SPECIFIC GRAVITY OF SOIL GRAINS (G_S)

DEFINITION

The specific gravity (G_s) of a soil is the ratio of the mass of a unit volume of a material at a stated temperature to the mass of the same volume of distilled water at stated temperature (4^oC). Or the specific gravity of soil grains is unit weight of the solid particles to the unit weight of distilled water at **4^oC**.

$$Gs = \frac{Ws/V}{Ww/V} = \frac{\gamma_{(material)}}{\gamma_{(water)} at 4^o C}$$

INTRODUCTION

- The choice of using a pycnometer or constant volume method is purely academic. When the soil particles passing the **No. 4 (4.75 mm)** sieve.
- The volume of a known weight of soil grains can be obtained by using stoppered bottle of known volume (pycnometer) depending on the **Archimedes** principle (if a body submerged in a volume of water will displace a volume of water equal to the volume of submerged body). Then the pycnometer holds a standard volume of distilled water at **20^o C.**
  - At temperature above **20 ^{o}C**, the volume will be slightly more.
  - At temperature below **20 ^{o}C**, the volume will be slightly less.
- The specific gravity of solids for most natural soils falls in the general range of **2.65** – **2.85**, the smaller values are for the coarse – grained soils.
- The G_s of soil grains (absolute solid) will always be **larger than** the bulk G_m based on non-inclusion of soil voids in the computation.

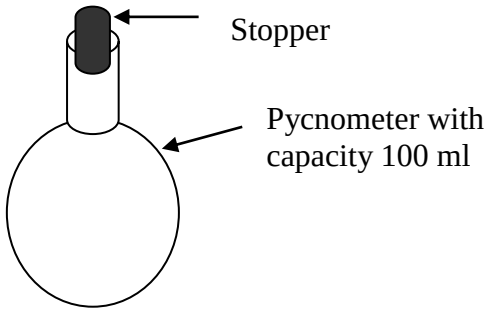
PURPOSES

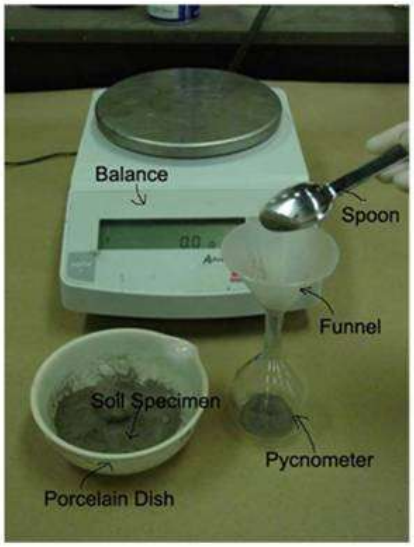
- Gs is useful for determining weight volume relationships.
- It's used in the computation of most of the laboratory tests; such as: hydrometer, consolidation.
- Specific gravity may be useful in soil mineral classification.

APPARATUS

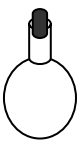
The equipment for determination specific gravity includes:

1. Pycnometer with capacity 100 ml and stopper.
2. Vacuum pump.
3. Desicator.
4. Wash bottle.
5. Thermometer, ranging from 0 to 50^o C.
6. Distilled deaired water.
7. Drying oven.
8. Balance accurate to 0.01 g.





PROCEDURE



1. Measure weight of empty stoppered bottle with stopper w_b, which must be clean and dry.

2. Take about 25 to 30 g of oven dried soil and transfer the soil into the pycnometer then obtain the weight of pycnometer and dry soil w_{bs}. Taking care not to lose any
of the soil.

3. Add sufficient distilled water to fill the stoppered bottle half-full to three-fourth full (do not fill it completely).

4. Put the stoppered bottle without stopper inside a desicator and attach the desicator to a vacuum line and for at least 10 min. subject the contents to a vacuum (the reduced air pressure should cause the water to boil).

T1

5. When deairing process is complete, add deaired water to fill the stoppered bottle volume.
6. Obtain the weight of (bottle + stopper + soil+ water) $\mathbf{w_{bws}}$ **,** and take water temperature **T1**.

T2

7. Empty the stoppered bottle and its contents. Then fill it with distilled deaired water and
   measure its weight $\mathbf{w_{bw}}$. Take the water temperature **T2.**

Now:

- If T1= T2 or the temperature is within $\pm$ 1 ^{o}C of the temperature used for obtaining $\mathbf{w_{bws}}$ the procedure is complete (has been terminated).
- If T1 $\neq$ T2 calibration is necessary. The bottle must be calibrated at the same temperature as during the test. Any change in water temperature modifies the bottle volume.
- w_{bw} (at T2) = $\frac{\gamma_w at T2}{\gamma_w at T1}$ *[w_{bw} (at T2)- w_b] + w_b

S. No.	Temperature (°C)	Relative density	S. No.	Temperature (°C)	Relative density
1	4	1.000000	22	25	0.997074
2	5	0.999992	23	26	0.996813
3	6	0.999968	24	27	0.996542
4	7	0.999930	25	28	0.996262
5	8	0.999876	26	29	0.995974
6	9	0.999809	27	30	0.995676
7	10	0.999728	28	31	0.995369
8	11	0.999633	29	32	0.995054
9	12	0.999525	30	33	0.994731
10	13	0.999404	31	34	0.994399
11	14	0.999271	32	35	0.994059
12	15	0.999127	33	36	0.993712
13	16	0.998970	34	37	0.993357
14	17	0.998802	35	38	0.992994
15	18	0.998623	36	39	0.992623
16	19	0.998433	37	40	0.992246
17	20	0.998232	38	41	0.99186
18	21	0.998021	39	42	0.99147
19	22	0.997799	40	43	0.99107
20	23	0.997567	41	44	0.99066
21	24	0.997326	42	45	0.99024

CALCULATION

The specific gravity of a soil is calculated as follows:

$W_w = W_{bw} + W_s - W_{bws}$

$W_s = W_{bs} - W_b$

Specific Gravity $(G_s) = \frac{W_s}{W_w} * \alpha$; $\alpha = \frac{\gamma_{(water)} at T2}{\gamma_{(water)} at 20^o C}$

Where:

w_s = is the weight of the soil solids (g).

w_{bws} = the weight of the bottle + stopper + soil+ water (g).

w_b = weight of empty stoppered bottle with stopper (g).

w_{bs} = the weight of stoppered bottle and dry soil (g).

w_{bw} = the weight of stoppered bottle full of water (g).

α = The temperature correction coefficient.

***** If two or three separate measurements have been made on the same soil specimen, the average value of specific gravity is then calculated.

DISCUSSION

Under which condition, kerosene is used as a liquid instead of distilled water?

Specific Gravity *(Gs)* Data Sheet

Name:. . . . . Signature: ……

Class:

Group No.: Test date: / /

Soil Type				
Samples	1	2	1	2
Number of a bottle				
Weight of empty stoppered bottle with stopper $\mathbf{w_b}$ (g)				
Weight of stoppered bottle and dry soil $\mathbf{w_{bs}}$ (g)				
Weight of (bottle + stopper + soil+ water) $\mathbf{w_{bws}}$ (g)				
The temperature of $\mathbf{w_{bws}}$ (T1)				
Weight of the bottle full of distilled water $\mathbf{w_{bw}}$ (g)				
The temperature of $\mathbf{w_{bw}}$ (T2)				
Specific Gravity $\mathbf{G_s}$				
Average Specific Gravity $\mathbf{G_s}$				