Guide to the field description of soils for engineering purposes

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GUIDE

to the

FIELD DESCRIPTION

of

SOILS

for

Engineering Purposes

Guide to the Field Description of Soils for Engineering Purposes

The purpose of this document is to enable field men to describe soils as they are encountered and used for engineering purposes. It is not intended to be a soil classification system. Wherever possible the terms conform with those of the Unified Soil Classification System (in use in the United States) and with the British Standard Code of Practice for Site Investigation.

2. WHAT IS MEANT BY "SOIL"

The word soil, as used in an engineering sense, refers to that portion of the earth's crust which is fragmentary, or such that some individual particles may be readily separated by the agitation in water of a dried sample. Soil has been derived from bed-rock or organic matter by natural processes of chemical decomposition and physical disintegration and may have been subsequently modified by atmospheric or biological agencies.

3. MAJOR SOIL DIVISIONS

Soil may be grouped into three major divisions: coarse-grained, fine-grained, and organic.

(a) *Coarse-grained soils* may be described briefly as those soils made up largely of particles visible to the naked eye. Further subdivisions may be made according to the particle size as follows:

Cobbles and Boulders.—particles larger than 3 inches in diameter:
Cobbles 3 to 8 inches; boulders greater than 8 inches;

Gravel.—particles smaller than 3 inches in diameter and larger than the No. 4 sieve (approx. ¼ inch);

Sand.—particles smaller than the No. 4 sieve and larger than the No. 200 sieve (particles smaller than the No. 200 sieve are not visible to the naked eye).

(b) *Fine-grained soils* are made up of particles not visible to the naked eye. Plasticity and particle size, therefore, cannot be judged accurately without the use of refined testing techniques. For field identification, fine-grained soils may be classed as silt or clay by their behaviour in a few simple indicator tests described later (under the field identification procedures).

(c) *Organic soils* are placed in a separate group because of their appreciable content of organic matter. Soils which are mostly organic may be described as organic material, a term which includes peat, muskeg and peat moss. Partly organic soils which are largely mineral types are described as the predominant soil modified by the word "organic" e.g., organic silt.

4. DESCRIPTION OF SOILS

(a) *Coarse-grained soils*

For adequate description of coarse-grained or cohesionless soils, reference should be made

to the *density, grading,* and *grain shape* of the soil.

Density.—Density is described by the terms "dense", "medium dense" and "loose" and should refer only to the density in place (i.e. in the ground). It is difficult to drive a 2- by 2-inch wooden picket into dense soil for more than a few inches. A 2- by 2-inch picket can be easily driven into loose soils. If the grains are "cemented" together, density cannot be estimated by this simple method.

Grading.—Grading is the term applied to the particle-size distribution of the soil. A uniform soil has a predominance of particles of one size, whereas a well-graded material has sizes assorted over a wide range, with no one size predominating. The word "uniform" is applied where it is obvious that one size is predominant, and "graded" if this is not the case.

Grain shape.—The terms used to describe grain shape are "angular", "subangular" and "rounded".

Angular particles have sharp edges and relatively plane sides with unpolished surfaces; subangular particles are similar to angular but have rounded edges; rounded particles have smoothly curved sides and no edges.

Additional descriptive notes.—Note should be made if the soil is stratified or contains any organic matter. If the soil contains some

fine material, but not sufficient to cause cohesion, this should also be noted.

(b) *Fine-grained soils*

The descriptive terms for fine-grained or cohesive soils are obtained by reference to *consistency* in the undisturbed and remoulded states, *plasticity, structure, colour,* and *odour.*

Consistency.—Consistency varies mainly with water content and density and is described by the adjectives "hard", "stiff", "firm", and "soft". Occasionally, cohesive soils are "sensitive", i.e., they undergo a great loss of strength when disturbed or remoulded. It is necessary, when describing consistency, to state whether it is consistency in the undisturbed or remoulded states. The proper adjectives for consistency may be determined by attempting to penetrate the soil with the thumb. It is difficult to indent hard clays or silts with the thumb-nail. Stiff soils are readily indented with the thumb. Firm soils can be penetrated by moderate thumb pressure. Soft soils are penetrated easily with the thumb, and can be remoulded under light finger pressure.

Plasticity.—Plasticity is the ability to change shape and to retain the impressed shape when the stress is removed. The degree of plasticity of soils is the range in moisture content through which the soil remains plastic or is capable of being moulded. An indication of plasticity can be gained by manipulating the soil with the fingers when

it is near the plastic limit. The plastic limit of a soil is defined as the moisture content at which a thread of soil one-eighth inch in diameter will begin to crumble when rolled further. Near the plastic limit, highly plastic soils will require considerable pressure to roll threads by hand, medium plastic soils a noticeable pressure, and soils weakly plastic can be rolled with little effort. The dry strength test is another indication of plasticity. Highly plastic soils are very hard when dry and cannot be broken by finger pressure. Medium plastic soils have a medium dry strength and can be crumbled only with difficulty. Weakly plastic soils have low dry strength and can be easily crumbled between thumb and forefinger.

Structure.—Structure is the term applied to the nature of the soil mass. The following terms are commonly used in describing special soil structures: "stratified", "fissured", "lensed", and "friable" or "blocky". The appearance of a fresh fracture may be used as an indication of structure. Stratification is evident when the soil has definite bedding planes and when these bedding planes are roughly parallel to one another. When there are definite stratifications, closely spaced, of alternating material the structure of the mass is described as "varved" or "laminated". Fissures are indicated when the soil breaks along definite planes of fracture, developing very little strength

TABLE 1

General Basis for Field Description of Soils

Major Divisions	Subdivisions	Field Identification	Information for Description
COARSE-GRAINED SOILS	COBBLES AND BOULDERS	Larger than 3 inches diameter —cobbles 3 to 8 inches —boulders greater than 8 inches	Density Particle Shape
	GRAVEL	Smaller than 3 inches but larger than No. 4 sieve (approx. ¼ inch)	Grading Density Particle Shape Stratification
	SAND	Smaller than No. 4 sieve but larger than No. 200 sieve. Particles smaller than No. 200 sieve are not visible to the naked eye.	Grading Density Particle Shape Stratification Organic Matter
FINE-GRAINED SOILS	SILT	Exhibits dilatancy (reacts to the shaking test). Powders easily when dry, only slight dry strength. Gritty to the teeth. Dries rapidly. No shine imparted when moist and stroked with knife blade.	Consistency Undisturbed Remoulded Plasticity Dry Strength Structure
	CLAY	Not dilatant. Possesses appreciable dry strength. When moist, sticks to fingers and does not wash off readily. Not gritty to the teeth. When moist a shiny surface is imparted when stroked with knife blade.	Consistency Undisturbed Remoulded Plasticity Dry Strength Structure
ORGANIC SOILS	PARTLY ORGANIC —organic clay —organic silt etc.	Depending on amount of organic material, these soils usually have some of the characteristics of their inorganic counterparts: usually highly compressible (spongy) usually have characteristic odour	Consistency Undisturbed Remoulded Plasticity Dry Strength Structure
	ORGANIC MATERIAL	Fibrous structure—usually brown or black when moist. Spongy. Usually has characteristic odour.	Organic terrain including muskeg, peat and peat moss

in fracturing. Near the surface, fissures may be indicated by slight discoloration along the planes. When the soil breaks along a fissure, the surface of the fracture will be very clean and glossy. A lensed structure is caused by the inclusion of small pockets of foreign material. For instance, a clay may have small lenses of sand scattered throughout. A friable or blocky structure is that found when a cohesive soil can be broken into small lumps easily with the lumps themselves more difficult to break.

Colour.—Colour indicates the depth of weathering in a soil and may also be helpful in identifying similar soils in the same region.

Odour.—Odour of the soil will normally indicate the presence of organic matter.

(c) *Organic soils*

The descriptive terms used for inorganic soils can be used to describe partly organic soils. For organic material, a separate classification system is necessary. This will be described in a booklet similar to this, based upon studies of Dr. N. W. Radforth.

5. FIELD IDENTIFICATION PROCEDURE

Most soils consist of mixtures of various particle sizes. Therefore the first step is to decide which of the principal fractions or characteristics predominate, then to decide which of these acts as a modifier. For example, a sand containing some silt would be called a silty sand. Table I lists the principal soil

divisions with their characteristics which lead to identification.

Boulders, cobbles, gravel, and sand are identified by visual examination as all their particles are visible to the naked eye. Size is the criterion of identification.

Fine-grained soils can only be identified by more indirect means. The tests listed below may be used to establish the identity of these soils:

(a) *Shaking test*

When a wet pat of soil is shaken vigorously in the hand, the surface will become glossy and show free water. If the pat of soil is then squeezed in the fingers, the free water may disappear and the surface become dull, i.e. dilates. With clay soils this phenomenon will not be noticeable but with silts and fine sands a rapid or good reaction will be exhibited;

(b) *Shine Test*

If a moist lump of soil is stroked with considerable pressure with the flat of a pen knife blade or finger-nail, the type of surface imparted is an indication of the soil: if a shiny surface results, the presence of clay is indicated; silt is indicated if a dull surface is produced;

(c) *Dry Strength Test*

If a small piece of dry fine-grained soil is broken or crushed with the fingers, the breaking strength is an indication of the relative

amounts of silt or clay. Very low dry strength is indicated when the soil powders readily in the fingers, and may be taken as an indication of a sandy silt or silt. Medium dry strength is shown by difficulty in powdering the soil by finger pressure, but the soil can be broken into small pieces without great difficulty. This state indicates silty clays and clays of medium plasticity. High dry strength is indicated when the pat of dry soil cannot be broken with the fingers. A highly plastic clay is indicated by this condition.

In addition to the tests mentioned above, clay sticks to the fingers when wet, and does not wash off readily, whereas silt will wash away easily or brush off if dry. When a small amount of soil is placed between the teeth, the presence of grit will indicate silt or sand, but if no grit is detected a pure clay is present.

Organic soils are very compressible and spongy. Purely organic soils are easily recognized by their matted or fibrous structure. Partly organic soils may behave as a silt or clay, but are very compressible and usually have a characteristic odour.

6. PARTICULAR SOIL NAMES AND CONDITIONS

Each soil has a definite origin, and many of its characteristics depend upon the environment under which it was formed. In some cases, the geological origin can only be determined after study by the specialist. In other cases, the nature of the soil is indicative of

the origin, and the soil can be described most adequately by using a special name.

(a) *Topsoil*

Topsoil is the layer of soil on the surface which will support plant life. It is characterized by the presence of organic material. Topsoil should be modified by reference to the predominant inorganic soil.

(b) *Fill*

Fill is a man-made deposit of natural soils or waste materials. It can usually be identified by the inclusion of grass, twigs, cinders, bricks, glass, etc., and by a layer of topsoil or profile development *under* the fill. To describe fill, an adjective indicating the predominant soil should be used, i.e. sand and gravel fill, clay fill, rubbish fill, or cinder fill.

(c) *Local names*

Frequently soils in one area are given local names by the inhabitants. These names give a vivid description of the soil, e.g. "bull's liver". To promote uniformity in soil terminology, such local names should be omitted or used only to supplement the description of the soil.

(d) *Permafrost*

In northern parts of Canada, the soil remains perennially frozen. These areas are known as permafrost regions. In such regions, the same soils exist as in other areas, but it is necessary not only to identify the soil, but to note the presence of permafrost, and if

possible the depth of the "active zone", i.e., the depth to which the soil thaws during the summer, and the thickness of organic cover if any.

7. OTHER FACTORS IN SOIL DESCRIPTION

If the vertical section of a boring or test pit is being examined, such data as the date of observation, depth below surface, elevation of surface, level of groundwater, and location of the boring or test pit must be recorded. A brief description of the method of sampling is necessary to show whether the sample can be regarded as undisturbed.

8. CHECK LIST FOR FIELD DESCRIPTION OF SOILS

General

The check list below may be used as a guide in a soil description. It includes the terms necessary for an adequate description of the soil. Any additional descriptive terms, which the user may think necessary, should be included to give a more complete description.

(a) *Environmental*

Sample No.	*Site*
Detailed Location	*Date*
Depth Below Surface	*Surface Elevation*
Boring *Test Pit*	*Excavation* *Other*
Remarks on Method of Sampling	
Groundwater Level	

(b) *Check list for coarse-grained soils*

Soil Subdivision	Boulders and Cobbles, Gravel, Sand		
Size of Maximum Particles			
Grain Shape	Angular	Subangular	Rounded
Grading	Uniform	Graded	
	Fine	Medium	Coarse
Density	Loose	Medium	Dense
Structure	Stratified	Nonstratified	
Colour			
Odour			
Organic Material			
Presence of Fines			

(c) *Check list for fine-grained soils*

Soil Subdivision	Sandy Silt	Silt	Clayey Silt	Silty Clay	Clay
Consistency	Hard	Stiff	Firm	Soft	
Dry Strength	None	Low	Medium	High	
Reaction to Shaking Test	Rapid	Slow	None		
Reaction to Shine Test	No clay		Clay present		
Reaction to Taste Test	Silt or sand present		No Silt or Sand		
Toughness at Plastic Limit	Weakly plastic		Medium plastic	Highly plastic	
Structure	Stratfied		Fissured		
	Friable or Blocky	Lensed	Nonstratified		
Odour					
Colour	Mottled				