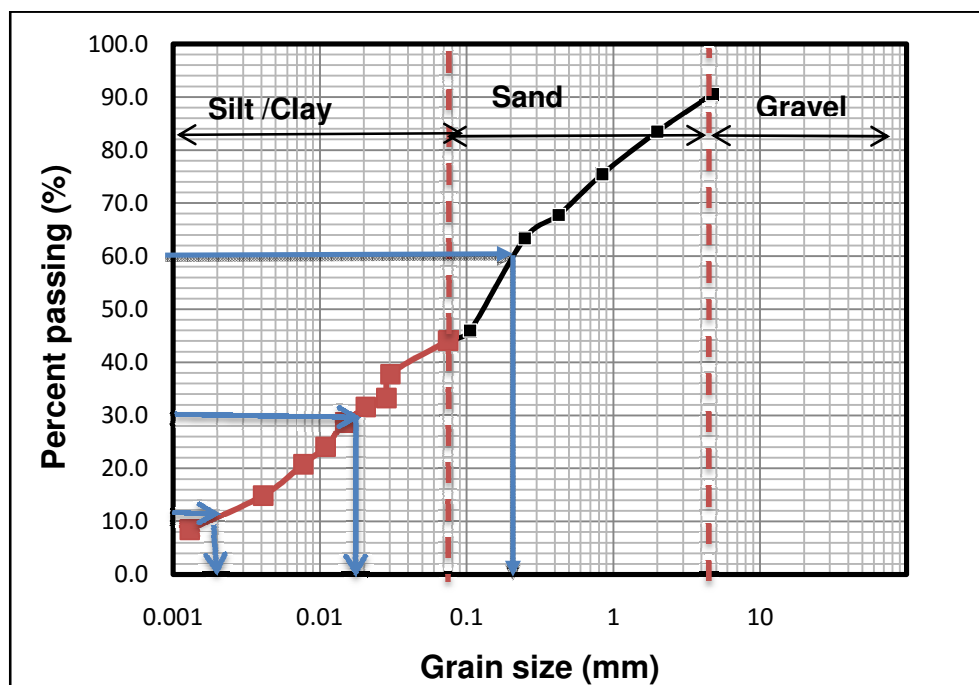


Soil Mechanics – Brief Review

Q1.

Sieve Number	Diameter (mm)	Mass of Empty Sieve (g)	Soil of Sieve + Soil Retained (g)	Soil Retained (g)	Percent Retained	Percent Passing
4	4.75	116.23	166.13	49.9	9.5	90.5
10	2	99.27	135.77	36.5	7.0	83.5
20	0.84	97.58	139.68	42.1	8.0	75.5
40	0.425	98.96	138.96	40	7.6	67.8
60	0.25	91.46	114.46	23	4.4	63.4
140	0.106	93.15	184.15	91	17.4	46.1
200	0.075	90.92	101.12	10.2	1.9	44.1
Pan	70.19	301.19	231	44.1	0.0
Total Weight=				523.7		



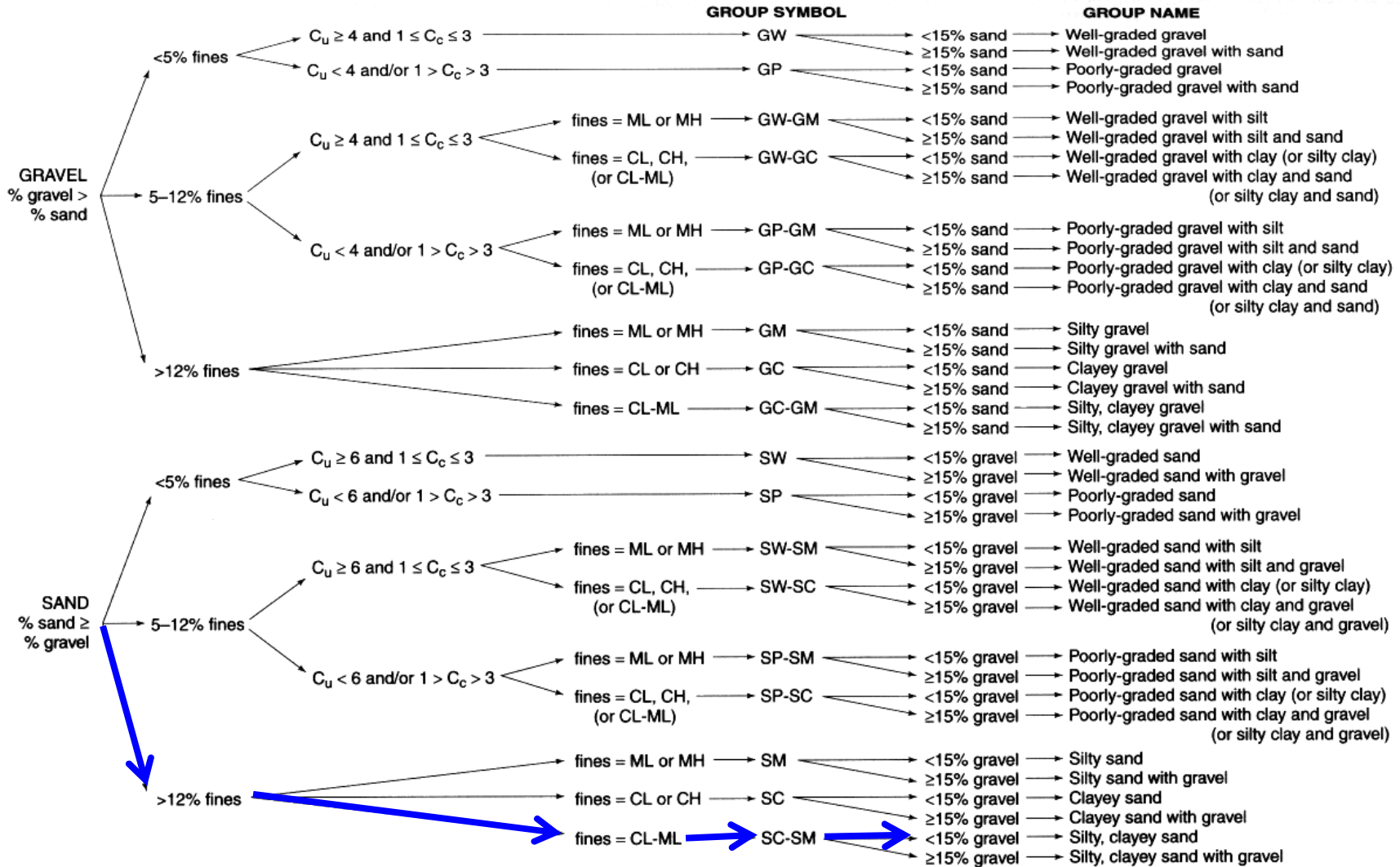
From Grain Size Distribution Curve:

Gravel	= 9.5 %	D_{10}	= 0.002 mm
Sand	= 46.4%	D_{30}	= 0.017 mm
Fine	=44.1%	D_{60}	=0.25 mm

$$C_U = \frac{D_{60}}{D_{10}} = \frac{0.25}{0.002} = 125 \quad C_z = \frac{(D_{30})^2}{D_{10} \times D_{60}} = \frac{(0.017)^2}{0.25 \times 0.002} = 0.58$$

Unified Soil Classification System (USCS): SC /SM (see next page for more details)

CVG 3109 SOIL MECHANICS I
ASSIGNMENT #1 SOLUTION



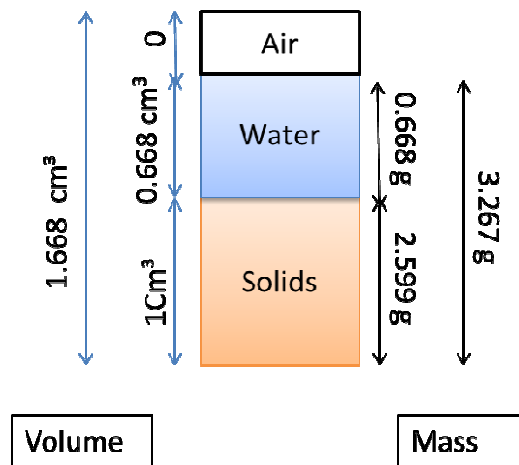
Q2.

Method 1: Assume volume of solids, $V_s = 1\text{cm}^3$, $\rho_w = 1\text{g/cm}^3$

Given: $w = 25.7\% = 0.257 \left(= \frac{M_w}{M_s} \right)$

$e = 0.668 \left(= \frac{V_v}{V_s} \right)$

$S = 100\% = 1.00 \left(= \frac{V_w}{V_v} \right)$



Phase diagram

Calculations:

1. $V_v = e \times V_s = 0.668 \times 1 = 0.668 \text{ cm}^3$

2. $V = V_v + V_s = 0.668 + 1 = 1.668 \text{ cm}^3$

3. $V_w = S \times V_v = 1.000 \times 0.668 \text{ cm}^3 = 0.668 \text{ cm}^3$

4. $V_a = V_v - V_w = 0.668 \text{ cm}^3 - 0.668 \text{ cm}^3 = 0.00$

5. $M_w = \rho_w \times V_w = 1.000 \text{ g/cm}^3 \times 0.668 \text{ cm}^3 = 0.668\text{g}$

6. $M_s = \frac{M_w}{w} = \frac{0.668 \text{ g}}{0.257} = 2.599\text{g}$

7. $M = M_s + M_w = 2.599\text{g} + 0.668\text{g} = 3.267\text{g}$

8. $\rho = \frac{M}{V} = \frac{3.267 \text{ g}}{1.668 \text{ cm}^3} = 1.959 \text{ g/cm}^3 = \mathbf{1959 \text{ kg/m}^3}$

9. $G_s = \frac{M_s}{V_s \times \rho_w} = \frac{1 \text{ g}}{0.3847 \text{ cm}^3 \times 1.000\text{g/cm}^3} = \mathbf{2.599}$

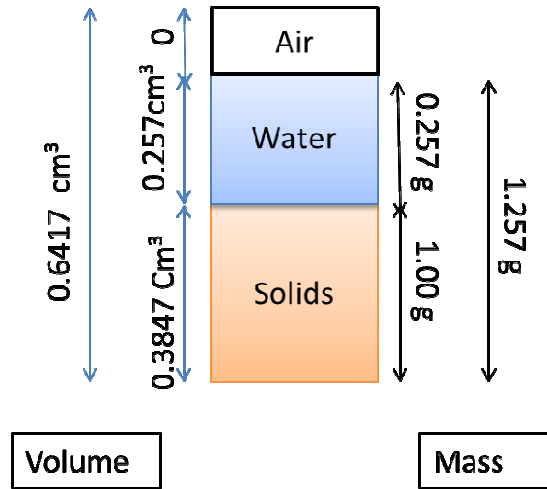


Method 2: Assume mass of solids, $M_s = 1\text{ g}$

Given: $w = 25.7\% = 0.257 \left(= \frac{M_w}{M_s} \right)$

$e = 0.668 \left(= \frac{V_v}{V_s} \right)$

$s = 100\% = 1.00 \left(= \frac{V_w}{V_v} \right)$



Phase diagram

Calculations:

1. $M_w = w \times M_s = 0.257 \times 1\text{ g} = 0.257\text{ g}$

2. $M = M_w + M_s = 0.257\text{ g} + 1\text{ g} = 1.257\text{ g}$

3. $V_w = \frac{M_w}{\rho_w} = \frac{0.257\text{ g}}{1.000\text{ g/cm}^3} = 0.257\text{ cm}^3$

4. $V_v = \frac{V_w}{S} = \frac{0.257\text{ cm}^3}{1.000} = 0.257\text{ cm}^3$

5. $V_a = V_v - V_w = 0.257\text{ cm}^3 - 0.257\text{ cm}^3 = 0\text{ cm}^3$

6. $V_s = \frac{V_v}{e} = \frac{0.257\text{ cm}^3}{0.668} = 0.3847\text{ cm}^3$

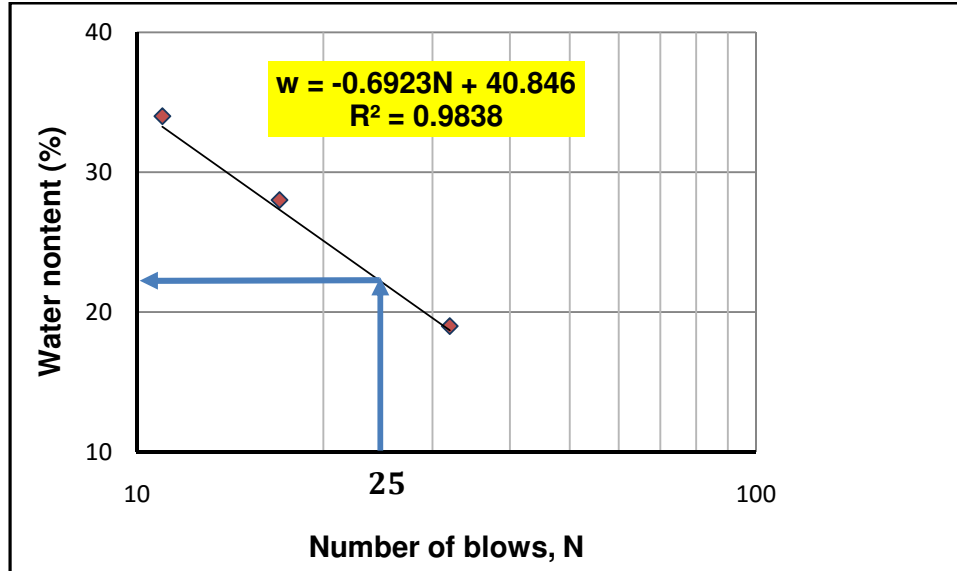
7. $V = V_s + V_v = 0.3847\text{ cm}^3 + 0.257\text{ cm}^3 = 0.6417\text{ cm}^3$

8. $\rho = \frac{M}{V} = \frac{1.257\text{ g}}{0.6417\text{ cm}^3} = 1.959\text{ g/cm}^3 = \mathbf{1959\text{ kg/m}^3}$

9. $G_s = \frac{M_s}{V_s \times \rho_w} = \frac{1\text{ g}}{0.3847\text{ cm}^3 \times 1.000\text{ g/cm}^3} = \mathbf{2.599}$

Q3.

a. Flow curve and liquid limit



From the equation for the flow curve

$$LL = -0.6923 \times 25 + 40.846 = 23.55 \%$$

b. Plasticity index:

$$PI = LL - PL = 23.55 - 12 = 11.55$$

c. Liquidity index:

$$LI = \frac{w - w_p}{w_L - w_p} = \frac{14 - 12}{23.55 - 12} = 0.17$$

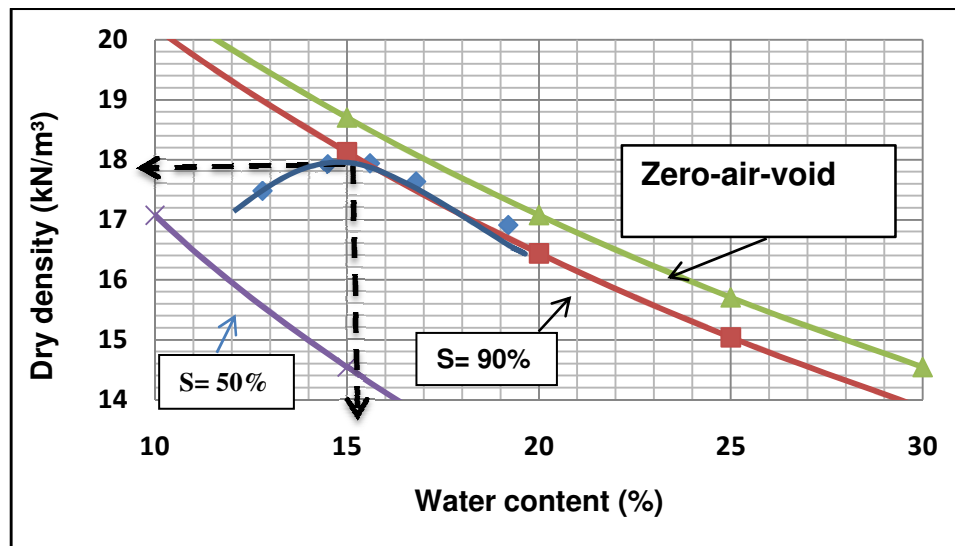
d. Application of Atterberg Limits

- used in engineering classifications
- used in Group Index for pavement designs
- plastic limit is an indicator of optimum moisture content for compaction
- correlation with strength parameters and compressibility

Q4.

Volume of the mold is 1000 cm³

Mass of soil (g)	2010	2092	2114	2100	2055
Density (kN/m ³)	19.72	20.52	20.74	20.60	20.16
Water content (%)	12.8	14.5	15.6	16.8	19.2
Dry density (kN/m ³)	17.48	17.92	17.94	17.64	16.91



$$\gamma_{d(max)} = 18.0 \text{ (kN/m}^3\text{)}$$

Optimum water content $w_c = 15.4\%$

(The above values can be slightly different depending on the compaction curves)

b. (Sample calculations: see next page for more details)

$$\gamma_{zav} = \frac{G_s \gamma_w}{1 + w G_s} = \frac{2.67 \times 9.81}{1 + (0.05 \times 2.67)} = 23.11 \text{ (kN/m}^3\text{)}$$

$$\gamma_{90\%} = \frac{G_s \gamma_w}{1 + \frac{w G_s}{S}} = \frac{2.67 \times 9.81}{1 + \frac{0.05 \times 2.67}{0.9}} = 22.81 \text{ (kN/m}^3\text{)}$$



G_s	w (%)	γ_{zav} (kN/m ³)	$\gamma_{90\%}$ (kN/m ³)	$\gamma_{50\%}$ (kN/m ³)
2.67	5	23.11	22.81	20.67
2.67	10	20.67	20.20	17.07
2.67	15	18.70	18.13	14.54
2.67	20	17.07	16.44	12.67
2.67	25	15.71	15.04	11.22
2.67	30	14.54	13.86	10.07