

Chapter 2

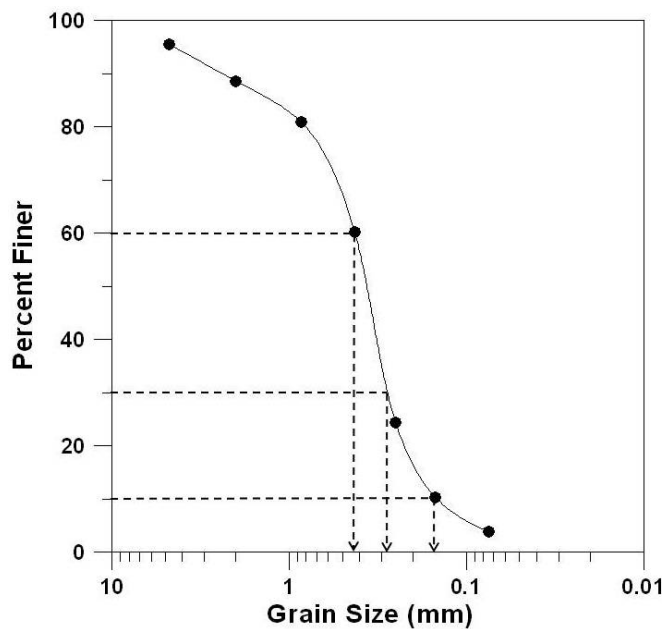
$$2.1 \quad C_u = \frac{D_{60}}{D_{10}} = \frac{0.42}{0.16} = 2.625 \approx \mathbf{2.63}; \quad C_c = \frac{D_{30}^2}{(D_{60})(D_{10})} = \frac{0.21^2}{(0.42)(0.16)} = 0.656 \approx \mathbf{0.66}$$

$$2.2 \quad C_u = \frac{D_{60}}{D_{10}} = \frac{0.81}{0.27} = \mathbf{3.0}; \quad C_c = \frac{D_{30}^2}{(D_{60})(D_{10})} = \frac{0.41^2}{(0.81)(0.27)} = 0.768 \approx \mathbf{0.77}$$

2.3 a.

Sieve no.	Mass of soil retained on each sieve (g)	Percent retained on each sieve	Percent finer
4	28	4.54	95.46
10	42	6.81	88.65
20	48	7.78	80.88
40	128	20.75	60.13
60	221	35.82	24.31
100	86	13.94	10.37
200	40	6.48	3.89
Pan	24	3.89	0.00

Σ 617 g



b. $D_{10} = 0.16 \text{ mm}; D_{30} = 0.29 \text{ mm}; D_{60} = 0.45 \text{ mm}$

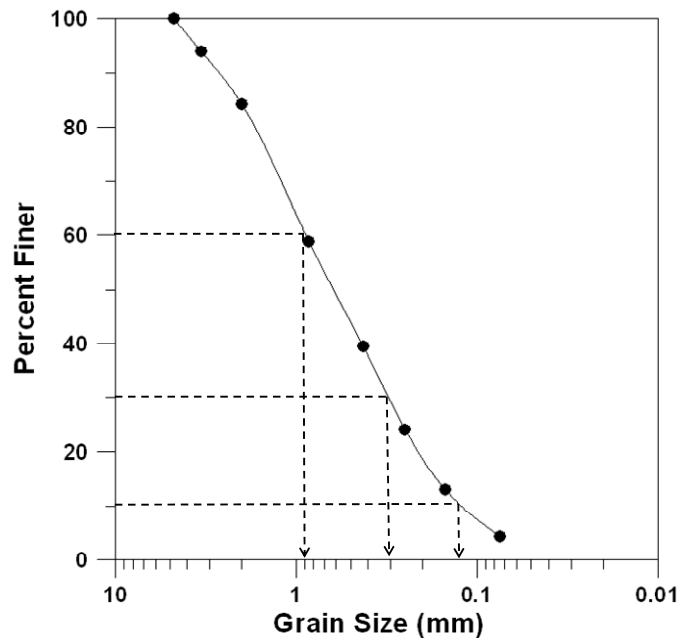
c. $C_u = \frac{D_{60}}{D_{10}} = \frac{0.45}{0.16} = 2.812 \approx 2.81$

d. $C_c = \frac{D_{30}^2}{(D_{60})(D_{10})} = \frac{0.29^2}{(0.45)(0.16)} = 1.168 \approx 1.17$

2.4 a.

Sieve no.	Mass of soil retained on each sieve (g)	Percent retained on each sieve	Percent Finer
4	0	0.0	100.00
6	30	6.0	94.0
10	48.7	9.74	84.26
20	127.3	25.46	58.80
40	96.8	19.36	39.44
60	76.6	15.32	24.12
100	55.2	11.04	13.08
200	43.4	8.68	4.40
Pan	22	4.40	0.00

$\Sigma 500 \text{ g}$



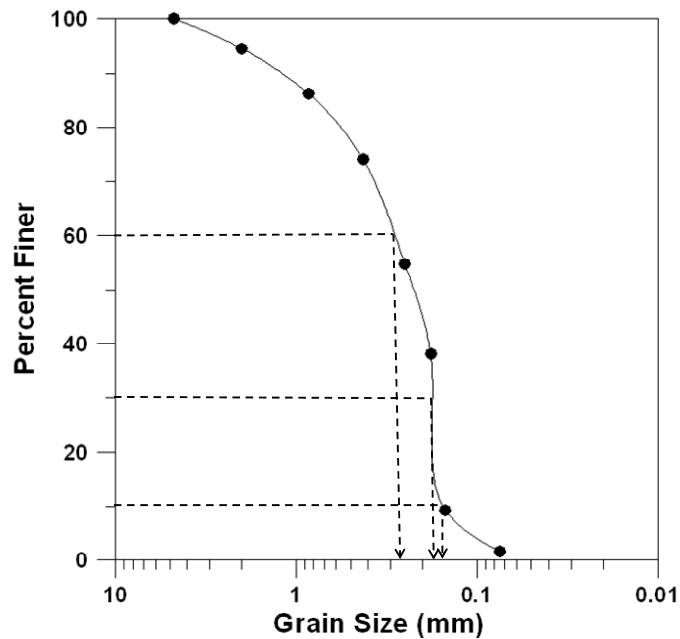
b. $D_{10} = 0.13 \text{ mm}; D_{30} = 0.3 \text{ mm}; D_{60} = 0.9 \text{ mm}$

$$c. C_u = \frac{D_{60}}{D_{10}} = \frac{0.9}{0.13} = 6.923 \approx \mathbf{6.92}$$

$$d. C_c = \frac{D_{30}^2}{(D_{60})(D_{10})} = \frac{0.3^2}{(0.9)(0.13)} = 0.769 \approx \mathbf{0.77}$$

2.5 a.

Sieve no.	Mass of soil retained on each sieve (g)	Percent retained on each sieve	Percent finer
4	0	0.0	100.00
10	40	5.49	94.51
20	60	8.23	86.28
40	89	12.21	74.07
60	140	19.20	54.87
80	122	16.74	38.13
100	210	28.81	9.33
200	56	7.68	1.65
Pan	12	1.65	0.00
$\Sigma 729 \text{ g}$			



b. $D_{10} = \mathbf{0.17 \text{ mm}}$; $D_{30} = \mathbf{0.18 \text{ mm}}$; $D_{60} = \mathbf{0.28 \text{ mm}}$

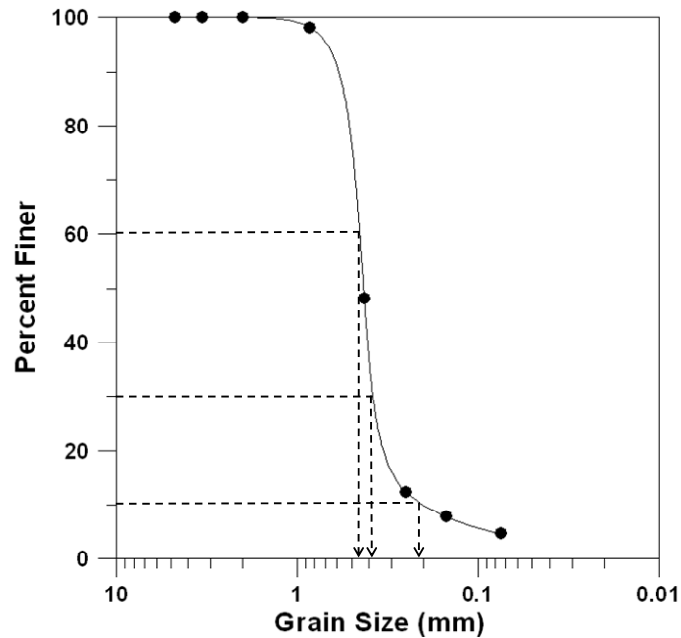
$$c. C_u = \frac{D_{60}}{D_{10}} = \frac{0.28}{0.17} = 1.647 \approx \mathbf{1.65}$$

$$d. C_c = \frac{D_{30}^2}{(D_{60})(D_{10})} = \frac{0.18^2}{(0.28)(0.17)} = \mathbf{0.68}$$

2.6 a.

Sieve no.	Mass of soil retained on each sieve (g)	Percent retained on each sieve	Percent finer
4	0	0.0	100.00
6	0	0.0	100.00
10	0	0.0	100.00
20	9.1	1.82	98.18
40	249.4	49.88	48.3
60	179.8	35.96	12.34
100	22.7	4.54	7.8
200	15.5	3.1	4.7
Pan	23.5	4.7	0.00

Σ 500 g

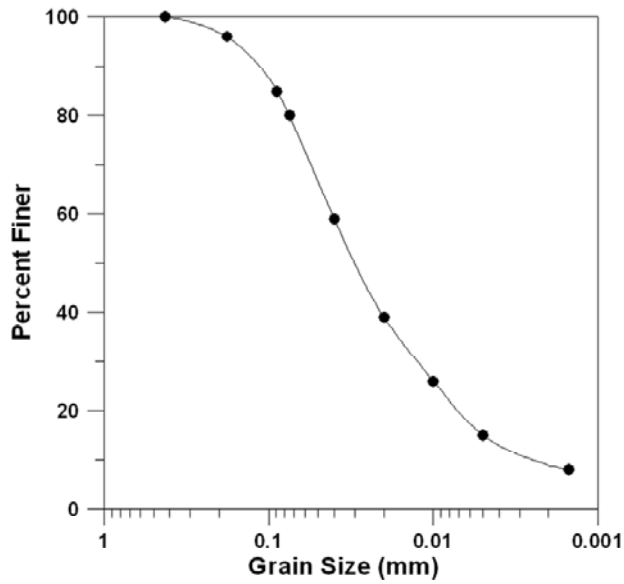


b. $D_{10} = 0.21 \text{ mm}$; $D_{30} = 0.39 \text{ mm}$; $D_{60} = 0.45 \text{ mm}$

$$c. C_u = \frac{D_{60}}{D_{10}} = \frac{0.45}{0.21} = 2.142 \approx \mathbf{2.14}$$

$$d. C_c = \frac{D_{30}^2}{(D_{60})(D_{10})} = \frac{0.39^2}{(0.45)(0.21)} = 1.609 \approx \mathbf{1.61}$$

2.7 a.



- b. Percent passing 2 mm = 100
Percent passing 0.06 mm = 73
Percent passing 0.002 mm = 9

GRAVEL: $100 - 100 = 0\%$
SAND: $100 - 73 = 27\%$
SILT: $73 - 9 = 64\%$
CLAY: $9 - 0 = 9\%$

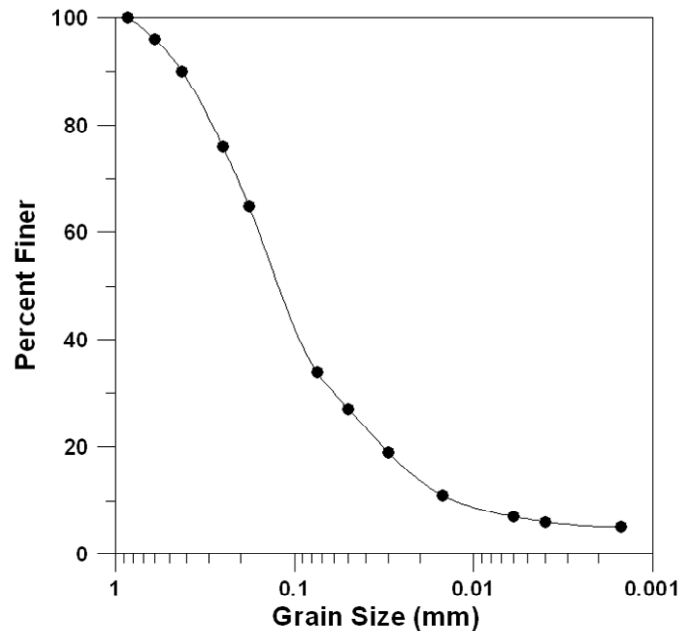
- c. Percent passing 2 mm = 100
Percent passing 0.05 mm = 68
Percent passing 0.002 mm = 9

GRAVEL: $100 - 100 = 0\%$
SAND: $100 - 68 = 32\%$
SILT: $68 - 9 = 59\%$
CLAY: $9 - 0 = 9\%$

- d. Percent passing 2 mm = 100
Percent passing 0.075 mm = 80
Percent passing 0.002 mm = 9

GRAVEL: $100 - 100 = 0\%$
SAND: $100 - 80 = 20\%$
SILT: $80 - 9 = 71\%$
CLAY: $9 - 0 = 9\%$

2.8 a.



- b. Percent passing 2 mm = 100
Percent passing 0.06 mm = 30
Percent passing 0.002 mm = 5

GRAVEL: $100 - 100 = 0\%$
SAND: $100 - 30 = 70\%$
SILT: $70 - 5 = 65\%$
CLAY: $5 - 0 = 5\%$

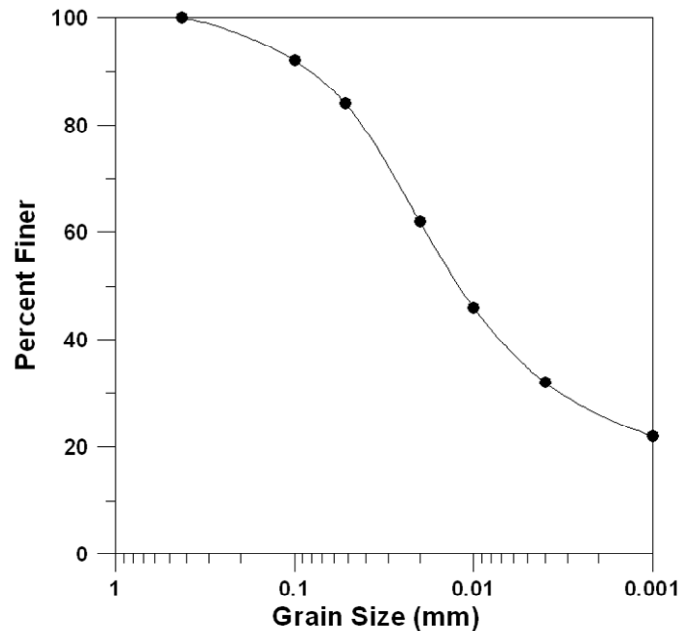
- c. Percent passing 2 mm = 100
Percent passing 0.05 mm = 28
Percent passing 0.002 mm = 5

GRAVEL: $100 - 100 = 0\%$
SAND: $100 - 28 = 72\%$
SILT: $72 - 5 = 67\%$
CLAY: $5 - 0 = 5\%$

- d. Percent passing 2 mm = 100
Percent passing 0.075 mm = 34
Percent passing 0.002 mm = 5

GRAVEL: $100 - 100 = 0\%$
SAND: $100 - 34 = 66\%$
SILT: $66 - 5 = 61\%$
CLAY: $5 - 0 = 5\%$

2.9 a.



- b. Percent passing 2 mm = 100
Percent passing 0.06 mm = 84
Percent passing 0.002 mm = 28

GRAVEL: $100 - 100 = 0\%$
SAND: $100 - 84 = 16\%$
SILT: $84 - 28 = 56\%$
CLAY: $28 - 0 = 28\%$

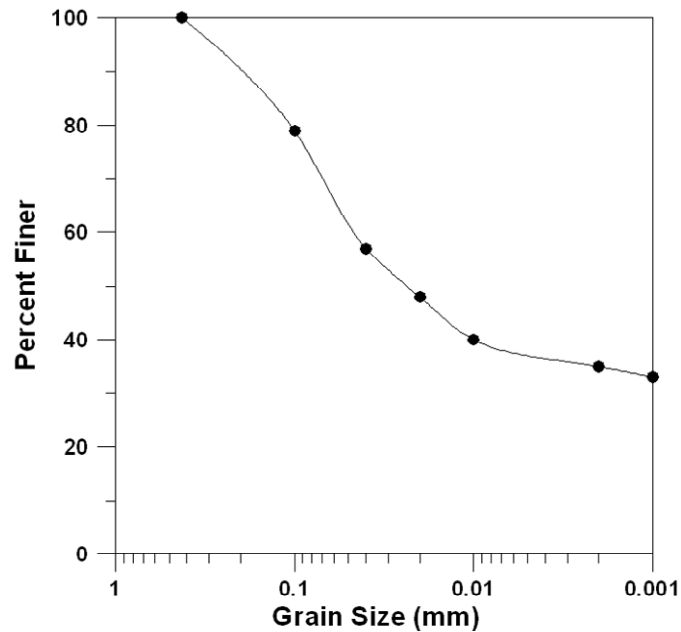
- c. Percent passing 2 mm = 100
Percent passing 0.05 mm = 83
Percent passing 0.002 mm = 28

GRAVEL: $100 - 100 = 0\%$
SAND: $100 - 83 = 17\%$
SILT: $83 - 28 = 55\%$
CLAY: $28 - 0 = 28\%$

- d. Percent passing 2 mm = 100
Percent passing 0.075 mm = 90
Percent passing 0.002 mm = 28

GRAVEL: $100 - 100 = 0\%$
SAND: $100 - 90 = 10\%$
SILT: $90 - 28 = 62\%$
CLAY: $28 - 0 = 28\%$

2.10 a.



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|--|--|
| <p>b. Percent passing 2 mm = 100
 Percent passing 0.06 mm = 65
 Percent passing 0.002 mm = 35</p> | <p>GRAVEL: 100 – 100 = 0%
 SAND: 100 – 65 = 35%
 SILT: 65 – 35 = 30%
 CLAY: 35 – 0 = 35%</p> |
| <p>c. Percent passing 2 mm = 100
 Percent passing 0.05 mm = 62
 Percent passing 0.002 mm = 35</p> | <p>GRAVEL: 100 – 100 = 0%
 SAND: 100 – 62 = 38%
 SILT: 62 – 35 = 27%
 CLAY: 35 – 0 = 35%</p> |
| <p>d. Percent passing 2 mm = 100
 Percent passing 0.075 mm = 70
 Percent passing 0.002 mm = 35</p> | <p>GRAVEL: 100 – 100 = 0%
 SAND: 100 – 70 = 30%
 SILT: 70 – 35 = 35%
 CLAY: 35 – 0 = 35%</p> |

2.11 $G_s = 2.7$; temperature = 24°; time = 60 min; $L = 9.2$ cm

Eq. (2.5):
$$D \text{ (mm)} = K \sqrt{\frac{L \text{ (cm)}}{t \text{ (min)}}}$$

From Table 2.6 for $G_s = 2.7$ and temperature = 24° , $K = 0.01282$

$$D = 0.01282 \sqrt{\frac{9.2}{60}} = \mathbf{0.005 \text{ mm}}$$

2.12 $G_s = 2.75$; temperature = 23°C ; time = 100 min; $L = 12.8 \text{ cm}$

$$\text{Eq. (2.5): } D \text{ (mm)} = K \sqrt{\frac{L \text{ (cm)}}{t \text{ (min)}}}$$

From Table 2.6 for $G_s = 2.75$ and temperature = 23° , $K = 0.01279$

$$D = 0.01279 \sqrt{\frac{12.8}{100}} = \mathbf{0.0046 \text{ mm}}$$

CRITICAL THINKING PROBLEM

2.C.1 a. Soil A: $C_u = \frac{D_{60}}{D_{10}} = \frac{11}{0.6} = \mathbf{18.33}$; $C_c = \frac{D_{30}^2}{(D_{60})(D_{10})} = \frac{5^2}{(11)(0.6)} = \mathbf{3.78}$

Soil B: $C_u = \frac{D_{60}}{D_{10}} = \frac{7}{0.2} = \mathbf{35}$; $C_c = \frac{D_{30}^2}{(D_{60})(D_{10})} = \frac{2.1^2}{(7)(0.2)} = \mathbf{3.15}$

Soil C: $C_u = \frac{D_{60}}{D_{10}} = \frac{4.5}{0.15} = \mathbf{30}$; $C_c = \frac{D_{30}^2}{(D_{60})(D_{10})} = \frac{1^2}{(4.5)(0.15)} = \mathbf{1.48}$

- b. Soil A is coarser than Soil C. A higher percentage of soil C is finer than any given size compared to Soil A. For example, about 15% is finer than 1 mm for Soil A, whereas almost 30% is finer than 1 mm in case of soil C.
- c. Particle segregation may take place in aggregate stockpiles such that there is a separation of coarser and finer particles. This makes representative sampling difficult. Therefore Soils A, B, and C demonstrate quite different particle size distribution.

d. Soil A:

Percent passing 4.75 mm = 29

Percent passing 0.075 mm = 1

GRAVEL: $100 - 29 = 71\%$

SAND: $29 - 1 = 28\%$

FINES: $1 - 0 = 1\%$

Soil B:

Percent passing 4.75 mm = 45

Percent passing 0.075 mm = 2

GRAVEL: $100 - 45 = 55\%$

SAND: $45 - 2 = 43\%$

FINES: $2 - 0 = 2\%$

Soil C:

Percent passing 4.75 mm = 53

Percent passing 0.075 mm = 3

GRAVEL: $100 - 53 = 47\%$

SAND: $47 - 3 = 44\%$

FINES: $3 - 0 = 3\%$