Expanded Testing Capabilities for Environmental Engineers

COOPER TESTING LABORATORY

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INSIDE THIS ISSUE:

Cooper Testing Labs is pleased to announce that we have expanded our testing capabilities in order to better serve the needs of our environmental clients.

AIR PERMEABILITY

The latest addition to our testing capabilities is ASTM D 6539 Measurement of Pneumatic Permeability of Partially Saturated Porous Material by Flowing Air. This test can help quantify how air or vapors move through the soil in the vadose zone and is useful for vapor intrusion projects or where vapor extraction, air sparging or bioventing may be utilized. Air permeability is one of the most sensitive parameters associated with advective transport of vapors in the vadose zone. Adequate characterization of the zones of interest through accurate air permeability testing can provide solid data for risk assessment efforts or assist in the optimal placement of injection or extraction wells. The benefit of performing air permeability testing in the lab vs. field testing is that the testing in the lab is conducted under very controlled conditions. The boundary conditions are well defined and the testing parameters can be modified if needed to model specific field conditions such as changes in moisture content.

While field testing measures a larger volume of soil than lab testing, the modified Hvorslev equation used for field air permeability testing assumes a uniform and isotropic soil condition. Uniform and isotropic are not typical soil conditions. We witness non-uniform and anisotropic soil conditions here in the lab every day. Even when the soil appears to be isotropic, the horizontal permeability can be significantly higher than the vertical permeability.

This test is similar in concept to the hydraulic conductivity test but the equipment required to perform it is quite different. We use a series of very accurate mass flow controllers along with a very sensitive differential pressure transducer to control and measure the flow rate of air and measure the pneumatic gradient across the sample. As with the hydraulic conductivity test, the air permeability test is based on Darcy's law.

Our equipment exceeds the standards set forth in ASTM which helps ensure that the data we provide will accurately reflect the sample being tested. We run a series of tests at different flow rates and verify that the data are sound and conform to Darcy's Law. The DTSC, in their interim final vapor intrusion guidance document (Feb. 7, 2005), expresses concern about applying too high a confining pressure which may bias the results low by reducing the porosity of the sample. We share this concern and we know that the air permeability test is sensitive to changes in confining pressure. We exceed the requirements of ASTM in this area and maintain the confining stress to within 0.1 psi of the target throughout the test. When you submit a sample to us for this test we will be happy to work with you to determine the appropriate target confining stress that will reflect the in-situ stress.

TESTING OPTIONS

The air permeability test can be run at the in-situ moisture content to provide the effective (aka native state) permeability. Effective permeability is defined as the permeability of one fluid (e.g. air) when the pore spaces also contain another fluid (e.g. water). The relative saturations of the two fluids as well as the properties of the porous medium affect the effective permeability. The test can also be run at an air-dried condition to provide the intrinsic (aka specific) permeability. Intrinsic permeability is defined as the permeability to a specific fluid (e.g. air) when that fluid is the only fluid present. The air permeability test can also be performed in either the typical vertical orientation or, if the diameter is large enough, a subsample can be trimmed for a horizontal sample.

JOHNSON & ETTINGER MODEL

The air permeability test data can be used in the Johnson-Ettinger model instead of assuming an air permeability value. In an effort to be as seamless as possible with the J&E (Johnson-Ettinger) model we include a data tab in our report that presents the data in the format of the J&E spreadsheets. Data included on this tab includes the soil vapor (pneumatic) permeability in cm^2, the SCS (USDA) soil type (if a sieve analysis is performed), soil dry bulk density in g/cm^3, soil total porosity (estimated unless the specific gravity test is also performed) and the soil water-filled porosity in cm^3/cm^3 (estimated unless the specific gravity test is also performed).

EFFECTIVE POROSITY*

We also offer the effective porosity testing for clients who need to estimate the velocity of groundwater flow. The test method we employ uses a pressure plate extractor to drain water

from the sample under very controlled conditions to a matric potential of 1/3 bar. This potential has been associated to the specific yield or field capacity which is the moisture content where the gravitational force causing water to drain is equal to the capillary forces holding the water to the soil. At this point the larger pore spaces are drained and the smaller ones are still saturated. It is these larger pore spaces that contribute the most to the flow of water. We determine the air-filled porosity at this point and equate that to the effective porosity. When you ask for this test we will determine and report the following parameters:

Effective porosity
Total porosity (θt)
Specific Gravity (Grain Density)
Moisture Content
Volumetric water content (θw)
Volumetric air content (θa)
Bulk density (Wet and Dry)

*While the total porosity is defined as the volume of voids/ the bulk volume of the sample (volume of voids plus volume of solids) not all of the void space contributes in a significant way to the flow of water. Some of the voids are isolated, are too small or are filled with water which is adsorbed to the clay minerals or other grains. Effective porosity is basically defined as the volume of voids that contribute in a significant way to the flow of water divided by the bulk volume of the soil. The effective porosity can approach the total porosity in the case of clean coarse sands and can approach zero in the case of clays but it is always less than the total porosity.

IRON QUANTIFICATION FOR IN-SITU TREATMENT OF PERMEABLE REACTIVE BARRIERS

If you are using zero valent iron to treat chlorinated volatile organic compounds such as TCE, Cooper Testing Labs can help you quantify the amount of iron injected into the soil. We have developed a technique that combines dispersion and both gravity and magnetic separation to separate the iron from the soil for quantification. This method is effective at capturing over 97 percent of the injected iron in the sample and also accounts for naturally occurring ferrous materials that may be present in the soil. If you are using iron coated with granular activated carbon let us know and we will adjust our testing protocol accordingly.

Air Permeameter

LEAD SHOT CHARACTERIZATION AND QUANTIFICATION FOR PROJECTS AT TRAP, SKEET, & SHOOTING CLAYS RANGES

Cooper Testing Labs is experienced in providing testing services where lead shot or slugs are mixed with the soil. We have developed procedures that are very effective at separating shot from soil so it can be characterized or quantified. This method of shot quantification can test relatively large volumes of soil (up to 6"x6"x4" or 0.0625 ft^3 or about 7 lbs) which can provide very accurate lead shot concentration values. Alternatively, the sample size tested by an analytical laboratory is very small (about 1 gram). Samples this small can result in wildly erratic values when lead shot is in the soil.

We recommend a pilot testing program where we can optimize our lab techniques to the physical characteristics of the project soils and your specific project requirements. If you need lead shot differentiated from bismuth or steel shot let us know and we will work up a customized laboratory testing program for you.

OTHER TESTING WE OFFER TO ENVIRONMENTAL ENGINEERS

Hydraulic Conductivity
(permeability) ASTM D5084
Total Porosity API RP40 - this includes:
Specific Gravity (Grain Density)
Moisture Content
Volumetric water content (θw)
Volumetric air content (θa)
Bulk density (Wet and Dry)
Organic Content, ASTM D2974
Fraction Organic Carbon, (FOC) by Walkley Black – subcontracted
Grain Size Distribution , ASTM D422 (Sieve and Hydrometer –Gravel, Sand , Silt and Clay sizes evaluated)
Sieve Analysis, ASTM D422 (Gravel and Sand sizes evaluated only)
#200 Wash, ASTM D1140 (only % passing #4 and #200 sieves)

SAMPLING PROBLEMS CAN AFFECT TEST RESULTS

Many of the tests that we perform for environmental engineers are sensitive to sample disturbance. The density of the soil and the arrangement of the soil particles can have a significant impact on the soil properties we measure in the lab. Tests that are impacted by sample disturbance include both water and air permeability, total and effective porosity, bulk density and the volumetric air and water content. For all of these tests no lab can provide representative test results if the samples are not representative of the in-situ conditions. The method of sampling and the way the samples are handled are key here. In our experience at Cooper Testing Labs samples that are a minimum of two inches in diameter have the best chances of being "undisturbed" and representative of the in-situ conditions. The smaller the sample diameter, the

more disturbed the sample is likely to be. If you have no choice but to use a direct push sampler we recommend that any samples for geotechnical testing are collected in a push not exceeding one foot. We have observed that the longer the push the more disturbed the soil is. We have written about this topic in a previous newsletter in 2009. For more information you can read this newsletter on our website: http://www.coopertestinglabs.com/pages/Newsletters/news.htm

Testing packages that we offer

In order to simplify your task of assigning tests we have put together testing packages that commonly meet the needs of environmental projects

Vadose Zone Package 1 ($650)

Air Permeability (k) ASTM D6539
Total Porosity (θt) - API RP40 and
Grain Density – ASTM D854
Moisture Content - ASTM D2216
Volumetric Water Content (θw) ASTM D2216
Volumetric Air Content (θa)
Bulk density (Wet and Dry) (ρs) - ASTM 2937
FOC Soil Fraction Organic Carbon - Walkley-Black method OR TOC – Percent Organic Content – ASTM D2974(CTL Default)
Grain Size (sieve and hydrometer) ASTM D422
Soil Classification by USCS (USDA by request)

Vasose Zone Package II ($320)

The same as Vadose Zone Package-I but without Air Permeability

Hydrogeology Package I ($645)

Total Porosity (θt) - API RP40
Effective Porosity API RP40
Grain Density – ASTM D854
Moisture Content –ASTM D2216
Volumetric Water Content (θw)
Volumetric Air Content (θa)
Bulk density (Wet & Dry) (ρs) ASTM D2937
Hydraulic Conductivity – ASTM D5084
Grain Size (sieve and hydrometer) ASTM D422
Soil Classification by USCS (USDA by request)

Hydrogeology Package II ($515)

Same as Hydrogeology Package-I but without Effective Porosity

We hope that these additions to our schedule of tests will make it easier to request. We do have an environmental engineer on staff so if you have any questions or suggestions please call and Peter Jacke will be happy to assist you.

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Air Permeability ASTM D6539

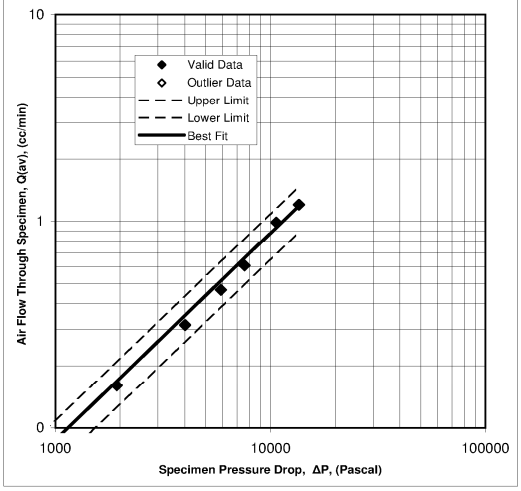
CTL Job No:	719-002	Boring: SB-3	Date: 9/27/2010
Client:	Acme Environmental Engineers	Sample:	By: PJ
Project Name:	Clearlake Cleaners	Depth, ft: 3	
Project No.:	RB-1	Sample Type: Undisturbed, Field Moisture	
Soil Description:	Mottled Light Olive Brown CLAY w/ Sand	Determined Gs 2.82	
Intrusions, if any:		Assumed Gs	

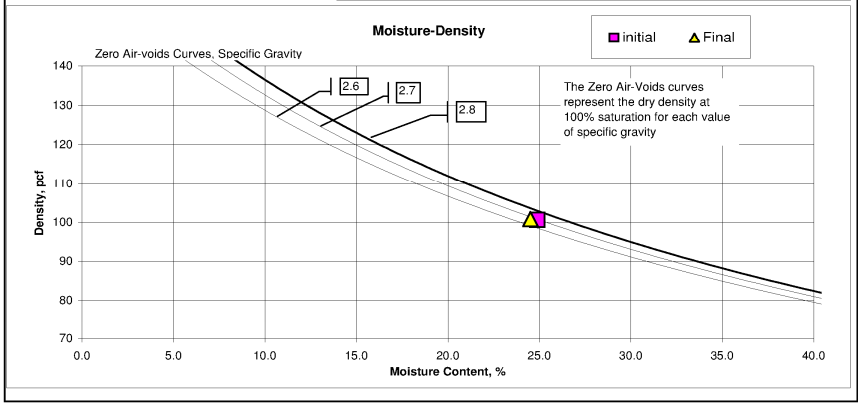
Test Result	
Coefficient of Pneumatic Permeability, K_P	
milliDarcy	cm^2
2	1.6E-11

Test Parameters	
Test Gas:	Dry Air
Flow Orientation Relative to Bedding:	Perpendicular
Effective Confining Stress, psi	2.6

Comments: Confining stress based on initial wet density and the sample depth. The final sample dimensions and associated values are approximate.

Specimen Parameters	Initial	Final
Sample Height, in.	2.53	2.52
Sample Diameter, in.	1.43	1.43
Wet Wt of Soil,g	133.12	132.72
Moisture Content %	24.9	24.5
Wet Unit wt, pcf	125.7	125.5
Dry Unit wt, pcf	100.6	100.8
Saturation, %	93.5	92.4
Total Porosity, %	42.9	42.8
Air filled Poros.,%	2.8	3.2
Water filled Poros.,%	40.1	39.6
Void Ratio	0.75	0.75





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GRAIN-SIZE DISTRUBUTION ON WATER

If you are designing a filter for a pump and treat system, evaluating sediment transport in a stream, or want to check the effectiveness of a settling basin Cooper Testing Labs can help. We have developed a procedure to provide gradation information for the sediment suspended in water. We can test samples that range from almost mud to almost clear. We provide gradation information from the largest particle size down to 1.5 microns and also provide TSS values. We accept sample sizes ranging from 0.5 liter for very high turbidity samples to 5 gallons for very low turbidity water. You can see an example report at our website in the "Test Description and Pricing" dropdown menu.