BIRZEIT UNIVERSITY

Faulty of Engineering and Technology

Civil Engineering Department

Soil Lab

ENCE311

Experiment #2 :

" Sieve Analysis "

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Contents :

Introduction :

The term soil can be defined in various ways. Geologists describe soil as layers of unconsolidated bulk material that extend from the surface to the solid rocks, which have been formed by weathering and disintegration of rocks, but to an engineer, soil is the base material that can be operated .

For engineers, the classification of soil types is important in order to describe the different materials and their properties on site. To do this, a series of simple checks are performed.

Some of these important properties are particle size and grading. This indicates the distribution of the granular material particles between different size ranges, and is usually expressed as larger or smaller than each series of sieve hole sizes. Particle size analysis of soil is performed by determining weight ratios that fall within the volume ranges represented by this division. In the case of coarse soils from which the fine particles have been removed (using a No. 4 sieve), the usual process is sieve analysis

Soils are generally composed of gravel, sand, silt, and clay, depending on the prevailing particle size within the soil. To describe soils with their particle size, many organizations have developed particle size classifications. Pebbles are chunks of rock with occasional particles of quartz, feldspar, and other minerals. Sand particles are mostly made of quartz and feldspar. Also, silt are microscopic fractions of soil made up of very fine quartz grains and some flake-shaped particles that are fragments of fine minerals. Clays are microscopic and semi-microscopic scale-like particles of mica, clay minerals, and other minerals.

This table shows particle size classifications that have been developed by many organizations , Look at Table (1) :

Name of organization	Grain size (mm)			
	Gravel	Sand	Silt	Clay
Massachusetts Institute of Technology (MIT)	>2	2 to 0.06	0.06 to 0.002	<0.002
U.S. Department of Agriculture (USDA)	>2	2 to 0.05	0.05 to 0.002	<0.002
American Association of State Highway and Transportation Officials (AASHTO)	76.2 to 2	2 to 0.075	0.075 to 0.002	<0.002
Unified Soil Classification System (U.S. Army Corps of Engineers, U.S. Bureau of Reclamation, and American Society for Testing and Materials)	76.2 to 4.75	4.75 to 0.075	Fines (i.e., silts and clays) <0.075	

Note: Sieve openings of 4.75 mm are found on a U.S. No. 4 sieve; 2-mm openings on a U.S. No. 10 sieve; 0.075-mm openings on a U.S. No. 200 sieve. See Table 2.5.

Table "1"

three typical range categories of soil grading. First, well graded soil which contains particles of a wide range from sieve # 4 to sieve # 200 sieves. Second, single size(poorly graded) soil which has small variation in size its contain particle with the same size. Third, Gap graded aggregate which has some of intermediate size particles are missing.

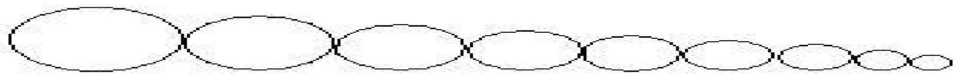


Figure 1. Well Graded

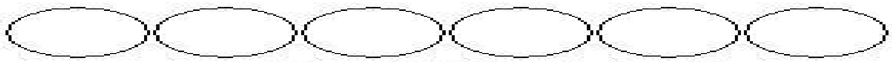


Figure 2. Uniformly-Graded

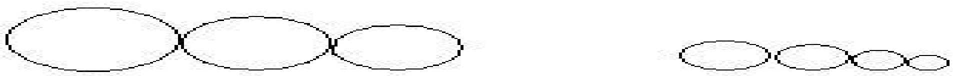


Figure 3. Gap-Graded

The principle of this test is sifted the sample through a series of sieves, beginning with a sieve with large apertures, through successively smaller. And this table gives a list of the U.S. standard sieve numbers with their corresponding size of openings.

Number of sieves and its opening size.

Table 2.5 U.S. Standard Sieve Sizes

Sieve no.	Opening (mm)	Sieve no.	Opening (mm)
4	4.75	35	0.500
5	4.00	40	0.425
6	3.35	50	0.355
7	2.80	60	0.250
8	2.36	70	0.212
10	2.00	80	0.180
12	1.70	100	0.150
14	1.40	120	0.125
16	1.18	140	0.106
18	1.00	170	0.090
20	0.850	200	0.075
25	0.710	270	0.053
30	0.600		

- The percentage retained on each sieve is calculated using the following formula :

$$\frac{retained\ mass\ (corrected)}{mass\ before\ sieving} * 100\%$$

And the accepted range is within 2%

* The corrected mass retained on each sieve is calculated using the following formula:

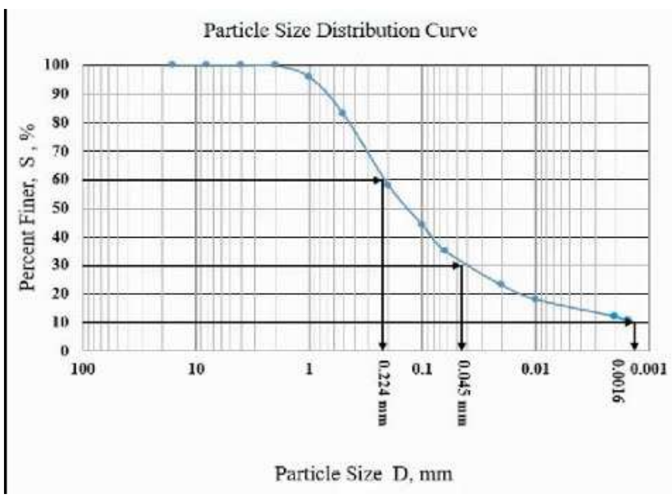
$$\text{Corrected mass} = \text{retained mass} + \text{mass difference} * \frac{\text{retained mass}}{\text{mass after sieving}}$$

*For the fine sample the riffling factor can be calculated using the following formula:

$$\text{Riffling factor} = \frac{weight\ pf\ passed}{weight\ of\ passed\ after\ riffling}$$

Also, there are some parameters required for classification of coarse grain soil depend on the grain size distribution curve:

- Effective size or effective diameter of the soil (D_{10}) that 10% of the particle is smaller than this size (diameter).
- Coefficient of gradation (Cc) = (D_{30}^2) / (D_{10}*D_{60})
- Uniformity coefficient (Cu) = D_{60} / D_{10}, and it's usually more than 1.



Purpose :

This test is used to determine the distribution of the size grains within a given sample of soil (used for the course, larger-sized particles usually more than 0.075 mm) that affected the engineering properties of soil and its classification

In addition to draw gradation curve for the grains in the soil sample and find the parameters required for classification of coarse grain soil .

Materials and Equipment's :

Look at the **"Table 2 "**that show the equipment we used in this experiment :

Equipment	The name of it :	Equipment	The name of it :
 Figure 1	**A stack of sieves with a pan at the bottom and a cover on the top**	 Figure 2	**Mechanical sieve shaker**
 Figure 3	**Sensitive Balance**		**Brush**
 Figure 5	**Many dishes**	Figure 6	**Coarse and fine soil**

" Table 2 "

Procedure :

1) A sample of washed soil was taken and its weight was measured, the sample was washed on sieve ***#200*** and then dried.

2) The sample was put on sieve ***#4*** to be divided into two samples (the passing particles are fine and the returned are coarse).

3) Each one's of two sample weight was measured separately.

4) Specific sieves for coarse aggregate was taken.

5) The coarse sample was put on the first sieve which was taken in the **last step**, then the weight of passing and returned soil was measured.

6) The last step was repeated on the all coarse sieves.

7) Specific sieves for fine aggregate was taken.

8) The fine sample was quartered (*refilling*).

9) Quartered sample was put on the specific sieves which was taken on **step 7**.

10) The sieves were taken to the mechanical sieve shaker.

11) The sample was shaken for **8 minutes**.

12) The weight of soil on each sieves was measured.

Data and Calculations :

Weight of sample = 4938.5 g

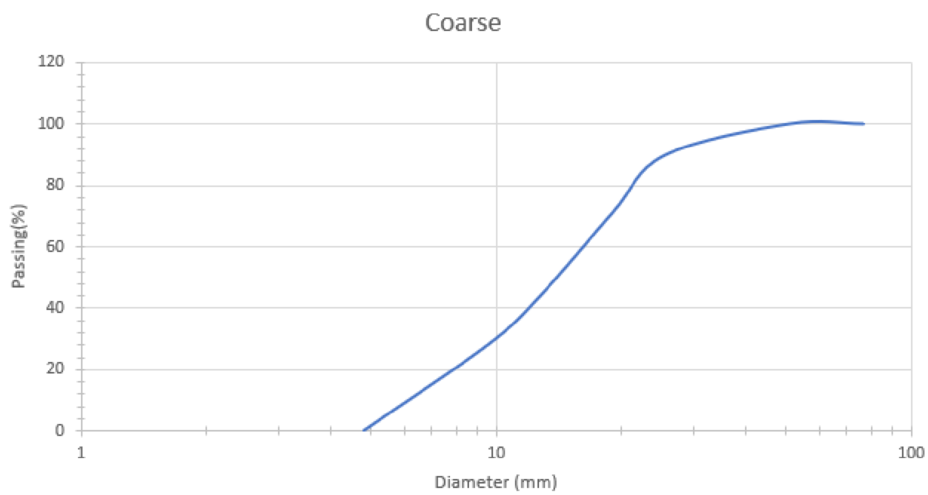
Weight of coarse = 2431 g

Weight of fine = 2504 g

Error = 4938.5 – (2431 + 2405) = 3.5 g

For Coarse :

Size (mm)	Retained weight (g)	Corrected weight (g)	% retained	Cumulative % retained	Cumulative % passing
76.5	0	0	0	0	100
50.8	0	0	0	0	100
25.4	248	248.2040313	10.2141629	10.21416285	89.78583715
19.05	450.5	450.8706294	18.5543563	28.76851916	71.23148084
12.7	663.5	664.0458659	27.3270042	56.0955234	43.9044766
9.525	381.5	381.8138626	15.7125126	71.80803601	28.19196399
4.75	685.5	686.0639654	28.2330993	100	0
	= 2429				



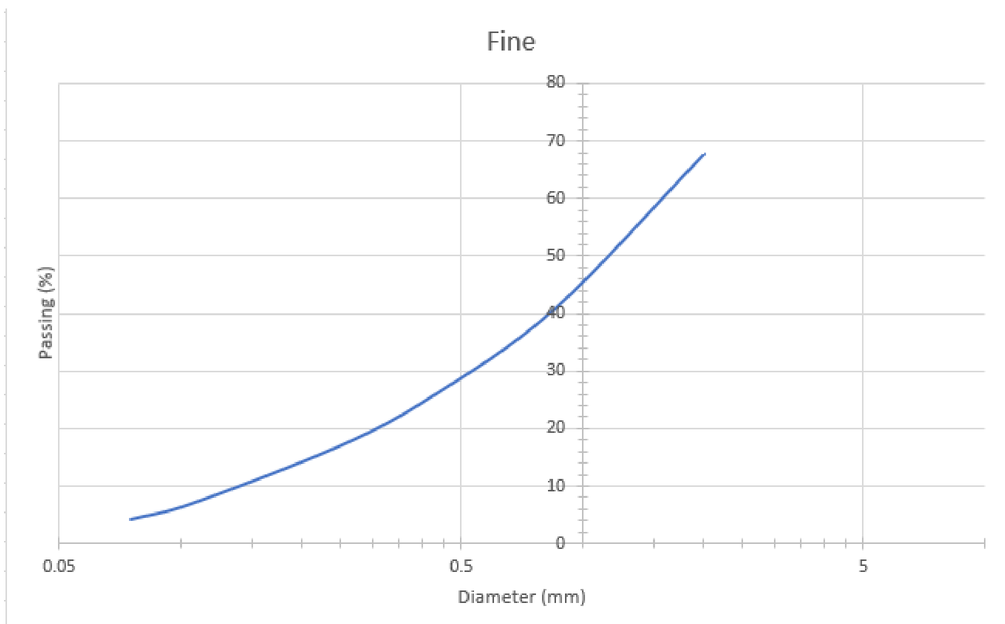
For Fine :

Weight of fine = 2504 g

Weight of fine after riffling = 1283.5 g

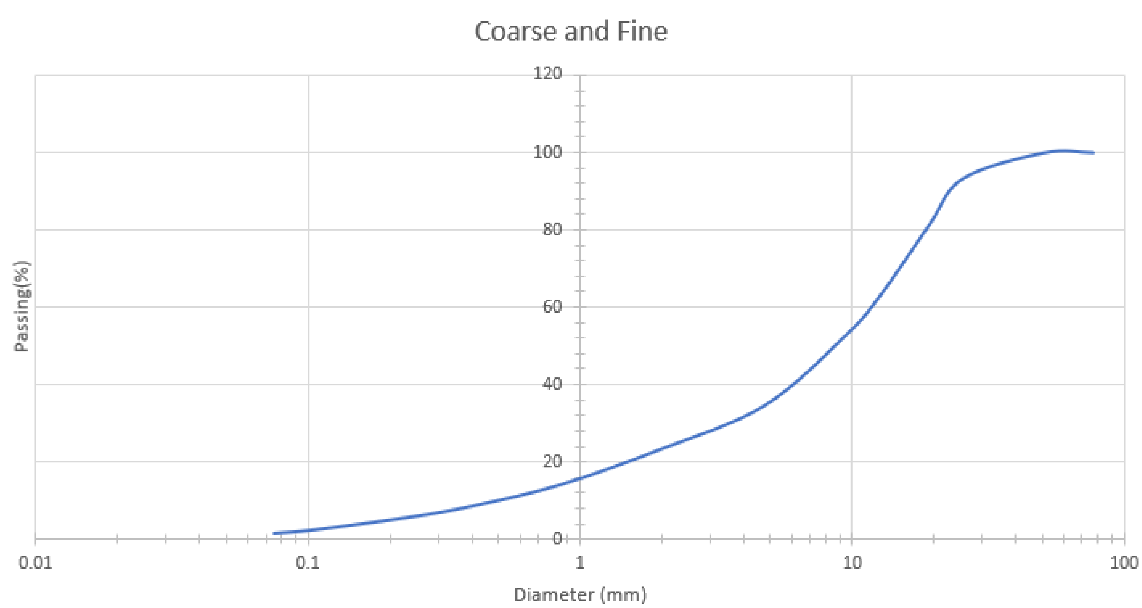
RF = 2504 / 1283.5 = 1.951

Size (mm)	Retained Weight (g)	Corrected Weight (g)	% retained	Cumulative % retained	Cumulative % passing	Adjust Weight
2	414.5	414.6614725	32.3133855	32.3133855	67.68661448	808.969479
0.85	345	345.1343981	26.895339	59.2087245	40.7912755	673.328035
0.425	192.5	192.5749903	15.0068196	74.21554407	25.78445593	375.697526
0.25	111.5	111.5434359	8.69226173	82.9078058	17.0921942	217.611814
0.106	130	130.0506428	10.1344756	93.04228136	6.957718643	253.717810
0.075	34.5	34.51343981	2.6895339	95.73181525	4.268184745	67.3328035
Pan	55	55.02142579	4.28766274	100	0	107.342180
	= 1283					=2503.9996



For all Sample :

Size (mm)	Corrected weight (g)	% retained	Cumulative % retained	Cumulative % passing
76.5	0	0	0	100
50.8	0	0	0	100
25.4	248.2040313	6.682034036	6.682034036	93.31796596
19.05	450.8706294	12.13813037	18.82016441	81.17983559
12.7	664.0458659	17.87713541	36.69729982	63.30270018
9.525	381.8138626	10.27901606	46.97631589	53.02368411
4.75	686.0639654	18.46989649	65.44621238	34.55378762
2	414.6614725	11.16332421	76.60953659	23.39046341
0.85	345.1343981	9.291548501	85.90108509	14.09891491
0.425	192.5749903	5.184414745	91.08549984	8.914500162
0.25	111.5434359	3.002920747	94.08842058	5.911579415
0.106	130.0506428	3.501163204	97.58958379	2.410416211
0.075	34.51343981	0.92915485	98.51873864	1.481261361
Pan	55.02142579	1.481261355	100	0
	= 3714.49816			



Calculations :

$D_{10} = 0.5$

$D_{25} = 1.3$

$D_{30} = 2.8$

$D_{60} = 12$

$D_{75} = 17$

** $C_u = \frac{D60}{D10} = \frac{12}{0.5} = 24$

** $C_c = \frac{D30}{D60*D10} = \frac{2.8}{12*0.5} = 0.467$

** $S_0 = \sqrt{\frac{D75}{D25}} = \sqrt{\frac{17}{1.3}} = 3.616$

Results and Conclusion :

Results :

$C_u = \frac{D60}{D10} = \frac{12}{0.5} = 24$

$C_c = \frac{D30}{D60*D10} = \frac{2.8}{12*0.5} = 0.467$

$S_0 = \sqrt{\frac{D75}{D25}} = \sqrt{\frac{17}{1.3}} = 3.616$

Conclusion :

The diameter, D_{10} is generally referred to as effective size. The effective size is used for
several empirical correlations, such as coefficient of permeability. The coefficient of
gradation, Cu, is a parameter which indicates the range of distribution of grain sizes in a
given soil specimen. If Cu is relatively large, it indicates a well graded soil. If Cu is nearly
equal to one, it means that the soil grains are of approximately equal size, and the soil may
be referred to as a poorly graded soil.

Sources of errors :

- Some of the sample was blown off as dust

- When transferring the sample from the tray to the sieve, there is a high probability that a small portion of the material remains on the tray

- The sieving process was done very quickly, which led to the loss of parts of the sample and some of them were to fly out and not towards the sieves

- Parts of the sample remain on the sieve even though it is able to penetrate from the sieve that it is on to the smaller sieve

References :

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