Appendix to rule 901:10-2-03

Soils - Engineering Classification (National Soil Survey Handbook 618.20 - 2001)

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 in the United States. The following are accepted guidelines for classifying soils.

(a) AASHTO (American Association of State Highway and Transportation Officials) Group Classification

(1) Definition

AASHTO group classification is a system that classifies soils specifically for geotechnical engineering purposes. It is based on particle-size distribution and Atterberg limits, such as liquid limit and plasticity index. This classification system is covered in AASHTO Standard No. M 145-91 (1995) 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: (i) granular materials having 35 percent or less, by weight, particles smaller than 0.074 mm in diameter and (ii) 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 are aids in the evaluation of soils. The classifications can help to make general interpretations relating to performance of the soil for engineering uses.

(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 methods 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 method 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 and particle-size distribution 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. Acceptable entries are A-1, A-l-A, A-l-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.

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 is an aid in the evaluation of the soils. The index can help to make general interpretations relating to performance of the soil for engineering uses.

Under average conditions of good drainage and thorough compaction and recompaction, the supporting value of a material as subgrade may be assumed as an inverse ratio to its group index, that is, a group index of 0 indicates a "good" subgrade material and group index of 20 or greater indicates a "very poor" subgrade material.

(3) Measurement

The group index 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. Negative group index is reported as zero (0).

For soils that are non-plastic and when the liquid limit cannot be determined, the group index shall be considered zero (0).

(4) Entries

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

(b) Unified Soil Classification

(1) Definition

The unified soil classification system is a system for classifying mineral and organic mineral soils for engineering purposes based on particle-size characteristics, liquid limit, and plasticity index.

(2) Classes

The Unified Soil Classification System identifies three major soil divisions: (i) coarse-grained soils having less than 50 percent, by weight, particles smaller than 0.074 mm in diameter; (ii) fine-grained soils having 50 percent or more, by weight, particles smaller than 0.074 mm in diameter, and (iii) highly organic soils that demonstrate certain organic characteristics. These divisions are further subdivided into a total of 15 basic soil groups. 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 D 2487 shows the criteria chart used for classifying soil in the Unified system and the 15 basic soil groups of the system and the plasticity chart for the Unified Soil Classification 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 serve 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 methods 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 methods 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 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 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 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, CH, MH, OL/OH, PT, GW-GM, GW-GC, GP-GM, GP-GC, SW-SM, SW-SC, SP-SM, and SP-SC.

Source: National Soil Survey Handbook (2001). USDA-Natural Resources Conservation Service, Washington, DC.