Study of soft soil reinforcement using woven waste plastic bottles

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Abstract, The construction of infrastructure on the ground that the carrying capacity is low resulting in a huge drop and lateral movement. Various methods have been developed to overcome these problems, particularly with the method of waste utilization. Therefore, the authors wanted to determine the effect of the use of woven plastic bottle waste on soil with low bearing capacity using experimental research methods. Testing is done by looking at the deformation that occurs in the soft ground without reinforcement and by reinforcement using woven plastic bottles tier 1 and tier 2. From the test results on the ground deformation that is not given retrofitting a load of 4 kN is 45.5mm, whereas by strengthening the use of woven plastic bottles tier 1 and tier 2 with the same load of 4 kN is 41.60mm and 38.20mm, so it can be concluded that the ground by reinforcement ply weaved plastic bottle 1 has increased by 9.38% strength and for woven layer 2 by 19.11% against the vertical deformation that occurs. Judging from the patterns of deformation modeling results is included in the pattern of local shear failure.

1. Introduction
Soil that has a lower carrying capacity also called soft ground, in this case, water is a very important effect on the characteristics of the soil properties. Soft ground with a dry mass has a greater carrying capacity but will behave plastically when added to water, it will cause a nuisance or problem in a variety of construction is because of the levels of development of shrinkage of the land is large enough. There are already many methods or ways to cope with a disorder or problem that can occur in a construction which is at a ground with a low bearing capacity. Various methods to overcome this problem as the use of a geo synthesis, mixing the soil or by replacing the material, the use of cerucuk, and also some materials from nature or from the utilization of waste. It is expected that the use of woven plastic bottle waste can reduce deformation and can increase the carrying capacity of the land.

2. Methods
2.1. Sample preparation and testing
Soil samples were collected from the area Wasur, Merauke District, Merauke. Plastic bottles used a type of vit/aqua, in a circular piece with a width of 1 cm then woven into a size of 40 cm x 40 cm. Testing tools used are:
1. Preparation of test tools on the physical and mechanical properties of the soil.
2. Test basins modeling: Model soil reinforcement using air bath dimensions of 120 cm x 60 cm x 50
cm.
3. Hydraulic pump: to provide a load on the plate.
4. Dial indicators: to see the value of the land deformations.
5. Manometer: to see the pressure that will be given on the ground.

2.2. Implementation research
Testing of physical and mechanical characteristics of soil testing moisture content [1], density[2], Atterberg [3,4], bulk density, compaction [4], sieving, and hydrometer [5].

Modelling of Soil Testing ground that basis we enter into a bath of 30 cm height, then add soil piled as high as 10 cm. Place the webbing at a height of 20 cm and 30 cm from the bottom of the tub. In this test, there are 3 schemes were created, namely: 1 without reinforcement matting scheme, Scheme 2 using woven layers 1, scheme 3 using a woven layer 2.

(a) scheme 1

Figure 1. Scheme 1 model of retrofitting without webbing
In the first scheme of testing without reinforcement after the tub filled subgrade as high as 30 cm, then filled with soil embankment was added to the test basin is 10 cm. Plate bearing placed in the middle ground is then weighted using a hydraulic pump. For the placement position of the dial A is above the plate serves to see a decline, dial 1 is positioned 30 cm to the left of the middle of the plate bearing. Dial 2 placed 45 cm to the left of the middle of the plate bearing, dial 3 is placed 30 cm to the right from the middle of the plate bearing, dial 4 placed 45 cm to the right of the center bearing plate. Dial 1 to 4 to see the value of deformation.

(b) Scheme 2

![Diagram of Scheme 2 models with woven reinforcement ply 1](image)

**Figure 2.** Scheme 2 models with woven reinforcement ply 1

In the modelling scheme 2, by using a woven reinforcement ply 1 first we remove the soil piled inside the tub, after the soil piled remove it's set back subgrade already in the test, after the conditions are ready for the test we put the woven plastic bottles tier 1 with dimensions of 40 cm x 40 cm above the ground base and placed in the middle of testing tub. Then we re-enter the soil piled on the vessel to a height of 10 cm. For placement plate and dial 1, 2, 3, and 4 is the same as testing scheme without retrofitting.
(c) Scheme 3

![Diagram of Scheme 3](image)

**Figure 3.** Schematic three-tier model of retrofitting with webbing 2.

For the third scheme testing using webbing reinforcement layer 2 first we remove the soil up to 10 cm below the woven layer 1 test we have before, then we put the retrofitting by adding 1 layer of woven exactly 10 cm below the basket on the first layer. And the placement of the dial plate and still the same as testing according to scheme 1 and 2.

3. **Result and discussion**

From the results of laboratory testing, in getting the results of the load reduction and the reading dial to deformation.

3.1. **Testing modeling**

(a) Subsidence of the load

| Distance (cm) | Load 1 kN | Load 2 kN | Load 3 kN | Load 4 kN | Information       |
|--------------|-----------|-----------|-----------|-----------|-------------------|
| 0            | -27.5     | -36.5     | -40.3     | -45.5     |                   |
| -15          | -27.5     | -36.5     | -40.3     | -45.5     | readings decline  |
| 15           | -27.5     | -36.5     | -40.3     | -45.5     |                   |
| Distance (cm) | Decrease (mm) | Information          |
|--------------|---------------|----------------------|
|              | Load 1 kN     | Load 2 kN            | Load 3 kN | Load 4 kN |
| 0            | -24.5         | -34.15               | -37.15    | -41.60    |
| -15          | -24.5         | -34.15               | -37.15    | -41.60    |
| 15           | -24.5         | -34.15               | -37.15    | -41.60    |
| -30          | 1.25          | 2                    | 2.7       | 4.3       |
| -45          | 1.1           | 2                    | 2.6       | 3.8       |
| 30           | 1.2           | 1.96                 | 2.56      | 4         |
| 45           | 1             | 1.8                  | 2.5       | 3.2       |

**Table 2. Increase the ground with webbing reinforcement ply 1.**

| Distance (cm) | Decrease (mm) | Information          |
|--------------|---------------|----------------------|
|              | Load 1 kN     | Load 2 kN            | Load 3 kN | Load 4 kN |
| 0            | -22.25        | -34.45               | -36.30    | -38.20    |
| -15          | -22.25        | -34.45               | -36.30    | -38.20    |
| 15           | -22.25        | -34.45               | -36.30    | -38.20    |
| -30          | 0.7           | 1.3                  | 1.8       | 2.85      |
| -45          | 0.9           | 1.1                  | 1.94      | 3.1       |
| 30           | 0.57          | 0.9                  | 1.76      | 2.89      |
| 45           |               |                      |           |           |

**Table 3. Increase the ground with webbing reinforcement layer 2.**

**Table 4. Readings dial deformation without retrofitting.**

| Load (kN) | Reading reduction | reading deformation |
|-----------|-------------------|---------------------|
|           | dial 1 | dial 2 | dial 3 | dial 4 |
| 0         | 0.00   | 0      | 0      | 0      |
| 0.5       | 19.2   | 0.6    | 0.47   | 0.52   | 0.4 |
| 1         | 27.5   | 1.4    | 1.2    | 1.35   | 1.18 |
| 1.5       | 30.7   | 1.86   | 1.62   | 1.73   | 1.5 |
| 2         | 36.5   | 2.6    | 2.2    | 2.55   | 2.15 |
| 2.5       | 38     | 2.87   | 2.56   | 2.70   | 2.24 |
| 3         | 40.3   | 3      | 2.90   | 2.97   | 2.70 |
| 3.5       | 43.1   | 4.1    | 3.7    | 3.7    | 3.38 |
| 4         | 45.5   | 5.7    | 4.8    | 5.6    | 4.4 |

**Table 5. Readings dial deformation with webbing reinforcement ply 1.**

| Load (kN) | Reading reduction | reading deformation |
|-----------|-------------------|---------------------|
|           | dial 1 | dial 2 | dial 3 | dial 4 |
| 0         | 0.00   | 0      | 0      | 0      |
| 0.5       | 15.3   | 0.4    | 0.38   | 0.34   | 0.32 |
| 1         | 24.5   | 1.25   | 1.10   | 1.2    | 1     |
| 1.5       | 28.4   | 1.67   | 1.43   | 1.54   | 1.33 |
| 2         | 34.15  | 2.10   | 2      | 1.96   | 1.8   |
| 2.5       | 35     | 2.49   | 2.36   | 2.35   | 2.2   |
| 3         | 37.15  | 2.70   | 2.6    | 2.56   | 2.5   |
| 3.5       | 39.1   | 3.20   | 3      | 3.10   | 2.99 |
Table 6. Dial readings deformation with webbing reinforcement layer 2.

| Load (kN) | reading Decrease | reading deformation | dial 1 | dial 2 | dial 3 | dial 4 |
|-----------|------------------|---------------------|-------|-------|-------|-------|
| 0        | 0.00             | 0                   | 0     | 0     | 0     | 0     |
| 0.5      | 14.20            | 0.28                | 0.22  | 0.21  | 0.19  |       |
| 1        | 22.25            | 1                   | 0.70  | 0.90  | 0.57  |       |
| 1.5      | 26.7             | 1.33                | 1.07  | 1.02  | 0.81  |       |
| 2        | 34.45            | 1.60                | 1.30  | 1.38  | 0.90  |       |
| 2.5      | 35               | 1.87                | 1.49  | 1.73  | 1.22  |       |
| 3        | 36.30            | 2                   | 1.80  | 1.94  | 1.76  |       |
| 3.5      | 37.60            | 3.10                | 2.10  | 2.68  | 2.00  |       |
| 4        | 38.20            | 3.89                | 2.85  | 3.10  | 2.89  |       |

From the results of testing models of reinforcement have been obtained combined data for the deformation that occurs in the land, among which are Scheme 1 retrofitting without using matting, Scheme 2 reinforcement using woven plastic bottles tier 1, scheme 3 reinforcement using woven plastic bottles tier 2.

![Figure 4. Graph deformation on load 1 kN](image-url)
Figure 5. Graph deformation on load 2 kN

Figure 6. Graph of deformation of the load 3 kN

Figure 7. Graph deformation on load 4 kN
4. Conclusion
From the analysis of laboratory test results, it is concluded that woven plastic bottles can be used as a soil reinforcement material base its carrying capacity is low, as it can reduce the deformation that occurs in the soil. It is known that the deformation of the ground without reinforcement webbing with a load of 4kN is 45.5 mm, while the use of woven wicker bottle tier 1 and tier 2 with the same load of 4 kN respectively by 41.60 mm and 38.20 mm. It was concluded that the soil with webbing reinforcement layer bottle 1 has increased by 9.38% and the strength of woven ply 2 at 19.11% against vertical deformation that occurs. Judging from the pattern of deformation modeling the results of the tests are included in the pattern collapse Local shear.

References
[1] Anon 1990 Kadar Air Tanah Sni 03-1965-1990 1990
[2] SNI 03-1964 2008 Berat Jenis Tanah 1–14
[3] SNI 03-1966 1990 Batas Plastis dan Indeks Plastis
[4] SNI 03-1742 1989 Kepadatan Tanah 1–9
[5] Pusat Penelitian dan Pengembangan Jalan dan Jembatan 1990 Metode Pengujuan Analisis Saringan Agregat Halus dan Kasar. SNI 03-1968-1990 Bandung Badan Stand. Indones. 1–17