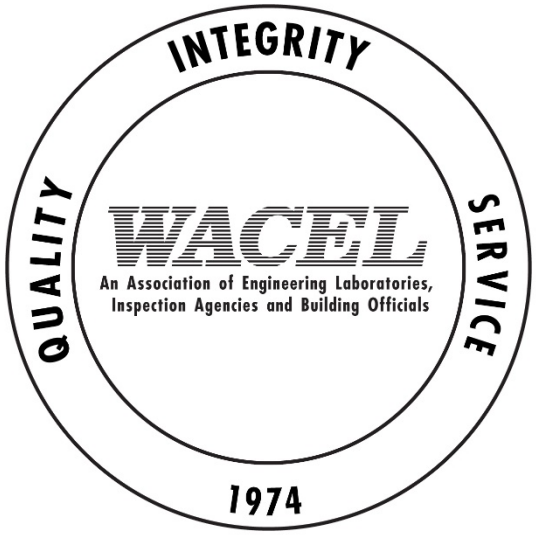

STUDY GUIDE

WACEL SOIL 1

SPECIAL INSPECTOR

JANUARY 2022

7508 Wisconsin Avenue, 4th Floor, Bethesda, MD 20814; 301-652-7925; www.wacel.org

Soil 1 Special Inspector Study Guide

Certification Objective:

The knowledge and skills being evaluated by the overall scope of this certification are for special inspectors who can properly observe and perform field testing site preparation and grading operations for relatively straightforward projects. The topics included address project documentation and specifications, a basic understanding of suitable materials for construction operations, the testing and operations that typically may be required, and a demonstrated ability to read and understand applicable project plans.

Scope:

Soil 1 Special Inspector is the first certification in the area of geotechnical testing and observations that most engineering field technicians must complete. The scope of knowledge required is fairly large; it is intended to prepare a special inspector to operate in the field with minimum on-site supervision.

The general scope of this certification includes:

1. Can visually describe basic soil types in general accordance with the USCS, and is familiar with general properties.

2. Is familiar with some ASTM laboratory tests used for classification and quality control purposes (grain size, Atterberg limits, moisture content, and proctor results).

3. Can obtain, identify, label, and transport representative samples.

4. Can understand and interpret basic earthwork specifications and geotechnical recommendations.

5. Understands the roles and responsibilities of project personnel (technician, geotechnical engineer, contractor, owner, and government agency).

6. Understands the principles of density testing.

7. Can perform, and evaluate compaction by the nuclear density gauge, sand cone, and drive-cylinder methods.

8. Can perform, and understands the uses and limitations of one-point Proctor test and a "family of curves."

9. Can perform field moisture tests of soil samples using direct heat.

10. Is familiar with effects of and corrections for micaceous soil and testing in trenches using nuclear gauges.

11. Is familiar with the types, uses and suitability of various types of compaction equipment.

12. Can perform basic observations of topsoil stripping, the removal of unsuitable materials, and proofrolling.

13. Is familiar with field equipment calibration and leak testing of nuclear gauges.

14. Is familiar with excavation safety and applicable OSHA requirements.

15. Completed basic radiation safety training, has certification (for Nuclear Gauge users only), and is familiar with the operational requirements of ASTM D6938.

Although not part of this certification, Soil I special inspectors also need to be familiar with the reporting requirements and formats for earthwork operations established by their employer.

Due to the lack of concise references that address the wide range of skills that are covered by this certification, the contents of this Study Guide take on a special significance. To a greater degree than other WACEL Study Guides, the listed learning objectives serve as an outline of much of the material soil technicians are expected to know. This same outline can serve as the starting point for Soil 1 training classes that are developed. It should be noted that this Study Guide is listed as a "Required Reference," and an unmarked copy can be used during the written examination.

Examinations: A photo identification card should be presented by each candidate prior to taking either the

written or the performance examination. A non-graphing calculator is authorized.

Written Exam:

The Soil 1 Special Inspector Examination is a 75-question test (55 academic, 20 plan-reading) based on the references listed below. 3 hours are allowed to complete this examination, and it is an open– book examination based on the required references listed below and the contents of this Study Guide. An overall grade of 75 percent or better is required for passing; with a score of at least 70% on the plan reading section of the exam (20 questions). A strong understanding of both academic and plan reading questions is imperative for a field technician to be self-sufficient and competent in the field.

No notes or working papers may be removed from the examination area. Examination candidates should bring all of the required references without markings or highlighting. Practical (Performance) Exam:

The Soil 1 Special Inspector Practical Examination is conducted by a WACEL-approved examiner. A copy of the practical examination is part of this Study Guide and is available on the WACEL website (www.wacel.org) in the 'Members Only' section, as well as by contacting WACEL and requesting a copy if you do not have access to the 'Members Only' section or have problems accessing it. Detailed instructions are given on the cover page of the practical examination for administration of it.

See the WACEL website for information on how the performance component can be administered remotely.

Required References:

1. ASTM D75-19 "Standard Practice for Sampling Aggregate."

2. ASTM D1556-15e1 – "Standard Test Method for Density and Unit Weight of Soil by the Sand-Cone Method."

3. ASTM D2937-17e2- "Standard Test Method for Density of Soil in Place by the Drive-Cylinder Method."

4. ASTM D4959-16 – "Standard Test Method for Water Content of Soil By Direct Heat Methods."

5. ASTM D6938-17a – "Standard Test Methods for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depths)."

6. AASHTO T272-18 – Family of Curves – One Point Method. (VTM 12)

7. WACEL Study Guide for Soil 1, November 2021.

Background References:

1. ASTM D422-63 (2007) – "Standard Test Method for Particle Size Analysis of Soils."

2. ASTM D698-12e2 – "Standard Test Method for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft^3) (600 kN-m/m^3)."

3. ASTM D1557-12e1 – "Standard Test Method for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft^3) (2,700 kN-m/m^3)."

4. ASTM D2487-17e1 – "Standard Practice for Classification of Soil for Engineering Purposes (USCS)."

5. ASTM D4318-10e1 – "Standard Test method for Liquid Limit, Plastic Limit, and Plasticity Index of Soil."

6. ASTM D4718-15 (2007) – "Standard Practice for Correction of Unit Weight and Water Content for Soil Containing Oversize Particles."

7. Geotechnical Testing, Observation, and Documentation – Second Edition, Tim Davis (Author), published by ASCE.

Learning Objectives:

To assist candidate soil technicians and their employers in preparing individuals and training programs for this entry-level certification, the following primary and supporting learning objectives have been developed. They are intended to focus on what is considered important, what must be addressed in training and preparation programs, and what will be the basis for evaluation.

Introduction and "Why We Test Soils":

1. Appreciates that soil or rock serve as the foundation for just about every building, road, or structure that is built.

a. Understands that different soil types can have dramatically different characteristics that impact how and where they are best used.

b. Knows that proper handling and testing of soil can significantly reduce the potential for failures or deficient work.

c. Realizes the key role that field soil technicians serve in the testing and observations of soil on a project to help produce a quality project.

Basic Concepts and Soil Characteristics:

2. Appreciates the basic soil types defined by the Uniform Soil Classification System (USCS), some of their construction related characteristics, and how they may be used in typical construction activities.

a. Understand the approximate particle sizes that define boulders, cobbles, gravel, sands, and silt/clay.

b. Knows the difference between well graded and poorly-graded soils.

c. Knows what soil types are generally best for drainage.

d. Knows what soil types are generally best for limiting the movement of water.

e. Understands the terms pervious and permeable as well as plasticity and shrink/swell potential.

f. Understand the major variable that influences how a soil reacts during construction to include particle size, plasticity, moisture content, and compaction.

g. Knows what soil types are generally best for engineered (structural) fill and for paved areas.

Technician Responsibilities:

3. Understands the roles and responsibilities of project personnel (technician, geotechnical engineer, contractor, owner, and government agency).

a. Understands when actual site conditions require the involvement of the geotechnical engineer of record.

b. Understands the role of a project's geotechnical engineer and its geotechnical report.

c. Knows that the general contractor's designated representative must be notified immediately of any deficient test results.

d. Understands that a field technician's primary functions are involved with confirming, observing, testing, recording, and reporting.

Select Laboratory Testing:

4. Is familiar with some relevant ASTM laboratory tests used for classification and quality control purposes (grain size, Atterberg limits, moisture content, and Proctor tests).

a. Knows the purposes of obtaining Atterberg limits.

b. Understands the meaning of the Atterberg terms (LL, PL, PI).

c. Has general knowledge of the various "Proctor" procedures.

d. Knows how particle sizes are determined.

Sampling:

5. Can obtain, label, and transport representative samples.

a. Is aware of how to obtain and properly label soil samples.

b. Has a basic understanding of how to obtain a representative sample.

Specifications and Geotechnical Recommendations:

6. Can fully understand and interpret basic earthwork specifications and geotechnical recommendations.

a. Knows what to do if unanticipated materials are encountered.

b. Can determine what materials are unsuitable for use and which on-site materials may be used.

c. Can properly identify other, proper construction quality control information from project specifications.

Field Observations, Compaction, and Oversize Corrections:

7. Understands the principles of density testing, including weight/volume and moisture/density relationships.

a. Knows how to interpret and apply Proctor data.

b. Can compute and evaluate moisture content data, optimum moisture contents (OMC), and moisture effects on compaction.

c. Can compute the dry density of a soil sample given the wet density and the moisture content.

d. Knows the proper use of the equipment and supporting documentation necessary for each system.

e. Given nuclear gauge readings, sand cone field data, or drive cylinder results, can compute percent compaction and moisture content.

f. Can adjust compaction and moisture content data based on oversized material using the appropriate formulae or nomograph. Emphasis will be on +4 corrections for material retained on a No. 4 sieve using the nomograph. Knows how to address and evaluate failing compaction test results and who must be provided this information.

g. Can compare computed results with specifications to confirm acceptability using the formula.

h. Is aware of the probable or specified testing frequency for compacted fill.

i. Understands the advantages and limitations of using either nuclear gauge equipment, the sand cone, or the drive cylinder.

Moisture Corrections:

8. Is familiar with effects of and corrections for certain soil (i.e., moisture corrections) and testing in trenches using nuclear gauges.

a. Understands the different times that moisture content corrections may be required when using portable nuclear gauges.

b. Has a basic knowledge of how these situations produce distorted results.

Proper Compaction Equipment:

9. Is familiar with the types, uses and suitability of various types of compaction equipment.

a. Type for soil type. Coarse grained soil compact better with smooth drum compactors; fine grained soil with sheepfoot rollers.

b. Size vs. lift thickness vs. passes.

Topsoil Stripping & Proofrolling:

10. Can perform basic observations of topsoil stripping, the removal of unsuitable materials, and proofrolling.

a. Can identify what is generally classified as top soil.

b. Knows the limitations if topsoil is used as structural fill.

c. Understands the purposes and limitations of proofrolling.

Calibration:

11. Is familiar with field equipment calibration/verification and leak testing of gauges.

a. Understands the importance of only using clean, serviceable, calibrated equipment.

b. Knows the range and interval of tests and checks that apply to portable nuclear gauges to include standardization, calibration, and leak tests.

c. Knows the calibration intervals for scales, sand cone components, proctor molds, etc.

Site Plan Reading:

12. Is familiar with and able to read earthwork site plans.

a. Able to read contour lines – existing grades and proposed grades.

b. Able to determine when cut or fill operations are necessary, based on grades/contour lines.

c. Knows how to become directionally oriented based on the North Arrow shown on the plans.

d. Able to read and decipher information shown on a profile, including (but not limited to) existing grade lines, proposed grade lines and invert elevations.

e. Familiar with symbols and common abbreviations used on plans. f. Can determine distances based on station numbers.

ASTMs Covered in Performance Evaluation:

13. Water content by Direct Heating (ASTM 4959-16).

a. Knows that determining the water content of a soil by direct heating in the field is a common expedient during construction.

b. Is aware that the heat source can take many forms so long as open flames are not applied to a specimen.

c. Knows that a calibrated scale or balanced allowing 0.1 grams readability is generally required.

d. Can determine the minimum mass of the moist specimen based on the sieve size retaining more than 10 percent of the sample in accordance with the table in ASTM D4959.

e. Knows to determine and record the mass of the clean, dry specimen container both before and after the moist specimen is added.

f. Understands the need to heat the specimen while stirring to obtain even heat distribution and taking care to avoid localized overheating.

g. Knows that specimen is heated initially until it appears dry and is typically allowed to cool. The mass is then determined and recorded.

h. Is aware that the heating, cooling, and weighing is repeated until the change between two consecutive mass determinations would have an insignificant effect on the calculated water content.

i. Can correctly calculate the water content of the specimen by dividing the mass of the water in the moist specimen by the mass of the dry soil. This is multiplied by 100 to express the result as a percentage.

14. Nuclear Density Gauge (ASTM D6938-17a).

a. Is aware of the standardization requirements for portable nuclear gauges to include checks before each day's use.

b. Knows the requirements for the preparations needed for each test site location. These preparations include smoothness and corrective actions if gaps are greater than standards.

c. Knows the gauge should be at least 6 inches from any vertical projection when being used in the direct transmission mode.

d. Is aware of the correct use of drive pins as well as the proper and safe insertion of test probes.

e. Knows that after the test probe is lowered into the hole that the gauge should be gently pulled back so that the probe is in direct contact with the side of the hole.

15. Density and unit weight of soil in place by sand-cone method (ASTM D1556-15e1).

a. Is aware that the sand-cone method can be for the determination of the in-place density and unit weight of intact or *in situ* soils, provided certain soil conditions are met.

b. Knows that the typical sand-cone apparatus is limited to soil with maximum particle size of approximately 11⁄2 inch.

c. Is knowledgeable of the time intervals and atmospheric conditions that would require the bulk-density of the sand to be redone.

d. Can properly select and prepare test locations that are representative, flat, level, and free of vibrations.

e. Knows how to estimate the proper depth and size of test holes.

f. Can properly go through the procedural steps to determine the volume of the test hole and the mass of the wet soil removed from the hole.

g. Determines the water content of the soil removed from the hole to the nearest 1 percent.

h. Can properly complete the calculations to determine the volume of the test hole, the moist mass of the material from the test hole, the dry mass of the material from the test hole, and the dry density of the tested material.

16. Density of soil in place by drive-cylinder method (ASTM D2937-17e2).

a. Knows what types of soil are suitable for this test method and what types are not.

b. Is aware of the maximum particle size limitations for both in-place density testing and field compacted soils.

c. Is knowledgeable of the approximate depth the top of the cylinder should be driven to relative to the original ground surface.

d. Knows the trimming, cleaning, and patching steps that may be required before the mass of the drive cylinder and soil sample is determined.

e. Can generally describe the conditions that would result in a specimen being discarded.

f. Knows how to determine the wet density (ρ_{wet}) and the moisture content (w) of the test specimen.

g. Can calculate the in-place dry density (ρ_{dry})

17. One-Point Proctor.

a. Can perform, and understands the uses and limitations of the one-point proctor test and a "family of curves."

b. Understands when it is appropriate to accomplish a one-point proctor test.

c. Understands that one-point proctor tests are typically conducted to give field technicians a relatively rapid "confirmation" of a provided proctor test or an interim control value for a new borrow source.

d. Understands the limitations of the results of a one-point Proctor test.

e. Realizes that contractors must be informed that one-point results must be validated by properly conducted laboratory testing of a representative sample.

f. Can properly accomplish a one-point Proctor test in accordance with VTM-12.

g. Given wet density and moisture content test results, can determine the maximum dry density and the optimum moisture content of a soil sample using the specified family of curves.