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EXTENDED ABSTRACT

The Amount of Sediment in Sand Drainage Columns after Drainage in the Soil

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1. Introduction

Historically for geotechnical engineers, the design and construction of structures on soft soil sediments has been a challenge. The ability to serve and limit the conditions as well as the cost and time program is considered. To meet these requirements, many types of construction methods are available. For example, replacing soft soil with other materials, reinforcing embankment, using lightweight filling materials, prefabricated vertical drainage and overhead or suction to accelerate consolidation, stage density, use of stone columns or different options from cement and cement mixture The soil is like a deep mixing or candle with reinforced reinforcement. Among all existing construction methods, the use of stone columns in soft soil is one of the most common things to reduce session and improve stability and freight capacity. However, when the stone columns are installed in very soft soils, it results in excessive clay pouring into the inner parts of the stone columns and reduces its stone column bearing capacity as well as its drainage capacity (Almeida, 2019). The stone column obstruction has been widely reported and its obstruction on the amount of soft soil improved with the stone columns is visible (Tai and Zhou, 2019) The use of stone columns is a popular technique in improving land with fine soil that can easily Reduce drainage and time of consolidation, as well as increased hardness and shear resistance (Indraratna, 2017). Vertical drainage, such as prefabricated drainage, sand drainage, stone columns and pebbles that are commonly used to accelerate or increase soil resistance. Many previous studies have reported that the area of the impact and resistance of the well causes excess water pressure in the soft soil to be improved with drainage (Nguyen, 2020). The stone column contains empty space or pores. The microphones are attached to the surface of the pores, through which penetrating water flows. Studies show that hydrodynamic or colloidal force is generally responsible for separating the microphones from the pores (Survi and Kousik, 2018). Stone columns create drainage paths due to high permeability (Weber et al., 2010).

The mechanism of clogging in stone columns varies at different stages. Density or tremor is the main reason for the start of obstruction when installation is because the force entered to compress the columns presses the column material to the surrounding clay, thereby pouring small soil grains into the sand cavities (HAN, 2015). The obstruction of the stone columns is obtained by mixing the column materials and the surrounding clay. This is a physical process and the biological or chemical cause is not involved. Physical obstruction is a process whereby small particles penetrate and sediment (Yong, 2013).

2. Methodology

The sand used in this study consists of 3 sizes, the first type of fine sand with a mean dimension of 0.5 cm, the second type of medium sand with a mean dimension of 0.75 cm and the third type of large sand with an average dimension of 1 cm, intended intended Is. To use the name of sand in charts and results and perform

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the process of the sand test is 0.5 cm, S_1, 0.75cm, S_2 and 1 cm S3. The sand is used in a washed so that the micro -stylus does not affect the permeability and friction of the mixed particles in the water. Fig. 1 is a sample of sand.

The soil added to the water reservoir to determine the amount of sediment includes a range of soil particles. The grading test is performed according to the ASTM D422-63 standard and presented in Fig. 2. Determination of the soil interval is due to the size of the precipitated particles in the drainage columns.

S_3

S_2

S_1

Fig. 1. The materials used in this research

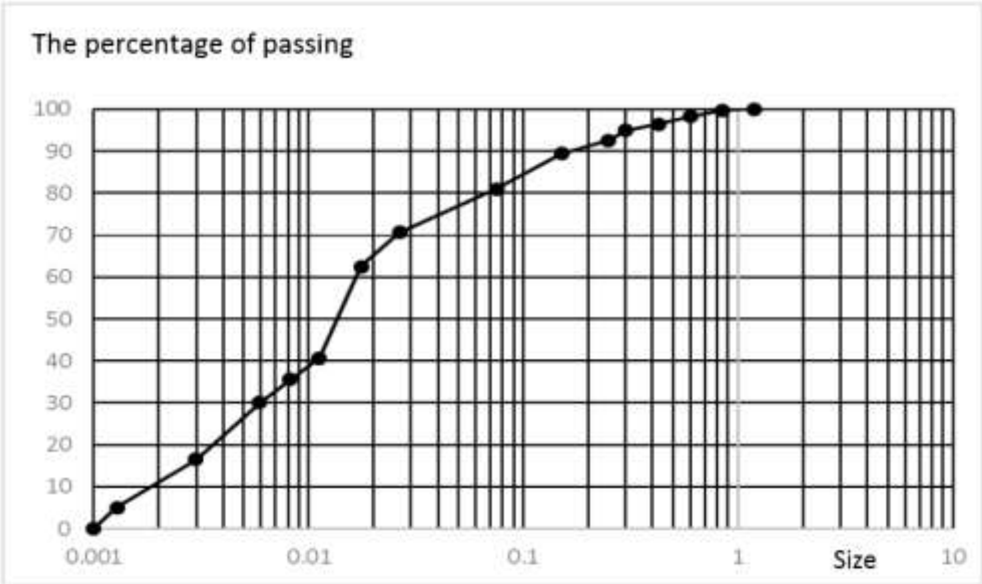

Fig. 2. Grain curve

3. Results and discussion

Depending on the relation of void ratio, the volume of solid particles or the volume of materials used in the column and the volume of the cavities should be calculated. At this stage, the column volume, which is 9 cm in diameter and 22.5 cm height, obtained the measurement based on the measurement, the columns closed with each of the materials filled with water and inside it with water up to 22.5 height. Fill the centimeter, after filling and reaching a certain height and full ventilation of the valves and collecting the outlet water in the container. Weighing the collected water and according to the equation of the porosity of the water volume of the cavities, the volume of the cavities is calculated, to obtain the volume of solid particles or the volume of materials inside the test cell, it is sufficient that the volume of the cylinder is 9 cm in diameter and height of 5/5 Calculate 22 cm and collect water volume to subtract the volume of cavities to obtain the volume of materials.

The testing coefficient of permeability coefficient with a fixed head according to the ASTM D2434-68-68. The permeability coefficient and the void ratio in each column are presented in Table 1. To obtain the volume of particles trapped in the column, the special density of these particles is required, using special density testing (specific gravity of soil solid particles with a picnic soil) based on the ATM D854-10 test standard and this special density is performed. Found in the soil trapped in the columns.

The density obtained in this experiment is calculated with Formula 1, which is extracted from this formula, which is obtained by this specific gravity according to Formula 2 of the detained particles (Balzer, 2015).

$$Gs = \gamma s / \gamma w \tag{1}$$

$$\gamma s = Ws / Vs \tag{2}$$

Table 1. Coefficient of permeability and void ratio of columns

No	Type	Permeability coefficient (m/s)	Void ratio
1	G_1	0.0780	0.508
2	G_2	0.0819	0.578
3	G_3	0.0888	0.710
4	1/3 $G_{1,2,3}$	0.858	0.633

3.1. Hydraulic guidance relationships

In grain soils, hydraulic conductivity is essentially dependent on porosity. In the past, numerous equations have been provided to connect the amount of hydraulic conductivity in void ratio in the grain soil. However, in 2003, Carrier has recommended the equation 3 for use.

$$k \propto \frac{e^3}{1+e^3} \tag{3}$$

Where in *K* Hydraulic conductivity, *E* void ratio, chapuis has an empirical relationship for *K* in relation to equation (3) as an equation (4):

$$k(cm/s) = 2.4622[D_{10}{}^2 \frac{e^3}{(1+e)}]^{0.7825} \tag{4}$$

According to laboratory results, Amer and AWAD in 1974 suggested the relationship (5) for *K* in grain soils:

$$k = 3.5 \times 10^{-4} (\frac{e^3}{1+e}) C_u{}^{0.6} D_{10}{}^{2.32} (\frac{\rho_w}{\eta}) \tag{5}$$

Where in *CU* Uniformity coefficient, *Pω* Water density (g/cm3), *η* Dynamic viscosity (g.S/cm2), given the empirical relationships presented and the experiments in this study, the relationship between void ratio, effective grain size, and hydraulic conductivity can be displayed according to the Fig. 3. By drawing the line equation in this graph, the equation 6 is extracted.

$$k = 1898.1\left[\frac{D_{10}{}^{0.3}}{D10} \times \frac{e^3}{1+e}\right]^2 - 302.08\left[\frac{D_{10}{}^{0.3}}{D10} \times \frac{e^3}{1+e}\right] + 12.137 \tag{6}$$

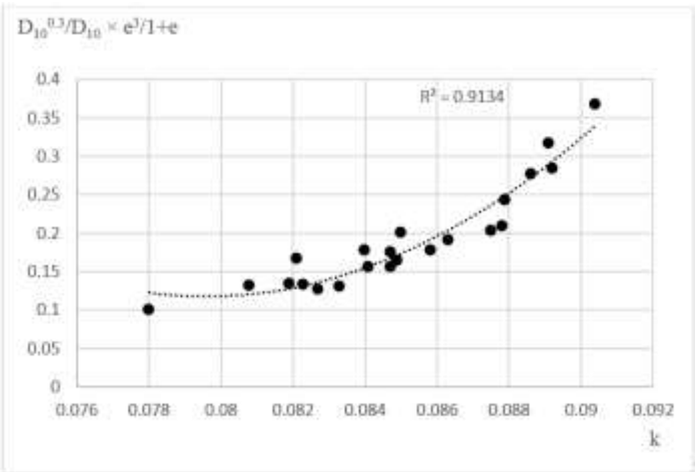

Fig. 3. Graph void ratio-hydraulic conductivity

4. Conclusions

Considering the charts and presenting the void ratio and permeability of each column separately, the results analysis can be presented as follows:

1) Farsi in the materials used in the drainage columns will reduce permeability due to the deposition of soil particles mixed with water, such as sand have friction and adhesion, which increases the amount of deposition inside the drainage columns and causes blockage to block. It will be time-run.

2) Using two different volumes of water and the results obtained, when the water pressure is increased, the weight of the sediment will decrease because the water pressure of the particle in the column will move and the obstruction function will decrease. However, when the ratio of porosity to the amount of sand is 0.5 cm, it will cause obstruction.

3) Soil aggregation before and after the test indicates that the particles passing through the sieve 200 are generally passed through the samples and the highest weight of the particles is precipitated, the particles greater than 0.5 mm.

4) The percentage of sediment compared to the primary soil mixed with water is the highest in the sand sample of 1 cm and the highest in the 0.5 cm sand sample. That is, the highest amount of sediment in the sand is 0.5 cm and the lowest deposition decrease in 1 cm.

5) According to the porosity -time ratio diagram, as the void ratio decreased, the amount of time required for the same volume of water and soil mixture has increased, which displays the obstruction phenomenon during drainage.

6) The amount of deposition in the drainage columns, due to the reasons for the type of material, the ratio of effective porosity, the ratio of ineffective porosity, the ratio of the primary porosity, the friction between the materials inside the column and the micro -mix in the water, the cavities at the surface of the material, roughness and geometrical shape of the materials. Deposition in drainage columns reduces void ratio, reduces current passing, increased internal friction, and creates communication bridges between the microphone, resulting in obstruction and elimination of column drainage function.

7) The ratio of porosity effective in sand drainage columns is directly related to the dimensions of the sand. With the increase in the dimensions of the sand due to the lack of communication bridges between the water and the mixture of a mixture passing through the drainage columns, there is an increase in the effective porosity in the sand drainage columns, which reduces the amount of sediment in these columns.

8) Roughness and geometric shape in materials due to cavities and effective void rates cause difference in obstruction. When the materials are below and the materials are sharply reduced the void ratio and causes adhesion between the rough surface of the materials and the micro-soil.

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