GRAIN SIZE ANALYSIS

Rafia Islam
Lecturer
Department of Environmental, Water Resources and Coastal Engineering (EWCE)
Military Institute of Science and Technology

Grain Size Analysis

- Grain size analysis is a procedure used to determine the **relative proportions** of **different particle sizes** in a soil sample.

1. **Sieve analysis –** Applicable when the soil contains mainly **sand and larger particles.**
2. **Hydrometer analysis** – Applicable when the soil is **fine-grained, or silt and clay particles.**
3. **Combined analysis i.e. both sieve and hydrometer analysis** – Applicable when the soil contains a sizable portion of **both fine and coarse fractions.**

Objective

- To determine the **percentage of different grain sizes** contained within a soil.



Sieve Analysis



Hydrometer Analysis

Significance

- Provides valuable information about the **composition** of sand, silt, and clay in the soil
- Essential for evaluating **soil characteristics**, including permeability, compressibility, and shear strength
- Plays a crucial role in **predicting** how soils will **behave** under different conditions



Sieve Analysis

Sieve analysis is performed to-

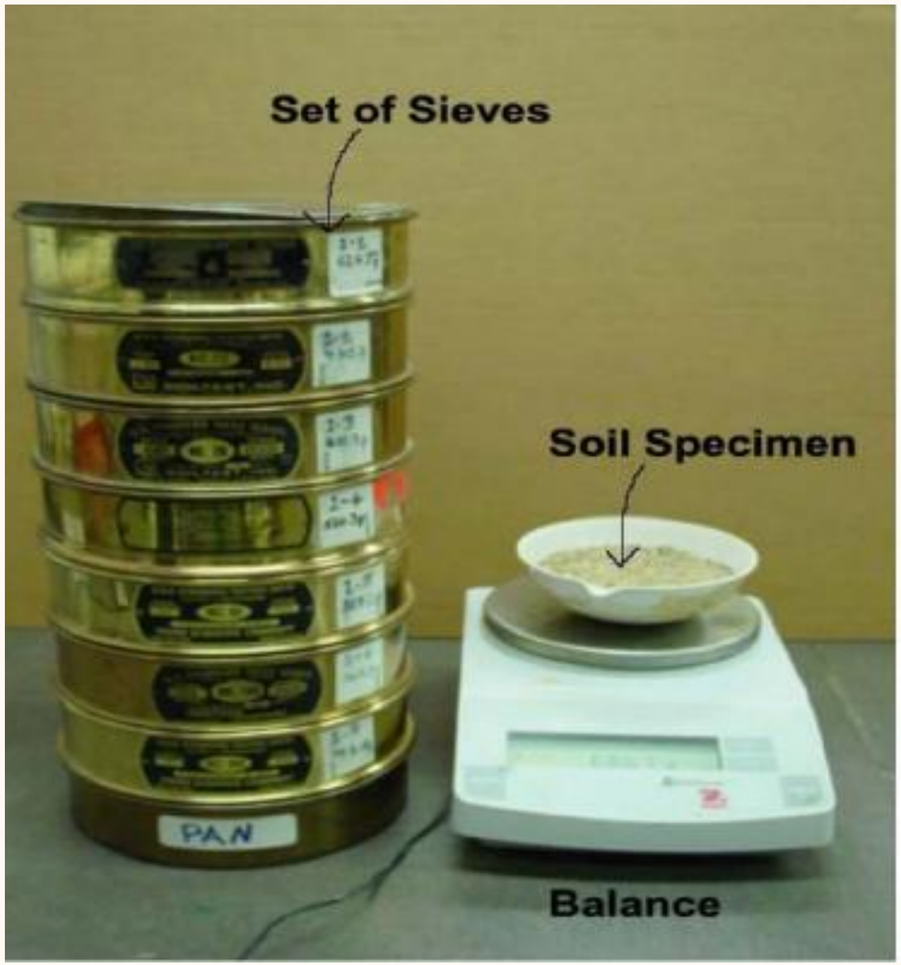
- Determine the **gradation** (or grain size distribution) of different particle sizes of-

1. **Coarse-grained** soil (sand)
2. **Coarser portion** of a soil containing both coarse (sand & silt) and fine (silt & clay) particles



Equipment

- #4, #8, #16,#30, #50, #100, #200 sieve
- Pan
- Lead
- Brush
- Container
- Spoon
- Bowel
- Balance
- Sieve shaker



Sieve no.	Opening (mm)	Sieve no.	Opening (mm)
4	4.75	35	0.50
5	4.00	40	0.425
6	3.35	45	0.355
7	2.80	50	0.30
8	2.36	60	0.25
10	2.00	70	0.212
12	1.70	80	0.180
14	1.40	100	0.150
16	1.18	120	0.125
18	1.00	140	0.106
20	0.85	200	0.075
25	0.71	270	0.053
30	0.60	400	0.038



For a #4 Sieve:

- #4 sieve means **4 openings per inch**
- Opening size = 25.4 mm per inch / 4 openings ≈ 6.35 mm center-to-center spacing
- However, the wires themselves take up space.
- So, the actual clear opening between the wires is less than 6.35 mm.



Test Procedure

- The weight of each **sieve** and the **bottom pan** should be determined and recorded.
- The weight of the given **dry soil sample** should be recorded.
- It should be ensured that all the sieves are clean and assembled in the **ascending order** of sieve numbers (#4 sieve at top and #200 sieve at bottom).
- The **pan** should be placed below the **#200** sieve. The soil sample should be poured into the top sieve, and the cap should be placed over it.
- The sieve stack should be placed in the **mechanical shaker** and shaken for 10 minutes.
- The **weight of each sieve** with its **retained soil** should be recorded.
- The weight of the **bottom pan** with its retained fine soil should be recorded.

Data Sheet

Data Table:

Sieve No.	Sieve opening (mm)	Wt. of empty sieve (gm)	Wt. of Sieve + Soil Retained (gm)	Wt. of Soil Retained (gm)	% of Soil Retained	Cumulative % Retained	% Finer

Calculation

For example:

Total mass = 500 g

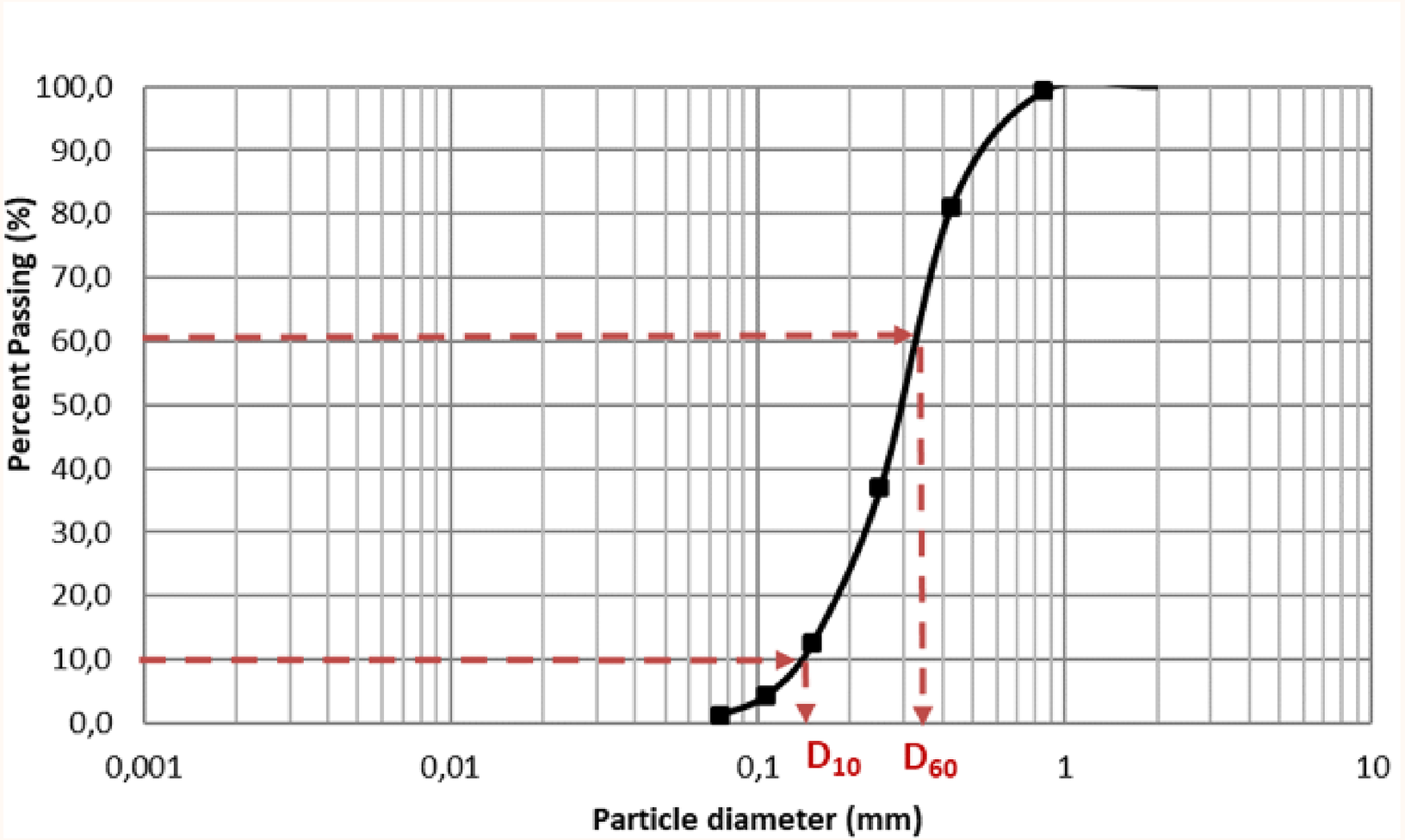
Mass retained on No. 4 sieve = 9.7 g

The percent retained is calculated as % retained = Mass retained/Total mass

= (9.7/500) X 100

= 1.9 %

From this, the % passing = 100 - 1.9 = 98.1 %



$$C_u = \frac{D_{60}}{D_{10}}$$

$$C_c = \frac{D_{30}^2}{D_{60} X D_{10}}$$

- D_{10} is called as **effective particle size**. This means that **10%** of the particles are **finer** and **90%** of the particles are **coarser** than D10. This is the size at 10% finer by weight.
- Similarly, D_{60} is the particle size at which **60%** of the particles are **finer** and **40%** of the particles are **coarser** than D60 size.

❑ Uniformity Coefficient (C_u):

- A higher value of C_u indicates that the soil mass consists of soil particles with different size ranges.
- A value of C_u **greater** than **4** classifies the soil as **well graded**.
- When C_u is **less than 4**, it is classified as **poorly graded** or uniformly graded soil.
- **Uniformly graded** soil has identical particles with Cu value approximately **equal to 1**.

❑ Coefficient of Curvature (C_c):

- For the soil to be well graded, the value of C_c must range between 1 and 3

Wash Sieving

- The wash sieve analysis is performed to accurately determine the **percentage of fine particles** (i.e., silt and clay) in a soil sample
- Wet sieving is suitable for samples with a high concentration of fine particles or samples whose particles are **not easily broken down by mechanical shaking**



Test Procedure

- For clay, first the **oven-dry** sample should be crushed with the help of a wooden hammer.
- Then 100 or 500 gm sample should be measured and **mixed with water** in a bowl. The sample in that condition should be kept for an hour.
- This sample should be **washed through #200 sieve** with the help of a **controlled** water flow.
- Special care should be taken to **avoid any overflow** or other losses.
- Once the flowing **water is clean**, the sample should be taken to an oven-proof bowl with the help of a wash bottle.
- Then it should be put in the **oven to dry**.

Calculation

Net dry mass of soil before sieving= B

Net dry mass of soil retained by #200 Sieve= C

Percent fines= A

$$\mathrm{A} = \frac{B - C}{B} \times 100\ \%$$

Thank You