Soil Mechanics and Founadtion Engineering

Rohit Sharma

Introduction

- Soil mechanics :- It may be defined as the branch of science which deals with the study of soil, its behaviour and its applications as an engineering material.
- Foundation engineering :- The branch of Civil Engineering, which deals with the design, construction, maintenance and renovation of footings and foundations of walls and other structures.

Importance

1. As a foundation material

i) In Buildings; ii) Roads and iii) Other Structures;

2. As a construction material

i) In earthen dams; ii) Bricks; iii) Embankments and iv) Other Structures;

Soil Classification

- Generally, soils are classified based on the soil grain size distribution and plasticity. Some of the popular systems of soil classifications are:
- Textural Soil Classification
- AASHTO Soil Classification System
- Unified Soil Classification System (USCS)
- Indian Standard Soil Classification System (ISSCS)

Indian Standard Soil Classification System

- ISSCS is the same as USCS with one modification the fine-grained soils are subdivided into 3 subgroups of low, medium, and high compressibility, whereas, in USCS, fine-grained soils are subdivided into 2 subgroups of low and high compressibility. 4 major groups and their symbol are given below:
- Coarse-grained soils - Gravel (G) and Sand (S)
- Fine-grained soils - Silt (M) and Clay (C)
- Organic soils (O)
- Peat (Pt)

Indian Standard Soil Classification System

- **Classification of Coarse-Grained Soil**

Case 1: %fineness < 5% by weight

The coarse-grained soils are classified as Gravel (G) if more than 50% of the coarse fraction of the soil is retained on a 4.75 mm sieve; otherwise, it is classified as Sand (S). They are further divided based on their gradation characteristics.

Gravel: Coarse fraction retained on 4.75 mm > 50%

- GW ⇒ Well-graded gravel
  $C_u \geq 4$ and $1 \leq C_c \leq 3$
- GP ⇒ Poorly graded gravel
  $C_u < 4$, or $1 > C_c$, or $C_c > 3$

Sand: Coarse fraction retained on 4.75 mm < 50%

SW ⇒ Well-graded sand
$C_u \geq 6$ and $1 \leq C_c \leq 3$

SP ⇒ Poorly graded sand
$C_u < 6$, or $1 > C_c$, or $C_c > 3$

Indian Standard Soil Classification System

- **Classification of Coarse-Grained Soil**

<u>Case 2: 5% < %fineness < 12% by weight</u>

Gravel: Coarse fraction retained on 4.75 mm > 50%

- GW-GC ⇒ Well-graded gravel containing clay as fine $C_u \geq 4$ and $1 < C_c < 3$ and clay fraction > silt fraction
- GP-GC ⇒ Poorly graded gravel containing clay as fine $C_u < 4$ or $1 > C_c$ or $C_c > 3$ and clay fraction> silt fraction
- GW-GM ⇒ Well-graded gravel containing silt as fine Cu ≥ 4 and 1 < Cc < 3 and clay fraction < silt fraction
- GP-GM ⇒ Poorly graded gravel containing silt as fine $C_u < 4$, or $1 > C_c$, or $C_c > 3$ and clay fraction < silt fraction

Indian Standard Soil Classification System

- **Classification of Coarse-Grained Soil**

Case 2: 5% < %fineness < 12% by weight

Sand: Coarse fraction retained on 4.75 mm < 50%

- SW-SC ⇒ Well-graded sand containing clay as fine $C_u \geq 6$ and $1 < C_c < 3$ and clay fraction > silt fraction
- SP-SC ⇒ Poorly graded sand containing clay as fine $C_u < 6$ or $1 > C_c$ or $C_c > 3$ and clay fraction> silt fraction
- SW-SM ⇒ Well-graded sand containing silt as fine $C_u \geq 6$ and $1 < C_c < 3$ and clay fraction < silt fraction
- SP-SM ⇒ Poorly graded sand containing silt as fine $C_u < 6$, or $1 > C_c$, or $C_c > 3$ and clay fraction < silt fraction

Indian Standard Soil Classification System

- **Case 3: %fineness > 12% by weight**

In this case, coarse-grained soil is classified based on its grain size and plasticity chart. The subgroups for this case are as follows:

Gravel: Coarse fraction retained on 4.75 mm > 50%

- GC ⇒ Clayey gravel
  I_p > 7% (clay fraction > silt fraction)
- GM ⇒ Silty gravel
  I_p < 4% (silt fraction > clay fraction)

Sand: Coarse fraction retained on 4.75 mm < 50%

- SC ⇒ Clayey sand
  I_p > 7% (clay fraction > silt fraction)
- SM ⇒ Silty sand
  I_p < 4% (silt fraction > clay fraction)

Indian Standard Soil Classification System

- **Classification of Fine-Grained Soil**

  The A-line is a boundary that represents the relationship between I_P and w_L. The equation of A-line is given as

  $$I_P = 0.73(w_L - 20)$$

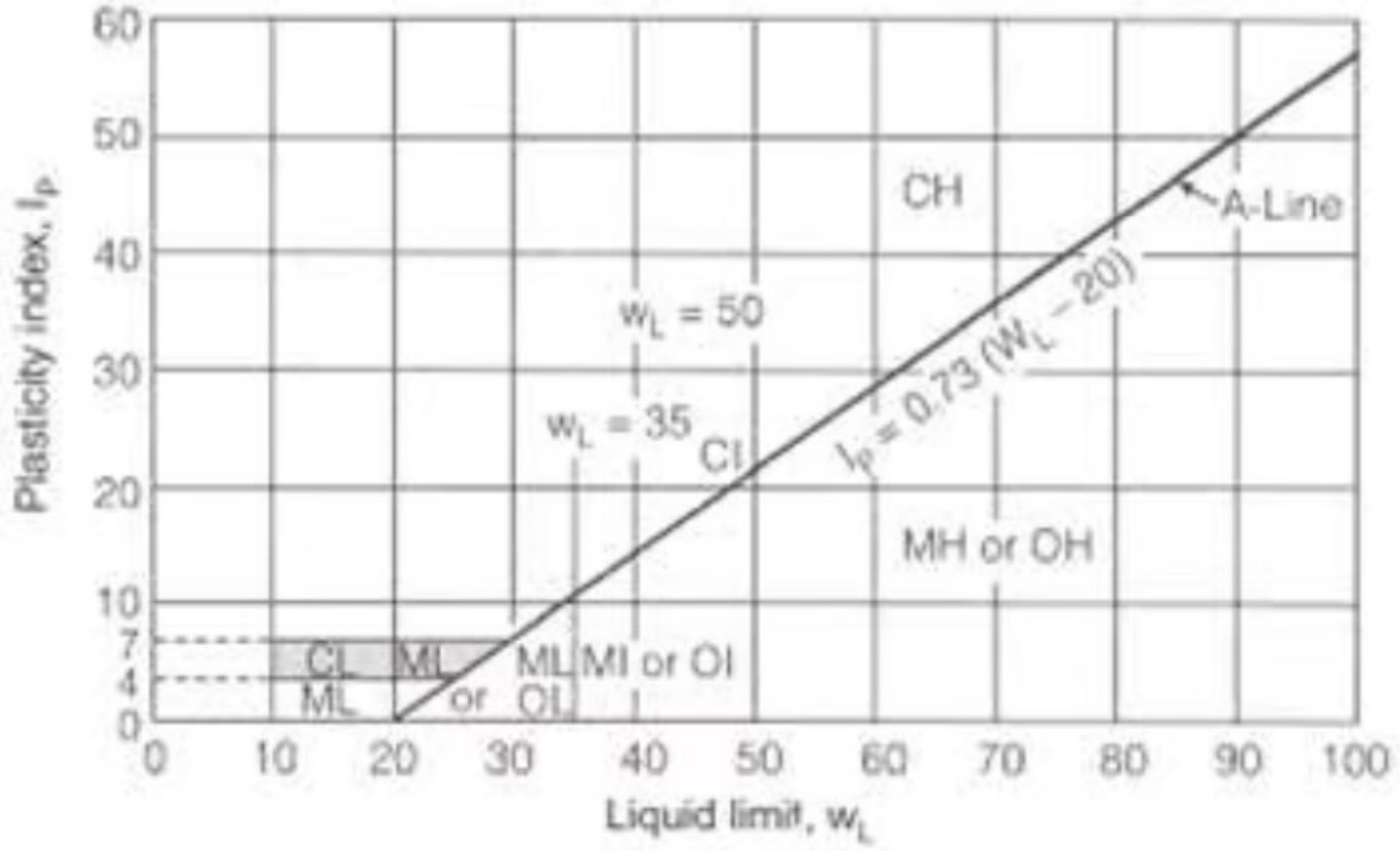
  If the soil lies above A-line (IP of soil > IP of A-line), then it is clay(C), and if the soil lies below A-line (IP of soil < IP of A-line), then it is either silt (M) or organic soil (O). Another boundary line, the U-line, represents the upper limit beyond which no soil should exist. If the soil goes above this boundary, the test to determine wL and wP is performed again. The equation for U-line is given as

  $$I_P = 0.9(w_L - 8)$$

Indian Standard Soil Classification System

- **Case 1: $w_L < 35\%$**
  The soil has low compressibility and is classified as low plastic soil. The low plastic soil can be denoted as CL (low plastic inorganic clay), ML (low plastic silt) or OL (low plastic organic clay)
- **Case 2: $35\% < w_L < 50\%$**
  The soil has intermediate compressibility and is classified as medium plastic soil. The medium plastic soil can be denoted as CI (medium plastic inorganic clay), MI (medium plastic silt) and OI (medium plastic organic clay)
- **Case 3: $w_L > 50\%$**
  The soil has high compressibility and is classified as highly plastic soil. The highly plastic soil can be denoted as CH (high plastic inorganic clay), MH (high plastic silt) and OH (high plastic organic clay).

Indian Standard Soil Classification System



Thank You