

Visual and Manual Soil Identification System

1 INTRODUCTION

The accurate and complete identification of soils is the first and most fundamental step in all soil investigation for engineering projects. Due to the complex and variable nature of soil deposits, identification must be made carefully, accurately and in considerable detail. This system is divided into two broad categories: granular soils in which the proportion and gradation of the components are most significant; cohesive soils in which the degree of plasticity is the controlling factor. Frequently the granular and cohesive soils will occur in combination.

2 GRANULAR SOILS

2.1 Definition of terms

Granular soils are cohesionless soils consisting of Boulders, Cobbles, Gravel, Sand and Silt, either separately or in combination. These components are defined as follows:

Soil Component	Size		Sieve Size	Opening (mm)
	From	To		
Boulders	8 in.	--		
Cobbles	3 in.	8 in.		
Gravel				
Coarse	1 in.	3 in.		
Medium	3/8 in.	1 in.		
Fine	2.0 mm	3/8 in.		
Sand				
Coarse	0.420 mm	2.0 mm	No. 10 No. 40	2.0 0.420
Fine	0.074 mm	0.420 mm	No. 40 No. 200	0.420 0.074
Silt	0.005 mm	0.074 mm		

Clay sizes are under 0.005 mm including colloids, the particles of the clay fraction smaller than 0.001 mm.

2.2 Descriptive Terminology

The following descriptive terminology is used to denote the percentage by weight of each component:

<u>Descriptive Term</u>	<u>Range of Proportion</u>
“Trace”	1-10%
“Little”	10-20%
“Some”	20-35%
“And”	35-50%

2.3 Identification Techniques

1. Grave Component

It is desirable to use a dish or a pan in which to spread out the sample to be identified. The gravel component then can be readily separated and its percentage of the total weight estimated.

2. Sand and Silt Components

a) The soil is handled lightly between the thumb and fore-finger to get an idea of the grittiness or softness of the soil. A pinch of the soil is smeared with considerable pressure between the thumb and forefinger to determine the degree of harshness and grittiness. The coarse sand exhibits a harsh and very gritty feel and smear. The fine sands have a softer feel and much less gritty smears.

This technique for identification requires practice and frequent comparisons with the size of components given under Part A- Definitions of Terms.

b) When a small sample of soil (any lumps being first broken up) is shaken in a test tube filled with water and allowed to settle, the time required for particles to fall through a distance of 4 inches is about 20 sec. for particles about 0.074 mm (line of demarcation between Sand and Silt) and about 75 minutes for particles of 0.005 mm (line of demarcation between Silt and Clay sizes). A rough idea of the grain sizes can be obtained in this manner.

c) Dilatancy. As given for cohesive soils below.

2.4 Typical Description of a Granular Soil

Yellow-brown c. to f. SAND, some m. to f. gravel, trace silt; few roots.

3 COHESIVE SOILS

3.1 Definition of terms

Cohesive soils are those soils which possess the characteristics of cohesiveness and plasticity. They may be granular soils as described above with the addition of clay or organic silt which causes cohesion and plasticity, or may be clay or organic silt with no coarse components.

3.2 Descriptive Terminology

Soil grains having an average particle diameter of less than 0.005 mm are referred to as clay-sizes. The identification system is based on degree of plasticity as well as on grain size.

The following terminology is used to denote the various degrees of plasticity:

Descriptive Term	Degree of Plasticity	Plasticity Index
SILT	None	Non-plastic
SILT Trace clay or ORGANIC SILT	Slight	1-5
Clayey SILT or ORGANIC clayey SILT	Medium	5-20
Silty Clay or ORGANIC silty CLAY	High	20-40
CLAY or ORGANIC CLAY	Very High	Over 40

For predominantly granular size soils with sufficient clay sizes to show marked plastic properties, it will be necessary to combine the granular and cohesive systems to give the truest description possible. Such identification might be SAND, some silty clay; or SAND and CLAY, little c-f gravel.

3.3 Identification Techniques

1. Differentiation between cohesionless silt and plastic silt-clay soils.
 - a) Dilatancy – A pat of wet soil is shaken in the palm of hand and alternately squeezed and released. Materials which are predominantly silt will show a dull dry surface upon squeezing and a glassy wet surface upon releasing the pressure. With increasing clay content this phenomenon becomes less pronounced due to lower mobility of the pore water.
 - b) Dry Strength – A portion of the soil is allowed to dry out completely in air. An angular fragment, about ½” in diameter of the dried soil is pressed between the fingers. Fragments with very high strength cannot be injured at all whereas those of very low strength disintegrate completely on gentle pressure. The strength is called medium if the fragment can be reduced to powder only with great effort. Those materials with greater dry strengths are predominantly clayey and those with less dry strength are predominantly silty.
 - c) Stickiness – A high degree of stickiness and a very smooth smear in the natural state are indicative of higher plasticity.
 - d) Identification can also be made on the following basis: The natural soil is worked until its moisture content is such that 1.5” diameter ball formed from the soil shows a flattened contact surface of 7/8” diameter when dropped from a height of 2 feet. (Gravel sizes are not included in the ball). The smallest thread possible without crumbling

is then rolled from the above soil sample. The approximate relationships below are then used for identification:

<u>Thread Diameter</u>	<u>Descriptive Term</u>
¼ inch	Silt, trace clay
1/8 in. to 1/16 in.	Clayey SILT
1/32 in.	Silty CLAY
1/64 in.	CLAY

2. Differentiation Between Clay Soils and Organic Soils:

- a) Clay Soils – Any color except dark gray or black may be expected of clay soils. For the more plastic clays, appreciable effort is required to pull the material apart. The broken pieces show the structure standing on end from the pulling. For high plasticities, the smear has a shiny, waxy appearance.
- b) Organic Soils – Dark gray, black, and dark brown, are the characteristic colors of organic soils. Fresh organic soils usually have a characteristic odor and heating the sample slightly will intensify the odor. Less effort is required to pull the material apart and a clean break is formed with a fine granular or silty texture and appearance. The smear, although smooth is very dull and appears silty. A fiber or root mat structure is sometimes detected in the organic soils as are twigs and leaves. Organic silts respond to the dilatancy test. Organic soils invariably have very low shear strength in their natural state.

3.4 Typical Descriptions of Cohesive Soils

Gray silty CLAY, some f. sand; trace f. gravel.

Red-brown CLAY varved with gray clayey SILT.

Dark gray ORGANIC SILT; many roots and fibers.

4 HIGHLY ORGANIC SOILS

This group consists of:

- A. Meadow or Root mat – organic soils that have a pronounced structure of living root fibers.
- B. Peat – organic soils with a higher percentage of vegetable material, without living fibers.
- C. Humus – completely decomposed organic matter.
- D. Lignite – immature coals having a woody appearance and brown in color.

Meadow or root mat and peat may contain sand, silt, organic silt, or clay in the interstices. The soil content of the mixture should be identified and description of this material given as in the appropriate section above. A typical description is as follows: dark brown compressed PEAT, some gray c. of f. sand.