Soft Soil Stabilization With Rice Husk Ash and Glass Powder Based on Physical Characteristics

D P Kusumastuti*, I Sepriyanna

1Sekolah Tinggi Teknik PLN, Menara PLN Jalan Lingkar Luar Barat, Duri Kosambi, Cengkareng, Jakarta Barat, Indonesia

*dyah.pratiwi@sttpln.ac.id

Abstract. Soft soil has poor characteristics when used as part of construction. This is because soft soil generally has low bearing capacity, large changes due to settlement and compression and high water content. Efforts to improve soil, especially soft soil using chemical stabilization methods or by adding materials, are one of the best and most applied solutions. The selection of the good material will affect the results of stabilization so that the objectives to improve physical characteristics, especially water content and consistency limits on soft soil will be fulfilled. Rice husk ash and glass powder as stabilizers in soft soil can change physical characteristics, especially water content and consistency limits. Based on the results of the study, rice husk ash and glass powder were able to reduce water content, liquid limit and plastic limit and increase the soft soil shrinkage limit test results.

1. Introduction

Soil is useful as a construction material in various types of Civil Engineering work, besides that the soil also functions as a support for the foundation of the building [1]. Soil is a material that is very influential on the stability of building structures, such as building structures, highway pavements, tunnels, dams, etc [2]. However, not all soil can be directly used in Civil Engineering work, this is because some soil has a low bearing capacity, large deformations or changes and a large enough water content that affects the consistency of the soil.

Soft soil is one type of soil that has a low bearing capacity [3], if given a load on it will result in a very significant decrease in the occurrence of a non-uniform decline [4]. To overcome or reduce the problem of construction that is erected on soft soil is to make soil improvement. The method of soil improvement that is generally applied to soft soil is stabilization. Soil stabilization is an attempt to change or improve the technical characteristics of the soil to meet certain technical requirements [5]. In general there are two ways of soil stabilization, namely by mechanical stabilization and chemical stabilization [6].

Cheap and effective stabilization in soft soil is to add certain chemicals [7]. Chemicals commonly used are cement, lime, fly ash [5] and other materials characterized by pozzolan so that it can produce cementation processes [8]. In this study, chemical stabilization of soft soil was carried out using rice husk ash and glass powder. The selection of rice husk ash as stabilization material because rice husk ash can fill the cavities that exist between the droplets of soil [9] and contains a lot of silicate elements (SiO₂) and aluminate (Al₂O₃) so it is categorized as pozzolan [10]. While the glass powder used is waste from glass fragments which are then crushed into powder. Broken glass which becomes
powder has silica content (SiO₂) [5][11], Na₂O and CaO which is quite large which is more than 70% [11]. Addition of husk ash and glass powder as a soft soil stabilator in this study will be reviewed changes in physical characteristics, especially water content and consistency limits, because generally soft soils have a high water content.

2. Research Methods

Research is experimental with a laboratory scale so that research is carried out at the Soil Mechanics Laboratory, Civil Department, Sekolah Tinggi Teknik PLN. The soil used is an example of soft soil disturbed. Soft soil samples were treated with the addition of rice husk ash with a percentage 0%, 2.5%, 5%, 7.5%, 10% and glass powder with a percentage 10%. The stages of research are generally divided into 3 stages, namely:

2.1. Preparation

The first thing to do at the preparation stage is to look for information through literature studies that fit the research topic with research needs, then prepare laboratory equipment used, namely measuring water content and consistency limits tests. Preparing the material used, namely soft soil as an example of disturbed soil, rice husk ash and glass powder.

Samples of disturbed soft soil used in this study were taken at a depth of 20 - 100 cm with a little waterlogged conditions in the rainy season. The sampling location for soft soil is in the PLN Substation, Duri Kosambi, Cengkareng, West Jakarta, Indonesia.

2.2. Implementation

The implementation stage consists of making and testing the test object. Making test specimens is carried out in the laboratory by preparing initial soft soil and soft soil stabilized with rice husk ash and glass powder. The specimens were made each variation of the addition of stabilator material on soft soil and soft initial soil as many as 3 pieces. Each specimen will be tested by the same method and treatment.

Testing is done to see the physical characteristics of soft soil, through testing moisture content and consistency limits. Testing the consistency limits of soft soil consists of testing the liquid limit, plastic limit and shrinkage limit.

2.3. Analysis

Stages of analysis are the final stages of the research conducted. Stages of analysis are carried out after a series of tests and data collection have been completed. Changes in physical characteristics, especially water content and the consistency limits of the initial soft soil and soft soil stabilized with rice husk ash and glass powder will be presented in the form of tables and graphs.

3. Result and Discussion

To facilitate the reading of the test results in the study, each soil sample is given a simple code that is sample 1 for original soil or initial soil, sample 2 for initial soil + 10% glass powder, sample 3 for initial soil + 10% glass powder + 2.5% rice husk ash, sample 4 for initial soil + 10% glass powder + 5% rice husk ash, sample 5 for initial soil + 10% glass powder + 7.5% rice husk ash and sample 6 for initial soil + 10% glass powder + 10% rice husk ash.

3.1. Water Content Test, w

Water content in the soil becomes a factor that affects the consistency and plasticity of the soil [12]. Water content is the ratio between the weight of the water and the weight of the soil. The weight of water used in the calculation of water content testing is the difference from the weight of the grain before and after drying in the oven for 24 hours. The results of water content testing are shown in Table 1.
### Table 1. Water Content (w) Test Results

| Code Sample | Water Content, w (%) |
|-------------|----------------------|
| Sample 1    | 55.928               |
| Sample 2    | 46.460               |
| Sample 3    | 45.243               |
| Sample 4    | 43.476               |
| Sample 5    | 42.220               |
| Sample 6    | 40.534               |

Based on Table 1, it can be seen that the addition of glass powder stabilizer and rice husk ash to soft soil affects changes in water content. The more stabilator ingredients are added, the lower the water content. The initial soil water content is reduced by 9.468% when 10% of rice husk ash is added, and is reduced by 15.394% when added by 10% rice husk ash and 10% glass powder.

#### 3.2. Consistency Limits Tests

The consistency of soft soil, especially in clay soil, will change with changes in water content. Clay will become softer if the water content increases and conversely it will harden and crack if the water content decreases [13]. Testing the consistency limits is carried out through 3 stages, namely liquid limit testing, plastic limit testing and shrinkage limit testing. The results of testing the consistency limits are shown in Table 2.

### Table 2. Consistency Limits Test Results

| Code Sample | Liquid Limit (%) | Plastic Limit (%) | Shrinkage Limit (%) |
|-------------|------------------|-------------------|---------------------|
| Sample 1    | 72.878           | 61.544            | 18.54               |
| Sample 2    | 67.314           | 47.198            | 22.95               |
| Sample 3    | 67.08            | 44.537            | 24.74               |
| Sample 4    | 66.743           | 44.506            | 25.14               |
| Sample 5    | 65.172           | 44.237            | 33.11               |
| Sample 6    | 62.413           | 40.652            | 35.15               |

Based on Table 2, there is a decrease in liquid limit and plastic limit along with the addition of stabilizers, namely rice husk ash and glass powder, where the lowest liquid limit value is 62.413% and the plastic limit is 40.652% in the original soil sample with the addition of 10% glass powder and 10% rice husk ash. In contrast to shrinkage limits, the more stabilizers (rice husk ash and glass powder) are added to the soft soil, the shrinkage limit value increases. The biggest shrinkage limit is 35.15% which is obtained by adding 10% stabilizer of glass powder and 10% rice husk ash or increasing by 16.61% compared to the initial soft soil.

The increase in shrinkage limit value is caused by the decrease in the content or moisture content in the soft soil due to the addition of stabilizers, namely glass powder and rice husk ash. Rice husk ash and glass powder absorb water which initially fills the pore space in soft soil, resulting in soft soil becoming more dense so that mercury is spilled during testing the shrinkage limit is more or more heavy.
3.3. Discussion

Based on the results of testing the physical characteristics of soft soil, it is seen that the addition of rice husk ash and glass powder greatly influences physical characteristics, especially water content (Figure 1) and consistency limits (Figure 2).

![Figure 1. Water Content (w) Test Results](image)

Based on Figure 1, that soft soil water content decreases with increasing and varying the stabilator material. The initial soft soil water content is 55.928% and the lowest water content is 40.534% which is obtained by adding 10% glass powder and 10% rice husk ash or decreasing by 27.52% compared to the initial soft soil moisture content. Glass powder and rice husk ash added to soft soil can function to absorb water so that soft soil characteristics become more rigid and dense.

![Figure 2. Consistency Limits Test Results of Stabilization Soft Soil with Rice Husk Ash and Glass Powder](image)

Based on Figure 2, the addition of stabilizer materials, namely glass powder and rice husk ash greatly influences the soft soil consistency limits. Liquid limits and plastic limits decrease with
increasing and varying stabilizer materials. This also strengthens changes in water content (Figure 1) which occurs in soft soil stabilized by glass powder and rice husk ash. In addition to reducing water content, glass powder and rice husk ash as stabilizers can also reduce liquid limits and plastic limit soft soil.

Conversely from shrinkage limit test result, the addition of rice husk ash and glass powder stabilizer material will increase the soft soil shrinkage limit. Increasing shrinkage limit in soft soil along with the addition and variation of glass powder and rice husk ash. The shrinkage limit in initial soft soil of 18.54% increased to 35.15% or increased by 89.59% compared to shrinkage limit of initial soft soil.

Increasing shrinkage limit is also influenced by changes in pore space in soft soil. Initially the initial soft soil pore space is filled with water and air, after the addition of the rice husk ash and glass powder stabilizer material, the rice husk ash will absorb the water stored in the soil pore space and urge the air to escape. This causes soft soil stabilized by glass powder and rice husk ash to become more rigid and dense.

4. Conclusion
Based on the results of the previous analysis and discussion, it can be concluded that the addition of glass powder and rice husk ash as a stabilator material greatly affects the water content and the consistency limits of soft soil. As a result of the stabilization of soft soil with the addition of glass powder and rice husk ash causes water content, liquid limit and plastic limit to decrease. Where the lowest result of water content, liquid limit and plastic limit on the stabilized soft soil was obtained at the addition of 10% glass powder and 10% rice husk ash. Conversely due to the stabilization of soft soil with glass powder and rice husk ash, the soft soil shrinkage limit increases. The biggest shrinkage limit was obtained by adding 10% glass powder and 10% rice husk ash.

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