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Effect of natural Basalt fibers on mechanical properties of clay Rey town

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ABSTRACT: A mechanical method for soil stabilization is the use of reinforcing elements such as geotextiles, geogrids and natural or artificial fibers. A new type of fiber that has a natural origin and its production and application has the least environmental impact is basalt fiber. In this study, in addition to index tests, a series of experiments including modified Proctor compaction test, uniaxial compressive strength test and indirect tensile strength test and SEM electron microscopy on stabilized clay with Basalt fibers with random distribution were carried out. The focus of this research was mainly on the effect of fibers length and weight percentage on soil resistance parameters. For this purpose, basalt fibers were mixed with soil in weight percentages of 0.25, 0.5, 0.75, 1, 1.5, 2 and with three different lengths of 6, 12, 25 mm, then compressed with optimum moisture content.

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1- INTRODUCTION

Some soils have undesirable technical properties or significant amounts of clay or silt and not suitable for some engineering projects[1]. Although the soil has good compressive strength, but due to weakness in shear and tensile strength, various methods such as soil reinforcement are used to improve engineering properties. In reinforced soil, soil particles withstand compressive stresses and elements withstand tensile stress and friction between soil grains and reinforcing materials, increases the shear strength of the soil[2]. Basalt fibers are made from melting of stone Basalt and without any additives. Therefore, using this fibers, in addition to high strength in alkaline and acidic environments, has not environmental problems and the time required to produce basalt fibers is reduced compared to other fibers. In order to resolve some ambiguities in past research, in this study the behavior of clay reinforced with basalt fibers were studied.

2- MATERIALS AND METHODS

In this research, clay was extracted from a region in North West of Rey town in the 20th district of Tehran. Based on the plasticity limit and liquid limit tests, the soil used in this study is clay. The plasticity limit and liquid limit are respectively 37 and 20. The optimum moisture content and maximum dry density were obtained 17 and 18kN/m3, respectively.

The fibers used in this research are Basalt fibers and purchased from GBF China Company. In this study, Basalt fibers with lengths of 6, 12, 25 mm and in weight percentages of 0.25, 0.5, 0.75, 1, 1.5, 2 were used.

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In this study, the mixing of fibers and soil was carried out manually and the fibers and dry soil were mixed together until they reached a uniform mixture. Then, the water was gradually added to the mixture until optimum moisture was reached and production of samples in all experiments was carried out at maximum dry weight. In addition to index tests, a series of experiments including modified Proctor compaction test, uniaxial compressive strength test and indirect tensile strength test, in accordance with existing standards, were carried out on unreinforced clay and reinforced with natural Basalt fiber with random distribution.

3- RESULTS AND DISCUSSION

By adding fibers, maximum dry density decreases and optimum moisture content increases. Lowest amount maximum dry density and highest amount optimum moisture content was observed in samples containing 2% W_f fibers and 25 mm fibers length.

The uniaxial compressive strength of unreinforced soil was obtained at 120.33 kPa. By increasing the fibers length to 12 mm and 1% by weight, the uniaxial compressive strength reaches a maximum of 434.7 kPa which will increase by 3.6 times the unreinforced soil. In the certain length of the fibers, by increasing the fiber weight to 1%, uniaxial compressive strength of reinforced soil increases and in weight percentages of 1.5% and 2%, the uniaxial compressive strength decreases. In addition, when the weight percentage of the fibers is the same, by increasing the length of the fiber from 6 mm to 12 mm, the uniaxial compressive strength initially increases and the strength decreases with increasing fiber length to

25 mm. Thus, the fiber is 12 mm in length and 1% in weight is the optimum fiber content and the maximum resistance is obtained. The reason for this increased resistance is the random distribution of fibers in the soil. Also, the reinforced soil works monolithic and this integrated soil and fiber functions causes trapping of soil particles between fibers.

Indirect tensile strength of unreinforced soil was obtained at 12.55 kPa. The maximum and minimum indirect tensile strengths in fibers with lengths of 12 and 25 mm and weight percentages of 0.75%, were 47.08 and 30.22 kPa, respectively. In the certain length of the fibers, by increasing the fiber weight to 0.75%, indirect tensile strength of reinforced soil increases and in weight percentages of 1, 1.5% and 2%, the indirect tensile strength decreases. In addition, when the weight percentage of the fibers is the same, by increasing the length of the fiber from 6 mm to 12 mm, the indirect tensile strength initially increases and the strength decreases with increasing fiber length to 25 mm.

In the low fiber percentages (less than optimal weight percent), the fiber spacing is high and the integrated mass between fibers and soil is not created. By increasing the fiber content by more than the optimal percentage, additional fibers, instead of continuity to the soil, form a separate mass with each other. Therefore, the fiber surface with the soil decreases and reduces soil resistance. In fibers with a length of less (6 mm), the fiber spacing is high and the transfer of tensions between soil particles is difficult and compared to the optimal length (12 mm), reinforced soil will have less effect on resistance.

4- CONCLUSION

The purpose of this study was to investigate the effect of Basalt fibers on density, optimum moisture content, uniaxial compressive strength and tensile strength of clay. For this purpose in this study, a set of experiments was carried out on Basalt fiber-reinforced specimens in weight percentages of 0.25, 0.5, 0.75, 1, 1.5, 2 and three different lengths of 6, 12, 25 mm.

Adding fibers to the soil reduces the maximum dry density and increases optimum moisture content. Replacing the fibers with soil particles and lowering the density of the fibers relative to the soil can reduce the maximum dry density. The porosity of the soil increases with the addition of fibers and to reach the maximum dry density, more water is needed.

The results show that with increasing the percentage of Basalt fibers and in different fibers lengths, soil resistance in all samples increases. The optimum amount of fiber for uniaxial compressive strength and tensile strength is 1, 0.75% and 12 mm in length, respectively.

Increasing the weight percentage and length of the fibers in all samples will cause softening of the samples and rainforced specimens show a more ductility behavior.

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