53:030 Soil Mechanics **The University of Iowa**
Lab. No. 1: **Fall Semester**

Measuring the Specific Gravity of Soil Grains

Equipment: Distilled water, 100 ml flask, thermometer, mass balance, oven-dried soil.

I. Background

The purpose of this lab is to measure the **average** specific gravity G_s of the grains comprising soil FI-6. Knowledge of G_s is often of use in identifying the minerals of which a soil is comprised, and of course G_s is also frequently used in soil mass-density-volume-void ratio relations.

II. Experimental Procedure

A. Calibration of the flask

To get an accurate calibration of the volume in the flask below the calibration line, the following procedure is employed:

1. Determine the mass of a **clean, dry** flask, M_f.
2. Slowly fill the flask with distilled water at room temperature (avoid introducing bubbles) **precisely** to the calibration mark.
3. Determine the mass of the flask and water, M_{fw}.
4. Record the temperature of the water, θ_i.
5. The mass of water in the flask is simply, $M_w = M_{fw} - M_f$.
6. The volume of water in the flask, and thus the volume of the flask V_f below the calibration line is obtained by $V_f = \frac{M_w}{\rho_w(\theta_i)}$. In the preceding expression, obtain $\rho_w(\theta_i)$ from Table 1 using the recorded temperature θ_i.

B. Specific Gravity Measurement

The calibrated flask can now be used to measure G_s for a soil sample.

1. Empty the flask and dry out the top portion with a paper towel.
2. Re-weigh the empty flask with moisture inside, and denote this quantity M_{fm}.
3. Place the calibrated, empty flask on a balance, and add enough oven-dried soil to increase the mass by at least 25 grams. Record the mass of the flask and the oven-dried soil M_{fs}.
4. The mass M_s of the dry soil grains is obviously $M_s = M_{fs} - M_{fm}$.
5. Fill the flask $\frac{2}{3}$ full with distilled water and soak the sample for a few minutes. (Under lab testing conditions, one would normally let the specimen sit for at least 12 hours, allowing the water to almost fully saturate the soil.)
6. After soaking, remove all visible trapped air bubbles from the soil by subjecting the contents of the flask to a vacuum for 5–15 minutes. Gentle rolling of the flask will facilitate the escape of trapped air.
7. Fill the flask **precisely** to the calibration mark, and determine the mass M_{fsw} of the flask, soil, and water.
8. Record the temperature θ_f of the water in the flask.
9. The mass of water in the flask, M_w, is determined from $M_w = M_{fsw} - M_f - M_s$, and the corresponding volume of water V_w in the flask is thus $\frac{M_w}{\rho_w(\theta_f)}$.
10. The volume of the soil grains V_s is then just $V_f - V_w$. [Recall that V_f was determined in the flask calibration.]
11. By virtue of its definition, the density of the soil grains is determined by the relation $\rho_s = \frac{M_s}{V_s}$.
12. Finally, the average specific gravity of the soil grains G_s is obtained as:

$$G_s = \frac{\rho_s}{\rho_w(20°C)}.$$

Table 1: Properties of Water at Atmospheric Pressure
$0°$ **to** $50°$ **C**

Temp. °**C**	**Density** $g \cdot \mathrm{cm}^{-3}$	**Dynamic Viscosity** $10^{-5}\mathrm{Pa} \cdot \mathrm{s}$	**Temp.** °**C**	**Density** $g \cdot \mathrm{cm}^{-3}$	**Dynamic Viscosity** $10^{-5}\mathrm{Pa} \cdot \mathrm{s}$
0	0.999841	179.21	26	0.996783	87.37
1	0.999900	173.13	27	0.996512	85.45
2	0.999941	167.28	28	0.996232	83.60
3	0.999965	161.86	29	0.995944	81.80
4	0.999973	156.74	30	0.995646	80.07
5	0.999965	151.88	31	0.995343	78.40
6	0.999941	147.28	32	0.995023	76.79
7	0.999902	142.84	33	0.994703	75.23
8	0.999849	138.60	34	0.994373	73.71
9	0.999781	134.62	35	0.994033	72.25
10	0.999700	130.77	36	0.993683	70.85
11	0.999605	127.13	37	0.993333	69.47
12	0.999498	123.63	38	0.992963	68.14
13	0.999377	120.28	39	0.992593	66.85
14	0.999244	117.09	40	0.992213	65.60
15	0.999099	114.04	41	0.991833	64.39
16	0.998943	111.11	42	0.991443	63.21
17	0.998774	108.28	43	0.991043	62.07
18	0.998595	105.59	44	0.990633	60.97
19	0.998405	102.99	45	0.990223	59.88
20	0.998203	100.50	46	0.989793	58.83
21	0.997992	98.10	47	0.989373	57.82
22	0.997770	95.79	48	0.988933	56.83
23	0.997538	93.58	49	0.988493	55.88
24	0.997296	91.40	50	0.988043	54.94
25	0.997044	89.37			