Michigan Department of Transportation

Uniform Field Soil Classification System
(Modified Unified Description)

Introduction

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The purpose of this system is to establish guidelines for the uniform classification of soils by inspection for MDOT Soils Engineers and Technicians. It is the intent of this system to describe only the soil constituents that have a significant influence on the visual appearance and engineering behavior of the soil. This system is intended to provide the best word description of the sample to those involved in the planning, design, construction, and maintenance processes. A method is presented for preparing a "word picture" of a sample for entering on a subsurface exploration log or other appropriate data sheet. The classification procedure involves visually and manually examining soil samples with respect to texture (grain-size), plasticity, color, structure, and moisture. In addition to classification, this system provides guidelines for assessment of soil strength (relative density for granular soils, consistency for cohesive soils), which may be included with the field classification as appropriate for engineering requirements. A glossary of terms is included at the end of this document for convenient reference.

It should be understood that the soil descriptions are based upon the judgment of the individual making the description. Laboratory classification tests are not intended to be used to verify the description, but to further determine the engineering behavior for geotechnical design and analysis, and for construction.

Primary Soil Constituents

The primary soil constituent is defined as the material fraction which has the greatest impact on the engineering behavior of the soil, and which usually represents the soil type found in the largest percentage. To determine the primary constituent, it must first be determined whether the soil is “Fine-Grained” or “Coarse-Grained” or “Organic” as defined below. The field soil classification “word picture” will be built around the primary constituent as defined by the soil types described below.

Coarse-Grained Soils: More than 50% of the soil is *RETAINED* on the (0.075 mm) #200 sieve. A good rule of thumb to determine if particles will be retained or pass the #200 sieve: If individual particles can be distinguished by the naked eye, then they will likely be retained. Also, the finest sand particles often can be identified by their sparkle or glassy quality.

Gravel Identified by particle size, gravel consists of rounded, partially angular, or angular (crushed faces) particles of rock. Gravel size particles usually occur in varying combinations with other particle sizes. Gravel is subdivided into particle size ranges as follows: (Note that particles > (75 mm) 3 inches are cobbles or boulders, as defined in the Glossary of Terms.)

Coarse - Particles passing the (75 mm) 3 inch sieve, and retained on the (19 mm) 3/4 inch sieve.

Fine - Gravel particles passing the (19 mm) 3/4 inch sieve, and retained on the (4.76 mm) #4 U.S. standard sieve.

Note: The term "gravel" in this system denotes a particle size range and should not be confused with "gravel" used to describe a type of geologic deposit or a construction material.

Sand Identified by particle size, sand consists of rock particles, usually silicate (quartz) based, ranging between gravel and silt sizes. Sand has no cohesion or plasticity. Its particles are gritty grains that can easily be seen and felt, and may be rounded (natural) or angular (usually manufactured). Sand is subdivided into particle size ranges as follows:

Coarse - Particles that will pass the (4.76 mm) #4 U.S. Standard sieve and be retained on the (2 mm) # 10 U.S. Standard sieve.

Medium - Particles that will pass the (2 mm) #10 U.S. Standard sieve and be retained on the (0.425 mm) # 40 U.S. Standard sieve.

Fine - Particles that will pass the (0.425 mm) #40 U.S. Standards sieve and be retained on the (0.075 mm) # 200 U.S. Standard sieve.

Well-Graded - Indicates relatively equal percentages of Fine, Medium, and Coarse fractions are present.

Note: The particle size of coarse-grained primary soils is important to the Soil Engineer! Always indicate the particle size or size range immediately before the primary soil constituent.
<u>Exception</u>: The use of 'Gravel' alone will indicate both coarse and fine gravel are present.
<u>Examples</u>: **Fine & Medium** Sand; **Coarse** Gravel.
Include the particle shape (angular, partially angular, or rounded) when appropriate, such as for aggregates or manufactured sands.
<u>Example</u>: **Rounded** Gravel.

Fine-Grained Soils: More than 50% of the soil PASSES the (0.075 mm) #200 sieve.

Silt Identified by behavior and particle size, silt consists of material passing the (0.075 mm) #200 sieve that is non-plastic (no cohesion) and exhibits little or no strength when dried. Silt can typically be rolled into a ball or strand, but it will easily crack and crumble. To distinguish silt from clay, place material in one hand and make 10 brisk blows with the other; if water appears on the surface, creating a glossy texture, then the primary constituent is silt.

Clay Identified by behavior and particle size, clay consists of material passing the (0.075 mm) #200 sieve AND exhibits plasticity or cohesion (ability of particles to adhere to each other, like putty) within a wide range of moisture contents. Moist clay can be rolled into a thin (3 mm)1/8 inch thread that will not crumble. Also, clay will exhibit strength increase with decreasing moisture content, retaining considerable strength when dry.

Clay is often encountered in combination with other soil constituents such as silt and sand. If a soil exhibits plasticity, it contains clay. The amount of clay can be related to the degree of plasticity; the higher the clay content, the greater the plasticity.

Note: When applied to laboratory gradation tests, silt size is defined as that portion of the soil finer than the (0.075 mm) # 200 U.S. Standard sieve and coarser than the 0.002 mm. Clay size is that portion of soil finer than 0.002 mm. For field classification, the distinction will be strictly based upon cohesive characteristics.

<u>Organic Soils</u>:

Peat Highly organic soil, peat consists primarily of vegetable tissue in various stages of decomposition, accumulated under excessive moisture conditions, with texture ranging from fibrous to amorphous. Peat is usually black or dark brown in color, and has a distinct organic odor. Peat may have minor amounts of sand, silt, and clay in various proportions.

Fibrous Peat - Slightly or un-decomposed organic material having identifiable plant forms. Peat is relatively very light-weight and usually has spongy, compressible consistency.

Amorphous Peat (Muck) - Organic material which has undergone substantial decomposition such that recognition of plant forms is impossible. Its consistency ranges from runny paste to compact rubbery solid.

Marl Marl consists of fresh water sedimentary deposits of calcium carbonate, often with varying percentages of calcarious fine sand, silt, clay and shell fragments. These deposits are unconsolidated, so marl is usually lightweight. Marl is white or light-gray in color with consistency ranging from soft paste to spongy. It may also contain granular spheres, organic material, or inorganic soils. Note that marl will react (fizz) with weak hydrochloric acid due to the carbonate content.

Secondary Soil Constituents

Secondary soil constituents represent one or more soil types other than the primary constituent which appear in the soil in significant percentages sufficient to readily affect the appearance or engineering behavior of the soil. To correlate the field classification with laboratory classification, this definition corresponds to amounts of secondary soil constituents > 12% for fine-grained and >30% for coarse-grained secondary soil constituents. The secondary soil constituents will be added to the field classification as an adjective <u>preceding the primary</u> <u>constituent.</u> Two or more secondary soil constituents should be listed in <u>ascending</u> order of importance. <u>Examples</u>: **Silty** Fine Sand; **Peaty** Marl; **Gravelly**, **<u>Silty</u>** Medium Sand; **Silty**, **<u>Sandy</u>** Clay.

Tertiary Soil Constituents

Tertiary soil constituents represent one or more soil types which are present in a soil in quantities sufficient to readily identify, but NOT in sufficient quantities to significantly affect the engineering behavior of the soil. The tertiary constituent will be added to the field classification with the phrase "with __" at the end, following the primary constituent and all other descriptors. This definition corresponds to approximately 5-12% for fine-grained and 15-29% for coarse-grained tertiary soil constituents. <u>Example</u>: Silty Fine to Coarse Sand with **Gravel and Peat**.

Soil types which appear in the sample in percentages below tertiary levels <u>need not be included</u> in the field classification. However, the slight appearance of a soil type may be characteristic of a transition in soil constituents (more significant deposits nearby), or may be useful in identifying the soil during construction. These slight amounts can be included for descriptive purposes at the end of the field classification as "Trace of ___."

Additional Soil Descriptors

Additional descriptors should be added as needed to adequately describe the soil for the purpose required. These descriptors should *typically* be added to the field classification before the primary and secondary constituents, in ascending order of significance (Exceptions noted below). Definitions for several descriptive terms can be found in the Glossary of Terms below. Other terms may be used as appropriate for descriptive purposes, but not for soil constituents.

Color	Brown, Gray, Yellow, Red, Black, Light-, Dark-, Pale-, etc.
Moisture Content	Dry, Moist, Saturated. Judge by appearance of sample before manipulating.
Structure	Fissured, Friable, Blocky, Varved, Laminated, Lenses, Layers, etc.

<u>Examples</u>: **Gray-Brown <u>Laminated</u>** Silty Clay; **Light-Brown <u>Saturated</u>** Fine & Medium Sand.

<u>Exceptions</u>: Certain descriptive terms such as "Fill", may be more appropriate after the primary constituent or at the end of the field classification. Also, the description of distinct soils (inclusions) within a larger stratum should be added after the complete field classification of the predominant soil.

<u>Examples of exceptions</u>: Stiff Brown Sandy Clay **Fill**, with Coarse Angular Gravel and Asphalt; Gray Silty Clay with Saturated Marl, **Lenses of Saturated Fine Sand.**

Soil Strength Assessment

Soil strength refers to the degree of load-carrying capacity and resistance to deformation which a particular soil may develop. For cohesionless granular soils (sand, gravel, and silt) the relative in-place density is a measure of strength. The in-place consistency for cohesionless soils can be estimated by the Standard Penetration Test (SPT - Blow counts) and by resistance to drilling equipment or “pigtail” augers as described below. For cohesive soils, “consistency” is a measure of cohesion, or shear strength. The shear strength of clay soils can be estimated in the field using the manual methods described below, the SPT, or resistance to drilling equipment. Note that for clay soils, loss of moisture will result in increased strength; therefore, consistency of clay soils should be estimated at the natural moisture content.

The soil consistency, when appropriate and available, should be added to the field classification at the very beginning, using the terminology described below. Examples: **Loose** Brown Rounded Fine Gravel; **Medium Stiff** Gray Moist Sandy Clay.

Cohesionless Soil

Classification	Standard Penetration, N	Relative Density, %	Resistance to Advancement of a (1.2 m) 4 ft. Long, (38 mm) 1.5 inch Diameter Spiral (Pigtail) Auger
Very Loose	< 4	0 - 15	The auger can be forced several inches into the soil, without turning, under the bodyweight of the technician.
Loose	4 - 10	15 - 35	The auger can be turned into the soil for its full length without difficulty. It can be chugged up and down after penetrating about (1/3 m) 1 ft. , so that it can be pushed down (25 mm) 1 inch into the soil.
Medium Dense	10 - 30	35 - 65	The auger cannot be advanced beyond ±(3/4 m) 2.5 ft without great difficulty. Considerable effort by chugging required to advance further.
Dense	30 - 50	65 - 85	The auger turns until tight at ±(1/3 m) 1 ft; cannot be advanced further.
Very Dense	> 50	85 - 100	The auger can be turned into the soil only to about the length of its spiral section.

Cohesive Soil

Classification	Manual Index for Consistency	Cohesion (psf)	Cohesion (kPa)	Standard Penetration, N
Very Soft	Extrudes between fingers when squeezed	0 - 250	0 - 12	< 2
Soft	Molded by light to moderate finger pressure	250 – 500	12 - 24	2 – 4
Medium Stiff	Molded by moderate to firm finger pressure	500 – 1000	24 - 48	4 – 8
Stiff	Readily indented by thumb, difficult to penetrate	1000 - 2000	48 - 96	8 – 15
Very Stiff	Readily indented by thumbnail	2000 - 4000	96 - 192	15 – 30
Hard	Indented with difficulty by thumbnail	4000 - 8000	192 - 384	> 30

Glossary of Terms

Blocky Cohesive soil which can be broken down into small angular lumps which resist further breakdown.

Boulder A rock fragment, usually rounded by weathering or abrasion, with average dimension of (300 mm) 12" or more.

Calcareous Soil containing calcium carbonate, either from limestone deposits or shells. The carbonate will react (fizz) with weak hydrochloric acid.

Cemented The adherence or bonding of coarse soil grains due to presence of a cementicious material. May be *weak* (readily fragmented), *firm* (appreciable strength), or *indurated* (very hard, water will not soften, rock-like)

Cobble A rock fragment, usually rounded or partially angular, with an average dimension (75 to 300 mm) 3" - 12".

Dry No appreciable moisture is apparent in the soil.

Fat Clay Fine-Grained soil with very high plasticity and dry strength. Usually has a sticky or greasy texture due to very high affinity for water. Remains plastic at very high water contents (Liquid Limit >50).

Fill Man-made deposits of natural soils and/or waste materials. Document the components carefully since presence and depth of fill are important engineering considerations.

Fissured The soil breaks along definite planes of weakness with little resistance to fracturing.

Frequent Occurring more than one per (300 mm)1 ft thickness.

Friable A soil which is easily crumbled or pulverized into smaller, non-uniform fragments or clumps.

Laminated Alternating horizontal strata of different material or color, usually in increments of (6 mm)1/4" or less.

Layer Horizontal inclusion or stratum of sedimentary soil greater than (100 mm) 4" thick.

Lens Inclusion of a small pocket of a sedimentary soil between (10 mm) 3/8 " and (100 mm) 4 " thick, often with tapered edges.

Moist Describes the condition of a soil with moderate to water content relative to the saturated condition (near optimum). Moisture is readily discernable but not in sufficient content to adversely affect the soil behavior.

Mottled Irregularly marked soil, usually clay, with spots of different colors.

Muck See *Amorphous Peat*, under Primary Soil Constituents heading.

Occasional Occurring once or less per (300 mm) 1 ft thickness.

Organic Indicates the presence of material which originated from living organisms, usually vegetative, undergoing some stage of decay. May range from microscopic size matter to fibers, stems, leaves, wood pieces, shells, etc. Usually dark brown or black in color, and accompanied by a distinct odor.

Parting A very thin soil inclusion of up to (10 mm) 3/8" thickness.

Saturated All of the soil voids are filled with water (zero air voids). Practically speaking, the condition where the moisture content is sufficient to substantially affect the soil behavior.

Trace Indicates appearance of a slight amount of a soil type, which may included in the classification for descriptive or identification purposes only. The Trace soil would have no effect on the soil behavior. Other modifiers such as "Slight" or "Heavy" should not be used with "Trace."

Varved The paired arrangement of laminations in glacial sediments that reflect seasonal changes during deposition; Fine sand and silt are deposited in the glacial lake during summer, and finer particles are usually deposited in thinner laminations in winter.