INS 3121
SOIL MECHANICS

Examples:
Grain Size Distribution

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Example 1

The table are the results of a sieve analysis:

a) Determine the percent finer than each sieve and plot a grain-size distribution curve.

b) Determine D_{10}, D_{30}, and D_{60} from the grain-size distribution curve.

c) Calculate the uniformity coefficient, C_u.

d) Calculate the coefficient of gradation, C_c.

e) Determine the percentages of gravel, sand, silt, and clay-size particles using the Unified Soil Classification System (USCS).

| U.S. sieve no.	Mass of soil retained (g)
4	0
10	18.5
20	53.2
40	90.5
60	81.8
100	92.2
200	58.2
Pan	26.5

Solution 1

Particle-size distribution curve

$$\frac{\sum M - col.\,4}{\sum M} \times 100$$

U.S. sieve (1)	Opening (mm) (2)	Mass retained on each sieve (g) (3)	Cumulative mass retained above each sieve (g) (4)	Percent Finer (5)
4	4.75	0	0	100.0
10	2.00	18.5	0 + 18.5 = 18.5	95.6
20	0.850	53.2	18.5 + 53.2 = 71.7	83.0
40	0.425	90.5	71.7 + 90.5 = 162.2	61.5
60	0.250	81.8	162.2 + 81.8 = 244	42.0
100	0.150	92.2	244 + 92.2 = 336.2	20.1
200	0.075	58.2	336.2 + 58.2 = 394.4	6.3
Pan	-	26.5	394.4 + 26.5 = 420.9 = $\sum$M	0.0

Solution 1

Particle-size distribution curve

Figure axes: Percent finer (y-axis, 0.0 to 100.0) versus Particle size (mm) (x-axis, 10 to 0.01, logarithmic).

$D_{60} = 0.412$

$D_{30} = 0.195$

$D_{10} = 0.095$
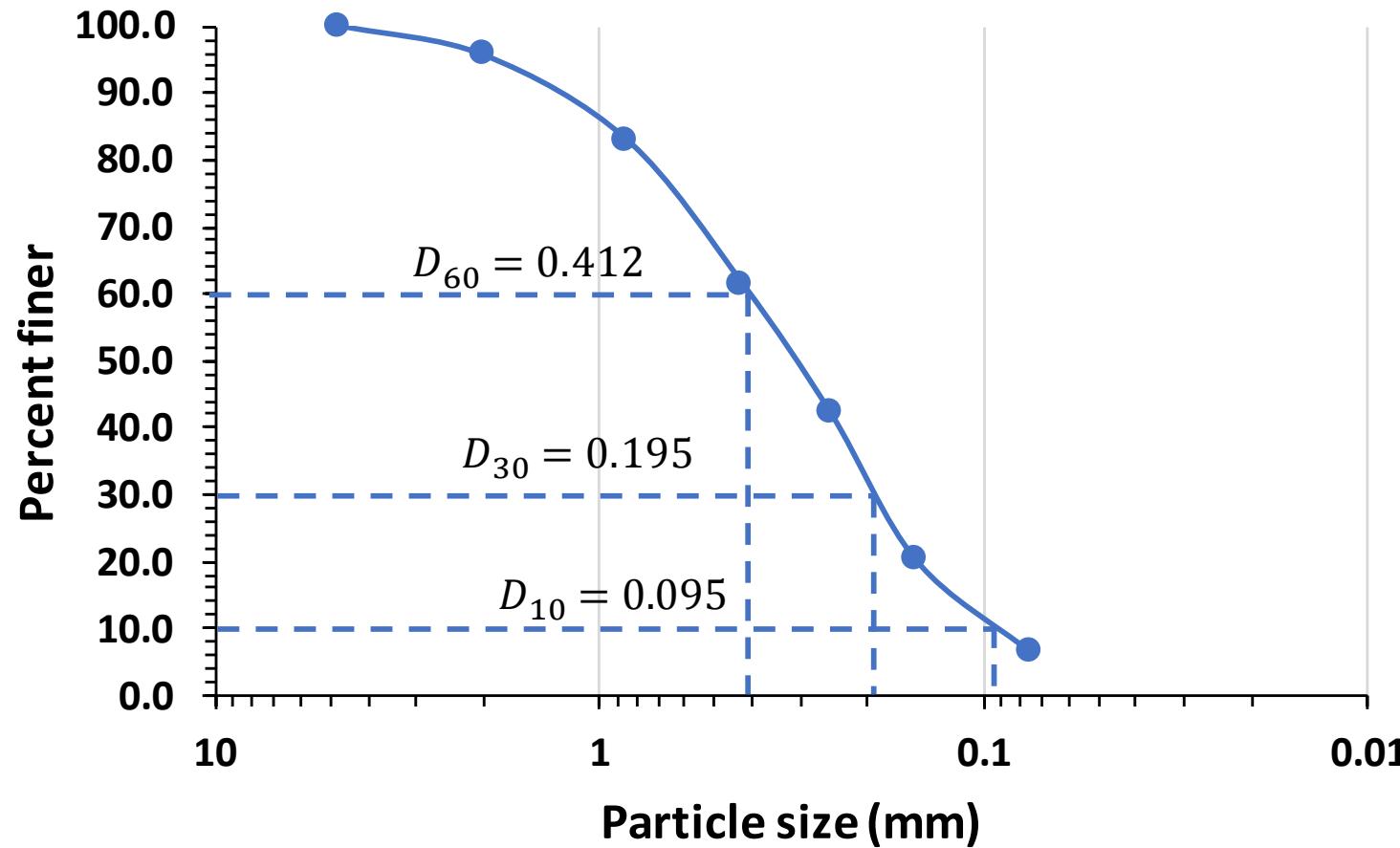
Solution 1

➢ **Uniformity coefficient, Cu**

$$C_u = \frac{D_{60}}{D_{10}} = \frac{0.412}{0.095} = \mathbf{4.3}$$

➢ **Coefficient of gradation, Cc**

$$C_c = \frac{D_{30}^2}{D_{60} \times D_{10}} = \frac{0.195^2}{0.412 \times 0.095} = \mathbf{0.97}$$

Solution 1

➢ **Percentages of gravel, sand, silt, and clay-size particles according to USCS.**

Size (mm)	Percent finer	
76.2	100	
4.75	100	100 – 100 = 0% **gravel**
0.075	6.3	100 - 6.3 = 93.7% **sand**
-	0	6.3 – 0 = 6.3% **silt and clay**

| Type	Particle Size (mm)		
	AASHTO	**USCS**	**TS-1500**
Gravel	2-76.2	4.75-76.2	2-76.2
Sand	0.075-2	0.075-4.75	0.075-2
Silt	0.002-0.075	<0.075	0.002-0.075
Clay	<0.002		<0.002

Example 2

Repeat Example 2 with the following:

U.S. sieve no.	Mass of soil retained (g)	Opening (mm) (2)	Percent Finer (5)
4	0	4.75	100.0
10	44	2.00	92.0
20	56	0.850	81.9
40	82	0.425	67.0
60	51	0.250	57.7
80	106	0.180	38.5
100	92	0.150	21.8
200	85	0.075	6.4
Pan	35	-	0.0

Solution 2

Particle-size distribution curve
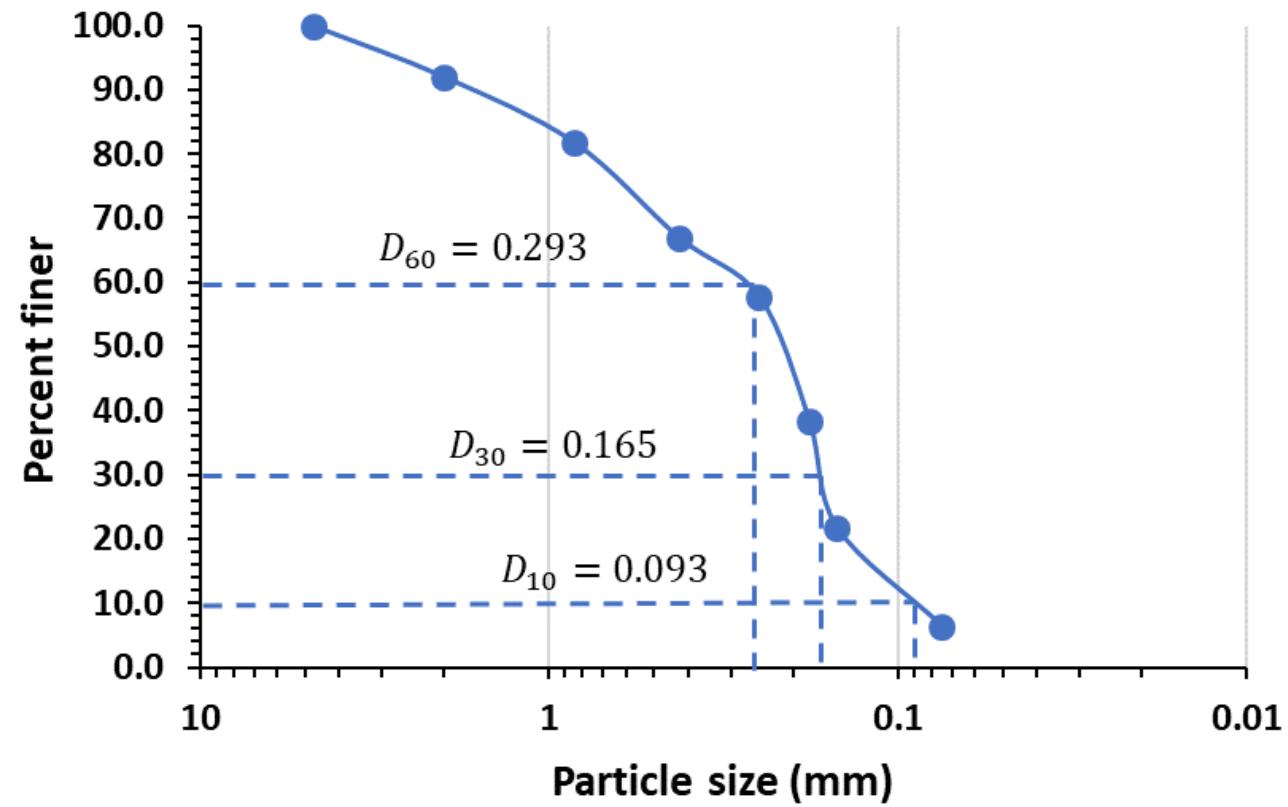
Solution 2

➢ **Uniformity coefficient, Cu**

$$C_u = \frac{D_{60}}{D_{10}} = \frac{0.293}{0.093} = \mathbf{3.15}$$

➢ **Coefficient of gradation, Cc**

$$C_c = \frac{D_{30}^2}{D_{60} \times D_{10}} = \frac{0.165^2}{0.093 \times 0.093} = \mathbf{1}$$

| Size (mm)	TS-1500	Percent finer
76.2	100	
2	92	100 − 92 = 8% **gravel**
0.075	6.4	92 - 6.4 = 85.6% **sand**
-	0	6.4 − 0 = 6.4% **silt and clay**

Example 3

The following are the results of a sieve and hydrometer analysis:

  a)   Draw the grain-size distribution curve.

  b)   Determine the percentages of gravel, sand, silt, and clay according to the MIT system.

  c)   Repeat part b according to the AASHTO system.

Analysis	Sieve number/grain size	Percent finer than
Sieve	40	100
	80	97
	170	92
	200	90
Hydrometer	0.04 mm	74
	0.015 mm	42
	0.008 mm	27
	0.004 mm	17
	0.002 mm	11

Solution 3

Grain size (mm)	Percent finer than
0.425	100
0.18	97
0.09	92
0.075	90
0.04	74
0.015	42
0.008	27
0.004	17
0.002	11
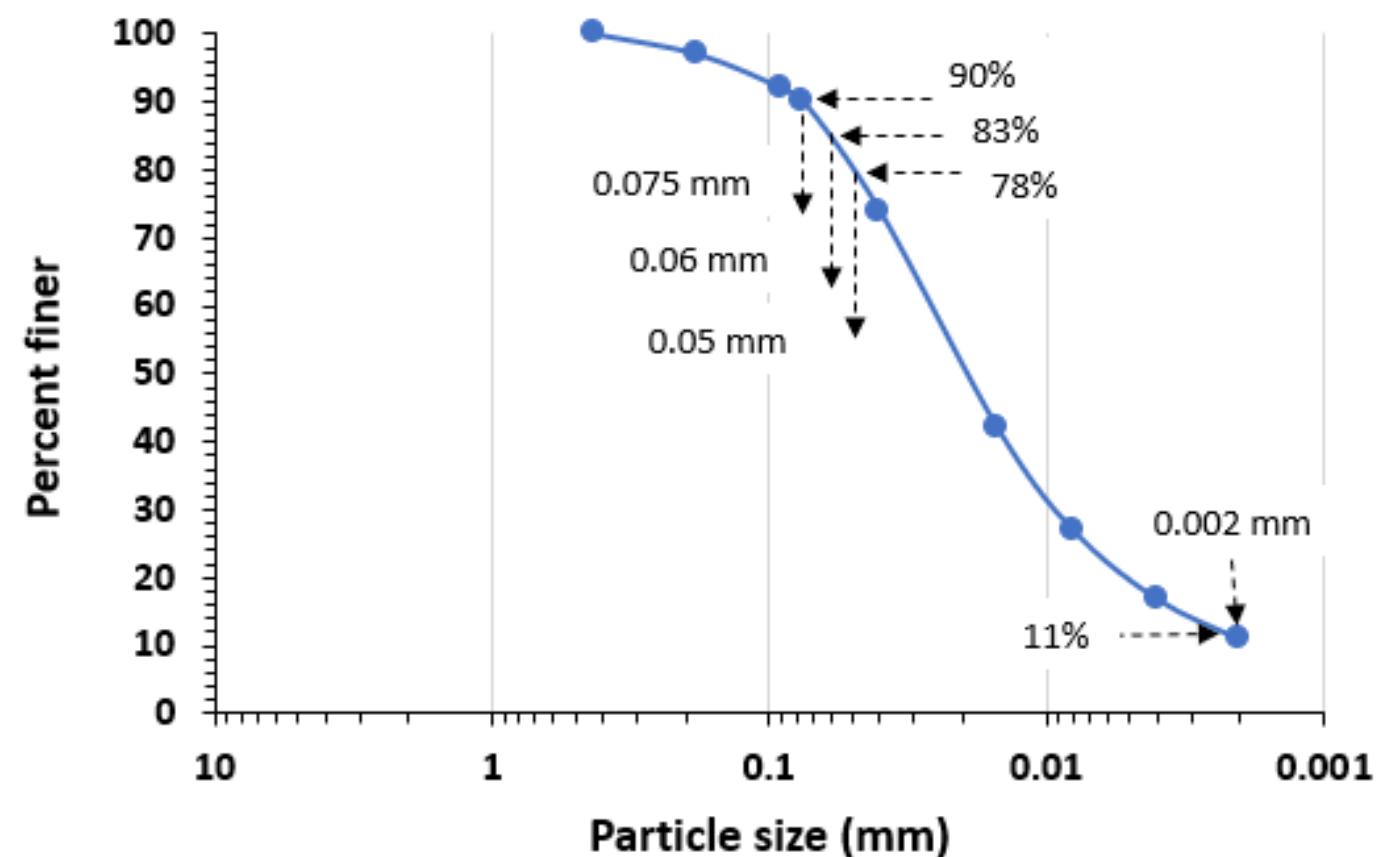
Solution 3

➢ **Percentages of gravel, sand, silt, and clay according to the MIT system.**

Passing 2 mm = 100%

Passing 0.06 mm = 83%

Passing 0.002 mm = 11 %
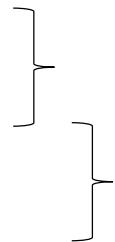
Gravel: 0%
Sand: 100 − 83 = 17 %
Silt: 83 − 11 = 72%
Clay: 11 − 0 = 11%

➢ <u>**According to the AASHTO system.**</u>

Passing 2 mm = 100%

Passing 0.075 mm = 90%

Passing 0.002 mm = 11 %
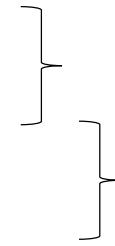
Gravel: 0%
Sand: 100 − 90 = 10 %
Silt: 90 − 11 = 79%
Clay: 11 − 0 = 11%