



WACEL

SOILS LABORATORY TECHNICIAN

STUDY GUIDE

June 2023

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Examination: The Soils Laboratory Technician examination is based on the following references. The exam is an open-book, 3-hour test. The examination comprises 75 multiple-choice questions. Only references listed in this study guide can be used and should be brought to the examination by the candidate. Note supervisors need to assure that references are clean copies. There can be no highlights, underlines or tabs. A basic calculator (i.e., no printing or programming capabilities) is also permitted.

References:

- A. ASTM D421-85 (2007) (withdrawn 2016), Standard Practice for Dry Preparation of Soil Samples for Particle-Size Analysis and Determination of Soil Constants.
- B. ASTM D422-63 (2007) (withdrawn 2016), Standard Test Method for Particle-Size Analysis of Soils.
- C. ASTM D698-12 (Reapproved 2021), Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort.
- D. ASTM D854-14, Standard Test Methods for Specific Gravity of Soil Solids by Water Pycnometer.
- E. ASTM D1557-12 (Reapproved 2021), Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort.
- F. ASTM D1883-21, Standard Test Method for CBR (California Bearing Ratio) of Laboratory-Compacted Soils.
- G. ASTM D2216-19, Standard Test Methods for Laboratory Determination of Water (Moisture) Content of Soil and Rock by Mass.
- H. ASTM D2487-17, Standard Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System).
- I. ASTM D4318-17, Standard Test Methods for Liquid Limit, Plastic Limit, and Plastic Index of Soils.

Learning Objectives

- I. ASTM D421:
 - A. Familiar with the scope of D421. (It should be noted that, while this specification has been withdrawn, the majority of soils laboratories are still practicing this test method because it is still accepted by AASHTO AMRL & ACOE).
 - Knows test methods that D421 prepares a soil sample for.
 - B. Familiar with the procedure of D421.
 - Knows the proper processing of soil to prepare for particle size analysis.

- Knows the proper processing of soil to prepare for soil constants testing (liquid limit and plastic limit).
- Knows the proper sample size requirements.

II. ASTM D422

- A. Familiar with the scope of D422. (Note: while this specification has been withdrawn, the majority of soils laboratories are still practicing this test method because it is still accepted by AASHTO AMRL & ACOE).
- Knows that this is a grain size distribution test. The distribution of particles larger than #200 sieve is determined by sieving, and the distribution of particles smaller than #200 sieve is determined by a sedimentation process using a hydrometer.
- B. Familiar with the test procedure and required equipment.
- Knows what sieve(s) may be used as a separation sieve.
 - Knows how to prepare the dispersing agent.
 - Knows proper sample sizes based upon nominal particle size.
 - Understands how to determine a composite correction and the need for this correction.
 - Understands the hygroscopic moisture sample.
 - Familiar with both stirring apparatus, A and B, and the necessary stirring times for each.

III. ASTM D698 and ASTM D1557

- A. Familiar with the scope of the ASTM D698 and D1557.
- Knows that ASTM D698 is the “Standard Proctor” and produces a compactive effort of 12,400 ft-lbf/ft³ (Standard Effort).
 - Knows that ASTM D1557 is the “Modified Proctor” and produces a compactive effort of 56,000 ft-lbf/ft³ (Modified Effort).
 - Knows what material that ASTM Proctors apply to and what material that these test methods are not applicable.
 - Knows which compaction method (A, B, or C) is applicable based on sample gradation.
- B. Familiar with the test procedures and the required equipment.
- Knows that ASTM D698 utilizes a “standard hammer” (5.5 lb. sliding hammer with 12” drop) and is compacted in 3 equal layers.
 - Knows that ASTM D1557 utilizes a “modified hammer” (10 lb. sliding hammer with 18” drop) and is compacted in 5 equal layers.
 - Knows required equipment based on compaction method (A, B, or C), and the procedures for preparing and compacting the material.

- Familiar with the calibration/verification of the equipment.
- Able to manually calculate (non-programmable calculator permitted) moisture contents, wet densities, and dry densities. Also, able to plot Proctor points and draw compaction curves.
- Able to determine optimum moisture content and maximum dry density from compaction curve.

IV. ASTM D854

- A. Familiar with the scope of ASTM D854.
 - Knows that there are two different acceptable methods for performing specific gravity tests according to D854.
 - Knows the differences between performing these two methods.
- B. Familiar with the test procedure and the required equipment.
 - Knows the following equipment purposes, as well as the proper readabilities, capacities, settings, etc.: pycnometer, balance, drying oven, thermometric device, desiccator, entrapped air removal apparatus (hot plate, Bunsen burner, and vacuum system), and the required type of water.
 - Knows the proper specimen size for different types of soil and test method performed.
 - Knows the procedure for calibration of the pycnometer.
 - Knows the procedures for performing test methods (Method A and Method B).

V. ASTM D1883

- A. Familiar with the scope of ASTM D1883.
 - Knows this method determines the bearing ratio of pavement subgrades, subbase, and base course materials.
 - Knows this method is primarily intended for materials with maximum particle sizes less than $\frac{3}{4}$ ", but provisions are made to test materials with maximum particle sizes greater than $\frac{3}{4}$ ".
- B. Familiar with the procedure and required equipment
 - Knows the different methods of compaction of soil in mold(s), dependent upon the specifier.
 - Knows the surcharge weights and what they simulate/represent.
 - Knows the soaking time(s).
 - Knows when and how to take the initial and final swell readings.
 - Knows what the Standard says about penetrations at 0.1" and 0.2".
 - Knows how to correct stress curves for upward concavity and surface irregularities.

- Able to manually calculate (non-programmable calculator permitted) a CBR value, given some of the starting laboratory test results.

VI. ASTM D2216

- A. Familiar with the scope of ASTM D2216.
 - Understands the differences between Method A and Method B moisture content tests.
- B. Familiar with the test procedure and required equipment.
 - Knows minimum specimen size requirements for samples based on maximum particle size and desired accuracy.
 - Knows balance readability requirements for samples based on maximum particle size and desired accuracy.
 - Knows proper oven temperature settings.
 - Knows how the Standard defines constant dry mass.
 - Knows when open containers are acceptable and when a desiccator and/or containers with close-fitting lids are required.
 - Able to manually calculate (non-programmable calculator permitted) moisture content.

VII. ASTM D2487

- A. Familiar with the scope of ASTM D2487.
 - Knows this standard for classification is applicable only to naturally occurring soils.
 - Understands this is a qualitative application and not quantitative. If quantitative information is required – supplemental testing results are necessary.
 - Knowledgeable of the history of the standard. It is based on an old airfield classification system, also known as the Casagrande system. It then became known as the USCS after adoption by several US government agencies.
- B. Familiar with the terminology used in the standard.
 - Understands what organic soils are.
 - Understands what clay is.
 - Knows that 'Fat Clay' is a 'highly plastic clay'."
 - Knows that "Lean Clay' is a 'low plasticity clay'."
 - Understands what silt is.
 - Understands what gravel is, and differences between coarse and fine gravels.
 - Understands what sand is, and the differences between coarse, medium, and fine sands.
- C. Familiar with the procedure for classification of soil.
 - Knows the soil classification names and group symbols.

- Able to classify soil when given the necessary basic laboratory test results.

VIII. ASTM D4318

A. Familiar with the scope of ASTM D4318.

- Knows that the material used for the test is obtained from either *wet preparation* or *dry preparation*, and that the *wet preparation* method is the default or ASTM preferred method.
- Knows the two methods for determining liquid limits, *Method A – Multipoint* and *Method B – One-Point*, and that *Multipoint* method is preferred when greater precision is required.
- Knows that the liquid limit and plastic limit tests are often collectively called the Atterberg limits.

B. Familiar with the procedure and required equipment.

- Knows how to prepare test sample(s).
- Knows the procedures for both *one-point* and *multipoint* liquid limit testing.
- Knows how to proceed with and conclude testing when non-plastic soils are encountered.
- Knows the testing procedure for plastic limit.
- Familiar with testing equipment (liquid limit device, grooving tool, scale/balance, specimen containers, ground glass plate, etc.)
- Able to manually calculate (non-programmable calculator permitted) liquid limit, plastic limit, and plasticity index when given the starting laboratory test results.