

Soil Classification Guide for Cohesive Soil

FINE GRAINED SOIL CLASSIFICATION (After Ref. ASTM D2487-17^{e1} and D2488-17^{e1})

Terms	Percent (by weight) of Total Sample
SILT, LEAN CLAY, FAT CLAY, ELASTIC SILT	PRIMARY CONSTITUENT*
Sandy, gravelly, abundant cobbles, abundant boulders with - sand, gravel, cobbles, boulders	>30 - 50
scattered - sand, gravel, cobbles, boulders	>15 - 30 - Secondary coarse grained constituents
trace - sand, gravel, boulders	5 - 15
	<5

* The relationship of clay and silt constituents is based on plasticity and normally determined by performing index tests. Refined classifications are based on Atterberg Limits tests and the Plasticity Chart.

CONSISTENCY (Ref. FHWA NHI-06-088)

TERM	N ₆₀ -VALUE (bpf)	POCKET PENETROMETER (tsf)	FIELD TEST
Very Soft	0 - 1	0.25 or Less	Specimen (height = twice the diameter) sags under its own weight; extrudes between fingers when squeezed.
Soft	2 - 4	0.25 - 0.50	Specimen can be pinched in two between the thumb and forefinger; remolded by light finger pressure.
Medium Stiff	5 - 8	0.50 - 1.00	Can be imprinted easily with fingers; remolded by strong finger pressure.
Stiff	9 - 15	1.00 - 2.00	Can be imprinted with considerable pressure from finger or indented by thumbnail.
Very Stiff	16 - 30	2.00 - 4.00	Can barely be imprinted by pressure from fingers or indented by thumbnail.
Hard	>30	over 4.00	Cannot be imprinted with fingers and is indented with difficulty by thumb nail.

*Blow counts may be amplified by gravel content and should be noted in boring log description.

MOISTURE CONDITION (Ref. ASTM D2488-17^{e1})

Descriptive Term	Guide
Dry	Absence of moisture, dusty, dry to the touch
Moist	Damp but no visible water
Wet	Visible free water, usually soil is below water table

CRITERIA FOR DESCRIBING STRUCTURE & THICKNESS (Ref. ASTM D2488-17^{e1} and FHWA NHI-06-088)

Description	Criteria
STRUCTURE	
Stratified	Alternating layers of varying material or color with layers at least ¼ inch thick; note thickness
Laminated	Alternating layers of varying material or color with the layers less than ¼ inch thick; note thickness
Fissured	Breaks along definite planes of fracture with little resistance to fracturing
Slickensided	Fracture planes appear polished or glossy, sometimes striated
Blocky	Cohesive soil that can be broken down into small angular lumps which resist further breakdown
Homogeneous	Same color and appearance throughout
THICKNESS	
Layer	Inclusion greater than 3 inches thick
Seam	Inclusion 1/8 inch to 3 inches thick extending through the sample
Parting	Inclusion less than 1/8 inch thick

SPT Hammer Energy Transfer Ratio (ETR)

Drill Rig	ETR	N ₆₀ Multiplier	50 Blow Equiv.
Acker XLS – G-9462	81.3	1.36	37
Acker Renegade – G-9667	92.3	1.54	33
Simco Versa Drill – G-8690	82.8	1.38	37
CME 45 – G-9577	87.2	1.45	35

Soil Classification Guide for Non Cohesive

COARSE GRAINED SOIL CLASSIFICATION (Modified after Ref. ASTM D2487-17e1 and D2488-17e1)

Terms	Percent (by weight) of Total Sample
GRAVEL, SAND, COBBLES, BOULDERS	PRIMARY CONSTITUENT
COARSE GRAINED SECONDARY CONSTITUENTS:	
Sandy, gravelly, abundant cobbles, abundant boulders with - sand, gravel, cobbles, boulders scattered - sand, gravel, cobbles, boulders trace - sand, gravel, boulders	>30 – 50 >15 – 30 - Secondary coarse grained constituents 5 – 15 <5
FINE GRAINED SECONDARY CONSTITUENTS *	
silty (MH & ML), clayey (CL & CH) with – silt, clay trace - silt, clay	>15 5 – 15 - Secondary coarse grained constituents <5

*Index tests and/or plasticity tests are performed to determined whether the term “silt” or “clay” is used.

DENSITY (Ref. ASTM D2488-17^{e1} & FHWA NHI-06-088)

Term	N ₆₀ -VALUE (bpf)
Very Loose	0 – 4
Loose	5 – 10
Medium Dense	11 – 30
Dense	31 – 50
Very Dense	over 51

*Blow counts may be amplified by gravel content and should be noted in boring log description.

MOISTURE CONDITION (Ref. ASTM D2488-17^{e1})

Descriptive Term	Guide
Dry	Absence of moisture, dusty, dry to the touch
Moist	Damp but no visible water
Wet	Visible free water, usually soil is below water table

GRAIN SIZE IDENTIFICATION (After Ref. ASTM D2488-17^{e1})

NAME	SIZE LIMITS	FAMILIAR EXAMPLE
Boulder	12 in. (305 mm) or more	Larger than Basketball
Cobbles	3 in. (76 mm) – 12 in. (305 mm)	Grapefruit to Basketball
Coarse Gravel	¾ in. (19 mm) – 3 in. (76 mm)	Grape to Grapefruit
Fine Gravel	4.75 mm (No. 4 sieve) – ¾ in. (19 mm)	Rocksalt to Grape
Coarse Sand	2 mm (No. 10 sieve) – 4.75 mm (No. 4 sieve)	Rocksalt
Medium Sand	0.42 mm (No. 40 sieve) – 2 mm (No. 10 sieve)	Sugar
Fine Sand*	0.075 mm (No. 200 sieve) – 0.42 mm (No.40 sieve)	Onion/Garlic Powder
Fines	Less than 0.075 mm (No. 200 sieve)	

*Particles finer than fine sand cannot be discerned with the naked eye at a distance of 8 inches.

SAMPLE COLLECTION GUIDE

Sample Type	Min Sample Length	ID Modifier	Comments
Moisture	.2'(SPT), .1'(ST)	Can #	Seal can with electrical tape.
Atterberg Limits	.4'(SPT), .2'(ST)	A	Cut up in small pieces. Collect for cohesive soils and silty or clayey sands and gravels in SE MO (refer to Seismic Sampling and grab larger sample)
Soil Qu	.6'(ST)	Q	Wrap in foil and wax in tubes ASAP after collection.
Direct Shear	.6'(ST)	DS	Wrap in foil and wax in tubes ASAP after collection.
Triaxial	.6'(ST)	T	Wrap in foil and wax in tubes ASAP after collection.
Consolidation	.5'(ST)	C	Wrap in foil and wax in tubes ASAP after collection.
Sieve (aka Scour)	1qt to 1gal bag	S	Bag entire sample, no more than 1gal from grab sample.
Rock Core Qu	.5'(avg core)	Q	Shorter cores may be collected so long as they can be trimmed & have a L/D ratio > 2. Wrap shale & SS in saran wrap 3 times each way, then foil.

Rock Classification Guide

ROCK TYPE CLASSIFICATION (Ref. FHWA-NHI-16-072, Table 4-19 & NRCS Part 631, Table 4-1)

Genetic group		Detrital sedimentary				Chemical organic	Metamorphic		Pyroclastic	Igneous							
Usual structure		Bedded				Bedded	Foliated	Massive	Bedded	Massive							
Composition		Grains of rock, quartz, feldspar, and clay minerals		At least 50% of grains are of carbonate		Salts, carbonates, silica, carbonaceous	Quartz, feldspars, micas, dark minerals	Quartz, feldspars, micas, dark minerals, carbonates	At least 50% of grains are of igneous rock	Quartz, feldspars, micas, dark minerals		Feldspar; dark minerals	Dark minerals				
									Acid	Intermediate	Basic	Ultrapasic					
Very coarse-grained	75 (3')	Rubidicous	Grains are of rock fragments				CLINKER (31)	TECTONIC BRECCIA (41)		Rounded grains: AGGLOMERATE (61) Angular grains: VOLCANIC BRECCIA (62)	PEGMATITE (71)						
			Rounded grains: CONGOMERATE (11) Angular grains: BRECCIA (12)		LIMESTONE (undifferentiated) (21)	CALCIRUDITE (23)	SALINE ROCKS Halite (32) Anhydrite (33) Gypsum (34)	MIGMATITE (42)	METACONGLOMERATE (51)		GABBRO (91)	PYROXENITE (01)					
Coarse-grained	4.75 (3')	Arenaceous	Grains are mainly mineral fragments				SCHIIST (44)	MARBLE (52)	GRANULITE (53)	QUARTZITE (54)			TUFF (63)	GRANITE (72)	DIORITE (81)	ANORTHOSITE (82)	GABBRO (91)
Medium-grained	0.074 (200)		SANDSTONE (13) ARKOSE (14) GRAYWACKE (Argillaceous ss) (15)		CALCARENITE (27)	CALCAREOUS ROCKS					Amphibolite (45)	HORNFELS (55)		DUNITE (03)			
Fine-grained	0.005	Argillaceous or Lubricious	MUDSTONE (16) SHALE: fissile mudstone (17)	SILTSTONE->50% fine-grained particles (18)	MARLSTONE (22)	LIMESTONE (undifferentiated) (21)	CALCISILTITE (25)	LIMESTONE (35)	PHYLITE (46)	Mylonite (47)	FINE-GRAINED TUFF (64)		TUFF (63)		APLITE (74)	MONZONITE (84)	DIABASE (92)
Very fine-grained			CLAYSTONE->50% very fine grained particles (19)	CHALK (26)			DOLOMITE (36)	Slate (48)				Very fine-grained TUFF (65)		RHYOLITE or FELSITE (75)	Dacite (85)	NEPHELINE-BASALT (04)	
Glassy amorphous							SILICEOUS ROCKS Chert (37) Flint (38)	Ultramylonite (49)		Welded TUFF (66)	VOLCANIC GLASSES						
							CARBONACEOUS ROCKS				PUMICE (67)	OBSIDIAN (76)	PITCHSTONE (87)	TACHYLITE (87)			
						LIGNITE/COAL (39)											

Arenaceous – Consisting of or in part of sand sized fragments; Argillaceous – notable proportion of clays, marl, or shale; Calcareous – >50% calcium carbonate (limestone); Carbonaceous – Rich in carbon, coaly; Micaceous – Consisting of mica; Siliceous – Abundant silica.

BEDDING THICKNESS (After Ref. NRCS Part 631, Table 4-15)

TERM	THICKNESS	TERM	THICKNESS
Massive	Greater than 20' thick	Very thin bedded	3/4" to 2 1/2" thick
Very Thick bedded	6.5' to 20' thick	Laminated	1/4" to 3/4" thick
Thick bedded	2' to 6.5' thick	Thinly laminated	1/16 to 1/4" thick
Medium bedded	8" to 2' thick	Fissile	Less than 1/16" thick
Thin bedded	2 1/2" to 8" thick		

TERMS TO DESCRIBE ROCK STRENGTH (Modified after Ref. FHWA-NHI-16-072, Table 4-25)

TERM	FIELD IDENTIFICATION	APPROXIMATE UNCONFINED COMPRESSIVE STRENGTH (ksf)
Very Weak Rock	Specimen can be indented by thumbnail.	5 - 25
Weak Rock	Crumbles under sharp blow with point of geological hammer & can be peeled with a pocketknife	25 - 100
Medium Strong Rock	Shallow cuts or scrapes can be made with a pocketknife. A firm blow with a geological hammer creates shallow indents.	100 - 500
Strong Rock	Cannot be scraped or cut with pocketknife. Can be fractured with a single firm blow with a geological hammer point.	500 - 1000
Very Strong Rock	Requires more than one firm blow of the point of a geological hammer to fracture.	1000 - 2000
Extremely Strong Rock	Requires many firm blows from hammer end of geological hammer to fracture.	> 2000

DEGREE OF WEATHERING (Modified after Ref. FHWA-NHI-16-072, Table 4-24)

TERM	DESCRIPTION
Fresh	No Visible sign of rock material weathering; slight discoloration on major discontinuity surfaces is possible
Slightly Weathered	Discoloration indicates weathering of rock material and discontinuity surfaces. All rock material may be discolored by weathering and the external surfaces may be somewhat weaker than its fresh color.
Moderately Weathered	Less than half of the rock material is decomposed and/or disintegrated to a soil. Fresh or discolored rock is present either as a discontinuous framework or as corestones. A minimum 2 in. diameter sample cannot be broken readily by hand across the rock fabric.
Highly Weathered	More than half of the rock is decomposed and/or disintegrated to soil. Fresh or discolored rock is present either as a discontinuous framework or as corestones. A minimum 2 in. diameter sample can be broken readily by hand across the rock fabric.
Completely Weathered	All rock material is decomposed and/or disintegrated to soil. The original mass structure is largely still intact. Material can be granulated by hand.

GRAIN SIZE (TYPICALLY FOR SEDIMENTARY ROCKS) - (Modified after Ref. FHWA-NHI-16-072, Table 4-23)

DESCRIPTION	DIAMETER	FIELD IDENTIFICATION
Very Fine Grained	< 0.003"	Cannot be distinguished by unaided eye. Few to no mineral grains are visible with a hand lens.
Fine Grained	0.003" to 0.02"	Few crystalline boundaries are visible; grains can be distinguished by the unaided eye but can be somewhat distinguished by hand lens.
Medium Grained	0.02" to 0.08"	Most crystalline boundaries are visible; grains distinguishable by eye and with hand lens.
Coarse Grained	0.08" to 0.2"	Crystal boundaries are visible; grains distinguishable with naked eye.
Very Coarse Grained	> 0.2"	Crystal boundaries are clearly visible; grains are distinguishable with naked eye.

VOIDS (Modified after Ref. USACE Geology Field Manual, VII.2.j; & NRCS Part 631, Table 4-21)

TERM	DESCRIPTION
Porous	Smaller than a pinhead, usually not discernable to the naked eye. Their presence is indicated by the degree of absorbency of the core.
Pitted	Pinhead size to ¼".
Vuggy	Openings ¼" to 2"; often lined with crystals.
Cavities	Openings larger than 2" in diameter
Honeycombed	Only thin walls separate pits and vugs.

ROCK QUALITY DESCRIPTION (Ref. FHWA-NHI-16-072, Table 4-12)

ROCK MASS DESCRIPTION	RQD
Excellent	90 - 100
Good	75 - 90
Fair	50 - 75
Poor	25 - 50
Very Poor	0-25