Soil Classification Outline

1. **Overview**
    a. Identify different soil types
    b. Understand the methods of testing the soil
    c. Understand the soil mechanics
    d. Understand the weight of the soil
    e. Review case studies
    f. Understanding workers rights

2. **Soil Types**
    a. Stable Rock
        i. Stable Rock is natural solid mineral matter that can be excavated with vertical sides and remain intact while exposed. It is usually identified by a rock name such as granite or sandstone. Determining whether a deposit is of this type may be difficult unless it is known whether cracks exist and whether or not the cracks run into or away from the excavation.
    b. Type A Soils
        i. Type A Soils are cohesive soils with an unconfined compressive strength of 1.5 tons per square foot (tsf) (144 kPa) or greater. Examples of Type A cohesive soils are often: clay, silty clay, sandy clay, clay loam and, in some cases, silty clay loam and sandy clay loam. (No soil is Type A if it is fissured, is subject to vibration of any type, has previously been disturbed, is part of a sloped, layered system where the layers dip into the excavation on a slope of 4 horizontal to 1 vertical (4H:1V) or greater, or has seeping water.
    c. Type B Soils
        i. Type B Soils are cohesive soils with an unconfined compressive strength greater than 0.5 tsf (48 kPa) but less than 1.5 tsf (144 kPa). Examples of other Type B soils are: angular gravel; silt; silt loam; previously disturbed soils unless otherwise classified as Type C; soils that meet the unconfined compressive strength or cementation requirements of Type A soils but are fissured or subject to vibration; dry unstable rock; and layered systems sloping into the trench at a slope less than 4H:1V (only if the material would be classified as a Type B soil).
    d. Type C Soils
        i. Type C Soils are cohesive soils with an unconfined compressive strength of 0.5 tsf (48 kPa) or less. Other Type C soils include granular soils such as gravel, sand and loamy sand, submerged soil, soil from which water is freely seeping, and submerged rock that is not stable. Also included in this classification is material in a sloped, layered system where the layers dip into the excavation or have a slope of four horizontal to one vertical (4H:1V) or greater.
    e. Multi-type soil
        i. Layered Geological Strata. Where soils are configured in layers, i.e., where a layered geologic structure exists, the soil must be classified on the basis of

the soil classification of the weakest soil layer. Each layer may be classified individually if a more stable layer lies below a less stable layer, i.e., where a Type C soil rests on top of stable rock.

3. Testing soil

a. Pocket Penetrometer
    i. Penetrometers are direct-reading, spring-operated instruments used to determine the unconfined compressive strength of saturated cohesive soils. Once pushed into the soil, an indicator sleeve displays the reading.
    ii. The instrument is calibrated in either tons per square foot (tsf) or kilograms per square centimeter (kPa). However, Penetrometers have error rates in the range of ± 20-40%.

b. Shear Vane
    i. To determine the unconfined compressive strength of the soil with a shear vane, the blades of the vane are pressed into a level section of undisturbed soil, and the torsional knob is slowly turned until soil failure occurs.
    ii. The direct instrument reading must be multiplied by 2 to provide results in tons per square foot (tsf) or kilograms per square centimeter (kPa)

c. Thumb penetration
    i. The thumb penetration procedure involves an attempt to press the thumb firmly into the soil in question.
    ii. If the thumb makes an indentation in the soil only with great difficulty, the soil is probably Type A.
    iii. If the thumb penetrates no further than the length of the thumb nail, it is probably Type B soil.
    iv. If the thumb penetrates the full length of the thumb, it is Type C soil. The thumb test is subjective and is therefore the least accurate of the three methods.

d. Dry strength
    i. Dry soil that crumbles freely or with moderate pressure into individual grains is granular.
    ii. Dry soil that falls into clumps that subsequently break into smaller clumps (and the smaller clumps can be broken only with difficulty) is probably clay in combination with gravel, sand, or silt.
    iii. If the soil breaks into clumps that do not break into smaller clumps (and the soil can be broken only with difficulty), the soil is considered unfissured unless there is visual indication of fissuring.

e. Plasticity or wet thread
    i. This test is conducted by molding a moist sample of the soil into a ball and attempting to roll it into a thin thread approximately 1/8 inch (3 mm) in diameter (thick) by 2 inches (50 mm) in length.
    ii. The soil sample is held by one end. If the sample does not break or tear, the soil is considered cohesive.

f. Visual
    i. A visual test is a qualitative evaluation of conditions around the site. In a visual test, the entire excavation site is observed, including the soil adjacent to the site and the soil being excavated. If the soil remains in clumps, it is cohesive; if it appears to be coarse-grained sand or gravel, it is considered granular. The evaluator also checks for any signs of vibration.
        1. During a visual test, the evaluator should check for crack-line openings along the failure zone that would indicate tension cracks, look for existing utilities that indicate that the soil has previously been disturbed, and observe the open side of the excavation for indications of layered geologic structuring.
        2. The evaluator should also look for signs of bulging, boiling, or sluffing, as well as for signs of surface water seeping from the sides of the excavation or from the water table. If there is standing water in the cut, the evaluator should check for "quick" conditions.
        3. In addition, the area adjacent to the excavation should be checked for signs of foundations or other intrusions into the failure zone, and the evaluator should check for surcharging and the spoil distance from the edge of the excavation.

4. Soil mechanics

a. Tension cracks
    i. Tension crack usually form at a horizontal distance of 0.5 to 0.75 times the depth of the trench, measured from the top of the vertical face of the trench.

b. Sliding or sluffing
    i. Sliding or sluffing may occur as a result of tension cracks.

c. Toppling
    i. In addition to sliding, tension cracks can cause toppling. Toppling occurs when the trench's vertical face shears along the tension crack line and topples into the excavation.

d. Subsidence or bulging
    i. An unsupported excavation can create an unbalanced stress in the soil, which, in turn, causes subsidence at the surface and bulging of the vertical face of the trench. If uncorrected, this condition can cause face failure and entrapment of workers in the trench.

e. Heaving or squeezing
    i. Bottom heaving or squeezing is caused by the downward pressure created by the weight of adjoining soil. This pressure causes a bulge in the bottom of the cut, as illustrated in the drawing above. Heaving and squeezing can occur even when shoring or shielding has been properly installed.

f. Boiling
    i. Boiling is evidenced by an upward water flow into the bottom of the cut. A high water table is one of the causes of boiling. Boiling produces a "quick"

condition in the bottom of the cut, and can occur even when shoring or trench boxes are used.

g. Soil weight
    i. Unit Weight of Soils refers to the weight of one unit of a particular soil. The weight of soil varies with type and moisture content. One cubic foot of soil can weigh from 110 pounds to 140 pounds or more, and one cubic meter (35.3 cubic feet) of soil can weigh more than 3,000 pounds.

5. Review case studies

a. February 1, 2006
    i. A 29-year-old male Hispanic laborer with 5 years of experience died when the 2-foot-wide, 16-foot-long, and 9-foot-deep unprotected trench he was working in collapsed and covered him with soil during waterproofing work. The victim and four other laborers, all of whom spoke primarily Spanish and very little English, had been hand digging the trench over a 2-day period at a private residence. The victim was kneeling to inspect a broken drain pipe at the bottom of the east end of the trench. The victim's brother saw the soil strike the victim and knock his head against the home's basement wall. The trench wall collapsed and the victim was completely covered with soil in seconds. The victim was pronounced dead at the scene by emergency response personnel.

b. November 3, 2003
    i. A 38-year-old male construction laborer died when the unprotected, 8-foot-high walls of the trench he was working in collapsed only a few minutes after he had entered. The victim was removing an old gas line that was a 6-inch diameter high pressure line (300–320 psi) in 10-inch steel casing. Five workers were at the job site excavating the gas line: a foreman who was a competent person, a lab technician who was a competent person, and 3 laborers (including the victim). The foreman had dug an 8-foot deep trench with a track hoe to expose the abandoned gas line. After the gas line was extracted from its casing, the victim climbed into the trench with a saw to free the casing, a job that the report indicated would only take a few minutes. Sloping, benching, or shoring methods were not used to support the trench. As the laborer began sawing, the sides of the trench collapsed, burying him. He was declared dead at the scene

6. Employee rights and responsibilities

a. Employee rights and responsibilities
    i. To assure safe and healthful working conditions for working men and women
    ii. By authorizing enforcement of the standards developed under the Act
    iii. By assisting and encouraging the States in their efforts to assure safe and healthful working conditions
    iv. By providing for research, information, education, and training in the field of occupational safety and health

b. A right to
    i. A safe and healthful workplace
    ii. Know about hazardous chemicals
    iii. Information about injuries and illnesses in your workplace
    iv. Complain or request hazard correction from employer
    v. File a confidential complaint with OSHA to have their workplace inspected.
    vi. Receive information and training about hazards, methods to prevent harm, and the OSHA standards that apply to their workplace. The training must be done in a language and vocabulary workers can understand.
    vii. Get copies of their workplace medical records.
    viii. Participate in an OSHA inspection and speak in private with the inspector.
    ix. File a complaint with OSHA if they have been retaliated or discriminated against by their employer as the result of requesting an inspection or using any of their other rights under the OSH Act.
    x. File a complaint if punished or discriminated against for acting as a "whistleblower" under the additional 20 federal statutes for which OSHA has jurisdiction.
c. Whistleblower Protection
    i. OSHA's Whistleblower Protection Program enforces the whistleblower provisions of more than twenty whistleblower statutes protecting employees who report violations of various workplace safety,

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