

Merriam-Webster Online Dictionary

**soil**, noun

- 1 : firm land : EARTH
- 2 a : the upper layer of earth that may be dug or plowed and in which plants grow  
b : the superficial unconsolidated and usually weathered part of the mantle of a planet and especially of the earth
- 3 : COUNTRY, LAND <our native soil>
- 4 : the agricultural life or calling
- 5 : a medium in which something takes hold and develops

Spangler & Handy, 1982, Soil Engineering,

Soils are natural materials which occur in infinite variety over the earth and whose engineering properties may vary widely from place to place within the relatively small confines of a single engineering project ...

The properties of soils are continuously changing as the amount of moisture fluctuates and other environmental influences vary... and may change dramatically under load

Soil is used as construction material ...

Perspectives

Soil Physics - Soil is a dynamic, heterogeneous, three-phase, porous media

Botany, Agronomy, Horticulture - Soil is the outer layer of the earth's crust capable of supporting plant growth (Pearson, 1967, Principles of Agronomy)

Geology, Engineers - Soil is unconsolidated, surficial material.

Engineering uses of soil: building media, foundation material, ...

Retaining Walls: The Good, The Bad, and the Ugly

<http://www.wtamu.edu/~crobinson/DrDirt/RetainingWalls.pdf>

SWPPP - Storm Water Pollution Prevention Plan

<http://www.wtamu.edu/~crobinson/DrDirt/SW3P.pdf>

<http://www.wtamu.edu/~crobinson/DrDirt/ErosionRunoff.pdf>

Texture, Density: Sieves, cores, core caps

texture classification systems (USDA triangle and Unified and AASHTO systems follow)

Activities: swelling soils, packing for maximum density

Sand, gravel, soil, silica flour, bentonite, water: wet bulk density vs dry bulk density

Well sorted vs. well graded: Example

Limitations for using soil for buildings and rural uses, e.g., houses with basements, septic tank absorption fields, local roads and streets, etc.

Excerpt from Collegiate Soils Contest Guidelines: Profile description, site characteristics, soil classification, interpretations

<http://www.wtamu.edu/~crobinson/DrDirt/RegIVexcerpt.pdf>

WebSoilSurvey <http://websoilsurvey.nrcs.usda.gov>

Texas Panhandle Soils and Palo Duro Canyon introduction

<http://www.wtamu.edu/~crobinson/DrDirt/TxPnhndlSoils.pdf>

AASHTO - American Association of State Highway and Transportation Officials  
[http://training.ce.washington.edu/WSDOT/Modules/04\\_design\\_parameters/aashto\\_terms.htm](http://training.ce.washington.edu/WSDOT/Modules/04_design_parameters/aashto_terms.htm)

AASHTO soil terminology comes from AASHTO M 145, "Classification of Soils and Soil-Aggregate Mixtures for Highway Construction Purposes". Aggregate terminology comes from AASHTO M 147, "Materials for Aggregate and Soil-Aggregate Subbase, Base and Surface Courses". Basic terms include:

Boulders & Cobbles	Material retained on a 75-mm (3-inch) sieve.
Gravel	Material passing a 75-mm (3-inch) sieve and retained on a 2.00-mm (No. 10) sieve.
Coarse Sand	Material passing a 2.00-mm sieve (No. 10) and retained on a 0.475-mm (No. 40) sieve.
Fine Sand	Material passing a 0.475-mm (No. 40) sieve and retained on a 0.075-mm (No. 200) sieve.
Silt-Clay	Material passing a 0.075-mm (No. 200) sieve.
Silt Fraction	Material passing the 0.075 mm and larger than 0.002 mm.
Clay Fraction	Material smaller than 0.002 mm.
Silty	Material passing a 0.075-mm (No. 200) sieve with a $PI \leq 10$
Clayey	Material passing a 0.075-mm (No. 200) sieve with a $PI \geq 11$
Coarse Aggregate	Aggregate retained on the 2.00 mm sieve and consisting of hard, durable particles or fragments of stone, gravel or slag. A wear requirement (AASHTO T 96) is normally required.
Fine Aggregate	Aggregate passing the 2.00 mm (No. 10) sieve and consisting of natural or crushed sand, and fine material particles passing the 0.075 mm (No. 200) sieve. The fraction passing the 0.075 mm (No. 200) sieve shall not be greater than two-thirds of the fraction passing the 0.425 mm (No. 40) sieve. The portion passing the 0.425 mm (No. 40) sieve shall have a $LL \leq 25$ and a $PI \leq 6$ . Fine aggregate shall be free from vegetable matter and lumps or balls of clay.

Note that these definitions are AASHTO definitions and are slightly different than those of the Unified Soil Classification system (ASTM). The table below shows the AASHTO soil classification system (from AASHTO M 145).

AASHTO Soil Classification System (from AASHTO M 145 or ASTM D3282)

General Classification	Granular Materials 35% or less passing the 0.075 mm sieve							Silt-Clay Materials >35% passing the 0.075 mm sieve			
Group Classification	A-1		A-3	A-2				A-4	A-5	A-6	A-7
	A-1-a	A-1-b		A-2-4	A-2-5	A-2-6	A-2-7				A-7-5 A-7-6
Sieve Analysis, % passing											
2.00 mm (No. 10)	50 max	...	...	...	...	...	...	...	...	...	...
0.425 (No. 40)	30 max	50 max	51 min	...	...	...	...	...	...	...	...
0.075 (No. 200)	15 max	25 max	10 max	35 max	35 max	35 max	35 max	36 min	36 min	36 min	36 min
Characteristics of fraction passing 0.425 mm (No. 40)											
Liquid Limit	...	...	40 max	41 min	40 max	41 min	40 max	41 min	40 max	41 min	41 min
Plasticity Index	6 max	N.P.	10 max	10 max	11 min	11 min	10 max	10 max	11 min	11 min <sup>†</sup>	
Usual types of significant constituent materials	stone fragments, gravel and sand	fine sand	silty or clayey gravel and sand				silty soils		clayey soils		
General rating as a subgrade	excellent to good							fair to poor			

† Plasticity index of A-7-5 subgroup is equal to or less than the LL - 30. Plasticity index of A-7-6 subgroup is greater than LL - 30

References:

Day, Robert W. 2001. Soil testing manual: procedures, classification data, and sampling practices. McGraw-Hill Professional. ISBN 0071363637, 9780071363631

[http://training.ce.washington.edu/WSDOT/Modules/04\\_design\\_parameters/aashto\\_terms.htm](http://training.ce.washington.edu/WSDOT/Modules/04_design_parameters/aashto_terms.htm)

## ASTM (American Society for Testing and Materials) Terminology

The Unified Soil Classification System is a soil classification system used in engineering and geology disciplines to describe the texture and grain size of a soil. The classification system can be applied to most unconsolidated materials. The basic reference for the Unified Soil Classification System is ASTM D 2487. Terms include:

Coarse-Grained Soils	More than 50 percent retained on a 0.075 mm (No. 200) sieve
Fine-Grained Soils	50 percent or more passes a 0.075 mm (No. 200) sieve
Gravel	Material passing a 75-mm (3-inch) sieve and retained on a 4.75-mm (No. 4) sieve.
Coarse Gravel	Material passing a 75-mm (3-inch) sieve and retained on a 19.0-mm (3/4-inch) sieve.
Fine Gravel	Material passing a 19.0-mm (3/4-inch) sieve and retained on a 4.75-mm (No. 4) sieve.
Sand	Material passing a 4.75-mm sieve (No. 4) and retained on a 0.075-mm (No. 200) sieve.
Coarse Sand	Material passing a 4.75-mm sieve (No. 4) and retained on a 2.00-mm (No. 10) sieve.
Medium Sand	Material passing a 2.00-mm sieve (No. 10) and retained on a 0.475-mm (No. 40) sieve.
Fine Sand	Material passing a 0.475-mm (No. 40) sieve and retained on a 0.075-mm (No. 200) sieve.
Clay	Material passing a 0.075-mm (No. 200) that exhibits plasticity, and strength when dry ( $PI \geq 4$ ).
Silt	Material passing a 0.075-mm (No. 200) that is non-plastic, and has little strength when dry ( $PI < 4$ ).
Peat	Soil of vegetable matter.

Each Group in the Unified Soil Classification System and is represented by a two-letter symbol.

Prefix		Suffix	
Letter	Definition	Letter	Definition
G	gravel	P	poorly graded (uniform particle sizes)
S	sand	W	well graded (diversified particle sizes)
M	silt	H	high plasticity, $LL > 50\%$
C	clay	L	low plasticity, $LL < 50\%$
O	organic		

Unified Soil Classification (USC) System (from ASTM D 2487)

Major Divisions			Group Symbol†	Typical Names
<b>Course-Grained Soils</b> More than 50% retained on the 0.075 mm (No. 200) sieve	<b>Gravels</b> 50% or more of course fraction retained on the 4.75 mm (No. 4) sieve	Clean Gravels	GW	Well-graded gravels and gravel-sand mixtures, little or no fines
			GP	Poorly graded gravels and gravel-sand mixtures, little or no fines
		Gravels with Fines	GM	Silty gravels, gravel-sand-silt mixtures
			GC	Clayey gravels, gravel-sand-clay mixtures
	<b>Sands</b> 50% or more of course fraction passes the 4.75 mm (No. 4) sieve	Clean Sands	SW	Well-graded sands and gravelly sands, little or no fines
			SP	Poorly graded sands and gravelly sands, little or no fines
		Sands with Fines	SM	Silty sands, sand-silt mixtures
			SC	Clayey sands, sand-clay mixtures
<b>Fine-Grained Soils</b> More than 50% passes the 0.075 mm (No. 200) sieve	<b>Silts and Clays</b> Liquid Limit 50% or less		ML	Inorganic silts, very fine sands, rock four, silty or clayey fine sands
			CL	Inorganic clays of low to medium plasticity, gravelly/sandy/silty/lean clays
			OL	Organic silts and organic silty clays of low plasticity
	<b>Silts and Clays</b> Liquid Limit greater than 50%		MH	Inorganic silts, micaceous or diatomaceous fine sands or silts, elastic silts
			CH	Inorganic clays or high plasticity, fat clays
			OH	Organic clays of medium to high plasticity
<b>Highly Organic Soils</b>			PT	Peat, muck, and other highly organic soils

†Prefix: G = Gravel, S = Sand, M = Silt, C = Clay, O = Organic

Suffix: W = Well Graded, P = Poorly Graded, M = Silty, L = Clay, LL < 50%, H = Clay, LL > 50%

USDA (United States Department of Agriculture) Particle size analysis

Coarse fragments <sup>†</sup>	> 2 mm
Stones or boulders	>250 mm
Cobbles (round)	250 - 75 mm
Flags (flat)	250 - 75 mm
Gravel	75 - 2 mm

<sup>†</sup>Coarse fragments are included as modifiers to the USDA soil texture class

Soil separates

<b>Sand</b>	<b>2.0 - 0.05 mm</b>
Very coarse	2.0 - 1.0 mm
Coarse	1.0 - 0.5 mm
Medium	0.5 - 0.25 mm
Fine	0.25 - 0.1 mm
Very fine	0.1 - 0.05 mm
<b>Silt</b>	<b>0.05 - 0.002 mm</b>
<b>Clay</b>	<b>&lt;0.002 mm (2 μm)</b>

Soil texture - the relative proportion of the particles < 2.0 mm. The different proportions of particle sizes are grouped in the USDA Soil Textural Triangle according to the way the soil properties affect agricultural management practices.

**USDA Texture Triangle**

