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# EXTENDED ABSTRACT

# Laboratory study of compressive strength, shear strength parameters, and durability against freeze-thaw cycles of silty sand improved with nano-silica and basalt fibers

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Compressive Strength, Shear Strength Parameters, Sand, Nano-silica, Basalt Fiber.

## 1. Introduction

Weak soils with unfavorable geotechnical characteristics cause many technical and economic problems in construction projects such as road construction. One of the solutions to the problem is soil improvement (Asgari et al., 2015; Bayat et al., 2021; Eshaghzadeh et al., 2021; Hadi Sahlabadi et al., 2021; Hakimelahi et al., 2023; Rezaei-Hosseinabadi et al., 2022, 2022; Saadat and Bayat, 2022; Tavakol et al., 2023). Many materials such as fiber, cement, lime, nanomaterials etc. have been used to improve of soils. On the other hand, previous studies indicate that freeze-thaw cycles have an important effect on the mechanical behaviour of geomaterials (Hadi Sahlabadi et al., 2021; Noroozi et al., 2022; Roustaei, 2021).

## 2. Methodology

This research investigates the compressive strength and shear strength parameters of sandy soil reinforced with basalt fibers and nano-silica as a new method of improving soils. For this purpose, a series of UCS and triaxial static tests have been conducted to investigate the effect of the content of basalt fibres, nano silica, and curing time.

## 3. Results and discussion

### *3.1. UCS results*

Fig. 1 shows the effect of nano-silica content and curing time on the UCS values of nano-silica stabilized specimens. As shown from the results, the specimens containing 10% of nano-silica show the highest values of UCS. On the other hand, the UCS values of specimens increase with increasing curing time. Fig. 2 shows the effect of fiber content and curing time on the UCS values of stabilized specimens with 10% nano-silica. As shown from the results, the specimens containing 10% of nano-silica and 1% of basalt fiber exhibited the maximum UCS values for a given curing time.

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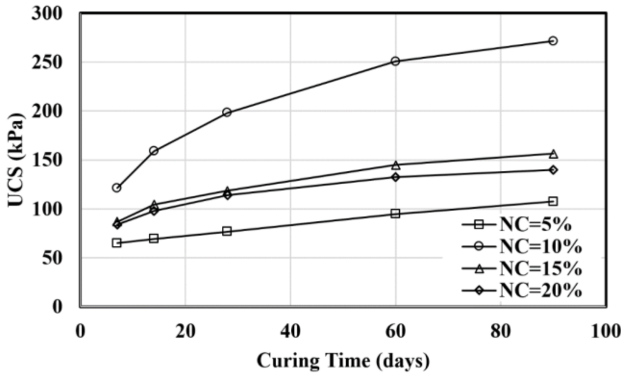


**Fig. 1.** Effect of nano-silica content and curing time on the UCS values of stabilized specimens.

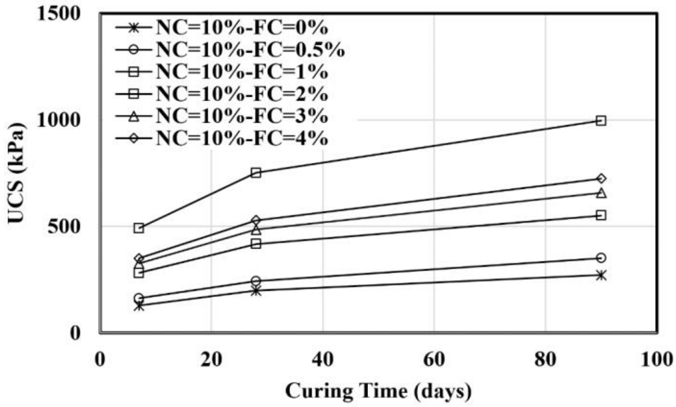


**Fig. 2.** Effect of fiber content and curing time on the UCS values of stabilized specimens with 10% nano-silica.

## *3.2. Triaxial test results*

Fig. 3 shows the Effect of fiber content on the maximum deviatoric stress and brittleness index. The results indicate that the reinforced specimen with 1% fiber has the highest value of deviatoric stress. On the other hand, adding fiber to the specimens resulted in a decrease in the brittle index. Fig. 4 shows the Effect of nano-silica content on the maximum deviatoric stress and brittleness index. The results indicate that the stabilized specimen with 10% nano-silica has the highest value of deviatoric stress. On the other hand, adding fiber to the specimens resulted in an increase in the brittle index. Fig. 6 shows the effect of freeze-thaw cycles on the shear strength parameters of improved specimens with 10% nano-silica and 1% basalt fiber. As you can see from the results, the shear strength parameters of specimens decrease with increasing freeze-thaw cycles.

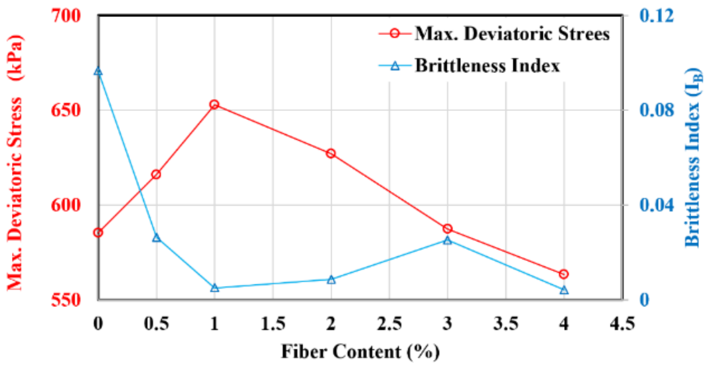


**Fig. 3.** Effect of fiber content on the maximum deviatoric stress and brittleness index

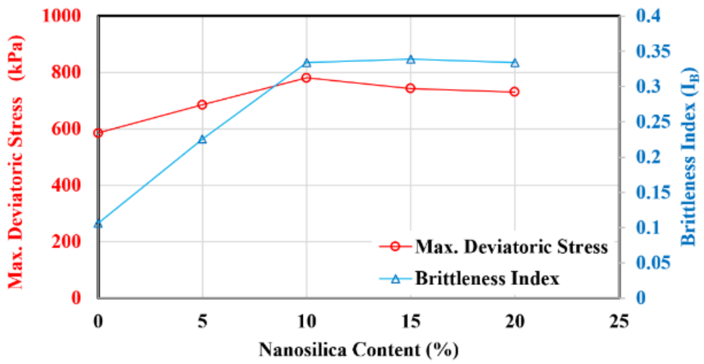


**Fig. 4.** Effect of nano-silica content on the maximum deviatoric stress and brittleness index

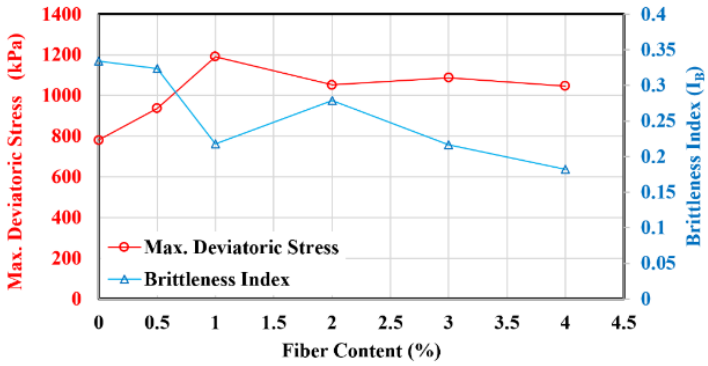


**Fig. 5.** Effect of fiber content on the maximum deviatoric stress and brittleness index of stabilized specimens with 10% nano-silica

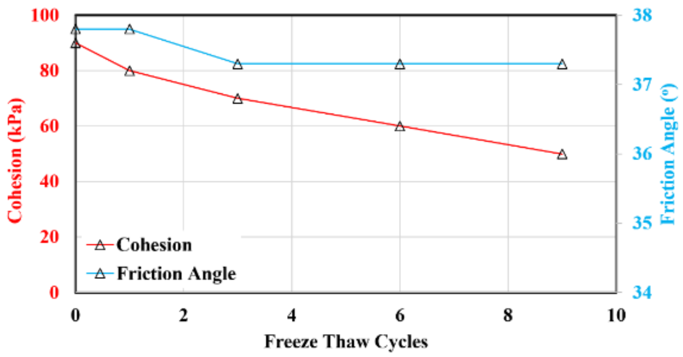


**Fig. 6.** Effect of freeze-thaw cycles on the shear strength parameters of improved specimens with 10% nano-silica and 1% basalt fiber

## 4. Conclusions

In this study, using UCS and triaxial static tests, compressive and shear strength parameters of sandy soil improved with basalt fibers and nano-silica were investigated. Based on the test results, the following results have been obtained:

1- Increasing the content of fibers from 0.5% to 1% increased the compressive strength of the sample, although after that, the compressive strength of the samples decreased with the increase of the content of fibers from 1% to 4%. However, increasing the content of fibers from 0.5% to 4% has increased the strain corresponding to the maximum compressive stress.

2- The results obtained for the samples stabilized with nano-silica show that the samples containing 10% nano-silica have the highest resistance. Increasing the content of nano-silica from 5 to 10% has increased the resistance, and then increasing the content of nano-silica from 10 to 20% has decreased the resistance. Increasing the curing time from 7 to 90 days has caused a significant increase in the compressive strength of the samples. The effect of the content of nano-silica has become more significant with the increase of curing days from 7 to 90 days, and it has also caused more brittle behavior of the samples.

3- Comparison of the results of samples improved with fibers and samples improved with nano-silica shows that the samples containing nano-silica have obtained higher compressive strength.

4- Based on the results, 1% of basalt fibers has been found as the optimal content, which has shown the highest compressive strength.

5- The results of triaxial static tests show that basalt fibers have increased all parameters of shear resistance, friction angle and adhesion. Although the increase in adhesion is greater than the friction angle.

The addition of nano-silica compared to the pure sand sample has also increased the resistance. Nano-silica has caused a slight increase in the friction angle and a significant increase in cohesion, which is due to the phenomenon of cementation created by nano-silica particles between sand particles.

6- Increasing the freeze-thaw cycles has caused a significant decrease in the maximum stress. The freeze-thaw cycles have caused a significant decrease in the cohesion of the sample while the friction angle has changed much less.

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