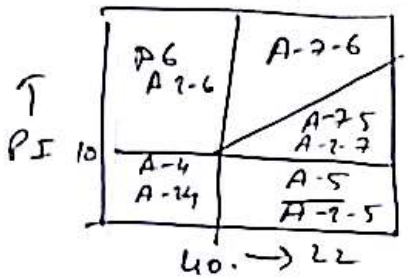
AASHTO classification.

Granular.
≤ 35% passing #200
A-1
A-2
A-3
≤ 35 | #200
25

Silty Clay.
> 35% passing #200
A-4
A-5
A-6
A-7
60 | #200
40



	A-1-a	A-1-b	A-3
#4	50 max		
#10	30 max	50 max	51 min
#40	15 max	25 max	10 max

USCS classification

% retained on #200 > 50% → Coarse Grain [G → Gravel, S → Sand]
% " " " ≤ 50% → Fin Grain [M → Silt, C → Clay]

% retain of #4 > 50 Gravels.
% " " #4 ≤ 50% Sand.

-% finer #200 ≤ 5% → clean gravel/sand.
% " 5-12% → Dual classification
> 12% → Gravel with fin Sand/Sand with

A line → for silt clay.

$PI = 0.73(LL-20)$

above A line → clay.
below → silt.

$C_u \geq 4$ $C_c = 1-3$ → GW.
otherwise → GP.

$C_u \geq 6$ $C_c = 1-3$ → SW.
otherwise → SP.

PI from graph.
PI from LL PL

from graph.
PI value
↳ compare
↓
A line
↓
below.
↓
[illegible]
↓
A line
above.

Group index

$GI = (F-35)[0.2+0.005(W_L-40)] + 0.01(F-15)(I_P-10)$.

For subgroup
A-2-6 A-2-7
Partial group index
$PGI = 0.01(F-15)(I_P-10)$

Coefficient of Uniformity $C_u = \frac{D_{60}}{D_{10}}$

" Curvature / Gradation $C_c = \frac{D_{30}^2}{D_{60} \times D_{10}}$

LL one point method.

$$w_L = w \left(\frac{N}{25}\right)^{0.1}$$

$$w_L = \frac{w}{1.3215 - 0.23 \log n}$$

↳ Nagraj and Jayadeva

$$w_L = \frac{w}{0.65 + 0.0175D}$$

↳ cone penetration

Shrinkage Limit

$$w_s = \frac{\text{Weight of water at Shrinkage Limit}}{\text{Weight of Soil Solid}}$$

$$= \frac{(w_1 - w_d) - (v_1 - v_d)\gamma_w}{w_d}$$

$$w_s = \frac{\gamma_w V}{w_s} - \frac{G_{es}}{G_{es}}$$

$$w_s = \frac{v_d \gamma_w - \frac{w_d}{G_{es}}}{w_d}$$

Linear Shrinkage $= \left(1 - \frac{\text{Final height}}{\text{Initial}}\right) \times 100$

$I_p = 2.13 L_s$

1. Flow index $I_f = \frac{w_1 - w_2}{\log\left(\frac{n_2}{n_1}\right)}$

plasticity - $PI / I_p = w_L - w_P$

Liquidity index $I_L = \frac{w_x - w_P}{w_L - w_P}$

toughness index $I_t = \frac{I_p}{I_F}$

consistency index $I_c = \frac{w_L - w_n}{I_p}$

↳ 0-100 → plastic
>100 → semi solid

15-16 ⑤

14-15 ④

13-14 ③

12-13 ②

11-12

10-11 ①

9-10 ④

8-9 ⑤

7-8 ③

#4 → 4.75
#10 → 2
#40 → 0.425
#200 → 0.075

15-16
⑤

% passing #4 = 98 → 4.75mm
% " #10 = 80 → 2mm
% " #40 = 70 → 0.425mm
% " #200 = 52 → 0.075mm

LL (casagrande) = 55
LL (cone) = 45
PL = 33

% retained on #200 = 100 - 52 = 48% < 50%

∴ Soil is fine grained
Soil is silt (M) or clay (C)

Now, PI = 0.73 (LL-20)
= 0.73 × (55-20) = 25.55

PI = LL - PL = 55 - 33 = 22

25.55 > 22

∴ below A line.

Soil is Silt (M)

Now, LL = 55 % > 50

↳ high plastic Soil

∴ Soil type in (MH)

AASHTO

% passing #200 = 52 % > 35 %

Soil is Silty clay

A_4 A_5 A_6 A_7.

LL = 55 So, A-4 or A-6 type.

PI = 22 So, A-4 type.

Group index = $(F-35)[0.2 + 0.005 \times (w_L - 40) + 0.01 \times (F-15) \times (I_P - 10)]$

$= (52-35) \times [(0.2 + 0.05 \times (55-40)] + 0.01 \times (52-15) \times (22-10)]$

$\approx 20.59 \approx 21$

∴ Soil type @ A_4 (21)

Organic test:

$LL\ (air) = 55$

$LL\ (oven) = 45$

$$\frac{LL_{oven}}{LL_{air}} = \frac{45}{55} = 0.81 \quad \boxed{> 0.75}$$

non organic soil

2014-15

(4)

% passing #4 = 100 $\quad D_{30} = 0.02$

% " #10 = 90 $\quad D_{10} = 0.005$ mm

% " #40 = 80 $\quad LL = 80$

% " #200 = 60% $\quad PL = 44$.

% retained on #200 = 100 − 60 = 40% $\boxed{< 50\%}$

- fine grained soil

  - Silt → M
  - Clay → C.

PI = ~~RETL~~ LL − PL = 80 − 44 = 36

PI = 0.73 (LL − 20) = 0.73 × (80 − 20)

= 43.8.

$\boxed{43.8 > 36}$ below A line.

Soil is silty type (M).

LL = 80% (high plastic)

∴ Soil type is (MH)

Organic test:

$$\frac{LL_{oven}}{LL_{air}} = \frac{55}{80} = 0.6875 < 0.75$$

Soil is organic.

LL air = 80% > 50 High

∴ OH → High organic

AASHTO

% passing #200 = 60% > 35%

= Silty clay type soil

$$\frac{A_4\ A_5}{\text{Silt}} \quad \frac{A_6\ A_7}{\text{clay}}$$

LL = 80.
PI = 36
PI (graph) = 43.6. (A-7-5)

A_4, A_5, A-7-5, A-6
$A_4\ A_5$ A-7-5

Soil is (A-7-5)

~~GI~~

$$GI = 0.01 (F-15) \times (I_p - 10)$$
$$= 0.01 \times (60-15) \times (36-10)$$
$$= 11.7 \approx 12$$

A-7-5(12)

13-14

(3)

% passing #4 = 95
% " #10 = 85
% " #40 = 75
% " #200 = 55

LL = 36
PL = 23
LI = 0.75

% retained on #200 = 100 - 55 = 45% < 50%

Soil is Silty (M) or clay (C)

$$PI = LL - PL = 36 - 23 = 13$$
$$PI\ (\text{graph}) = 0.73(LL - 20) = 11.68$$

$11.68 < 13$

above A line.

Soil type is clay (C).

~~LL = 36 < 50~~

$LL = 36 < 50$ low plastic.

∴ CL type soil.

12-13

Soil - A

% passing #200 = 52

LL = 30

PL = 16

flow index = 12 = If

water conten = 32%.

% retained on #200 = 100 - 52

= 48% (< 50%)

Clay/Silt.

PI = LL - PL = 30 - 16 = 14.

PI = 0.73 (LL - 20) = ~~4.6~~ 7.3

~~4.6 > 14~~ 7.3 < 14

abv ~~below~~ A-line.

Clay ~~Silt~~ more soil (CL)

LL = 30 (< 50%) low plastic.

CL more soil

Soil - B

LL = 52
PL = 19
If = 6
% ω = 40

% passing #200 = 52 % > 35

Silty clay type

A-4 A5 A6 A7.
Silt clay.

~~A-7-6, A-7-5, A-5~~ A-4, A-6

LL = 52.
PI = 52 - 19
= 33.

A-4, A-6.

PI = LL - 30
= 22

A-6.

Soil is A-6.

$$GI = a(F-35)[0.2 + 0.005(w_L - 40] + 0.01(F-15)(I_p - 10).$$

$$= (52-35)[0.2 + 0.05 \times (52-40)] + 0.01(52-15)(33-10)$$

$$= 22.11 \approx 22$$

A-6 (22)

10-11

7(b)

% fine #4 = 100
% " #200 = 96.9

$C_u = 1.40$
$C_c = 1.03$
$LL = 20$
$PI = 6$.

% retained on #200 = 100 - 96.9

= ~~2.04~~.

= 3.1 % (< 50%)

Soil is Silt or clay.

LL

~~PL = LL~~.

PI = 6

PI = 0.73 (LL - 20)

= 0. ⊗ < 6

above A line.

Soil is clay (M)

LL = 20 < 50 low.

∴ Soil is ML

AASHTO

% finer than #200 = 96.9 (> 50%)

Silt or clay

A-4, A-5, A-6, A-7

LL = 20 → A-4 - A-6

PI = 6 → A-4, ~~A-6~~.

$$GI = (F-35)[0.2 + 0.005(LL-40)] + 0.01 \times (F-15) \times (IP-10)$$

$$= (96.9-35)[0.2 + 0.005(20-40)] + 0.01(96.9-15)(6-10)$$

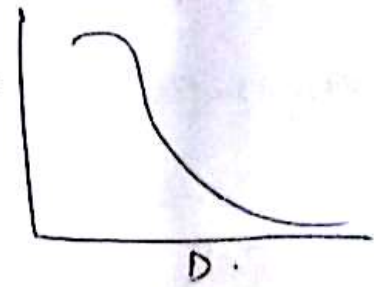
$$= 2.9 \simeq 3$$

A-4 (3)

Q 10

20 M

#4 % finer = 100
#40 " = 80
#200 " = 60
$C_u = 3$
$C_c = 1.92$
LL = 43
PL = 15



% retained on #200 = 100 - 60
= 40 % < 50%

fine grain soil
Silt or clay.

PI = LL - PL = 43 - 15 = 28.
PI (graph) = 0.73 (LL - 20) = 16.79

16.79 < 28

above A line
soil is clay. (M)

LL = 43 < 50 low.

Soil is ML

AASHTO

% passing #200 = 60% > 35%

Soil is clay/silt type.

A4 A5 / silt A6 A7 / clay.