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Effect of Zeolite and tire granules on cement stabilization of the sand

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ABSTRACT: Soil stabilization is one of the important issues as an improvement method of weak soils in geotechnical engineering. The increasing amount of rubber wastes and their depots is a significant environmental problem. In geotechnical engineering, wastes can be used to improve soils. On the other hand, cement production causes environmental pollution. If natural cementitious materials such as zeolite, which have abundant resources in Iran, are used, it improves the environment while being economical. In this research, the use of rubber granule and zeolite as additives in the stabilization of sandy soils with cement, is evaluated. For this purpose, unconfined compressive tests on 28-days samples with different amounts 6, 8 and 10% of cement, different percentages of 0, 10, 30, 50, 70 and 90 of zeolite as cement substitute and percentages 0, 2.5, 5, 7.5, 10 and 12.5 of rubber granules, have been performed. The results show that not only the replacement of rubber granules and zeolites does not reduce the strength but also can increase the final strength by a maximum of 100% and also the strainability of the samples up to a maximum of 58%. The results show that rubber granules improve the stabilizing performance in the presence of zeolite. Electron microscopy (SEM) imaging of the samples showed the cohesion and integrity of the stabilization due to the addition of zeolite and rubber granules. The best mixing composition in the present study is 7.5% rubber granules and 30% zeolite as cement substitute.

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1- Introduction

Cement stabilization is one of the most effective common methods to improve the sandy soils, but the use of cement causes environmental problems. During the production process of the cement, in addition to consuming a lot of energy, a large amount of greenhouse gases are released into the atmosphere, which causes significant environmental problem [1]. In order to solve these problems of traditional stabilizers, some materials that improve the physical properties of the soil and do not cause environmental degradation must be investigated. Today, the accumulation of waste tires in landfills has become an important environmental problem and increases the need to reuse them in newer applications. Unique features such as high strength, low density, and high frictional resistance make waste tires a valuable engineering resource. Bikdeli and Jiryaei examined the use of waste tires and reclaimed asphalt pavement (RAP) as stone column materials. The results showed that the performance of the stone column made by RAP and surrounded by waste tires is satisfactory [2]. Zeolites are crystalline aluminosilicates of alkaline earth materials of sodium, potassium, magnesium and calcium, which have different applications. Zeolite resources are abundant in the country, especially in Semnan, Damavand, Qom and other regions in Iran. Research by Jafarpour et al., Mullah Abbasi et al. And Izadpanah et al. showed that replacing an optimal amount of zeolite instead of cement in sand stabilization increases the shear strength, and replacing a larger amount of zeolite reduces shear strength [3-5]. In the present study, the use of rubber granules and also zeolite as cement substitute is evaluated. Unconfined compressive tests have been used to evaluate the performance of these materials and their effect on sand stabilization with cement.

2- Experimental Program

The type of zeolite in this study was clinoptilolite, which is actually a sodium and potassium aluminosilicate and was prepared from the Semnan mine. The soil used in the present study was prepared from Qom, Shokohiyeh industrial town. After drying the natural soil and performing gradation tests according to the ASTM C136 standard, the soil was classified as poorly graded sand according to ASTM D2487 unified classification system. The rubber granules used had a diameter of 0.8 mm and a specific gravity of 0.8 according to ASTM D854. The amount of additive water and dry density of samples was considered based on the optimum moisture content and maximum dry density obtained from the compaction proctor test according to ASTM D698, respectively. According to ASTM D2166, unconfined

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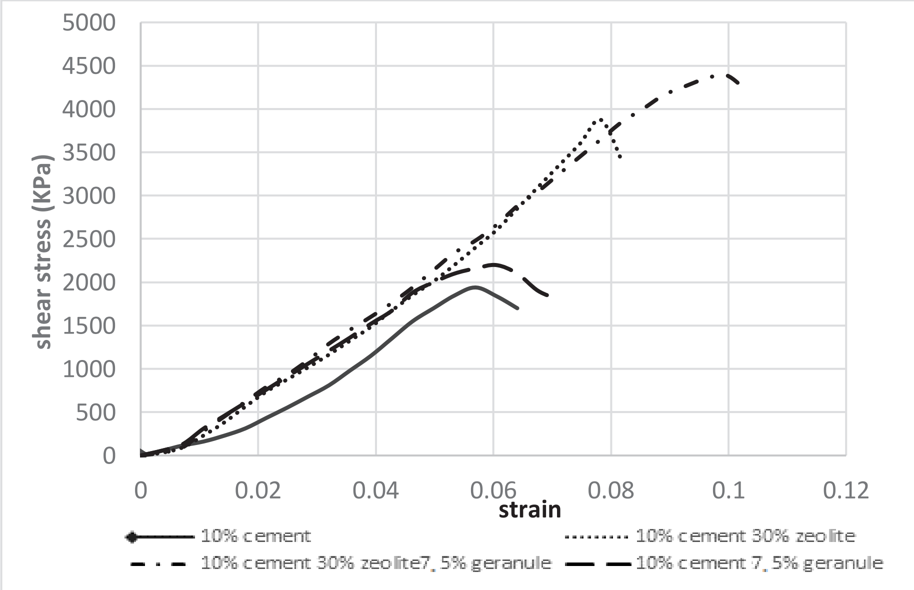

Fig. 1. Effect of zeolite and granule on stress-strain behavior.

compressive tests on 28-days samples constituting different amounts of cement, 0-12% of rubber granules and replacement values of 0, 10, 30, 50, 70 and 90% of zeolite as a substitute of the cement.

3- Results and discussion

The results showed that the amount of zeolite in cement stabilization has an optimum value. Zeolite reacts well with the cement during hydration due to the presence of aluminum silicates and improves the stabilization structure. By increasing the amount of zeolite compared to the optimum amount, the reactivity capacity of the cement ends and the excess zeolite as additional material reduces the stabilization strength. According to the results of the present study, the optimal amount of zeolite stabilized with cement is 30% by weight of cement. The addition of zeolite up to 30% to the composition of 6, 8 and 10% of the cement and 7.5 % granules, increases the strength significantly to 30, 58 and 100%, respectively. Based on the observations of the present study, the optimal amount of rubber granules can be suggested by 7.5% with a good approximation. In curing duration, rubber granules prevent the occurrence of small cracks. Also, with the addition of rubber granules, the deformability of samples increases under higher stresses. It should be noted that increasing the strength due to the addition of granules requires more deformation. As shown in Figure 2, zeolite increases the strainability of samples, especially at stresses much higher than the strength of samples without zeolite, so that adding zeolite to the sample without the rubber granule increases the strain corresponding to the failure by 30 %. It should be noted that the sample with zeolite easily withstands the stress and strain corresponding to the failure of the samples without zeolite and reaches the stress and strain path at a higher level. Addition of zeolite to the sample with 7.5% granular increases the strain corresponding to the failure by 58%. Electron microscopy (SEM) images showed that by adding 30% zeolite to the soil mixture with 10% cement, more pores are filled than non-zeolite samples. By adding granules to the composition of the soil, cement and zeolite, more pores are filled and the soil texture changes to a continuous texture.

4- Conclusions

The use of rubber granule and zeolite as additives in the stabilization of sandy soils with cement, was evaluated. For this purpose, unconfined compressive tests on 28-days samples with different amounts of cement, zeolite and rubber granules were performed. Results showed that the amount of zeolite in cement stabilization has an optimal value of 30%. Zeolite reacts well with the cement during hydration due to the presence of aluminum silicates and improves the stabilization structure. The optimal amount of rubber granules can be suggested as 7.5% with a good approximation. In curing duration, rubber granules prevent the occurrence of small cracks. Addition of zeolite to the sample with 7.5% granular increases the strain corresponding to the failure as well as strength, significantly. Electron microscopy (SEM) images showed that by adding zeolite and rubber granules to the soil mixture with cement, more pores are filled than non-zeolite samples.

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