

# KLASIFIKASI TANAH

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- Tanah diklasifikasikan berdasarkan ukuran partikel tanah dan dikelompokkan menjadi tanah butir kasar (**coarse grained soil**) seperti pasir dan kerikil (**sand and gravel**); dan tanah butir halus (**fine grained soil**) seperti lempung dan lanau (**silts and clays**).
- Distribusi ukuran butiran tanah (**grain size distribution / GSD**) ditentukan dengan **analisis saringan** (SNI 3423-2008 / ASTM D 422-635). Untuk tanah butir halus dapat dilanjutkan dengan **analisis Hydrometer**.
- Selanjutnya tanah butir halus diklasifikasikan berdasarkan batas-batas konsistensi. Batas-batas konsistensi ini ditentukan dengan **uji batas Atterberg**.

# Ukuran partikel & distribusi ukuran partikel (Grain size distribution / GSD)

Sieve analysis/Analisa ayakan



HYdrometer analysis/Analisa hidrometer

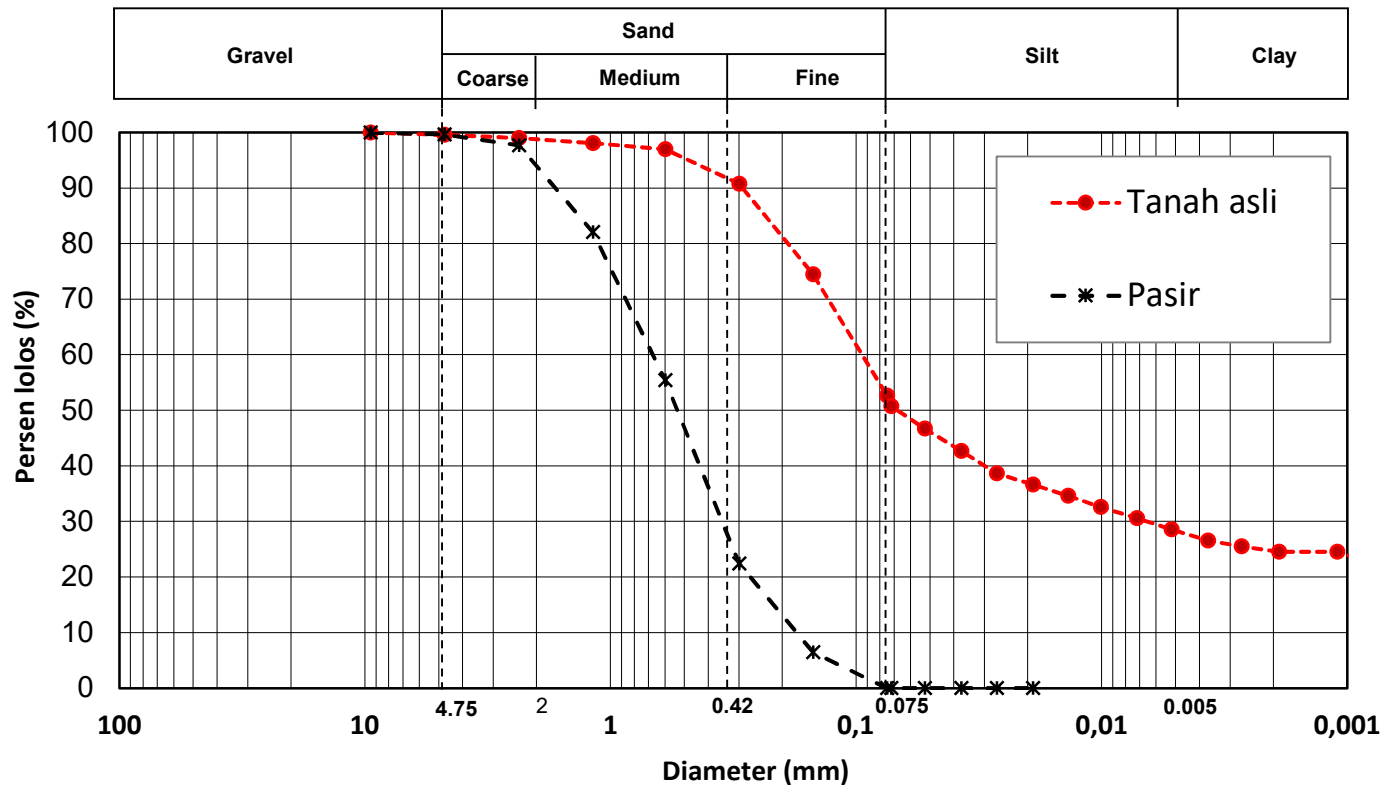


SNI 8640-2017

**Tabel 1 Standar ukuran saringan**

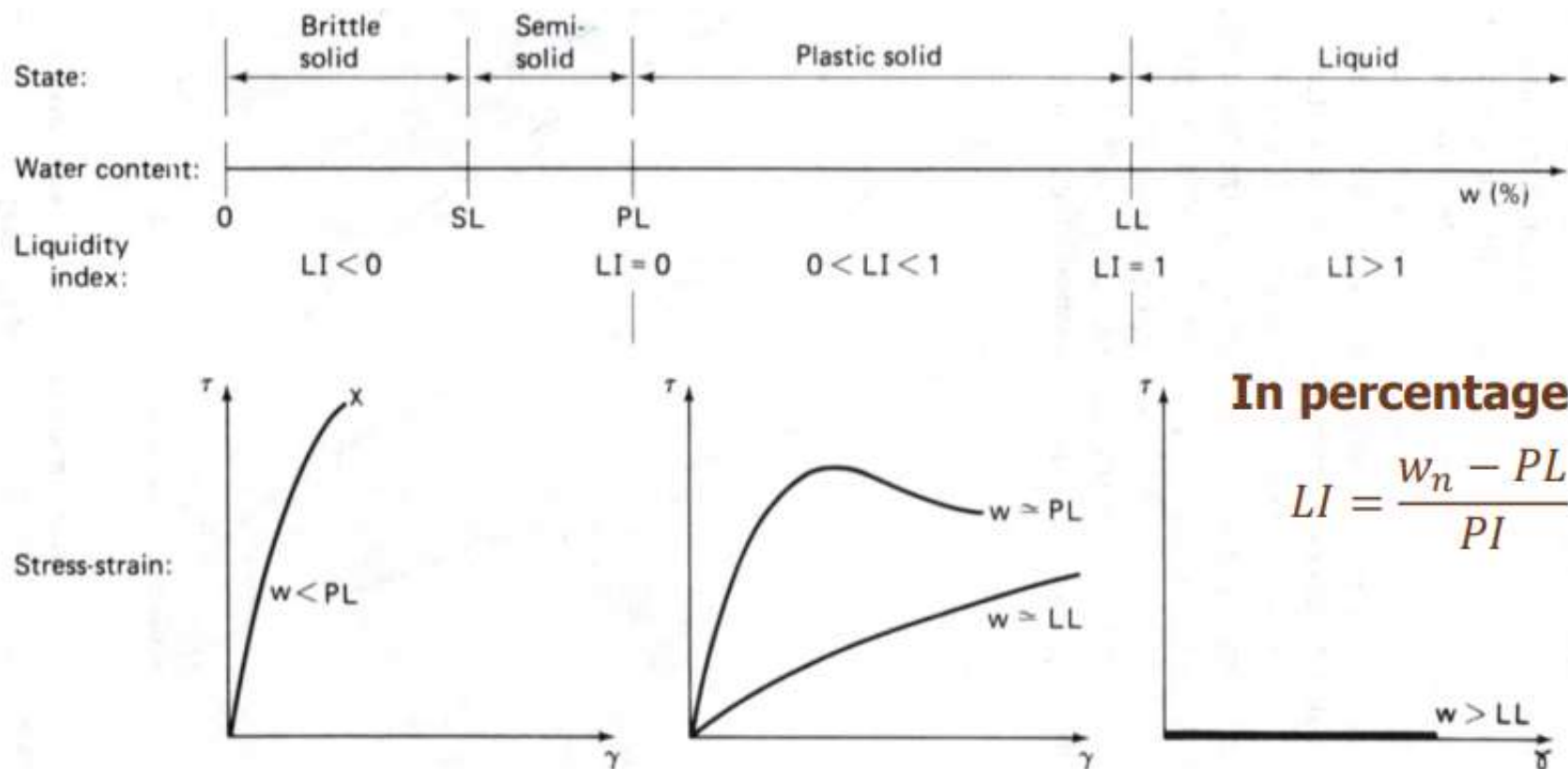
| <b>Standar Ukuran<br/>mm</b>   | <b>Alternatif satuan</b> |
|--|--------------------------|
| 75   | 3 inci                   |
| 50   | 2 inci                   |
| 25   | 1 inci                   |
| 9,25   | 3/8 inci                 |
| 4,75   | No. 4                    |
| 2,00   | No. 10                   |
| 0,425  | No.40                    |
| 0,075  | NO. 200                  |
| Catatan: Saringan di atas memenuhi persyaratan SNI 03-6797-2002 dan SNI 03-6388-2000. Jika dikehendaki ukuran saringan antara dapat digunakan sebagai berikut: |                          |
| <b>Standar Ukuran<br/>mm</b>   | <b>Alternatif satuan</b> |
| 75   | 3 inci                   |
| 37,5   | 1 ½ inci                 |
| 19   | 3/4 inci                 |
| 9,5  | 3/8 inci                 |
| 4,75   | No. 4                    |
| 2,36   | No. 8                    |
| 1,18   | No. 16                   |
| 0,60   | No. 30                   |
| 0,30   | No. 50                   |
| 0,15   | No. 100                  |
| 0,075  | No. 200                  |

## Hasil Uji Saringan dan Hidrometer → Grain size distribution



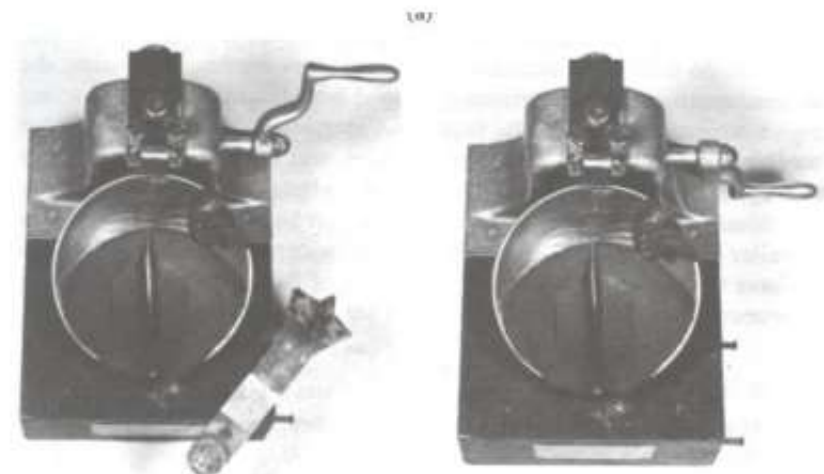
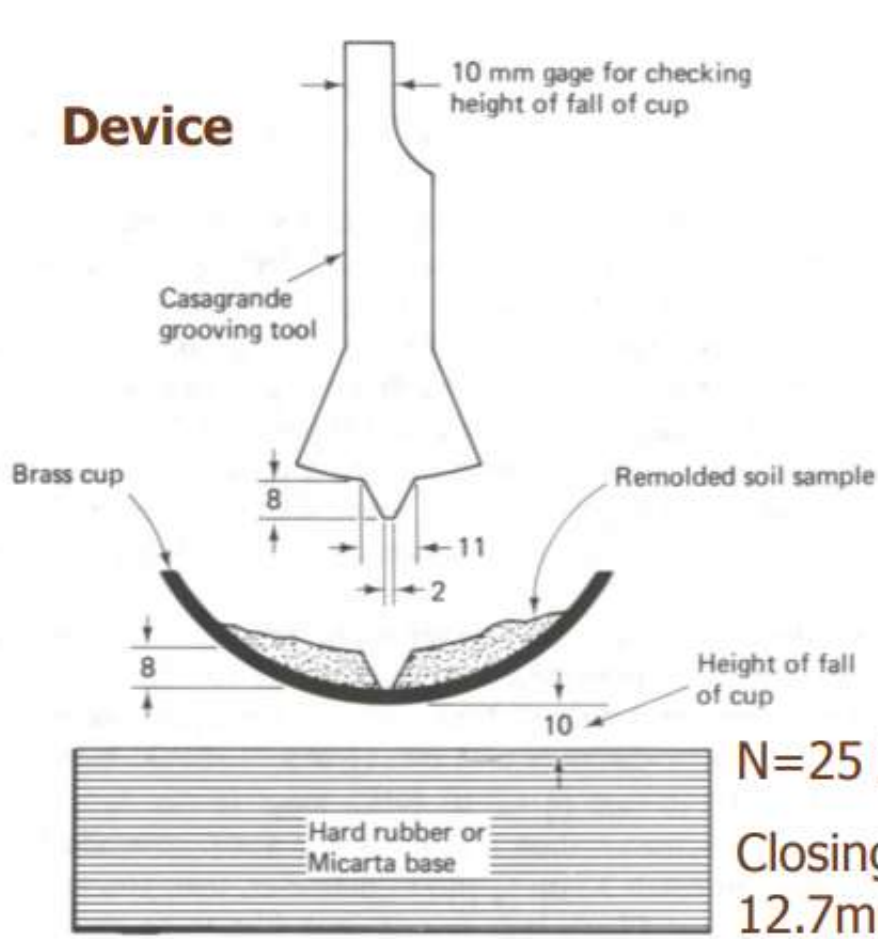
## 2. Konsistensi Tanah (tanah kohesif)

- The presence of water in **fine-grained soils** can significantly affect associated engineering behavior, so we need a reference index to clarify the effects. (The reason will be discussed later in the topic of clay minerals)

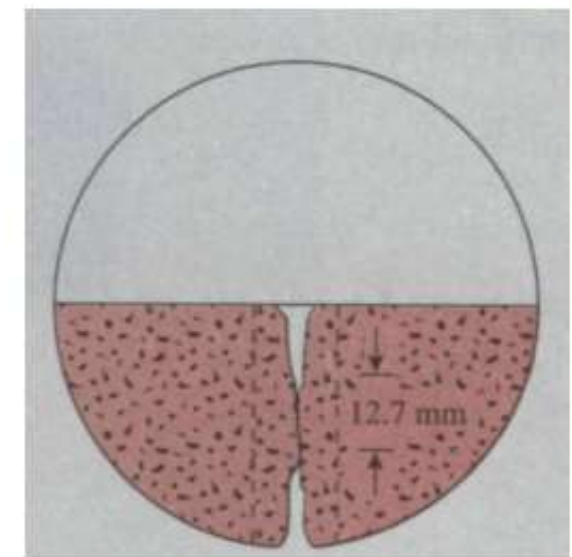




# Casagrande Method (ASTM D4318-95a)



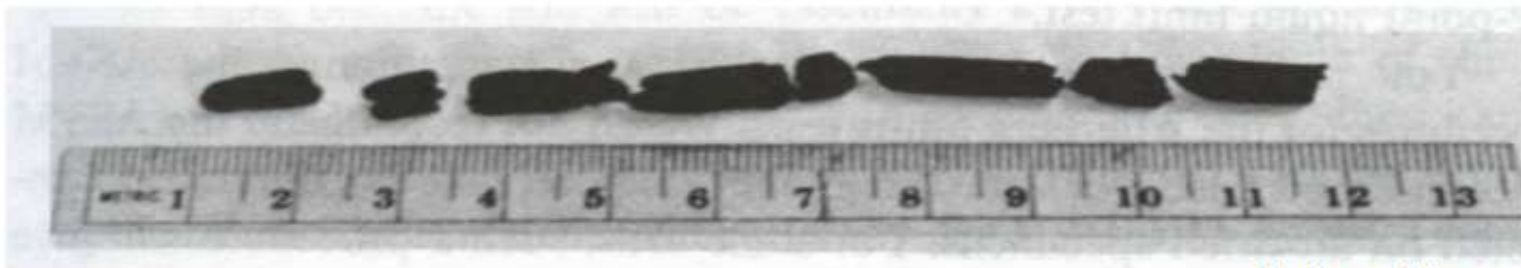
N=25 blows  
Closing distance =  
12.7mm (0.5 in)



The water content, in percentage, required to close a distance of 0.5 in (12.7mm) along the bottom of the groove after 25 blows is defined as the liquid limit

(Holtz and Kovacs, 1981)

## Plastic Limit-PL



(Holtz and Kovacs, 1981)

The plastic limit PL is defined as the water content at which a soil thread with **3.2 mm diameter just** crumbles.

ASTM D4318-95a, BS1377: Part 2:1990:5.3



# Atterberg Limits

*Fluid soil-water mixture*

↑  
Increasing water content

Liquid State

Liquid Limit, LL

Plastic State

Plastic Limit, PL

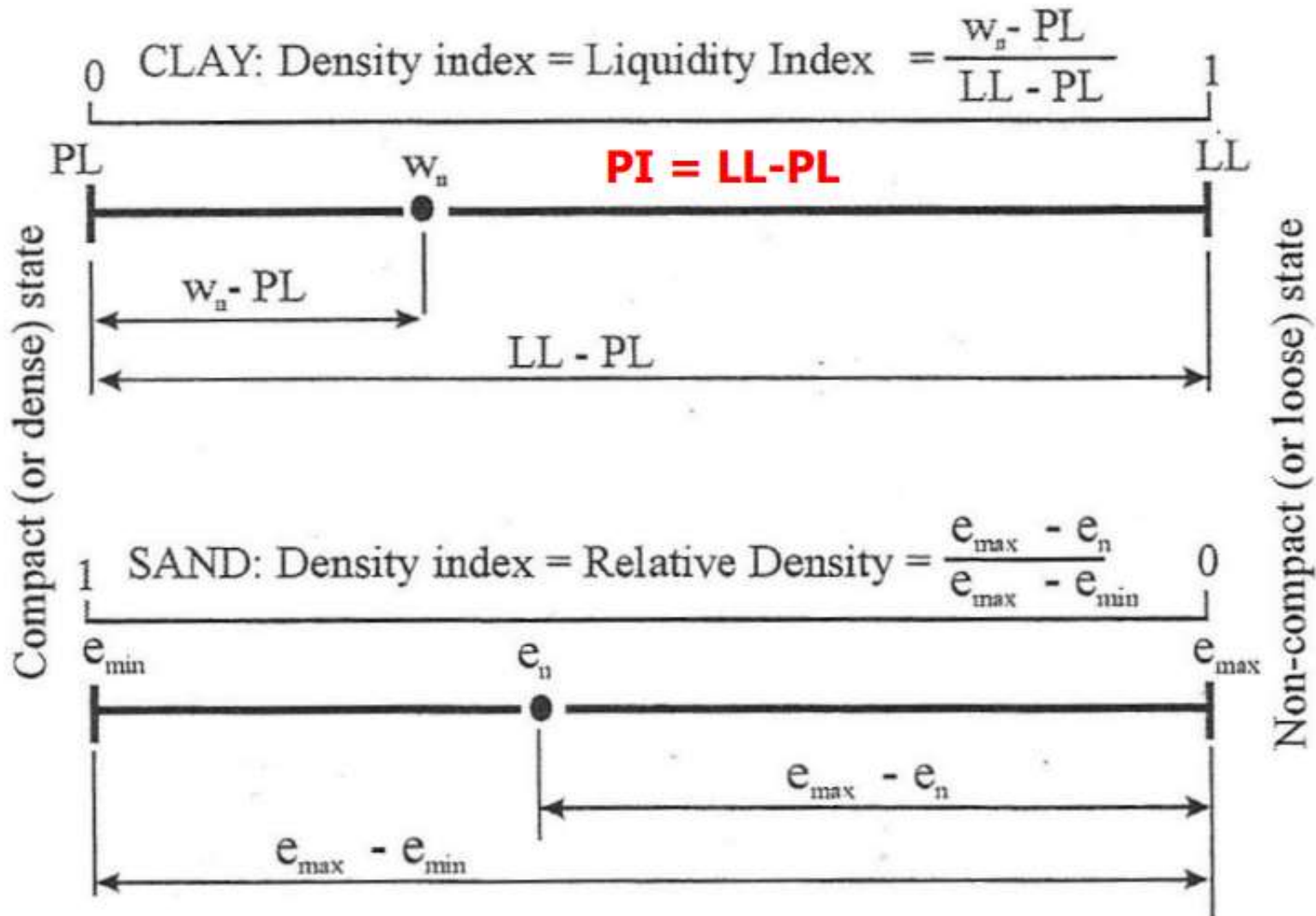
Semisolid State

Shrinkage Limit, SL

Solid State

*Dry Soil*

# Atterberg Limit vs Soil State



(Wesley)

# Sistem Klasifikasi Tanah

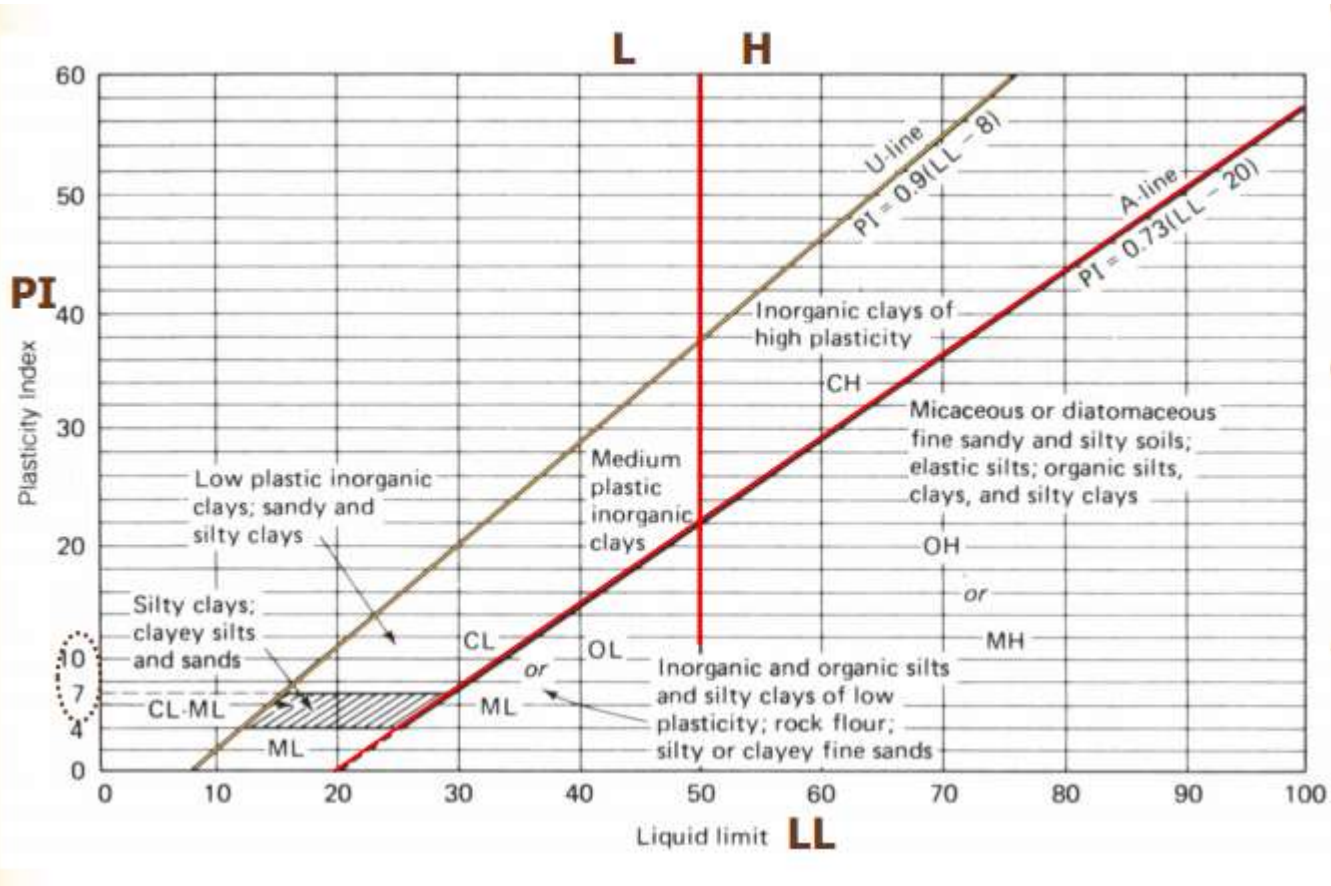
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- Unified Classification System (USCS) di adopsi oleh ASTM D 2487-06, di adopsi juga oleh SNI 6371: 2015
- American Association of State Highway and Transportation Officials (AASHTO) classification (ASTM D3282)

# USCS Classification System (ASTM)

Tabel Klasifikasi Tanah Sistem USCS (ASTM)

| Divisi Utama   |  | Simbol kelompok  | Nama Jenis tanah | Kriteria klasifikasi  |   |  |
|--|--|--|------------------|---|---|--|
| TANAH BERBUTIR KASAR<br>Lebih dari setengah meteralnya lebih kasar dari saringan no. 200 | KERIKIL<br>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 sama sekali tidak mengandung butiran halus<br>$Cu = D_{60}/D_{10}$ Lebih besar dari 4<br>$CC = (D_{30})^2/D_{10} \times D_{60}$ Antara 1 dan 3 |   |  |
|  |  | Kerikil dengan bahan halus   | GP               | Kerikil bergradasi buruk dan campuran kerikil pasir, sedikit atau sama sekali tidak mengandung butiran halus<br>Tidak memenuhi kriteria untuk GW  |   |  |
|  |  | Kerikil dengan bahan halus   | GM               | Kerikil berlanau, campuran kerikil-pasir-lanau  | Batas-batas Atterberg di bawah garis A atau $PI < 4$  |  |
|  |  |  | GC               | Kerikil berlempung, campuran kerikil-pasir-lanau  | Batas-batas Atterberg di atas garis A dengan $PI > 7$   |  |
|  | PASIR<br>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<br>$Cu = D_{60}/D_{10}$ Lebih besar dari 6<br>$CC = (D_{30})^2/D_{10} \times D_{60}$ Antara 1 dan 3            |   |  |
|  |  |  | SP               | Pasir bergradasi-buruk, pasir berkerikil, sedikit atau sama sekali tidak mengandung butiran halus<br>Tidak memenuhi kriteria untuk SW   |   |  |
|  |  | Kerikil dengan bahan halus   | SM               | Pasir berlanau, campuran pasir-Lanau  | Batas-batas Atterberg di bawah garis A atau $PI < 4$  |  |
|  |  |  | SC               | Pasir berlempung, campuran pasir-Lempung  | Batas-batas Atterberg di atas garis A dengan $PI > 7$   |  |
|  |  |  | ML               | ML  | Lanau anorganik, pasir halus sekali, serbuk batuan, pasir halus berlanau atau berlempung  | Penentuan persentase pasir dan kerikil dari kurva analisis butiran<br> |
|  |  |  |                  | 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           |  |                  |   |   |  |
| MH   | 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 BERBUTIR HALUS<br>Lebih dari setengah meteralnya lebih halus dari saringan no. 200 | LANAU DAN LEMPUNG  | Batas cair kurang dari 50  | ML               | OH dan MH   |   |  |
|  |  |  |                  |   | Batas cair lebih dari 50  |  |
| TANAH-TANAH DENGAN KANDUNGAN ORGANIK SANGAT TINGGI                                       | PT   | Peat (gambut), muck dan tanah-tanah lain dengan kandungan organik tinggi           | CL               | CL-ML   |   |  |





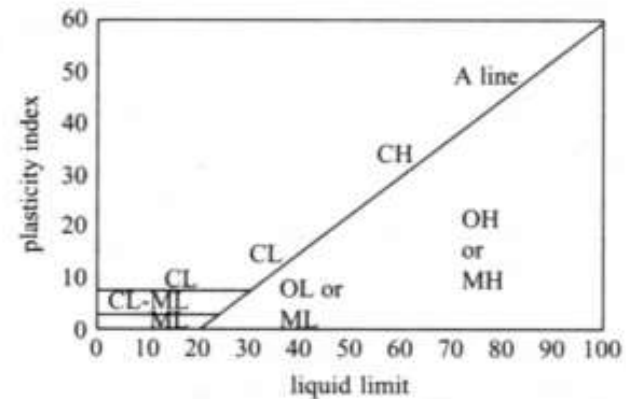
# Procedures for Classification

Coarse-grained material  
Grain size distribution

|   |   |                     |                              |      |
|---|---|---------------------|------------------------------|------|
| COARSE<br>More than 50% retained sieve #200 | Gravel:<br>more than 50% coarse fraction retained on sieve #4 | Less than 5% fines  | $C_u > 4, 1 \leq C_c \leq 3$ | → GW |
|   |   |                     | Not satisfying GW            | → GP |
|   |   | More than 12% fines | Below 'A' line               | → GM |
|   | Sand:<br>less than 50% coarse fraction retained on sieve #4   | Less than 5% fines  | $C_u > 6, 1 \leq C_c \leq 3$ | → SW |
|   |   |                     | Not satisfying SW            | → SP |
|   |   | More than 12% fines | Below 'A' line               | → SM |
|   |   | Above 'A' line      | → SC                         |      |

Fine-grained material  
LL, PI

FINE  
Less than 50% retained sieve #200  
LL < 50  
LL > 50



Highly ORGANIC SOILS

→ Pt

(Santamarina et al., 2001)

# AASHTO Classification System (biasa digunakan untuk konstruksi jalan)

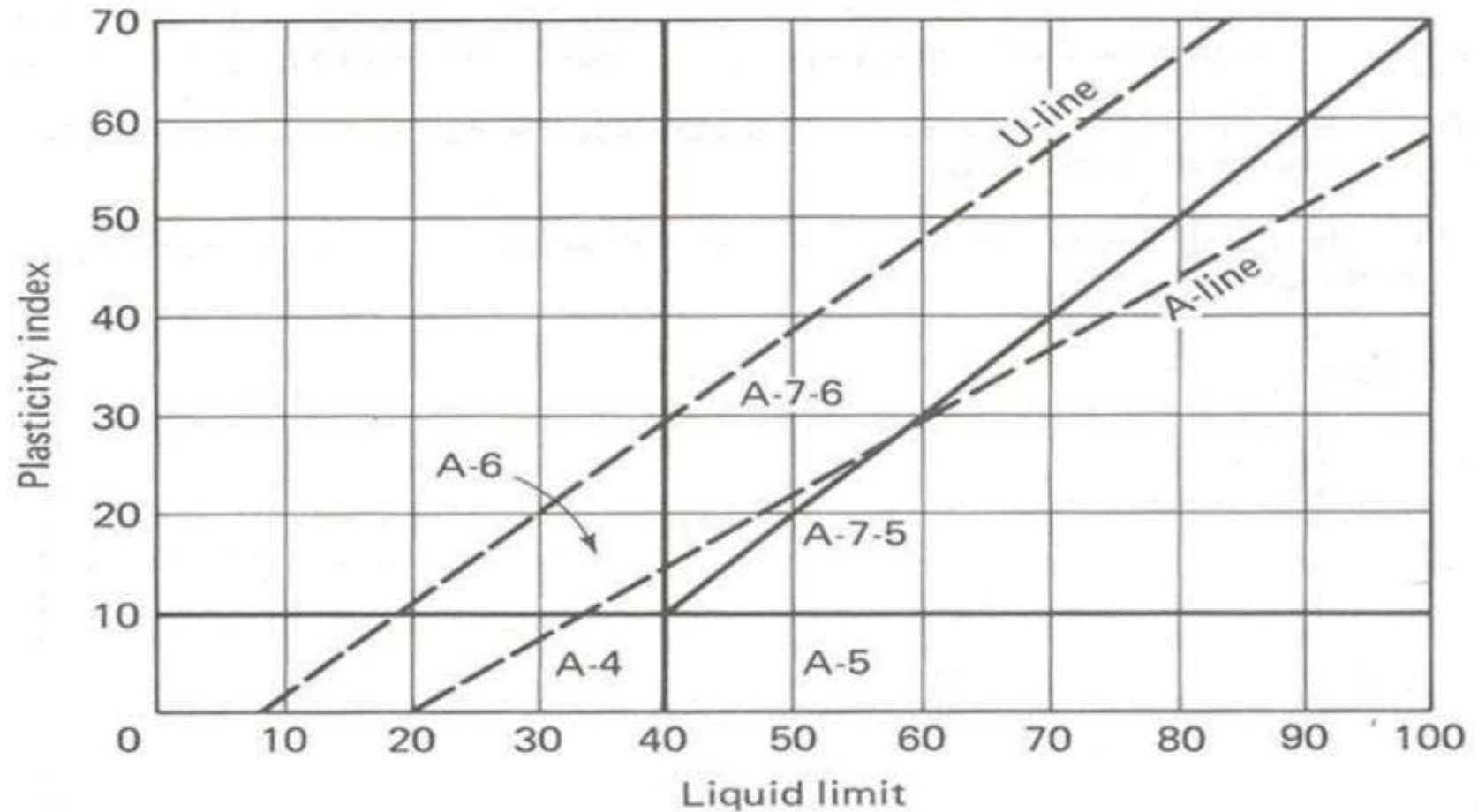
Table 1.6 AASHTO Classification System (AASHTO M-145)

| General Classification                              | Granular Material<br>(35 % or less passing 0.075 mm (sieve no 200)) |        |               |                                 |        |        | Fine grained soils<br>(> 35% passing 0.075 mm (No. 200)) |             |        |              |        |
|---|---|--------|---------------|---------------------------------|--------|--------|--|-------------|--------|--------------|--------|
|   | A-1   |        | A-3           | A-2                             |        |        |  | A-4         | A-5    | A-6          | A-7    |
| Group classification                                | A-1-a   | A-1-b  |               | A-2-4                           | A-2-5  | A-2-6  | A-2-7  |             |        |              |        |
| Sieve analysis<br>(% 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<br>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<br>constituent materials | Stone<br>fragments,<br>gravel and<br>sands                          |        | Fine<br>sands | Silty or clayey gravel and sand |        |        |  | Silty soils |        | Clayey soils |        |
| General rating as<br>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

# Klasifikasi Tanah AASHTO



**Penentuan Klasifikasi Group A-4 s/d A-7**

## General Guidance - AASHTO

- 8 major groups: A1~ A7 (with several subgroups) and organic soils A8
- The required tests are sieve analysis and Atterberg limits.
- The group index, an empirical formula, is used to further evaluate soils within a group (subgroups).



Using LL and PI separates silty materials from clayey materials (only for A2 group)

Using LL and PI separates silty materials from clayey materials

- The original purpose of this classification system is used for road construction (subgrade rating).



## **Following are some rules for determination of group index:**

- a. If the equation for group index gives a negative value for GI, it is taken as zero.**
- b. The group index calculated from the equation is rounded off to the nearest whole number (for example, GI = 4.4 is rounded off to 4; and GI = 4.5 is rounded off to 5).**
- c. There is no upper limit for the group index.**
- d. The group index of soils belonging to groups A-1-a, A-1-b, A-2-4, A-2-5, and A-3 will always be zero.**
- e. When calculating the group index for soils belonging to groups A-2-6, and A-2-7, the partial group index equation related to plasticity index (as given below) should be used.**

$$\text{GI} = 0.01(F_{200} - 15)(\text{PI} - 10)$$