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Standard Guide to Site Characterization for Engineering Design and Construction Purposes[1]

This standard is issued under the fixed designation D 420; 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.

INTRODUCTION

Investigation and identification of subsurface materials involves both simple and complex techniques that may be accomplished by many different procedures and may be variously interpreted. These studies are frequently site specific and are influenced by geological and geographical settings, by the purpose of the investigation, by design requirements for the project proposed, and by the background, training, and experience of the investigator. This guide has been extensively rewritten and enlarged since the version approved in 1987. Material has been added for clarification and for expansion of concepts. Many new ASTM standards are referenced and a bibliography of non-ASTM references is appended.

This document is a guide to the selection of the various ASTM standards that are available for the investigation of soil, rock, and ground water for projects that involve surface or subsurface construction, or both. It is intended to improve consistency of practice and to encourage rational planning of a site characterization program. Since the subsurface conditions at a particular site are usually the result of a combination of natural, geologic, topographic, and climatic factors, and of historical modifications both natural and manmade, an adequate and internally consistent exploration program will allow evaluation of the results of these influences.

1. Scope

1.1 This guide refers to ASTM methods by which soil, rock, and ground water conditions may be determined. The objective of the investigation should be to identify and locate, both horizontally and vertically, significant soil and rock types and ground water conditions present within a given site area and to establish the characteristics of the subsurface materials by sampling or in situ testing, or both.

1.2 Laboratory testing of soil, rock, and ground water samples is specified by other ASTM standards not listed herein. Subsurface exploration for environmental purposes will be the subject of a separate ASTM document.

1.3 Prior to commencement of any intrusive exploration the site should be checked for underground utilities. Should evidence of potentially hazardous or otherwise contaminated materials or conditions be encountered in the course of the investigation, work should be interrupted until the circumstances have been evaluated and revised instructions issued before resumption.

1.4 The values stated in (SI) inch-pound units are to be regarded as the standard.

1.5 *This guide offers an organized collection of information or a series of options and does not recommend a specific course of action. This document cannot replace education or experience and should be used in conjunction with professional judgment. Not all aspects of this guide may be applicable in all circumstances. This ASTM standard 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 document 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.*

1.6 *This guide 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.*

2. Referenced Documents

2.1 *ASTM Standards:*

C 119 Terminology Relating to Dimension Stone[2]

C 294 Descriptive Nomenclature for Constituents of Natural Mineral Aggregates[3]

[1] This guide is under the jurisdiction of ASTM Committee D-18 on Soil and Rock and is the direct responsibility of Subcommittee D18.01 on Surface and Subsurface Characterization.

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[2] *Annual Book of ASTM Standards*, Vol 04.08.

[3] *Annual Book of ASTM Standards*, Vol 04.09.

C 851 Practice for Estimating Scratch Hardness of Coarse Aggregate Particles[3]
D 75 Practice for Sampling Aggregates[4]
D 653 Terminology Relating to Soil, Rock, and Contained Fluids[2]
D 1194 Test Method for Bearing Capacity of Soil for Static Load and Spread Footings[2]
D 1195 Test Method for Repetitive Static Plate Load Tests of Soils and Flexible Pavement Components, for Use in Evaluation and Design of Airport and Highway Pavements[2]
D 1196 Test Method for Nonrepetitive Static Plate Load Tests of Soils and Flexible Pavement Components, for Use in Evaluation and Design of Airport and Highway Pavements[2]
D 1452 Practice for Soil Investigation and Sampling by Auger Borings[2]
D 1586 Test Method for Penetration Test and Split-Barrel Sampling of Soils[2]
D 1587 Practice for Thin-Walled Tube Sampling of Soils[2]
D 2113 Practice for Rock Core Drilling, and Sampling of Rock for Site Investigation[2]
D 2487 Classification of Soils for Engineering Purposes (Unified Soil Classification System)[2]
D 2488 Practice for Description and Identification of Soils (Visual-Manual Procedure)[2]
D 2573 Test Method for Field Vane Shear Test in Cohesive Soil[2]
D 2607 Classification of Peats, Mosses, Humus, and Related Products[2]
D 3017 Test Method for Water Content of Soil and Rock in Place by Nuclear Methods (Shallow Depth)[2]
D 3213 Practices for Handling, Storing, and Preparing Soft Undisturbed Marine Soil[2]
D 3282 Classification of Soils and Soil-Aggregate Mixtures for Highway Construction Purposes[2]
D 3385 Test Method for Infiltration Rate of Soils in Field Using Double-Ring Infiltrometers[2]
D 3404 Guide to Measuring Matric Potential in the Vadose Zone Using Tensiometers[2]
D 3441 Test Method for Deep, Quasi-Static, Cone and Friction-Cone Penetration Tests of Soil[2]
D 3550 Practice for Ring-lined Barrel Sampling of Soils[2]
D 3584 Practice for Indexing Papers and Reports on Soil and Rock for Engineering Purposes[2]
D 4083 Practice for Description of Frozen Soils (Visual-Manual Procedure)[2]
D 4220 Practices for Preserving and Transporting Soil Samples[2]
D 4394 Test Method for Determining the In Situ Modulus of Deformation of Rock Mass Using the Rigid Plate Loading Method[2]
D 4395 Test Method for Determining the In Situ Modulus of Deformation of Rock Mass Using the Flexible Plate Loading Method[2]
D 4403 Practice for Extensometers Used in Rock[2]
D 4428 Test Methods for Crosshole Seismic Testing[2]
D 4429 Test Method for CBR (California Bearing Ratio) of Soils in Place[2]
D 4452 Methods for X-Ray Radiography of Soil Samples[2]
D 4506 Test Method for Determining the In Situ Modulus of Deformation of Rock Mass Using a Radial Jacking Test[2]
D 4544 Practice for Estimating Peat Deposit Thickness[2]
D 4553 Test Method for Determining the In Situ Creep Characteristics of Rock[2]
D 4554 Test Method for In Situ Determination of Direct Shear Strength of Rock Discontinuities[2]
D 4555 Test Method for Determining Deformability and Strength of Weak Rock by an In Situ Uniaxial Compressive Test[2]
D 4622 Test Method for Rock Mass Monitoring Using Inclinometers[2]
D 4623 Test Method for Determination of In Situ Stress in Rock Mass by Overcoring Method—USBM Borehole Deformation Gage[2]
D 4630 Test Method for Determining Transmissivity and Storativity of Low Permeability Rocks by In Situ Measurements Using the Constant Head Injection Test[2]
D 4631 Test Method for Determining Transmissivity and Storativity of Low Permeability Rocks by In Situ Measurements Using the Pressure Pulse Technique[2]
D 4633 Test Method for Stress Wave Energy Measurement for Dynamic Penetrometer Testing Systems[2]
D 4645 Test Method for Determination of the In Situ Stress in Rock Using the Hydraulic Fracturing Method[2]
D 4700 Guide for Soil Sampling from the Vadose Zone[2]
D 4719 Test Method for Pressuremeter Testing in Soils[2]
D 4729 Test Method for In Situ Stress and Modulus of Deformation Using the Flatjack Method[2]
D 4750 Test Method for Determining Subsurface Liquid Levels in a Borehole or Monitoring Well (Observation Well)[2]
D 4879 Guide for Geotechnical Mapping of Large Underground Openings in Rock[2]
D 4971 Test Method for Determining the In Situ Modulus of Deformation of Rock Using the Diametrically Loaded 76-mm (3-in.) Borehole Jack[5]
D 5079 Practices for Preserving and Transporting Rock Core Samples[5]
D 5088 Practice for Decontamination of Field Equipment Used at Nonradioactive Waste Sites[5]
D 5092 Practice for Design and Installation of Ground Water Monitoring Wells in Aquifers[5]
D 5093 Test Method for Field Measurement of Infiltration Rate Using a Double-Ring Infiltrometer with a Sealed-Inner Ring[5]
D 5126 Guide for Comparison of Field Methods for Determining Hydraulic Conductivity in the Vadose Zone[5]
D 5195 Test Method for Density of Soil and Rock In-Place at Depths Below the Surface by Nuclear Methods[5]
E 177 Practice for the Use of the Terms Precision and Bias

[4] *Annual Book of ASTM Standards*, Vol 04.03.

[5] *Annual Book of ASTM Standards*, Vol 04.09.

in ASTM Test Methods[6]

E 380 Practice for the Use of the International System of Units (SI) (the Modernized Metric System)[6]

G 51 Test Method for pH of Soil for Use in Corrosion Testing[7]

G 57 Method for Field Measurement of Soil Resistivity Using the Wenner Four-Electrode Method[7,8]

3. Significance and Use

3.1 An adequate soil, rock, and ground water investigation will provide pertinent information for decision making on one or more of the following subjects:

3.1.1 Optimum location of the structure, both vertically and horizontally, within the area of the proposed construction.

3.1.2 Location and preliminary evaluation of suitable borrow and other local sources of construction aggregates.

3.1.3 Need for special excavating and dewatering techniques with the corresponding need for information, even if only approximate, on the distribution of soil water content or pore pressure, or both, and on the piezometric heads and apparent permeability (hydraulic conductivity) of the various subsurface strata.

3.1.4 Investigation of slope stability in natural slopes, cuts, and embankments.

3.1.5 Conceptual selection of embankment types and hydraulic barrier requirements.

3.1.6 Conceptual selection of alternate foundation types and elevations of the corresponding suitable bearing strata.

3.1.7 Development of additional detailed subsurface investigations for specific structures or facilities.

3.2 The investigation may require the collection of sufficiently large soil and rock samples of such quality as to allow adequate testing to determine the soil or rock classification or mineralogic type, or both, and the engineering properties pertinent to the proposed design.

3.3 This guide is not meant to be an inflexible description of investigation requirements; methods defined by other ASTM standards or non-ASTM techniques may be appropriate in some circumstances. The intent is to provide a checklist to assist in the design of an exploration/investigation plan.

4. Reconnaissance of Project Area

4.1 Available technical data from the literature or from personal communication should be reviewed before any field program is started. These include, but are not limited to, topographic maps, aerial photography, satellite imagery, geologic maps, statewide or county soil surveys and mineral resource surveys, and engineering soil maps covering the proposed project area. Reports of subsurface investigations of nearby or adjacent projects should be studied.

NOTE 1—While certain of the older maps and reports may be obsolete and of limited value in the light of current knowledge, a comparison of the old with the new will often reveal valuable information.

4.1.1 The United States Geological Survey and the geological surveys of the various states are the principal sources of geologic maps and reports on mineral resources and ground water.

4.1.2 United States Department of Agriculture Soil Conservation Service soil surveys, where available and of recent date, should enable the investigator to estimate the range in soil profile characteristics to depths of 5 or 6 ft (1.5 or 2 m) for each soil mapped.

NOTE 2—Each soil type has a distinctive soil profile due to age, parent material, relief, climatic condition, and biological activity. Consideration of these factors can assist in identifying the various soil types, each requiring special engineering considerations and treatment. Similar engineering soil properties are often found where similar soil profiles characteristics exist. Changes in soil properties in adjacent areas often indicate changes in parent material or relief.

4.2 In areas where descriptive data are limited by insufficient geologic or soil maps, the soil and rock in open cuts in the vicinity of the proposed project should be studied and various soil and rock profiles noted. Field notes of such studies should include data outlined in 10.6.

4.3 Where a preliminary map covering the area of the project is desired, it can be prepared on maps compiled from aerial photography that show the ground conditions. The distribution of the predominant soil and rock deposits likely to be encountered during the investigation may be shown using data obtained from geologic maps, landform analysis and limited ground reconnaissance. Experienced photo-interpreters can deduce much subsurface data from a study of black and white, color, and infrared photographs because similar soil or rock conditions, or both, usually have similar patterns of appearance in regions of similar climate or vegetation.

NOTE 3—This preliminary map may be expanded into a detailed engineering map by locating all test holes, pits, and sampling stations and by revising boundaries as determined from the detailed subsurface survey.

4.4 In areas where documentary information is insufficient, some knowledge of subsurface conditions may be obtained from land owners, local well drillers, and representatives of the local construction industry.

5. Exploration Plan

5.1 Available project design and performance requirements must be reviewed prior to final development of the exploration plan. Preliminary exploration should be planned to indicate the areas of conditions needing further investigation. A complete soil, rock, and ground water investigation should encompass the following activities:

5.1.1 Review of available information, both regional and local, on the geologic history, rock, soil, and ground water conditions occurring at the proposed location and in the immediate vicinity of the site.

5.1.2 Interpretation of aerial photography and other remote sensing data.

5.1.3 Field reconnaissance for identification of surficial geologic conditions, mapping of stratigraphic exposures and outcrops, and examination of the performance of existing structures.

5.1.4 On site investigation of the surface and subsurface materials by geophysical surveys, borings, or test pits.

[6] *Annual Book of ASTM Standards*, Vol 14.02.

[7] *Annual Book of ASTM Standards*, Vol 03.02.

[8] The boldface numbers in parentheses refer to the list of references at the end of this standard.