Training Solutions, Delivered!

SOIL CLASSIFICATION

Leader's Guide, Fact Sheet & Quiz

Item Number: 4055

This easy-to-use Leader's Guide is provided to assist in conducting a successful presentation.

PREPARING FOR THE MEETING

Here are a few suggestions for using this program:

a) Review the contents of the Fact Sheet that immediately follows this page to familiarize yourself with the program topic and the training points discussed in the program. The Fact Sheet also includes a list of Program Objectives that details the information that participants should learn from watching the program.

b) If required by your organization, make an attendance record to be signed by each participant to document the training to be conducted.

c) Prepare the area and equipment to be used for the training. Make sure the watching environment is comfortable and free from outside distractions. Also, ensure that participants can see and hear the TV screen or computer monitor without obstructions.

d) Make copies of the Review Quiz included at the end of this Leader's Guide to be completed by participants at the conclusion of the presentation. Be aware that the page containing the answers to the quiz comes *before* the quiz itself, which is on the final page.

CONDUCTING THE PRESENTATION

a) Begin the meeting by welcoming the participants. Introduce yourself and give each person an opportunity to become acquainted if there are new people joining the training session.

b) Introduce the program by its title and explain to participants what they are expected to learn as stated in the Program Objectives of the Fact Sheet.

c) Play the program without interruption. Upon completion, lead discussions about your organization's specific policies regarding the subject matter. Make sure to note any unique hazards associated with the program's topic that participants may encounter while performing their job duties at your facility.

d) Hand out copies of the review quiz to all of the participants and make sure each one completes it before concluding the training session.

4055 SOIL CLASSIFICATION
FACT SHEET

LENGTH: 20 MINUTES

PROGRAM SYNOPSIS:
If you have been around construction or public works for any length of time, you know that working around trenches can be dangerous. In fact, as little as a cubic foot generally weighs as much as 100 pounds or more, and a cubic yard can weigh 2,700 lbs or as much as a small truck. Before work can begin in such a setting, a competent person must identify the hazardous conditions inside and around the trench and then determine the precautions that must be taken to control these threats and keep workers safe. This program reviews the various inspections and tests competent persons can perform to determine the type of soil that is present at the site of a trenching operation.

PROGRAM OBJECTIVES:
After watching the program, the participant will be able to explain the following:
- How to perform a visual inspection of a soil sample;
- What the characteristics of the four types of soil are;
- How to perform plasticity, dry strength and thumb penetration tests;
- How to use a pocket penetrometer and shear vane to calculate the unconfined compressive strength of soil;
- How to conduct drying and olive jar tests.

INSTRUCTIONAL CONTENT

WHY TRENCH WORK IS SO DANGEROUS
- Most workers don't realize the forces and impact associated with a cave-in and are usually kneeling or in a bent over position at the bottom of the trench when performing trench work.
- A person buried under only a couple of feet of soil can experience enough pressure to the chest to prevent the lungs from expanding causing suffocation. Heavier soil and boulders can crush us in an instant.
- Of course, we must remember that the average cave-in can drop five yards of soil or more. That's 13,500 pounds of dirt.
- How quickly can your co-workers dig through five or more yards of dirt to find you? Survival is unlikely.
- Remember, while working in trenches and excavations, there is absolutely no room for risk-taking. Any condition you ignore or overlook can be fatal.

DEFINITION & DUTIES OF THE COMPETENT PERSON
- The term "competent person" is defined in the OSHA standards as relating to trenching and excavation activities.
- A competent person is chosen by the employer who, by training and/or experience, is knowledgeable of applicable safety standards and is capable of identifying existing and predictable hazards in the surroundings and/or working conditions which are unsanitary, hazardous and/or dangerous to employees.
- One of the most important conditions is that the competent person has been given the authority to take prompt corrective measures to eliminate hazards.
- A key aspect of the standard is the requirement for the competent person to conduct inspections: daily and before the start of each work shift or as required by the work being performed, after every rain storm or other weather event that could adversely affect trench stability such as snow, freeze and thaw conditions, windstorms, earthquake, or any other dramatic weather change, when there is a change in the size, location, or placement of the spoil pile or materials and whenever there is evidence of tension cracking, fissures, bulging, water incursion, sloughing or any other condition or indication where soil stability may be questioned.

SOIL CLASSIFICATION STANDARDS
- It is important to understand that the testing criteria, definitions and examples are located in the OSHA Code of Federal Regulations 29 CFR 1926.650, 651 and 652.
- Soil classification is based on, in whole or in part, in the American Society for Testing Materials (ASTM) Standards D653-85 and D2488, The Unified Soils Classification System, The U.S. Department of Agriculture (USDA) Textural Classification Scheme and the National Bureau of Standards Report BSS-121.
- It is highly recommended that you acquire a copy of the standards and take the time to be thoroughly familiar with the methods and ensure that they are closely followed to ensure accurate soil classification.

VISUAL INSPECTIONS

- As a competent person, you must conduct an analysis of the soil to determine its classification as required by the standard. The soil classification will help you determine the appropriate trench protection measures to choose by consulting the sloping and shoring tables in the standards.
- The very first thing you must do in order to classify soil is to simply look at it and handle it. The purpose is to conduct an examination to visually determine soil condition and its properties.
- The general requirements of the regulation require that a competent person type or classify the soil by using at least one visual and one manual test.
- A visual test would include observing the soil as it is being removed looking for clues to help you determine the classification.
- Begin by going to the spoil pile and choose a number of clumps of soil. By the way, never take samples from the trench wall as it's just too dangerous.

DETERMINING THE COHESIVENESS OF THE SOIL

- When classifying soil, look for evidence of the type of soil. Does it appear as clay, sand, granular or silt?
- Next, look at the size of the individual gains of soil. Are they large, small, clumped or smooth?
- Basically, you are looking for clues as to the make of the soil. Is it cohesive or granular?
- The term cohesive refers to the soil's ability to stick together. Clay is the key component as it relates to cohesiveness. The more clay, the better the soil will stay together.
- Note that soil that breaks up easily and does not stay in clumps may be granular in nature. Look for evidence of wet, saturated, or submerged soil.
- Basically, you are trying to determine if the soil has a high degree of clay or sand, giving you a clue as to the ability of the soil to remain stable.
- Cohesive soil does not crumble. It usually can be easily molded when moist and is hard to break up when dry. When you see clay, it appears as a very fine-grained soil and is very cohesive or "sticky."
- Generally speaking, the more clay in the soil makeup, the better the trench wall will hold up. Conversely, granular soil contains enough sand and granular material to prevent the soil from having any significant cohesive strength.
- During your visual exam, you will notice that granular soil has little or no clay content. You may see material that appears to be gravel, sand or silt.
- When granular soil is handled it cannot be molded when moist and crumbles when dry. So, it is clear that this type of soil is risky and demands extra attention to prevent a trench failure!

CEMENTED & SATURATED SOIL

- Your visual examination may reveal what appears to be a cemented soil. We must be wary with this type of soil, as the soil particles may be held together with a natural chemical agent such as calcium carbonate.
- Cemented soil may look like concrete but can turn to a dusty non-cohesive material once excavated.
- Another factor in soil cohesion is water. Soil that is filled with water is termed saturated.
- Saturated soil generally does not hold together well and is particularly dangerous in excavation work; however, the opposite can also be true.
- We want to see soil that is moist versus heavily saturated. Soil that has little or no moisture can crumble easily and therefore may not hold together when excavated.

THE FOUR TYPES OF SOIL

- OSHA classifies soils into four categories: Solid Rock, Type A, Type B, and Type C. As the competent person, you will be determining the soil classification in order to help choose the proper trench protection. The classification must be based upon at least one visual and one manual soils test.
- Solid Rock is the most stable and Type C soil is the least stable. Soils are classified not only by how cohesive they are, but also by the conditions in which they are found.
- Stable rock is not as common as one would think. This is because the excavation of rock typically requires cutting, drilling and blasting, which may fracture the rock, possibly making it less stable.
- Type A soil generally will be made up of clay, silty clay or sandy clay.
- Many OSHA compliance officers believe that construction equipment on the site can create enough vibration to prevent the soil from being typed as "A." If vibrations are present, the competent person would need to downgrade the soil type to the next lower classification.
- A soil cannot be considered Type A if it is fissured; has cracks or other conditions that can adversely affect stability, such as

being subject to vibration from heavy traffic, pile driving or similar activities; having been previously disturbed or excavated; where it is part of a layered system where less stable soil is near the bottom of the excavation with the more stable soils on top; or, subject to other factors which would make it unstable, such as the presence of groundwater or freezing and thawing conditions.

- In many projects, the soil being excavated has been previously disturbed. This means the soil has been dug up or manipulated in the past. This is another factor that you as the competent person must consider when typing soils.
- Previously-disturbed soil is commonly found above existing utilities, such as water, sewer, electrical and gas lines. This makes work around these utilities far more dangerous due to the unstable nature of the back filled soil. This could also apply to projects where the soil has been disturbed in order to construct homes.
- Type B soils can include both cohesive and non-cohesive soils. They include silts, sandy loams, medium clays, and unstable rock.
- Soils that might be classified as A, but have been previously disturbed, have fissures or are subject to vibration might also be classified as B soils.

- Type C soils are the most unstable and therefore the most dangerous. They are usually recognized by the continual sloughing of the sides of the walls of excavation.
- If soil is submerged or water is seeping from the sides of an excavation, it's likely Type C.

MANUAL TESTING

- The standard provides for a number of tests to help determine soil classification. Manual tests are used to identify the soil type and cohesiveness.
- It is recommended that your organization retain the services of a soils engineer to provide additional formal training on how conduct the most accurate soil classification.
- Be sure to carefully study the OSHA standards and related information to ensure that you have a good understanding of the tests and methods necessary to conduct the manual testing.
- Regardless of the methods used, the classification of soil must be performed by the competent person prior to anyone entering the excavation. Remember, never enter the trench to take soil samples.
- A manual test means assessing the soil with either your hands or with an instrument designed to measure soil strength.

PLASTICITY TESTS

- One of the manual tests discussed in the standard include the plasticity test used to help to determine if the soil contains cohesive material.
- To perform this test, find a palm sized sample of moist soil and mold it into a ball, and then attempt to roll it into threads about 1/8 inch in diameter. You may add water to help gain enough moisture in order to help roll out the sample.
- If the soil contains cohesive properties, it can usually be rolled into threads without crumbing. If at least a two-inch length of 1/8 inch thread can be held on one end without tearing, the soil is likely cohesive and therefore may be Type A soil. If the soil will not roll into a thread, the material would not be considered cohesive.
- Another plasticity test is known as the ribbon test. It is conducted in a similar manner, but rather than rolling into a thread, a larger roll, about 3/4 to 1 inch thick is used and squeezed between the thumb and forefinger. If it ribbons around the hand, it may contain a sufficient amount of clay to be considered cohesive or Type A.

THE DRY STRENGTH TEST

- Another permissible test is known as the dry strength test. To conduct this test, choose an undisturbed sample from the spoil pile about the size of a small plate. (By the way, undisturbed means that you are testing it as you found it, and have not added water or disturbed it in any other way.)
- Now, use your thumb or fingers to apply light to moderate pressure to the sample. If the sample easily crumbles into individual grains or powder with moderate pressure, the soil is usually considered granular.
- If the soil is dry and breaks into clumps, which can only be broken with difficulty, it may contain enough clay in combination with gravel, sand or silt, and therefore may be cohesive.

THE THUMB PENETRATION TEST

- The thumb penetration test may be used to estimate the unconfined compressive strength of cohesive soil material and classification.
- When performing this test, it must be done on undisturbed moist soil samples about the size of a baseball. This test should be performed as soon as possible after excavation to reduce the effects of drying or additional water.
- Begin pressing your thumb into the sample, using just thumb pressure. If you cannot penetrate the sample or just barely

indent the soil, the standard indicates that it may be Type A soil. According to the standard, Type A soils have an unconfined compressive strength of 1.5 tons per square foot or greater and cannot readily be indented by thumb pressure.

- Type B soils are those with 0.5 to 1.5 tons per square foot of unconfined compressive strength and can generally be penetrated only to the first joint of the thumb.
- Lastly type C soil has an unconfined compressive strength of 0.5 tons per square foot or less and can easily be fully penetrated by the thumb and molded by light finger pressure.
- Be aware, the major concern with using the thumb penetration test is that you have no hard data to support your findings should you need to defend your position at an OSHA hearing.

USING A POCKET PENETROMETER

- One very useful instrument for measuring soil strength is a pocket penetrometer. This test is used to obtain the shear strength parameters of cohesive fine grained soils.
- These instruments are key in helping to calculate the unconfined compressive strength of the soil in tons per square foot.
- When using the pocket penetrometer:

1. Perform the test on a number of undisturbed samples of soil such as fist sized clumps. Shave off a clean spot that is free of rocks and other debris.
2. Following the manufacturer's instructions, move the ring or plunger to the lowest setting.
3. Grip the handle and with steady pressure, push slowly until the soil reaches the marking on the piston, about ¼ inch from the end.
4. Read the unconfined compressive strength in tons/square foot or TSF on the indicator; however, be sure to follow the manufacturer's instructions for your instrument!
5. Take about a dozen readings on the samples and take an average of the findings to come up with the final calculation for the unconfined compressive strength. Be sure to throw out any particularly high or low readings to get a good representative number.

- Type A soil will have an unconfined compressive strength in tons per square foot of 1.5 or greater, Type B 0.5 to 1.5 and Type C 0.5 or less. Your findings will be used to help choose the proper trench protection for the soil using the tables in the standard.
- Be sure to document your findings in the event you have to prove them to a compliance officer.

USING A SHEAR VANE

- Another instrument that might consider is a shear vane. Use this instrument according to the manufacturers' recommendations, again being careful to read and follow the instructions.
- Since the shear vane measures shear strength as opposed to unconfined compressive strength, you will need to double the number to get the correct result.
- Again, take about a dozen samples and calculate an average. Do not forget to document!

THE DRYING TEST

- The drying test may be used, but the basic purpose is to differentiate between cohesive material with fissures, unfissured cohesive material and granular material.
- This test should be conducted by a qualified individual since the test requires the use of a field lab oven or other heat source.

THE OLIVE JAR TEST

- A fun test to perform is known as the mixed media or olive jar test. This test can be used to help estimate the amount of clay, silt and/or sand in a soil sample.
- It requires quite a bit of work to perform as you must take about six shovels of soil removing all rocks and other debris. Mix thoroughly, then cut into quarters and throw out two; mix and repeat at least two more times, mixing the final sample again.
- Generally, a tall jar is used with a mark about 1 ½ inch from the bottom. The soil sample is placed in the jar up to the line and water added to the top (about 5-6 inches of water). The jar is shaken vigorously, given a twist and the sample timed.
- The type of soil within the jar will dictate how quickly it will settle out. For example, if about 80 percent of the soil settles out within the first 30 seconds, the soil is generally Type C material. If after 30 seconds, 70-80 percent of the material does not settle out, it could be Type B soil.

DETERMINING TRENCH PROTECTION & SUPPORT MEASURES

- Once you have determined the soil classification, you will now be able to use this information to help determine the

appropriate trench protection and support measures or systems for workers.

- Consult the standard and tables within the standard that corresponds to the soil classification. You will be choosing between sloping or benching, a shoring system, or a trench box to provide protection for your workers.

SOIL CLASSIFICATION

ANSWERS TO THE REVIEW QUIZ

1. c
2. a
3. a
4. b
5. c
6. a
7. b
8. b
9. c
10. b

SOIL CLASSIFICATION
REVIEW QUIZ

The following questions are provided to determine how well you understand the information presented in this program.

Name_____Date_____

1. An average cave-in of five yards of soil will weigh _____ pounds.

a. 1,350
b. 5,000
c. 13,500

2. You should never take samples of soil to test from a trench wall.

a. true
b. false

3. What is the key component of soil that makes it more cohesive?

a. clay
b. silt
c. sand

4. Soil that is filled with water is termed _____.

a. soluble
b. saturated
c. hydrated

5. Which type of soil is the least stable?

a. Type A
b. Type B
c. Type C

6. Type B soils may be cohesive or non-cohesive.

a. true
b. false

7. Which type of manual test is performed on a sample that is the size of a small plate?

a. the plasticity test
b. the dry strength test
c. the thumb penetration test

8. Which type of soil has an unconfined compressive strength of .5 to 1.5 tons per square foot?

a. Type A
b. Type B
c. Type C

9. When using a pocket penetrometer or shear vane to measure soil strength, how many samples should you test?

a. 2
b. 6
c. 12

10. What is another name for the mixed media test?

a. the pickle jar test
b. the olive jar test
c. the mason jar test