REVIEW OF SOIL MECHANICS

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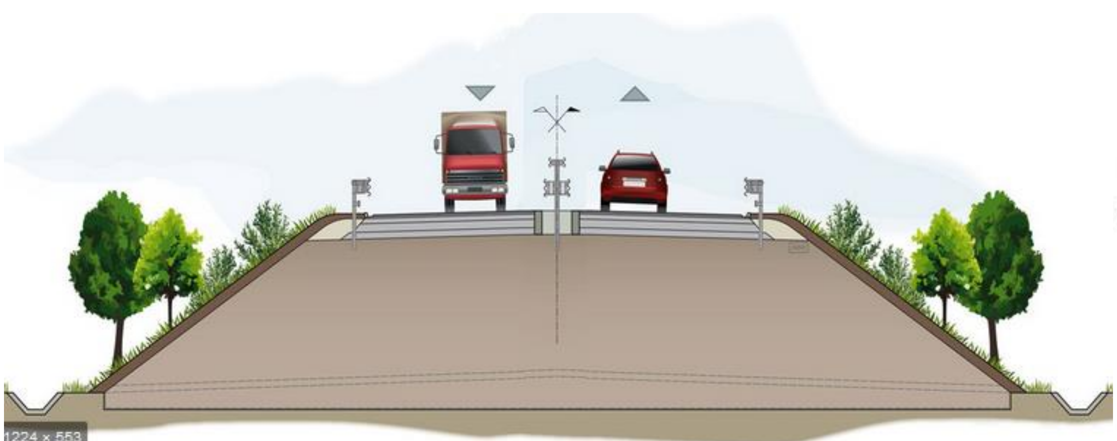
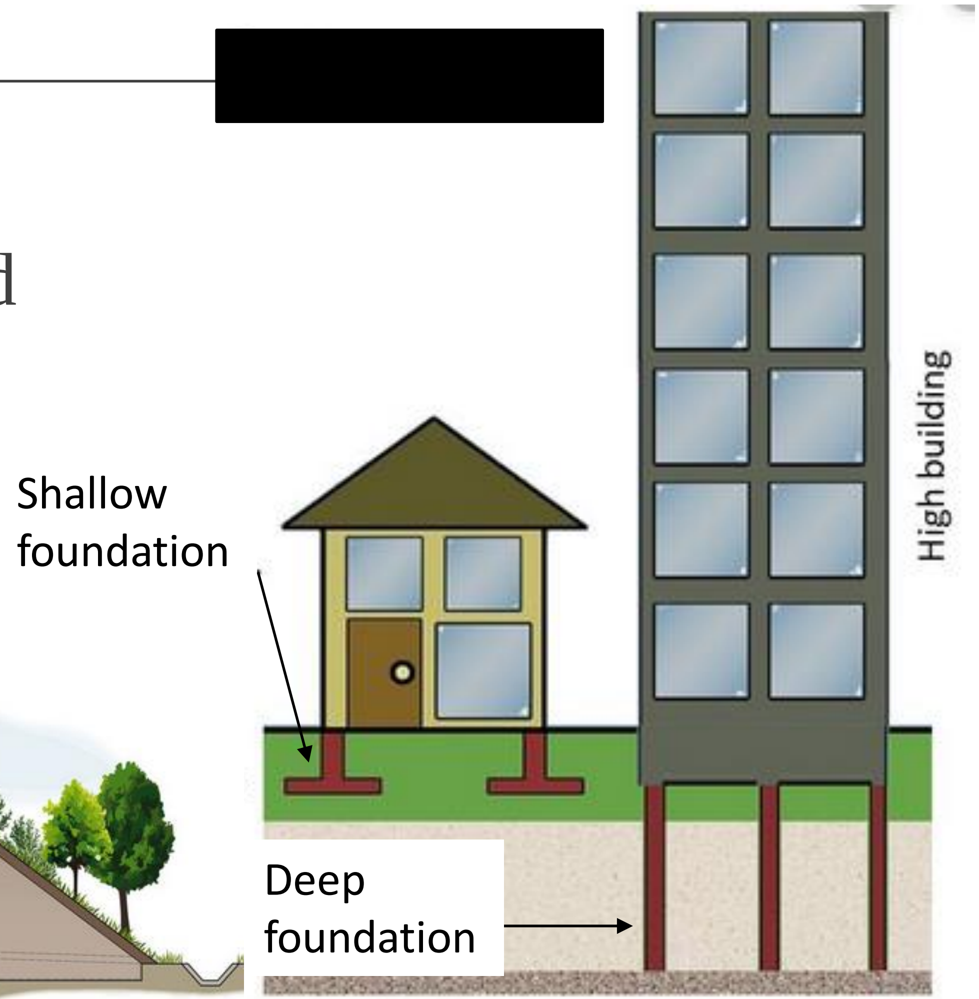
In civil engineering practice (on broad sense), soil is known as:

[redacted]

- Foundations to support structures and embankments





In civil engineering practice (on broad sense), soil is known as ____________________

Construction Material for:

- Dam
- Soil Reclamation
- Highway construction
- Slope and Excavation
- Underground
- Earth Retaining Structures

Soil as Foundation:

In the design of any foundation, the focus was

1. to prevent the settlements large enough to damage the structures or impair its functions.

2. The allowable settlement depends on the size, type and use of structure, type of foundation and source of the settlement and the location of the structure.

3. In most cases, the critical settlement is not the total settlement but rather the differential settlement.

Soil as Construction Material:

Soil could be used as construction material for road embankment, dam and even building.

The properties of soil as construction material could be designed (or modified) based on the requirements

The focus was to obtain a stable construction on top of foundation

Preview of Soil Behavior

- Soil behavior is governed by its parent materials and the process of soil formation. Thus the first topic in Soil Mechanics is The origin of soil
- Soil is a unique material because it is particulate and it is multiphase. Thus, the second topic in soil mechanics is Phase Relationship (Hubungan Fasa)
- The process of soil formation results in wide range of particle sizes. Thus soil classified is based on particle sized and consistency. The third topic in soil mechanics is Soil Classification.
- Soil response to load is affected by the presence of water, thus the fourth topic is Seepage or Flow of water in soil.
- Shear stress can only be resisted by soil particles, thus the concept of effective stress is very important in soil mechanics
- Other applicable topics in Soil Mechanics are Lateral earth pressure, shear strength, and Compressibility (these are not included in this matriculation)

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.

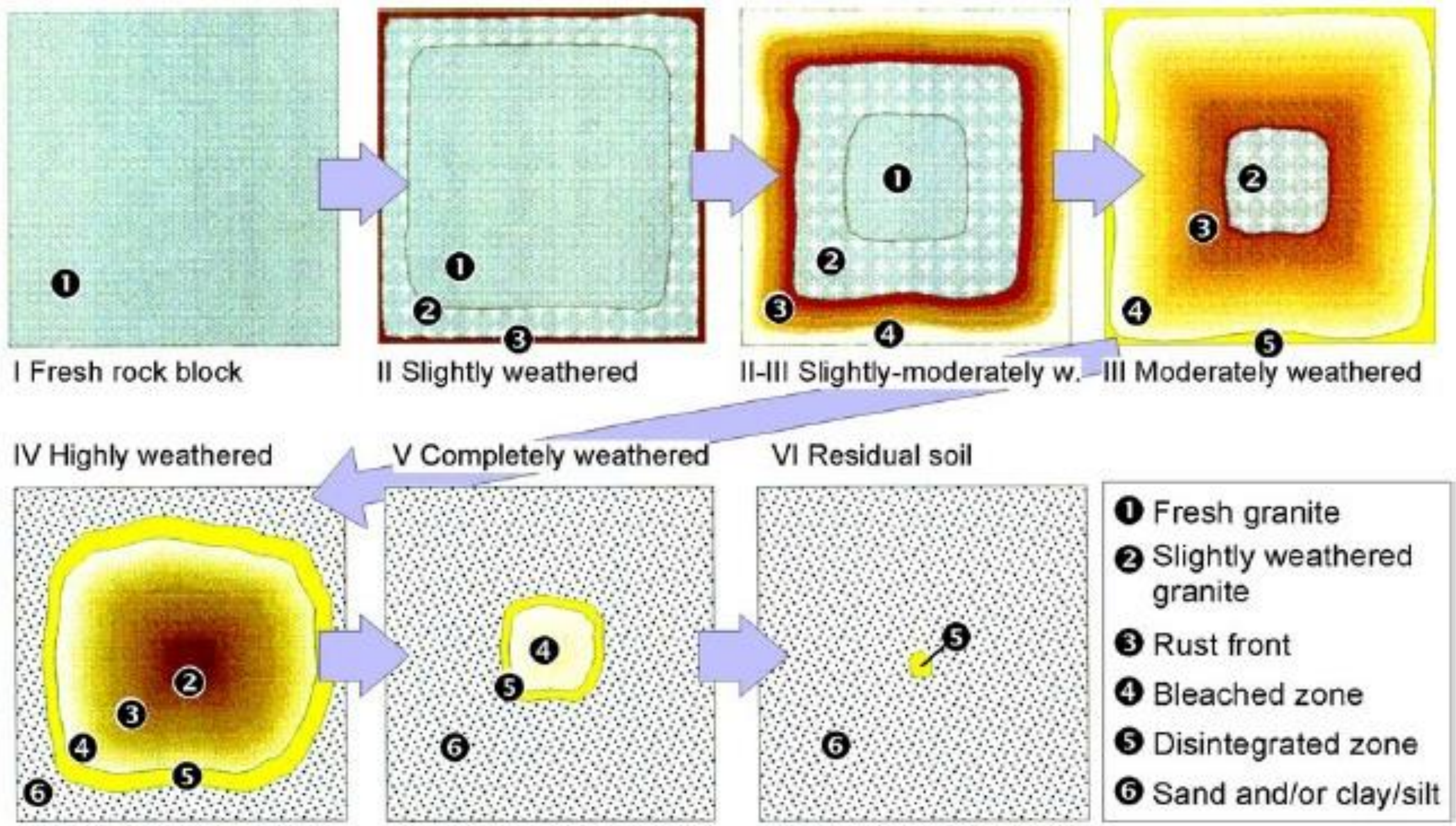
Types of Soils

Residual Soils: Rock that was weathered in place, thus retain its characteristics (Mechanical weathering; chemical weathering)

Transported Soils: Rock that was weathered and transported through different media (water, ice, wind)

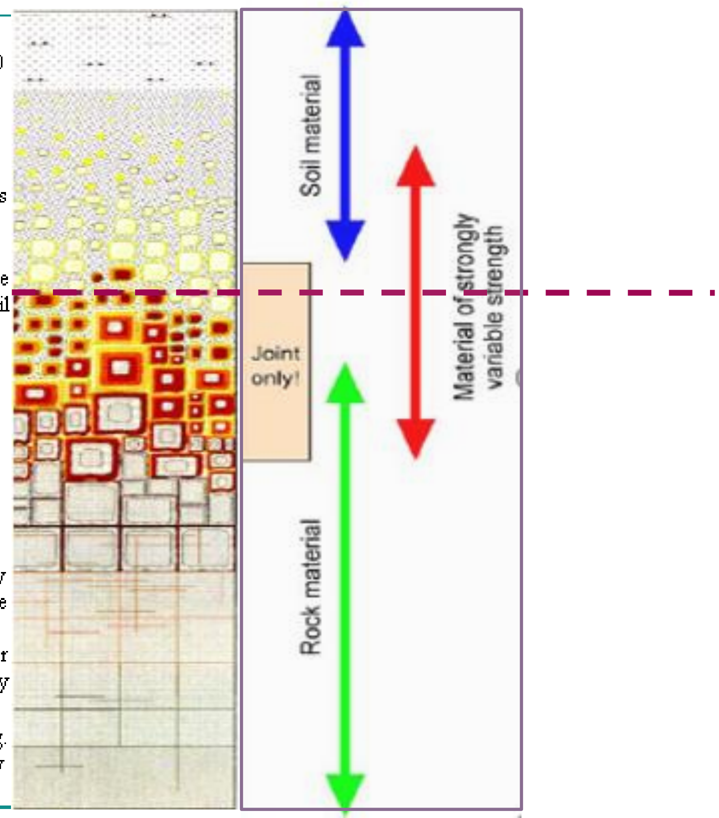
RESIDUAL SOILS

Process of Rock Weathering



Weathering Classification

Weathering classification		Description
Term	Zone	
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

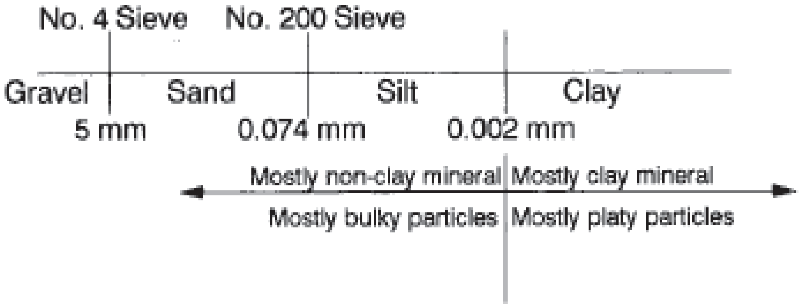


Figure 3.1 Particle size ranges in soils.

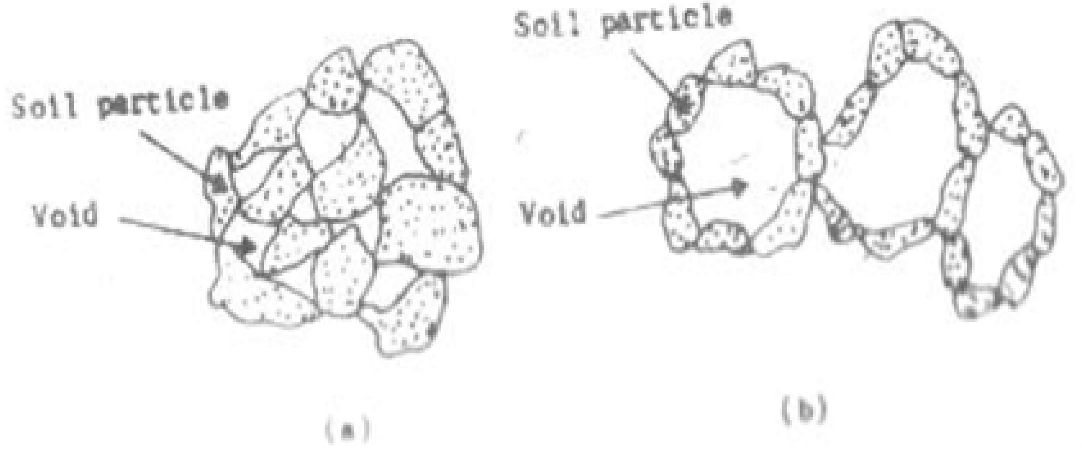
REVIEW: SOIL CLASSIFICATION:
BS, ASTM, AASHTO etc.
(including lab tests for soil classification purposes).

Cohesionless soil:

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

(a) single grained;

(b) honeycombed



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

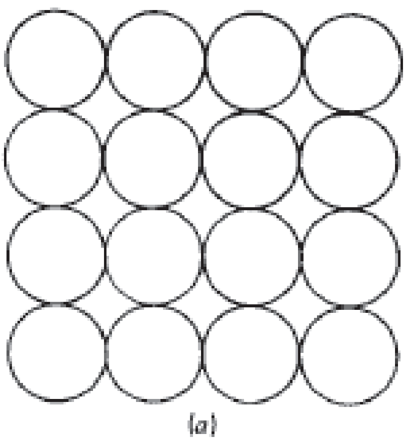
Cohesionless soil:

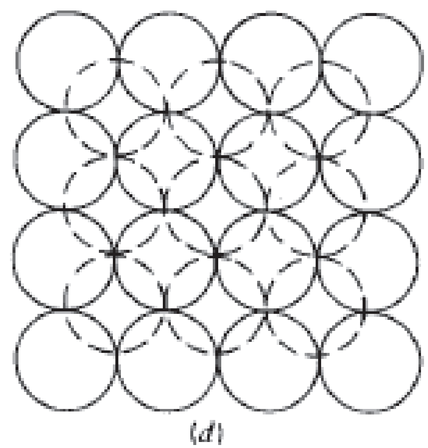
The density of packing depends on the size, shape and distribution of particles and their relative positions.

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)

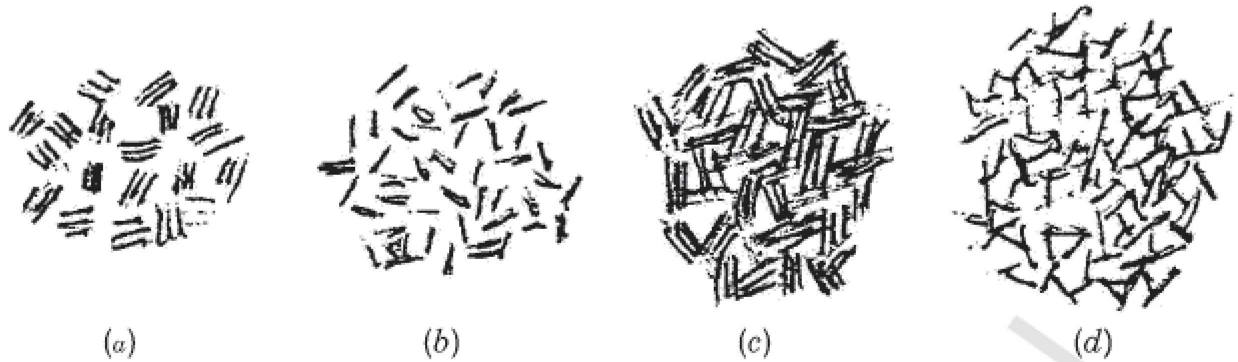


Exhibit 5.1 Soil fabrics.

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

Clay Mineral

1. Clay minerals are complex aluminum silicates composed of: silica tetrahedrons and alumina octahedrons. Combining the silicon-oxygen tetrahedron yields silica. Combining the aluminum oxygen tetrahedrons yields gibbsite Combining magnesium-oxygen tetrahedron gives brucite Combination of these units forms clay particles.
2. There are three groups of clay mineral i.e. Kaolinite (Not expansive); Mica: e.g. *llites* and *vermiculites* (somewahat expansive) and Smectite, e.g: *montmorillonites* (highly expansive).

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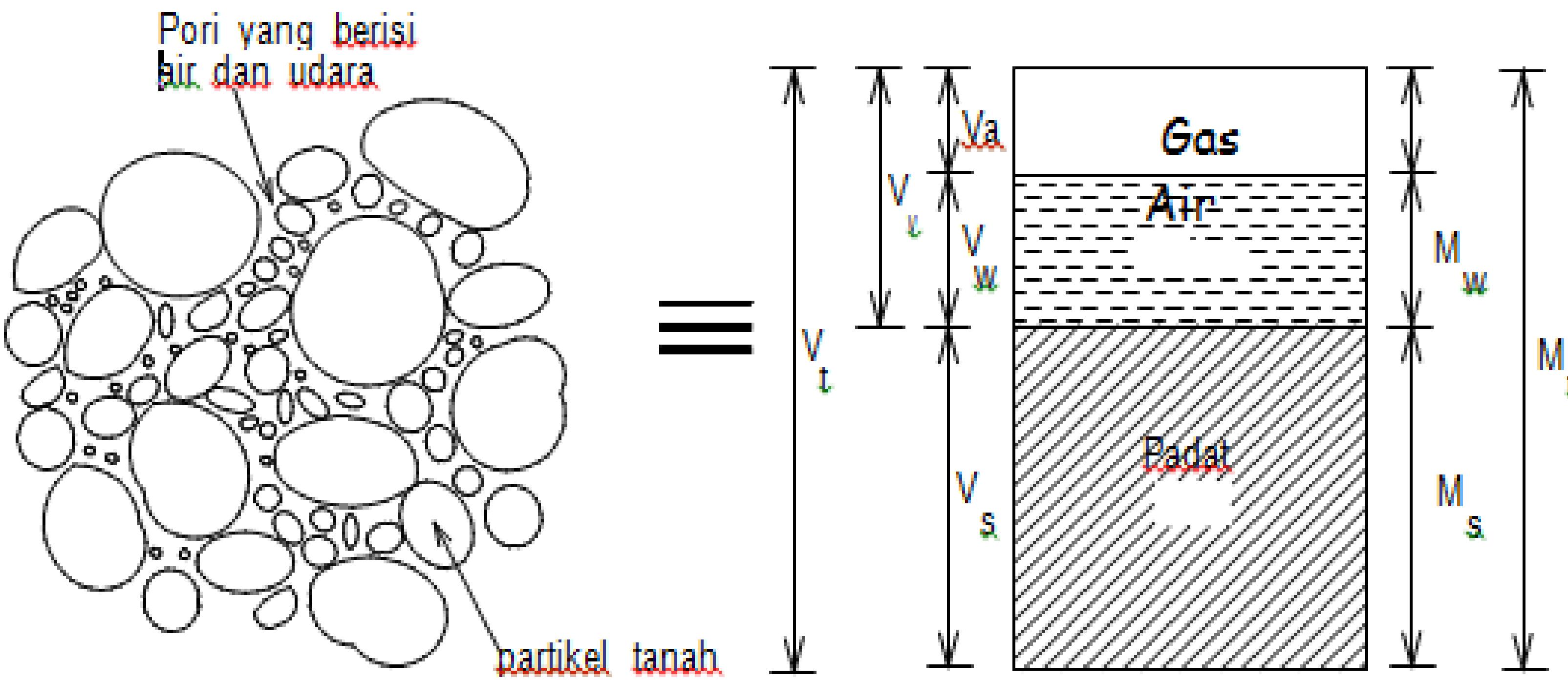
Hubungan Fasa



(a) Tanah

(b) Diagram Fasa

Tanah terdiri dari 3 fasa yaitu: padat, cair dan gas

Diagram Fasa

Notasi

M = massa atau berat

V = volume

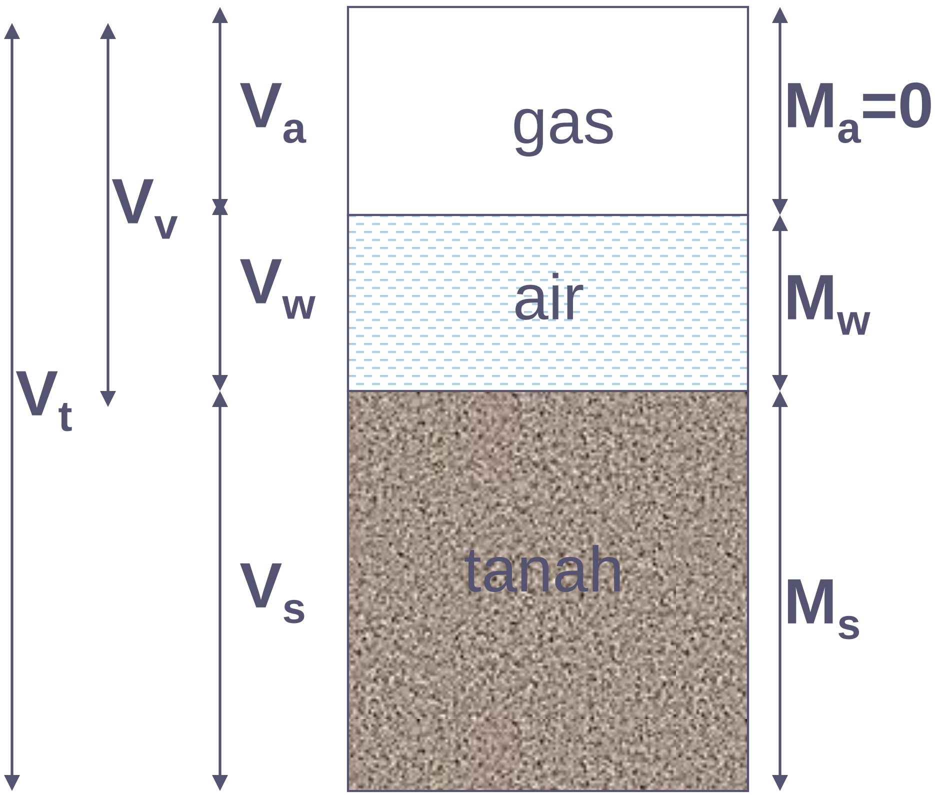
s = partikel tanah

w = air

a = gas

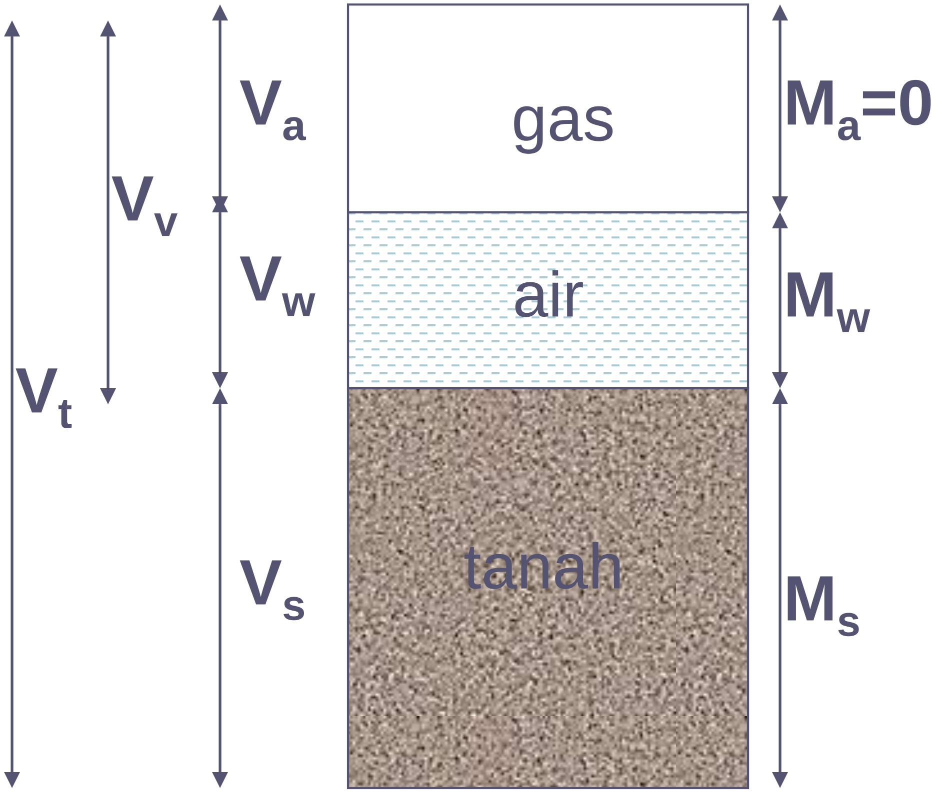
v = pori

t = total



Definisi

Kadar air (ω) adalah ukuran banyaknya air dalam tanah dinyatakan dalam persen



$$\omega = \frac{M_W}{M_S} \text{x}100\%$$

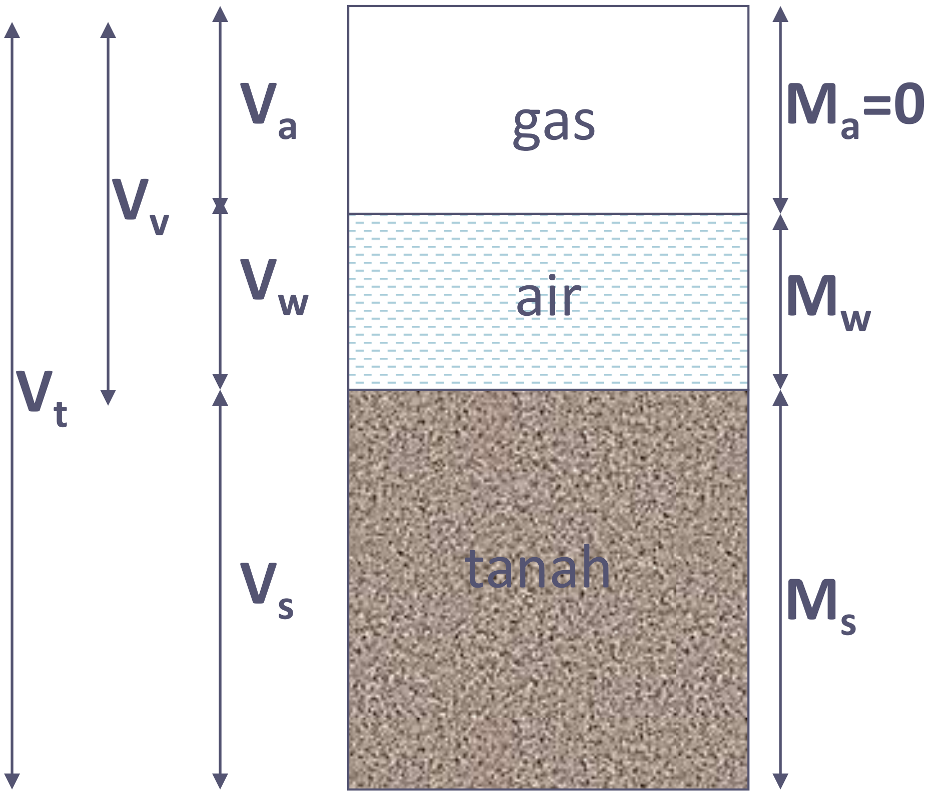
Diagram Fasa

Definisi

Angka pori (e) adalah ukuran pori dalam tanah. Pori ini berisi air dan udara

$$e = \frac{V_V}{V_S}$$

Diagram Fasa

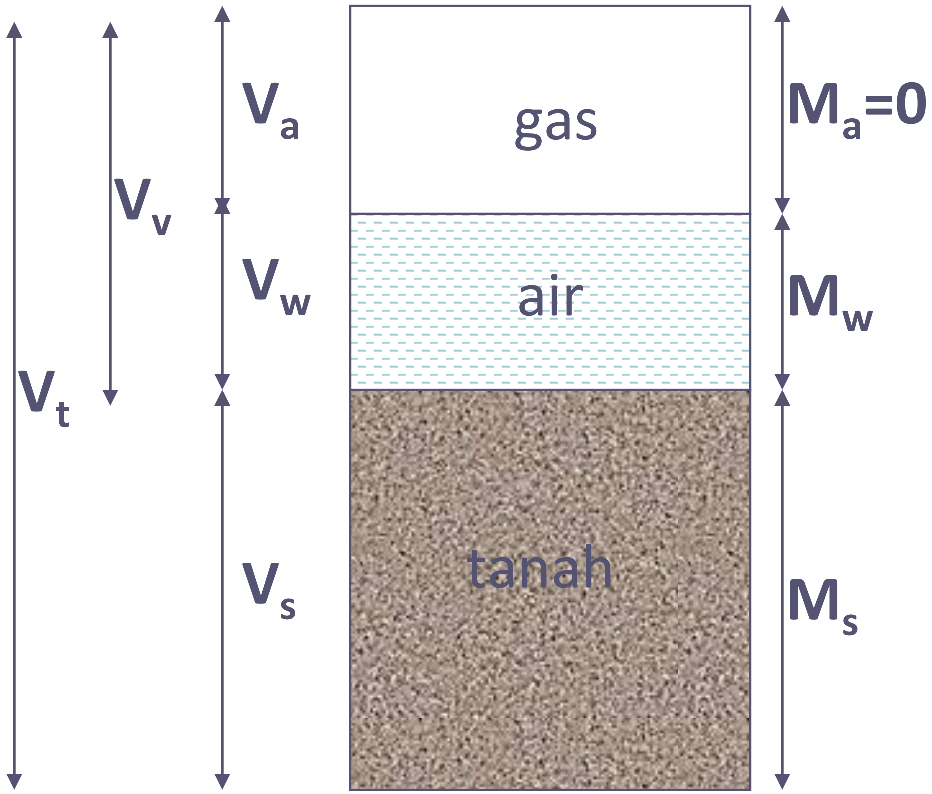


Definisi

Porositas (n) adalah ukuran volume pori, dinytakan dalam persen.

$$n = \frac{V_V}{V_T} \text{x} 100\%$$

Diagram Fasa

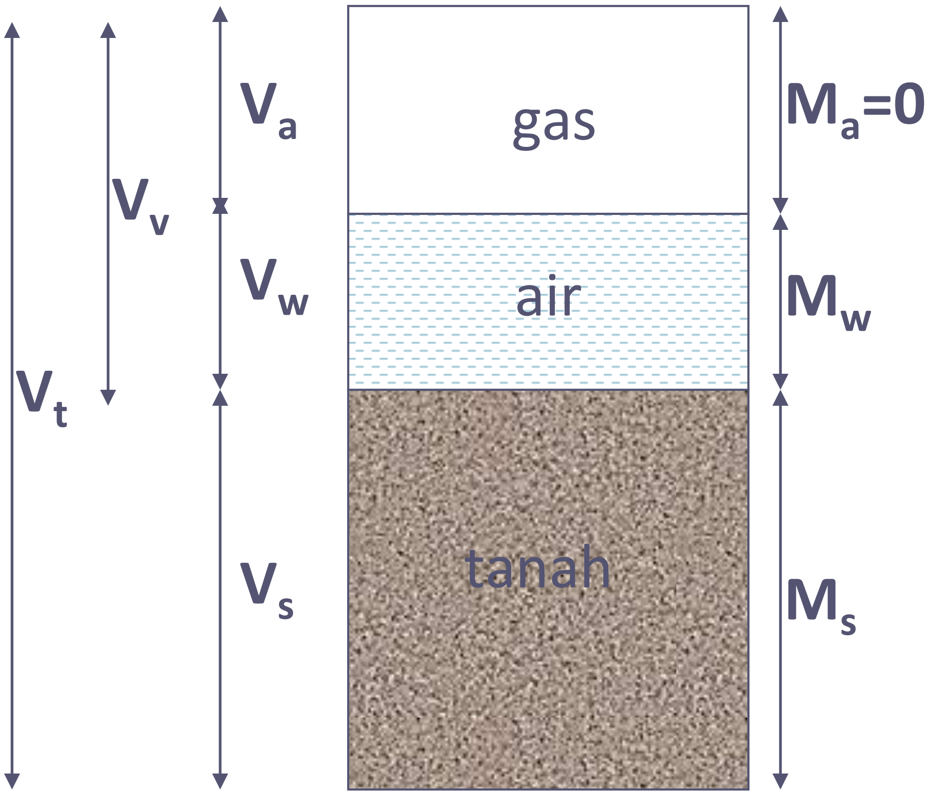


Definisi

Derajat kejenuhan (S) banyaknya air dalam pori, dinyatakan dalam persen.

$$S = \frac{V_W}{V_V} \times 100\%$$

Diagram Fasa

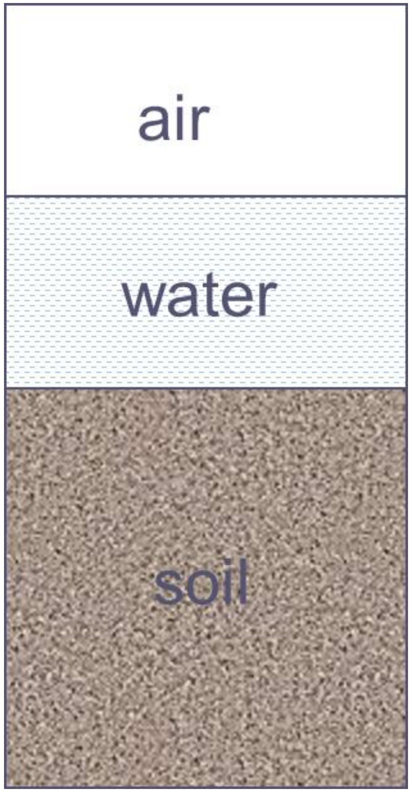


Untuk gambar ini,

$e = 1$

$n = 50\%$

$S = 50\%$

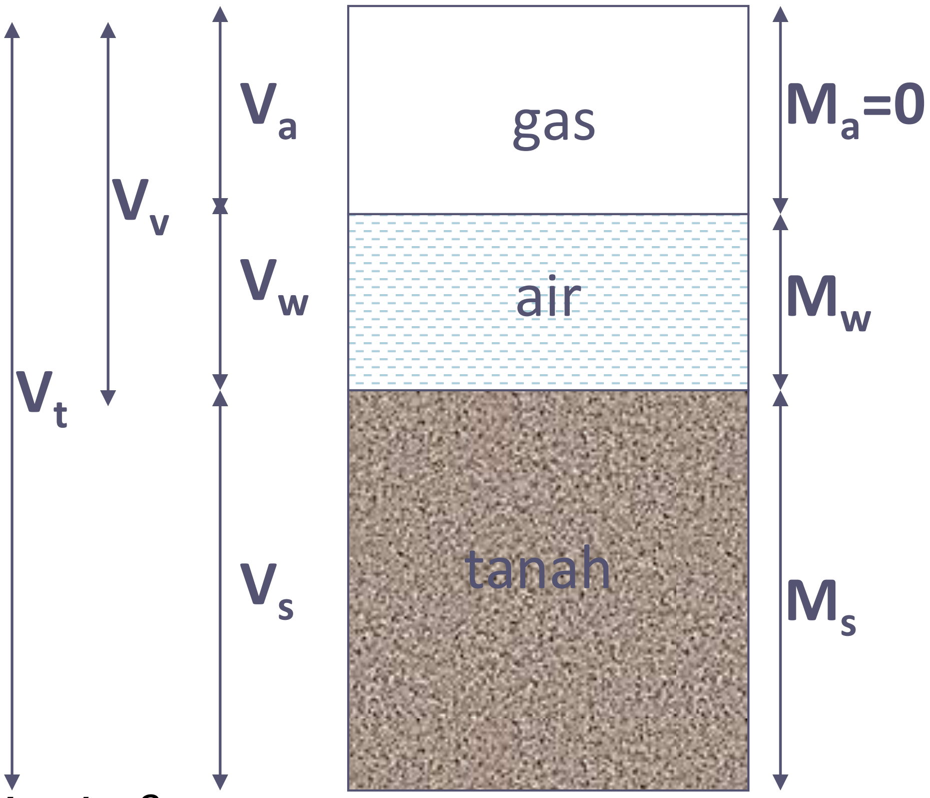


Definisi

Diagram Fasa

Bulk density (ρ_m) adalah kerapatan tanah pada kondisi yang ada.

$$\rho_m = \frac{M_T}{V_T}$$



Satuan: *kN/m³, t/m³, g/ml, kg/m³*

Definisi

Saturated density (ρ_{sat}) (kerapatan tanah jenuh) adalah kerapatan tanah apabila semua pori berisi air

Submerged density (ρ') adalah kerapatan tanah jenuh yang berada di bawah permukaan air.

$$\rho' = \rho_{sat} - \rho_w$$

Definisi

Kerapatan kering (ρ_d) adalah kerapatan tanah pada kondisi kering.

$$\rho_d = \frac{M_S}{V_T}$$

Unit: kN/m^3; t/m^3, g/ml, kg/m^3

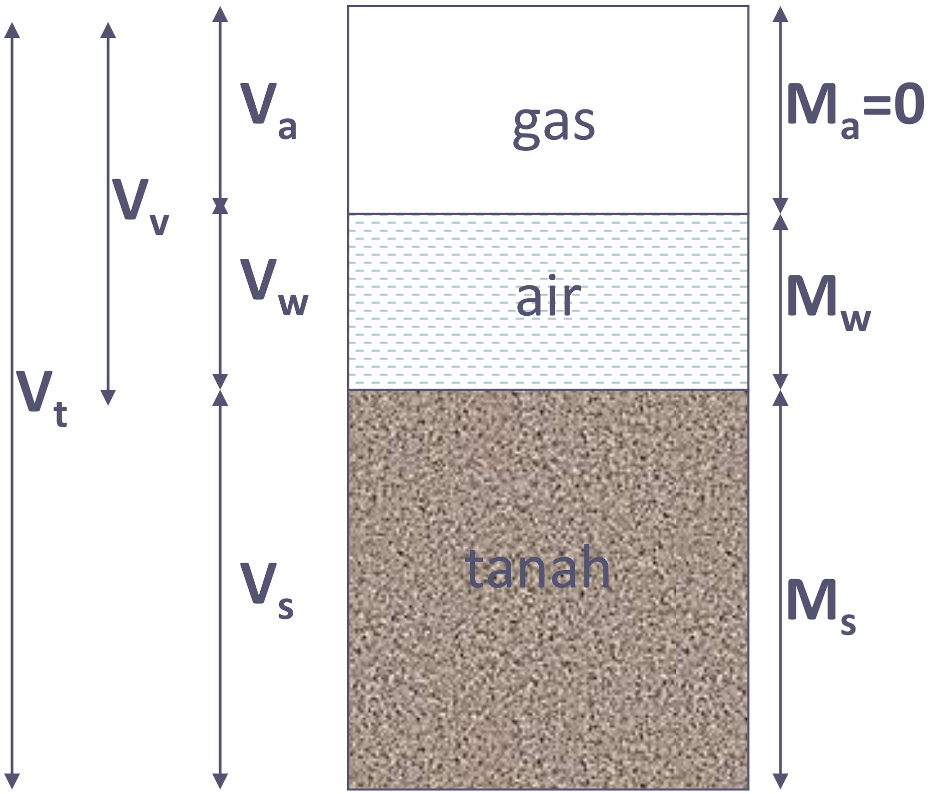


Diagram Fasa

Definisi

Berat jenis (γ) di definisikan dengan cara yang sama dnegan berat isi. Dalam hal ini digunakan satuan berat (kN) dan bukannya massa (kg).

$$\gamma = \rho g$$

N/m^3 kg/m^3 m/s^2

Specific gravity (G_s) butiran tanah berkisar antara 2.6 and 2.8.

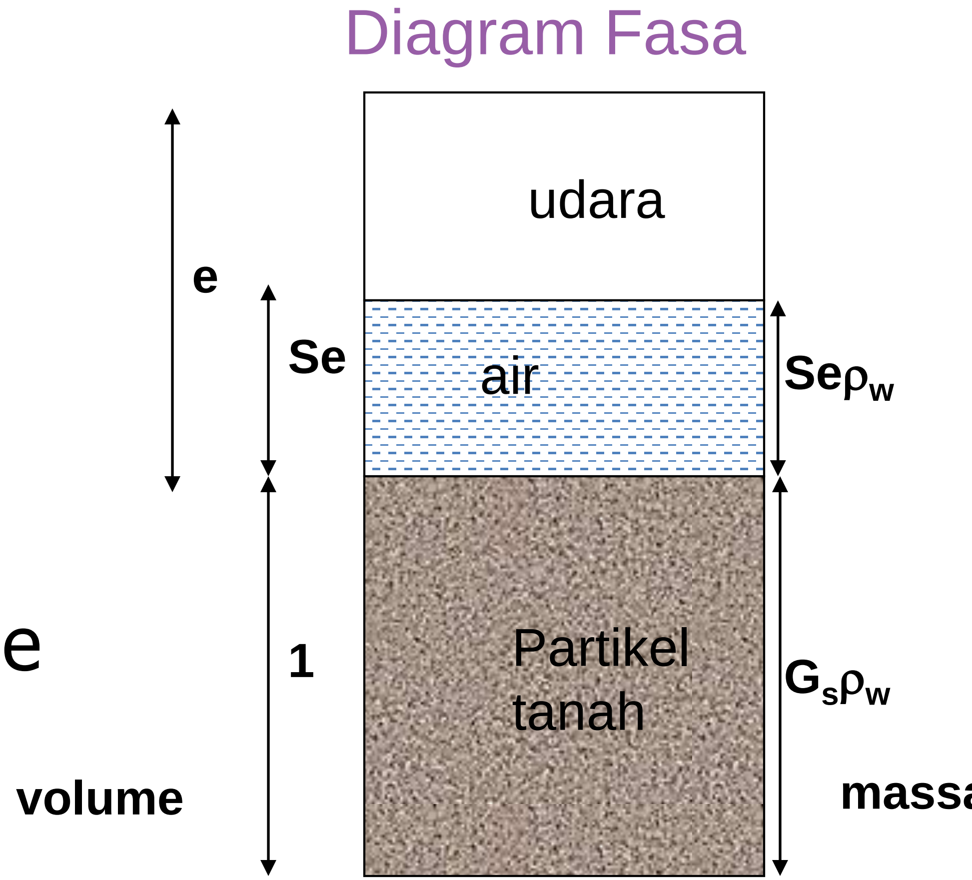
Rumus rumus Hubungan Fasa

Gunakan fraksi tanah dimana volume solid V_s **= 1.**

Volume volume lainnya dapat dijabarkan dari V_s

Kemudian massa didapat dari hubungan berikut

Mass = Density x Volume

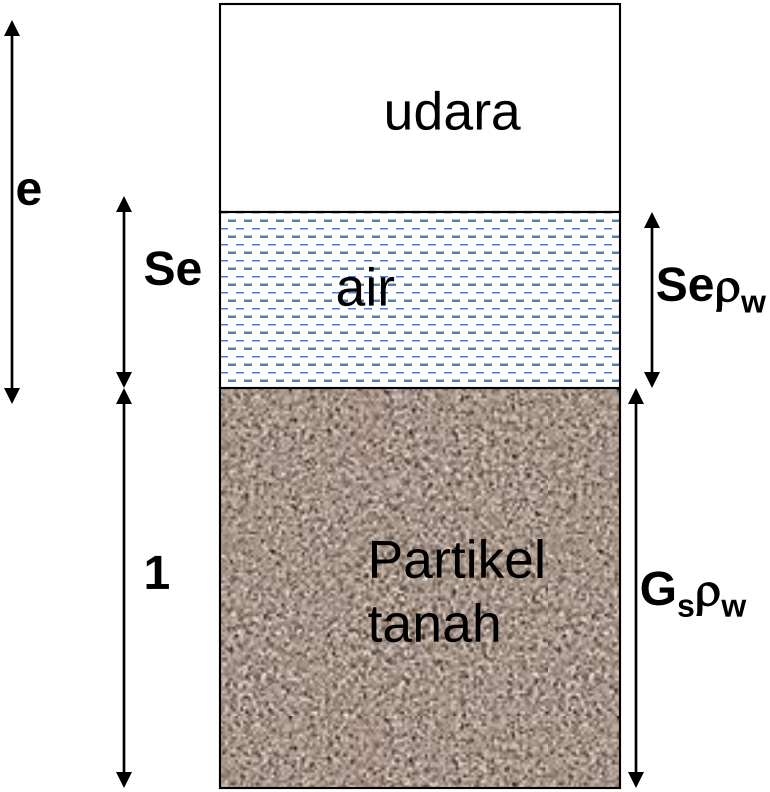


Rumus rumus Hubungan Fasa

Dari definisi sebelumnya,

$$\omega = \frac{M_W}{M_S} = \frac{Se}{G_S}$$

$$\eta = \frac{V_V}{V_T} = \frac{e}{1+e}$$

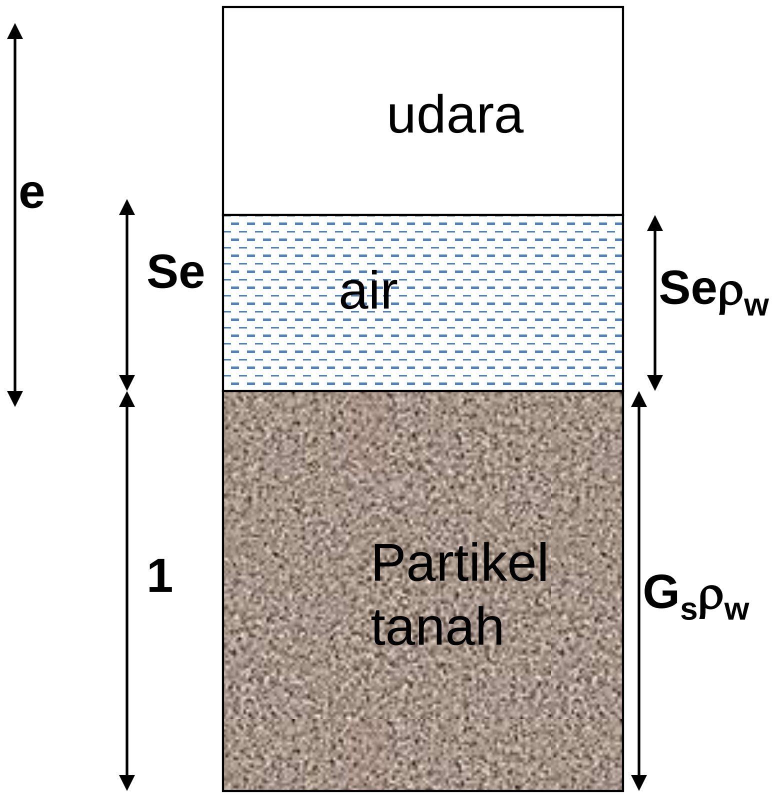


Rumus rumus Hubungan Fasa

$$\rho_m = \frac{M_T}{V_T} = \frac{G_S + Se}{1+e}\rho_W$$

$$\rho_{sat} = \frac{M_T}{V_T} = \frac{G_S + e}{1+e}\rho_W$$

$$\rho_d = \frac{M_S}{V_T} = \frac{G_S}{1+e}\rho_W$$

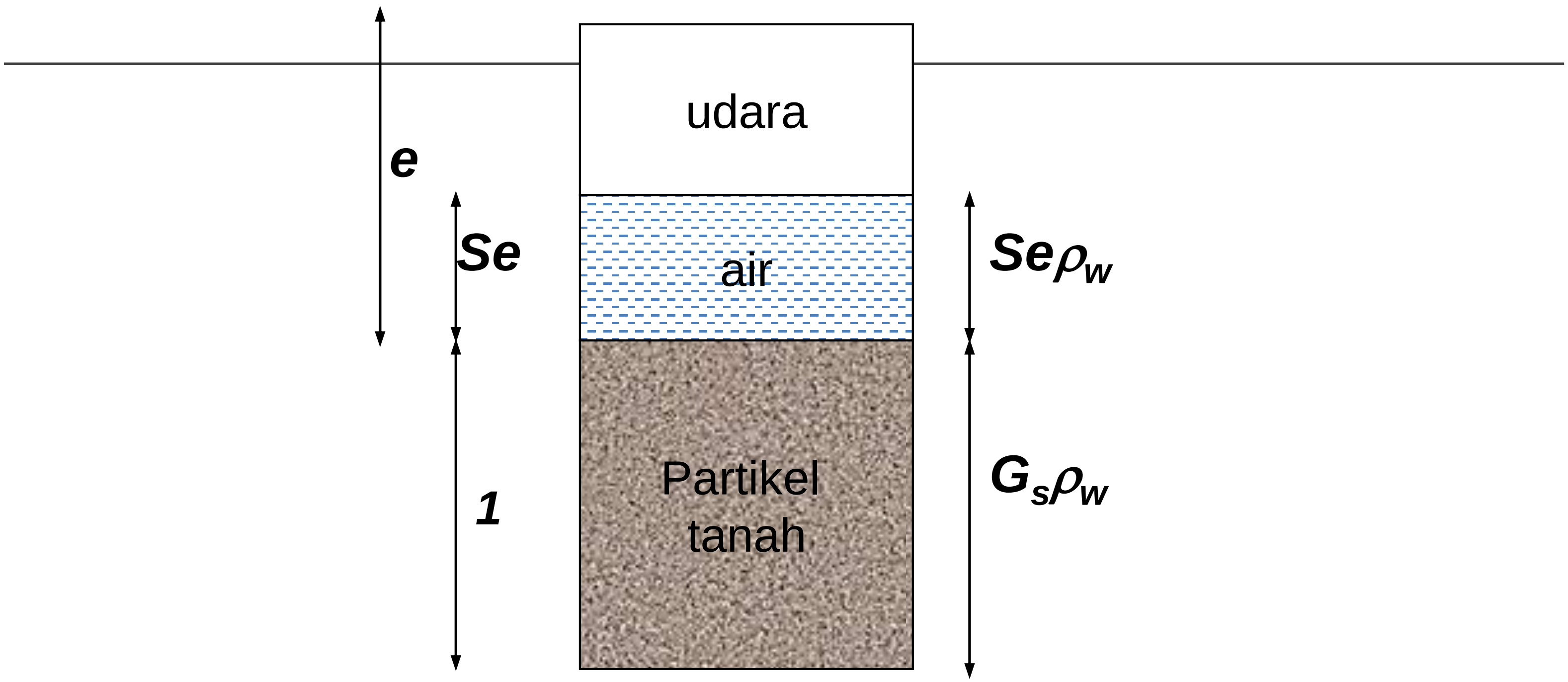


Jangan coba untuk menghafal rumus. ***Fahami*** definisi dan kembangkan hubungan dengan menggambar diagram fasa dengan $V_S = 1$;

Gunakan G_S (2.6-2.8) kalau tidak diketahui dalam soal;

Kerapatan (density) tidak sama dengan berat jenis (unit weights);

Volume partikel tanah tidak berubah. Massa dan volume partikel tanah adalah tetap untuk semua keadaan.


udara
e
Se
air
Seρw
Partikel tanah
1
Gsρw

[redacted]

KLASIFIKASI TANAH

Soil is classified based on particle size. Based on particle size, soil can be grouped into coarse grained soil such as sand and gravel; and fine grained soil such as silts and clays. The grain size distribution (GSD) of soil is determined by means of sieve analysis. The standard procedure to determine GSD is given in BS 1377 Part 2 and ASTM D 422-635.

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

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)

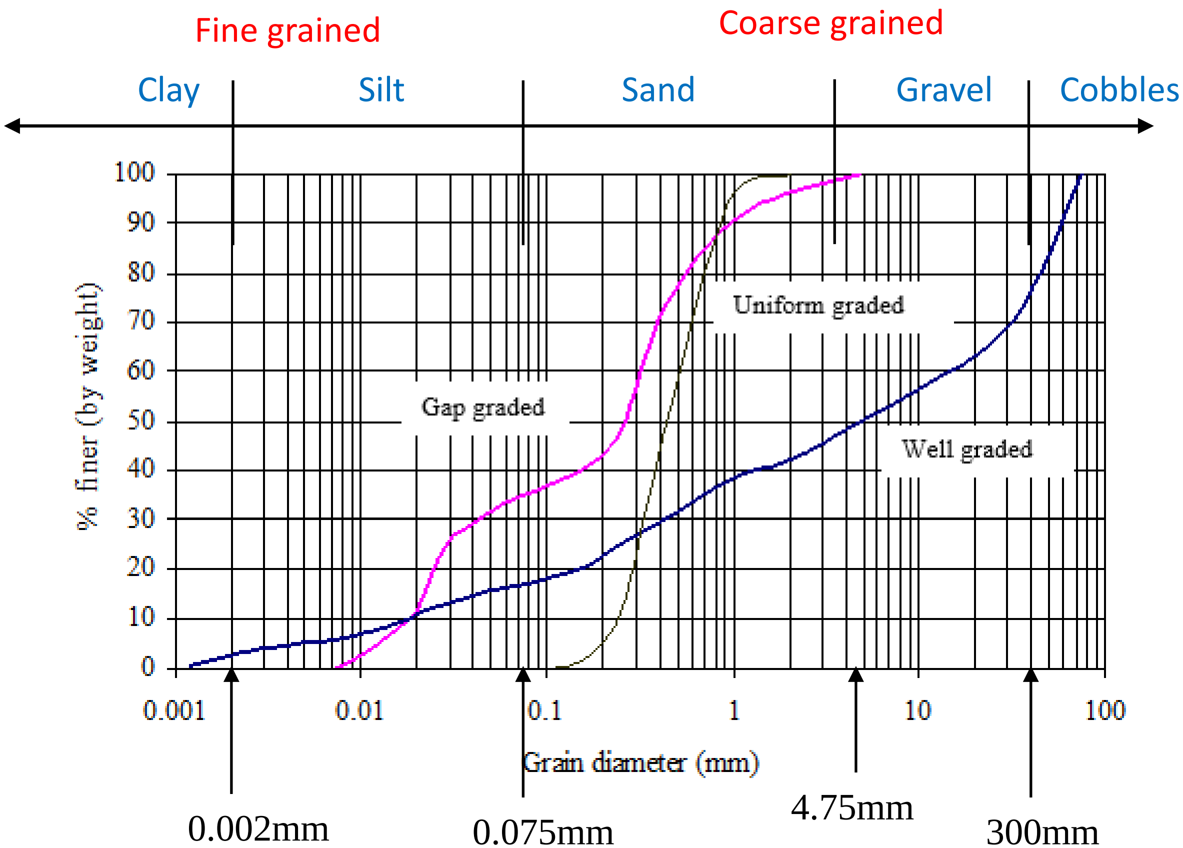
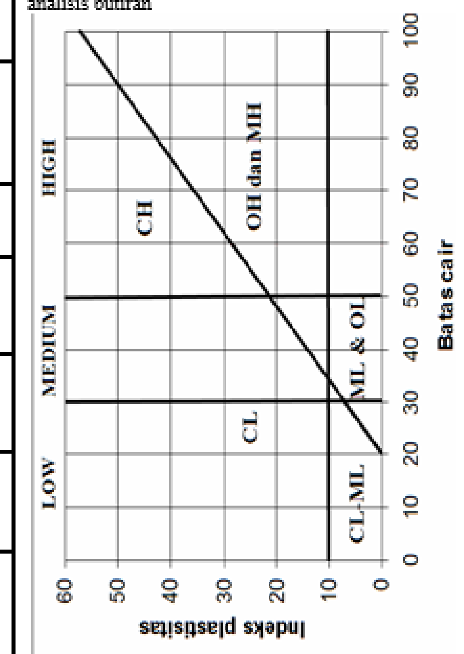


Figure 1.1 Typical grain size distribution

USCS Classification System (ASTM

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		

British Classification System

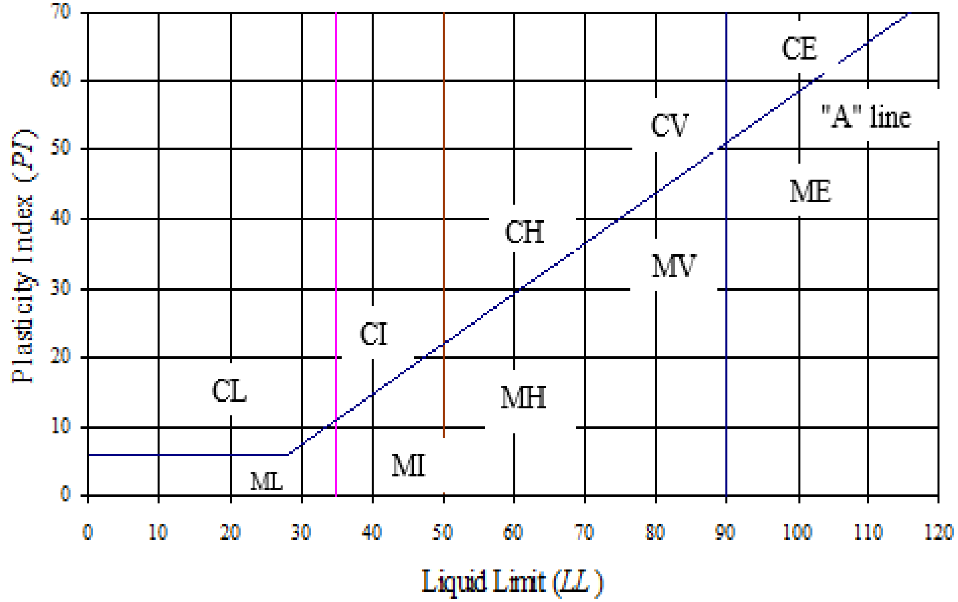


Figure 1.2 Plasticity chart: British system (BS 5930, 1981)

Table 1.4 Group symbols used in British soil classification system

Main terms	Symbol	Qualifying terms	Symbol
GRAVEL	G	Well graded	W
SAND	S	Uniform graded	Pu
		Gap graded	Pg
FINES SOILS, FINES	F	*LL*<35	L
SILTS	M	35 < *LL*< 50	I
CLAY	C	50 < *LL* < 70	H
		70 < *LL* < 90	V
		LL > 90	E
		IP > 35	U
		Organic	O
PEAT	Pt		

AASHTO Classification System (biasa digunakan untuk konstruksi jalan)

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

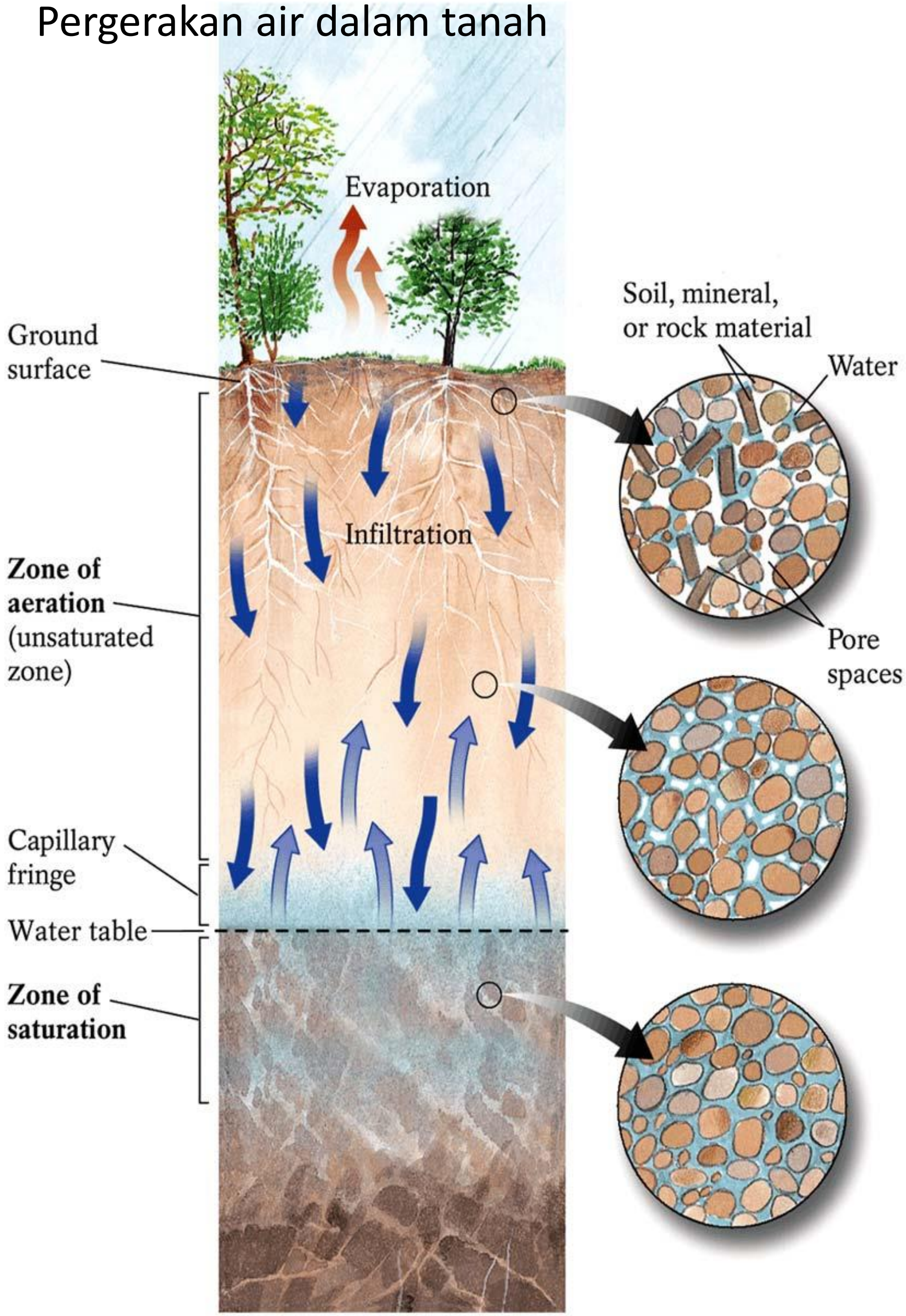
[redacted]

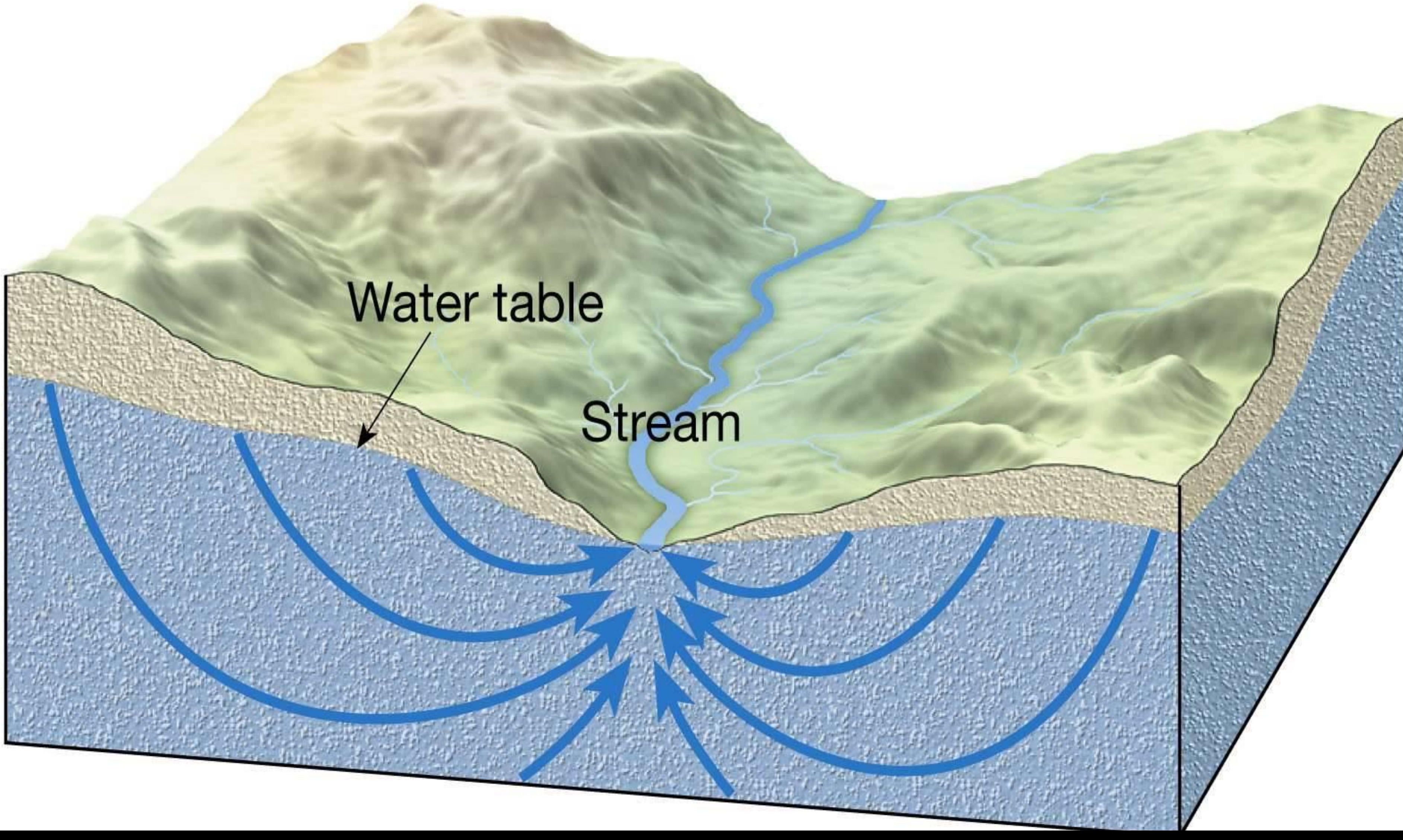
Aliran air tanah

Theori Bernaulli dapat diterapkan untuk air pori, tetapi kecepatan rembesan dalam tanah biasanya sangat kecil sehingga tekanan akibat kecepatan dapat diabaikan:

$$h = \frac{u}{\gamma_w} + z$$

Pergerakan air dalam tanah



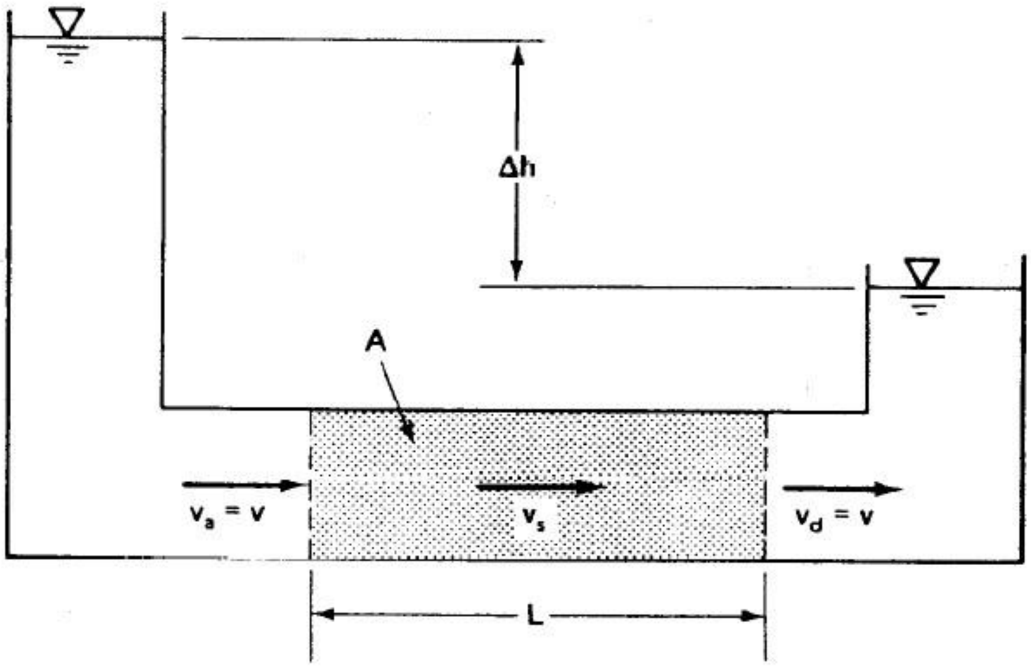

Water table
Stream

Aliran air dalam tanah

Since pores are interconnected, the water can flow through the densest of natural soil. The basic of water flow in soil is the Darcy's law

$$Q = k\,i\,A$$

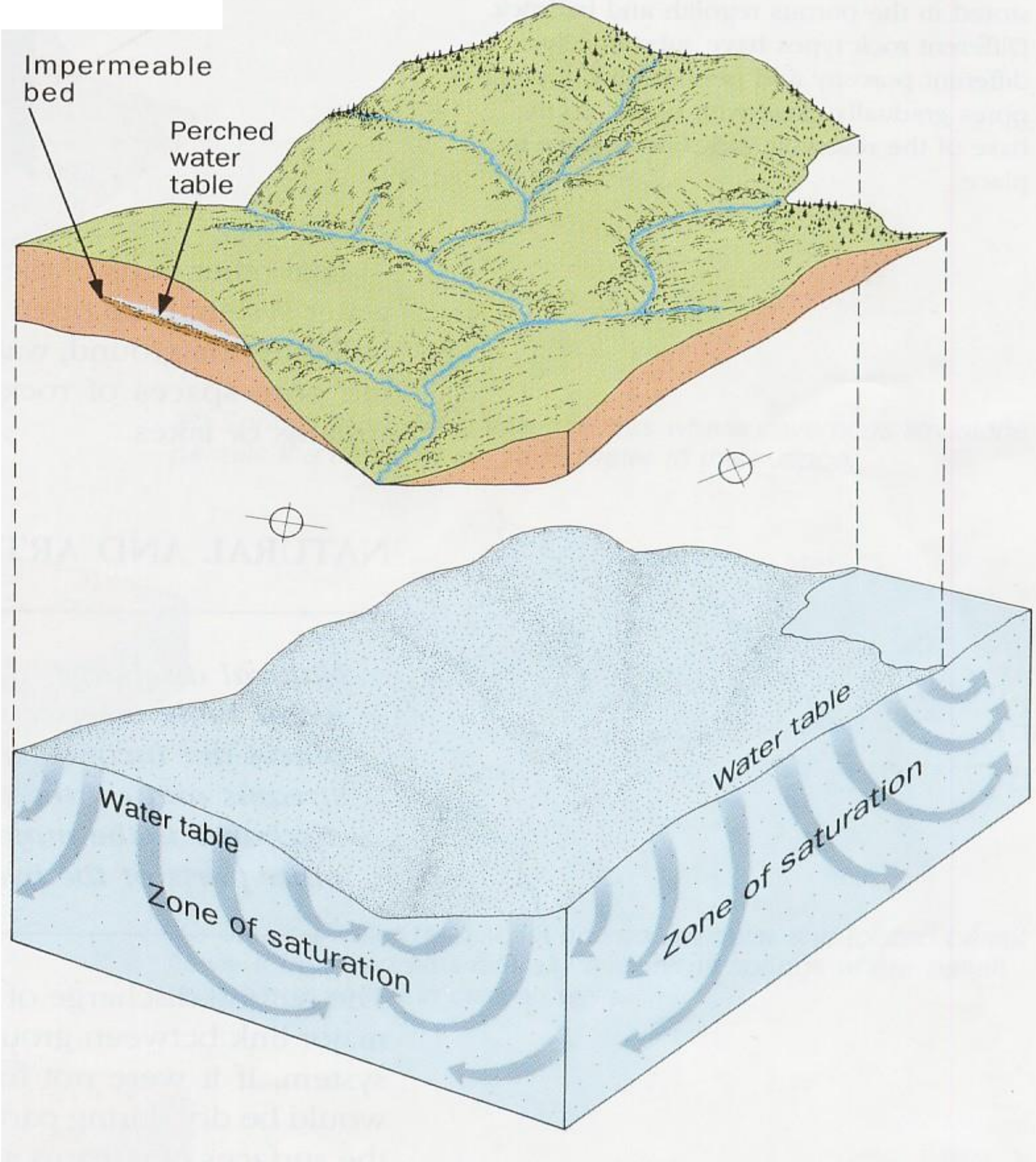
$$v = \frac{q}{A} = k.i$$



k = *koefisien pemeabilitas*

A: *luas daerah aliran*

i = *Hydraulic Head* : Formula Darcy berlaku untuk aliran laminar, kalau *i* sangat besar maka akan terjadi aliran turbulen. Untik tanah biiasanya *i* sangat rendah

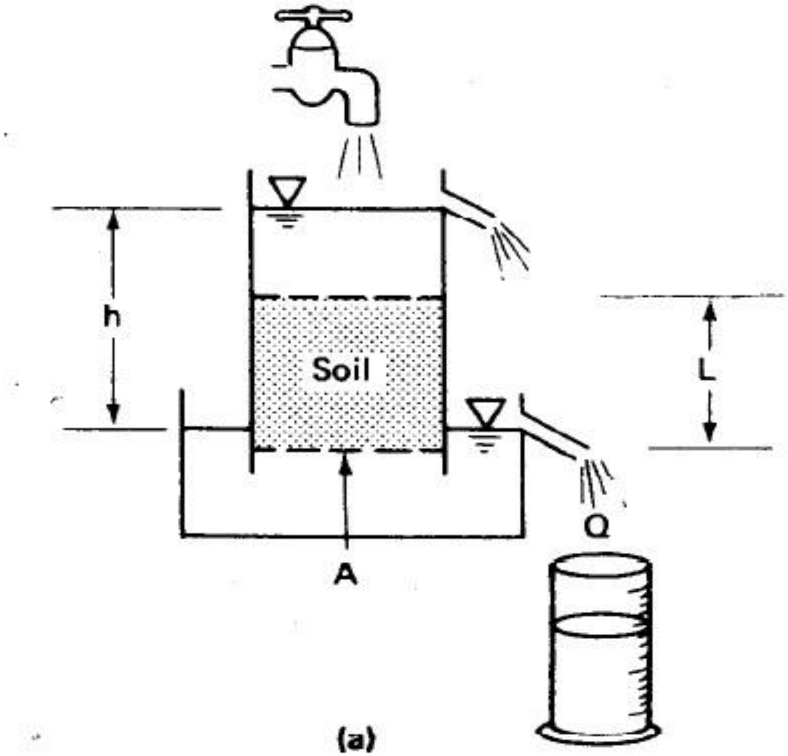


Pengukuran permeabilitas tanah (k)

◦Constant head for coarse grained soil

$$k = \frac{QL}{Ah\Delta t}$$

$$k_{20^o C} = \frac{\mu_T}{\mu_{20^o C}} k_T$$



Pengukuran permeabilitas tanah (k)

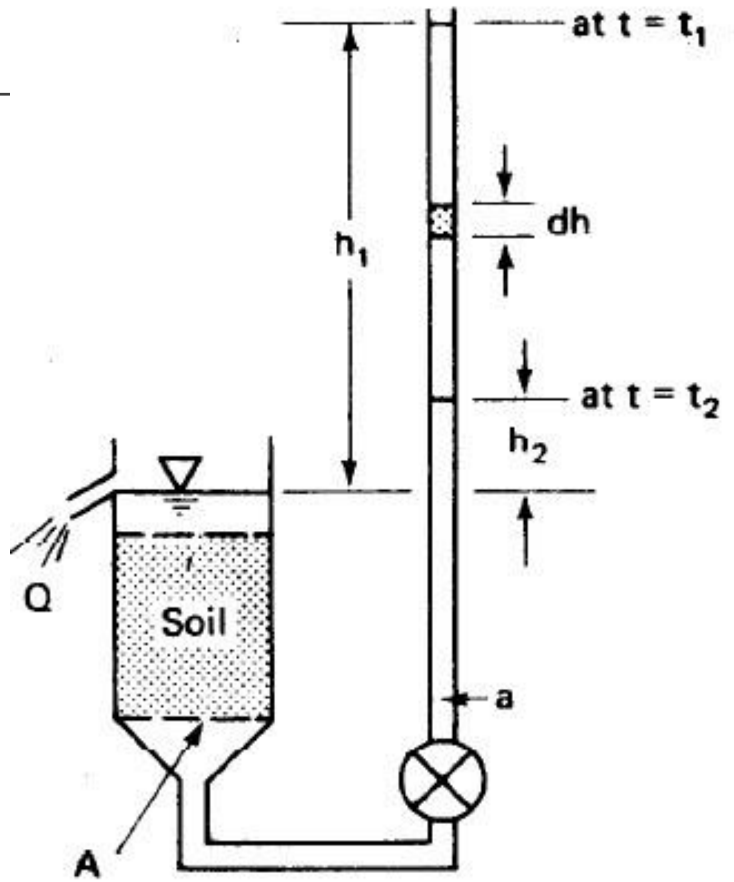
Falling head for fine grained soil

$$-a\frac{dh}{dt} = A\,k\,\frac{h}{l}$$

$$-a\int_{h1}^{h2}\frac{dh}{h} = \frac{A\,k}{l}\int_{t1}^{t2}dt$$

$$k = \frac{al}{A\,\Delta t}\ln\frac{h_o}{h_1} = 2.3\frac{al}{A\,\Delta t}\log\frac{h_1}{h_2}$$

$$k_{20^o C} = \frac{\mu_T}{\mu_{20^o C}}k_T$$



Kecepatan aliran dalam tanah

- In small scale, water flow through inter-particle pores. However, in a larger scale, it could be assumed that the water flow through a straight line. The average velocity of water flow in soil is called seepage velocity (v):

$$v' = \frac{q}{A_v} \qquad A_v = n A$$

Assuming 2 D case $$v' = \frac{q}{nA} = \frac{v}{n}$$ where n is porosity

Range of permeability

Table 2.1 Coefficient of permeability (m/s) (BS 8004: 1986)

1	10^{-1}	10^{-2}	10^{-3}	10^{-4}	10^{-5}	10^{-6}	10^{-7}	10^{-8}	10^{-9}	10^{-10}
Clean gravels		Clean sands and sand–gravel mixtures		Very fine sands, silts and clay-silt laminate			Unfissured clays and clay-silts (>20% clay)			
		Desiccated and fissured clays								

Correlation for permeability

For coarse grained soil (Hazen, 1911):

$$k = C_1 D_{10}^2 \ (m/sec)$$

where C_1 *= constant (=viaries from 0.4* 10^{-2} *– 1.2* 10^{-2} *with avarge of* $1x10^{-2}$ *for clean sand) and* D_{10} is effective diameter in mm (D_{10} sizes between 0.1 to 3.0 mm). This equation is valid for k ≥ 10^{-5} *m/sec.*

For clay (Taylor,1948)

$$\log k = \log k_o - \frac{e_o - e}{C_k}$$

where

C_k = permeability change index, while k_o, e_o = *in-situ* value.

Correlation for permeability

- The permeability of porous media is related to the size, shape, and distribution of their voids.

- For sands the relevant relationships was developed by Kozeny and Carman (Kozeny, 1927; and Carman, 1939) and is written in the form:

$$k = \frac{\gamma_w}{5 f \eta S^2} \frac{e^3}{1+e}$$

where

e = void ratio, and

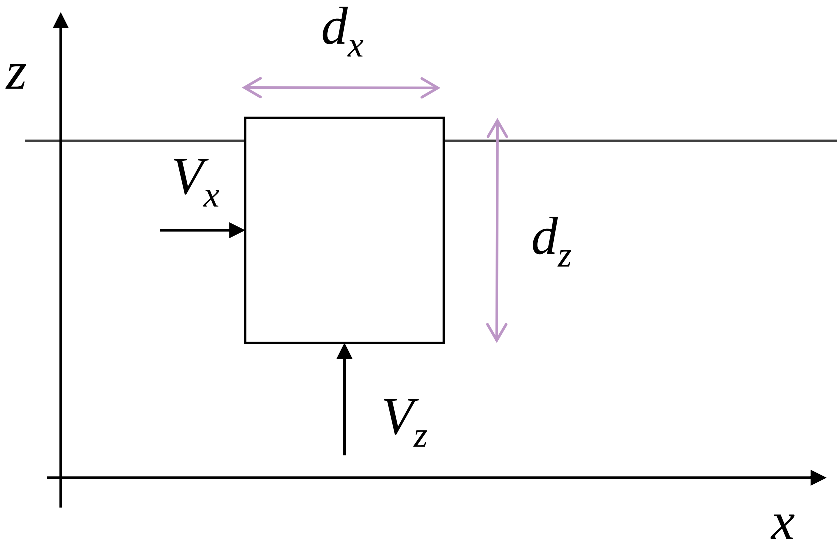
η = dynamic viscosity of water.

The coefficient f depends on pore shape: *f* = 1.1 for rounded grains, *f* = 1.25 for sub rounded grains and *f* = 1.4 for angular grains (London, 1952).

- The specific surface area S:

$$S = \frac{6}{\sqrt{d_{\max} d_{\min}}} \left(mm^{-1} \right)$$

Aliran 2 dimensi



$$v_x = k\, i_x = -k \frac{\partial h}{\partial x}$$

$$v_z = k\, i_z = -k \frac{\partial h}{\partial z}$$

The amount of water flowing into the element:

$$v_x dy\ dz + v_z dx\ dy$$

and out from the element:

$$\left[v_x + \frac{\partial v_x}{\partial x}\right] dy\ dz + \left[v_z + \frac{\partial v_z}{\partial z}\right] dx\ dy$$

Berbagai cara menggambarkan aliran 2 dimensi

Flow net (see Craig Soil Mechanics or other textbook)

Method of fragments (Harr, 1962 ; Holtz, 1981)

Finite difference solution (Bardett, 1997)

Computer program (SEEP/W, SVFlux, MODFlow, SoilVision etc.)

Pemadatan Tanah

Pemadatan adalah proses mengeluarkan udara dari dalam pori² tanah. Ini adalah cara murah dan efektif untuk memperbaiki sifat² tanah.

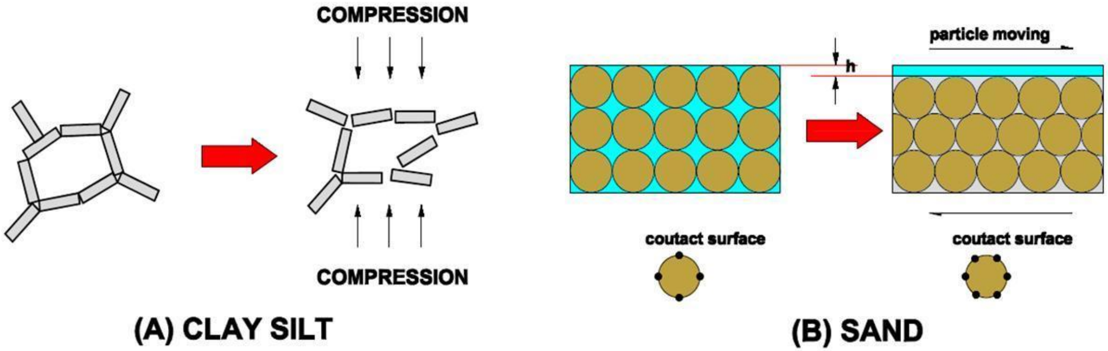
Pemadatan akan meningkatkan kerapatan (berat isi) tanah sehingga:

- Kuat geser meningkat
- Penurunan tanah berkurang
- Permeabilitas tanah menurun

Pengertian Pemadatan

menambah berat volume kering dengan beban dinamis sehingga butiran tanah kan merapat mengurangi rongga

.



Jenis :

a. Pemadatan Dangkal : yang dipadatkan top soil, menggunakan penumbuk sederhana atau penumbuk mesin.

b. Pemadatan Dalam : Precompression, peledakan, **dynamic compaction**, compaction grouting, vibroflotation

Pemadatan Tanah Pasir

Kepadatan tanah pasir dinyatakan sebagai densitas relative (Relative density):

$$D_r = \frac{e_{max} - e}{e_{max} - e_{min}} = \frac{1/\gamma_{dmin} - 1/\gamma_d}{1/\gamma_{dmin} - 1/\gamma_{dmax}}$$

Angka pori tertinggi atau densitas kering terendah dicapai pada kondisi longgar.

Angka pori terendah atau densitas kering tertinggi dicapai pada kondisi paling padat.

Pemadatan Tanah lempung

Compaction is quantified in terms of soil's dry unit weight where:

$$\gamma_d = \frac{\gamma}{1+\omega}$$

maximum dry unit weight is achieved at *optimum moisture content*

Soil is compacted by field compaction methods until the laboratory maximum dry unit weight is achieved

The maximum dry unit weight is used by the engineer in specifying design shear strength

Faktor2 yang mempengaruhi pemadatan tanah

Compaction of soil can be affected by:

- Moisture content
- Compaction effort
- Type of soil

Compaction effort

- can be quantified in terms of the compaction energy per unit volume
- The greater the compaction energy per unit volume, the greater the compaction

Field compaction, sandy soil

- Measured by relative density (D_r)
- Compaction is normally done in layers
- Moisture control not necessary
- Compact by vibration: Combination of Dynamic compaction (large area) and vibratory compactor (small or narrow area)

Field compaction, clayey soil

Compaction id normally done in layers

Moisture content can be

- **Increased by sprinkling water**
- **Decreased by aeration**

The surface of each compacted layer should be scarified by disk plowing to provide for bonding between layers

Various kind of field compaction equipment:

- **Tampers**
- **Rollers**

Alat-alat pemadat untuk tanah dangkal

PENGGILAS BESI (TANDEM ROLLER)

PENGGILAS BAN KARET (PNEUMATIC TIRED ROLLER)

Alat-alat pemadat untuk tanah dangkal

PEMADAT PLAT GETAR MANUAL (STAMPER)

PENGGILAS KAKI KAMBING (SHEEP FOOT ROLLER)

PENGGILAS GETAR (VIBRO ROLLER)

Deep Compaction; Pemadat Tanah Dalam

Dynamic compaction rig and pounder

This is just introduction to what you should have studied in undergraduate level…. Thus you have to do some reading and review......

For overview reading you can read my book (Introduction to Geotechnical Eng Part 1, or Soil and Foundation)

For advanced reading, please read Holtz and Kovacs chapters 1-4, and for more advanced reading : Mitchell & Soga chapters 1-8.

You are not an undergraduate student…..you are studying to **MASTER** your knowledge in Geotechnical Engineering. So…use library…do your own reading

References

Holtz & Kovacs (1981) *Introduction to Geotechnical Engineering* Prentice Hall (Chapter 1, 2, 3)

Cheng Liu & Jack B Evett (2005) *Soils & Foundation (SI edition by:Nurly Gofar)* Pearson/Prentice Hall (Chapter 1 and 2)

Nurly Gofar and KA. Kassim (2007) *Introduction to Geotechnical Engineering*, Part I Pearson/Prentice Hall (Chapter 1)

Thanks for your attention