Exercise 1 - Soil Mechanics
ENV 601 - Spring 2009

Part A

1) a) determine the weights (mass) of gravel, sand, and silt/clay in the sample measured in class
b) take each portion as a percentage of the total mass

"pan" = _____

gravel + "pan" = _____

sand + "pan" = _____

silt/clay + "pan = _____

2) The mass of clay, silt, and sand was found from analysis of a soil sample. The mass proportions are as follows: 35% clay, 50% silt, and 15% sand.

a) plot on the supplied ternary diagram (like Fig. 16.3 in Keller, 4th ed.)
b) give the textural classification of the soil

Part B Complete the following problems (from Rahn, 1996)

1. (From Bouwer, 1978) For the soil sample described below, calculate the following parameters:
- **a.** water content by weight,
- **b.** porosity,
- **c.** void ratio,
- **d.** saturation percentage (ratio of water volume to total void volume),
- **e.** bulk density.

Data is for an undisturbed core sample of sandy soil taken above the water table. The net weight of the sample is 419 g before drying and 371 g after drying. The core sample is 10.19 cm high and has a 5 cm diameter. Assume the solids are quartz grains ($\rho = 2.65$ g/cm^3).

Hints: You'll need to calculate what you need for each part using what you already have.
also:
- look up formula for volume of a cylinder
- density = mass / volume so volume = mass / density
(using basic algebraic manipulation)

2. Organic clay from New London, Connecticut, and gumbo clay from Arkansas both have a liquid limit of about 65%, but the plasticity index of the Connecticut clay is about 25% whereas the Arkansas clay is about 50%. Plot data on Figure 5.6 and discuss significance.

Hint: Tell whether each soil will behave more as a silty or clayey soil and any benefits/problems associated with each

5. Refer to Figure 5.10. Below what approximate depth should foundations be anchored so that the highest seasonal value of water content (W_{max}) does not exceed the liquid limit?

Hints: In Figure 5.10
the horizontal bars' ends are the Atterberg limits of soil samples taken at various depths
left end of a bar is plastic limit
right end of a bar is liquid limit
the three sub-vertical curves are measured water contents of the soil at increasing depth
(the minimum, average, and maximum water content through the course of a year)
Consider that you don't want the soil beneath your foundation to ever liquefy.

6. (From *Soil Mechanics* by T.W. Lambe and R.V. Whitman, 1969. Reprinted by permission of John Wiley & Sons, Inc.) A sieve analysis on a soil yields the following results:

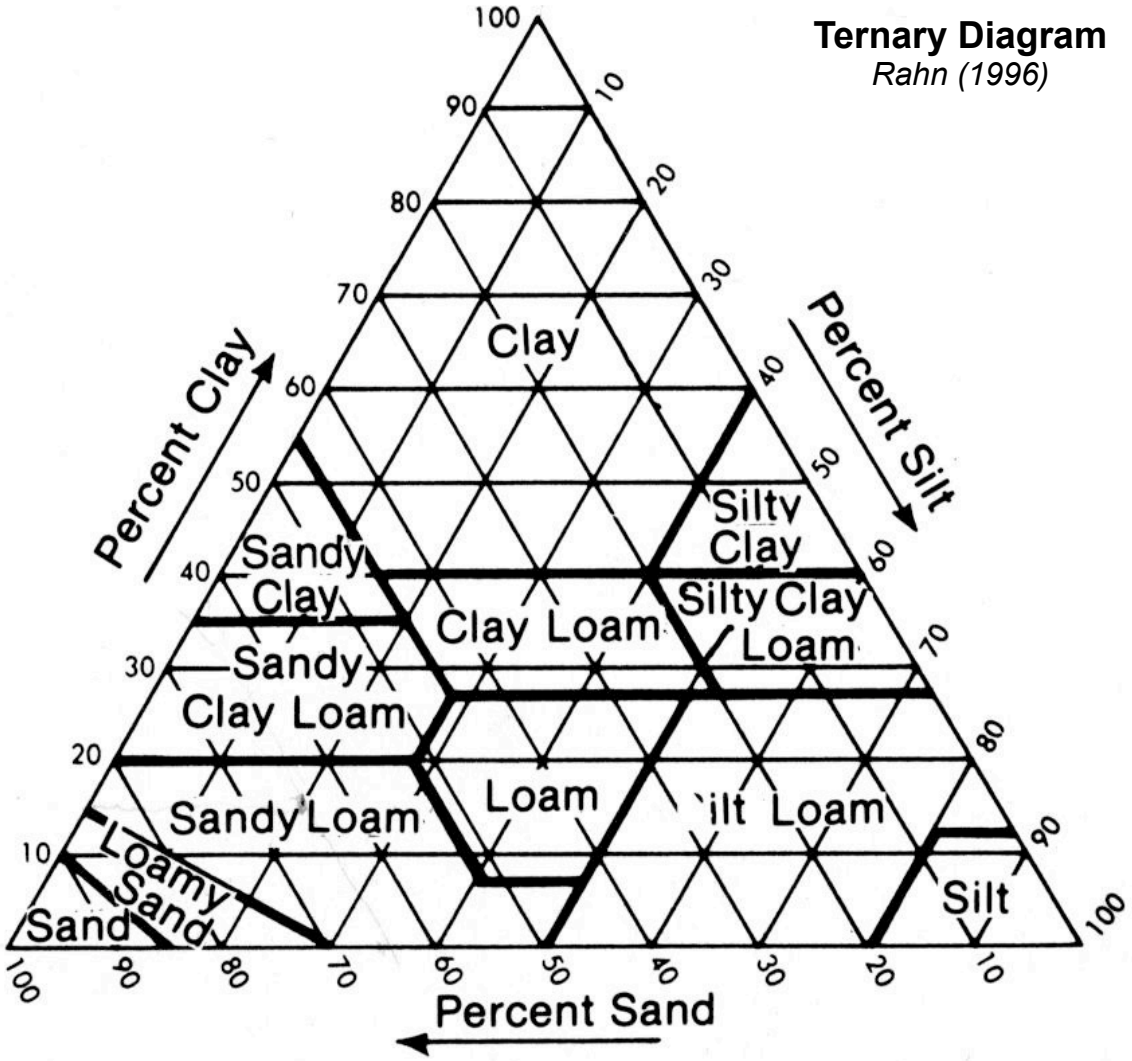
Sieve	3 in. (7.6 cm)	2 in. (5.1 cm)	1 in. (2.5 cm)	0.5 in. (1.2 cm)	#4	#10	#20	#40	#60	#100	#200
Cum. % passing by wt	100	95	84	74	62	55	44	32	24	16	9

a. Plot the particle size distribution as a curve on the graph at the top of the next page.
b. Classify the soil according to the scale shown on the graph.
c. Determine the uniformity coefficient.
d. Make a general comment on the suitability of this soil as a drainage material behind a concrete retaining wall. (Hint: To drain properly, the soil must be very permeable. To mitigate frost heave, less than 3% of the soil should be finer than 0.02 mm in size.)

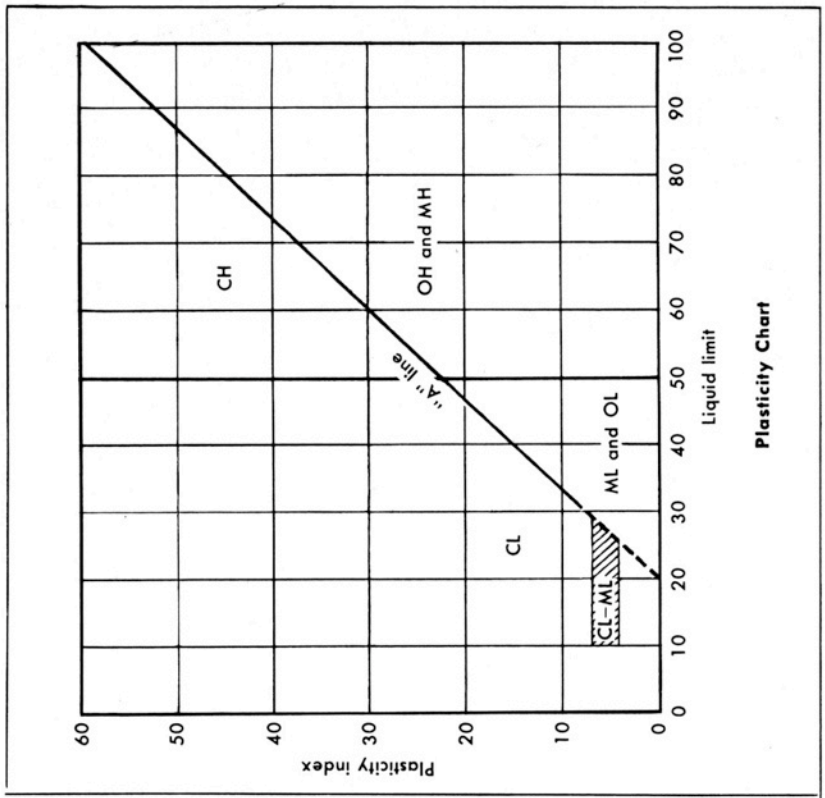
Hints: Use the included graph paper.
Plot the points and connect them with a smooth curve.

The classification name is based on the most abundant and the second most abundant grain size range. For example if the sample is 40% silt and 60% sand, it would be classified a silty sand. So you will need to determine the percentage of gravel, sand, silt, and clay in the sample.

Ternary Diagram
Rahn (1996)



Unified Soil Classification and Soil Plasticity Chart
Figure 5.6 *(Rahn, 1996)*



Fine-grained soils (More than half of material is smaller than No. 200 sieve)	Silts and clays (Liquid limit less than 50)	ML	Inorganic silts and very fine sands, rock flour, silty or clayey fine sands, or clayey silts with slight plasticity
		CL	Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays
		OL	Organic silts and organic silty clays of low plasticity
	Silts and clays (Liquid limit greater than 50)	MH	Inorganic silts, micaceous or diatomaceous fine sandy or silty soils, elastic silts
		CH	Inorganic clays of high plasticity, fat clays
		OH	Organic clays of medium to high plasticity, organic silts
	Highly organic soils	Pt	Peat and other highly organic soils

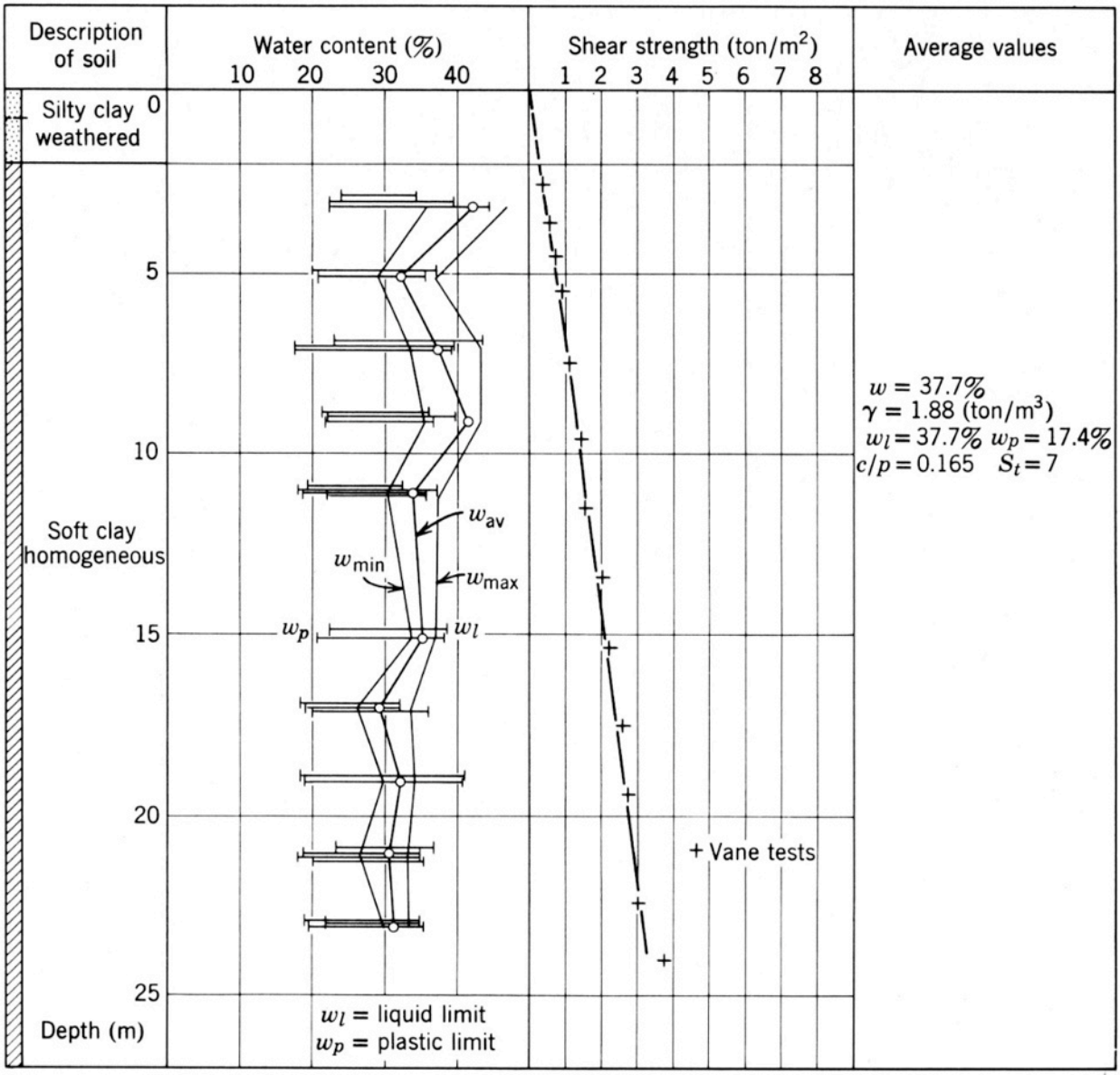
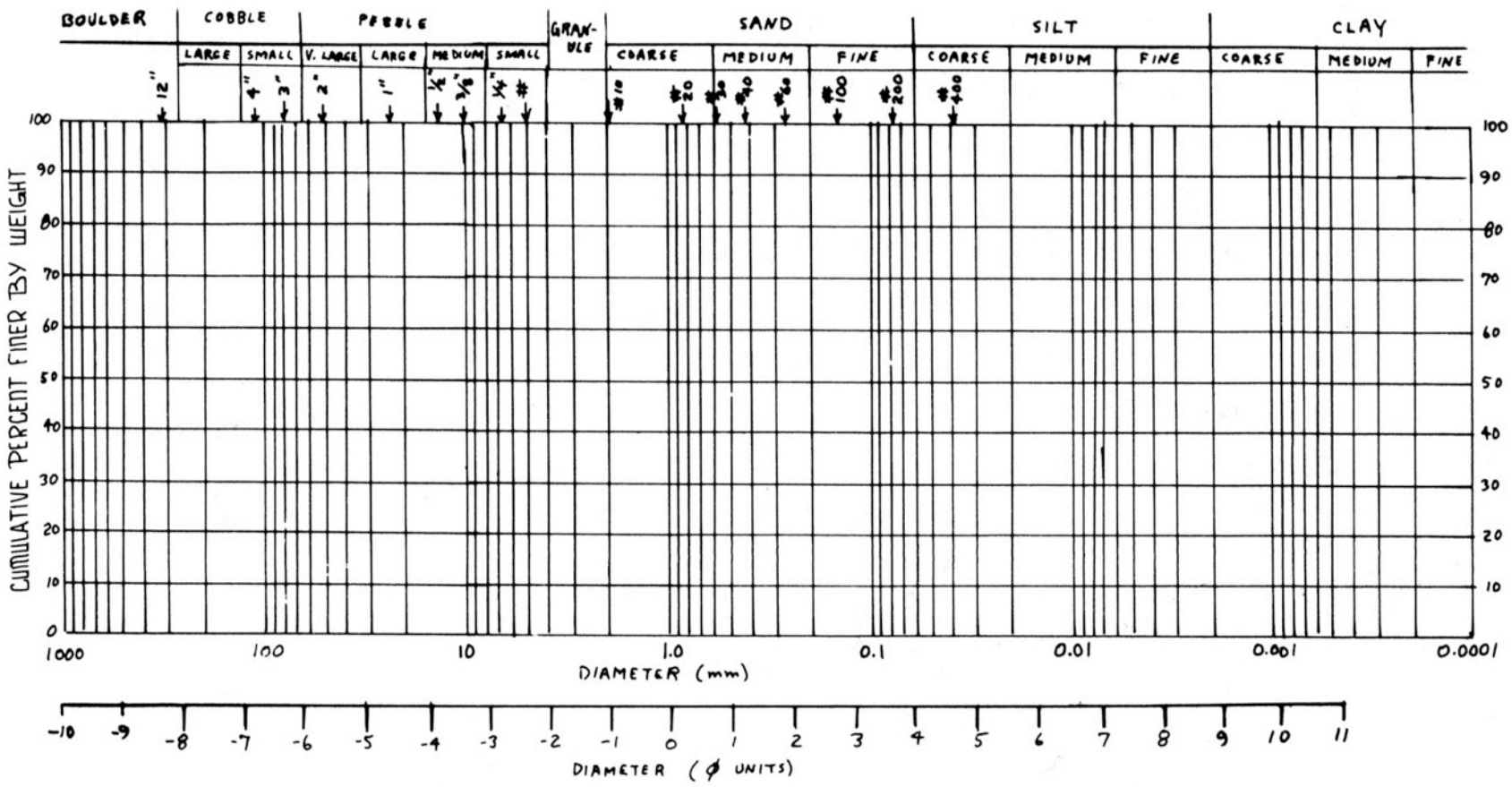


Fig. 5.10 - Norwegian marine clay soil (Rahn, 1996)
The soil water content varies through the course of a year from W_{min} to W_{max}



Particle size distribution graph for exercise B6