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Evaluation of Marble Dust for Soil Stabilization

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Usage of marble dust was investigated for soil stabilization in the scope of utilization of waste material. Geotechnical properties, such as compaction, Atterberg limits, unconfined compressive strength of the mixtures and changes of these properties with the marble dust ratio were determined. From the test results it is seen that marble dust increases the mechanical properties of soil and application of dust wastes for soil stabilization will be an efficient practice in terms of solid waste management.

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1. Introduction

Expansive soils can be a significant problem in engineering applications and stabilization of these soils is necessary to mitigate their detrimental effects. Lime, cement and bitumen are commonly used additives for stabilization of expansive soils [1–3]. Recently, different additive materials such as fly ash, rice husk ash, silica fume, ladle furnace slag and geo fibers are used to improve some geotechnical properties of poor soils [4–10]. Besides these additives, industrial wastes such as olive oil wastes [11] and basalt fibers [12] are also used for remediation of soils. Yilmaz et al. [13] have used stone wastes in stabilization of clayey soils as a pozzolanic additive. That study had proven that using stone wastes with lime for stabilization of clayey soils gives meaningful values on unconfined compressive strength.

The main objective of this study was to investigate the effect of marble dust on strength behaviour of high plasticity silty soils. Prepared natural and stabilized soil samples were cured 28 days and after curing period uniaxial compressive strength tests were performed.

2. Materials and methods

Marble dust was used in this research study to see the improvement of high plasticity silty soil with addition of this by-product. Besides, 10% bentonite was added to natural soil and bentonite-soil mixture was treated with the addition of marble dust in different percentages. Type of mixtures and their notations are presented in Table I. Marble dust used in this investigation was provided by marble stone quarries in Bayburt.

Figure 1 presents grain size curves of soil and marble dust, respectively. Engineering properties of silty soil are given in Table II.

After sieving analysis, Atterberg limit tests were performed and soil type has been classified as high plasticity silt (MH), according to Unified Soil Classification System (USCS). Optimum moisture content of soil has been calculated to be 18% after compaction test. Through this experiment, it was found that optimum moisture content increases with the increasing marble dust ratio.

TABLE I

Type of mixtures and their notations.

Type of mixture	Notation
Soil	S
Soil&Bentonite	SB
Soil, Bentonite & Marble Dust	SBMD
Soil, Bentonite & 5% Marble Dust	SBMD/5
Soil, Bentonite & 10% Marble Dust	SBMD/10
Soil, Bentonite & 15% Marble Dust	SBMD/15
Soil, Bentonite & 20% Marble Dust	SBMD/20
Soil, Bentonite & 25% Marble Dust	SBMD/25
Soil, Bentonite & 30% Marble Dust	SBMD/30
Soil, Bentonite & 35% Marble Dust	SBMD/35
Soil, Bentonite & 40% Marble Dust	SBMD/40

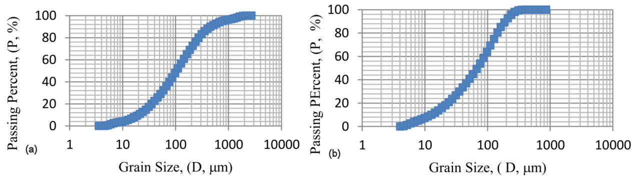

Fig. 1. Grain size curve of soil (a) and marble dust (b).

TABLE II

Engineering properties of silty soil used in experiments.

IS claasification	MH
Liquid limit, LL [%]	55.0
Plastic limit, PL [%]	34.0
Plasticity index, PI [%]	21.0
Optimum moisture content, w_{opt} [%]	18.0
Maximum dry density, ρ_{kmax} [Mg/m^3]	1.56

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3. Results and conclusions

Unconfined compressive strength values of specimens are presented in Table III and it is indicated that the strength of each marble dust-silty soil specimen increases with the increase of the curing duration and the percentage of marble dust. The variations of unconfined compressive strength with marble dust content for 7 and 28 days of curing are plotted in Fig. 2, respectively.

TABLE III

Unconfined compressive strength of specimens.

Type of mixture	Uniaxial compressive strength [kPa]	
	Curing period	
	7 days	28 days
S	107.14	117.35
SB	104.96	115.00
SBMD/5	112.24	130.00
SBMD/10	120.00	140.00
SBMD/15	150.00	155.00
SBMD/20	173.47	193.98
SBMD/25	183.97	198.98
SBMD/30	195.00	224.49
SBMD/35	200.00	230.00
SBMD/40	212.00	255.10

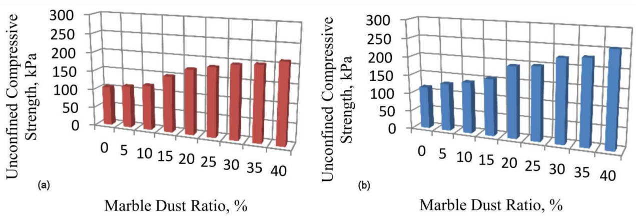

Fig. 2. Variation of unconfined compressive strength with marble dust ratio after 7 (a) and 28 (b) days of curing.

The effect of marble dust on unconfined compressive strength of silty soil has been studied. It is seen from the test results that the addition of marble dust enhances the strength values of soil. The variation of unconfined compressive strength after 7 and 28 days of curing period was similar and the maximum strength values were found in SBMD/40 specimen. On the other hand, getting to higher values of strength shows pozzolanic activity of marble dust.

As a consequence, experimental results of this study reveal that using marble dust as an additive for soil stabilization gives good results and it is an environmentally friendly implementation in terms of solid waste management.

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