

Reuse of Waste Marble Dust in the Landfill Layer

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Abstract: Waste materials are serious environmental problem because they have harmed to soil and ground water. Rapidly developing technology has increased production and consumption. The increasing of production and consumption results in the increase of amount of waste. In the developing countries, distinct rules of waste disposing are initiated to prevent the environment pollution. This case was positive effects on environment by means of recycling, regains to economy and reducing environmental pollutions. Recently, some waste materials were began to be used with clay in landfill layer design. Because the waste materials increases characteristic of clay liner such as impermeability, strength, heavy metal absorption, etc. In this study, waste marble dust was used as an additive material in landfill liner. Mixtures of kaolinite-bentonite were mixed with waste marble dust for design of landfill liner. This process was performed at marble dust ratio of 5%, 10% and 15%. Freezing-thawing tests were carried out in these mixtures. At the end of the tests, it was observed that waste marble dust increased strength of liner in conditions of freezing and thawing.

Keywords: Waste marble dust, Environment, landfill liner, freezing-thawing

1. Introduction

The waste materials are serious environmental problem. Rapidly growing cities with increasing population have formed this problem. Concentration of population in cities has increased consumption. The increasing of production and consumption results in the increase of amount of waste. In the developing countries, distinct rules of waste disposing are initiated to prevent the environment pollution. However, many technologies are developed for the recycling of wastes; many of them cannot be recycled by the economical and technological points of view. The collected wastes can be burned and/or composted by newly developed technologies; however, a final amount of trashes must be stored for the last removal procedure.

In the landfill layers, usage of suitable materials and possibly waste mixture material are important to prevent from environmental conditions. By this way, the waste materials, such as fly ash, would be gained to economy.

In recent times, waste marble dust was used as an additive material for soil stabilization. Okagbue and Onyeobi's study (1999) showed that the geotechnical parameters of red tropical soils are improved substantially by the addition of marble dust, plasticity was reduced by 20 to 33% and strength and CBR increased by 30 to 46% and 27 to 55% respectively. Additionally, normal 28 day curing improved after 7 to 10 days of normal curing.

The effect of waste marble dust on swelling potential of Na-bentonite and Meşelik clays was investigated by Zorluer (2003). Specimens were mixed with marble dust at different percentages of dry soil weight. Then, they were compacted at the standard compaction effort and swelling tests were carried out with odometer apparatus. The experimental results reveal that waste marble dust is effective for controlling of swelling potential and it can be used for this purpose.

Also marble dust affect unconfined compression strength of clay soils according to study of Zorluer (2006). Clay soil had mixed marble dust at 3, 5, 8, 10 % percentages. Then mixtures had been compacted with standard proctor compaction energy. Specimens had been sampled from compacted soils for compression test. At the end of 28 days curing time, strength increased 20.1 by N/cm² to 57.3 N/cm².

Hassini (1992) determined that impermeable layer cycles much at landfills. In doing so, he carried out an experiment of freezing-thawing to specify soil strength and its permeability. After 12 cycles, as suggested by Chamberlain (1981), he found that 10-15% grain loss does not have any impact on strength.

This study examines the degree of deformation derived from seasonal temperature differences at impermeable layers with marble dust. For this reason, three mixture of soil to waste marble dust (the proportions were 5, 10, 15% dust to dry soil by weight) have been prepared. And freezing-thawing tests were carried out in these mixtures.

2. Materials

2.1 Na Bentonite Clay

Bentonite is a colloidal aluminium hydro silicate. The volume of bentonite can rise 10 to 30 times by the addition of water. It has a swelling characteristic till 200°C. This property loses completely over 600°C. The bentonite clay used in this study is Na-Bentonite. It was supplied from the Karakaya Bentonite factory, Ankara Turkey. Some physicochemical and geotechnical parameters of Na Bentonite clay were shown in table 1, The results of chemical analysis determined by the X-Ray Flourans Elemental analysis are shown in table 2 (Koyuncu 1998).

2.2 Kaolinite Clay

Kaolinite clay is a product of a type of rock which contains a great amount of feldspar. Kaolinite consists of silica and aluminium layers. The thickness of layers is 7.2 Å, the length of layers is between 1000 and 20000 Å and the specific surface area is (SSA) 15m²/g. The clay used in this study is obtained from the Bilecik district. The clay is produced by a three step procedure; first excavation from clay ores, then cleaning from fine sand by water washing and, finally crashing below 40 µm at the end of washing, groups of clay and shale are completely decomposed. The clay used consists of kaolinite mineral. Some physicochemical and geotechnical parameters of the kaolinite clay are shown in table 1, The results of chemical analysis determined by the X-Ray Flourans Elemental analysis are shown in table 2 (Koyuncu 1998).

2.3 Waste Marble Dust

Marble dust is minimum sized marble waste. It occurs with sawing process of marble blocks and plates. This dust is carried by water to sedimentation pond. Sediment dust is removed from this pond to wasteland, but this condition have formed serious problem for environment. Because, waste marble dust is used in very little quantities even though it used in the very different industries such as construction, ceramics and cement industry, paint industry, agriculture and fertilizer industry, etc. Therefore, they have happened big mass in the waste areas (Zorluer 2003).

Marble dust, used in this study, was obtained a marble processing factory in Afyonkarahisar-Turkey. Then, it is dried and sieved with #40 sieve. The marble dust grains are smaller than 300 micron. Some physicochemical and geotechnical parameters of waste marble dust are shown in table 1, The results of chemical analysis determined by the X-Ray Flourans Elemental Analysis are shown in the table 2 (Koyuncu 1998).

Additions	WC ^a (%)	GSG ^b	UW ^c (g/cm ³)	Grain Size Distribution (%)		
				Sand	Silt	clay
Na-Bentonite	12.7	2.76	0.94	2	46	52
Kaolinite	0.1	2.64	0.59	11	26	63
Marble Dust	4.1	2.75	2.73	14	78	8

(^a): Water Content, (^b): Grain Specific gravity:, (^c): Unit Weight.

Table 1 Some physicochemical and geotechnical properties of materials.

Additions	SiO ₂	Al ₂ O ₃	Fe ₂ O ₃	CaO	MgO	P ₂ O ₃	K ₂ O	Na ₂ O	SO ₃	Mn ₂ O ₃	LOI ^a
Na-Bentonite	59.49	18.06	4.14	3.72	2.42	0.11	0.91	2.50	0.10	-	8.55
Kaolinite	51.52	32.00	1.75	0.20	0.20	-	0.50	0.09	-	0.04	12.62
Marble Dust	0.01	0.85	0.04	55.30	0.24	-----	0.20	0.03	-----	-----	43.51

(^a): Loss of Ignition.

Table 2 Chemical compound of materials.

3. Experimental Study

The changes in the strength at material against seasonal impact are determined by using freezing-thawing test. The deformation in the material as a result of this test is closely related to the amount of the water in it given that the nature and ratio of soil water changes to a grade extent when it freezes. When the water transform in to ice, its volume increases about 9% in accordance with the development of its hexagonal crystal texture (Penner & Ueda 1977).

Test specimens were prepared by 90% kaolinite and 10% bentonite mixture by dry weight for use in the impermeable clay layer. This mixture was named as control specimen - 90K+10B. Then, the waste marble dust was added to the mixture at ratio of 5%, 10% and 15%. These ratios were obtained from other studies in the literature. Marble dust is abbreviated as a MD. Specimens were prepared with compaction in a standard proctor mold by using optimum water contents for every mixture.

Freezing-thawing strength was determined according to “Methods for Freezing and Thawing Tests of Compacted Soil-Cement Mixtures” indicated in ASTM D560 (1985). In this experiment, samples are stored in a freezer at -20° C for 24 hours. Then, the same samples are stored at the room temperatures at 18° C for 24 hours. This process is called as one cycle. 12 cycles are carried out for the samples in this experiment after which the surfaces of the samples are brushed gently with wire brush to remove particles. Then, they are weighted to determine the percentage of the loss compared to their previous weight. The highest loss rate accepted in the literature is 15%. The surface crystallization and the sample deformation after the cycle are given in figure 1 and figure 2 respectively.



Fig. 1 Crystallization on surface after the freezing



Fig. 2 Deformation after the cycles

4. Test results

After freezing and thawing test consisting of totally 12 cycles, it was seen that grain loss has decreased with marble dust increase. It has decreased from 17.6% to 12.5% at the end of 12 cycles. It can be declared that this decreasing can make positive influence to the strength values of layers. The less the grain losses is, the higher the soil strength is. The findings show that the strength of the samples increases when the amount of the

added marble dust increases. As it is seen in table 3, an additional 5% of marble dust is ineffective on freezing-thawing. While an additional 15% marble dust results in 12,5% grain loss, an additional 10 % marble dust bring in 13,5 grain loss.

Materials	Initial water contents (%)	Number of cycle	Grain loss (%)
Control (90K10B)	25	12	17.6
90K10B +5% MD	25	12	18
90K10B +10% MD	25	12	13.5
90K10B +15% MD	25	12	12.5

Table 3 Freeze-Thaw experiment results of waste marble dust mixtures.

5. Conclusions

Firstly, it is observed that the amount of grain loss in the samples with 10% and 15% of marble dust addition as a result of deformation in the freezing-thawing test are in compliance with the highest grain loss referred in the literature.

Secondly, it is seen that on addition of 5 % of marble dust is ineffective since the results from this sample are close to those of the control sample.

Thirdly, As it is seen in figure 3, the study shows that the lowest deformation occurs in the material with 15% of marble addition.

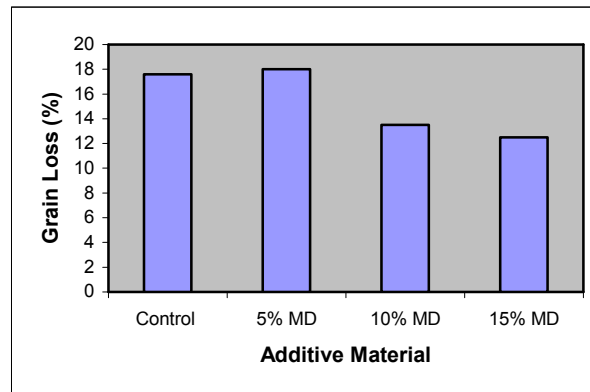


Fig.3 Effect of waste marble dust on freezing-thawing

In the light of the given findings, it can be argued that use of marble dust increases the strength of landfill liner. Trough its use in landfill liners, the recycling of marble dust will be possible. Consequently, this will not only to contribute to the protection of the environment but also to provide an economical additive material to landfill layer.

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