

**Appendix to rule 901:10-2-03****Soils – Engineering Classification (National Soil Survey Handbook 618.23 – 2013)**

The National Soil Survey Handbook and other technical and procedural references provide the standards, guidelines, definitions, policy, responsibilities, and procedures for conducting the National Cooperative Soil Survey of the United States. The following are accepted guidelines for classifying soils.

**A. AASHTO Group Classification**

- (1) **Definition.**—“AASHTO group classification” is a system that classifies soils specifically for geotechnical engineering purposes that are related to highway and airfield construction. It is based on particle-size distribution and Atterberg limits, such as liquid limit and plasticity index. This classification system is covered in Standard No. M 145-82, published by the American Association of State Highway and Transportation Officials (AASHTO), and consists of a symbol and a group index. The classification is based on that portion of the soil that is smaller than 3 inches in diameter.
- (2) **Classes.**—The AASHTO classification system identifies two general classifications: granular materials having 35 percent or less, by weight, particles smaller than 0.074 mm in diameter and silt-clay materials having more than 35 percent, by weight, particles smaller than 0.074 mm in diameter. These two divisions are further subdivided into seven main group classifications. The group and subgroup classifications are based on estimated or measured grain-size distribution and on liquid limit and plasticity index values.
- (3) **Significance.**—The group and subgroup classifications of this system aid in the evaluation of soils for highway and airfield construction. The classifications can help to make general interpretations relating to performance of the soil for engineering uses, such as highways and local roads and streets.
- (4) **Measurements.**—Measurements involve sieve analyses for the determination of grain-size distribution of that portion of the soil between a 3 inch and 0.074 mm particle size. ASTM Designations D 422, C 136, and C 117 have applicable procedures for the determination of grain-size distribution. The liquid limit and plasticity index values (ASTM Designation D 4318) are determined for that portion of the soil having particles smaller than 0.425 mm in diameter (no. 40 sieve). Measurements, such as laboratory tests, are made on most benchmark soils and on other representative soils in survey areas.
- (5) **Estimates.**—During soil survey investigations and field mapping activities, the soil is classified by field methods. This classification involves making estimates of particle-size fractions by a percentage of the total soil, minus the greater-than-3-inch fraction. Estimates of liquid limit and plasticity index are based on clay content and mineralogy relationships. Estimates are expressed in ranges that include the estimating accuracy as well as the range of values for the taxon.
- (6) **Entries.**—Enter classes and separate them by commas for each horizon, for example, A-7, A-6. The acceptable entries for AASHTO group are A-1, A-1-a, A-1-b, A-2, A-2-4, A-2-5, A-2-6, A-2-7, A-3, A-4, A-5, A-6, A-7, A-7-5, A-7-6, and A-8.

**B. AASHTO Group Index**

- (1) **Definition.**—The AASHTO group and subgroup classifications may be further modified by the addition of a group index value. The empirical group index formula was devised for

approximate within-group evaluation of the “clayey granular” materials and the “silty-clay” materials.

(2) Significance.—The group index aids in the evaluation of the soils for highway and airfield construction. The index can help to make general interpretations relating to performance of the soil for engineering uses, such as highways and local roads and streets.

(3) Measurement.—The group index (GI) is calculated from an empirical formula:

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

Where:

F = percentage passing sieve No. 200 (75 micrometer), expressed as a whole number

LL = liquid limit

PI = plasticity index

In calculating the group index of A-2-6 and A-2-7 subgroups, only the PI portion of the formula is used.

(4) Entries.—The group index is reported to the nearest integer. If the calculated group index is negative, the group index value is zero. The minimum group index value is 0 and the maximum is 120.

### C. Unified Soil Classification

(1) Definition.—The “Unified soil classification system” is a system that classifies mineral and organic mineral soils for engineering purposes based on particle-size characteristics, liquid limit, and plasticity index.

(2) Classes

(i) The Unified soil classification system identifies three major soil divisions:

- a. Coarse-grained soils having less than 50 percent, by weight, particles smaller than 0.074 mm in diameter.
- b. Fine-grained soils having 50 percent or more, by weight, particles smaller than 0.074 mm in diameter.
- c. Highly organic soils that demonstrate certain organic characteristics. These divisions are further subdivided into a total of 15 basic soil groups.

(ii) The major soil divisions and basic soil groups are determined on the basis of estimated or measured values for grain-size distribution and Atterberg limits. ASTM Designation D 2487 shows the criteria chart used for classifying soil in the Unified system, the 15 basic soil groups of the system, and the plasticity chart for the system.

(3) Significance.—The various groupings of this classification have been devised to correlate in a general way with the engineering behavior of soils. This correlation provides a useful first step in any field or laboratory investigation for engineering purposes. It can be used to make some general interpretations relating to probable performance of the soil for engineering uses.

(4) Measurement.—The methods for measurement are provided in ASTM Designation D 2487. Measurements involve sieve analysis for the determination of grain-size distribution of that portion of the soil between 3 inches and 0.074 mm in diameter (no. 200 sieve). ASTM Designations D 422, C 136, and C 117 have applicable procedures that are used, where appropriate, for the determination of grain-size distribution. Values for the Atterberg limits

- (liquid limit and plasticity index) are also used. Specific tests are made for that portion of the soil having particles smaller than 0.425 mm in diameter (no. 40 sieve) according to ASTM Designations D 423 and D 424. Measurements, such as laboratory tests, are made on most benchmark soils and on other representative soils in survey areas.
- (5) Entries for Measured Data.—For measured Unified data, enter up to four classes for each horizon. ASTM Designation D 2487 provides flow charts for classifying the soils. Separate the classes by commas, for example, CL-ML, ML. Acceptable entries are GW, GP, GM, GC, SW, SP, SM, SC, CL, ML, OL, CH, MH, OH, PT, CL-ML, GW-GM, GW-GC, GP-GM, GP-GC, GC-GM, SW-SM, SW-SC, SP-SM, SP-SC, and SC-SM.
  - (6) Estimates.—The methods for estimating are provided in ASTM Designation D 2488. During all soil survey investigations and field mapping activities, the soil is classified by field methods. The methods include making estimates of particle-size fractions by a percentage of the total soil. The Atterberg limits are also estimated based on the wet consistency, ribbon or thread toughness, and other simple field tests. These tests and procedures are explained in ASTM Designation D 2488. If samples are later tested in the laboratory, adjustments are made to field procedures as needed. Estimates are expressed in ranges that include the estimating accuracy as well as the range of values from one location to another within the map unit. If an identification is based on visual-manual procedures, it must be clearly stated so in reporting.
  - (7) Entries for Estimated Soils.—For estimated visual-manual Unified data, enter up to four classes for each horizon. ASTM Designation D 2488 provides flow charts for classifying the soils. Separate the classes by commas, for example, CL, ML, SC. Acceptable entries are GW, GP, GM, GC, SW, SP, SM, SC, CL, ML, OL, CH, MH, OH, PT, CL-ML, GW-GM, GW-GC, GP-GM, GP-GC, GC-GM, SW-SM, SW-SC, SP-SM, SP-SC, and SC-SM.

Source: National Soil Survey Handbook (2013). USDA-National Resources Conservation Service, Washington, DC.