EXPERIMENT 7
VISUAL CLASSIFICATION OF SOILS

Purpose:

Visually classify the soils.

Standard Reference:

ASTM D 2488 - Standard Practice for Description and Identification of Soils (Visual - Manual Procedure)

Significance:

The first step in any geotechnical engineering project is to identify and describe the subsoil condition. For example, as soon as a ground is identified as gravel, engineer can immediately form some ideas on the nature of problems that might be encountered in a tunneling project. In contrast, a soft clay ground is expected to lead to other types of design and construction considerations. Therefore, it is useful to have a systematic procedure for identification of soils even in the planning stages of a project.

Soils can be classified into two general categories: (1) coarse grained soils and (2) fine grained soils. Examples of coarse-grained soils are gravels and sands. Examples of fine-grained soils are silts and clays. Procedures for visually identifying these two general types of soils are described in the following sections.

Equipment:

Magnifying glass (optional)

Identification Procedure:

a. Identify the color (e.g. brown, gray, brownish gray), odor (if any) and texture (coarse or fine-grained) of soil.

b. Identify the major soil constituent (>50% by weight) using Table 1 as coarse gravel, fine gravel, coarse sand, medium sand, fine sand, or fines.

c. Estimate percentages of all other soil constituents using Table 1 and the following terms:

Trace - 0 to 10% by weight
Little - 10 to 20%
Some - 20 to 30%
And - 30 to 50%

(Examples: trace fine gravel, little silt, some clay)

d. If the major soil constituent is sand or gravel:

Identify particle distribution. Describe as **well graded** or **poorly graded**. Well-graded soil consists of particle sizes over a wide range. Poorly graded soil consists of particles which are all about the same size.

Identify particle shape (angular, subangular, rounded, subrounded) using Figure 1 and Table 2.

e. If the major soil constituents are fines, perform the following tests:

Dry strength test: Mold a sample into 1/8" size ball and let it dry. Test the strength of the dry sample by crushing it between the fingers. Describe the strength as none, low, medium, high or very high depending on the results of the test as shown in Table 3(a).

Dilatancy Test: Make a sample of soft putty consistency in your palm. Then observe the reaction during shaking, squeezing (by closing hand) and vigorous tapping. The reaction is rapid, slow or none according to the test results given in Table 3(b).

During dilatancy test, vibration densifies the silt and water appears on the surface. Now on squeezing, shear stresses are applied on the densified silt. The dense silt has a tendency for volume increase or dilatancy due to shear stresses. So the water disappears from the surface. Moreover, silty soil has a high permeability, so the water moves quickly. In clay, we see no change, no shiny surface, in other words, no reaction.

Plasticity (or Toughness) Test: Roll the samples into a thread about 1/8" in diameter. Fold the thread and reroll it repeatedly until the thread crumbles at a diameter of 1/8". Note (a) the pressure required to roll the thread when it is near crumbling, (b) whether it can support its own weight, (c) whether it can be molded back into a coherent mass, and (d) whether it is tough

during kneading. Describe the plasticity and toughness according to the criteria in Tables 3(c) and 3(d). A low to medium toughness and non-plastic to low plasticity is the indication that the soil is silty; otherwise the soil is clayey.

Based on dry strength, dilatancy and toughness, determine soil symbol based on Table 4.

f. Identify moisture condition (dry, moist, wet or saturated) using Table 5.

g. Record visual classification of the soil in the following order: color, major constituent, minor constituents, particle distribution and particle shape (if major constituent is coarse-grained), plasticity (if major constituent is fine-grained), moisture content, soil symbol (if major constituent is fine-grained).

Examples of coarse-grained soils:

Soil 1: Brown fine gravel, some coarse to fine sand, trace silt, trace clay, well graded, angular, dry.

Soil 2: Gray coarse sand, trace medium to fine sand, some silt, trace clay, poorly graded, rounded, saturated.

Examples of fine-grained soils:

Soil A: Brown lean clay, trace coarse to fine sand, medium plasticity, moist, CL.

Soil B: Gray clayey silt, trace fine sand, non-plastic, saturated, ML.

Laboratory Exercise:

You will be given ten different soil samples. Visually classify these soils. Record all information on the attached forms.

Table 1. Grain Size Distribution

Soil Constituent	Size Limits	Familiar Example
Boulder	12 in. (305 mm) or more	Larger than basketball
Cobbles	3 in (76 mm) -12 in (305 mm)	Grapefruit
Coarse Gravel	¾ in. (19 mm) – 3 in. (76 mm)	Orange or Lemon
Fine Gravel	4.75 mm (No.4 Sieve) – ¾ in. (19 mm)	Grape or Pea
Coarse Sand	2 mm (No.10 Sieve) – 4.75 mm (No. 4 Sieve)	Rocksalt
Medium Sand	0.42 mm (No. 40 Sieve) – 2 mm (No. 10 Sieve)	Sugar, table salt
Fine Sand*	0.075 mm (No. 200 Sieve) – 0.42 mm (No. 40 Sieve)	Powdered Sugar
Fines	Less than 0.0075 mm (No. 200 Sieve)	-

*Particles finer than fine sand cannot be discerned with the naked eye at a distance of 8 in (20 cm).

Figure 1. Shape of Coarse-Grained Soil Particles

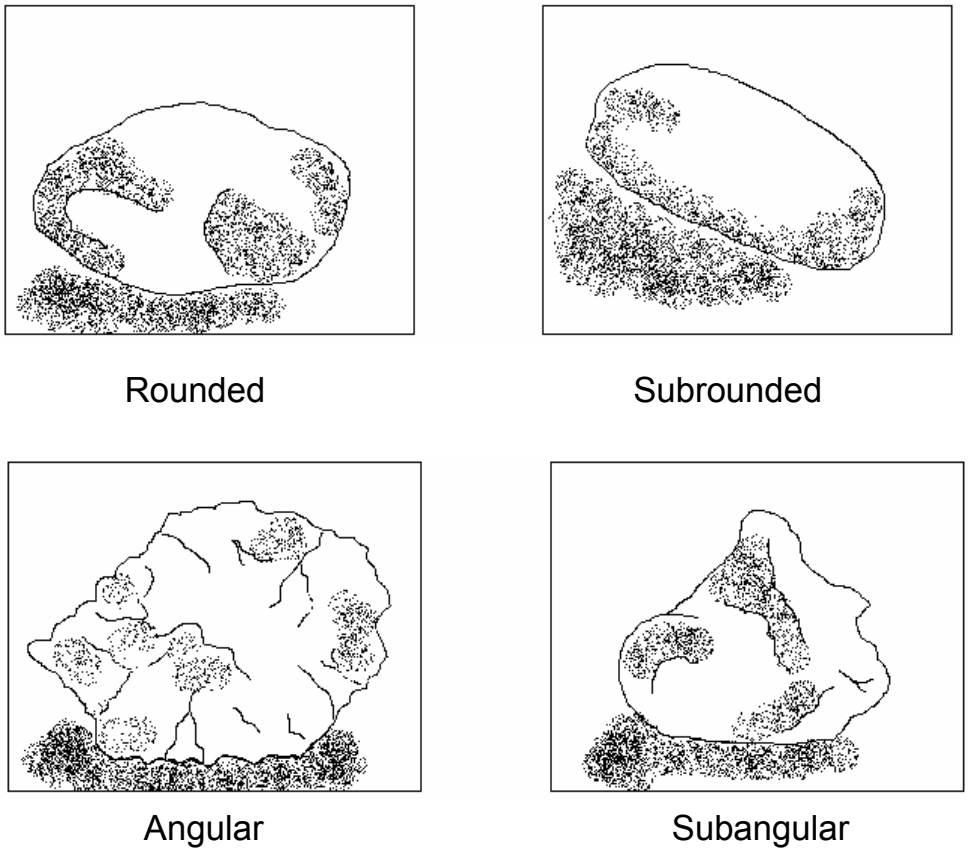

Table 2. Criteria for Describing Shape of Coarse-Grained Soil Particles

Description	Criteria
Angular	Particles have sharp edges and relatively plane sides with unpolished surfaces.
Subangular	Particles are similar to angular description, but have rounded edges.
Subrounded	Particles have nearly plane sides, but have well-rounded corners and edges.
Rounded	Particles have smoothly curved sides and no edges.

Table (3a). Criteria for Describing Dry Strength

Description	Criteria
None	The dry specimen ball crumbles into powder with the slightest handling pressure.
Low	The dry specimen crumbles into powder with some pressure form fingers.
Medium	The dry specimen breaks into pieces or crumbles with moderate finger pressure.
High	The dry specimen cannot be broken with finger pressure. Specimen will break into pieces between thumb and a hard surface.
Very High	The dry specimen cannot be broken between the thumb and a hard surface.

Table (3b). Criteria for Describing Dilatancy of a Soil Sample

Description	Criteria
None	There is no visible change in the soil samples.
Slow	Water slowly appears and remains on the surface during shaking or water slowly disappears upon squeezing.
Rapid	Water quickly appears on the surface during shaking and quickly disappears upon squeezing.

Table (3c). Criteria for Describing Soil Plasticity

Description	Criteria
Non-plastic	A 1/8" (3-mm) thread cannot be rolled at any water content.
Low	The thread is difficult to roll and a cohesive mass cannot be formed when drier than the plastic limit.
Medium	The thread is easy to roll and little time is needed to reach the plastic limit. The thread cannot be re-rolled after the plastic limit is reached. The mass crumbles when it is drier than the plastic limit.
High	Considerable time is needed, rolling and kneading the sample, to reach the plastic limit. The thread can be rerolled and reworked several times before reaching the plastic limit. A mass can be formed when the sample is drier than the plastic limit

Note: The plastic limit is the water content at which the soil begins to break apart and crumbles when rolled into threads 1/8" in diameter.

Table (3d). Criteria for Describing Soil Toughness

Description	Criteria
Low	Only slight pressure is needed to roll the thread to the plastic limit. The thread and mass are weak and soft.
Medium	Moderate pressure is needed to roll the thread to near the plastic limit. The thread and mass have moderate stiffness.
High	Substantial pressure is needed to roll the thread to near the plastic limit. The thread and mass are very stiff.

Table 4. Identification of Inorganic Fine-Grained Soils

Soil Symbol	Dry Strength	Dilatancy	Toughness
ML	None or Low	Slow to Rapid	Low or thread cannot be formed
CL	Medium to High	None to Slow	Medium
MH	Low to Medium	None to Slow	Low to Medium
CH	High to Very High	None	High

Note: ML = Silt; CL = Lean Clay (low plasticity clay); MH = Elastic Soil; CH = Fat Clay (high plasticity clay). The terms 'lean' and 'fat' may not be used in certain geographic regions (midwest).

Table 5. Criteria for Describing Soil Moisture Conditions

Description	Criteria
Dry	Soil is dry to the touch, dusty, a clear absence of moisture
Moist	Soil is damp, slight moisture; soil may begin to retain molded form
Wet	Soil is clearly wet; water is visible when sample is squeezed
Saturated	Water is easily visible and drains freely from the sample

EXAMPLE DATA

VISUAL SOIL CLASSIFICATION
DATA SHEET

Soil Number: Soil A
Classified by: RES
Date: 09-29-02

1. Color brown
2. Odor none
3. Texture Coarse
4. Major soil constituent : gravel
5. Minor soil constituents: Sand, fines

Type	Approx. % by weight
gravel	60
sand	30
fines	10

6. For coarse-grained soils:

   Gradation: well graded
   Particle Shape: subrounded

7. For fine-grained soils:
   Dry Strength _____
   Dilatancy _____
   Plasticity _____
   Toughness _____
   Soil Symbol _____

8. Moisture Condition: dry

Classification:

Brown gravel, some sand, trace fines, well graded, subrounded, dry

VISUAL SOIL CLASSIFICATION
DATA SHEET

Soil Number: Soil B
Classified by: RES
Date: 09-27-02

1. Color gray
2. Odor none
3. Texture coarse
4. Major soil constituent: sand
5. Minor soil constituents: gravel, fines

Type	Approx. % by weight
sand	80
fine gravel	15
fines	5

6. For coarse-grained soils:

   Gradation: poorly graded
   Particle Shape: rounded

7. For fine-grained soils:
   - Dry Strength _____
   - Dilatancy _____
   - Plasticity _____
   - Toughness _____
   - Soil Symbol _____

8. Moisture Condition: dry

Classification:

Gray sand, little fine gravel, trace fines, poorly graded, rounded, dry

VISUAL SOIL CLASSIFICATION
DATA SHEET

Soil Number: Soil C
Classified by: RES
Date: 09-29-02

1. Color gray
2. Odor none
3. Texture fine-grained
4. Major soil constituent : fines
5. Minor soil constituents: Fine Sand

Type	Approx. % by weight
Fines	95
Fine Sand	5

6. For coarse-grained soils:

   Gradation: _____
   Particle Shape: _____

7. For fine-grained soils:

   Dry strength high
   Dilatancy none
   Plasticity medium
   Toughness medium
   Soil Symbol CL

8. Moisture Condition: moist

Classification:

Gray silty clay, trace fine sand, medium plasticity, moist, CL

BLANK DATA SHEETS

VISUAL SOIL CLASSIFICATION
DATA SHEET

Soil Number: _____
Classified by: _____
Date: _____

1. Color _____
2. Odor _____
3. Texture _____
4. Major soil constituent: _____
5. Minor soil constituents: _____

Type	Approx. % by weight
_____	_____
_____	_____
_____	_____

6. For coarse-grained soils:

   Gradation: _____
   Particle Shape: _____

7. For fine-grained soils:
   - Dry Strength _____
   - Dilatancy _____
   - Plasticity _____
   - Toughness _____
   - Soil Symbol _____

8. Moisture Condition: _____

Classification: