An Introduction to Identification and Classification of Soil and Rock

An Online Continuing Education Course for Engineers

Course Number: G-2001

Credit: 2 Hours / 2 PDH / 2 CPD

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1. INTRODUCTION

This is an introduction to soil and rock identification and classification. It is not a design or engineering manual, or an exhaustive treatise. It is intended to give those engineers and construction professionals not familiar with the topic an introduction to the terminology, techniques and concepts involved, so that they can move forward in applying this information to engineering projects in their professional activities.

2. SOIL DEPOSITS

2.1 GEOLOGIC ORIGIN AND MODE OF OCCURRENCE.

2.1.1 Principal Soil Deposits. See Table 1 for principal soil deposits grouped in terms of origin (e.g., residual, colluvial, etc.) and mode of occurrence (e.g., fluvial, lacustrine, etc.).

2.1.2 Importance. A geologic description assists in correlating experiences between several sites, and in a general, indicates the pattern of strata to be expected prior to making a field investigation (test borings, etc.). Soils with similar origin and mode of occurrence are expected to have comparable if not similar engineering properties. For quantitative foundation analysis, a geological description is inadequate and more specific classification is required. A study of references on local geology should precede a major subsurface exploration program.

2.1.3 Soil Horizon. Soil horizons are present in all sedimentary soils and transported soils subject to weathering. The A horizon contains the maximum amount of organic matter; the underlying B horizon contains clays, sesquioxides, and small amounts of organic matter. The C horizon is partly weathered parent soil or rock and the D horizon is unaltered parent soil and rock.

Table 1. Principal Soil Deposits

Major Division	Principal Soil Deposits	Pertinent Engineering Characteristics
Sedimentary Soils		
Residual		
Material formed by disintegration of underlying parent rock	Residual sands and fragments of gravel size formed by solution and leaching of cementing material, leaving the more resistant particles, commonly quartz	Generally favorable foundation conditions
	Residual clays formed by decomposition of silicate rocks, disintegration of shales, and solution of carbonates in limestone. With few exceptions becomes more compact, rockier, and less weathered with increasing depth.	Variable properties requiring detailed investigation. Deposits present favorable foundation conditions except in humid and tropical climates, where depth and rate of weathering are very great.
Organic		
Accumulation of highly organic material formed in place by the growth and subsequent decay of plant life	Peat. A somewhat fibrous aggregate of decayed and decaying vegetation matter having a dark color and odor of decay.	Very compressible. Entirely unsuitable for supporting building foundations.
	Muck. Peat deposits which have advanced in stage of decomposition to such extent that the botanical character is no longer evident.	
Materials transported and deposited by running water	Estuarine deposits. Mixed deposits of marine and alluvial origin laid down in widened channels at mouths of rivers and influenced by tide of body of water into which they are deposited.	Generally fine-grained and compressible. Many local variations in soil conditions.
	Alluvial-Lacustrine deposits. Material deposited within lakes (other than those associated with glaciations) by waves, currents, and organo-chemical processes. Deposits consist of unstratified organic clay or clay in central portions of the stratified silts and sands in peripheral zones.	Usually very uniform in horizontal direction. Fine-grained soils generally compressible.
	Deltaic deposits. Deposits found in the mouths of rivers which result in extension of the shoreline.	Generally fine-grained and compressible. Many local variations in soil condition.

Major Division	Principal Soil Deposits	Pertinent Engineering Characteristics
	Piedmont deposits. Alluvial deposits at foot of hills or mountains. Extensive plains or alluvial fans.	Generally favorable foundation conditions.
Aeolian		
Materials transported and deposited by wind	Loess. A calcareous, unstratified deposit of silts or sandy of clayey silt transverse by a network of tubes formed by root fibers now decayed. Dune sands. Mounds, ridges, and hills of uniform fine sand characteristically exhibiting rounded grains.	Relatively uniform deposits characterized by ability to stand in vertical cuts. Collapsible structure. Deep weathering or saturation can modify characteristics. Very uniform grain sizes may exist in relatively loose condition.
Glacial		
Material transported and deposited by glaciers or by meltwater from the glacier.	Glacial till. An accumulation of debris, deposited beneath, at the side (lateral moraines), or at the lower limit of a glacier (terminal moraine). Material lowered to ground surface in an irregular sheet by a melting glacier is known as a ground moraine. Glacio-Fluvial deposits. Coarse and fine-grained material deposited by streams of meltwater from glaciers. Material deposited on ground surface beyond terminal of glacier is known as an outwash plain. Gravel ridges known as kames and eskers. Glacio-Lacustrine deposits. Material deposited within lakes by meltwater from glaciers. Consisting of clay in central portions of lake and alternate layers of silty clay or silt and clay (varved clay) in peripheral zones.	Consists of material of all sizes in various proportions from boulder and gravel to clay. Deposits are unstratified. Generally present favorable foundation conditions, but rapid changes in conditions are common. Many local variations. Generally present favorable foundation conditions. Very uniform in a horizontal direction
Marine		
Material transported and deposited by ocean waves and currents in shore and offshore areas.	Shore deposits. Deposits of sands and/or gravels formed by the transporting, destructive and sorting action of waves on the shoreline. Marine clays. Organic and inorganic deposits of fine-grained material.	Relatively uniform and of moderate to high density. Generally, very uniform in composition. Compressible and usually very sensitive to remolding.

Major Division	Principal Soil Deposits	Pertinent Engineering Characteristics
Colluvial		
Material transported and deposited by gravity.	Talus. Deposits created by gradual accumulation of unsorted rock fragments and debris at base of cliffs. Hillwash. Fine colluviums consisting of clayey sand, sand silts, or clay. Landslide deposits. Considerable masses of soil or rock that have slipped down, more or less as units, from their former position on steep slopes.	Previous movement indicates possible future difficulties. Generally unstable foundation conditions.
Pyroclastic		
Material ejected from volcanoes and transported by gravity, wind and air.	Ejecta. Loose deposits of volcanic ash, lapilli, bombs, etc. Pumice. Frequently associated with lava flows and mud flows, or may be mixed with non-volcanic sediments.	Typically, shardlike particles of silt size with larger volcanic debris. Weathering and redeposition produce highly plastic compressible slay. Unusual and difficult foundation conditions.

Table 2. Visual Identification of Samples

Definitions of Soil Components and Fractions		
Grain Size		
Material	**Fraction**	**Sieve Size**
Boulders		12”
Cobbles		3” – 12”
Gravel	coarse	¾” – 3”
	fine	¼”
Sand	coarse	No. 4
		No. 10
		No. 40
Fines (Silt & Clay)		No. 200
Coarse and Fine-Grained		
Descriptive Adjective		
trace		
little		
some		
substantial		
Fine-Grained Soils. Identif described in Table 3.		and toughness as
Stratified soils		
		ness
		ness
		ss
		osit, usually less
	le	lenticular deposit
	oc	one or less per foot of thickness
	frequent	more than one per foot of thickness

3. SOIL IDENTIFICATION

3.1 REQUIREMENTS. A complete engineering soil identification includes: (a)

a classification of constituents, (b) the description of appearance and structural characteristics, and (c) the determination of compactness or consistency in situ.

3.1.1 Field Identification. Identify constituent materials visually according to their grain size, and/or type of plasticity characteristics per ASTM Standard D2488, Description of Soils (Visual-Manual Procedure).