Effect of Fines Content on the Mechanical Behavior and Groutability of Acrylamide Grouted Sands

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Abstract:

The effect of fines content (particle size<0.075 mm) on the groutability and mechanical properties of grouted sands were investigated. The sand-silt mixes, fines contents varying from 0 % to 27 %, were injected with acrylamide grout using injection pressures up to 140 kPa (20 psi), equivalent to a hydraulic gradient of 155. A relationship between grouting pressure and fines content has been developed from the groutability study. Grouted sand strength increased with the fines content.

1. Introduction:

Groutability of soil is of primary concern in field applications. A groutable soil is one which, under practical pumping pressure limitations, accept the injection of a chemical grout at a sufficient flow rate to make the project economically feasible (Baker 1982). The initial permeability or the grain size distribution is used to determine the groutability of soil. Acrylamide based grouts can be easily pumped into soils with initial permeabilities as low as 10^{-4} cm/sec (Baker 1982). Also, soils with fines content more than 20% (particles smaller than #200 US sieve size) have been reported to be non-groutable (Baker 1982). Overburden pressure of soil to be grouted posts another limitation to the groutability of soil. Practically, the grout injection pressure is limited to overburden effective pressure of soil to avoid disturbance and fracturing of soil, and prevent heaving during grouting process.

2. Objectives:

(a) To quantify the groutability of acrylamide grout into sand-silt mix based on fines content and grouting pressure; (b) To investigate the effect of fines content on the mechanical properties 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. For the groutability study, No.2 sand and A, B, C and D silty-sands having fines contents of 3 %, 6 %, 12 % and 27 % respectively, and silt (commercially named Silcosil 250 and designated as E in this study) were used. The particle size distributions of sands are shown in Fig.1. Silty-sands had relative densities of 100 %, and the void ratios varied from 0.53 to 0.32.

4. Results and Discussion:

(a) The compressive strength of grouted sands increased from 55 psi to 95 psi with increasing the fines content from 0 % (No.2) to 6 % (B). The variation of strength with fines content is shown in Fig.2.

(b) Groutability of sand with acrylamide grout was influenced by the fines content (silts) and the grouting pressure-fines content relationship was non-linear (Fig.3). Acrylamide grout was injected into sand-silt mixes having permeabilities as low as 10^{-5} cm/sec (12 % Fines) using a grouting pressure of 117 kPa (17 psi).

(c) The injection pressure required for grout injection increased from 24 kPa (3.5 psi) to 117 kPa (17 psi) with the increasing fines content of sand from 6 % to 12 %. The permeability of soil with 12 % fines was 5 x 10^{-5} cm/sec. Acrylamide grout failed to permeate into more than ¼ of the total height (3.6 in) of sand column at a grouting pressure of 138 kPa (20 psi) when the fines content of sand-silt mix was 27 %.

5. Conclusions:

Compressive strength and elasticity modulus of grouted sands increased by increasing fines content, and groutability of sand is affected by the fines content.

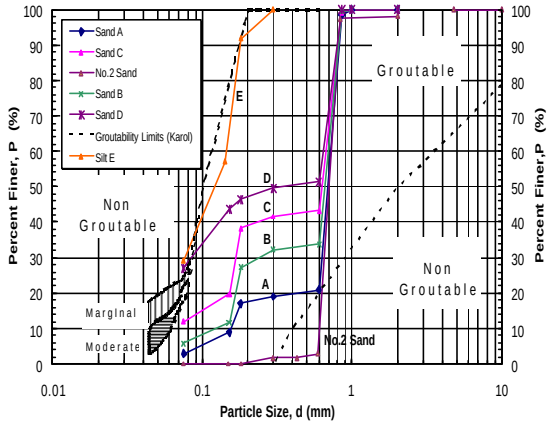

Figure1. Particle Size Distribution of Experimental Sands

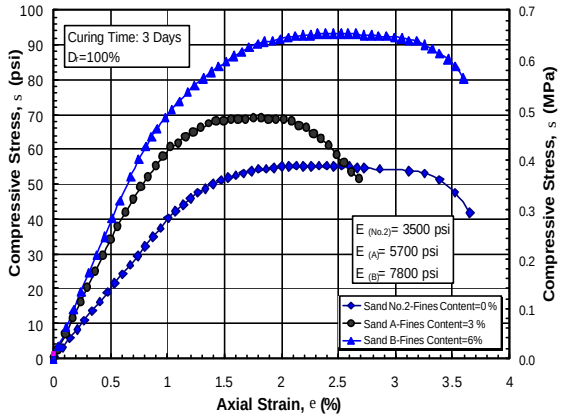

Figure2. Stress-Strain Relationship of Grouted Sands

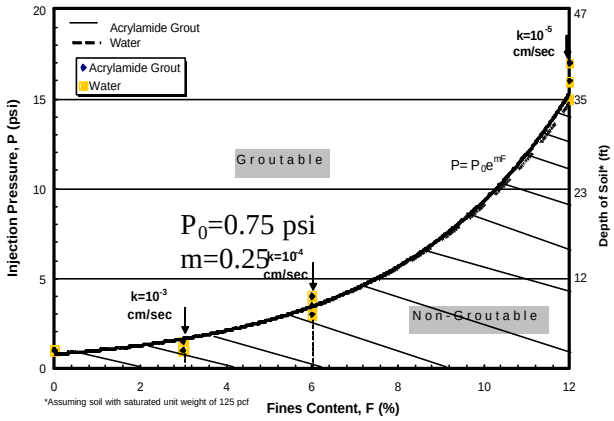

Figure3. The Variation of Grouting Pressure as a Function of Fines Content.

5. Acknowledgements:

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6. References:

(1) Baker W.H., "Planning and performing structural chemical grouting," Proceedings of the ASCE Specialty Conference Grouting in Geotechnical Engineering, Feb. 1982, ASCE, New York.