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EXTENDED ABSTRACT

The Effect of Bio-Micro Piles on the Improvement of Sandy Soil

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1. Introduction

Recently, industrial development and high growth of constructions have increased the need to pay attention to the improvement of construction sites. Meanwhile, soil biological improvement as a new, low cost and environmentally friendly method has been considered by many researchers. On the other hand, the use of micro piles by cement or chemical grout injection as one of the methods of soil improvement has been proposed since almost the middle of the twentieth century. Of course, one of the disadvantages of micro piles is the use of cement or chemical grouts, which have both limited resources and environmental pollution. The use of biological micro piles is one of the new and economical solutions to solve these problems.

2. Methodology

2.1. Soil characteristics and experimental study

The sandy soil used in this test at the unified system classification is poorly granulated sandy soil (SP) and at the AASHTO system, the soil type is A-1-b. According to MICP research, poorly granulated sandy soil is 5 times more abundant than well-granulated sandy soil under the same conditions. Because more uniform pores allow for better biological precipitation. Since the cell size of microorganisms is between 0.5 to 3 micrometers, it easily penetrates into the soil granulation. From the direct shear test, it was found that the sandy soil has no adhesion and has an internal friction angle of 30 degrees (Fig.1). In this experiment, we use the PLT test to evaluate the effects of biological micro piles. A cylindrical rigid tank with a 50 cm diameter and 60 cm height is considered so that the boundary effect can be ignored. The rigid steel plate with dimensions of 8 x 8 x 1 cm^3, which acts as a rigid foundation, distributes the stress equivalently. The micro piles used in the steel tube have a grout injection hole with an arrangement of 1, 3 and 5 micro piles below the loading plate. To investigate the effect of grout in mode of micro pile without injection and two modes of injection of cement grout and biological grout.

2.2. Biological test

In this study, we used microorganism Sporosarsina pstorii. This microorganism is from the Bacillus family and is an enzyme with high urease that accelerates biological precipitation by hydrolyzing urea (NG and Lee 2012). To prepare the biological solution, dissolve 20 grams of urea in one liter of distilled water and weigh about 8 grams of yeast extract powder of the culture medium along with 100 mg of industrial calcium chloride and pour it into Erlenmeyer and mix the solution well with a shaker (Chou et al. 2011). In order to prepare a

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solid culture medium, after preparing a liquid culture medium, place it on a hot plate until the temperature rises, then 15 grams of agar is added to the solution (Fig. 2).

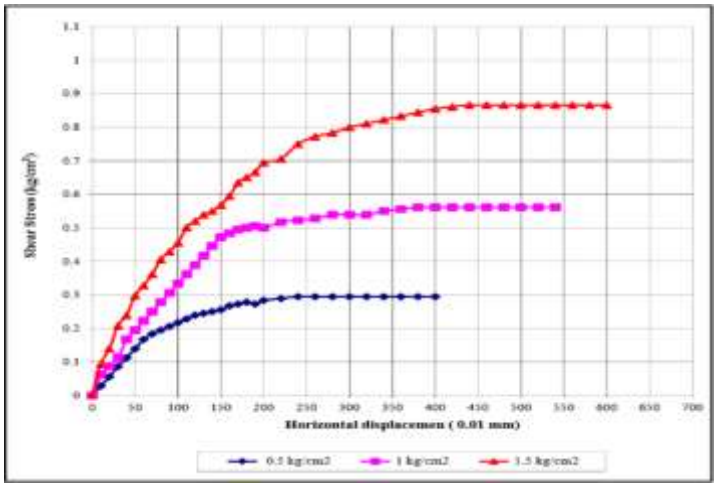


Fig. 1. Rapid direct shear test

(a) (b)

Fig. 2. Biological test: a) Production of biological solution in the laboratory, b) Oxidase test

3. Results and discussion

3.1. Investigation of the effects of grout injection in reinforced soil

Experimental results show that soil reinforcement with a micro pile without injection increases soil bearing capacity by about 55%. Also, the results of plate loading test show that the ratio of increasing the load-bearing capacity of reinforced soil with cement grout to non-reinforced soil in the 50 mm meeting is 126%, which means a 46% effect of biological grout injection compared to micro pile without injection. Also, comparing the results of the experiments shows that the soil reinforced with a micro pile by injecting biological grout compared to normal soil increases the bearing capacity of the soil in a settlement such as 50 mm by 94% (Fig. 3).

3.2. Investigation of the effects of micro piles length and diameter in different injection mode

Research has shown that by increasing the length and diameter of the micro pile, the soil bearing capacity increases in all injection modes. The test results with one 20 cm micro pile show that with a 25% increase in micro pile diameter in the mode of biological, cement and without injection, the soil bearing capacity increases by about 10, 6 and 8% The test results also showed that by increasing the micro pile length by about 42%, the soil bearing capacity in the mode of biological, cement and without injection conditions increased by about 33, 26.5 and 22%. Significantly the greater impact of biological injection compared to cement injection increased in both parameters (Fig. 4).

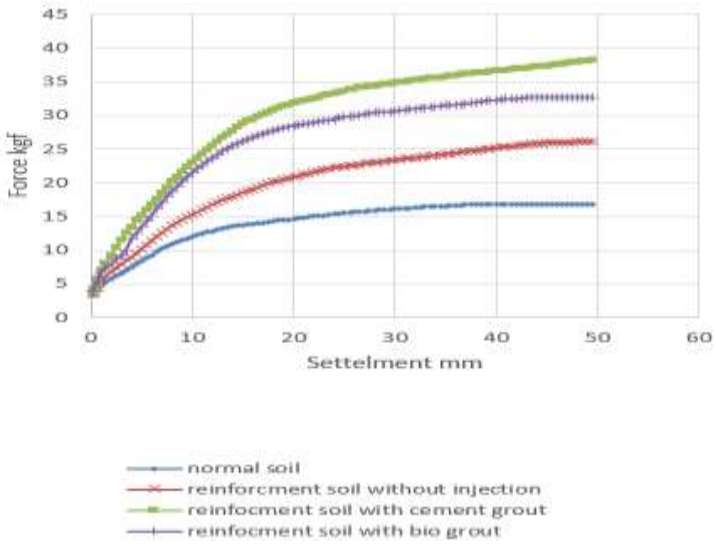
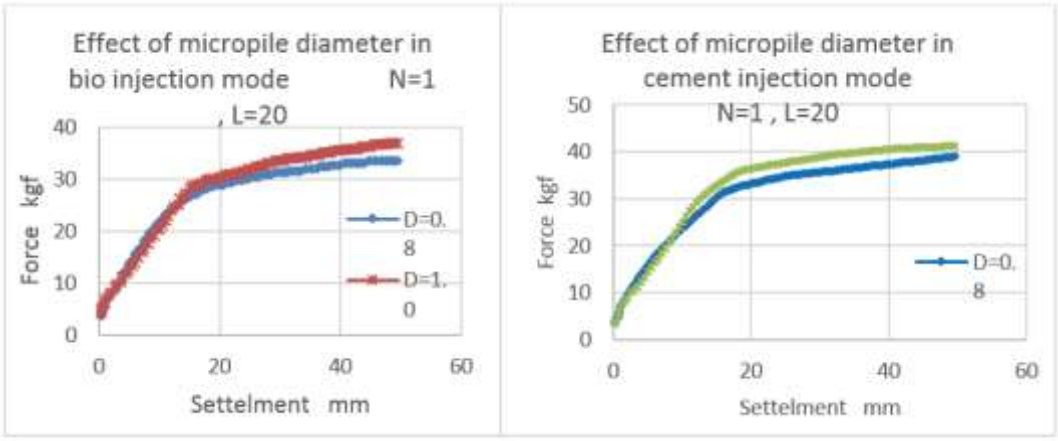


Fig. 3. Comparative diagram of the impact of injection on improving soil bearing capacity



(a) (b)

Fig. 4. Comparative diagram of the impact of injection and micro pile diameter on improving soil bearing capacity: a) Without injection mode, b) Bio injection mode

4. Conclusions

The results showed that the biological micro piles method can be an economical and environmentally friendly option. Bio-grout solution with low viscosity provides high permeability and biological precipitation. This biological deposition increases the soil bearing capacity and decrease soil settelment. The results showed that the reinforced soil bearing capacity icreasing in without injection mode in the case of one micro pile is 55% but with bio-injection same case this amount increases to 94%. Also, the behavior of micro pile group effect at bio-injection mode is very similar to the cement injection micro pile behavior and the interference of stress bulbs at the end of both types of micro piles reduces the efficiency by increasing the number of micro piles in a certain range. Increasing the length of biological micro piles has a greater effect on increasing the mechanical properties of the soil than increasing its diameter, so that by increasing the diameter of micro piles by 25%, increasing the bearing capacity of reinforced soil in biological and cement state increases only 10 and 8%, while increasing the length of micro piles by 42%. Soil bearing capacity in biological and cementitious condition increases by 33% and 26.5%.

5. References

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