

Chapter 2

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$$2.1 \quad C_u = \frac{D_{60}}{D_{10}} = \frac{0.41}{0.08} = \mathbf{5.13}$$

$$C_c = \frac{(D_{30})^2}{(D_{10})(D_{60})} = \frac{(0.22)^2}{(0.08)(0.41)} = \mathbf{1.48}$$

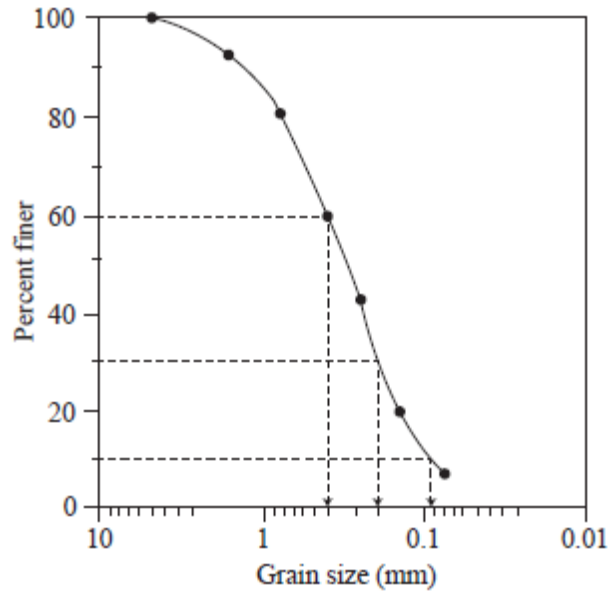
$$2.2 \quad C_u = \frac{D_{60}}{D_{10}} = \frac{1.81}{0.24} = \mathbf{7.54}$$

$$C_c = \frac{(D_{30})^2}{(D_{10})(D_{60})} = \frac{(0.82)^2}{(0.24)(1.81)} = \mathbf{1.55}$$

2.3 a.

Sieve no.	Mass of soil retained on each sieve (g)	Percent retained on each sieve	Percent finer
4	0.0	0.0	100.0
10	18.5	4.4	95.6
20	53.2	12.6	83.0
40	90.5	21.5	61.5
60	81.8	19.4	42.1
100	92.2	21.9	20.2
200	58.5	13.9	6.3
Pan	26.5	6.3	0
	Σ 421.2 g		

The grain-size distribution is shown in the figure.



b. $D_{60} = 0.4 \text{ mm}$; $D_{30} = 0.2 \text{ mm}$; $D_{10} = 0.095 \text{ mm}$

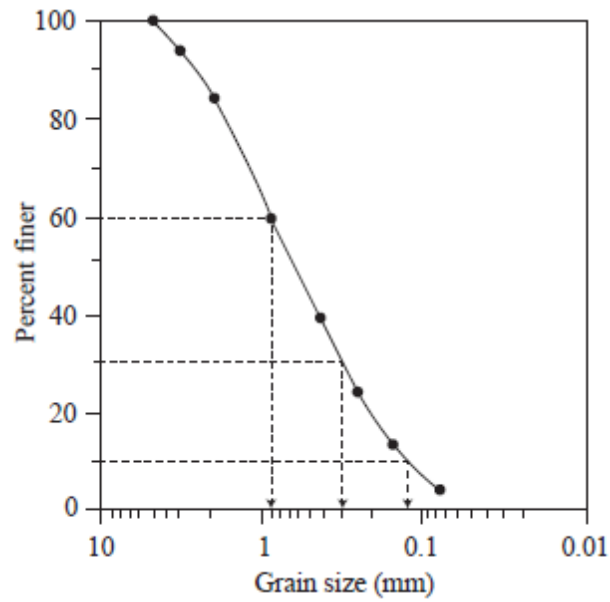
c. $C_u = \frac{D_{60}}{D_{10}} = \frac{0.4}{0.095} = 4.21$

d. $C_c = \frac{(D_{30})^2}{(D_{10})(D_{60})} = \frac{(0.2)^2}{(0.4)(0.095)} = 1.05$

2.4 a.

Sieve no.	Mass of soil retained on each sieve (g)	Percent retained on each sieve	Percent finer
4	0.0	0.0	100
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
	$\Sigma 500 \text{ g}$		

The grain-size distribution is shown in the figure.



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

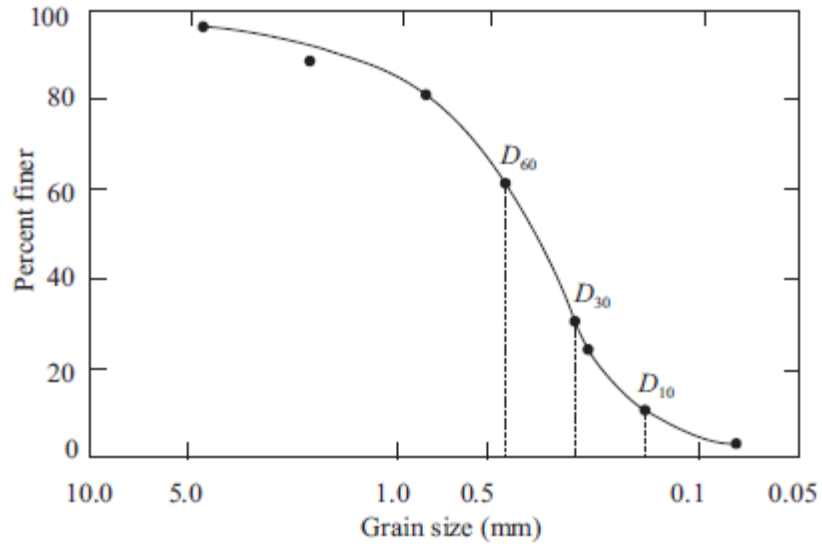
c. $C_u = \frac{D_{60}}{D_{10}} = \frac{0.9}{0.13} = 6.923 \approx 6.92$

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

2.5 a.

Sieve no.	Mass retained (g)	Percent retained on each sieve	Percent finer
4	28	4.54	95.46
10	42	6.81	88.65
20	48	7.78	80.87
40	128	20.75	60.12
60	221	35.82	24.3
100	86	13.94	10.36
200	40	6.48	3.88
Pan	24	3.88	0
	$\Sigma 617 \text{ g}$		

The graph for percent finer versus grain size is shown.



b. From the graph, $D_{10} = 0.14 \text{ mm}$, $D_{30} = 0.27 \text{ mm}$, $D_{60} = 0.42 \text{ mm}$

c.
$$C_u = \frac{D_{60}}{D_{10}} = \frac{0.42}{0.14} = 3$$

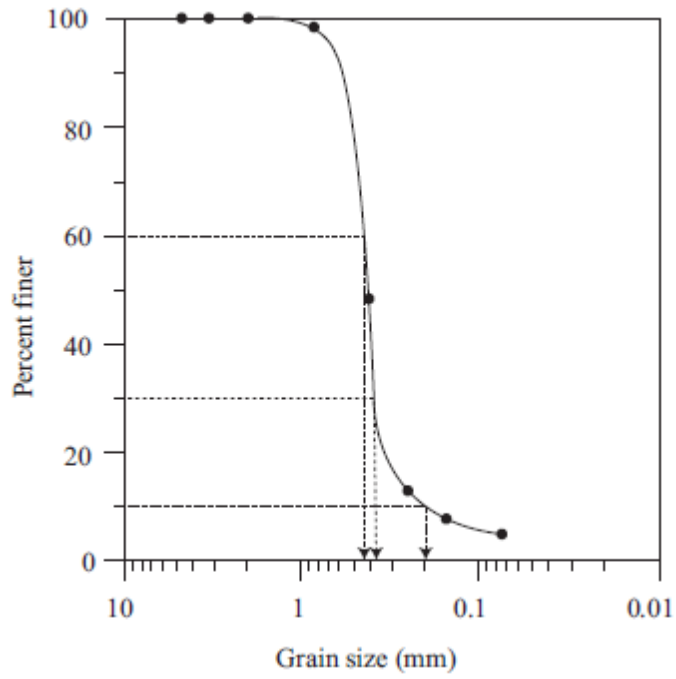
d.
$$C_c = \frac{(D_{30})^2}{(D_{60})(D_{10})} = \frac{(0.27)^2}{(0.42)(0.14)} = 1.24$$

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2.6 a.

The grain-size distribution is shown in the figure.

Sieve no.	Mass of soil retained on each sieve (g)	Percent retained on each sieve	Percent finer
4	0	0.0	100
6	0	0.0	100
10	0	0.0	100
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
	$\Sigma 500 \text{ g}$		

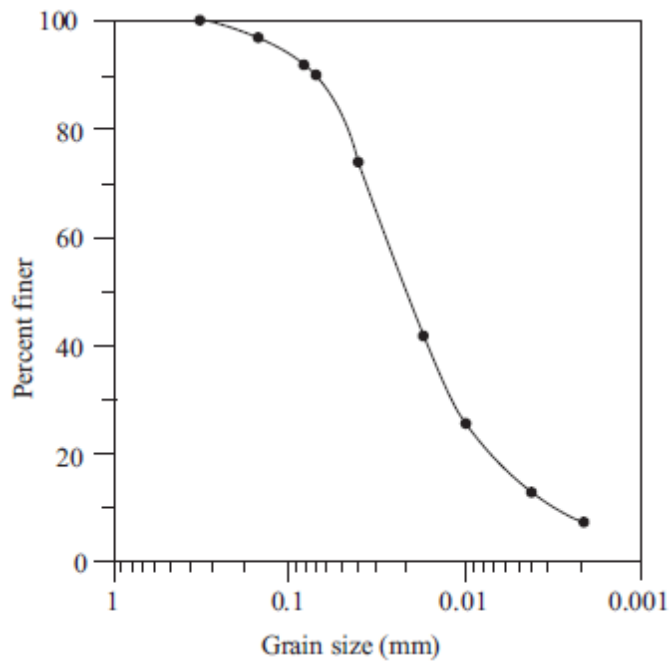


b. $D_{10} = 0.21 \text{ mm}$; $D_{30} = 0.39 \text{ mm}$; $D_{60} = 0.45 \text{ mm}$

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

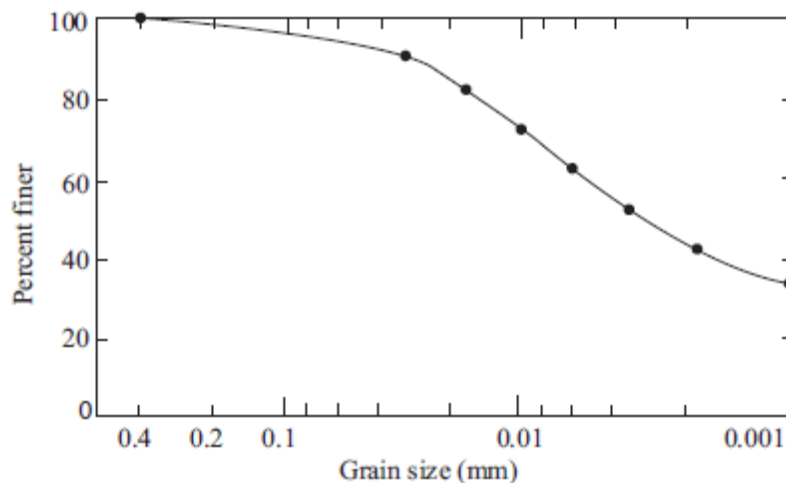
d.
$$C_c = \frac{D_{30}^2}{(D_{60})(D_{10})} = \frac{0.39^2}{(0.45)(0.21)} = 1.609 \approx 1.61$$

2.7 a. The grain-size distribution curve is shown in the figure.



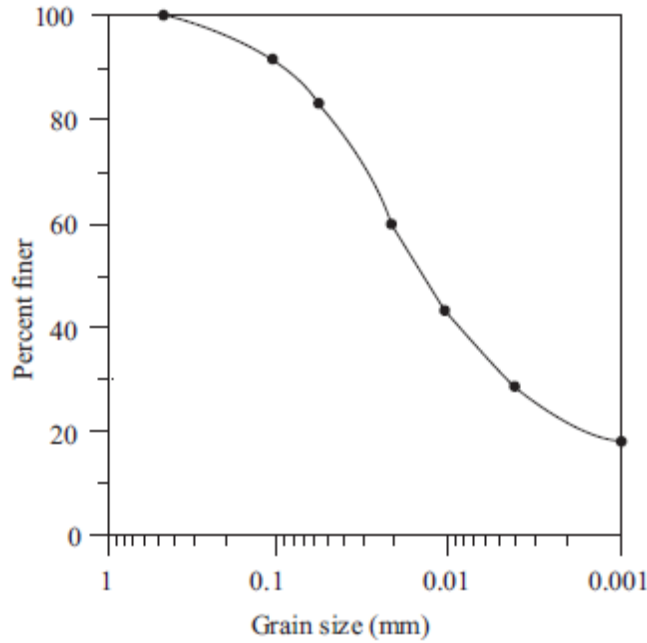
- | | |
|-------------------------------|---------------------------|
| b. Percent passing 2 mm = 100 | GRAVEL: $100 - 100 = 0\%$ |
| Percent passing 0.06 mm = 84 | SAND: $100 - 84 = 16\%$ |
| Percent passing 0.002 mm = 11 | SILT: $84 - 11 = 73\%$ |
| | CLAY: $11 - 0 = 11\%$ |
| | |
| c. Percent passing 2 mm = 100 | GRAVEL: $100 - 100 = 0\%$ |
| Percent passing 0.05 mm = 80 | SAND: $100 - 80 = 20\%$ |
| Percent passing 0.002 mm = 11 | SILT: $80 - 11 = 69\%$ |
| | CLAY: $11 - 0 = 11\%$ |
| | |
| d. Percent passing 2 mm = 100 | GRAVEL: $100 - 100 = 0\%$ |
| Percent passing 0.075 mm = 90 | SAND: $100 - 90 = 10\%$ |
| Percent passing 0.002 mm = 11 | SILT: $90 - 11 = 79\%$ |
| | CLAY: $11 - 0 = 11\%$ |

2.8 The grain-size distribution curve is shown in the figure.



- | | |
|-------------------------------|---------------------------|
| a. Percent passing 2 mm = 100 | GRAVEL: $100 - 100 = 0\%$ |
| Percent passing 0.05 mm = 94 | SAND: $100 - 94 = 6\%$ |
| Percent passing 0.002 mm = 42 | SILT: $94 - 42 = 52\%$ |
| | CLAY: $42 - 0 = 42\%$ |
| | |
| b. Percent passing 2 mm = 100 | GRAVEL: $100 - 100 = 0\%$ |
| Percent passing 0.075 mm = 97 | SAND: $100 - 97 = 3\%$ |
| Percent passing 0.002 mm = 42 | SILT: $97 - 42 = 55\%$ |
| | CLAY: $42 - 0 = 42\%$ |

2.9 a. The grain-size distribution curve is shown below.



- | | |
|-------------------------------|-------------------------------|
| b. Percent passing 2 mm = 100 | GRAVEL: 100 – 100 = 0% |
| Percent passing 0.06 mm = 84 | SAND: 100 – 84 = 16% |
| Percent passing 0.002 mm = 28 | SILT: 84 – 28 = 56% |
| | CLAY: 28 – 0 = 28% |
| | |
| c. Percent passing 2 mm = 100 | GRAVEL: 100 – 100 = 0% |
| Percent passing 0.05 mm = 83 | SAND: 100 – 83 = 17% |
| Percent passing 0.002 mm = 28 | SILT: 83 – 28 = 55% |
| | CLAY: 28 – 0 = 28% |
| | |
| d. Percent passing 2 mm = 100 | GRAVEL: 100 – 100 = 0% |
| Percent passing 0.075 mm = 90 | SAND: 100 – 90 = 10% |
| Percent passing 0.002 mm = 28 | SILT: 90 – 28 = 62% |
| | CLAY: 28 – 0 = 28% |

2.10 $G_s = 2.60$; temperature = 24° ; $R = 43$; time = 60 min. Referring to Table 2.10, $L = 9.2$.

$$\text{Eq. (2.6): } D \text{ (mm)} = K \sqrt{\frac{L(\text{cm})}{t(\text{min})}}$$

From Table 2.9 for $G_s = 2.60$ and temperature = 24° , $K = 0.01321$.

$$D = 0.01321 \sqrt{\frac{9.2}{60}} = \mathbf{0.0052 \text{ mm}}$$

2.11 For $G_s = 2.70$ and temperature = 23° , $K = 0.01297$ (Table 2.9);
 $R = 25$, $L = 12.2$ (Table 2.10).

$$D(\text{mm}) = K \sqrt{\frac{L(\text{cm})}{t(\text{min})}} = 0.01297 \sqrt{\frac{12.2}{120}} = \mathbf{0.0041 \text{ mm}}$$

2.12 a. Total mass in the ternary mix = $8000 \times 3 = 24,000 \text{ kg}$

$$\text{Percent of each soil in the mix} = \frac{8000}{24,000} \times 100 = 33.33\%$$

Mass of each soil used in the sieve analysis, $\Sigma m_A = \Sigma m_B = \Sigma m_C = 500 \text{ g}$

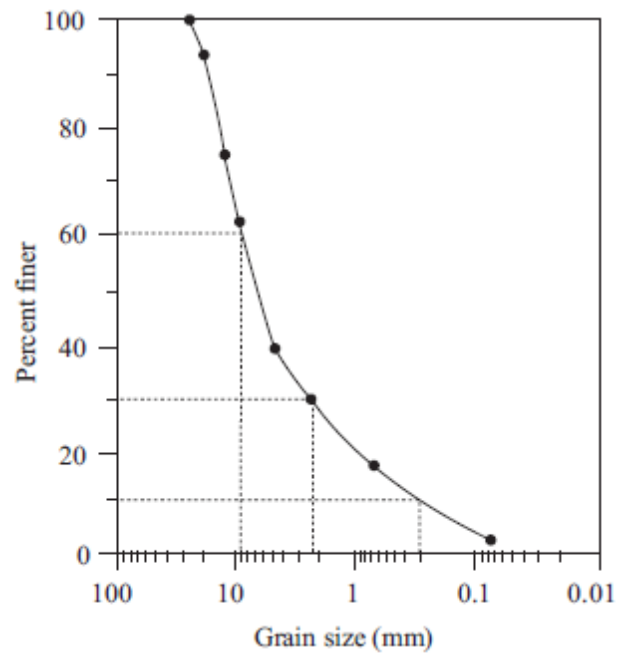
If a sieve analysis is conducted on the ternary mix using the same set of sieves, the percent of mass retained on each sieve, $m_M(\%)$, can be computed as follows:

$$m_M(\%) = 0.333 \left(\frac{m_A}{500} \times 100 \right) + 0.333 \left(\frac{m_B}{500} \times 100 \right) + 0.333 \left(\frac{m_C}{500} \times 100 \right)$$

The calculated values are shown in the following table.

Sieve size (mm)	Mass retained			$m_M(\%)$	Percent passing for the mixture
	m_A (g)	m_B (g)	m_C (g)		
25.0	0.0	0	0	0.0	100
19.0	60	10	30	6.66	93.34
12.7	130	75	75	18.65	74.69
9.5	65	80	45	12.65	62.04
4.75	100	165	90	23.64	38.4
2.36	50	25	65	9.32	29.08
0.6	40	60	75	11.65	17.43
0.075	50	70	105	14.98	2.45
Pan	5	15	15	2.33	≈ 0

b. The grain-size distribution curve for the mixture is drawn below.



From the curve, $D_{10} = 0.21$; $D_{30} = 2.5$; $D_{60} = 9.0$;

$$C_u = \frac{D_{60}}{D_{10}} = \frac{9.0}{0.21} = \mathbf{42.85}; \quad C_x = \frac{D_{30}^2}{(D_{60})(D_{10})} = \frac{2.5^2}{(9.0)(0.21)} = \mathbf{3.31}$$

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