Mechanical Behavior and Permeability of Acrylamide Grouted Sands

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Abstract:

In order to investigate the effects of sands on the mechanical properties and permeability of grouted sands, several sands were grouted using acrylamide chemical grout and tested. The influence of relative density of sands, fines content (particle size<0.075 mm), curing conditions and dilution were investigated. The strength of grouted sands increased with fines content, and remained unchanged after 28 days of curing. The permeability of grouted sands was in the order of 10^{-10} cm/sec and was not affected by up to 50 % dilution.

1. Introduction:

During the last 40 years various chemical grouts have been developed and used in controlling sewer leaks. Among the chemical grouts, acrylamide based grouts come close to satisfying the attributes of an ideal grout (Karol 1990). In 1991, EPA proposed a regulation to prohibit the manufacture, importation, distribution and use of acrylamide based grouts due to the health risks with grouting workers. This proposition was withdrawn by the EPA in December 2, 2002 with the availability of affordable personal protective equipment that provides adequate protection to workers (EPA Federal Register 2002). Acrylamide grouts have low initial viscosity until the very end of the gelling stage when they rapidly set, and develop adequate strength for most applications. These grouts have initial viscosities close to that of water (1 cP) and can penetrate into formations with a coefficient of permeability as low as 10^{-4} cm/sec (Karol 1990). Unconfined compressive strength has been used in determining the quality of grouted sand regardless of application related to strengthening or reducing permeability of soil. However, little is known about the relationship between strength and permeability of acrylamide grouted soil.

2. Objectives:

The overall objective was to investigate the influence of sand particle size and distribution, fines content and curing conditions on the mechanical properties and permeability of grouted sand,

3. Materials and Testing Method:

A commercially available "AV-118 Duriflex" N-methylolacrylamide (NMA) grout (Avanti Grout International, Webster Texas) was used for this study. Five different commercially available silicate sands were used in this study. These were coded as No.1, 2, 3, 4 and 5 sands. Effective grain size (d_{10}) ranged from 0.09 mm to 0.7 mm. Particle size distributions of experimental sands are shown in **Fig.1**. All the sands tested were classified as poorly graded sands based on USCS Classification. The coefficient of curvature (C_c) ranged from 0.95 to 1.48, and coefficient of uniformity (C_u) ranged from 1.2 to 3.4. CIGMAT test methods were used to determine the mechanical properties and permeability of grouted sands.

4. Results and Discussion:

Based on the test results following could be concluded:

(a) Unconfined compressive strength of grouted sand was influenced by the particle size and gradation, relative density, and fines content of sands. The finer the particle, the higher was the compressive strength and it varied by 300 % in the particle size range investigated. Grouted sand strength did not change after 3 days curing. Stress-strain relationships of acrylamide grouted sands are shown in **Fig.2**.

(b) The permeability of grouted sand was not influenced by the sand type, and was in the range of 10^{-10} cm/sec. There was no correlation between the unconfined compressive strength and permeability of acrylamide grouted sands. Permeabilities of various sands and grouted sands are shown in **Fig.3**.

5. Conclusion:

The strength of grouted sand was influenced by particle size and distribution and fines content of soil while the permeability of grouted sands did not vary with soil properties.

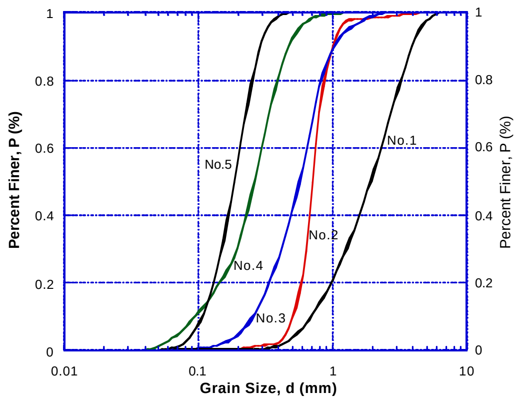

Figure1. Particle Size Distribution of Experimental Sands

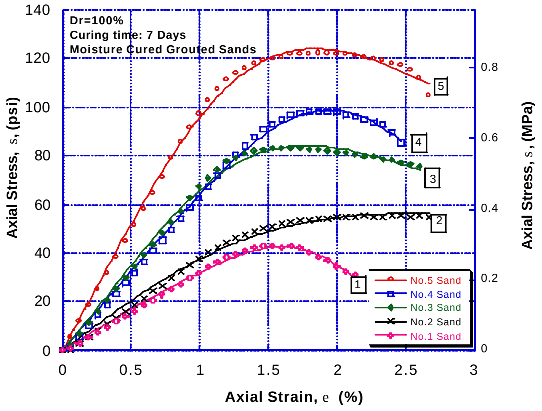

Figure2. Stress-Strain Relationship of Grouted Sands

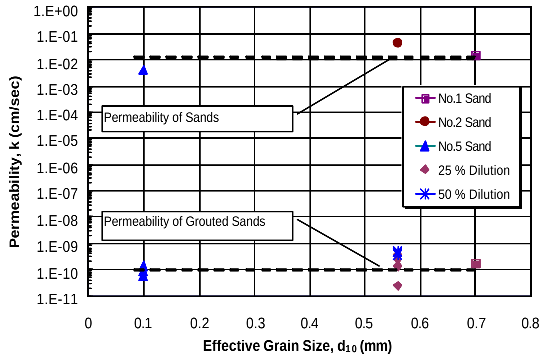

Figure3. Permeability of Sands and Grouted Sands

5. Acknowledgements:

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6. References:

(1) EPA, "Federal Register," Vol. 67, No. 231, December 2, 2002.

(2) Karol, Chemical Grouting, Marcel Dekker, Inc., New York,1990.

(3) "Standard Test Method for Compressive Strength and Stress-Strain Relationship for Grouts and Grouted Sands," Standard No. CIGMAT GR 2-02, 2002.

(3) "Standard Test Method for Permeability of Grouts and Grouted Sands," Standard No. CIGMAT GR 7-02, 2002.