Title

Measurement of the Hydraulic Conductivity of Gravels Using a Laboratory Permeameter and Silty Sands Using Field Testing with Observation Wells

Author

Aaron Judge, *University of Massachusetts Amherst* Follow

Date of Award

5-2013

Document Type

Open Access Dissertation

Degree Name

Doctor of Philosophy (PhD)

Degree Program

Civil Engineering

First Advisor

Don J. DeGroot

Second Advisor

David W. Ostendorf

Third Advisor

David F. Boutt

Subject Categories

Civil and Environmental Engineering

Abstract

A new laboratory permeameter was developed for measuring the hydraulic conductivity of gravels ranging from 0.1 to 2 m/s. The release of pneumatic pressure applied to the test specimen induces an underdamped oscillatory response of the water level above the permeameter, similar to an underdamped in situ slug test response in monitoring wells. A closed form model was derived to calibrate the hydraulic minor losses in the permeameter and the hydraulic conductivity of the specimen by performing tests without and with a specimen. The majority of each test series performed on individual specimens produced hydraulic conductivity values within 10% of the average, which is very small for such a measurement.

Tests were performed using the permeameter on a collection of subrounded and angular gravels prepared to measured grain size distributions and porosities. The surface area was determined by evaluating the shape and angularity using a method developed in this research and these parameters were used with the measured tortuosity and hydraulic conductivity, to back calculate the packing factor of the Kozeny-Carman equation. The results show that the packing factor for the gravels and materials tested is proportional to the tortuosity cubed. These results provide a valuable update to the Kozeny-Carman equation for predicting the hydraulic conductivity of gravels.

Field slug interference tests were performed in pairs of monitoring wells installed at the same elevation in a floodplain deposit of silty sand in Dedham MA. Slug tests were performed in one of the wells while the response was monitored simultaneously in both wells. The measured responses were both analyzed by modifying the KGS model of Hyder et al. (1994) to consider the wellbore storage and filter packs effects. This modification was found to produce estimates of hydraulic conductivity based on the slugged well response that compared well with that estimated based on the observation well's response. Calibrated hydraulic conductivities for the pairs of wells tested ranged from 4x10-6 to 1.5x10-5 m/s and specific storage ranged from 2x10-5 to 7x10-4 m-1.

Recommended Citation