# *Chapter 3*

# *Soil Classification and Field Identification*

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# General Outline

- Soil Classification
- Field Identification of Soils

# 1. Soil Classification

- Introduction
- Particle Size Classifications
- Textural Classification
- Unified Soil Classification System
- AASHTO Classification  System

# Introduction

A soil classification system is the arrangement of different soils having similar properties into groups and sub-groups based on their application.

It provides a common language to express briefly the general characteristics of soils.

Communicate between engineers

Simple indices (GSD, LL, PI) → Classification system (Language) → Estimate engineering properties → Achieve engineering purposes

Use the accumulated experience

# Introduction cntd

Classifying soils into groups with similar behavior, in terms of simple indices, can provide geotechnical engineers a general guidance about engineering properties of the soils through the accumulated experience.

- *To determine the suitability of different soils for different purposes*
- *To develop correlations with useful soil properties*
- *To develop a systematic way to describe and classify soils;*

# Introduction cntd

Classification systems provide a common language to clearly express the general characteristics of soils.

- Many classification systems exists therefore difference in opinion may arise.
- Other tests and parameters are thus necessary before making conclusions about the behavior of the soil.
- The purpose of the classification of soil is to arrange various types of soils into groups according to their engineering or agricultural properties and various other characteristics.

# Introduction cntd

- Soil possessing similar characteristics can be placed in the same group.
- Soil survey and soil classification are carried out by several agencies for different purposes.
- For example, the agriculture departments undertake soil investigations from the point of view of the suitability, or otherwise, of the soil for crops and its fertility.
- However, from the engineering point of view, the classification may be done with the objective of finding the suitability of the soil for construction of dams, highways or foundations, etc.

# Particle Size Classifications

- In this system, soils are arranged according to the grain size.
- Terms such as gravel, sand, silt, and clay are used to indicate grain sizes.
- These terms are used only as a designation of particles size and do not signify the naturally occurring soil types, which arc mixtures of particles of different sizes and exhibit definite characteristics.
- It is preferable to use the word ‘silt size’ and ‘clay size’ in place of simply ‘silt’ or ‘clay’ in this system.

# Particle Size Classifications

There are various grain size classifications in use, but the more commonly used systems are following.

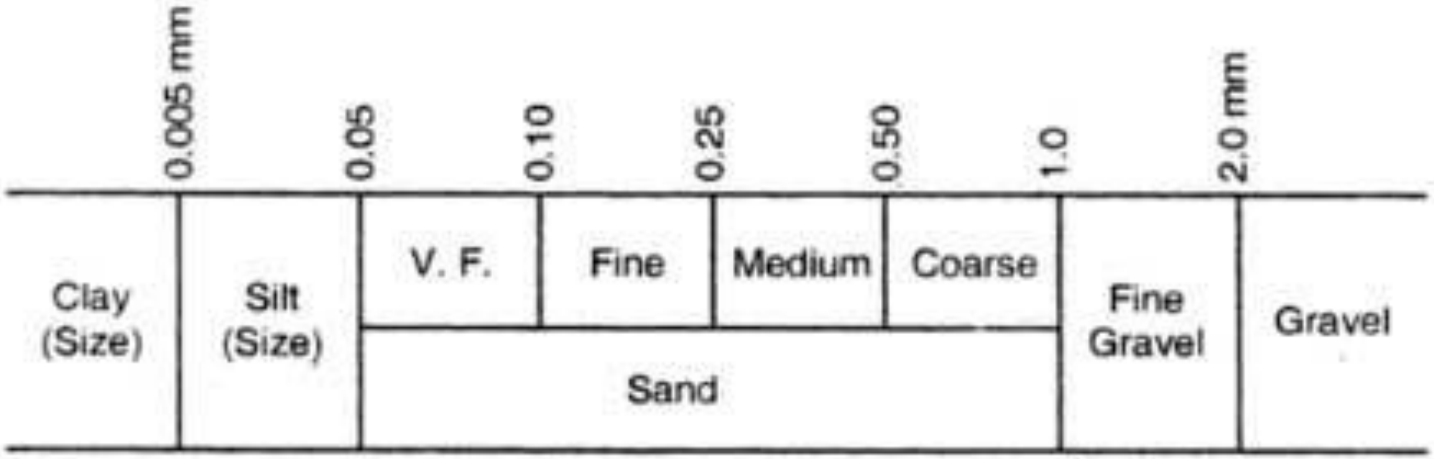
1. U.S. Bureau of Soil and Public Road Administration (PRA) System of the United States.

2. International soil classification, proposed at the International Soil Congress at Washington. D.C. in 1927.

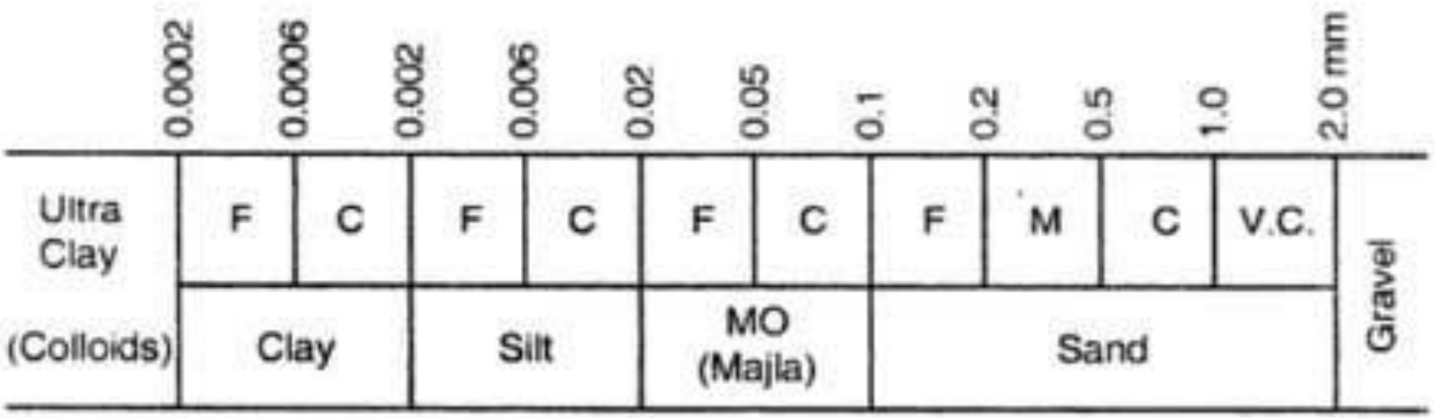
3. The M.I.T. classification proposed by Prof. Gilboy of Massachusetts Institute of Technology as a simplification of the Bureau of Soils Classification, and

4. The Indian Standard Classification (IS: 1948-1970) based on the M.I.T. system.

# Particle Size Classifications cntd

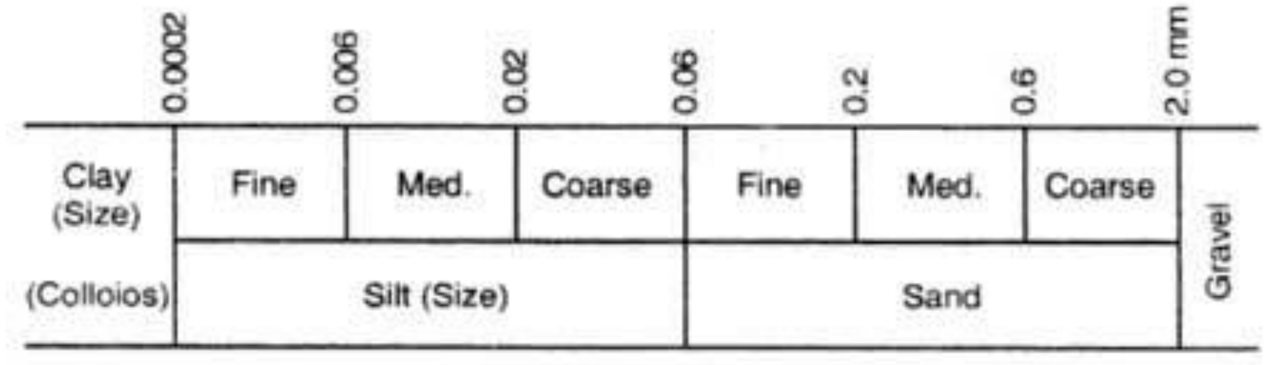



(a) U. S. Bureau of soils and PRA classification

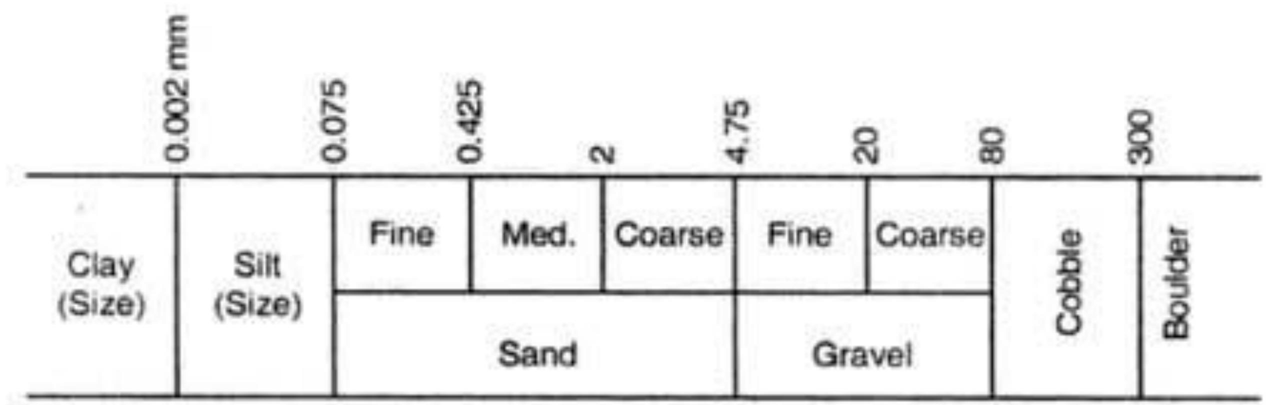



(b) International Classification

# Particle Size Classifications cntd




(c) M.I.T. Classification




(d) I.S. Classification (IS : 1498-1970)

GRAIN-SIZE CLASSIFICATION SCALES.

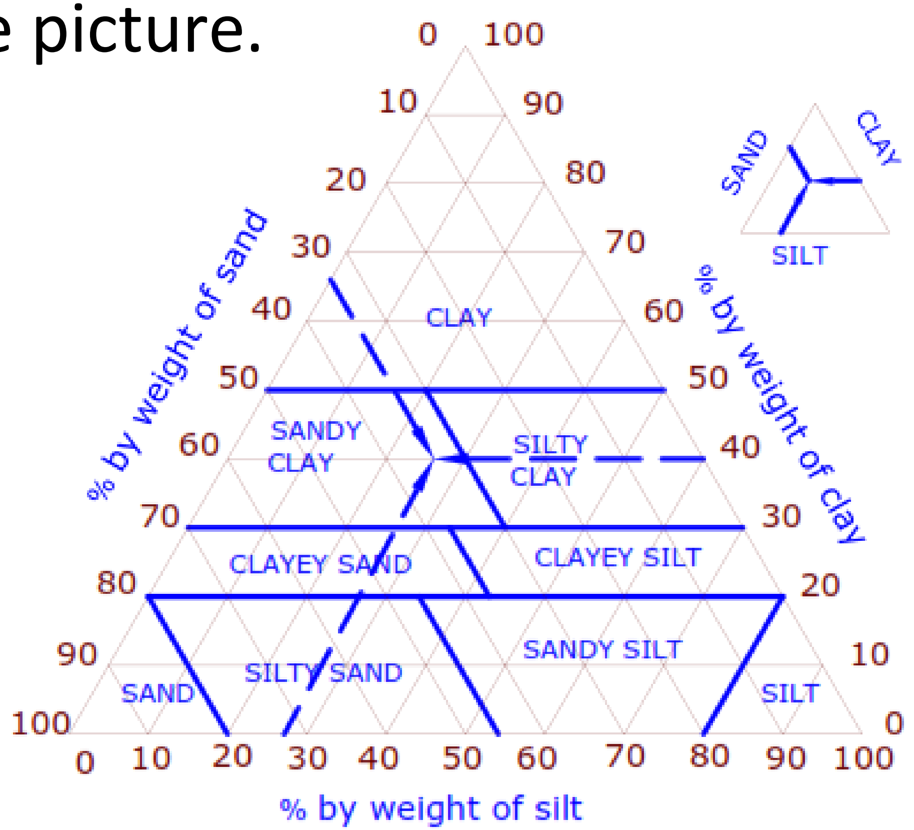
# Textural Classification

- Based on the % of sand, silt and clay size materials (i.e. fraction of soil passing a No. 10 sieve (≤ 2mm).)
  - If soil contains certain percentage of particle >2mm, a correction is necessary.
- More suitable for describing coarse-grained soils rather than clay soils.
- Doesn’t reveal any property other than the grain size distribution
- Doesn’t express the physical characteristics of the soil
- Mostly used for agricultural and highway engineering.

# Textural Classification cntd

To use the chart, for the given percentages of the three constituents forming a soil, lines are drawn parallel to the three sides of the equilateral triangle, as shown by arrows in the 'key' of above picture.

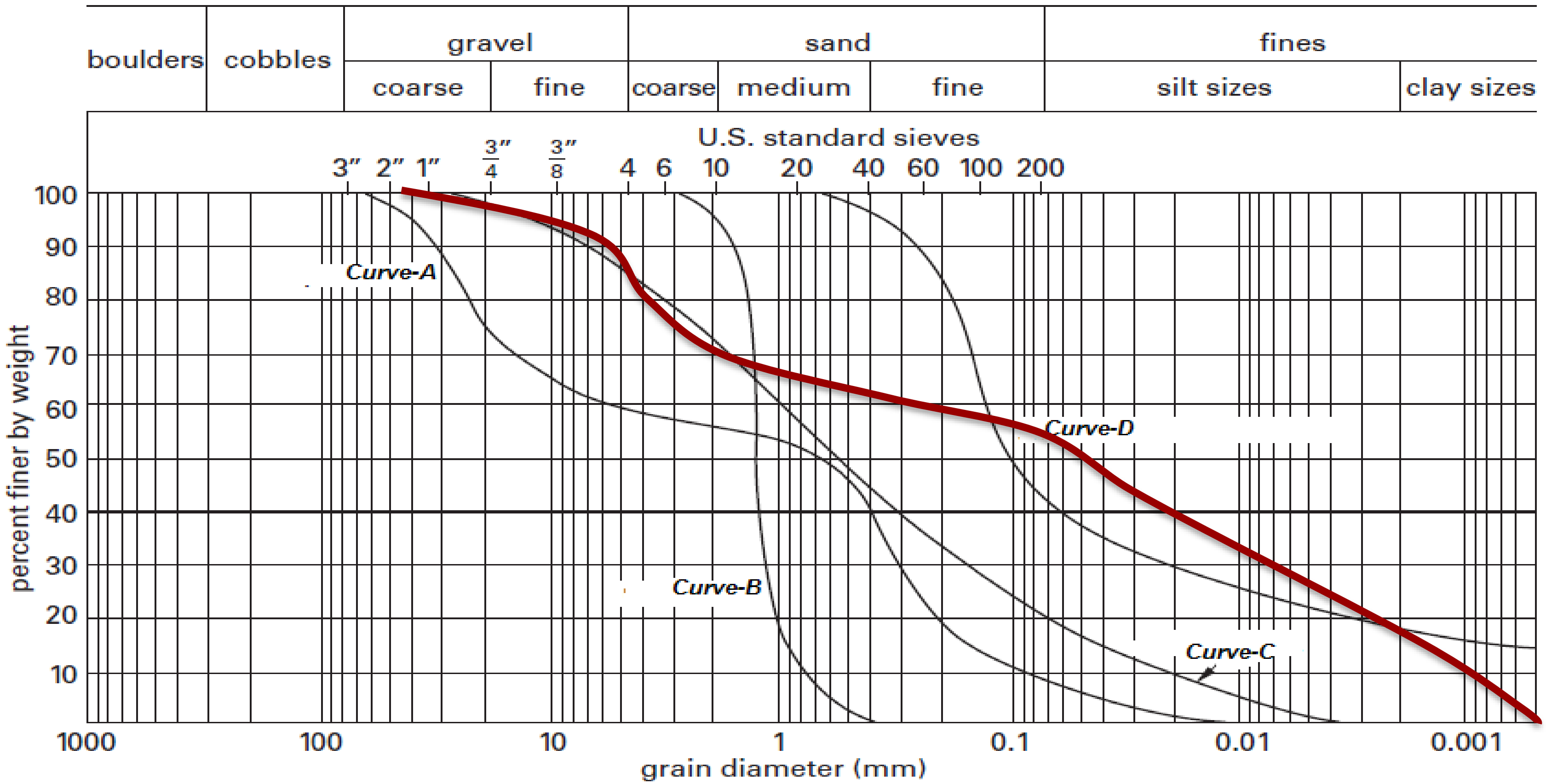
For example, if the soil is composed of 34 percent sand, 26 percent silt sizes, and 40 percent clay sizes, the three lines so drawn intersect at the point A situated in the sector designated as 'clay'.



# Textural Classification cntd

## EXERCISE 3.1.1 – TEXTURAL CLASSIFICATION

Classify the soils indicated by curves A to D using textural system.



# USCS=Unified Soil Classification System

- This system was first developed by Professor A. Casagrande (1948) for the purpose of airfield construction during World War II.
- Afterwards, it was modified by Professor Casagrande, the U.S. Bureau of Reclamation, and the U.S. Army Corps of Engineers to enable the system to be applicable to dams, foundations, and other construction.

Four major divisions:

i) Coarse-grained soils

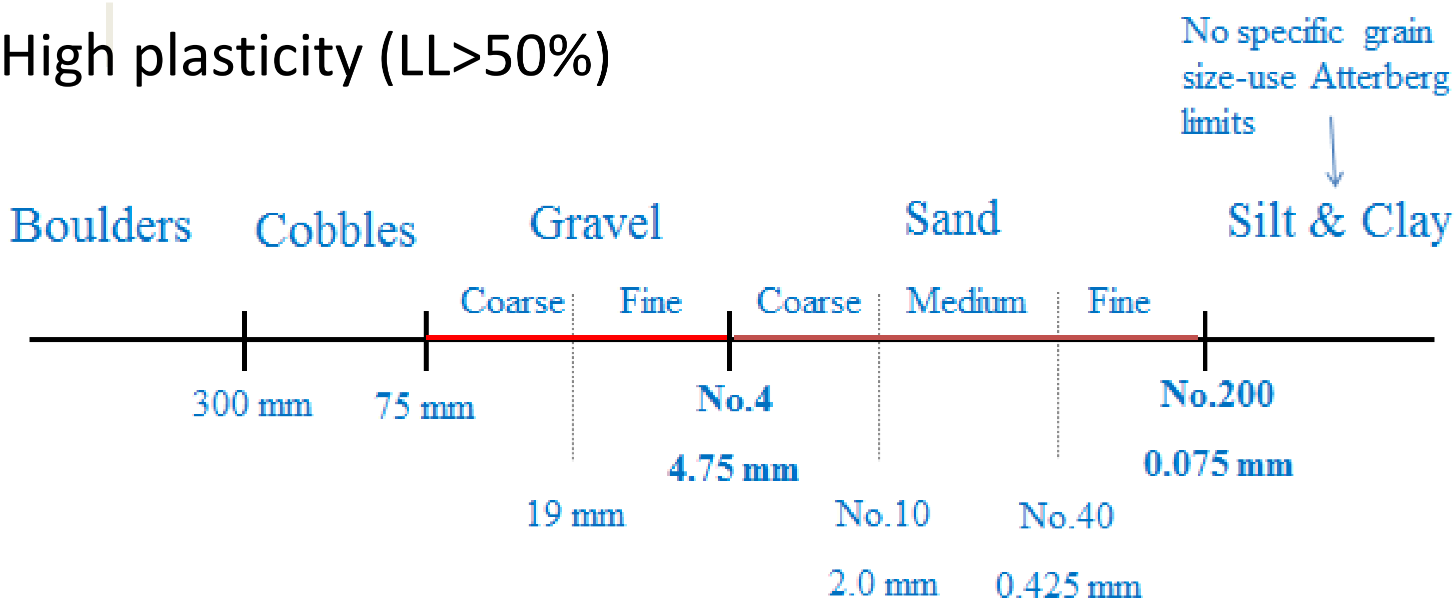
ii) Fine-grained soils

iii) Organic soils

iv) Peat

# USCS cntd

- Fine-grained soil
  - M=Inorganic silt
  - C=Inorganic clay
  - O=Organic silt and clay
  - Pt=Peat
  - L=Low plasticity (LL<50%)
  - H=High plasticity (LL>50%)
- Course-grained soil
  - G=Gravel
  - S=Sand
  - W=Well graded
  - P=Poorly graded



# USCS cntd

*50 %*

Coarse-grained soils: Fine-grained soils:

Gravel *50%* Sand Silt Clay

*NO. 4* *NO.200*

*4.75 mm* *0.075 mm*

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- Grain size distribution
- $C_u$
- $C_c$

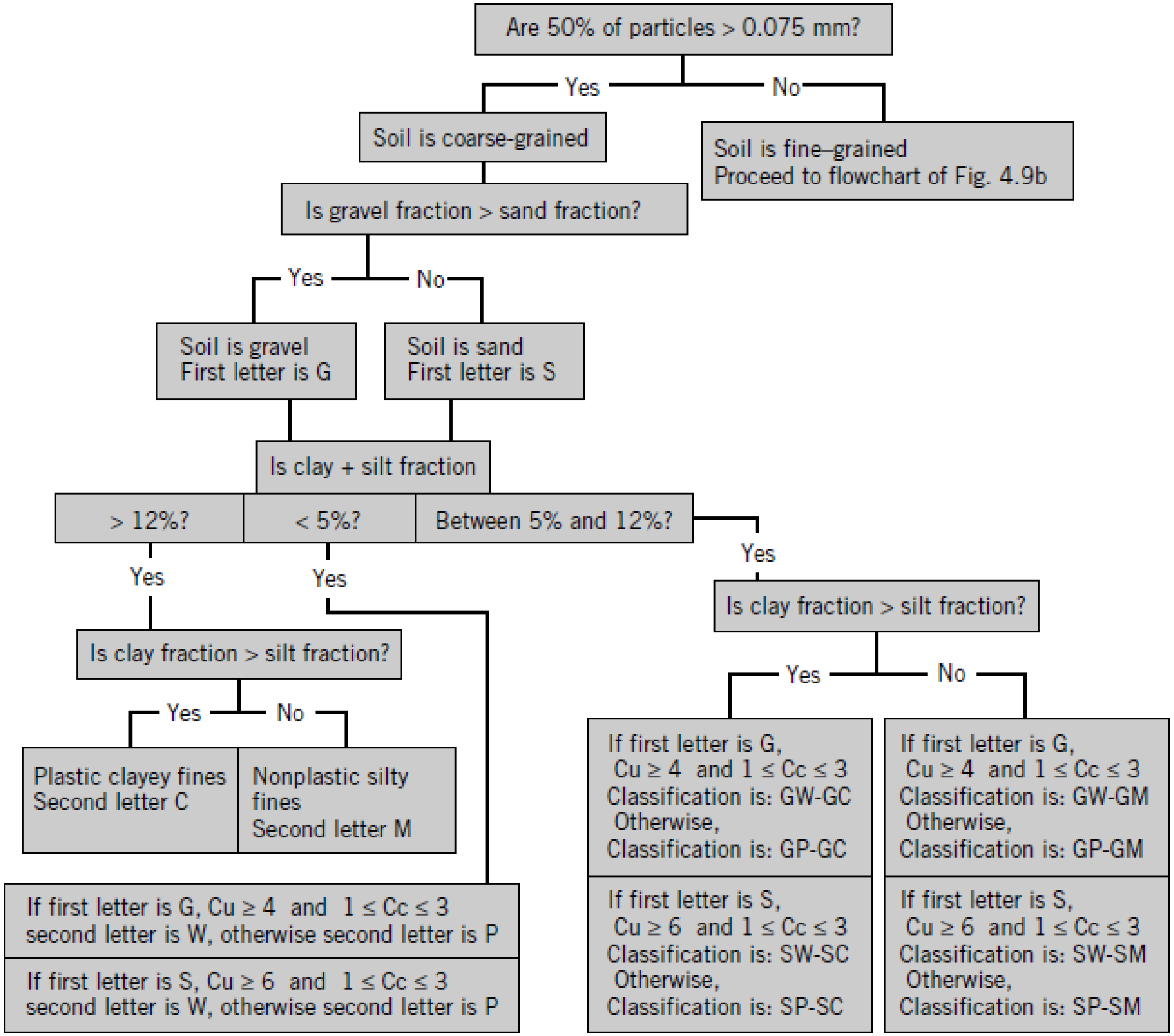
- PL, LL
- Plasticity chart

*LL>50*
*LL <50*

Required tests: Sieve analysis
Atterberg limit

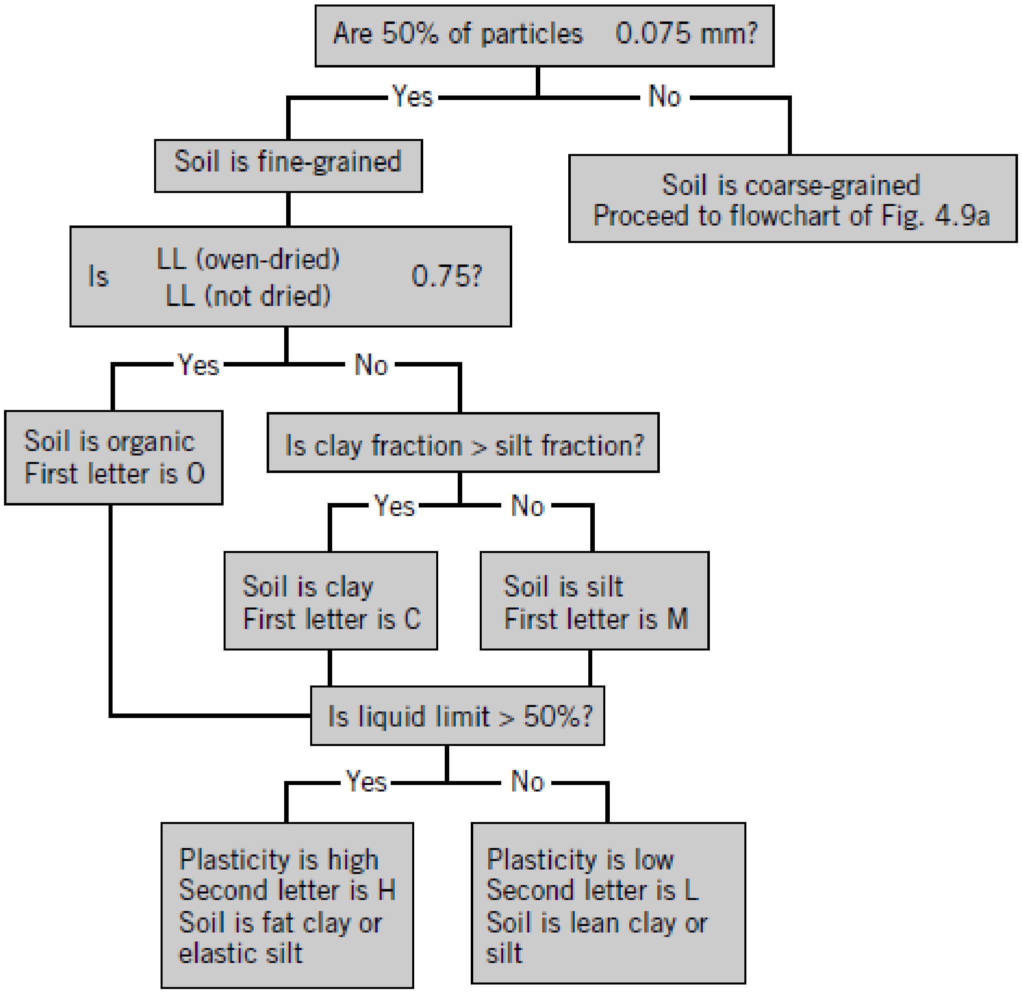
7

## USCS Flow Chart for Coarse Grained Soils



# USCS cntd

## USCS Flow Chart for Fine Grained Soils



# USCS cntd

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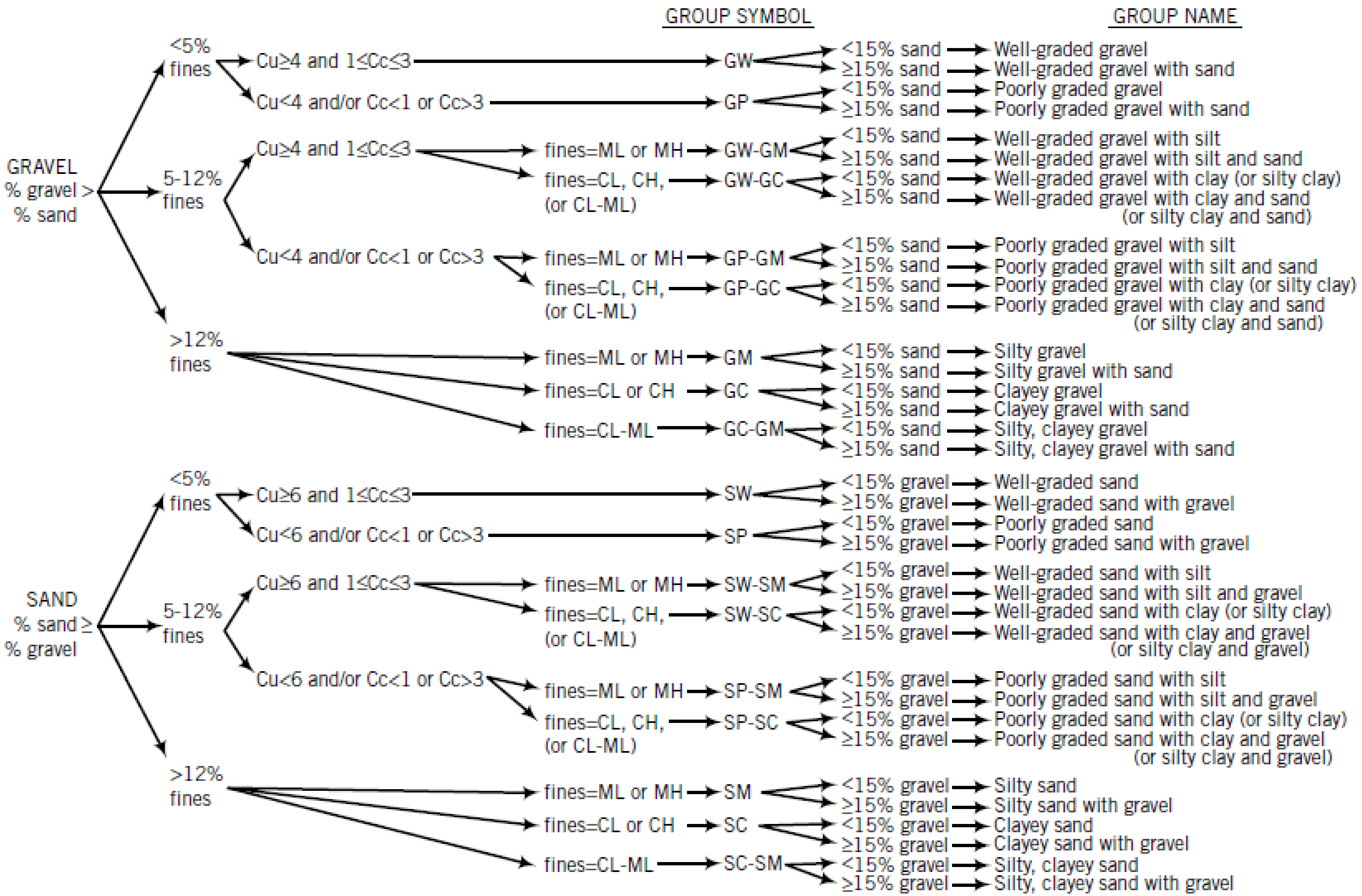
**TABLE 1 Soil Classification Chart**

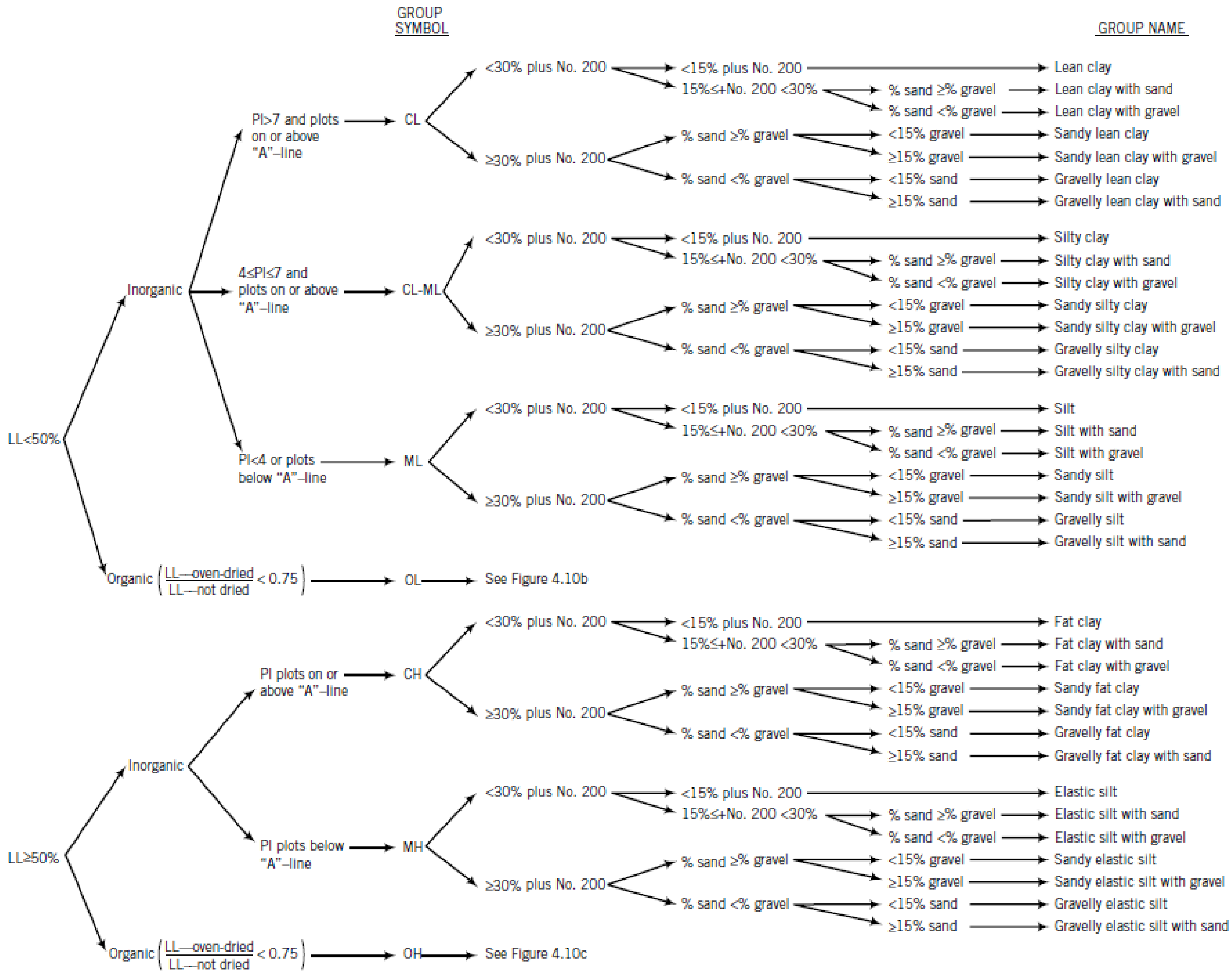
| Criteria for Assigning Group Symbols and Group Names Using Laboratory Tests[A] | | | | Soil Classification: Group Symbol | Soil Classification: Group Name[B] |
|---|---|---|---|---|---|
| COARSE-GRAINED SOILS More than 50 % retained on No. 200 sieve | Gravels More than 50 % of coarse fraction retained on No. 4 sieve | Clean Gravels Less than 5 % fines[C] | $Cu \geq 4$ and $1 \leq Cc \leq 3$[E] | GW | Well-graded gravel[F] |
| | | | $Cu < 4$ and/or $1 > Cc > 3$[E] | GP | Poorly graded gravel[F] |
| | | Gravels with Fines More than 12 % fines[C] | Fines classify as ML or MH | GM | Silty gravel[F,G,H] |
| | | | Fines classify as CL or CH | GC | Clayey gravel[F,G,H] |
| | Sands 50 % or more of coarse fraction passes No. 4 sieve | Clean Sands Less than 5 % fines[D] | $Cu \geq 6$ and $1 \leq Cc \leq 3$[E] | SW | Well-graded sand[I] |
| | | | $Cu < 6$ and/or $1 > Cc > 3$[E] | SP | Poorly graded sand[I] |
| | | Sands with Fines More than 12 % fines[D] | Fines classify as ML or MH | SM | Silty sand[G,H,I] |
| | | | Fines classify as CL or CH | SC | Clayey sand[G,H,I] |
| FINE-GRAINED SOILS 50 % or more passes the No. 200 seive | Silts and Clays Liquid limit less than 50 | inorganic | PI > 7 and plots on or above "A" line[J] | CL | Lean clay[K,L,M] |
| | | | PI < 4 or plots below "A" line[J] | ML | Silt[K,L,M] |
| | | organic | $\frac{\text{Liquid limit – oven dried}}{\text{Liquid limit – not dried}} < 0.75$ | OL | Organic clay[K,L,M,N] |
| | | | | OL | Organic silt[K,L,M,O] |
| | Silts and Clays Liquid limit 50 or more | inorganic | PI plots on or above "A" line | CH | Fat clay[K,L,M] |
| | | | PI plots below "A" line | MH | Elastic silt[K,L,M] |
| | | organic | $\frac{\text{Liquid limit – oven dried}}{\text{Liquid limit – not dried}} < 0.75$ | OH | Organic clay[K,L,M,P] |
| | | | | | Organic silt[K,L,M,O] |
| HIGHLY ORGANIC SOILS | Primarily organic matter, dark in color, and organic odor | | | PT | Peat |

# USCS cntd



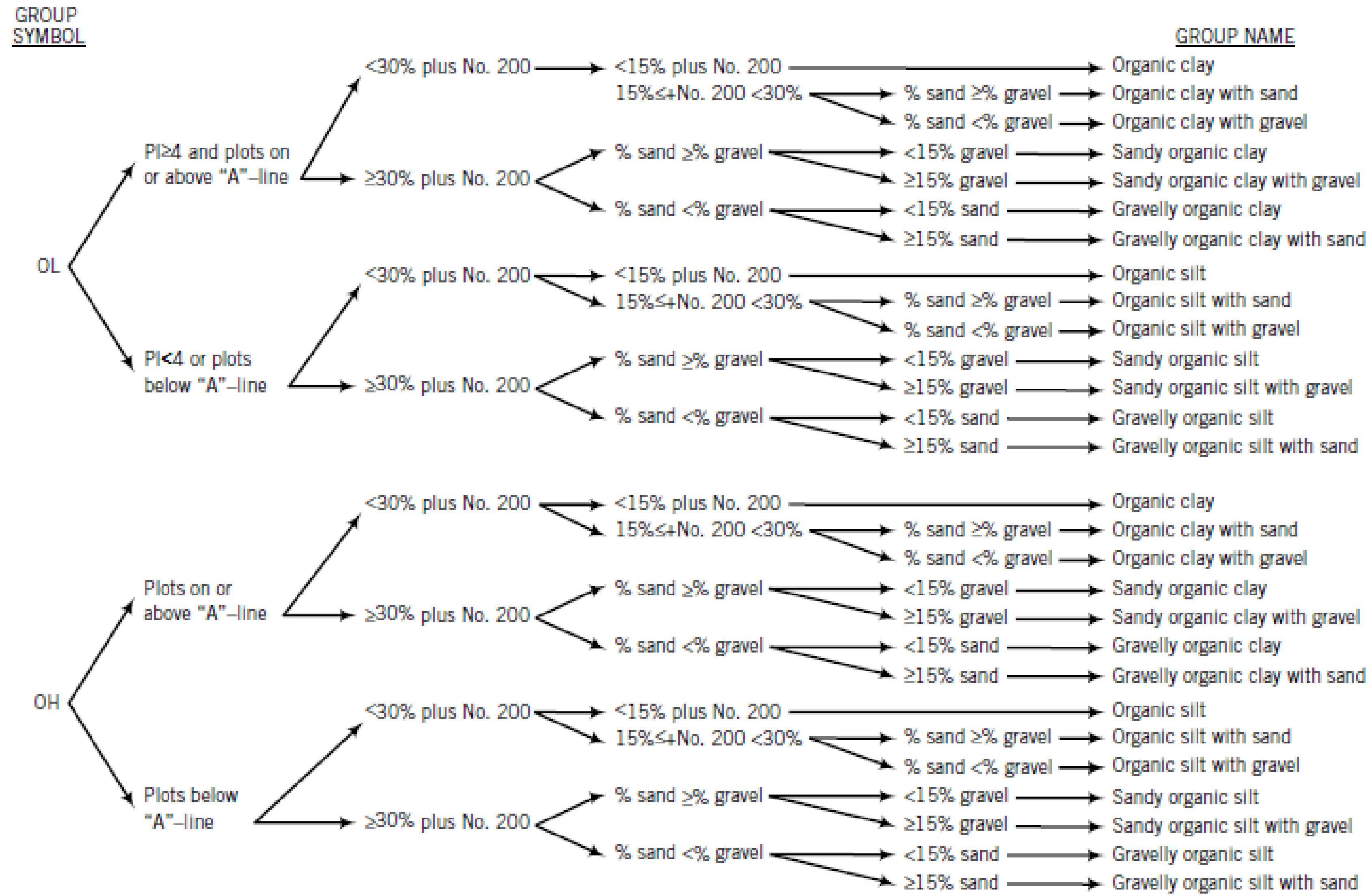
GROUP SYMBOL
GROUP NAME
GRAVEL
% gravel >
% sand
<5%
fines
Cu≥4 and 1≤Cc≤3
GW
<15% sand
Well-graded gravel
≥15% sand
Well-graded gravel with sand
Cu<4 and/or Cc<1 or Cc>3
GP
<15% sand
Poorly graded gravel
≥15% sand
Poorly graded gravel with sand
5-12%
fines
Cu≥4 and 1≤Cc≤3
fines=ML or MH
GW-GM
<15% sand
Well-graded gravel with silt
≥15% sand
Well-graded gravel with silt and sand
fines=CL, CH,
(or CL-ML)
GW-GC
<15% sand
Well-graded gravel with clay (or silty clay)
≥15% sand
Well-graded gravel with clay and sand
(or silty clay and sand)
Cu<4 and/or Cc<1 or Cc>3
fines=ML or MH
GP-GM
<15% sand
Poorly graded gravel with silt
≥15% sand
Poorly graded gravel with silt and sand
fines=CL, CH,
(or CL-ML)
GP-GC
<15% sand
Poorly graded gravel with clay (or silty clay)
≥15% sand
Poorly graded gravel with clay and sand
(or silty clay and sand)
>12%
fines
fines=ML or MH
GM
<15% sand
Silty gravel
≥15% sand
Silty gravel with sand
fines=CL or CH
GC
<15% sand
Clayey gravel
≥15% sand
Clayey gravel with sand
fines=CL-ML
GC-GM
<15% sand
Silty, clayey gravel
≥15% sand
Silty, clayey gravel with sand
SAND
% sand ≥
% gravel
<5%
fines
Cu≥6 and 1≤Cc≤3
SW
<15% gravel
Well-graded sand
≥15% gravel
Well-graded sand with gravel
Cu<6 and/or Cc<1 or Cc>3
SP
<15% gravel
Poorly graded sand
≥15% gravel
Poorly graded sand with gravel
5-12%
fines
Cu≥6 and 1≤Cc≤3
fines=ML or MH
SW-SM
<15% gravel
Well-graded sand with silt
≥15% gravel
Well-graded sand with silt and gravel
fines=CL, CH,
(or CL-ML)
SW-SC
<15% gravel
Well-graded sand with clay (or silty clay)
≥15% gravel
Well-graded sand with clay and gravel
(or silty clay and gravel)
Cu<6 and/or Cc<1 or Cc>3
fines=ML or MH
SP-SM
<15% gravel
Poorly graded sand with silt
≥15% gravel
Poorly graded sand with silt and gravel
fines=CL, CH,
(or CL-ML)
SP-SC
<15% gravel
Poorly graded sand with clay (or silty clay)
≥15% gravel
Poorly graded sand with clay and gravel
(or silty clay and gravel)
>12%
fines
fines=ML or MH
SM
<15% gravel
Silty sand
≥15% gravel
Silty sand with gravel
fines=CL or CH
SC
<15% gravel
Clayey sand
≥15% gravel
Clayey sand with gravel
fines=CL-ML
SC-SM
<15% gravel
Silty, clayey sand
≥15% gravel
Silty, clayey sand with gravel

# USCS cntd



GROUP SYMBOL
GROUP NAME
LL<50%
Inorganic
PI>7 and plots on or above "A"–line
CL
<30% plus No. 200
<15% plus No. 200
Lean clay
15%≤+No. 200 <30%
% sand ≥% gravel
Lean clay with sand
% sand <% gravel
Lean clay with gravel
≥30% plus No. 200
% sand ≥% gravel
<15% gravel
Sandy lean clay
≥15% gravel
Sandy lean clay with gravel
% sand <% gravel
<15% sand
Gravelly lean clay
≥15% sand
Gravelly lean clay with sand
4≤PI≤7 and plots on or above "A"–line
CL-ML
<30% plus No. 200
<15% plus No. 200
Silty clay
15%≤+No. 200 <30%
% sand ≥% gravel
Silty clay with sand
% sand <% gravel
Silty clay with gravel
≥30% plus No. 200
% sand ≥% gravel
<15% gravel
Sandy silty clay
≥15% gravel
Sandy silty clay with gravel
% sand <% gravel
<15% sand
Gravelly silty clay
≥15% sand
Gravelly silty clay with sand
PI<4 or plots below "A"–line
ML
<30% plus No. 200
<15% plus No. 200
Silt
15%≤+No. 200 <30%
% sand ≥% gravel
Silt with sand
% sand <% gravel
Silt with gravel
≥30% plus No. 200
% sand ≥% gravel
<15% gravel
Sandy silt
≥15% gravel
Sandy silt with gravel
% sand <% gravel
<15% sand
Gravelly silt
≥15% sand
Gravelly silt with sand
Organic (LL—oven-dried / LL—not dried < 0.75)
OL
See Figure 4.10b
LL≥50%
Inorganic
PI plots on or above "A"–line
CH
<30% plus No. 200
<15% plus No. 200
Fat clay
15%≤+No. 200 <30%
% sand ≥% gravel
Fat clay with sand
% sand <% gravel
Fat clay with gravel
≥30% plus No. 200
% sand ≥% gravel
<15% gravel
Sandy fat clay
≥15% gravel
Sandy fat clay with gravel
% sand <% gravel
<15% sand
Gravelly fat clay
≥15% sand
Gravelly fat clay with sand
PI plots below "A"–line
MH
<30% plus No. 200
<15% plus No. 200
Elastic silt
15%≤+No. 200 <30%
% sand ≥% gravel
Elastic silt with sand
% sand <% gravel
Elastic silt with gravel
≥30% plus No. 200
% sand ≥% gravel
<15% gravel
Sandy elastic silt
≥15% gravel
Sandy elastic silt with gravel
% sand <% gravel
<15% sand
Gravelly elastic silt
≥15% sand
Gravelly elastic silt with sand
Organic (LL—oven-dried / LL—not dried < 0.75)
OH
See Figure 4.10c

# USCS cntd


GROUP SYMBOL
GROUP NAME
OL
PI≥4 and plots on or above "A"–line
<30% plus No. 200
<15% plus No. 200
Organic clay
15%≤+No. 200 <30%
% sand ≥% gravel
Organic clay with sand
% sand <% gravel
Organic clay with gravel
≥30% plus No. 200
% sand ≥% gravel
<15% gravel
Sandy organic clay
≥15% gravel
Sandy organic clay with gravel
% sand <% gravel
<15% sand
Gravelly organic clay
≥15% sand
Gravelly organic clay with sand
PI<4 or plots below "A"–line
<30% plus No. 200
<15% plus No. 200
Organic silt
15%≤+No. 200 <30%
% sand ≥% gravel
Organic silt with sand
% sand <% gravel
Organic silt with gravel
≥30% plus No. 200
% sand ≥% gravel
<15% gravel
Sandy organic silt
≥15% gravel
Sandy organic silt with gravel
% sand <% gravel
<15% sand
Gravelly organic silt
≥15% sand
Gravelly organic silt with sand
OH
Plots on or above "A"–line
<30% plus No. 200
<15% plus No. 200
Organic clay
15%≤+No. 200 <30%
% sand ≥% gravel
Organic clay with sand
% sand <% gravel
Organic clay with gravel
≥30% plus No. 200
% sand ≥% gravel
<15% gravel
Sandy organic clay
≥15% gravel
Sandy organic clay with gravel
% sand <% gravel
<15% sand
Gravelly organic clay
≥15% sand
Gravelly organic clay with sand
Plots below "A"–line
<30% plus No. 200
<15% plus No. 200
Organic silt
15%≤+No. 200 <30%
% sand ≥% gravel
Organic silt with sand
% sand <% gravel
Organic silt with gravel
≥30% plus No. 200
% sand ≥% gravel
<15% gravel
Sandy organic silt
≥15% gravel
Sandy organic silt with gravel
% sand <% gravel
<15% sand
Gravelly organic silt
≥15% sand
Gravelly organic silt with sand

**Plasticity Chart for USCS (PI Vs LL)**

- Clays, silts and organic soils lie below the line with the equation below and is called the 'A-Line'.

$$PI = 0.73(LL - 20)\%$$

- A-Line delineates the boundaries between clays and silts and organic soils.
- The U-Line defines the upper limit of the correlation between PI and LL.

$$PI = 0.9(LL - 8)\%$$

- The U-line indicates the upper bound for general soils.
- Note: If the measured limits of soils are on the left of U-line, they should be rechecked.

# USCS cntd

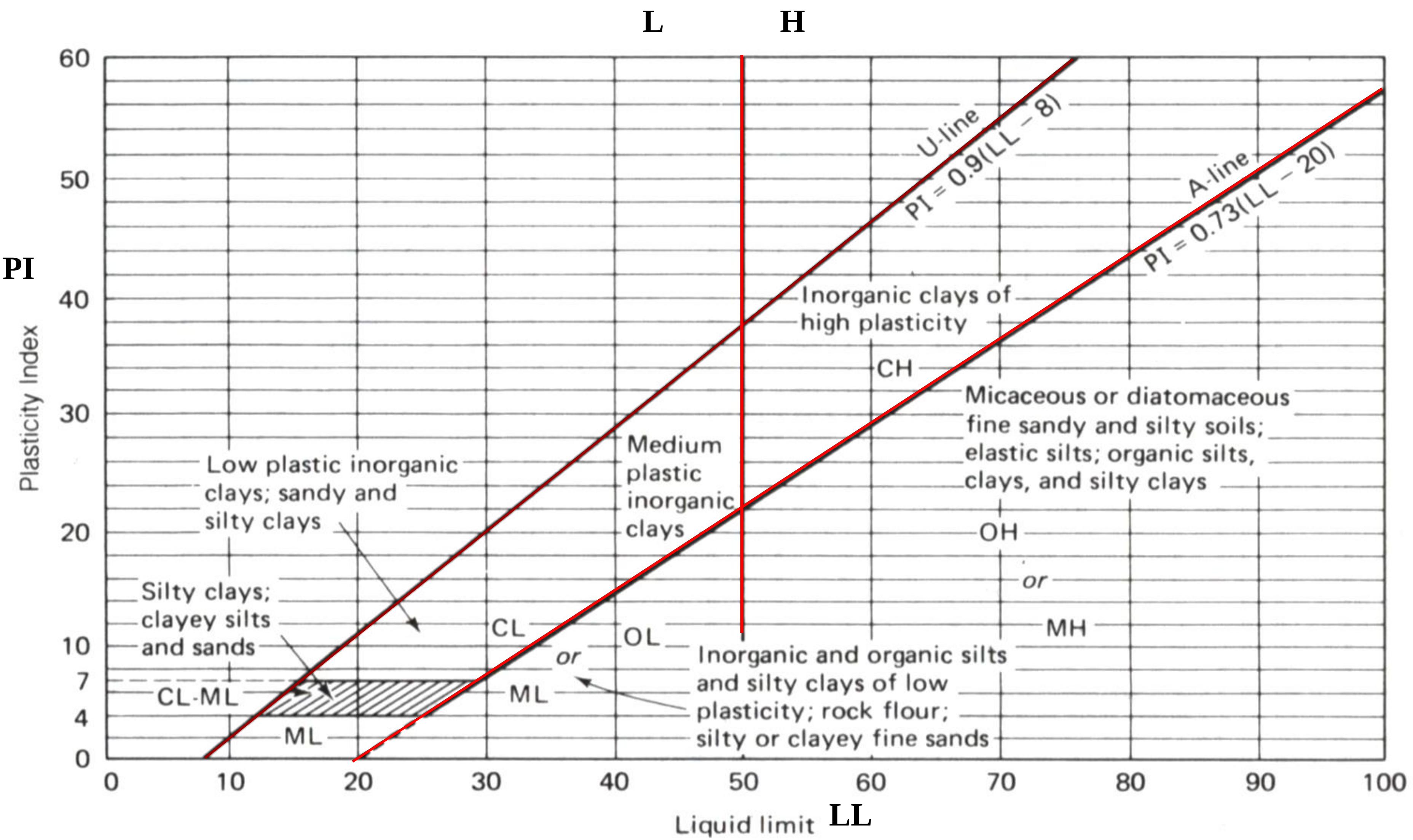



Fig. 3.2 Casagrande's plasticity chart, showing several representative soil types (developed from Casagrande, 1948, and Howard, 1977).

(Holtz and Kovacs, 1981)

**EXERCISE 3.1.2 – USCS**

Classifiy the soils in EXERCISE 3.1.1 using USCS if the corresponding Atterberg limits are provided as follows.

| Soil | Liquid Limit | | Plastic Limit |
|---|---|---|---|
| | Oven-dried | Not dried | |
| A | 36 | 36 | 22 |
| B | 30 | 30 | 10 |
| C | 18 | 26 | 12 |
| D | 40 | 50 | 24 |

# AASHTO = American Association of State Highway and Transportation Officials

Used to determine the suitability of soils for earthwork, embankments, and road bed materials.

- Classification is based on
  - Grain size distribution
  - Liquid limit
  - Plasticity index
- 8 major groups: A1~ A7 (with several subgroups) and organic soils A8

# AASHTO cntd

- A characteristic called **Group Index (GI)**, appended in parentheses to the main group, is used to describe the performance of a soil when used as a highway sub-grade material.

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

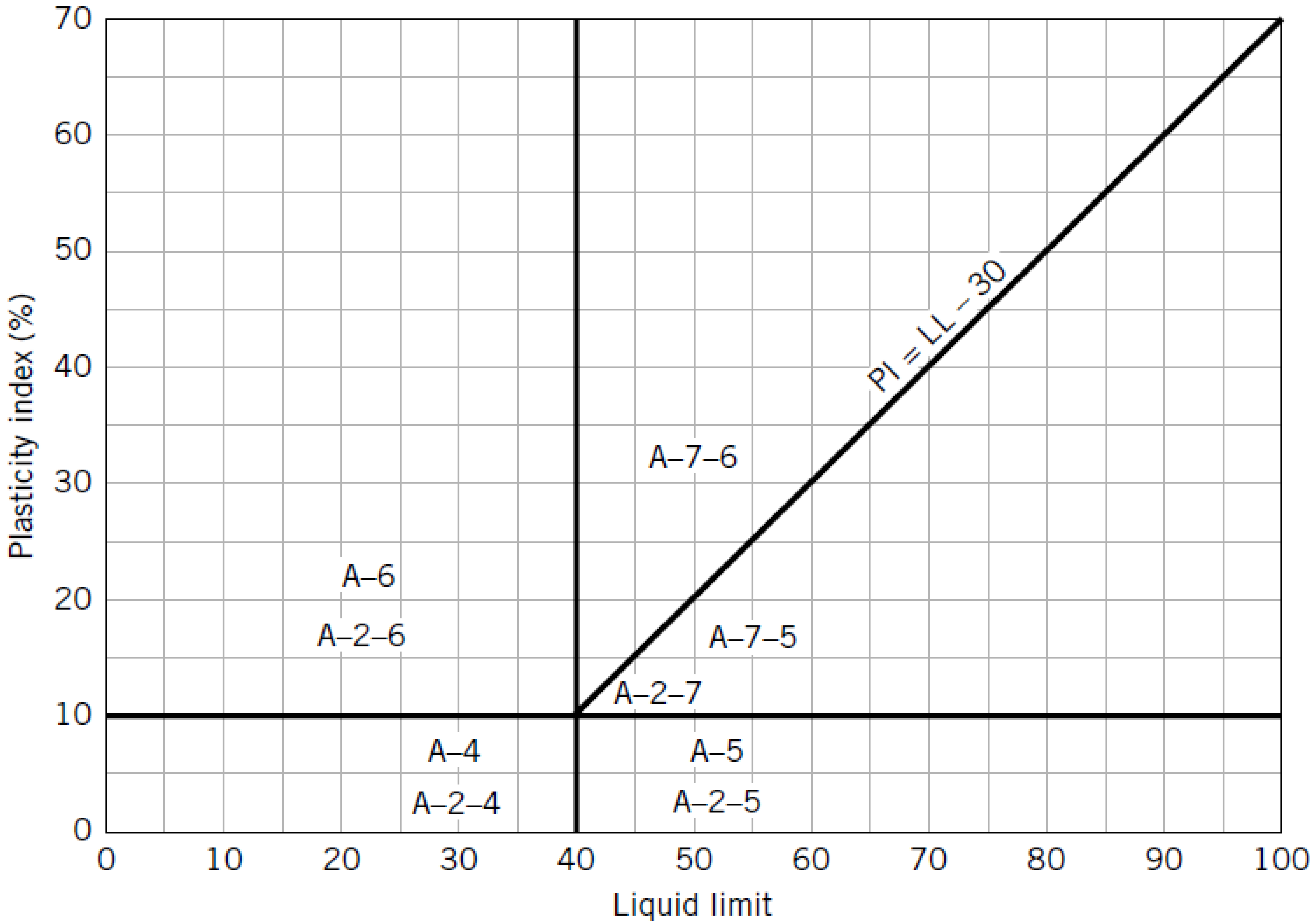
where F is percent passing NO.200 sieve.

- GI is reported to the nearest whole number, and if GI<0, it is set to 0.
- GI=0 for groups A-1-1, A-1-b, A-2-4, A-2-5, and A-3.
- $GI = 0.01(F - 15)(PI - 10)$ for groups A-2-6 and A-2-7.
- GI should not exceed 20 for any of groups A-4 through A-7.

# AASHTO cntd

| General Classification | Granular Materials (35% or less passing No. 200) | | | | | | | Silt-Clay Materials (More than 35% passing No. 200) | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Group Classification | A–1 | | A–3 | A–2 | | | | A–4 | A–5 | A–6 | A–7 |
| | A–1–a | A–1–b | | A–2–4 | A–2–5 | A–2–6 | A–2–7 | | | | A–7–5, A-7–6 |
| Sieve analysis, % passing | | | | | | | | | | | |
| No. 10 (2.00 mm) | 50 max | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... |
| No. 40 (425 m) | 30 max | 50 max | 51 min | ... | ... | ... | ... | ... | ... | ... | ... |
| No. 200 (75 m) | 15 max | 25 max | 10 max | 35 max | 35 max | 35 max | 35 max | 36 min | 36 min | 36 min | 35 min |
| Characteristics of fraction passing No. 40 (425 m) | | | | | | | | | | | |
| Liquid limit | ... | | ... | 40 max | 41 max | 40 max | 41 min | 40 max | 41 min | 40 max | 41 min |
| Plasticity index | 6 max | | N.P. | 10 max | 10 max | 11 min | 11 min | 10 max | 10 max | 11 min | 11 min[A] |
| Usual types of significant constituent materials | Stone Fragments, Gravel and Sand | | Fine Sand | Silty or Clayey Gravel and Sand | | | | Silty Soils | | Clayey Soils | |
| General rating as subgrade | Excellent to Good | | | | | | | Fair to Poor | | | |

# AASHTO cntd



Plasticity index (%)
70
60
50
40
30
20
10
0
0
10
20
30
40
50
60
70
80
90
100
Liquid limit
PI = LL – 30
A–7–6
A–6
A–2–6
A–7–5
A–2–7
A–4
A–2–4
A–5
A–2–5

# AASHTO cntd

**EXERCISE 3.1.3 – AASHTO Classification**

Classify the soils A through D in EXERCISE 3.1.2 using AASHTO classification system.

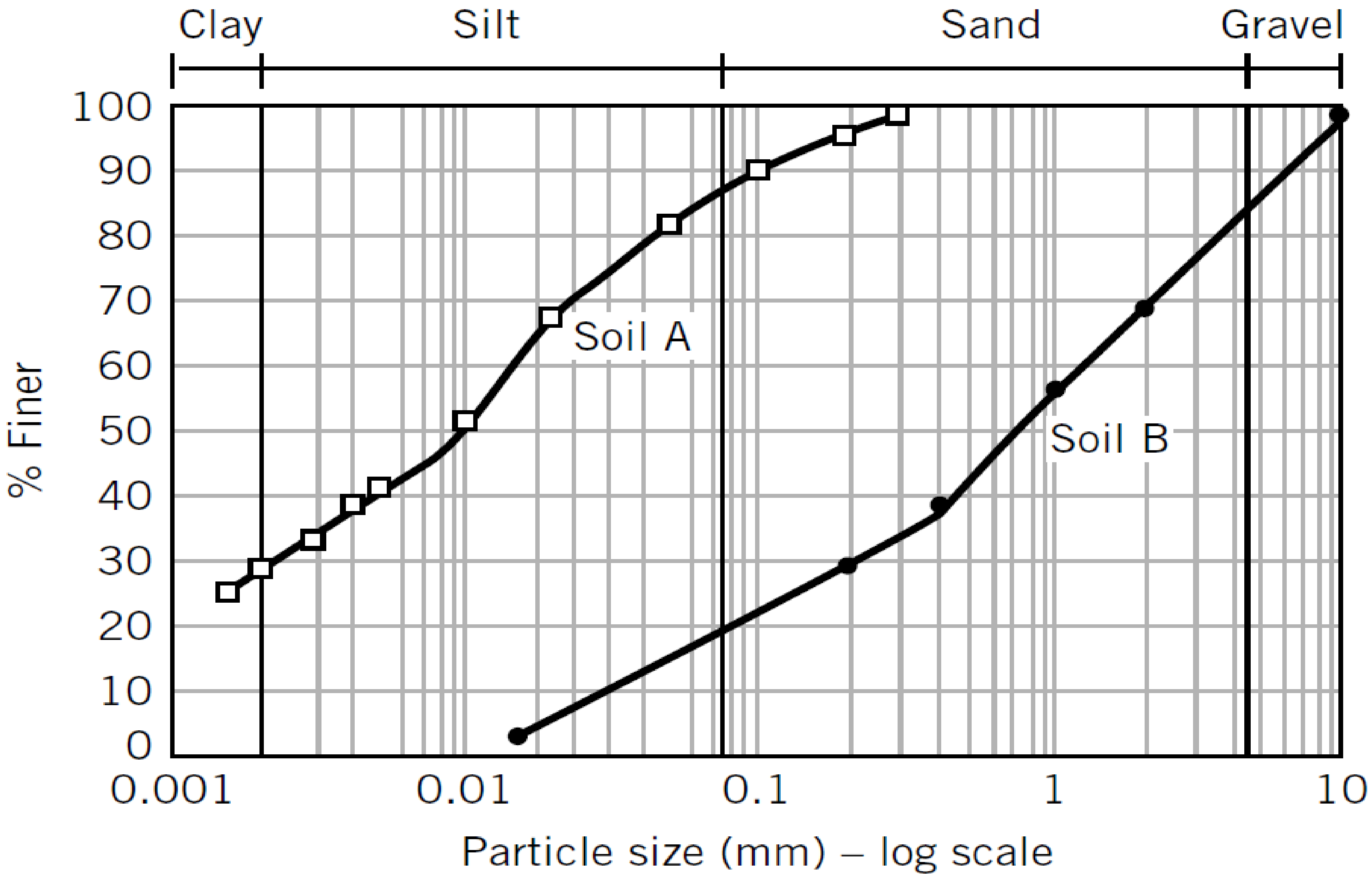
**EXERCISE 3.1.4 – Comparing USCS & AASHTO**

Particle size analyses were carried out on two soils—Soil A and Soil B—and the particle size distribution curves produced.

The Atterberg limits for the two soils are:

| Soil | LL | PL |
|---|---|---|
| A | 26 (oven-dried; asume same for not dried) | 18 |
| B | Non-plastic | |

# AASHTO cntd



Clay
Silt
Sand
Gravel
100
90
80
70
60
50
40
30
20
10
0
% Finer
Soil A
Soil B
0.001
0.01
0.1
1
10
Particle size (mm) – log scale

**EXERCISE 3.1.4 – Comparing USCS & AASHTO**

**(a)** Classify these soils according to USCS.

**(b)** Is either of the soils organic?

**(c)** In a preliminary assessment, which of the two soils is a better material for the core of a rolled earth dam?

**(d)** Classify Soils A and B according to the AASHTO system. Which soil is better for a subgrade?

# 2. Field Identification of Soils

- Introduction
- Coarse-grained Soils
- Fine Grained Soils
- Organic Soils

# Introduction cntd

**Common descriptive terms and methods of identification**

1. *Color*
2. *Moisture*
3. *Structure*
4. *Shape*
5. *Weathering*
6. *Carbonate*
7. *Smell*
8. *Feel*
9. *Consistency*
10. *Dilatancy*
11. *Packing*

# Introduction cntd

1. ***Color***: color is not directly related to engineering properties of soils, but is related to soil mineralogy and texture.
   - Gray and bluish: unoxidized soils
   - White and cream: calcareous soils (containing calcium carbonate)
   - Red and yellow: oxidized soils
   - Black and dark brown: soils containing organic matter
2. ***Moisture***: Appearance due to water is described as wet, dry or moist.

# Introduction cntd

3. ***Structure***:
   - Homogeneous: Color and texture feel the same throughout
   - Non-homogeneous: Color and texture vary

4. ***Shape***: Angular, sub-angular, sub-rounded, rounded, flaky
5. ***Weathering***: Fresh, decomposed, weathered
6. ***Carbonate***: Effervesces with acid. Add a small amount of hydrochloric acid and check if soil effervesces. If it does, it contains carbonate

# Introduction cntd

7. ***Smell***: Organic soils give off a strong odor that intensifies with heat. Non-organic soils have a subtle odor with the addition of water.
8. ***Feel***: Use feel to distinguish between sand, silt and clay
   - Sand: has gritty feel
   - Silt: has rough feel similar to fine sandpaper
   - Clay: feels smooth and greasy. It sticks to fingers when wet and is powdery when dry

# Introduction cntd

9. ***Consistency***

- Very stiff: Finger pressure barely dents soils, but it cracks under significant pressure
- Stiff: Finger pressure dents soil
- Firm: Soil can be molded using strong finger pressure
- Soft: Easily molded by finger
- Very soft: Soil flows between fingers when fist is closed

10. ***Dilatancy***: Place small amount of the soil in your palm and shake horizontally. Then strike it with the other hand. If the surface is slurry and water appears, the soil probably has a large amount of silt.

# Introduction cntd

11. ***Packing***: Coarse-grained soils are described as:
    - Very loose: collapses with slight disturbance; open structure
    - Loose: Collapses upon disturbance; open structure
    - Medium dense: Indents when pushed firmly
    - Dense: Barely deforms when pushed by feet or by stomping
    - Very dense: Impossible to depress with stomping

# Introduction cntd

Soils can be broadly identified in the field by conducting the following simple test.

The sample is first spread on a flat surface.

If more than 50% of the particles are visible to the naked eye, the soil is coarse-grained; otherwise, it is fine-grained.

The fine-grained particles are smaller than 0.075mm size and are not visible to naked eye.

# Introduction cntd

Feel Method

- Wet soil in hand
- Make ribbon
  - Length of ribbon indicates clay content
  - Grit or lack of grit indicates sand or silt
  - Smoothness indicates silt

# Introduction cntd

Sand - does not stick together in a mass unless it is very wet.

Silt - does not feel gritty; has floury feel

Clay - can be molded readily into a shape or rod; can be formed into long ribbons

# Coarse Grained Soils

- Engineers should have an idea of the relative sizes of the grains in order to identify the various fractions.
- The description of sand and gravel should include an estimate of the quantity of material in the different size ranges as well as a statement of the shape and mineralogical composition of the grains.
- The mineral grains can be rounded, sub-rounded, sub-angular, or angular. The presence of mica or a weak material such as shale affects the durability of compressibility of the deposit. A small magnifying glass can be used to identify the small fragments of shale or mica.

# Fine Grained Soils cntd

Inorganic Soils: - The constituent parts of fine-grained materials are silt and clay fractions. Since both these materials are microscopic in size, physical properties other than grain size must be used as criteria for field identification.

The classification tests used in the field for preliminary identification are;

- Dry strength test
- Shaking test
- Plasticity test

# Fine Grained Soils cntd

**Dry Strength Test**

- The strength of a soil in a dry state is an indication of its cohesion and hence of its nature.
- It can be estimated by crushing a 3mm size of a dried fragment between thumb and forefinger.
- A clay fragment can be broken only with a great effort, whereas a silt fragment crushes easily.

# Fine Grained Soils cntd

**Plasticity Test**

- If a sample of moist soil can be manipulated between the palms of the hands and fingers and rolled into a long thread of about 3mm diameter, the soil then contains a significant amount of clay.
- Whereas silt cannot be rolled into a thread of 3mm diameter without sever cracking.

# Fine Grained Soils cntd

**Shaking Test**

-also called as dilatancy test.

-helps to distinguish silt from clay since silt is more permeable than clay.

- In this test a part of soil mixed with water to a very soft consistency is placed in the palm of the hand.
- The surface of the soil is smoothed out with a knife and the soil pat is shaken by tapping the back of the hand. If the soil is silt, the water will rise quickly to the surface and give it a shiny glistening appearance.

# Fine Grained Soils cntd

- If the pat is then deformed either by squeezing or by stretching, the water will flow back into the soil and leave the surface with a dull appearance.
- Since clay soils contain much smaller voids than silts and are much less permeable, the appearance of the surface of pat does not change during the shaking test.
- An estimate of the relative proportions of silt and clay in an unknown soil mixture can be made by noting whether the reaction is rapid, slow or non-existent.

# Organic Soils

- Surface soils and many underlying formations may contain significant amounts of solid matter derived from organisms.
- While shell fragments and similar solid matter are found at some locations, organic material in soil is usually derived from plant or root growth and consists of almost completely disintegrated matter, such as much or more fibrous material, such as peat.

# Organic Soils cntd

- The soils with organic matter are weaker and more compressible than soils having the same mineral composition but lacking in organic matter.

- The presence of an appreciable quantity of organic material can usually be recognized by the dark-grey to black colour and odour of decaying vegetation, which it lends to the soil.

# Organic Soils cntd

**Organic Silt**

- It is a fine-grained more or less plastic soil containing mineral particles of silt size and finely divided particles of organic matter.
- Shells and visible fragments of partly decayed vegetative matter may also be present.

# Organic Soils cntd

**Organic Clay**

- It is a clay soil, which owes some of its significant physical properties to the presence of finely divided organic matter.
- Highly organic soil deposits such as peat or muck may be distinguished by a dark-brown to black color, by the presence of fibrous particles of vegetable matter in varying states of decay.
- The organic odor is a distinguishing characteristic of the soil. The organic odor can sometimes be distinguished by a slight amount of heat.

| SOIL GROUP | PRINCIPLE SOIL TYPE | PARTICLE SIZE, MM | | VISUAL IDENTIFICATION | RELATIVE DENSITY/ CONSISTENCY: TERM / FIELD TEST |
|---|---|---|---|---|---|
| VERY COARSE SOILS | Boulder | Large Boulder | 630 | Only seen complete in pits or exposures<br>Often difficult to recover whole from boreholes | None defined.<br>Qualitative description of packing by inspection and ease of excavation |
| | | Boulder | 200 | | |
| | Cobble | Cobble | 63 | | |
| COARSE SOILS (OVER 65% SAND AND GRAVEL SIZES) | Gravel | Coarse | 20 | Easily visible to naked eye; particle shape can be described; grading can be described | BOREHOLE WITH SPT N VALUE |
| | | Medium | 6.3 | | Very loose. 0-4 |
| | | Fine | 2 | | Loose. 4-10 |
| | Sand | Coarse | 0.63 | Visible to naked eye; no cohesion when dry; grading can be described | Medium dense. 10-30 |
| | | Medium | 0.2 | | Dense. 30-50 |
| | | Fine | 0.063 | | Very dense. >50 |
| FINE SOILS (35% SILT AND CLAY SIZES) | Silt | Coarse | 0.02 | Only coarse silt visible with hand lens; exhibits little plasticity and marked dilatancy; slightly granular or silky to the touch; disintegrates in water; lumps dry quickly; possesses cohesion but can be powdered easily between fingers | Very soft. Finger easily pushed in up to 25mm; exudes between fingers |
| | | Medium | 0.0063 | | Soft. Finger pushed in up to 10mm; moulded by light finer pressure |
| | | Fine | 0.002 | | Firm. Thumb makes impression easily; cannot be moulded by fingers; rolls to thread |
| | Clay | | | Dry lumps can be broken but not powdered between fingers; they also disintegrate under water but more slowly than silt; smooth to the touch; exhibits plasticity but no dilatancy; sticks to the fingers and dries slowly; shrinks appreciably on drying, usually showing cracks | Stiff. Can be indented slightly by thumb; cannot be moulded;<br>Very stiff. Can be indented by thumb; cannot be moulded; crumbles |

## DISCONTINUITIES

Describe spacing of features such as fissures, shears, partings, isolated beds or laminae, desiccation cracks, rootlets, etc

Fissured
Soil breaks into blocks along unpolished discontinuities

Sheared
Soil breaks into blocks along polished discontinuities

## BEDDING

Describe thickness of beds in accordance with geological definition

Alternating layers of different types

Inter-bedded or inter-laminated

Prequalified by thickness term if in equal proportions

Otherwise thickness of and spacing between subordinate layers defined

| SCALE OF SPACING OF DISCONTINUITIES: TERM / MEAN SPACING, MM | SCALE OF SPACING OF DISCONTINUITIES: TERM / MEAN SPACING, MM |
|---|---|
| Very widely >2000 | Very thickly bedded >2000 |
| Widely 2000-600 | Thickly bedded 2000-600 |
| Medium 600-200 | Medium bedded 600-200 |
| Closely 200-60 | Thinly bedded 200-60 |
| Very closely 60-20 | Very thinly bedded 60-20 |
| Extremely closely 20-6 | Thickly laminated 20-6 |
| | Thinly laminated <6 |

## COLOUR

LIGHTNESS

Light
Dark

CHROMA

Pinkish
Reddish
Yellowish
Orangish
Brownish
Greenish
Bluish
Greyish
etc

HUE

Pink
Red
Orange
Cream
Brown
Yellow
Green
Blue
White
Grey
Black

More than 3 colours is multicoloured

Colours may be mottled

## COMPOSITE SOIL TYPES (MIXTURES OF BASIC SOIL TYPES)

For mixtures involving very coarse soils see BS 5930:1999 Cl41.4.4.2

| TERM BEFORE PRINCIPAL SOIL TYPE | PROPORTION OF SECONDARY (SEE NOTE A) |
|---|---|
| slightly (sandy) (See note B) | <5% |
| (sandy) (See note B) | 5 – 20% (See note C) |
| very (sandy) (See note B) | >20% (See note C) |
| SAND AND GRAVEL | About 50% |

| TERM BEFORE PRINCIPAL SOIL TYPE | PROPORTION OF SECONDARY (SEE NOTE A) |
|---|---|
| slightly (sandy) (See note D) | <35% |
| (sandy) (See note D) | 35% - 65% (See note E) |
| very (sandy) (See note F) | >65% (See note E) |
| Silty CLAY<br>Clayey SILT | Terms used to reflect secondary fine constituents where this is important |

## MINERALOGY

Mineralogical terms can include:
glauconitic
micaceous
calcareous (see below)
shelly
organic

slightly (glauconitic)

(glauconitic)

very (glauconitic)

Proportions defined on a site or material specific basis or subjectively

Carbonate content
Slightly calcareous – weak or sporadic effervescence from HCl
Calcerous - clear but not sustained effervescence from HCl
Highly calcerous - strong and sustained effervescence from HCl

## PARTICLE SHAPE

Angularity
Very angular
Angular
Subangular
Subrounded
Rounded
Well rounded

Shape
Cubic
Flat
Elongate

## PRINCIPAL SOIL TYPE

Boulder
Cobble
Gravel
Sand
Silt
Clay

## TERTIARY CONSTITUENTS

Terms can include:

shell fragments
pockets of peat
gypsum crystals
brick fragments
roots
rootlets
fossil roots
fossil rootlets
plastic bags
etc

with rare

with occasional

with numerous/ frequent/abundant

Proportions defined on a site or material basis, or subjectively

## GEOLOGICAL UNIT

Name in accordance with published geological maps, memoirs or sheet explanation

For example:

RIVER TERRACE DEPOSITS

GLACIAL SAND AND GRAVEL

MADE GROUND

BRICK EARTH

DARTFORD SILT MEMBER

WEATHERED CHARMOUTH MUDSTONE FORMATION

CLAY WITH FLINTS

OXFORD CLAY

GLACIAL TILL

EMBANKMENT FILL

ALLUVIUM

TOPSOIL

UPPER MOTTLED CLAY, LAMBETH GROUP

## ORGANIC SOILS

| CONDITION | | |
|---|---|---|
| Firm | Spongy | Plastic |
| Fibres compressed together | Very compressible open structure | Can be moulded in hand; smears fingers |

| ACCUMULATED IN SITU | |
|---|---|
| PEAT | Predominately plant remains, usually dark brown or black in colour, distinctive smell, and low bulk density; can include disseminated or discrete inorganic particles |
| Fibrous peat | Plant remains recognisable and retain some strength; water and no solids on squeezing |
| Pseudo-fibrous peat | Plant remains recognisable and strength lost; turbid water and <50% solids on squeezing |
| Amorphous peat | No recognisable plant remains; mushy consistency; paste and >50% solids on squeezing |

### TRANSPORTED MIXTURES

Contains finely divided or discrete particles of organic matter, often with distinctive smell, may oxidise rapidly. Describe as for inorganic soils using terms above.

| TERM | COLOUR |
|---|---|
| Slightly Organic | Grey |
| Organic | Dark Grey |
| Very Organic | Black |

## NOTES

A Percentage coarse or fine soil assessed excluding cobbles and boulders
B Gravelly or sandy and/or silty or clayey
C Or described as fine soil depending on mass behaviour
D Gravelly and/or sandy
E Or described as coarse soil depending on mass behaviour
F Gravelly or sandy

## SAMPLE DESCRIPTIONS:

- Loose brown very sandy subangular fine to coarse flint GRAVEL with small pockets (up to 30mm) of clay (TERRACE GRAVELS)
- Medium dense light brown gravelly clayey fine SAND. Gravel is fine (GLACIAL DEPOSITS)
- Stiff closely sheared medium strength orange mottled brown slightly sandy slightly gravelly CLAY. Gravel is fine and medium of quartzite. (REWORKED LONDON CLAY)
- Firm thinly laminated grey silty CLAY with closely spaced thick laminae of sand (ALLUVIUM)
- Plastic brown clayey amorphous PEAT


# አመሰግናለሁ!

# Galatoma!