SSC 107 – LABORATORY EXERCISE 1

Physical Properties of Soils

Introduction

In the discipline of soil physics, the characterization of soils fundamentally involves measuring their physical properties. The flow and transport of fluids (water or gas), energy (heat), and chemical solutes are strongly dependent upon the properties of individual soil particles, as well as the composite soil matrix. The primary characteristics of interest include the distribution of particle sizes within the soil, the ratio of pore space relative to solid material, and the amount of water contained in the pore space. Particle size analysis is traditionally accomplished through a combination of mechanical sieving and sedimentation procedures (hydrometer or pipette method). A relatively new and promising technique for determining particle sizes involves the diffraction of laser light. Individual particles are classified according to their size (see chapter 1 lecture notes, or Jury et al., pg. 4), and the bulk soil is classified according to the relative proportions of each textural class (see handout of textural triangle). Other measurements of the bulk soil such as porosity and volumetric water content are accomplished by core sampling in the field and weighing of samples in the laboratory.

Procedure

1. Obtain one field core sample and one 105?C oven dried sample for each soil type represented in the lab.
2. Using the calibrated balance, weigh all samples *including* the tare weight of the core sleeves and the sampling tins.
3. Measure the diameter and height of the core sleeves, and calculate the total volume of the core samples (cm^3).
4. Calculate the dry bulk density (g/ cm^3), porosity (cm^3/ cm^3), gravimetric water content (g/g) and volumetric water content (cm^3/cm^3) for each soil. *Assume the mineral density of all soils equals 2.65 g/cm^3.
5. Assemble a table of raw data (measured weights) and calculated results (dry bulk density, porosity, etc…)
6. Obtain soil sample designated for Sieve Analysis and record the total dry sample weight (sample has previously undergone physical and chemical pretreatment including disaggregation by mortar and pestle and removal of organic matter by hydrogen peroxide).
7. Record the tare weight of each individual sieve and assemble the series of sieves from coarser on top to finer on bottom, according to the USDA textural classification system (Jury et al., pg. 4). **Remember to include the bottom pan*
8. Pour the soil sample uniformly across the top sieve (2mm) and secure the sieve stack on the automated shaker assembly.

9. Allow sample to shake on the sieves for 10-15 minutes (exact time depends on total mass of sample).
10. Use cover to carefully disassemble the stack of sieves.
11. Record the total weight of each sieve and subtract the tare weight to obtain the mass of sample retained on each sieve.
12. Use the initial total sample weight to calculate the percentage of sample within each designated textural class.
13. Plot the data in two graphs- one showing the percentage of sample retained versus particle diameter, the other showing the cumulative percent *passing* versus particle diameter (see results from laser particle size analyzer).

After completing the sieve analysis, two additional methods of Particle Size Analysis will be demonstrated. The first demonstration is the hydrometer method- a sedimentation procedure according to Stokes' Law. Because mechanical sieving is limited to particle sizes of 0.05mm or greater (sand and gravel size), fractionation between silt and clay size particles is accomplished by dispersing the sample in an aqueous solution and measuring the change in fluid density through time as particles settle out of solution. The velocity at which particles settle is directly dependent upon the square of the particle diameter, as well as particle density, fluid density and viscosity (see Jury et al., pg. 2-3). The second demonstration is the laser particle size analyzer. This method involves directing a laser beam at a soil suspension and measuring the resultant pattern of scattered light with photo-detectors. The diffraction pattern of each particle is dependent upon the size of the particle. By continuously measuring diffraction patterns from 126 separate detectors, a composite distribution of patterns is assembled by which the particle size distribution is calculated (see figures 1 and 2). This method is effective for measuring particles in the range of 0.4 microns to 2mm. Results of the laser analysis will be provided during the demonstration. **Your laboratory report discussion should focus on the variability of the laser analyzer results and a comparison of the different particle size analysis results and the methods presented in this lab.**

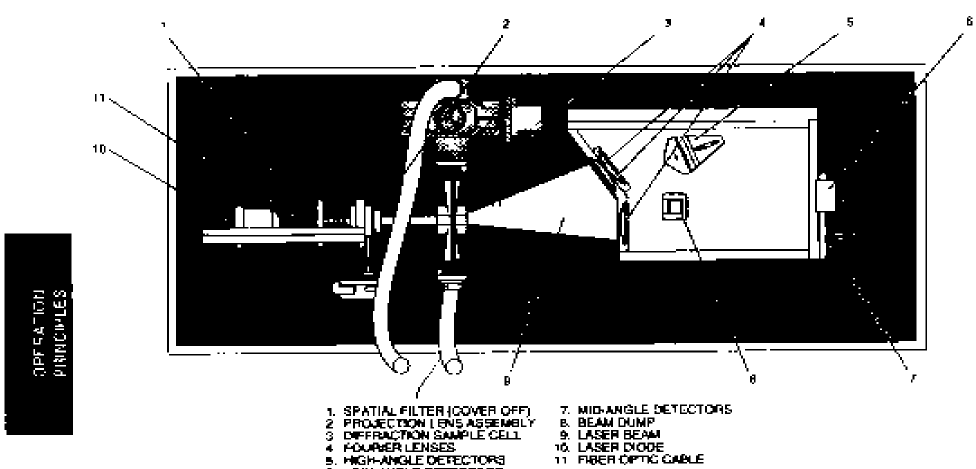

Figure 4.1 Laser Optical Path

Figure 1

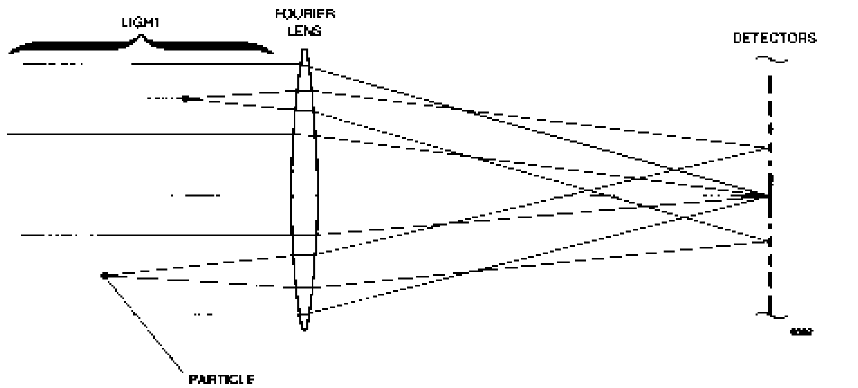

Figure 4.2 Fourier Lens Focusing

Figure 2

Questions

1. Is the Yucca Mountain Sand really a sand? Explain.

Lab Report Point Distribution

Abstract: 0.5
Methods: 0.5
Results: 2.0
Discussion: 3.0
Conclusion: 0.5
Question 1: 0.5
Overall Composition: 0.5

Total: 7.5