ASAL MULA, PROSES PEMBENTUKAN DAN KALSIFIKASITANAH

Kuliah 2

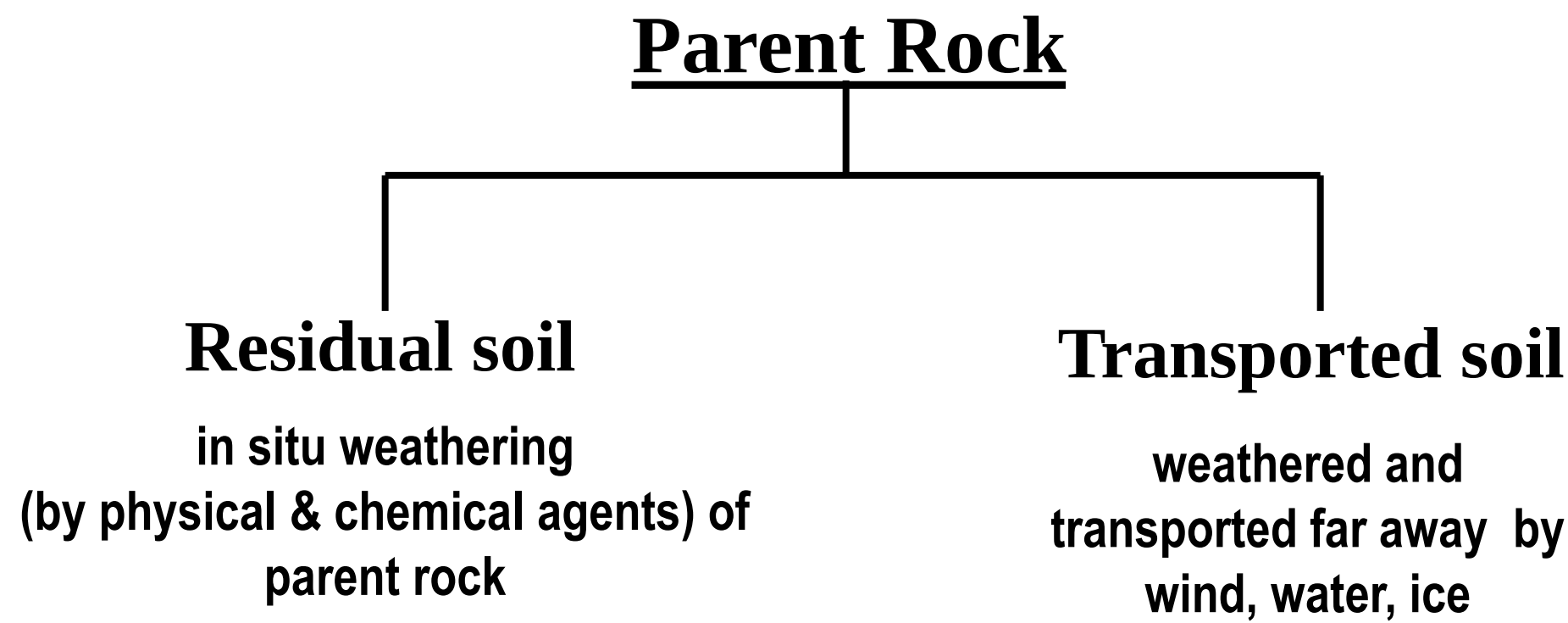
Mekanika Tanah I

Jurusan Teknik Sipil Universitas Bina Darma

Origin of Soil:

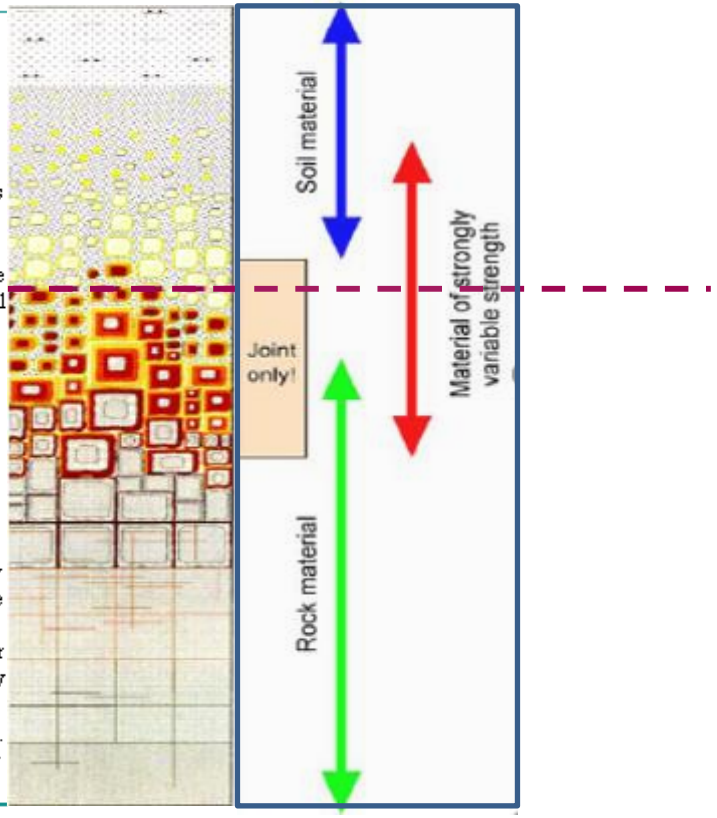
- For Geologist, soils means unconsolidated material. In civil engineering, soil is defined as a collection of mineral particles that was formed due to the weathering process of igneous rock and mixed with organic matter.
- The void between particles is filled with water and gas.
- Cementation among the particles is weak and is due to carbonation and oxidation between particles and organic matter.

Types of Soil



Weathering Classification

Weathering classification Term	Zone	Description
Residual soil	VI	All rock material is converted to soil. The mass structure and material fabric (texture) are completely destroyed. The material is generally silty or clayey and shows homogenous color.
Completely weathered	V	All rock material is decomposed to soil. Material partially preserved. The material is sandy and is friable if soaked in water or squeezed by hand.
Highly weathered	IV	The rock material is in the transitional stage to form soil. Material condition is either soil or rock. Material is completely discolored but the fabric is completely preserved. Mass structure partially present.
Moderately weathered	III	The rock material shows partial discoloration. The mass structure and material texture are completely preserved. Discontinuity is commonly filled by iron-rich material. Material fragment or block corner can be chipped by hand.
Slightly weathered	II	Discoloration along discontinuity and may be part of rock material. The mass structure and material texture are completely preserved. The material is generally weaker but fragment corners cannot be chipped by hand
Fresh rock	I	No visible sign of rock material weathering. Some discoloration on major discontinuity surfaces.



Transported Soils: Rock and Soil particles are transported in other locations by:

- glaciers (*glacial soils*),
- running water (*alluvial soils*),
- quiet water (*lacustrine* soils),
- sea water (*marine soils*),
- wind (*aeolian soils*),
- gravity (*colluvial soils*).

Alluvial soils retain the most groundwater

Soil Texture

In general, soil characteristics is highly depends on the grain size characteristics which was influenced by the history and the process of soil formation. The size varies from 100 mm to less than 0.001 mm. Based on the particle size, soil can be grouped as:

- Coarse Grained (Gravels, Sands)
- Fine Grained (Silts)
- Fine Grained (Clay)
- Organic soil

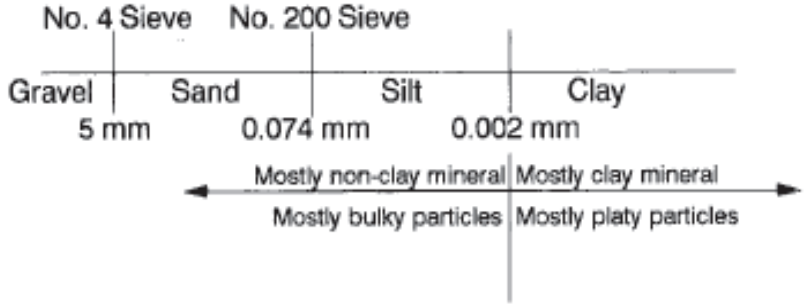


Figure 3.1 Particle size ranges in soils.

REVIEW: SOIL CLASSIFICATION:
BS, ASTM, AASHTO etc.
(including lab tests for soil classification purposes).

Soil Texture

In general, soil characteristics is highly depends on the grain size characteristics which was influenced by the history and the process of soil formation. The size varies from 100 mm to less than 0.001 mm.

Based on the particle size, soil can be grouped as:

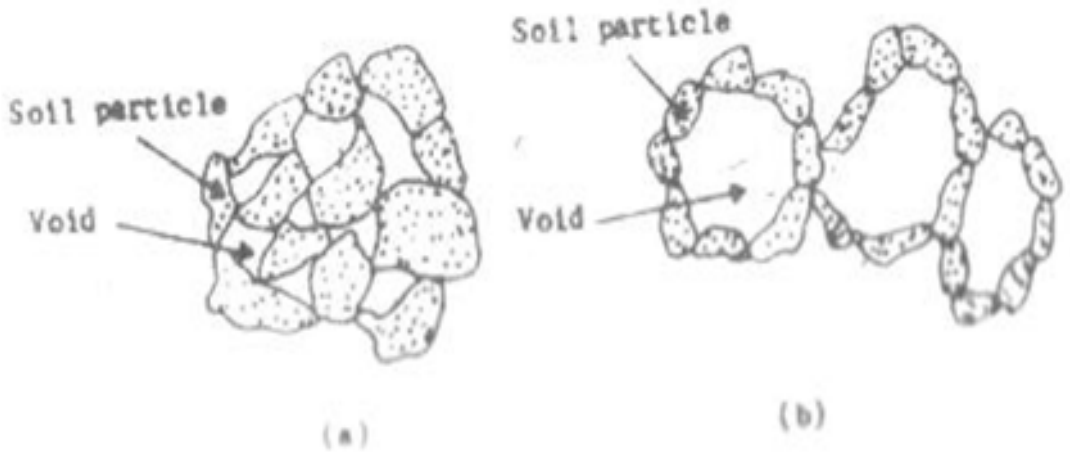
- Coarse Grained (Gravels, Sands) --- COHESIONLESS
- Fine Grained (Silts and Clay) -------- COHESIVE
- Organic soil (Peat)

Cohesionless soil:

The structures generally encountered in cohesion-less soils can be divided into two major categories:

(a) single graine

(b) honeycombe

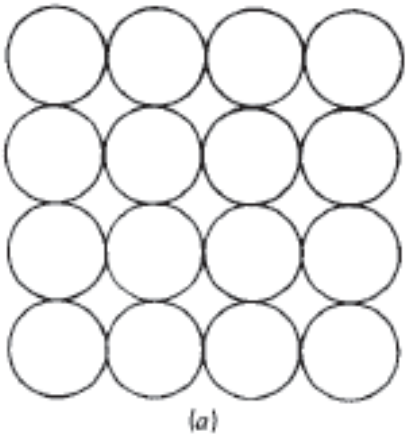


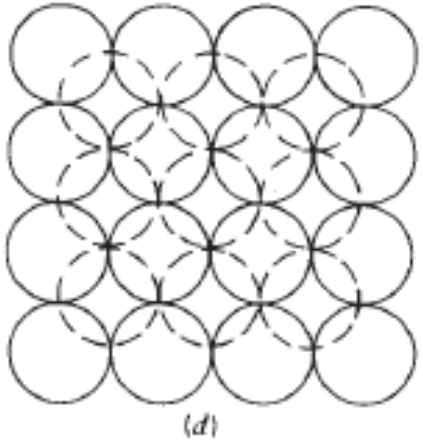
- The single grained structure is more stable because each particle is in contact with other particles.

Cohesionless soil:

- The density of packing depends on the size, shape and distribution of particles and their relative positions.
- For simple cubic packing e = 0.91, while for pyramidal type e = 0.35.
- Thus the behavior of cohesionless depends on the particle size and packing

Loosest





Densest

Cohesive soil:

Contain more than 30% (by weight) clay size particles
Parts of the clay particles are clay minerals
Clay minerals govern soil behavior

What are clay size particles?

- Particles less than 2 mm in size
- Contain clay and non-clay minerals
- Has plasticity → Use Atterberg Limits to determine

Clay particles exist in the form of platelets or sheet. Ends of these particles have a positive charge, while its surface is negatively charge. If clay is mixed with water, then the particles will move away from each other. Then the particle will form sediment, or flows in water.

Cohesive soil:

If the sediment has a loose structure and,

- the particles arrangement is parallel to each other, it is called dispersed.
- If the particles form a right angle to each other, then it is called flocculent. If salt is added in the clay-water solutions, then it is called salt flocculated (Marine soils)

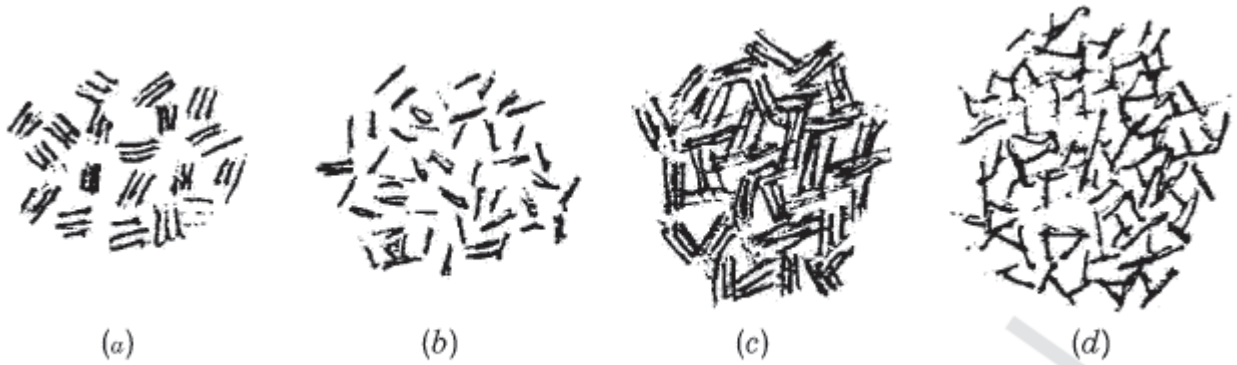


Exhibit 5.1 Soil fabrics.

Flocculated sediment has higher void ratio and less specific gravity. Soil structure formed in marine environment is highly flocculent; thus highly compressible.

Important groups of clay mineral

1. Kaolinite, Not expansive, formed by several sheets composed of one silica and one alumina atau gibbsite. This mineral is usually called 1:1 Layer mineral. The chemical composition of this mineral is Al2Si2O5 (OH)4. Two members of this family is kaolinite and serpentine. Other mineral that comes in the same form is *Halloysite*.
2. Mica: e.g. *llites* and *vermiculites*, sometimes expansive, referred as 2:1 layer mineral because it contain two silica and one alumina . Potassium atom exists between the layers. Member of this group is Illite, with chemical composition : Ky.Al2.(Fe2.Mg2.Mg3).(Si4-y.Aly).O10(OH)2 where y varied from 1.0 to1.5.
3. Smectite, e.g: *montmorillonites*, highly expansive. This mineral is referred as 2:1 layer mineral composed of two silica dan one alumina. The chemical formula of montmorillonite is: Al2.Mg(Si4O10)(OH)2.xH2O. Montmorillonite is smaller in size as compared to illite dan kaolinite. The shape is platy with the thickness of 0,001 micron and length of $\pm$ 0,003 micron. The small size makes montmorillonite is highly plastic and very active. The cation exchange capacity of montmorillonite is 0.8–1.5 mequiv/gram.

KLASIFIKASI TANAH

Kuliah 2

Mekanika Tanah I

Jurusan Teknik Sipil Universitas Bina Darma

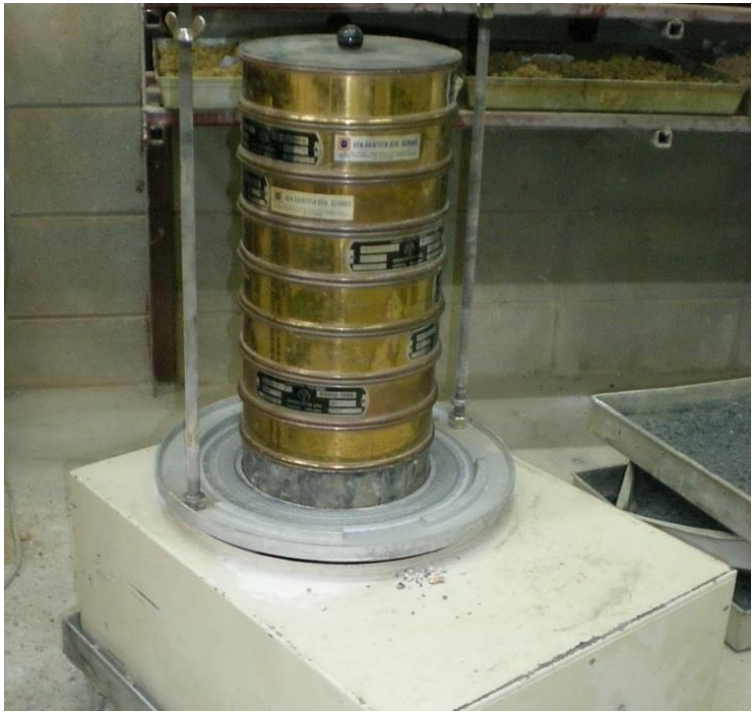
Table 1.1 Soil types based on particle size

Soil Types	Particle sizes (mm)			
	British Standard (BS)	**ASTM D422/ D635**	**USCS**	**AASHTO**
Boulders	> 200	> 300	> 300	> 75
Cobbles	60 – 200	75 - 300	75 - 300	
Gravel	2 – 60	4.75 – 75	4.75 – 75	20 – 75
Sand	0.063 – 2	0.075 – 4.75	0.075 – 4.75	0.075 – 2
Silt	0.002 – 0.063	0.005 – 0.075	0.005 – 0.075	0.005 – 0.075
Clay	< 0.002	< 0.005	< 0.005	0.001 – 0.005
Colloids				< 0.001

Table 1.2 Mesh opening sizes according to ASTM and BS standards

ASTM standards		**BS standards**
Sieve No	**Mesh opening size (mm)**	**Mesh opening size (mm)**
	75	63
	25	20
4	4.75	6.30
10	2.00	2.00
40	0.425	0.600
100	0.150	0.212
200	0.075	0.063

Klasifikasi Tanah
Distribusi ukuran butiran tanah



For particles smaller than 0.075 mm (ASTM) or 0.063mm (BS), the distribution can be determined by sedimentation principles (hygrometer, pipette, buoyancy methods). Fine grained soils is also further classified based on consistency through Atterberg Limit test (LL and PL)

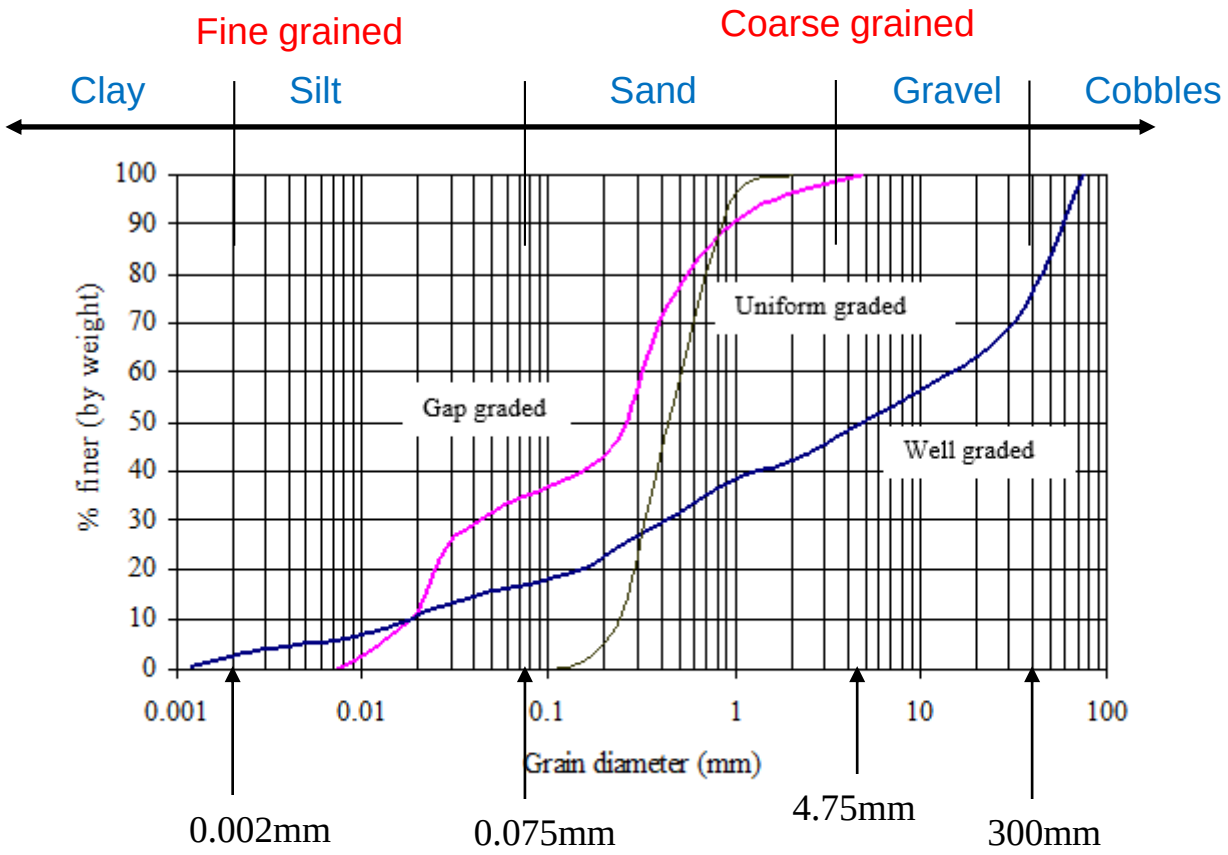
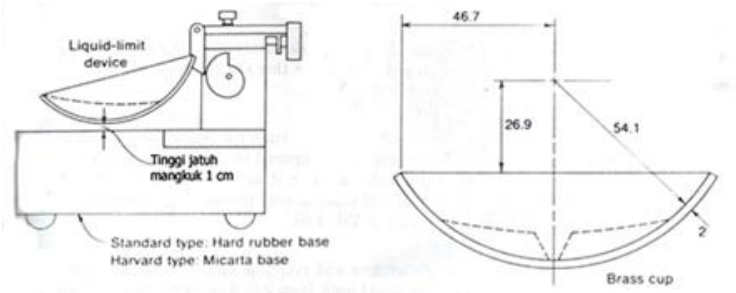


Figure 1.1 Typical grain size distribution

Atterberg Limits

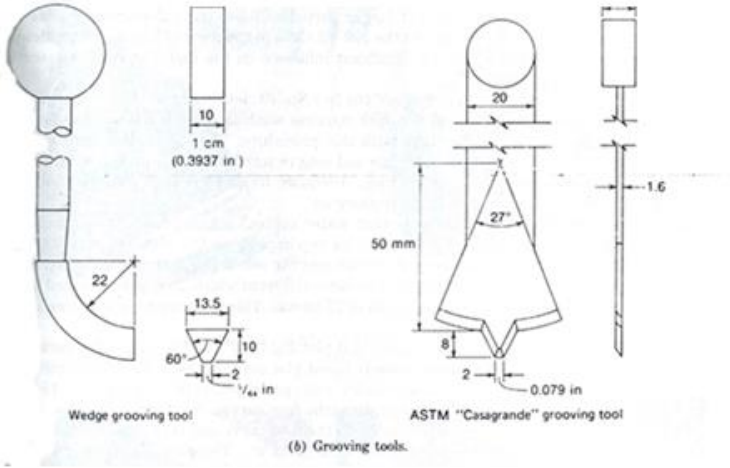
Penentuan batas cair

Gambar peralatan batas cair



Mesin batas cair dan detail mangkuk casagrande

Peralatan untuk Penentuan Batas Plastis



Tabel Klasifikasi Tanah Sistem USCS (ASTM)

Divisi Utama			Simbol kelompok	Nama Jenis tanah	Kriteria klasifikasi	
TANAH BERBUTIR KASAR Lebih dari setengah meterialnya lebih kasar dari saringan no. 200	KERIKIL Lebih dari setengah fraksi kasarnya lebih kasar dari saringan no. 4	Kerikil bersih (hanya kerikil)	GW	Kerikil bergradasi baik dan campuran kerikil pasir, sedikit atau sam sekali tidak mengandung butiran halus	$Cu = D_{60}/D_{10}$ Lebih besar dari 4 $CC = (D_{30})^2/D_{10} \times D_{60}$ Antara 1 dan 3	
			GP	Kerikil bergradasi buruk dan campuran kerikil pasir, sedikit atau sama sekali tidak mengandung butiran halus	Tidak memenuhi kriteria untuk GW	
		Kerikil dengan bahan halus	GM	Kerikil berlanau, campuran kerikil-pasir-lanau	Batas-batas Atterberg di bawah garis A atau PI<4	Batas-batas Aterberg yang digambar dalam daerah yang diarsir merupakan klasisifkasi batas yang membutuhkan simbol ganda
			GC	Kerikil berlempung, campuran kerikil-pasir-lanau	Batas-batas Attergerg di atas garis A dengan PI>7	
	PASIR Lebih dari setengah fraksi kasarnya lebih kasar dari saringan no. 4	Pasir bersih (hanya kerikil)	SW	Pasir bergradasi-baik, pasir berkerikil, sedikit atau sama sekali tidak mengandung butiran halus	$Cu = D_{60}/D10$ Lebih besar dari 6 $CC = (D_{30})^2/D_{10} \times D_{60}$ Antara 1 dan 3	
			SP	Pasir bergradasi-buruk, pasir berkerikil, sedikit atau sama sekali tidak mengandung butiran halus	Tidak memenuhi kriteria untuk SW	
		Kerikil dengan bahan halus	SM	Pasir berlanau, campuran pasir-Lanau	Batas-batas Atterberg di bawah garis A atau PI<4	Batas-batas Aterberg yang digambar dalam daerah yang diarsir merupakan klasisifkasi batas yang membutuhkan simbol ganda
			SC	Pasir berlempung, campuran pasir-Lempung	Batas-batas Attergerg di atas garis A dengan PI>7	
TANAH BERBUTIR HALUS Lebih dari setengah meterialnya lebih halus dari saringan no. 200	LANAU DAN LEMPUNG	Batas cair kurang dari 50	ML	Lanau anorganik, pasir halus sekali, serbuk batuan, pasir halus berlanau atau berlempung	Penentuan persentase pasir dan kerikil dari kurva analisis butiran	
			CL	Lempung anorganik dengan plastisitas rendah sampai dengan sedang lempung berkerikil, lempung berpasir, lempung berlanau, lempung "kurus" (lean clays)		
			OL	Lanau-organik dan lempung berlanau organik dengan plastisitas rendah		
		Batas cair lebih dari 50	MH	Lanau anorganik atau pasir halus diatomae, atau lanau diatomae, lanau yang elastis		
			CH	Lempung anorganik dengan plastisitas yang tinggi, lempung "gemuk" (fat clays)		
			OH	Lempung organik dengan plastisitas sedang sampai dengan tinggi		
Tanah-tanah dengan kandungan organik sangat tinggi			PT	Peat (gambut), muck dan tanah-tanah lain dengan kandungan organik tinggi		

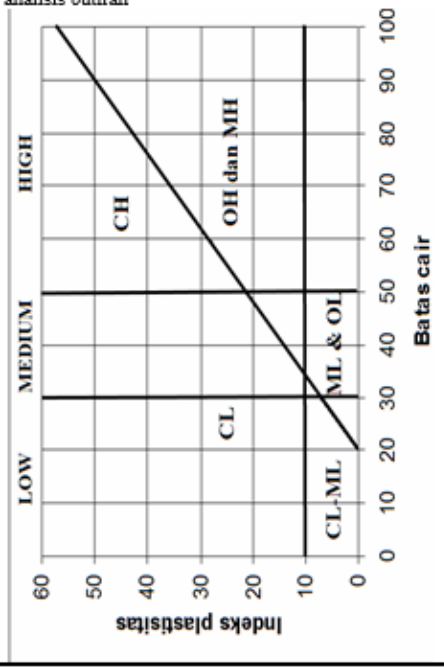


Table 1.6 AASHTO Classification System (AASHTO M-145)

General Classification	Granular Material (35 % or less passing 0.075 mm (sieve no 200)							Fine grained soils (> 35% passing 0.075 min (No. 200)			
Group classification	A-1		A-3	A-2				A4	A-5	A-6	A-7
	A-l-a	A-l-b		A-24	A-2-5	A-2-6	A-2-7				A-7-5 A-7-6
Sieve analysis (% passing)											
No.10	50 max										
No.40	30 max	50 max	51 max								
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 No. 40											
Liquid limit				40 max	41 min	40 max	41 min	40 max	41 min	40 max	41 min
Plasticity index	6 max		NP	10 max	10 max	11 min	11 min	10 max	10max	11 min	11 min
Usual types of significant constituent materials	Stone fragments, gravel and sands		Fine sands	Silty or clayey gravel and sand				Silty soils		Clayey soils	
General rating as subgrade	Excellent to good					Fair to poor					

Notes : Plasticity index for subgroup A-7-5<*LL*-30

Plasticity index for subgroup A - 7 - 6 > *LL* - 30