



Standard Practice for Classification of Soils and Soil-Aggregate Mixtures for Highway Construction Purposes¹

This standard is issued under the fixed designation D3282; 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 U.S. Department of Defense.

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 *Units*—The sieve designations are identified using the “standard” system in accordance with Specification E11, such as 75-mm and 75- μ m, followed by the “alternative” system of 3-in. and No. 200, respectively.

1.3 *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.*

1.4 *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.*

¹ This practice 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. Referenced Documents

2.1 ASTM Standards:²

- D421 Practice for Dry Preparation of Soil Samples for Particle-Size Analysis and Determination of Soil Constants
- D422 Test Method for Particle-Size Analysis of Soils
- D653 Terminology Relating to Soil, Rock, and Contained Fluids
- D1140 Test Methods for Determining the Amount of Material Finer than 75- μ m (No. 200) Sieve in Soils by Washing
- D1452 Practice for Soil Exploration and Sampling by Auger Borings
- D1586 Test Method for Penetration Test (SPT) and Split-Barrel Sampling of Soils
- D1587 Practice for Thin-Walled Tube Sampling of Soils for Geotechnical Purposes
- D3740 Practice for Minimum Requirements for Agencies Engaged in Testing and/or Inspection of Soil and Rock as Used in Engineering Design and Construction
- D4318 Test Methods for Liquid Limit, Plastic Limit, and Plasticity Index of Soils
- D4700 Guide for Soil Sampling from the Vadose Zone
- D6913 Test Methods for Particle-Size Distribution (Gradation) of Soils Using Sieve Analysis
- E11 Specification for Woven Wire Test Sieve Cloth and Test Sieves

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:

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, <http://www.transportation.org>.

*A Summary of Changes section appears at the end of this standard

3.1.1 The following terms are frequently used in this practice. These terms differ slightly from those given in Terminology **D653**, but are used here to maintain consistency with common highway usage.

3.1.2 *boulders*—particles of rock with a minimum dimension of 305-mm (12-in.) or more.

3.1.3 *cobbles*—particles of rock with a minimum dimension of less than 305-mm (12-in.) and be retained on a 75-mm (3-in.) sieve.

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

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

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

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

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

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

3.1.10 *irreversible mineral colloid, n*—in soils, certain minerals such as feldspars, when weathered bind with water to form clay minerals containing interlayer moisture, that when dried above 50°C, permanently lose this structural moisture.

3.1.10.1 *Discussion*—The dewatering process changes the nature of the mineralogy. This permanent dehydration has been shown to reduce plasticity, increase particle size and may potentially skew the soil classification

3.1.11 *stone fragment*—a small piece of rock that has been mechanically broken from a larger stone.

NOTE 2—The terminology used above differs from terminology used in Terminology **D653**. The above terminology conforms in part to AASHTO standard M 145.

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.

NOTE 3—The quality of the result produced by this standard is dependent upon the competence of the personnel performing it, and the suitability of the equipment and facilities used. Agencies that meet the criteria of Practice **D3740** are generally considered capable of competent and objective testing/sampling/inspection/etc. Users of this standard are cautioned that compliance with Practice **D3740** does not in itself assure

reliable results. Reliable results depend on many factors; Practice **D3740** provides a means of evaluation some of those factors.

5. Apparatus

5.1 *Apparatus for Preparation of Samples*—See Practice **D421**.

5.2 *Apparatus for Particle-Size Analysis*—See Test Methods **D1140**, **D422**, and **D6913**.

5.3 *Apparatus for Liquid Limit and Plastic Limit Tests*—See Test Methods **D4318**.

6. Sampling

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

6.1.1 Guide **D4700**,

6.1.2 Practice **D1452**,

6.1.3 Test Method **D1586**, and

6.1.4 Practice **D1587**.

7. Test Samples and Testing Procedures

7.1 Prepare test specimens and perform testing in accordance with the following procedures:

7.1.1 *Test Samples and Testing for Particle-Size Analysis*—Use either Test Methods **D1140**, **D422** or **D6913**.

7.1.2 *Test Samples and Testing for Liquid Limit and Plastic Limit Tests*—Use Test Method **D4318**

8. Classification Procedure

8.1 Using the test data determined by the methods in Section 7, 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. Classification of materials in the various groups applies only to the fraction passing the 75-mm (3-in.) sieve. Boulders and cobbles shall be excluded from the portion of the sample to be classified. However, the percentage of such material, if any, shall be recorded.

8.1.1 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.

8.1.2 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 4—Classification of materials in the various groups applies only to the fraction passing the 75-mm (3-in.) sieve. Therefore, any specification regarding the use of soil and soil-aggregate mixtures in construction should state whether boulders, or cobbles, or both, are permitted.

9. Description of Classification Groups

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

9.1.1 *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.

TABLE 1 Classification of Soils and Soil-Aggregate Mixtures

General Classification	Granular Materials 35 % or Less Passing 75 µm (No. 200)			Silt-Clay Materials More Than 35 % Passing 75 µm (No. 200)			
Group Classification	A-1	A-3 ^A	A-2	A-4	A-5	A-6	A-7
Sieve analysis, % passing:							
2.00 mm (No. 10)	...	...	...	...	...	...	...
425 µm (No. 40)	50 max	51 min	...	...	...	...	...
75 µm (No. 200)	25 max	10 max	35 max	36 min	36 min	36 min	36 min
Characteristics of fraction passing 425 µm (No. 40):							
Liquid Limit	...	...	<i>B</i>	40 max	41 min	40 max	41 min
Plasticity Index	6 max	N.P.	<i>B</i>	10 max	10 max	11 min	11 min
General rating as subgrade	Excellent to Good			Fair to Poor			

^AThe 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.

^BSee 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 75 µm (No. 200)							Silt-Clay Materials More Than 35 % Passing 75 µm (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				
Sieve analysis, % passing:											
2.00 mm (No. 10)	50 max	...	...	...	...	...	...	...	...	...	...
425 µm (No. 40)	30 max	50 max	51 min	...	...	...	...	...	...	...	...
75 µm (No. 200)	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 425 µm (No. 40):											
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			

^APlasticity 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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9.1.1.1 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.

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

9.1.2 *Group A-3*—The typical material of this group is fine beach sand or fine desert-blown sand without silty or clayey 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.

9.1.3 *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 75-µm (No. 200) 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.

9.1.3.1 Subgroups A-2-4 and A-2-5 include various granular materials containing 35 % or less passing a 75-µm (No. 200) sieve and with a minus 425-µm (No. 40) 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.

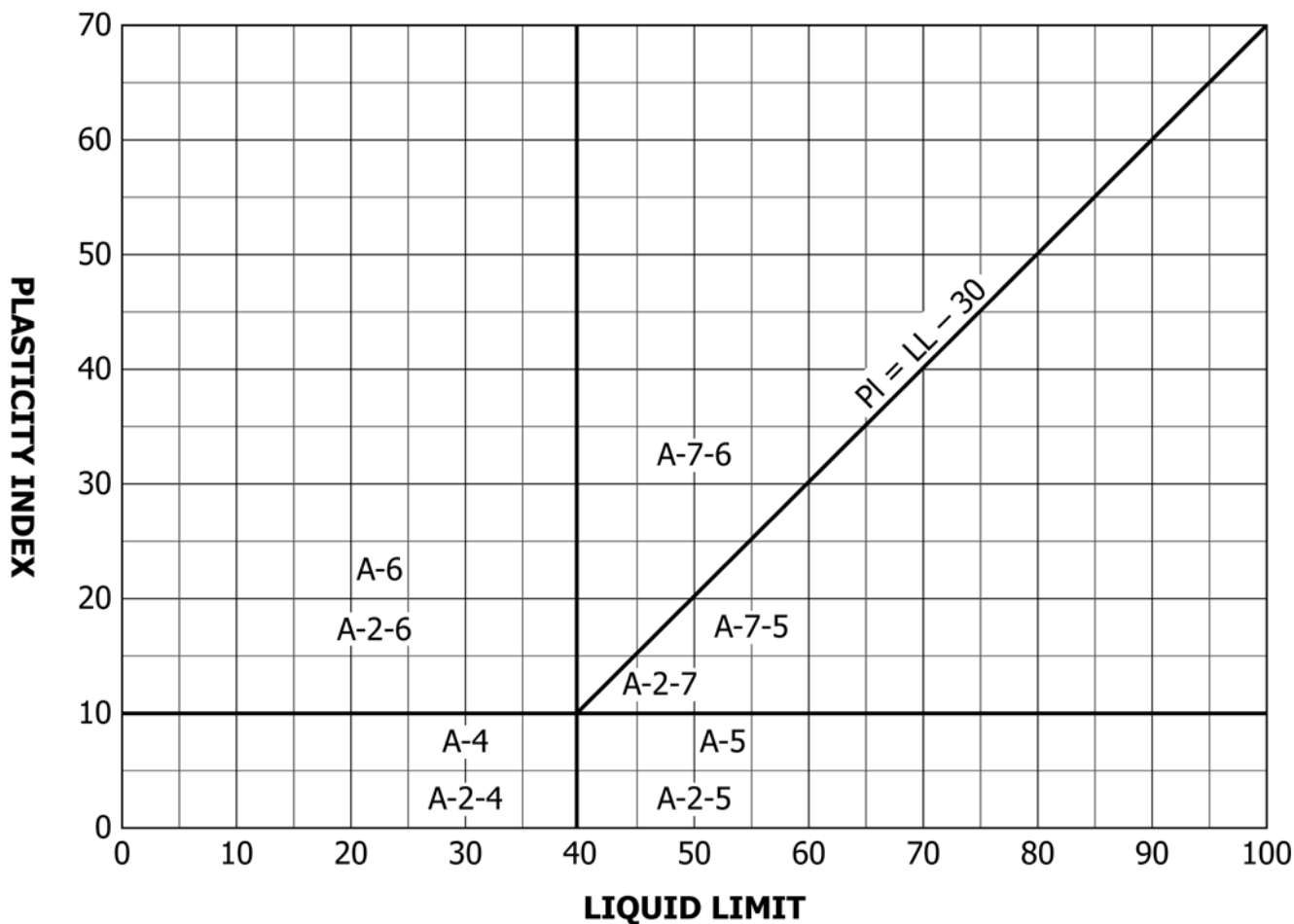
9.1.3.2 Subgroups A-2-6 and A-2-7 include materials similar to those described under Subgroups A-2-4 and A-2-5, except that the fine portion contains plastic clay having the characteristics of the A-6 or A-7 group, respectively.

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

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

9.2.2 *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.

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



A-2 soils contain less than 35 % passing the 75- μ m (No. 200) sieve.

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

75- μ m (No. 200) sieve. Materials of this group usually have a high volume change between wet and dry states.

9.2.4 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.

9.2.4.1 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.

9.2.4.2 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 5—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 75- μ m (No. 200) 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.

10. Group Index Computation

10.1 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.

10.1.1 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 75- μ m (No. 200) sieve, expressed as a whole number (this percentage is based only on the material passing the 75-mm (3-in.) sieve),

LL = liquid limit, and

PI = plasticity index.

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

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

10.1.4 Report the group index to the nearest whole number, as shown in 10.1.

10.1.5 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 (see Eq 5 as an example).

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

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

$$\text{Group index} = (55 - 35)[0.2 + 0.005(40 - 40)] + [0.01(55 - 15)(25 - 10)] = 4.0 + 6.0 = 10.0 \quad (2)$$

(report as 10)

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

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

(report as 46)

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

$$\text{Group index} = (60 - 35)[0.2 + 0.005(25 - 40)] + [0.01(60 - 15)(1 - 10)] =$$

$$25 \times (0.2 - 0.075) + [0.01(45)(-9)] = 3.1 - 4.1 = -1.0 \quad (\text{report as } 0) \quad (4)$$

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

$$\text{Group index} = 0.01[(30 - 15)(30 - 10)] = 3.0 \quad (\text{report as } 3) \quad (5)$$

Note that only the PI portion of the formula was used..

11. Discussion of Group Index

11.1 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 6—Group index values should only be used to compare soils within the same group and not between groups.

11.1.1 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.

11.1.2 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 11.1.1, in order to furnish adequate support for traffic loads.

11.1.3 A minimum of 35 % passing a 75- μm (No. 200) 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.

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

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

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

11.2 There is no upper limit of group index value obtained by use of the formula: The adopted critical values of percentage passing the 75- μm (No. 200) 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.

11.3 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.

12. Keywords

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

SUMMARY OF CHANGES

In accordance with Committee D18 policy, this section identifies the location of changes to this standard since the last edition (2009) that may impact the use of this standard. (November 1, 2015)

(1) Revised 1.2 by adding clarification between “standard” and “alternative” sieve designations. The sieve designations have been updated throughout this practice.

(2) Revised Section 2 by deleting the reference to D420 and D2217, as they have been withdrawn. References to D3740, D4700, D6913 and E11 have been added.

(3) Revised Section 3 by adding the definition for boulder, cobbles, irreversible mineral colloids and stone fragment.

(4) Revised Section 4 by adding Note 3, the D3740 minimum agencies requirement caveat.

(5) Revised 5.1 by deleting the reference to D2217.

(6) Revised 5.2 by adding reference to D6913.

(7) Revised 6.1.1 by adding reference to D4700.

(8) Revised Sections 7 and 8 by updating 7.1 through 7.2, as they suggest that material is sampled and tested, and data is generated. Field sampling and testing are now done by reference to specific standards. The classification practice actually begins with the receipt of this data. Section 8 has been deleted in its entirety. All subsequent Sections and Notes have been renumbered.

(9) Revised new Section 8, Classification Procedure by adding emphasis on the fact that classification is performed on minus 75-mm (3-in.) material.

(10) Revised Table 1 and Table 2 for better graphic definition and data alignment to improve ease of use.

(11) Deleted Figure 2, as it is for the estimation of and not the accurate calculation of the group index.

(12) Corrected former 11.2.1, 11.2.2, and 11.2.3 (new 10.2.1, 10.2.2, and 10.2.3) by removing the numerical equation designation, as they are examples of equation 1 and not new equations.

(13) Corrected former 11.2.2 (new 10.2.2), example equation by replacing “±” with “+”.

(14) Deleted former 11.2.4 and the associated example equation as they refer to partial group indices.

(15) Deleted Appendix X1, as this is the third revision since the practice was updated in 1992. This reference is no longer relevant.

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