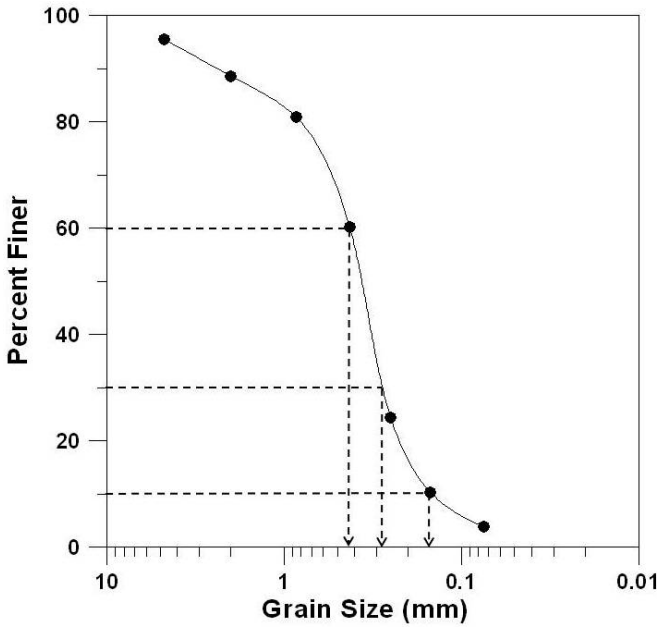
# Chapter 2

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

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

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** |
| | $\Sigma$ 617 g | | |



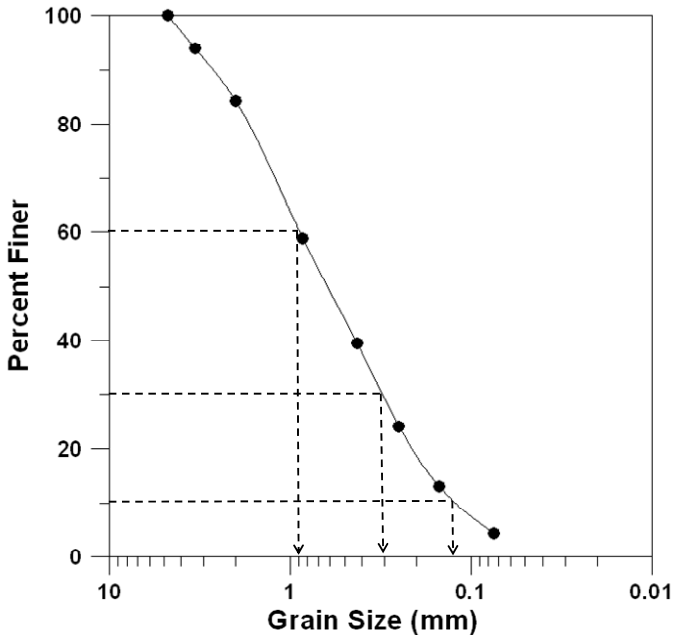
b. $D_{10}$ = **0.16 mm**; $D_{30}$ = **0.29 mm**; $D_{60}$ = **0.45 mm**

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

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

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 g | | |



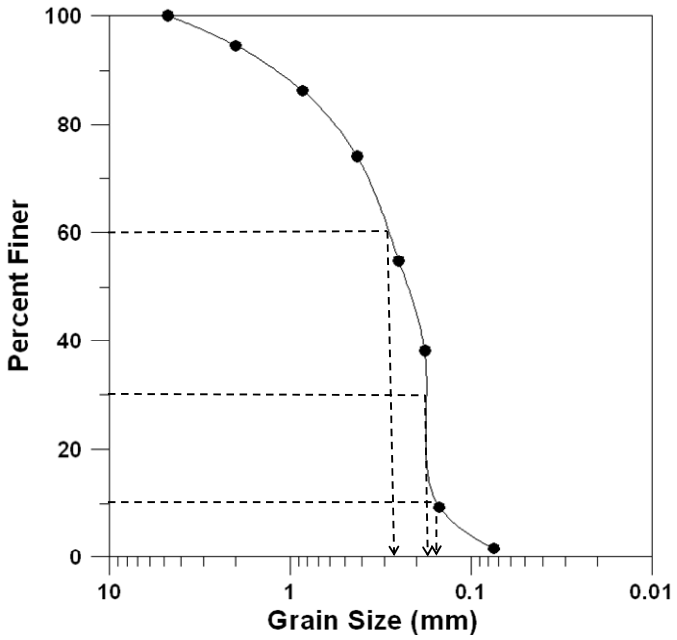

b. $D_{10}$ = **0.13 mm**; $D_{30}$ = **0.3 mm**; $D_{60}$ = **0.9 mm**

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

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

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 g | | |



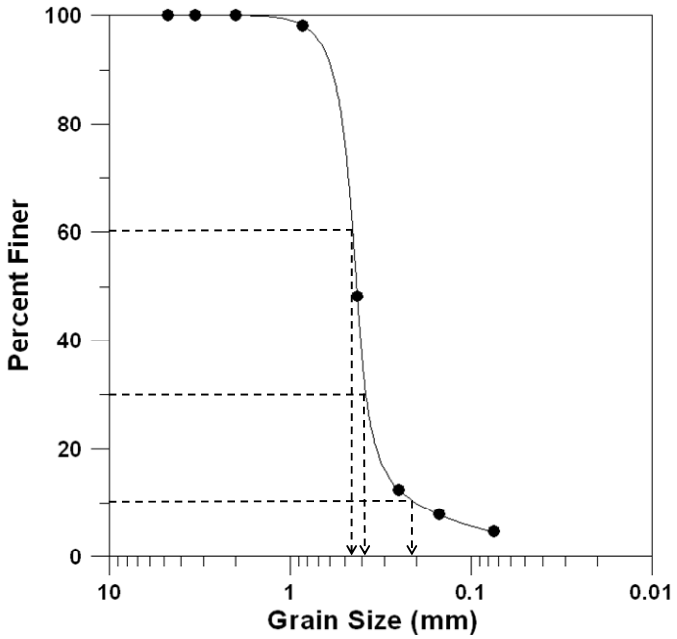

b. $D_{10}$ = **0.17 mm**; $D_{30}$ = **0.18 mm**; $D_{60}$ = **0.28 mm**

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

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

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** |
| | $\Sigma$ 500 g | | |

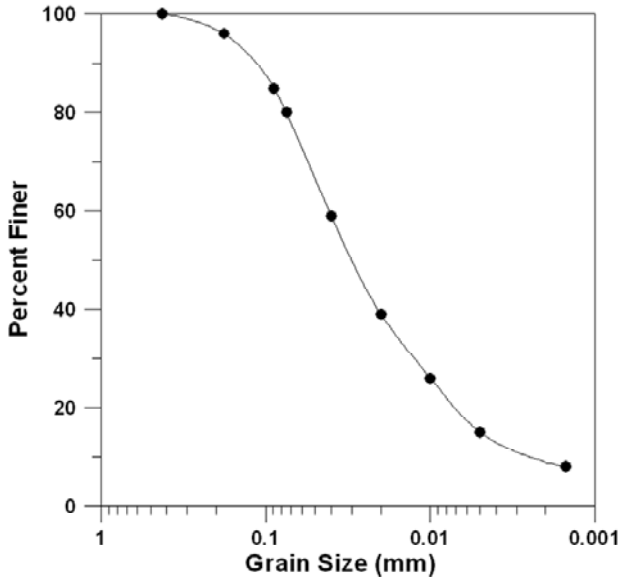



b. $D_{10}$ = **0.21 mm**; $D_{30}$ = **0.39 mm**; $D_{60}$ = **0.45 mm**

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

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

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%**

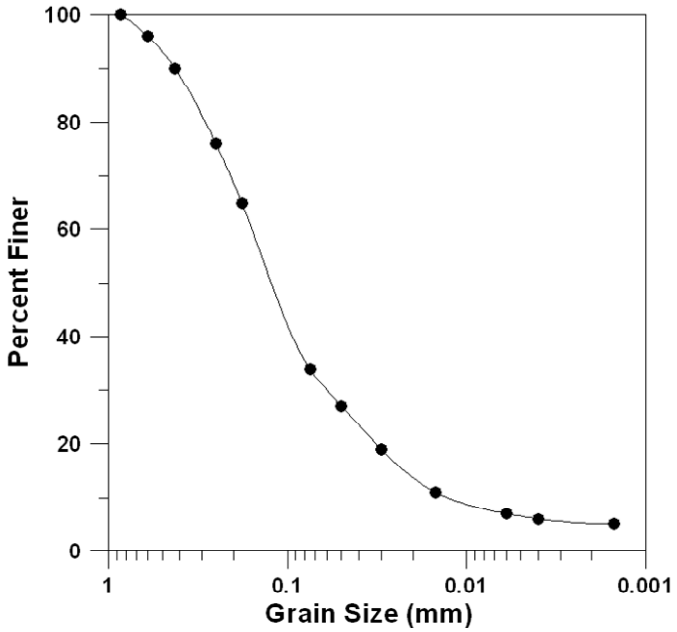
c. Percent passing 2 mm = 100
Percent passing 0.05 mm = 68
Percent passing 0.002 mm = 9

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%**

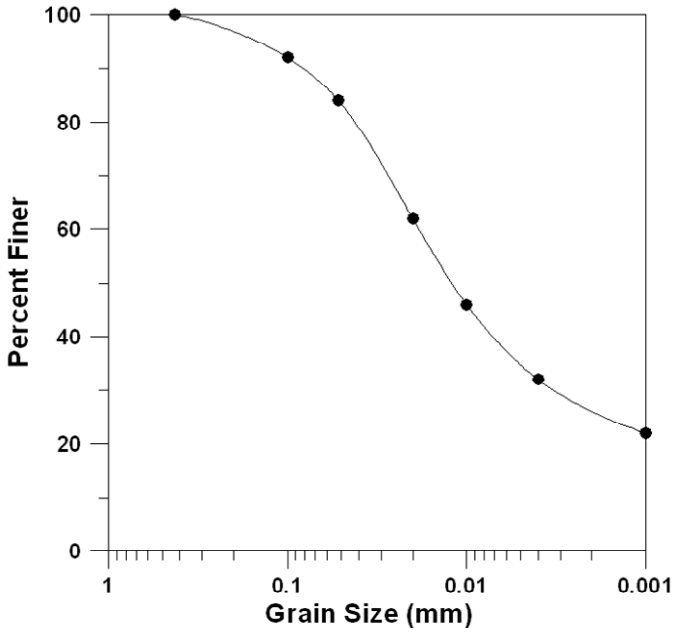
c. Percent passing 2 mm = 100
Percent passing 0.05 mm = 28
Percent passing 0.002 mm = 5

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%**

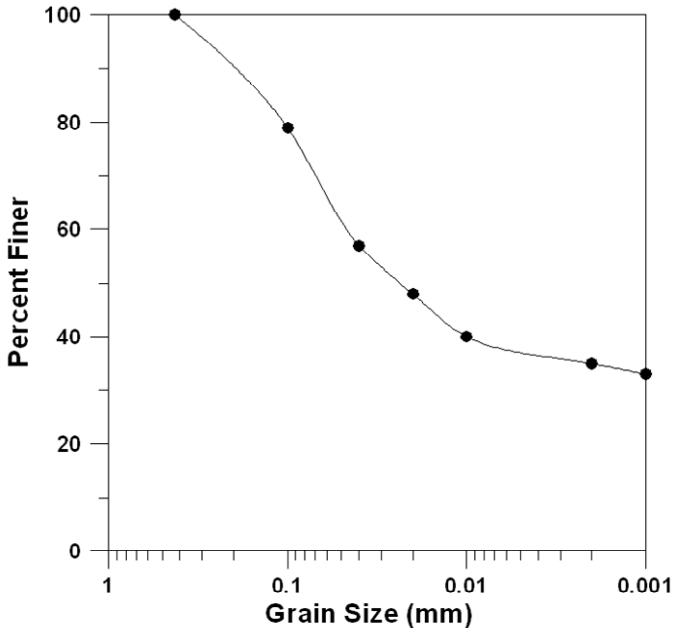
c. Percent passing 2 mm = 100
Percent passing 0.05 mm = 83
Percent passing 0.002 mm = 28

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.




b. Percent passing 2 mm = 100 — GRAVEL: 100 – 100 = **0%**
Percent passing 0.06 mm = 65 — SAND: 100 – 65 = **35%**
Percent passing 0.002 mm = 35 — SILT: 65 – 35 = **30%**
CLAY: 35 – 0 = **35%**

c. Percent passing 2 mm = 100 — GRAVEL: 100 – 100 = **0%**
Percent passing 0.05 mm = 62 — SAND: 100 – 62 = **38%**
Percent passing 0.002 mm = 35 — SILT: 62 – 35 = **27%**
CLAY: 35 – 0 = **35%**

d. Percent passing 2 mm = 100 — GRAVEL: 100 – 100 = **0%**
Percent passing 0.075 mm = 70 — SAND: 100 – 70 = **30%**
Percent passing 0.002 mm = 35 — SILT: 70 – 35 = **35%**
CLAY: 35 – 0 = **35%**

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

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

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

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

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

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

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

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

## CRITICAL THINKING PROBLEM

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

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

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

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 | GRAVEL: 100 – 29 = **71%** |
| Percent passing 0.075 mm = 1 | SAND: 29 – 1 = **28%** |
| | FINES: 1 – 0 = **1%** |

Soil B:

| | |
|---|---|
| Percent passing 4.75 mm = 45 | GRAVEL: 100 – 45 = **55%** |
| Percent passing 0.075 mm = 2 | SAND: 45 – 2 = **43%** |
| | FINES: 2 – 0 = **2%** |

Soil C:

| | |
|---|---|
| Percent passing 4.75 mm = 53 | GRAVEL: 100 – 53 = **47%** |
| Percent passing 0.075 mm = 3 | SAND: 47 – 3 = **44%** |
| | FINES: 3 – 0 = **3%** |