Designation: D 3282 – 93 (Reapproved 2004)ε1

Standard Practice for Classification of Soils and Soil-Aggregate Mixtures for Highway Construction Purposes[1]

This standard is issued under the fixed designation D 3282; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

This standard has been approved for use by agencies of the Department of Defense.

ε[1] NOTE—Added keywords editorially in May 2004.

1. Scope

1.1 This practice covers a procedure for classifying mineral and organomineral soils into seven groups based on laboratory determination of particle-size distribution, liquid limit, and plasticity index. It may be used when a precise engineering classification is required, especially for highway construction purposes. Evaluation of soils within each group is made by means of a *group index*, which is a value calculated from an empirical formula.

NOTE 1—The group classification, including the group index, should be useful in determining the relative quality of the soil material for use in earthwork structures, particularly embankments, subgrades, subbases, and bases. However, for the detailed design of important structures, additional data concerning strength or performance characteristics of the soil under field conditions will usually be required.

1.2 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.*

1.3 *This practice offers a set of instructions for performing one or more specific operations. This practice cannot replace education or experience and should be used in conjunction with professional judgment. Not all aspects of this practice may be applicable in all circumstances. This practice is not intended to represent or replace the standard of care by which the adequacy of a given professional service must be judged, nor should this practice be applied without consideration of a project's many unique aspects. The word "Standard" in the title of this document means only that the document has been approved through the ASTM consensus process.*

2. Referenced Documents

2.1 *ASTM Standards:* [2]

D 420 Guide to Site Characterization for Engineering, Design, and Construction Purposes

D 421 Practice for Dry Preparation of Soil Samples for Particle-Size Analysis and Determination of Soil Constants

D 422 Test Method for Particle-Size Analysis of Soils

D 653 Terminology Relating to Soil, Rock, and Contained Fluids

D 1140 Test Methods for Amount of Material in Soils Finer Than the No. 200 (75-µm) Sieve

D 1452 Practice for Soil Investigation and Sampling by Auger Borings

D 1586 Test Method for Penetration Test and Split-Barrel Sampling of Soils

D 1587 Practice for Thin-Walled Tube Sampling of Soils for Geotechnical Purposes

D 2217 Practice for Wet Preparation of Soil Samples for Particle-Size Analysis and Determination of Soil Constants

D 4318 Test Methods for Liquid Limit, Plastic Limit, and Plasticity Index of Soils

2.2 *AASHTO Document:*[3]

M 145 The Classification of Soils and Soil Aggregate Mixtures for Highway Construction Purposes

3. Terminology

3.1 *Definitions of Terms Specific to This Standard:*

[1] This standard is under the jurisdiction of ASTM Committee D18 on Soil and Rock and is the direct responsibility of Subcommittee D18.07 on Identification and Classification of Soils.

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[2] For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

[3] Available from American Association of State Highway and Transportation Officials (AASHTO), 444 N. Capitol St., NW, Suite 249, Washington, DC 20001.

3.1.1 The following terms are frequently used in this practice. These terms differ slightly from those given in Terminology D 653, but are used here to maintain consistency with common highway usage.

3.1.2 *boulders*—rock fragments, usually rounded by weathering or abrasion, that will be retained on a 3-in. (75-mm) sieve.

3.1.3 *coarse sand*—particles of rock or soil that will pass a No. 10 (2-mm) sieve and be retained on a No. 40 (425-µm) sieve.

3.1.4 *fine sand*—particles of rock or soil that will pass a No. 40 (425-µm) sieve and be retained on a No. 200 (75-µm) sieve.

3.1.5 *gravel*—particles of rock that will pass a 3-in. (75-mm) sieve and be retained on a No. 10 (2-mm) sieve.

3.1.6 *silt-clay (combined silt and clay)*—fine soil and rock particles that will pass a No. 200 (75-µm) sieve.

3.1.7 *silty*—fine-grained material that has a plasticity index of 10 or less.

3.1.8 *clayey*—fine-grained material that has a plasticity index of 11 or more.

4. Significance and Use

4.1 The practice described classifies soils from any geographic location into groups (including group indexes) based on the results of prescribed laboratory tests to determine the particle-size characteristics, liquid limit, and plasticity index.

4.2 The assigning of a group symbol and group index can be used to aid in the evaluation of the significant properties of the soil for highway and airfield purposes.

4.3 The various groupings of this classification system correlate in a general way with the engineering behavior of soils. Also, in a general way, the engineering behavior of a soil varies inversely with its group index. Therefore, this practice provides a useful first step in any field or laboratory investigation for geotechnical engineering purposes.

5. Apparatus

5.1 *Apparatus for Preparation of Samples*—See Practices D 421 or D 2217.

5.2 *Apparatus for Particle-Size Analysis*—See Test Methods D 1140 and D 422.

5.3 *Apparatus for Liquid Limit and Plastic Limit Tests*—See Test Methods D 4318.

6. Sampling

6.1 Conduct field investigations and sampling in accordance with one or more of the following procedures:

6.1.1 Guide D 420,

6.1.2 Practice D 1452,

6.1.3 Test Method D 1586, and

6.1.4 Practice D 1587.

7. Test Sample

7.1 Test samples shall represent that portion of the field sample finer than the 3-in. (75-mm) sieve and shall be obtained as follows:

7.1.1 Air-dry the field sample,

7.1.2 Weigh the field sample,

7.1.3 Separate the field sample into two fractions on a 3-in. (75-mm) sieve,

7.1.4 Weigh the fraction retained on the 3-in. (75-mm) sieve. Compute the percentage of plus 3-in. material in the field sample, and note this percentage as auxiliary information, and

7.1.5 Thoroughly mix the fraction passing the 3-in. (75-mm) sieve and select the test samples.

NOTE 2—If visual examination indicates that no boulder size material is present, omit 7.1.3 and 7.1.4.

7.2 Prepare the test sample in accordance with Practices D 421 or D 2217. Determine the percentage of the sample finer than a No. 10 (2-mm) sieve.

NOTE 3—It is recommended that the method for wet preparation be used for soils containing organic matter or irreversible mineral colloids.

8. Testing Procedure

8.1 Determine the percentage of the test sample finer than a No. 200 (75-µm) sieve in accordance with Test Methods D 1140 or D 422.

NOTE 4—For granular materials, the percentage of the sample finer than a No. 40 (425-µm) sieve must also be determined.

8.2 Determine the liquid limit and the plasticity index of a portion of the test sample passing a No. 40 (425-µm) sieve in accordance with Test Methods D 4318.

9. Classification Procedure

9.1 Using the test data determined in Section 8, classify the soil into the appropriate group or subgroup, or both, in accordance with Table 1 or Table 2. Use Fig. 1 to classify silt-clay materials on the basis of liquid limit and plasticity index values.

NOTE 5—All limiting values are shown as whole numbers. If fractional numbers appear on test reports, convert to the nearest whole numbers for the purpose of classification.

9.1.1 With the required test data available, proceed from left to right in Table 1 or Table 2 and the correct classification will be found by the process of elimination. The first group from the left into which the test data will fit is the correct classification.

NOTE 6—Classification of materials in the various groups applies only to the fraction passing the 3-in. (75-mm) sieve. Therefore, any specification regarding the use of A-1, A-2, or A-3 materials in construction should state whether boulders (retained on 3-in. sieve) are permitted.

10. Description of Classification Groups

10.1 *Granular Materials*, containing 35 % or less passing the No. 200 (75-µm) sieve:

10.1.1 *Group A-1*—The typical material of this group is a well-graded mixture of stone fragments or gravel, coarse sand, fine sand, and a nonplastic or feebly-plastic soil binder. However, this group also includes stone fragments, gravel, coarse sand, volcanic cinders, etc., without a soil binder.

10.1.1.1 Subgroup A-1-a includes those materials consisting predominantly of stone fragments or gravel, either with or without a well-graded binder of fine material.

10.1.1.2 Subgroup A-1-b includes those materials consisting predominantly of coarse sand, either with or without a well-graded soil binder.

TABLE 1 Classification of Soils and Soil-Aggregate Mixtures

General Classification	Granular Materials (35 % or less passing No. 200)			Silt-Clay Materials (More than 35 % passing No. 200)			
Group Classification	A-1	A-3[A]	A-2	A-4	A-5	A-6	A-7
Sieve analysis, % passing:							
No. 10 (2.00 mm)	...	...	...	...	...	...	...
No. 40 (425 µm)	50 max	51 min	...	...	...	...	...
No. 200 (75 µm)	25 max	10 max	35 max	36 min	36 min	36 min	36 min
Characteristics of fraction passing No. 40 (425 µm):							
Liquid limit	...	...	[B]	40 max	41 min	40 max	
Plasticity index	6 max	N.P.	[B]	10 max	10 max	11 min 41 min 11 min	
General rating as subgrade	Excellent to Good			Fair to Poor			

[A] The placing of A-3 before A-2 is necessary in the "left to right elimination process" and does not indicate superiority of A-3 over A-2.
[B] See Table 2 for values.
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TABLE 2 Classification of Soils and Soil-Aggregate Mixtures

General Classification	Granular Materials (35 % or less passing No. 200)							Silt-Clay Materials (More than 35 % passing No. 200)			
Group classification	A-1		A-3	A-2				A-4	A-5	A-6	A-7
	A-1-a	A-1-b		A-2-4	A-2-5	A-2-6	A-2-7				A-7-5, A-7-6
Sieve analysis, % passing:											
No. 10 (2.00 mm)	50 max	...	...	...	...	...	...	...	...	...	...
No. 40 (425 µm)	30 max	50 max	51 min	...	...	...	...	...	...	...	...
No. 200 (75 µm)	15 max	25 max	10 max	35 max	35 max	35 max	35 max	36 min	36 min	36 min	36 min
Characteristics of fraction passing No. 40 (425 µm):											
Liquid limit	...		...	40 max	41 min	40 max	41 min	40 max	41 min	40 max	41 min
Plasticity index	6 max		N.P.	10 max	10 max	11 min	11 min	10 max	10 max	11 min	11 min[A]
Usual types of significant constituent materials	Stone Fragments, Gravel and Sand		Fine Sand	Silty or Clayey Gravel and Sand				Silty Soils		Clayey Soils	
General rating as subgrade	Excellent to Good							Fair to Poor			

[A] Plasticity index of A-7-5 subgroup is equal to or less than *LL* minus 30. Plasticity index of A-7-6 subgroup is greater than *LL* minus 30 (see Fig. 1).
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10.1.2 *Group A-3*—The typical material of this group is fine beach sand or fine desert-blow sand without silty or clay fines, or with a very small amount of nonplastic silt. This group also includes stream-deposited mixtures of poorly-graded fine sand and limited amounts of coarse sand and gravel.

10.1.3 *Group A-2*—This group includes a wide variety of "granular" materials which are borderline between the materials falling in Groups A-1 and A-3, and the silt-clay materials of Groups A-4, A-5, A-6, and A-7. It includes all materials containing 35 % or less passing a No. 200 (75-µm) sieve which cannot be classified in Groups A-1 or A-3, due to the fines content or the plasticity indexes, or both, in excess of the limitations for those groups.

10.1.3.1 Subgroups A-2-4 and A-2-5 include various granular materials containing 35 % or less passing a No. 200 (75-µm) sieve and with a minus No. 40 (425-µm) portion having the characteristics of Groups A-4 and A-5, respectively. 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 nonplastic-silt content in excess of the limitations of Group A-3.

10.1.3.2 Subgroups A-2-6 and A-2-7 include materials similar to those described 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, respectively.

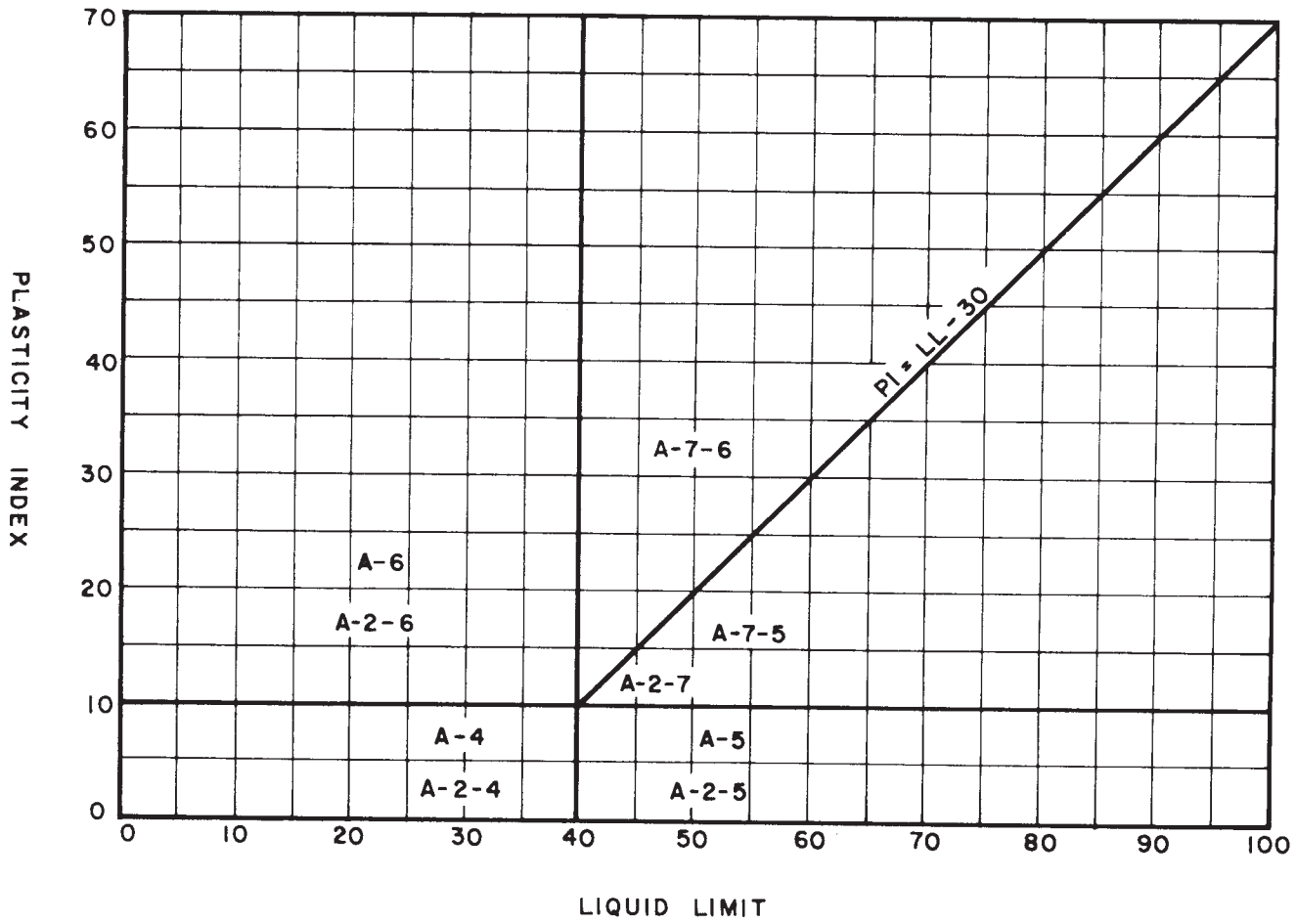
10.2 *Silt-Clay Materials*, containing more than 35 % passing a No. 200 (75-µm) sieve:

10.2.1 *Group A-4*—The typical material of this group is a nonplastic or moderately plastic silty soil usually having 75 % or more passing a No. 200 (75-µm) sieve. This group also includes mixtures of fine silty soil and up to 64 % of sand and gravel retained on a No. 200 sieve.

10.2.2 *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.

10.2.3 *Group A-6*—The typical material of this group is a plastic clay soil usually having 75 % or more passing a No. 200 (75-µm) sieve. This group also includes mixtures of fine clayey soil and up to 64 % of sand and gravel retained on a No. 200 sieve. Materials of this group usually have a high volume change between wet and dry states.

10.2.4 *Group A-7*—The typical material of this group is similar to that described under Group A-6, except that it has the high liquid limits characteristic of Group A-5 and may be elastic as well as subject to high-volume change.



NOTE 1—A-2 soils contain less than 35 % finer than 200 sieve.

FIG. 1 Liquid Limit and Plasticity Index Ranges for Silt-Clay Materials

10.2.4.1 Subgroup A-7-5 includes those materials with moderate plasticity indexes in relation to the liquid limit and which may be highly elastic as well as subject to considerable volume change.

10.2.4.2 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.

NOTE 7—Highly organic soils (peat or muck) may be classified in Group A-8. Classification of these materials is based on visual inspection and is not dependent on the percentage passing the No. 200 (75-µm) sieve, liquid limit, or plasticity index. The material is composed primarily of partially decayed organic matter, generally has a fibrous texture, a dark brown or black color, and an odor of decay. These organic materials are unsuitable for use in embankments and subgrades. They are highly compressible and have low strength.

11. Group Index Computation

11.1 The classifications obtained from Table 1 or Table 2 may be modified by the addition of a group-index value. Group-index values should always be shown in parentheses after the group symbol as A-2-6(3), A-4(5), A-6(12), A-7-5(17), etc.

11.1.1 Calculate the group index from the following empirical formula:

$$\text{Group index} = (F - 35)[0.2 + 0.005(LL - 40)] + 0.01(F - 15)(PI - 10) \quad (1)$$

where:

F = percentage passing No. 200 (75-µm) sieve, expressed as a whole number (this percentage is based only on the material passing the 3-in. (75-mm) sieve),
LL = liquid limit, and
PI = plasticity index.

11.1.2 If the calculated group index is negative, report the group index as zero (0).

11.1.3 If the soil is nonplastic and when the liquid limit cannot be determined, report the group index as zero (0).

11.1.4 Report the group index to the nearest whole number.

11.1.5 The group index value may be estimated using Fig. 2 by determining the partial group index due to the liquid limit and that due to the plasticity index, then obtaining the total of the two partial group indexes.

11.1.6 The group index of soils in the A-2-6 and A-2-7 subgroups shall be calculated using only the *PI* portion of the formula (or Fig. 2).

11.2 The following examples illustrate the calculations for the group index:

11.2.1 Assume that an A-6 material has 55 % passing a No. 200 (75-µm) sieve, a liquid limit of 40, and a plasticity index of 25, then:

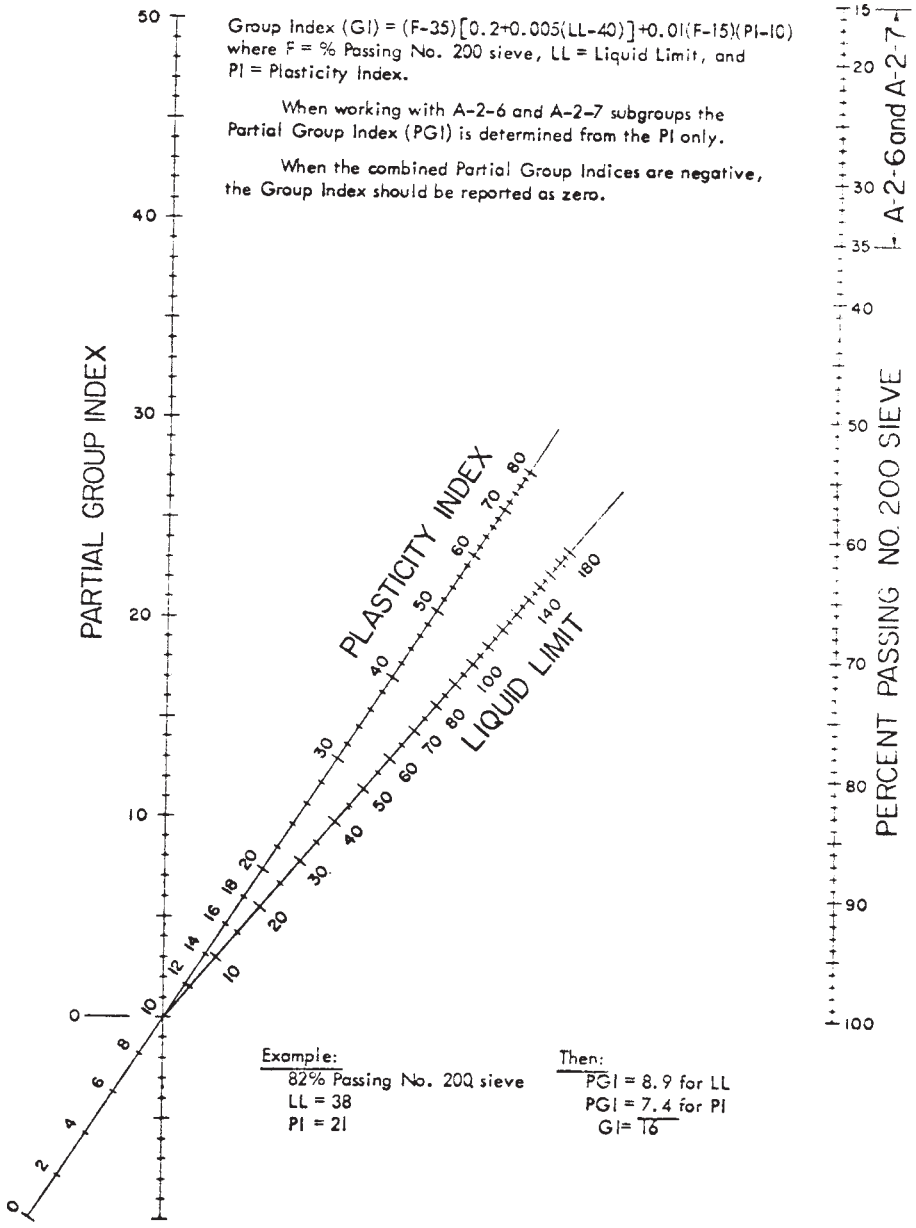


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FIG. 2 Group Index Chart

$$\text{Group index} = (55 - 35)[0.2 + 0.005(40 - 40)] \quad (2)$$
$$+ [0.01(55 - 15)(25 - 10)] = 4.0 + 6.0 = 10$$

11.2.2 Assume that an A-7 material has 80 % passing a No. 200 (75-µm) sieve, a liquid limit of 90, and a plasticity index of 50, then:

$$\text{Group index} = (80 - 35)[0.2\pm 0.005(90 - 40)] \quad (3)$$
$$+ [0.01(80 - 15)(50 - 10)] = 20.3 + 26.0 = 46.3 \text{ (report as 46)}$$

11.2.3 Assume that an A-4 material has 60 % passing a No. 200 (75-µm) sieve, a liquid limit of 25, and a plasticity index of 1, then

$$\text{Group index} = (60 - 35)[0.2 + 0.005(25 - 40)] \quad (4)$$
$$+ [0.01(60 - 15)(1 - 10)] = 25 \times (0.2 - 0.075)$$
$$+ 0.01(45)(-9) = 3.1 - 4.1 = -1.0 \text{ (report as 0)}$$

11.2.4 Assume that an A-2-7 material has 30 % passing a No. 200 (75-µm) sieve, a liquid limit of 50, and a plasticity index of 30, then

$$\text{Group index} = 0.01(30 - 15)(30 - 10) \quad (5)$$
$$= 3.0 \text{ or } 3 \text{ (note that only the PI portion of the formula was used)}$$

12. Discussion of Group Index

12.1 The empirical group index formula devised for approximate within-group evaluation of the "clayey-granular materials" and the "silt-clay materials" is based on the following assumptions:

NOTE 8—Group index values should only be used to compare soils within the same group and not between groups.

12.1.1 Materials falling within Groups A-1-a, A-1-b, A-2-4, A-2-5, and A-3 are satisfactory as subgrade when properly drained and compacted under moderate thickness of pavement (base or surface course, or both) of a type suitable for traffic to be carried or can be made satisfactory by additions of small amounts of natural or artificial binders.

12.1.2 Materials falling within the "clayey granular" Groups A-2-6 and A-2-7 and the "silt-clay" Groups A-4, A-5, A-6, and A-7 will range in quality as subgrade from the approximate equivalent of the good A-2-4 and A-2-5 subgrades to fair and poor subgrades requiring a layer of subbase material or an increased thickness of base course over that required in 12.1.1, in order to furnish adequate support for traffic loads.

12.1.3 A minimum of 35 % passing a No. 200 (75-µm) sieve is assumed to be critical if plasticity is neglected, but the critical minimum is only 15 % when affected by plasticity indexes greater than 10.

12.1.4 Liquid limits of 40 and above are assumed to be critical.

12.1.5 Plasticity indexes of 10 and above are assumed to be critical.

12.2 There is no upper limit of group index value obtained by use of the formula: The adopted critical values of percentage passing the No. 200 (75-µm) sieve, liquid limit, and plasticity index, are based on an evaluation of subgrade, subbase, and base-course materials by several highway organizations that use the tests involved in this classification system.

12.3 Under average conditions of good drainage and thorough compaction, 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 a group index of 20 or greater indicates a "very poor" subgrade material.

13. Keywords

13.1 airfields; Atterberg limits; classification; clay; embankments; gradation; gravel; group index; highway construction; highways; index ranges; sand; silt; soil aggregate mixtures; soil classification; soil tests; subgroups

APPENDIX

(Nonmandatory Information)

X1. RATIONALE

X1.1 The 1992 edition differs from the previous edition in that the title was changed to better indicate the use of the standard.