Permeability of Sand with Bentonite Slurry

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Extended Abstract

(Paper pages 299-318)

Introduction

Bentonite has been used industrially in various construction projects. This material is used, due to its limited hydraulic conductivity, in some cases such as landfill, sealing walls and nuclear waste disposal tanks. Recently, many researchers have investigated the use of bentonite slurry systems for injection into granular soils under static and dynamic loading conditions in order to improve soil engineering performance. In this condition, bentonite slurry is deposited in a loose soil with low pressure and without disturbance in the structure of the soil under injection. Due to the nature of the thixotropy of the bentonite slurry, the injected material is deposited in the form of gel structures in the soil and leads to increasing soil resistance to static and dynamic loads. For suitable soil engineering properties in granular soil, the use of concentrated bentonite slurry is appropriate; high concentrations will limit the penetration of bentonite due to low soil permeability. In order to overcome this limitation, slurry rheological properties such as viscosity must be corrected in order to increase the depth of sand penetration. Other researchers observed that with the reduction of viscosity in the cement slurry with micro-size particles, the amount of its penetration in the sand column significantly increased.

In present paper, due to the lack of studies on the penetration rate of bentonite in sand and also the effective role of bentonite in the mechanical properties of sandy soils, the permeability of sandy soils by bentonite under the influence of change factors such as concentration of bentonite in injection suspension were investigated.

Material and Methods

In the present study, Firoozkooh sand samples with the traditional names of 131, D11 and D1 were used for testing. Different concentrations of bentonite slurry which is used in this study are 3, 5 and 7% of the bentonite to water ratio.

Figure 1 shows the location of the reading of the penetration length and Figure 2 shows variations in the length of infiltration against time for different heights of the pressure head.

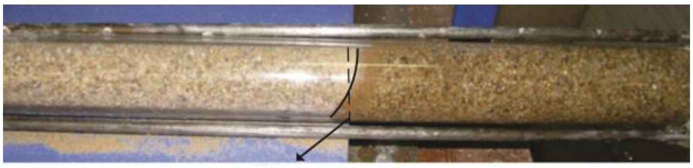


Figure 1. The reading point of the penetration length in the sample

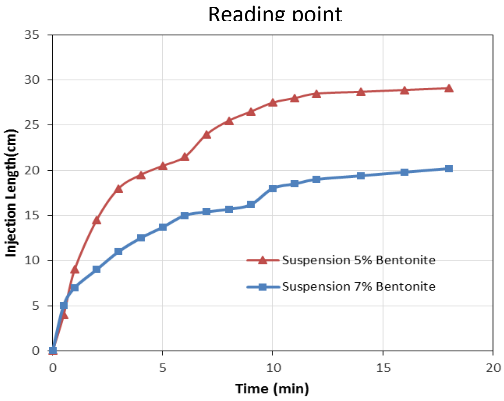
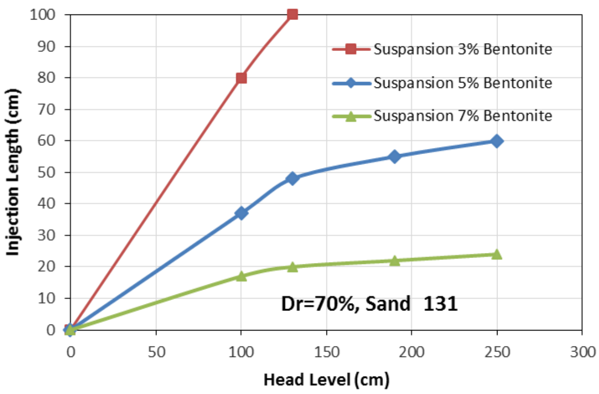


Figure 2. Bentonite slurry injection length versus time

Results

Figure 3 shows the variations of penetration length versus pressure heads for samples with a relative density of 70% at concentrations of bentonite slurry of 3, 5 and 7% in different aggregates. It can be stated that while the concentration of bentonite to water increases, the longitudinal penetration of the injected substance into the sample is reduced. For example, in sand 131 with Dr=70% the penetration value at a pressure head of 130 cm for suspension containing 3% bentonite slurry is 100 cm. The same values for samples containing 5% and 7% bentonite are 45 and 20 cm respectively. This is due to the increase in the presence of bentonite slurry (solid substance) in the suspension. The greater amount of solids inside the suspension causes the greater contact between sand grains with solid particles of suspensions. As a result, it causes increasing friction for longitudinal motion. Therefore, with increasing the concentration of suspension the length of its movement in the soil is reduced. Also, due to the increased viscosity of the injectable substance with increasing the amount of bentonite, the forward movement of the suspension under constant pressure is reduced. This is another important parameter that leads to a reduction in the length of the injection by increasing the concentration of the bentonite slurry.

It is also observed that the variation of penetration in higher concentrations is less than the low concentration. For example, in sand D1 (coarse sand) at a pressure height of 100 cm, the penetration rate at a concentration of 5% increases by 35% compared to a concentration of 3% and at a concentration of 7% increases by 300% compared to the sample containing 3% bentonite. This indicates that at less than 5% concentration the presence of bentonite in the sample is less effective, and the suspension can be more easily move between the pores. This result indicates that by reducing the pores inside the sand, the effect of changing to the suspension concentration is reduced.



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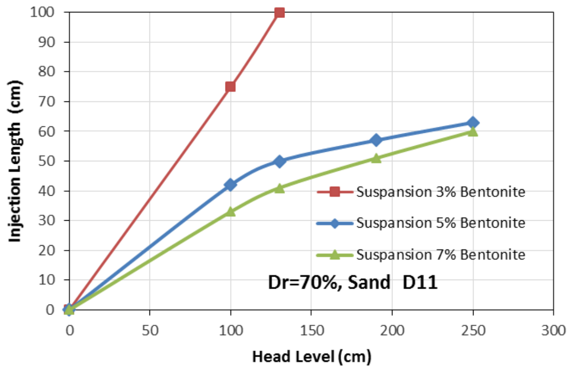

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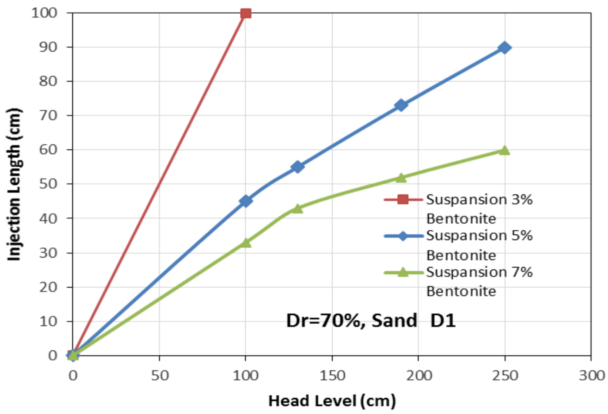

c

Figure 3. Penetration length versus pressure level for specimens with a Dr=70% in concentrations of bentonite of 3, 5 and 7% in different aggregates; a) fine sand (sand 131); b) moderate sand (sand D11); c) coarse sand (sand D1)

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