4.48   | 5.23   | -14.35            | 5.23    | 4.49   |                  |
| Distance (cm) | 25 | 20 | 0 | 20 | 25 |

In table 3 above, it is known that the deformation that occurs with a 4 kN load on the soil which is given a plastic bottle reinforcement above a wooden pile of depth of 10 cm is - 14.35 mm. Deformation that occurs can be seen in Figure 3.
Deformation reading that occur on dial 1 are 5.23 mm, dial 2 deformations that occur at 4.49 mm, dial A deformation that occurs at 5.23 mm, and on dial B deformations that occur at 4.48 mm

Table 4. Settlement in strength of bottle woven on wood pile at a depth of 20 cm

| Load (KN) | Deformation Reading (mm) | Settlement Dial (mm) | Deformation Reading (mm) |
|-----------|--------------------------|----------------------|--------------------------|
|           | Dial B | Dial A |                     | Dial B |                   |
| 0         | 0      | 0      | 0                    | 0      | 0                   |
| 0.5       | 0.99   | 1.36   | -5.34                | 1.35   | 0.96                |
| 1         | 1.68   | 2.03   | -7.97                | 2.00   | 1.66                |
| 1.5       | 1.77   | 2.49   | -9.69                | 2.48   | 1.75                |
| 2         | 2.70   | 2.92   | -11.85               | 2.91   | 2.68                |
| 2.5       | 3.12   | 3.47   | -12.09               | 3.47   | 3.11                |
| 3         | 3.52   | 4.18   | -13.77               | 4.19   | 3.51                |
| 3.5       | 4.29   | 4.75   | -14.16               | 4.73   | 4.25                |
| 4         | 4.93   | 5.48   | -15.62               | 5.44   | 4.92                |
| Distance (cm) | 25      | 20     | 0                    | 20      | 25                  |

In table 4 above, it is known that the deformation that occurs with a 4 kN load on the soil which is given a plastic bottle reinforcement and a wooden buspipe depth of 20 cm is - 15.62 mm. Deformation that occurs can be seen in Figure 4.

Figure 3. Graph of Soil with reinforced woven bottles and wooden pile at a depth of 10 cm

Figure 4. Graph of soil with reinforced woven bottles on a wooden pile at a depth of 20 cm
Deformation reading that occur on dial 1 are 5.44 mm, dial 2 deformation occurs 4.92 mm, dial A deformation occurs 5.48 mm, and on dial B deformation occurs 4.93 mm.

3.4. Discussion
Based on the analysis of laboratory testing results obtained data for the settlement that occurred in the soil, it is known that the settlement that occurred in the soil that was not reinforced with a load of 4 kN was 25.89 mm, while the settlement that occurred in the soil that was reinforced using woven plastic bottles and bus wood piles on the subgrade and variations in depth of 10 cm and 20 cm with the same load of 4 kN each of 8.68 mm, 14.35 mm and 15.62 mm. Thus, the smallest reduction in the 4kN load-bearing soil occurs in reinforced soils using woven plastic bottles on a wooden pile with a value of 8.68 mm.

4. Conclusion
Based on the results of tests in the laboratory, the use of reinforcement from woven plastic waste materials and wood piles affects the soil deformation that occurs. The use of plastic bottle waste woven reinforcement on wood piles experienced the smallest deformation compared to the use of woven plastic bottle waste and wood piles placed at a depth of 10 cm and 20 cm from the ground surface.

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