

# Chapter 2

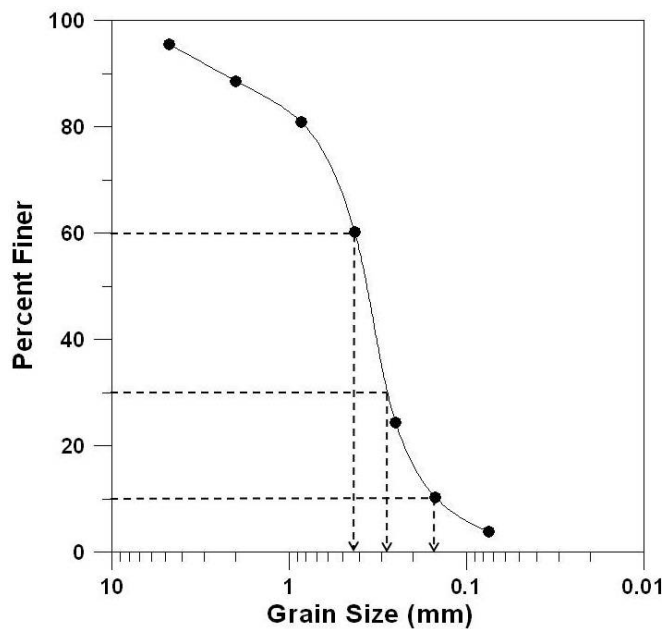
2.1  $C_u = \frac{D_{60}}{D_{10}} = \frac{0.42}{0.16} = 2.625 \approx \mathbf{2.63}$ ;  $C_c = \frac{D_{30}^2}{(D_{60})(D_{10})} = \frac{0.21^2}{(0.42)(0.16)} = 0.656 \approx \mathbf{0.66}$

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	<b>95.46</b>
10	42	6.81	<b>88.65</b>
20	48	7.78	<b>80.88</b>
40	128	20.75	<b>60.13</b>
60	221	35.82	<b>24.31</b>
100	86	13.94	<b>10.37</b>
200	40	6.48	<b>3.89</b>
Pan	24	3.89	<b>0.00</b>

Σ 617 g



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

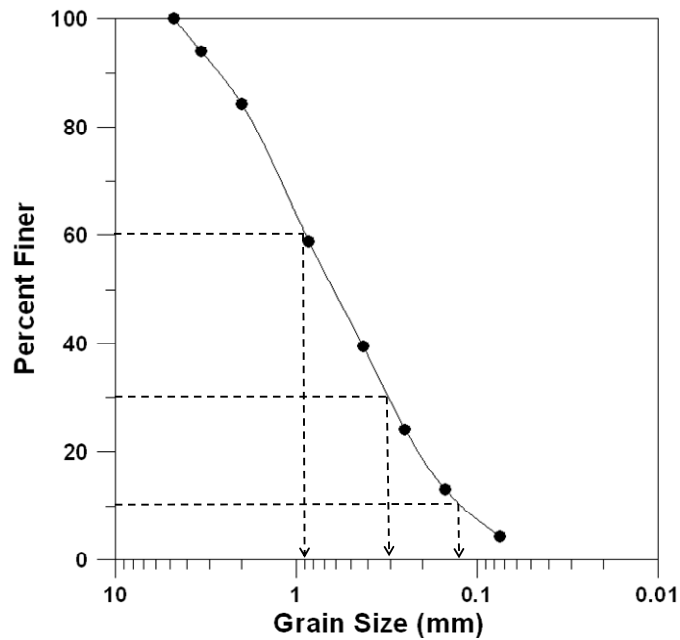
c.  $C_u = \frac{D_{60}}{D_{10}} = \frac{0.45}{0.16} = 2.812 \approx 2.81$

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	<b>100.00</b>
6	30	6.0	<b>94.0</b>
10	48.7	9.74	<b>84.26</b>
20	127.3	25.46	<b>58.80</b>
40	96.8	19.36	<b>39.44</b>
60	76.6	15.32	<b>24.12</b>
100	55.2	11.04	<b>13.08</b>
200	43.4	8.68	<b>4.40</b>
Pan	22	4.40	<b>0.00</b>

$\Sigma 500 \text{ g}$



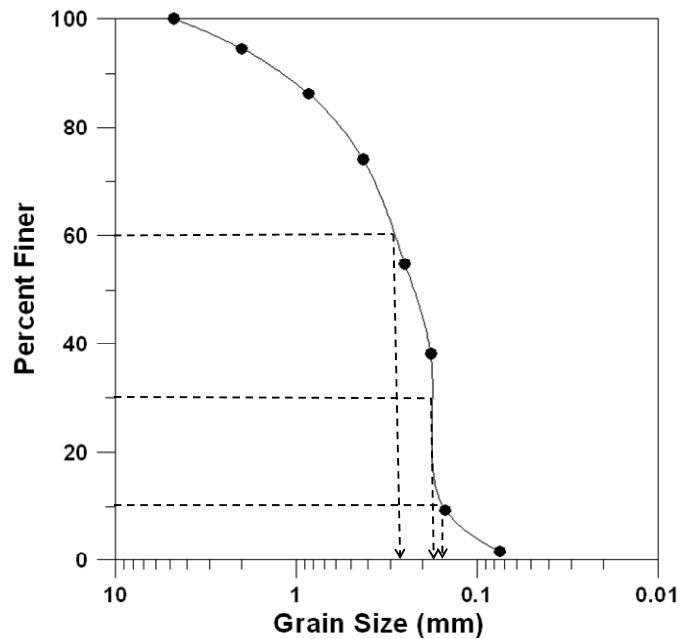
b.  $D_{10} = 0.13 \text{ mm}; D_{30} = 0.3 \text{ mm}; D_{60} = 0.9 \text{ mm}$

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

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

2.5 a.

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



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

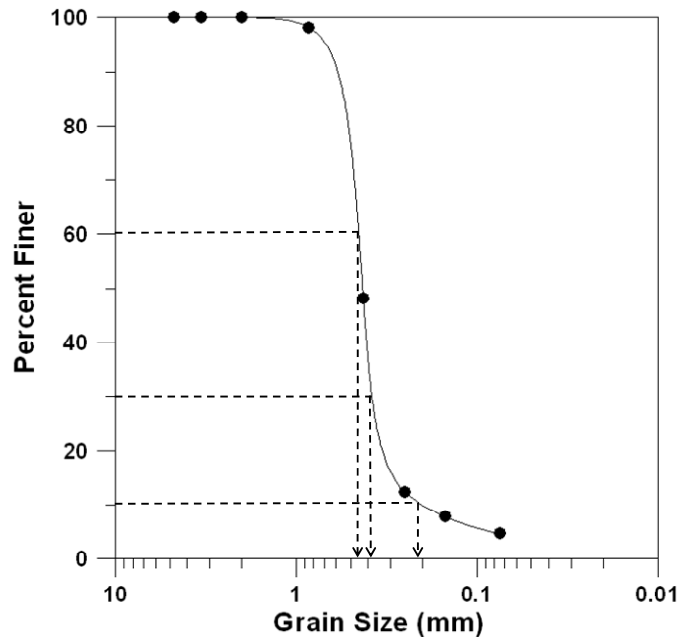
$$c. C_u = \frac{D_{60}}{D_{10}} = \frac{0.28}{0.17} = 1.647 \approx \mathbf{1.65}$$

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

2.6 a.

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

Σ 500 g

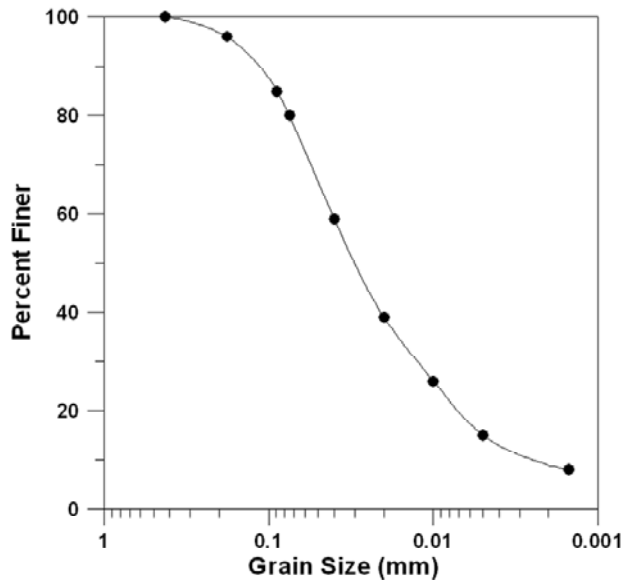


b.  $D_{10} = 0.21 \text{ mm}$ ;  $D_{30} = 0.39 \text{ mm}$ ;  $D_{60} = 0.45 \text{ mm}$

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

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

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:  $9 - 0 = 9\%$

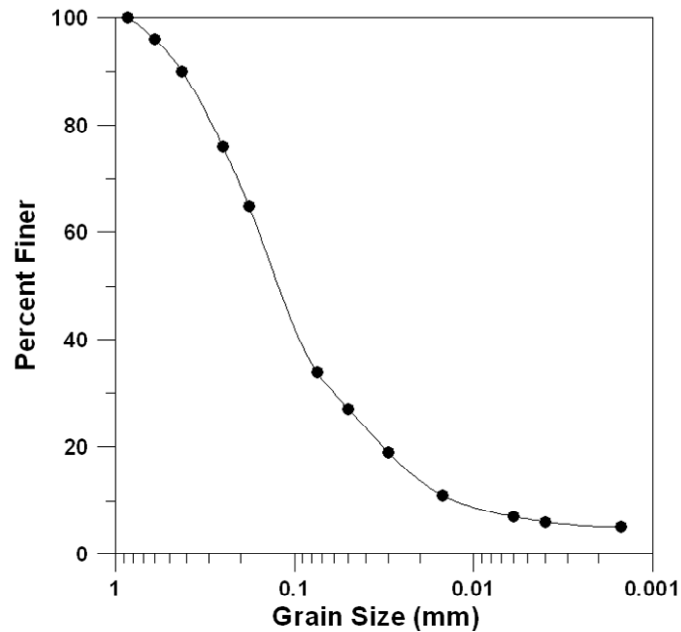
- c. Percent passing 2 mm = 100  
Percent passing 0.05 mm = 68  
Percent passing 0.002 mm = 9

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:  $5 - 0 = 5\%$

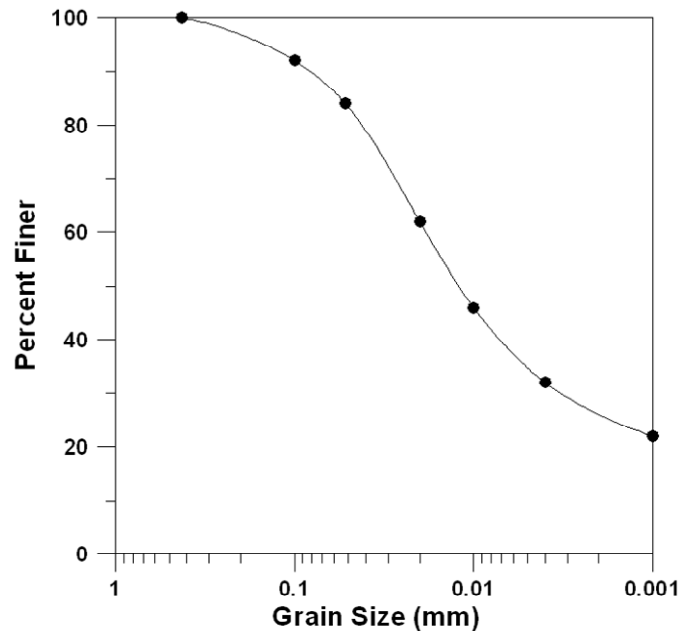
- c. Percent passing 2 mm = 100  
Percent passing 0.05 mm = 28  
Percent passing 0.002 mm = 5

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:  $28 - 0 = 28\%$

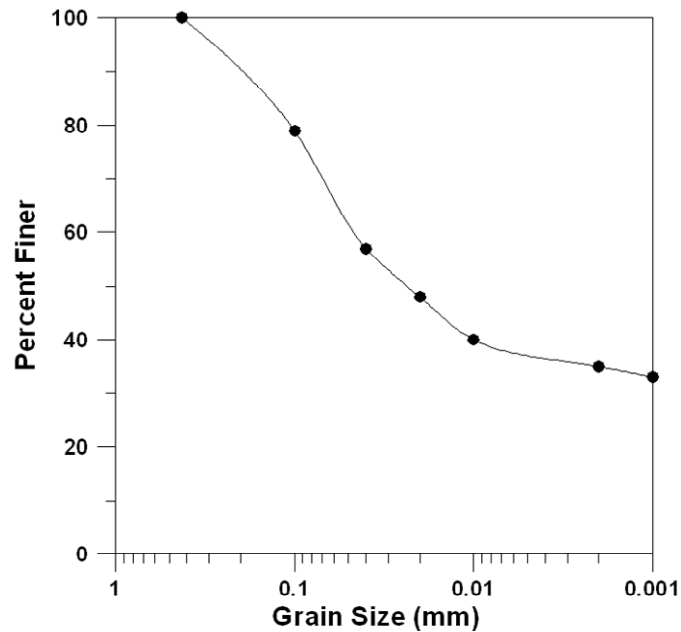
- c. Percent passing 2 mm = 100  
Percent passing 0.05 mm = 83  
Percent passing 0.002 mm = 28

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.



- b. Percent passing 2 mm = 100  
 Percent passing 0.06 mm = 65  
 Percent passing 0.002 mm = 35

GRAVEL:  $100 - 100 = 0\%$   
 SAND:  $100 - 65 = 35\%$   
 SILT:  $65 - 35 = 30\%$   
 CLAY:  $35 - 0 = 35\%$

- c. Percent passing 2 mm = 100  
 Percent passing 0.05 mm = 62  
 Percent passing 0.002 mm = 35

GRAVEL:  $100 - 100 = 0\%$   
 SAND:  $100 - 62 = 38\%$   
 SILT:  $62 - 35 = 27\%$   
 CLAY:  $35 - 0 = 35\%$

- d. Percent passing 2 mm = 100  
 Percent passing 0.075 mm = 70  
 Percent passing 0.002 mm = 35

GRAVEL:  $100 - 100 = 0\%$   
 SAND:  $100 - 70 = 30\%$   
 SILT:  $70 - 35 = 35\%$   
 CLAY:  $35 - 0 = 35\%$

2.11  $G_s = 2.7$ ; temperature =  $24^\circ$ ; 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 =  $24^\circ$ ,  $K = 0.01282$

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

2.12  $G_s = 2.75$ ; temperature =  $23^\circ\text{C}$ ; 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 =  $23^\circ$ ,  $K = 0.01279$

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

<b>CRITICAL THINKING PROBLEM</b>
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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:  $3 - 0 = 3\%$