Classification of Soil and Soil-Aggregate Mixtures For Highway Construction Purposes AASHTO M-145-91 (2000) (Modified)

This practice describes a procedure for classifying soils into seven groups based on laboratory determination of particle-size distribution, liquid limit, and plasticity index. The group classification should be useful in determining the relative quality of the soil material for use in embankments, subgrades, and backfills. For detailed design of important structures, additional data concerning strength or performance characteristics of the soil under field conditions will usually be required.

Modification: Determination of Group Index will not be a part of certification, but taught as a useful tool for more accurate determination of soil classification.

Key Elements:

1. **Determine sieve analysis.** Determine sieve analysis using AASHTO T-11 and AASHTO T-27 test procedures (Note 1). The 2.00 mm (No. 10) sieve, 425-µm (No. 40) sieve, and 75-µm (No. 200) sieve must be included to determine the particle size distribution as a basis for classification.

2. **Determine the liquid limit.** Determine the liquid limit of the material using AASHTO T-89 test procedures.

3. **Determine the plastic limit.** Determine the plastic limit and plasticity index of the material using AASHTO T-90 test procedures.

4. **Determine classification of material.** Using the test limits shown in Table 1 of AASHTO M-145, make the classification of the material. If a more detailed classification is desired, a further subdivision of the groups may be made using Table 2 of AASHTO M-145 **(3.1)**. With required test data available, proceed from left to right in Table 1 or Table 2 and the correct group will be found by process of elimination **(3.2)**. The first group from the left into which the test data will fit is the correct classification **(3.2)**.

5. **Report classification.** All limiting test values are shown as whole numbers. If fractional numbers appear on test reports, convert to the nearest whole number for purposes of classification **(3.2)**.

DESCRIPTION OF SOIL CLASSIFICATION GROUPS:

Soil Fractions: According to the AASHTO system, soils are divided into two major groups as shown in Table 1 of AASHTO M-145. These are the granular materials with 35 percent or less passing the 75-µm (No. 200) sieve **(5.1, Note 2)** and the silt-clay materials with more than 35 percent passing the 75-µm (No. 200) sieve **(5.2)**. Moreover, five soil fractions are recognized and often used in word descriptions of a material. These five fractions are defined as follows:

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Boulders and Cobbles – material retained on the 75 mm (3 in.) sieve. They should be excluded from the portion of a sample to which the classification is applied, but the percentage of such material should be recorded **(4.1.5)**.

Gravel – materials passing sieve with 75 mm (3 in.) square openings and retained on the 2.0 mm (No. 10) sieve **(4.1.1)**.

Coarse Sand – materials passing the 2.0 mm (No. 10) sieve and retained on the 425-µm (No. 40) sieve **(4.1.2)**.

Fine Sand – materials passing the 425-µm (No. 40) sieve and retained on the 75-µm (No. 200) sieve **(4.1.3)**.

Combined Silt and Clay – material passing the 75-µm (No. 200) sieve. The word "silty" is applied to a fine material having a Plasticity Index of **10** or less, and the term "clayey" is applied to fine material having a PI of more than **10 (4.1.6)**.

GRANULAR MATERIALS:

Group A-1: Well-graded mixtures of stone fragments or gravel ranging from coarse to fine with a non-plastic or slightly plastic soil binder **(5.1.1)**. However, this group also includes coarse materials without soil binder.

> **Subgroup A-1-a**: Materials consisting predominantly of stone fragments or gravel, either with or without a well graded soil binder **(5.1.1.1)**.
>
> **Subgroup A-1-b**: Materials consisting predominantly of coarse sand either with or without a well-graded soil binder **(5.1.1.2)**.

Group A-3: Material consisting of sands deficient in coarse material and soil binder. Typical is fine beach sand or fine desert blow sand, without silt or clay fines or with a very small amount of non-plastic silt. This group also includes stream deposited mixtures of poorly graded fine sand and limited amounts of coarse sand and gravel **(5.1.2)**. These soils make suitable subgrades for all types of pavements when confined and damp. They are subject to erosion and have been known to pump and blow under rigid pavements. (Information: They can be compacted by vibratory, pneumatic-tired, and steel-wheeled rollers but not with a sheepsfoot roller.)

Group A-2: This group includes a wide variety of "granular" materials that are borderline between the materials falling in Groups A-1 and A-3 and silt-clay materials of Groups A-4, A-5, A-6 and A-7. It includes all materials containing 35 percent or less passing the 75-µm (No. 200) sieve that cannot be classified as A-1 or A-3 **(5.1.3)**.

> **Subgroups A-2-4 and A-2-5**: Include various granular materials containing 35 percent or less passing the 75-µm (No. 200) sieve, and with that portion passing 425-µm (No. 40) sieve having the characteristics of the A-4 and A-5 groups. These groups include such materials as

gravel and coarse sand with silt contents or Plasticity Indexes in excess of the limitations of Group A-1, and fine sand with non-plastic silt content in excess of the limitations of Group A-3 **(5.1.3.1)**.

Subgroups A-2-6 and A-2-7: Include materials similar to those describe under Subgroups A-2-4 and A-2-5, except that the fine portion contains plastic clay having the characteristics of the A-6 or A-7 group **(5.1.3.2)**.

A-2 soils are given a poorer rating than A-1 soils because of inferior binder, poor grading, or a combination of the two. Depending on the character and amount of binder, A-2 soils may become soft during wet weather and loose and dusty in dry weather when used as a road surface. If, however, they are protected from these extreme changes in moisture content, they may be quite stable. The A-2-4 and A-2-5 soils are satisfactory as base materials when properly compacted and drained. A-2-6 and A-2-7 soils with low percentages of minus 75-µm (no. 200) sieve material are classified as good bases, whereas these same soils with high percentages of minus 75-µm (No. 200) sieve and PI's of 10 or higher are questionable as a base material. Frequently, the A-2 soils are employed as a cover material for very plastic subgrades.

SILT-CLAY MATERIALS:

Group A-4: The typical material of this group is a non-plastic or moderately plastic silty soil usually having 75 percent or more passing the 75 µm (No. 200) sieve. The group includes also mixtures of fine silty soil and up to 64 percent of sand and gravel retained on the 75-µm (No. 200) sieve **(5.2.1)**. These predominantly silty soils are quite common in occurrence. Their texture varies from sandy loams to silty and clayey loams. With the proper amount of moisture present, they may perform well as a pavement component. However, they frequently have an affinity for water and will swell and lose much of their stability unless properly compacted and drained. Moreover, they are subject to frost heave. These soils do not drain readily and may absorb water by capillary action with resulting loss in strength. The silty loams are often difficult to compact properly. Careful field control of moisture content and pneumatic tired rollers are normally required for proper compaction.

Group A-5: The typical material of this group is similar to that described under Group A-4, except that it is usually of diatomaceous or micaceous character and may be highly elastic as indicated by the high liquid limit **(5.2.2)**. These soils do not occur as widely as the A-4 soils. They are normally elastic or resilient in both the damp and semi-dry conditions. They are subject to frost heave, erosion, and loss of stability if not properly drained. Since these soils do not drain readily and may absorb water by capillary action with resulting loss in strength. Careful control of moisture content is normally required for proper compaction.

Group A-6: The typical material of this group is plastic clay soil usually having 75 percent or more passing the 75-µm (No. 200) sieve. The group includes also mixtures of fine clayey soil and up to 64 percent of sand and gravel retained on the 75-µm (No. 200) sieve. Materials of this group usually have high volume change between wet and dry states **(5.2.3)**. These soils are quite common in occurrence and are widely used in fills. When moisture content is properly controlled, they compact

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quite readily with either a sheepsfoot or pneumatic tired roller. They have high dry strength but lose much of this strength upon absorbing water. The A-6 soils will compress when wet and shrink and swell with changes in moisture content. When placed in the shoulders adjacent to the pavement, they tend to shrink away from the pavement edge upon drying and thereby provide an access route to the under side of the pavement for surface water. The A-6 soils do not drain readily and may absorb water by capillary action with resulting loss in strength.

Group A-7: The typical materials and problems of this group are similar to those described under Group A-6, except that they have the high liquid limits characteristic of the A-5 group and may be elastic as well as subject to high volume change **(5.2.4)**.

> **Subgroup A-7-5**: Includes those materials with moderate Plasticity Indexes in relation to Liquid Limit and which may be highly elastic as well as subject to considerable volume change **(5.2.4.1)**.
>
> **Subgroup A-7-6**: Includes those materials with high Plasticity Indexes in relation to Liquid Limit and which are subject to extremely high volume change **(5.2.4.2)**.
>
> Highly organic soils such as peat or muck are not included in this classification. Because of their many undesirable properties, their use should be avoided, if possible, in all types of construction.