Amirkabir Journal of Civil Engineering

Amirkabir J. Civil Eng., 55(11) (2024) 457-460
DOI: 10.22060/ceej.2023.21117.7627

The effect of calcium presence in limepet for clayey soil stabilization using the geopolymer method

N. bahrami [1], D. Moazami [1]*,Sh. Pourakbar

[1] Department of Civil Engineering, Mashhad Branch, Islamic Azad University, Mashhad, Iran
[2] Department of Civil Engineering, Faculty of Engineering, Binaloud University, Mashhad, Iran

ABSTRACT: In geotechnical engineering, clay is known as problematic soil, including low compressive strength, low bearing capacity, and high swelling potential. Chemical stabilization of soil with different additives is one of the possible methods for soil improvement. Portland cement is commonly used for the soil stabilization process. Climate change and global warming a life-threatening challenges, and governments have enacted laws restricting carbon dioxide emissions. Therefore, the use of environmentally friendly additives, cheap and available in the soil stabilization process is essential. In this regard, in recent years, geopolymerization processes have been introduced as the most serious alternatives to cement.

Review History:
Received: Feb. 18, 2022
Revised: Jan. 14, 2023
Accepted: Mar. 31, 2023
Available Online: Oct. 17, 2023

Keywords:
Clay
soil stabilization
geopolymer
uniaxial compressive strength
direct shear test

1- Introduction

Hu et al., 2008, investigated the mechanical characteristics of three source materials that were prepared through the geopolymerization process. The results showed that geopolymers had repair features rather than cement-based materials [1].

Oh et al., 2010, studied mechanical characteristics and the crystalline phases of fly ash-based geopolymers, Class C and Class F fly ashes. To increase the crystallinity of the geopolymer samples, the reactions were carried out at 80 °C. They found that the presence of blast furnace slag can decrease the permeability of geopolymer samples [2].

Sargent et al. studied the possibility of using waste materials in the geopolymerization process for stabilizing soft soils. Results showed that alkali-activated waste binders perform better than cement in deep soil mixing [3].

Yi et al., 2015, investigated the microstructural and mechanical properties of soft marine clay. They used the lime-activated ground granulated blast furnace slag to stabilize the soil and applied unconfined compressive strength, scanning electron microscopy, and X-ray diffraction tests. This study revealed that the stabilized clays with a lime/ground granulated blast furnace slag ratio of 0.1 were 1.7 times that of Portland cement stabilized clay. Regarding the economic and environmental aspects, using lime-activated ground granulated blast furnace slag instead of Portland cement can be beneficial [4].

As the first researchers, Phummiphan et al. utilized calcium carbide residue (CCR) as a promoter in the alkaline activator. They aimed to improve the strength of marginal lateritic soil. The results showed that CCR was prosperous in improving soil characteristics. CCR with small size functions as a connector, reacts with alumina and silica, and produces calcium. Besides, the high-calcium FA-based geopolymer with CCR can act as a green stabilizer of marginal lateritic soils. Consequently, it can be an alternative to conventional PC and develop a sustainable bound for pavement material [5].

Toufigh et al. investigated the usage of various concentrations of Taftan pozzolan as a new stabilizing material to enhance the mechanical specifications of soil. Results indicated that the stabilizing specimens have better quality than the control ones [6].

In this study, limpet mineral was used as a source material in the stabilization process to stabilize the clay. Also, an attempt has been made to investigate the role of calcium oxide (CaO) in this mineral for soil stabilization through geopolymerization. In this regard, a combination of sodium hydroxide and silicate adhesive has been used as an alkaline activator.

*Corresponding author's email: D_moazami@mshdiau.ac.ir

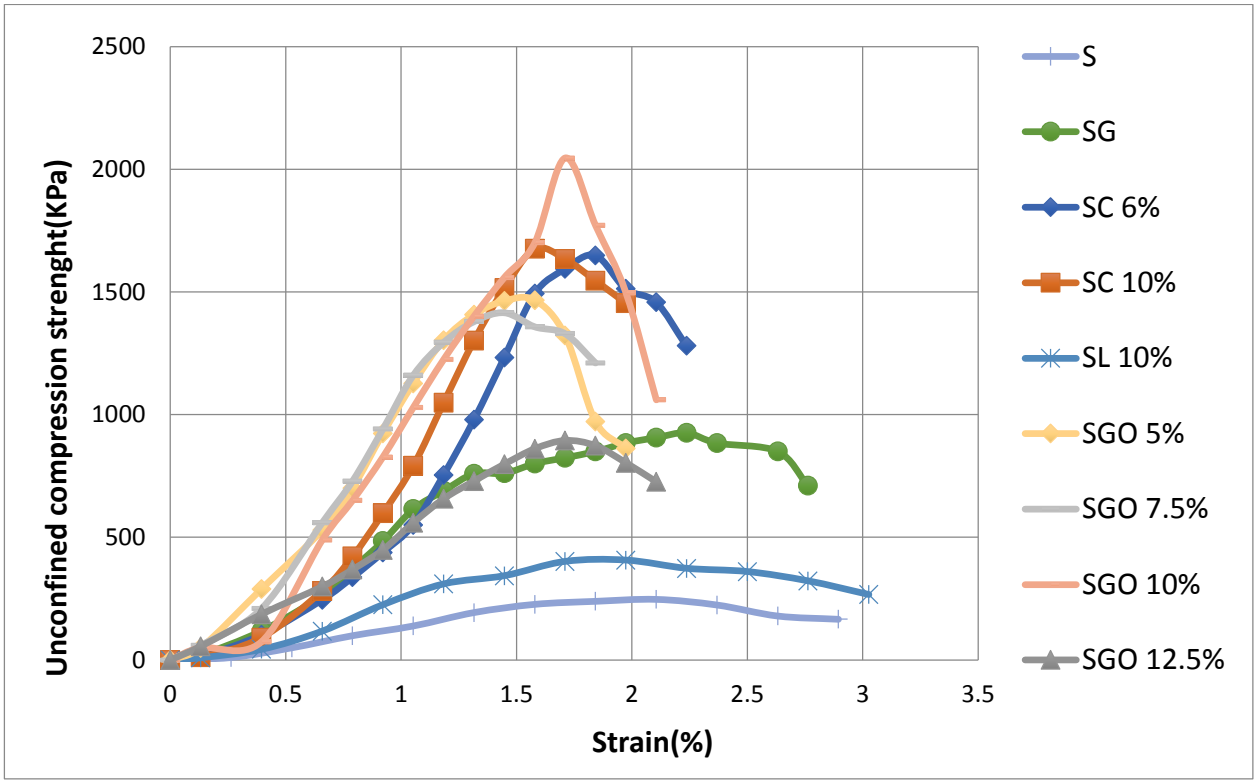

Fig. 1. Phase velocity dispersion curves for a steel pipe with outer diameter of 220 mm and wall thickness of 4.8 mm

2- Materials and Methods:

The uniaxial compression strength (UCS) test was used as the main criterion for comparing stabilized soil samples. Besides, the direct shear test was used to investigate the adhesion and internal friction angle of stabilized specimens. Chemical analysis of reactions and elemental lineage changes was performed by electron imaging (SEM) on selected samples.

3- Analysis and Conclusion:

The results show that increasing minerals rises uniaxial compressive strength (UCS). The results of the microstructural analysis show the reaction of iron slag residue, acetylene gas residue, and oyster mineral with soil and the formation of aluminosilicate gel in geopolymer samples. Based on the results obtained in this study, the use of residues and minerals with high CaO element in its structure can cause a significant increase in the strength of soil stabilized by the geopolymer method.

These materials can significantly increase the strength of soil stabilized by the geopolymer method. Utilizing 10 percent of minerals in the geopolymer method caused UCS of 671 KPa and 2/04 MPa in 7 and 45 curing time, respectively.

References

[1] S. Hu, H. Wang, G. Zhang, Q. Ding, Bonding and abrasion resistance of geopolymeric repair material made with steel slag, Cement and concrete composites, 30(3) (2008) 239-244.

[2] J.E. Oh, P.J. Monteiro, S.S. Jun, S. Choi, S.M. Clark, The evolution of strength and crystalline phases for alkali-activated ground blast furnace slag and fly ash-based geopolymers, Cement and Concrete Research, 40(2) (2010) 189-196.

[3] P. Sargent, P.N. Hughes, M. Rouainia, M.L. White, The use of alkali activated waste binders in enhancing the mechanical properties and durability of soft alluvial soils, Engineering geology, 152(1) (2013) 96-108.

[4] Y. Yi, X. Zheng, S. Liu, A. Al-Tabbaa, Comparison of reactive magnesia-and carbide slag-activated ground granulated blastfurnace slag and Portland cement for stabilisation of a natural soil, Applied Clay Science, 111 (2015) 21-26.

[5] I. Phummiphan, S. Horpibulsuk, P. Sukmak, A. Chinkulkijniwat, A. Arulrajah, S.-L. Shen, Stabilisation of marginal lateritic soil using high calcium fly ash-based

geopolymer, Road Materials and Pavement Design, 17(4) (2016) 877-891.

[6] M.S. Gol, V. Toufigh, Feasibility study of sandy soil stabilization with glass powder and natural pozzolan based geopolymer, Amirkabir Journal of Civil Engineering, 51(1) (2019) 169-182.

HOW TO CITE THIS ARTICLE

N. bahrami, D. Moazami,Sh. Pourakbar, The effect of calcium presence in limepet for clayey soil stabilization using the geopolymer method, Amirkabir J. Civil Eng., 55(11) (2024) 457-460.

DOI: 10.22060/ceej.2023.21117.7627