SMG-02: PARTICLE SIZE ANALYSIS (SIEVE TEST)

Reference Standard: BS EN ISO 17892-4; BS 1377: Part 2 1990; ASTM D422

INTRODUCTION

Natural soil deposit may consist of wide range of particle sizes. For engineering design and construction purposes, the soil needs to be characterized and classified using an engineering classification system. Engineering soil classification involves grouping soil into its various types, namely gravel, sand, silt and clay. Gravel and sand are categorized as coarse-grained soil and their characteristics can be determined through particle size analysis. Sieve and sedimentation test methods are used to determine particle size distribution of the coarse-grained soil; particle size ranging from 60mm – 0.06mm. On the other hand, silt and clay are categorized as fine-grained soil; particle size smaller than 0.06 mm. For this category of soil, the plasticity characteristic of the soil plays a major role in its engineering behavior. Plasticity characteristic can be determined through the Atterberg limit tests.

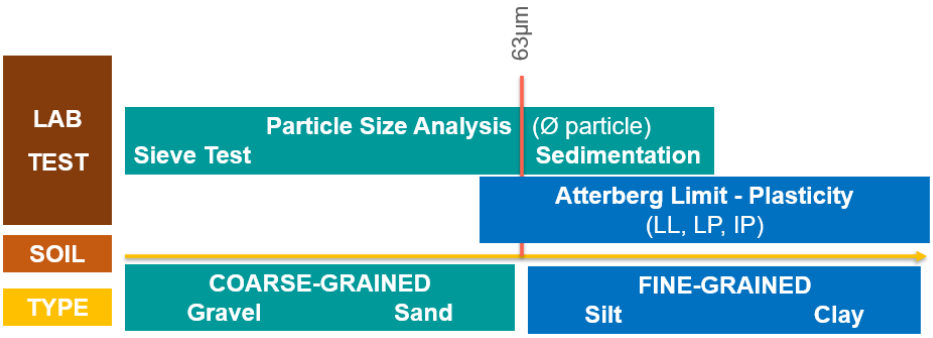


Figure 1: Laboratory testing for soil classification

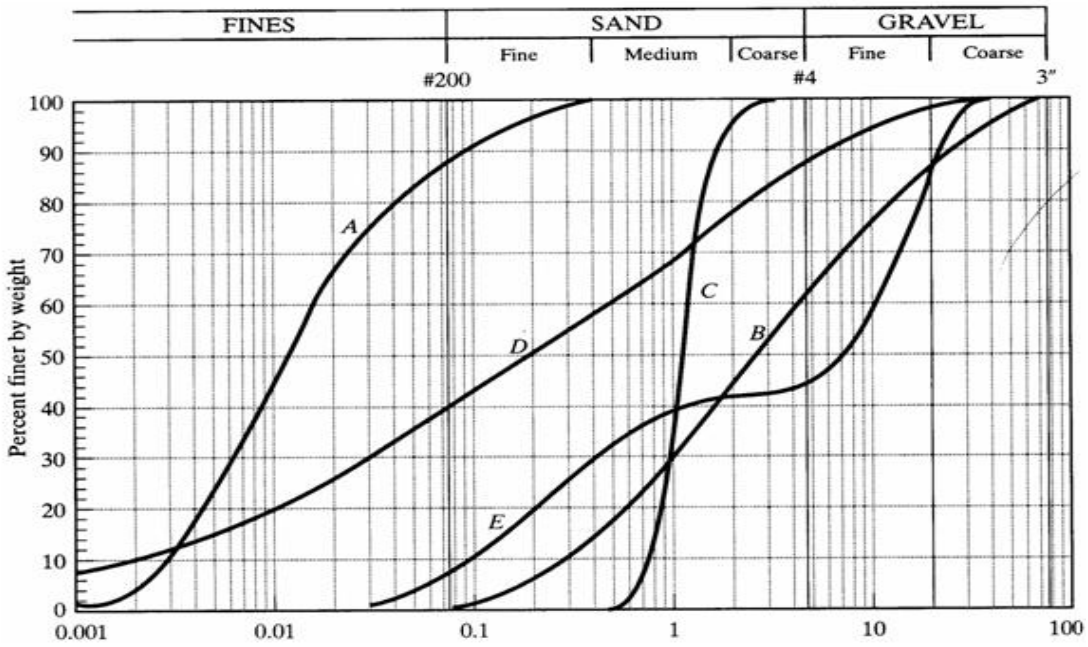


Figure 2: Typical particle size distribution curves

Table 1: Particle Size Scale

Gravel			**Sand**			**Silt**			**Clay**		
C	M	F	C	M	F	C	M	F	C	M	F
60	20	6	2	0.6	0.2	0.06	0.02	.006	. 002	.0006	.0002

Note:

C, M, F stand for coarse, medium and fine respectively, and the particle sizes are in millimeters.

Determination of Particle Size Distribution (PSD)

The particle size distribution is one of the most important physical characteristics of soil. Classification of soil is based on PSD. Many geotechnical and geohydrological properties of soil are related to PSD. To determine the particle size distribution of coarse-grained soil, sieve test can be carried out. The particle size distribution of fine fraction of the coarse-grained soil can be determined through sedimentation test, either by the pipette method or the hydrometer method. The combined sieve and sedimentation test will generate a complete particle size distribution data for a given soil.

Sieve Test Method

The sieve test or the sieving method is a process of separating soil particles into size classes by the use of test sieves. Wet sieving is the definitive method applicable to all soils. Dry sieving is suitable only for coarse soils containing insignificant quantities of silt and clay. A

known weight of soil is passed through a series of standard sieves with the mesh size aperture reducing progressively. Particles smaller than the mesh size will pass through the sieve and the bigger particles retained. The proportions by weight of the soil retained on each sieve are measured. There is a range of sieve sizes aperture available to be used and the finest sieve aperture is 63 µm.

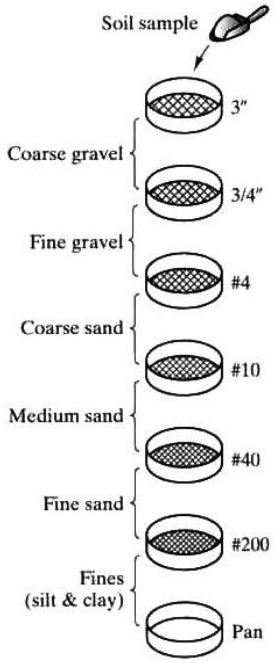


Figure 3: Test sieves

Note:

The inclusion of sieves 63 mm, 20 mm, 6.3 mm, 2 mm, 0.63 mm 0.20 mm and 0.063 mm is recommended as these represent the boundary sizes for course materials as defined in the standard. These facilitate sample description and classification

DATA PROCESSING

1) Calculate mass retained on each sieve by subtracting mass of sieve from mass of sieve + mass of soil retained.
2) Calculate the total mass ***M*** by summing all the masses of retained soil. Compare total mass M with the initial dry mass ***m***.
3) Use the total mass ***M*** after sieving to calculate % retained.
4) Calculate cumulative percentage retained (Σ (% retained)) and percentage passing

5) Plot particle size distribution curve on the PSD chart (particle size against percentage passing)

6) From the PSD curve, determine effective size D_{10}, D_{30} and D_{60}

7) Calculate the coefficient of uniformity, C_u and coefficient of curvature, C_c

OBJECTIVES

1. To determine the particle size distribution (PSD) and the grading curve for a given soil sample.
2. To determine the grading characteristics of the soil tested.

APPARATUS

List out equipment and apparatus use in the experiment complete with figures.

PROCEDURE

1) Weigh approximately 500g of oven-dried sample in a tray.
2) Determine the sieves to be used based on visual inspection of the given soil sample. Consider choosing several sieves as recommended in the above note and several others to produce well distributed data within the range of the soil sample particle size. Record selected sieves size on the data sheet provided. Add a pan to catch the fine material and a lit as not to lose the material.
3) Inspect each sieve including a pan and a lit from defects such as tear, split, large holes, etc and ensure they fit snugly one inside the other. Clean them using a sieve brush.
4) Weigh each sieve including the pan and record them on the data sheet.
5) Stack sieves together with decreasing aperture size from top to bottom. Place a pan below the stack.
6) Pour the soil sample in to top of the sieve stack and put the lit on. Place the sieve stack into the mechanical shaker.
7) Set the agitation timer of the shaker to 10 minutes. *Note: An unduly long period of sieving must be avoided, because this would give particles additional opportunity to pass through any openings, which may be slightly oversize.*
8) After 10 minutes, weigh each sieve with the materials retained to an accuracy of 0.1%. and record them on the data sheet.

DATA SHEET

Sieve Test

Location:	Job ref.	
	Borehole/ Pit no.	
Soil Description	Sample no.	
	Depth	
Test Method: BS1377-2:1990:9.2/9.3/9.4/9.5	Date	

Initial dry mass: _____ g (***m***)

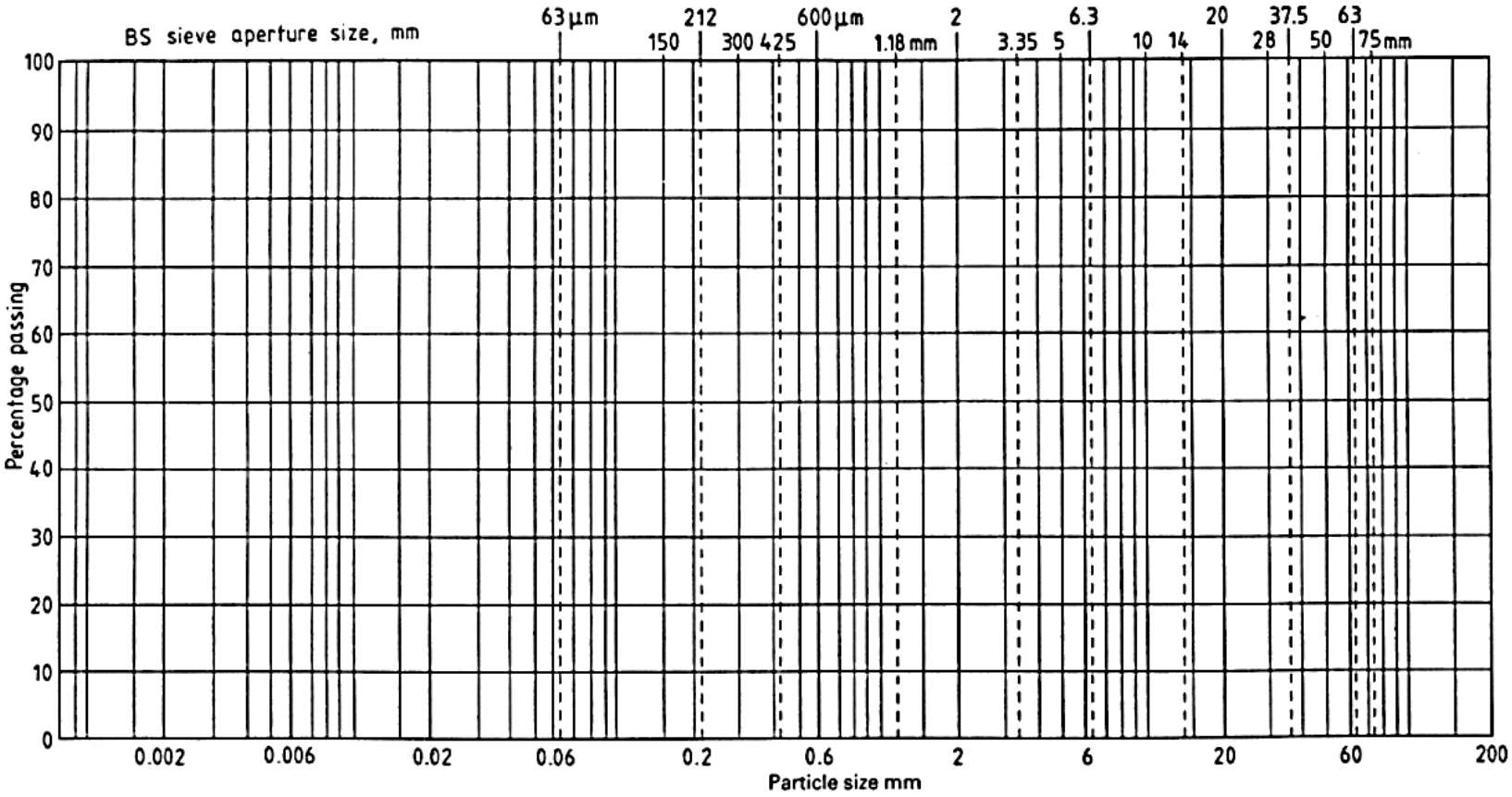
BS test sieve (mm)	**Mass of sieve (g)**	**Mass of sieve + mass of soil retained (g)**	**Mass retained (g) (M_r)**	**% Retained (M_r/M)x100**	**Σ (% retained)**	**Percentage Passing (100 - Σ (% retained))**
Pan						
Total Mass ***M***						

Summary:

D_{10}		C_u	
D_{30}		C_c	
D_{60}			

Grading characteristic: **Well-graded / Poorly-graded (uniform/gap)**

Note: Complete particle size distribution is determined through a combined results of sieve and sedimentation test.



(Source: extracted and adapted from BS1377- 2:1990)