The effect of the addition ethylene-vinyl acetate on granular soil strength parameters

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ABSTRACT

Soil improvement has long played an important role in civil sciences, especially in geotechnics. However, with the passage of time and the lack of resilient lands for the construction of more advanced construction structures, engineers in this field decided to use new methods to stabilize and reinforce problematic soils. Also in recent years, environmental problems such as the increase of waste and industrial waste and their release into the living environment have created problems for the life of living Creatures. In these circumstances, geotechnical engineers have tried to use these materials in construction projects to protect the environment and, also, due to the very low cost of waste materials, reduce the economic costs of soil improvement projects. As a result of this study, granular soil is reinforced in two loose and semi-dense states using Polymeric industrial waste material called full ethylene-vinyl acetate (EVA). The experiments were performed at different weight percentages of EVA (0, 0.25, 0.5, 0.75, 1, 1.25, 1.5, 1.75, 2, 2.25, 2.5, 3 and 4), without adding moisture and using the CBR device. The results show that soil CBR has increased significantly with the use of these additives, and its effect on the soil increases with the reduction of the specific weight of the soil.

KEYWORDS

Soil improvement, granular soil Reinforcement, Ethylene-vinyl acetate (EVA), waste material, environment.

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1. Introduction

Stabilization and reinforcement of soils plays an important role in civil engineering projects, especially in geotechnics in loose soils. The importance of this issue has doubled in recent years with the progress of growing communities, especially in big cities, which are among the reasons for this: problems such as problematic soils, lack of suitable and high-resistance land for providing more housing. As a result of solving such issues and problems, it has been more and more attention and focus of civil engineers and especially geotechnical experts and new and new methods should be presented in addition to the old methods for soil improvement.

Geoenvironmental aspects are essential and very important in soil reclamation. It is clear that the use of cement and lime in soil stabilization causes environmental damage to our soil and nature. Researchers are interested in using safe and clean materials for soil remediation. The use of waste materials with minimal environmental damage to the soil is included in these categories.

Various researches in the field of stabilization or reinforcement of clay and sandy soils by previous researchers using natural polymers such as coconut shell fibers [1] and knaf fibers [2], and waste synthetic polymers such as rubber tire fibers [3], polyester fibers [4], tire and glass fibers [5], ethylene-vinyl acetate copolymer [6], polypropylene fibers [7] and disposable plastic waste [8] done. In this research, based on one of the methods of soil improvement, mixing materials with soil, the reinforcement of sandy soil using ethylene-vinyl acetate (EVA) additive has been discussed. EVA is considered as one of the industrial waste materials, and its use in construction projects, in addition to reducing the cost of projects, can also be effective in improving environmental conditions.

2. materials and methods

The base natural granular soil studied in this research is SP in the Unified Soil Classification System (USCS) with a specific gravity of 2.65. Also, this type of granular soil was prepared based on a geotechnical and geoenvironmental material with the full name of ethylene vinyl acetate (EVA), in two different densities (loose and semi-dense states). These waste materials do not have a negative effect on soil parameters and properties (dry or saturated) and it is also obvious that these waste materials are problematic for the environment. Based on the tensile test of polymer materials, the modulus of elasticity of EVA used in this research is about 2.9 megapascals.

Extensive laboratory samples were made for mixing natural granular soil and EVA in dry conditions and using weight method to investigate the effect of EVA on reinforced granular soil. Figure 1 shows the mixing of EVA material and sandy soil. In this article, the test results are obtained based on the CBR test. This test is a suitable evaluation method to check the shear strength of reinforced soil.

Figure 1: Mixture of soil and EVA material

3. Discussion and Results

The CBR results for samples reinforced with EVA in weight percentages of 0, 0.2, 0.5, 1, 1.5, 1.75, 2, 2.25, 2.5, 3 and 4 for loose samples and weight percentages 0, 0.2, 0.5, 0.75, 1, 1.25, 1.5 and 2 have been done for semi-dense samples.

Results extracted in this research show that using EVA waste material has a significant increase effect on CBR test results. Based on evaluated results it is clear that reinforced granular soil with EVA has higher shear strength in comparison with unreinforced granular soil studied in this research. Figure 2 shows stress-mandrel penetration diagram for the base soil (unreinforced soil) in two loose and semi-dense conditions using the CBR test and Figure 3 shows the comparison of two densities of sandy soil in different percentages of additives.

Another important result in these tests are decreasing the unit weight of granular soil–EVA mixture in comparison with granular soil in a specific volume. This advantage makes this reinforced soil mixture a proper material for backfill to retaining wall and other similar structure, performing drainage and also higher shear strength geotechnical parameters.

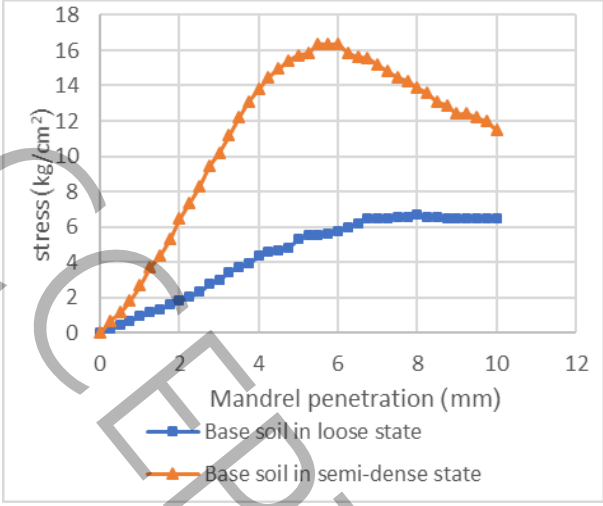

Figure 2: stress-Mandrel penetration diagram for base soil in two loose and semi-dense states

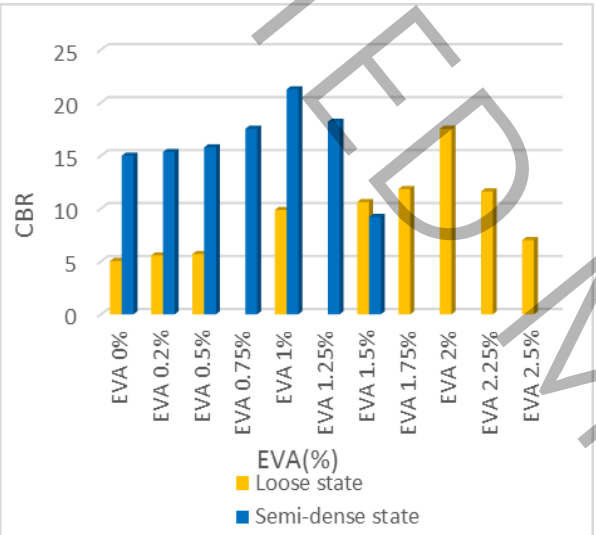

Figure 3: Comparison of two densities of sandy soil in terms of CBR value in different additive percentages

In this research the optimum content of EVA in granular soil to reach the maximum CBR results are also studied. This is a significant aspect of this experimental that represent a clear answer for geotechnical engineering and also researcher to use this waste material to reinforce granular soil in projects. Based on many CBR tests that are explained in the main paper text, the optimum content EVA for loose granular soil is evaluated to 2% and this optimum content for semi-dense is 1%. It should be mentioned that these optimum contents are based on weight percent and also in dry condition. These obtained result show that optimum contents of reinforcement are different with each other in two different soil densities. The CBR test results show that loose granular soil needs more reinforcement EVA to reach the maximum CBR. Another important matter that should be mentioned in detail of tests is that compaction of higher weight content of EVA is a hard process, so it was very important to evaluate optimum weight percent to obtain maximum CBR.

4. Conclusions

The optimal amount of adding EVA material to sandy soil that shows the highest relative resistance is 2% additive in a loose state and 1% additive in a semi-dense state**.** Also, the results show that due to the flexibility of this material, it has reduced the porosity of the soil and thus increased its relative resistance, and with the increase in weight percentage, the CBR number increases compared to the base soil, of course, the CBR number increases with the increase in specific gravity. also increases. It should be noted that the compaction of the soil and EVA mixture at higher additive percentages is a difficult process, so evaluating the optimal weight percentage to obtain the maximum CBR was very important**.**

In addition to the advantages mentioned above, the use of this waste material in soil reinforcement has reduced costs in construction projects, and also due to spending less energy for mixing materials and achieving greater resistance even in the weakest soil density, in time and time is also saved. Improving soils with such materials, in addition to achieving a more resistant soil, also preserves the environment due to their long life**.**

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