

Organic Silts and Clays

If the soil has a dark color and an organic odor when moist and warm, a second liquid limit test shall be performed on a test specimen which has been oven dried at $110 \pm 5^\circ\text{C}$ to a constant weight.

The soil is an organic silt or organic clay if the liquid limit after oven drying is less than 75 % of the liquid limit of the value determined before oven drying.

USCS

Table 4.2 Unified Soil Classification System (Based on Material Passing 75-mm Sieve)

| Criteria for Assigning Group Symbols | | | | Group Symbol |
|--|--|------------------------------------|---|--------------|
| Coarse-Grained Soils More than 50% of retained on No. 200 sieve | Gravels More than 50% of coarse fraction retained on No. 4 sieve | Clean Gravels | $C_u \geq 4$ and $1 \leq C_c \leq 3^c$ | GW |
| | | Less than 5% fines ^a | $C_u < 4$ and/or $1 > C_c > 3^c$ | GP |
| | Gravels with Fines More than 12% fines ^{a,d} | Gravels with Fines | $PI < 4$ or plots below "A" line (Figure 4.2) | GM |
| | | More than 12% fines ^{a,d} | $PI > 7$ and plots on or above "A" line (Figure 4.2) | GC |
| Fine-Grained Soils 50% or more passes No. 200 sieve | Sands 50% or more of coarse fraction passes No. 4 sieve | Clean Sands | $C_u \geq 6$ and $1 \leq C_c \leq 3^c$ | SW |
| | | Less than 5% fines ^b | $C_u < 6$ and/or $1 > C_c > 3^c$ | SP |
| | Sands with Fines More than 12% fines ^{b,d} | Sands with Fines | $PI < 4$ or plots below "A" line (Figure 4.2) | SM |
| | | More than 12% fines ^{b,d} | $PI > 7$ and plots on or above "A" line (Figure 4.2) | SC |
| Silts and Clays Liquid limit less than 50 | Inorganic | | $PI > 7$ and plots on or above "A" line (Figure 4.2) ^e | CL |
| | | | $PI < 4$ or plots below "A" line (Figure 4.2) ^e | ML |
| | Organic | ★ Liquid limit—oven dried | < 0.75 ; see Figure 4.2; OL zone | OL |
| | | ★ Liquid limit—not dried | | |
| Silts and Clays Liquid limit 50 or more | Inorganic | | PI plots on or above "A" line (Figure 4.2) | CH |
| | | | PI plots below "A" line (Figure 4.2) | MH |
| | Organic | ★ Liquid limit—oven dried | < 0.75 ; see Figure 4.2; OH zone | OH |
| | | ★ Liquid limit—not dried | | |
| Highly Organic Soils | Primarily organic matter, dark in color, and organic odor | | | Pt |

^aGravels with 5 to 12% fine require dual symbols: GW-GM, GW-GC, GP-GM, GP-GC.

^bSands with 5 to 12% fines require dual symbols: SW-SM, SW-SC, SP-SM, SP-SC.

$$C_u = \frac{D_{60}}{D_{10}}; \quad C_c = \frac{(D_{30})^2}{D_{60} \times D_{10}}$$

^dIf $4 \leq PI \leq 7$ and plots in the hatched area in Figure 4.2, use dual symbol GC-GM or SC-SM.

^eIf $4 \leq PI \leq 7$ and plots in the hatched area in Figure 4.2, use dual symbol CL-ML.

Example

The table below shows the sieve analysis results obtained on a sample of soil. Assume that tests on the portion passing the No. 40 sieve show $LL = 16$ and $PL = 11$. Classify the soil using the USCS.

| U.S. sieve (1) | Opening (mm) (2) | Mass retained on each sieve (g) (3) | Cumulative mass retained above each sieve (g) (4) | Percent finer ^a (5) |
|----------------|------------------|-------------------------------------|---|--------------------------------|
| 4 | 4.75 | 0 | 0 | 100 |
| 10 | 2.00 | 21.6 | 21.6 | 95.2 |
| 20 | 0.850 | 49.5 | 71.1 | 84.2 |
| 40 | 0.425 | 102.6 | 173.7 | 61.4 |
| 60 | 0.250 | 89.1 | 262.8 | 41.6 |
| 100 | 0.150 | 95.6 | 358.4 | 20.4 |
| 200 | 0.075 | 60.4 | 418.8 | 6.9 |
| Pan | — | 31.2 | 450 = ΣM | |

Example 2.1

Example

Part c

From Eq. (2.7),

$$C_u = \frac{D_{60}}{D_{10}} = \frac{0.41}{0.09} = \mathbf{4.56}$$

Part d

From Eq. (2.8),

$$C_c = \frac{D_{30}^2}{D_{60} \times D_{10}} = \frac{(0.185)^2}{(0.41)(0.09)} = \mathbf{0.93}$$

Example 2.1

Dual-Symbol Sands and Gravels

If the fines plot as a silty clay, CL-ML, the second group symbol should be either GC or SC.

For example, a poorly graded sand with 10% fines, a liquid limit of 20, and a plasticity index of 6 would be classified as a poorly graded sand with silty clay, SP-SC.