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Analysis of medium characteristic based on grain size Gua Mimpi Maros Karst Region Bantimurung – Bulusaraung National Park

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Abstract. Research about Analysis of Medium Characteristic Based on Grain Size Gua Mimpi Maros Karst Region Bantimurung-Bulusaraung National Park. Sample of the research location in Gua Mimpi on the cave floor, which divided into 6 trajectories with a distance of 100 meters each trajectory that starts from the mouth of Gua Mimpi. The width of the cave is divided into three points. Soil samples taken from the research location are then tested in a laboratory to obtain the value of soil grain size and soil permeability. Based on the results of physical soil tests that have been carried out, it is known that the grain size of the soil obtained from the research results is a type of soil dust to very coarse sand with a diameter of (0.002 - 2.0) mm. Obtained by hydraulic conductivity that is equal 3.75×10^{-4} cm/s, large and small value of the permeability of the soil obtained. The permeability value of the soil obtained at each sampling point is different, with the average permeability coefficient of the soil is 3.75 $\times 10^{-5}$ cm/s which means the ability of the soil to pass water to the Gua Mimpi is slow.

1. Introduction

Indonesia has a region with various kinds of landscapes and one of them is the karst area. The karst area has typical relief and drainage characteristics, mainly due to the higher degree of dissolution of rocks in water when compared to other regions [6]. One of the karst areas in Indonesia is in the province of South Sulawesi, namely the Maros Karst mountain - Pangkep. The Maros Karst region has 268 caves scattered in the protected forest areas of Pattunuang and Karaengta, Maros Regency, of which there are 18 artifacts [7]. Of the 268 caves, two of them are found in Bantimurung - Bulusaraung National Park, namely Gua Batu and Gua Mimpi.

The Karst area of the Bantimurung - Bulusaraung National Park (BaBul National Park) is a limestone mountain which has many unique and quite unique potentials. These characteristics invite many people from various disciplines. For this reason, a systematic effort is needed to maintain its sustainability, manage and utilize it for various purposes.

The karst formation genesis in terms of soil physical properties in Gua Mimpi, namely soil permeability has a good content with a scale of 10-100 mD [8]. The permeability (k) coefficient cannot stand alone, but there are several variables that influence each other, including those affected by porosity and density. Permeability can be measured using a permeameter.

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Permeability research on the ground floor of Gua Mimpi needs to be done. The method used in soil permeability research is the falling head permeability method, because the soil from the Gua Mimpi floor is clay that has fine grains. The fine and coarse grains of the soil can be tested by a sieve analysis method which is used to analyze the percentage of grain weight that passes from a set of Sieves at a certain size, then cumulative percentage passes are illustrated on a grain size distribution graph.

For this reason, the purpose of this study is to describe the size of the soil grain, determine the price of soil hydraulic conductivity, and determine the permeability price of soilin Gua Mimpi Maros Karst Region Bantimurung - Bulusaraung National Park.

2. Experimental

2.1. Sampling

Gua Mimpi has a length or depth of cave ± 800 m. For sampling points, the Gua Mimpi floor is divided into 6 trajectories with a distance of 100 meters each track, starting from the mouth of Gua Mimpi. The width of the cave is divided into three points. The sampling points were carried out on the right, middle and left sides of the cave width. Soil samples taken from Gua Mimpi floor using sample tubes. The sample tube is immersed 20 cm deep from the ground surface with 6 trajectories with a distance of 100 m per track.

2.2. Physical Test Procedure

2.2.1. Soil grain size testing

Soil grain size testing based on ASTM D - 421 - 85. The testing of soil grain size is intended to determine the coarse grain and fine grain of the soil by using a sieve.

2.2.2. Soil permeability testing

The method used is the falling head permeability method. The soil testing procedure refers to ASTM D – 5084.

2.3. Sample Physical Test Analysis

2.3.1. Soil grains size

- Calculate the weight of the soil held in each Sieve.
- Soil that passes the Sieve cumulatively.
- Calculate the percentage of the amount of soil that passes through the Sieve to the total weight of the soil.
- Test data are prepared and displayed in tables and a graph that is the relationship between Sieve size and cumulative percent pass.

2.3.2. Soil permeability

Soil samples that have been tested for soil grain size will then be analyzed using equation (1), while the conductivity price uses equation (2):

$$k = \frac{K\eta}{\rho g} \quad (1)$$

The hydraulic conductivity value using the following equation [9]:

$$K = \left[\frac{aL}{At} \ln \frac{h_1}{h_2} \right] cm/s \quad (2)$$

3. Results and Discussion

3.1. Research Result

The results of the study on the physical properties of Gua Mimpi soil in the Maros Karst area of Bantimurung - Bulusaraung National Park, namely the results of soil grain size test, hydraulic conductivity, and soil permeability coefficient can be seen as follows:

3.1.1. SoilGrainSize of Gua Mimpi

The following is the result of testing the size of the soil grain by using a Sieve on several soil samples which illustrates the graph of the sieve size relationship with cumulative pass percentage:

- Soil sample point f.1

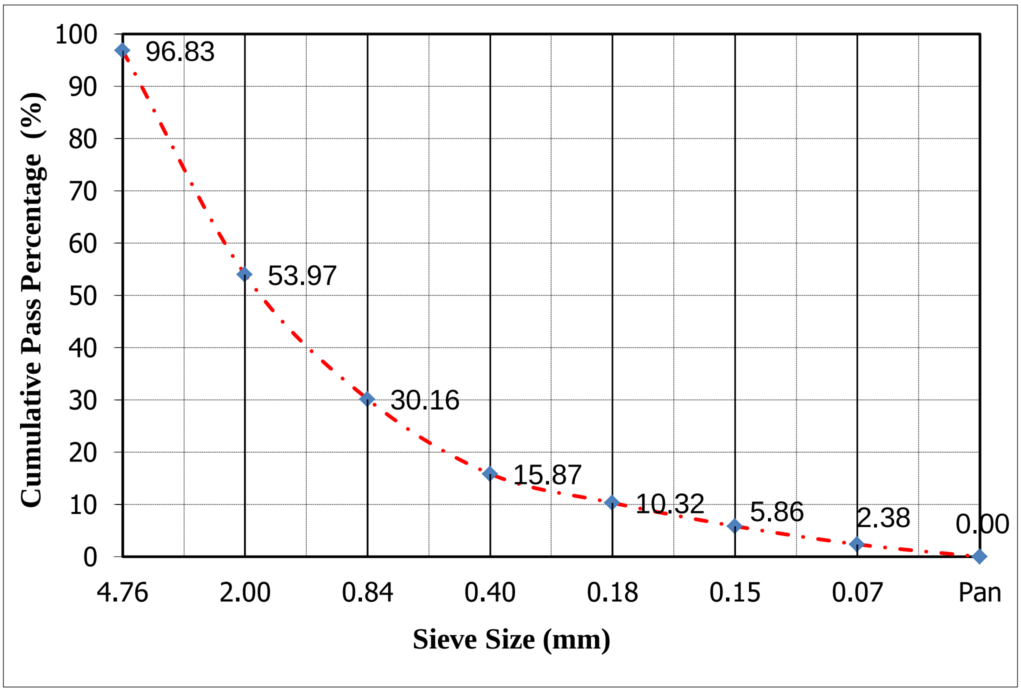

Figure 1. Relationship between Sieve Size and Cumulative Pass Percentage on Soil Sample Pointf.1

Figure 1 above illustrates the graph of sieve size and cumulative percentage of soil samples with a sample code point f.1. The type of soil obtained is very coarse sand with a diameter of 2.00 mm, coarse sand with a diameter of 0.84 mm, medium sand with a diameter of 0.40 mm, fine sand with a diameter of (0.15 – 0.18) mm and dust with a diameter 0.07 mm. Cumulative percentages were 53.93%, 30.16%, 15.87%,(5.86 - 10.32) %, and 2.38% respectively. It can be seen that the (0.07 - 0.4) mm sieve size has a cumulative range of pass percentage values that are close enough so that the lines on the graph depicted are irregular.

- Soil sample point f.2

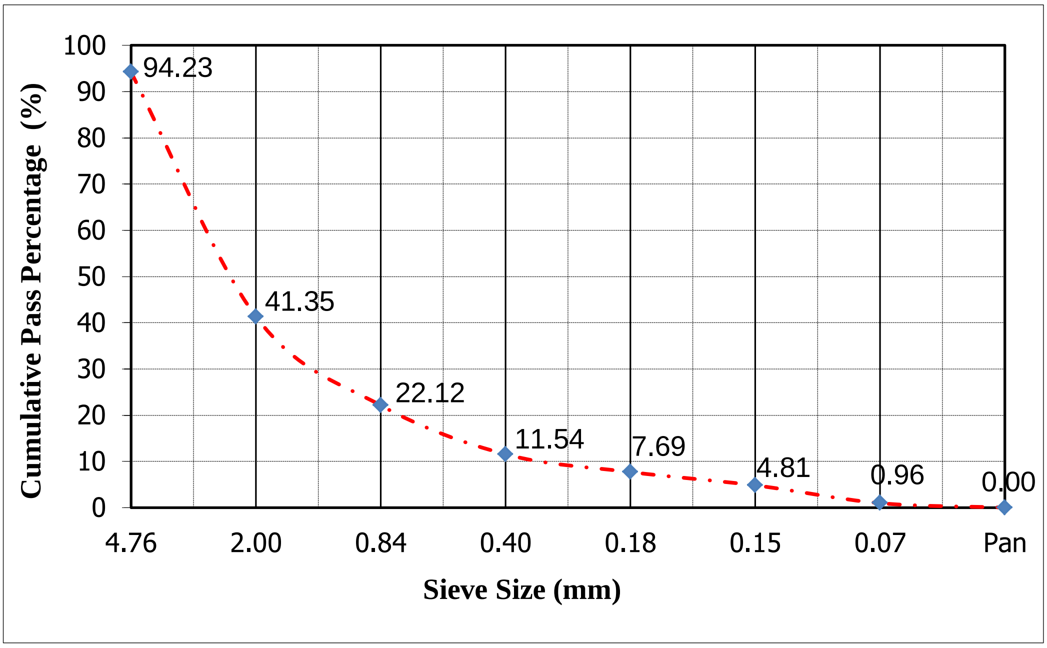

Figure 2. Relationship between Sieve Size and Cumulative Pass Percentage on Soil Sample Point f.2

Figure 2 is a graph that illustrates the relationship between Sieve size and cumulative pass percentage on the ground with point sample code f.2. The results obtained that in the soil sample point f.2 there is a type of very coarse sand soil with a diameter of 2.00 mm, coarse sand with a diameter of 0.84 mm, medium sand with a diameter of 0.40 mm, fine sand with a diameter of (0.15 – 0.18) mm, (4.81 – 7.61)%, and 0.96% respectively. Cumulative percentage obtained is smaller than the cumulative percentage value in the previous graph. The size of the Sieve with one another has a fairly close range so that the graph shown looks different from the graph in the soil sample f.1.

- Soil sample point f.3

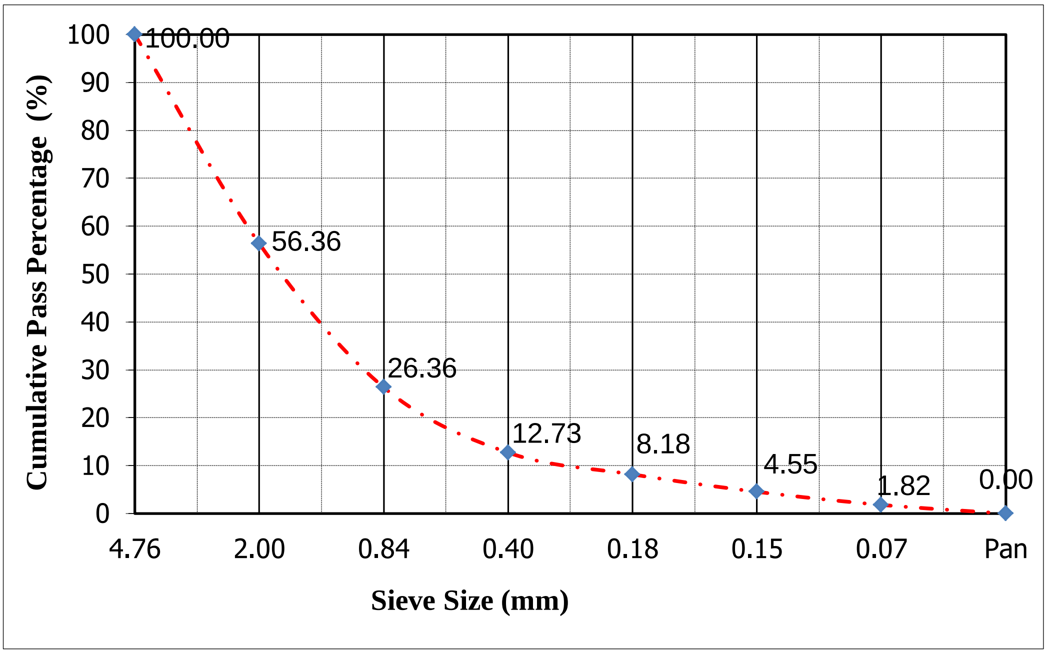

Figure 3. Relationship between Sieve Size and Cumulative Pass Percentage on Soil Sample Point f.3

Figure 3 above shows a graph of the relationship between sieve size and cumulative pass percentage on the results of the soil grain size test with a sample code point a.3. The type of soil obtained is very coarse sand with a diameter of 2.00 mm, coarse sand with a diameter of 0.84 mm, medium sand with a diameter of 0.40 mm, fine sand with a diameter of (0.15 – 0.18) mm, and dust with a diameter 0.07 mm. The cumulative percentages were 56.36%, 26.36%, 12.73%, (4.55 - 8.18) %, and 1.82%. The graph in the soil sample a.3 has a graph that is almost the same as the graph in figure 4.1. The value range between the size of the Sieve with one another is quite far, but at a certain Sieve size has a fairly close range of values.

3.1.2. Soil Hydraulic Conductivity of Gua Mimpi

The results of the study of hydraulic conductivity of the floor of the Gua Mimpi floor can be seen in the Table 1.

Table 1. Soil Hydraulic Conductivity Value of Gua Mimpi

Sample Code	Density (gr/cm^3)	K (cm/s)
Point a.1	2.30	1.68×10^{-7}
Point a.2	2.29	1.76×10^{-7}
Point a.3	1.87	1.74×10^{-7}
Point b.1	1.87	2.75×10^{-7}
Point b.2	1.83	2.90×10^{-7}
Point b.3	2.05	2.94×10^{-7}
Point c.1	1.91	3.37×10^{-4}
Point c.2	1.43	1.60×10^{-5}
Point c.3	1.57	1.30×10^{-3}
Point d.1	1.46	4.02×10^{-5}
Point d.2	1.79	1.77×10^{-4}
Point d.3	1.56	1.77×10^{-4}
Point e.1	1.99	1.46×10^{-3}
Point e.2	1.49	5.22×10^{-5}
Point e.3	2.05	1.30×10^{-3}
Point f.1	1.62	1.16×10^{-5}
Point f.2	2.02	1.74×10^{-3}
Point f.3	2.10	1.30×10^{-4}
Average	1.84	3.75×10^{-4}

Source: Processed Primary Data (2018)

Based on Table 1, the soil at each point has a hydraulic conductivity value that varies from one track to another. This is due to the small grain size distribution. The results of the study obtained an average value of hydraulic conductivity of 3.75×10^{-4} cm/s which means that the ability of the soil to pass water is slow. The value of hydraulic conductivity is the value needed to obtain the value of soil permeability.

3.1.3. Soil Permeability of Gua Mimpi

The results of permeability research on the Gua Mimpi floor can be seen in Table 2.

Table 2. Soil Permeability Value of Gua Mimpi

Sample Code	**Density (gr/cm^3)**	**K (cm/s)**
Point a.1	2.30	1.68×10^{-8}
Point a.2	2.29	1.76×10^{-8}
Point a.3	1.87	1.74×10^{-8}
Point b.1	1.87	2.75×10^{-8}
Point b.2	1.83	2.90×10^{-8}
Point b.3	2.05	2.94×10^{-8}
Point c.1	1.91	3.37×10^{-5}
Point c.2	1.43	1.60×10^{-6}
Point c.3	1.57	1.30×10^{-4}
Point d.1	1.46	4.02×10^{-6}
Point d.2	1.79	1.77×10^{-5}
Point d.3	1.56	1.77×10^{-5}
Point e.1	1.99	1.46×10^{-4}
Point e.2	1.49	5.22×10^{-6}
Point e.3	2.05	1.30×10^{-4}
Point f.1	1.62	1.16×10^{-6}
Point f.2	2.02	1.74×10^{-4}
Point f.3	2.10	1.30×10^{-5}
Average	1.84	3.75×10^{-5}

Source: Processed Primary Data (2018)

Based on Table 2, that soil samples at each point have different permeability coefficients between one path to another, as well as the soil in the same path has a different permeability coefficient at each point. This is due to the small grain size distribution. With the difference in permeability coefficient values obtained, it can be seen that soil permeability cannot stand alone or there are several variables that affect the size of the k value obtained from the test results. In testing the physical properties of the soil, namely soil permeability, the soil hydraulic conductivity value is obtained, then the calculation is done to obtain the value of soil permeability. Soil density testing is performed to find out that the k value measured at the time of testing is the actual k value. The soil density values obtained on each path also vary. This is because the density of the soil at each point is different, depending on the soil texture at each point.

3.2. Discussion

The physical properties of the soil tested are soil grain size and soil permeability. The soil grain size test uses a set of sieve or sieve consisting of several different sieve sizes and arranged according to the sieve size. The purpose of testing the soil grain size using a Sieve is to determine the distribution of fine grains and coarse grains of the soil under test. By knowing the distribution of these granules, it can be analyzed its effect on the value of soil permeability obtained from the test results.

The results of soil grain size testing can be seen from several graphs of soil grain size distribution that have been displayed on the results of soil testing. In the graph illustrated, there are several graphs showing that on the 4.76 mm sieve size the cumulative percentage is 100%. Indicates that no soil is retained on the size of the Sieve so that the grain size of the soil is smaller than 4.76 mm. The graph of soil grain size illustrated shows that the soil samples in each sample have different cumulative pass percentage values in each Sieve used, it is known that the grain size of the soil obtained from the test results is a very coarse type of sand soil that is in the diameter range (1.0 – 2.0) mm, coarse sand with a diameter of (0.5 – 1.0) mm, medium sand (0.25 - 0.5) mm, fine sand with a diameter of (0.1 – 0.25) mm, and dust with a diameter of (0.002 - 0.05) mm. Soils with varying grain sizes have small pores. This is because small granules will fill the pores between larger granules so that the pores become smaller, in other words the high density or ability of the soil to pass low water.

Conductivity was obtained as shown in Table 1, the results of testing the physical properties of the soil showed that on each path of sampling the soil had different hydraulic conductivity values. The hydraulic conductivity of the Gua Mimpi floor is 3.75×10^{-4} cm/s, this value is needed to reduce the hydraulic value of the soil permeability on the cave floor. Table 2 shows that the permeability coefficient value (k) of the soil obtained is very small, namely 3.75×10^{-5} cm/s.

The soil permeability coefficient value with falling head permeability method where the coefficient of falling soil permeability in the Karst Maros area is 1.35E-03 cm/s (clay) and 7.33E-08 cm/s (chalk) [1]. This is because the grain size of the soil is small. That porosity or pore space is the cavity of the soil which is usually filled with water or filled with air [4]. In this case the pore determines the price of soil permeability, the smaller the pore that is contained in the soil, the slower the permeability of the soil. Likewise, the larger the pore in the soil, the faster the soil permeability will be. The ability of the soil to pass water is not only affected by the size of the soil pore, but also influenced by soil texture. If the soil texture is sand, the soil permeability will be fast, because sand has large pores so that the movement of water and other substances moves quickly. The results of soil permeability testing on Gua Mimpi floor are known to have a clay texture so that the ability of the soil to pass water is included in the slow category.

4. Conclusion

Based on the results of the research, it can be concluded that the soil grain size of floor Gua Mimpi Maros Karst Region Bantimurung - Bulusaraung National Park is a type of soil dust to very coarse sand with a diameter of (0.002 - 2.0) mm, with a soil hydraulic conductivity value of Gua Mimpi Karst Maros Region Bantimurung – Bulusaraung National Park is $3.75 \times \mathbf{10^{-4}}$ cm/s, and soil permeability of Gua Mimpi Maros Karst Region Bantimurung - Bulusaraung National Park is $3.75 \times \mathbf{10^{-5}}$cm/s which means that the ability of the soil to pass water is slow.

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