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Effect of fly ash and lime on mechanical behavior of sand

M. Bayat*[1], S.M.H. Bahreynian [2]

Abstract

The use of waste materials from various factories and industries in the soil to improve engineering properties is one of the new approaches in this field. Inflatable ash is also an important by-product of coal-fired power plants or from the waste heat of some plants, which has a good pozzolanic character and is used in construction projects for use in concrete and in geotechnical projects. Soil stabilization is used. In this study, a type of fly ash with different chemical properties was used in comparison with other studies aimed at improving the existing soil in central Iran. Density, permeability and CBR tests were performed on samples with different percentages of fly ash with or without lime at different processing times. According to the results of the study, it can be concluded that the addition of fly ash up to 20% in the lime-free sandy soil will increase the maximum specific gravity dry weight and this amount will decrease to 10% despite the 10% lime content. Find out. The results also show that 20% of fly ash is an optimum value for stabilizing soil with or without lime so that the highest California bearing ratio is achieved in this area. In addition, the use of fly ash has a direct relationship with the reduced permeability of the specimens. Finally, the results are interpreted on the basis of microscopic photographs of the samples.

Keywords: *Acid rain, Geotechnical properties, Clay, CBR test, Unconfined compressive strength*

[1] Assistant professor, Department of Civil Engineering, Najafabad Branch, Islamic Azad University, Najafabad, Iran.
[2] M.Sc. student, Department of Civil Engineering, Najafabad Branch, Islamic Azad University, Najafabad, Iran.

*** Corresponding Author**: bayat.m@pci.iaun.ac.ir

Extended Abstract:

1. Introduction

It is more than several years, lime, cement, fly ash, industrial waste products, potassium nitrate, calcium chloride, phosphoric acid, and … used successfully for stabilization of various types of soils (Miller and Azad 2000; Nalbantoglu and Gucbilmez 2001; Rao et al. 2001; Aiban et al. 2006; Chun-Yang et al. 2006; Guney et al. 2007; Harichane et al. 2011; Yilmaz and Ozaydin 2013; Asgari et al. 2015; Suthar and Aggarwal 2018; Ghadir and Ranjbar 2018; Yize et al. 2019). One of the possible problems that that could be encountered with execution of future civil projects in the Maranjab desert that is located in Aran va Bidgol, Isfahan, Iran, is inappropriate soil mechanical behavior. Such soils can be treated with the general traditional soil stabilization methods such as lime and flyash additive processes. In the current study, the effects of two types of additive for the soil (i.e., lime/flyash) on the mechanical properties of the soil are investigated.

2. Methodology

2.1. Experimental study

In the current study, the modified Proctor compaction test, the California bearing ratio test and the falling head permeability test, was performed on lime-stabilized or lime and flyash –stabilized specimens. Scanning electron microscopy (SEM) analysis was also conducted on the specimens.

3. Results and discussion

3.1. Proctor compaction test results

Proctor test is used for the determination of optimum moisture content and maximum dry density. A series of Proctor Compaction tests have been carried out on soil mixed with flyash and lime/flyash. The results of Proctor's compaction test for the soil specimens mixed with flyash and lime/flyash are given in Tables 1 and 2. The results indicate that at the addition of 20% flyash without lime results in the maximum value of dried specific weight and also the corresponding flyash content is about 10% when mixed with lime content of 10%.

Table 1. Proctor's Compaction test results for soil mixed with flyash

$\gamma_{d-\max}\left(gr/cm^3\right)$	$\omega_{opt}\,(\%)$	**Flyash content (%)**
1.69	13.5	0
1.69	13.7	2
1.71	14.3	10
1.75	14.5	20
1.74	14.8	30
1.72	15	40

Table 2. Proctor's Compaction test results for soil mixed with flyash and Lime (lime content of 10%)

$\gamma_{d-\max}\left(gr/cm^3\right)$	$\omega_{opt}\,(\%)$	**Flyash content (%)**
1.69	13.5	0
1.71	13.8	2
1.75	14.1	10
1.73	14.3	20
1.70	14.7	30
1.67	15.3	40

3.2. California bearing ratio (CBR) test results

In the current study, CBR test is used to measure the bearing capacity of the stabilized soil with flyash and lime/flyash. Fig.1 shows the results of the CBR test for the stabilized specimens. Curing times of 2, 7, 14 and 28, days were used in the current study. As the results show, the curing period has effect on CBR values of the stabilized specimens, so that increasing the curing time increased the CBR values. The rate of resistance increase in the stabilized specimens with flyash and lime is higher than the stabilized specimens with flyash. On the other hand, the CBR value of the stabilized specimens with flyash and lime is considerably larger than the corresponding value for the stabilized specimens with flyash for a given curing time and flyash content. As shown in Fig.1, CBR value increased with an increase in flyash content up to 20% and then decreased. In other words, the stabilized specimen with flyash content=20% recorded the highest CBR value at a given curing time.

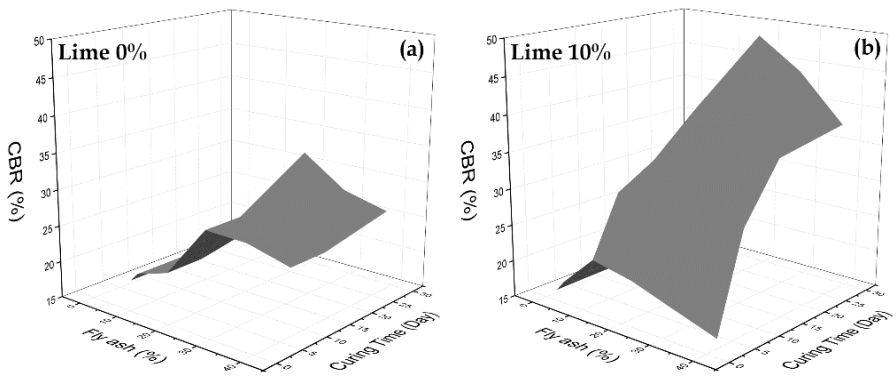

Fig. 1. The results of the CBR tests for the stabilized specimens with: (a) flyash, (b) flyash and lime content of 10%.

3.3. permeability test results

The water permeability test results are plotted in Fig. 2. It can be seen that value of coefficient of permeability decrease with increase in flyash content because the flyash particles act as a barrier for water seepage path.

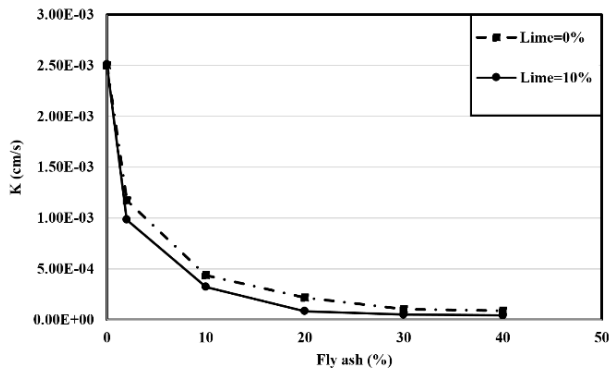

Fig. 2. The water permeability test results

For a given flyash, the results indicate that the presence of lime has less impact on the coefficient of permeability than flyash.

3.4. scanning electron microscope (SEM) images

A SEM was used to investigate the effect of flyash content on the grain contact structure of the stabilized specimens with flyash or flyash and lime. The SEM results indicate taht the stabilized specimens consisted of some large particle packs; sand particles cohered together in the presence of flyash and lime, therefore forming large particle packs and a densified soil matrix.

4. Conclusions

The addition of 20% flyash without lime results in the maximum value of dried specific weight and also the corresponding flyash content is about 10% when mixed with lime content of 10%. As the results show, the curing period has effect on CBR values of the stabilized specimens, so that increasing the curing time increased the CBR values. On the other hand, the CBR value of the stabilized specimens with flyash and lime is considerably larger than the corresponding value for the stabilized specimens with flyash for a given curing time and flyash content. The results indicate that CBR value increased with an increase in flyash content up to 20% and then decreased. In other words, the stabilized specimen with flyash content=20% recorded the highest CBR value at a given curing time. The water permeability test results indicate that value of coefficient of permeability decrease with increase in flyash content because the flyash particles act as a barrier for water seepage path. For a given flyash, the presence of lime has less impact on the coefficient of permeability than flyash.

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