Chapter 5

Visual Classification of Soils

During drilling and sampling operations in the field classification has to be carried out quickly and without gradation analyses or Atterberg limits. An approximate procedure is then used and the description is noted on the boring log. The initial boring log is often checked later in the laboratory with the help of the retrieved soil samples. Even in the laboratory a small portion of the samples will be actually tested for classification purposes. The specimens for classification testing are chosen from the different layers that were identified during field operations and from previous information, where available. The remaining samples are classified based on their similarities to the tested samples and visual-manual procedures illustrated below.

5.1 Scope

This practice covers procedures for the description of soils for engineering purposes. The identification is based on visual examination and manual tests. It must be clearly stated in a report that an identification that is based on visual-manual procedures. When precise classification of soils for engineering purposes is required, the procedures prescribed in Test Method D 2487 shall be used.

In this practice, the identification of portion assigning a group symbol and name is limited to soil particles smaller than 3in. The identification portion of this practice is limited to naturally occurring soils (disturbed or undisturbed).

5.2 Terminology

**Gravel**  Particles of rock that will pass a 3 in. (75mm) sieve and be retained on a No. 4 (4.75mm) sieve with the following subdivisions:

- coarse - passes 3in. (75mm) sieve and retained on \(\frac{3}{4}\) in. (19mm) sieve.
- fine - passes 3.4 in. (19mm) sieve and retained on a No.4 (4.75mm) sieve.

**Sand**  Particles of rock that will pass a No. 4 (4.75 mm) sieve and be retained on a No. 200 (75 μm) sieve with the following subdivisions:

- coarse - passes a No. 4 (4.75mm) and retained on No. 10 (2.00mm) sieve
- medium - Passes a No. 10 (2.00mm) sieve and is retained on a No. 40 (425μm) sieve.
Silt  Soil passing a No. 200 (75µm) sieve that is non-plastic or very slightly plastic and that exhibits little of no strength when dry. For classifications, a silt is fine grained soil or the fine grained portion of a soil, with a plasticity index less than 4, or the plot of plasticity index versus liquid limit falls below the "A" line.

Clay  Soil passing a No. 200 (75µm) sieve that can be made to exhibit plasticity within a range of water contents, and that exhibits considerable strength when air-dry. For classifications a clay is a fine grained soil or a fine grained portion of a soil, with a plasticity index equal to or greater than 4, and the plot of plasticity index versus liquid limit falls on or above the "A" line.

Organic Silt  A silt with sufficient organic content to influence the soil properties. For classifications, an organic silt is a soil that would be classified as a silt, except that its liquid limit value after oven drying is less than 75% of its liquid limit value before oven drying.

Organic Clay  A clay with sufficient organic content to influence the soil properties. For classification, an organic clay is a soil that would be classified as a clay, except that its liquid limit value after oven drying is less than 75% of its liquid limit value before oven drying.

5.3 Significance and Use

The descriptive information required in this practice can be used to describe a soil to aid in the evaluation of its significance properties for engineering use.

5.4 Sampling

The sample shall be considered to be representative of the stratum from which it was obtained by an appropriate, accepted, or standard procedure.

5.5 Descriptive Information for Soils

Angularity  Describe the angularity of the sand (coarse sizes only), gravel, cobbles, and boulders, as angular, subangular, subrounded, or rounded in accordance with the criteria in table 5.1. A range of angularity may be stated, such as subrounded to rounded.

Shape  Describe the shape of gravel, cobbles, and boulders as flat, elongated, or flat and elongated if they meet the criteria if they meet in table 5.2. Otherwise do not mention the shape. Indicate the fraction of particles that have that shape; for example: "one-third of the gravel is flat".

Color  Described the color of the sample when moist.

<table>
<thead>
<tr>
<th>Description</th>
<th>Criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td>Angular</td>
<td>Particles have sharp edges and relatively plane sides with unpolished surfaces</td>
</tr>
<tr>
<td>Subangular</td>
<td>Particles are similar to angular description but have corners and edges</td>
</tr>
<tr>
<td>Subrounded</td>
<td>Particles have nearly plane sides but have rounded corners and edges</td>
</tr>
<tr>
<td>Rounded</td>
<td>Particles have smoothly curved sides and no edges</td>
</tr>
</tbody>
</table>

Table 5.1: Criteria for describing angularity of coarse-grained particles.

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The particle shape shall be described as follows where length, width, and thickness refer to the greatness, intermediate, and least dimensions of a particle respectively.

<table>
<thead>
<tr>
<th>Description</th>
<th>Criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flat</td>
<td>Particles with width/thickness &gt; 3</td>
</tr>
<tr>
<td>Elongated</td>
<td>Particles with length/width &gt; 3</td>
</tr>
<tr>
<td>Flat and Elongated</td>
<td>Particles meet criteria for both flat and elongated</td>
</tr>
</tbody>
</table>

Table 5.2: Criteria for describing particle shape.

**Odor** Describe the odor of the sample if organic or unusual

**Moisture Condition** Describe the moisture condition as dry, moist, or wet in accordance with the criteria in table 5.3

<table>
<thead>
<tr>
<th>Description</th>
<th>Criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dry</td>
<td>Absence of moisture, dusty, dry to the touch</td>
</tr>
<tr>
<td>Moist</td>
<td>Damp but no visible water</td>
</tr>
<tr>
<td>Wet</td>
<td>Visible free water, usually soil is below water table</td>
</tr>
</tbody>
</table>

Table 5.3: Criteria for describing moisture conditions.

**Consistency** For intact fine-grained soil, describe the consistency as very soft, soft, firm, hard, or very hard in accordance with the criteria in table 5.4. This observation is inappropriate for soils with significant amounts of gravel.

<table>
<thead>
<tr>
<th>Description</th>
<th>Criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td>Very soft</td>
<td>Thumb will penetrate soil more than 1 in. (25 mm)</td>
</tr>
<tr>
<td>Soft</td>
<td>Thumb will penetrate soil about 1 in. (25 mm)</td>
</tr>
<tr>
<td>Firm</td>
<td>Thumb will indent soil about 1/4 in. (6 mm)</td>
</tr>
<tr>
<td>Hard</td>
<td>Thumb will not indent soil but will readily indent with thumbnail</td>
</tr>
<tr>
<td>Very Hard</td>
<td>Thumbnail will not indent soil</td>
</tr>
</tbody>
</table>

Table 5.4: Criteria for describing consistency

**Cementation** Describe the cementation of intact coarse-grained soil as weak, moderate, or strong, in accordance with Table 5.5.

<table>
<thead>
<tr>
<th>Description</th>
<th>Criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td>Weak</td>
<td>Crumbles or breaks with handling of little finger pressure</td>
</tr>
<tr>
<td>Moderate</td>
<td>Crumbles or breaks with considerable finger pressure</td>
</tr>
<tr>
<td>Strong</td>
<td>Will not crumble with finger pressure</td>
</tr>
</tbody>
</table>

Table 5.5: Criteria for Describing Cementation

**Range of particle sizes** For gravel and sand components, described the range of particle sizes within each components. For example, about 20% fine to coarse gravel, about 40% fine to coarse sand.
Maximum particle size Describe the maximum particle size found in the sample for each size classification. For example, the largest particle size for sand size particles and the largest particle for gravel size particles.

Hardness Describe the hardness of coarse sand and larger particles.

5.6 Procedure for Identifying Fine-Grained Soils

Select a representative sample of the material for examination. Remove particles larger than the No. 40 sieve until a specimen equivalent to about a handful of material is available. Use this specimen for performing the dry strength, dilatancy, and toughness test.

Dry Strength Select a few dry lumps of about 1/2in. in diameter. Test the strength of the dry pieces by crushing between the fingers. Note the strength as none, low, medium, high, or very high in accordance with the criteria in Table 5.6. If natural dry lumps are used do not use the results of any of the lumps that are found to contain particles of coarse sand.

<table>
<thead>
<tr>
<th>Description</th>
<th>Criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td>None</td>
<td>The dry specimen crumbles into powder under mere pressure of handling</td>
</tr>
<tr>
<td>Low</td>
<td>The dry specimen crumbles into powder with some finger pressure</td>
</tr>
<tr>
<td>Medium</td>
<td>The dry specimen breaks into pieces or crumbles with considerable finger pressure</td>
</tr>
<tr>
<td>High</td>
<td>The dry specimen cannot be broken with finger pressure</td>
</tr>
<tr>
<td>Very High</td>
<td>The dry specimen cannot be broken with thumb and a hard surface</td>
</tr>
</tbody>
</table>

Table 5.6: Criteria for Describing Dry Strength

Dilatancy From the specimen select enough material to mold into a ball about 1/2in. in diameter. Mole the material, adding water if necessary, until it has a soft, but not sticky consistency. Smooth the soil in the palm of one hand with a small spatula. Shake horizontally, striking the side of the hand vigorously against the other hand several times. Note the reaction of water appearing on the surface of the soil. Squeeze the sample by closing the hand or pinching the soil between the fingers, and note the reaction as none, slow, or rapid in accordance with the criteria in Table 5.7. The reaction is the speed at which the water appears while shaking, and disappears while squeezing.

<table>
<thead>
<tr>
<th>Description</th>
<th>Criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td>None</td>
<td>No visible change in specimen</td>
</tr>
<tr>
<td>Slow</td>
<td>Water appears slowly on the surface during shaking and does not disappear or disappears slowly upon squeezing</td>
</tr>
<tr>
<td>Rapid</td>
<td>Water appears quickly during shaking and disappears quickly during squeezing</td>
</tr>
</tbody>
</table>

Table 5.7: Criteria for Describing Dilatancy

Toughness Following the completion of the dilatancy test, the test specimen is shaped into an elongated pat and rolled by hand on a smooth surface or between the palms into a thread about 1/8in. in diameter. Fold the threads and reroll repeatedly until the thread crumbles at a diameter of about 1/8in. The thread will crumble at a diameter of 1/8 in. when the
soil is near the plastic limit. Note the pressure required to roll the thread near the plastic limit. Also, note the strength of the thread. After the thread crumbles, the pieces should be lumped together and kneaded until the lump crumbles. Note the toughness of the material during kneading. Describe the toughness of the thread and lump as low, medium or high in accordance with the criteria in table 5.8.

<table>
<thead>
<tr>
<th>Description</th>
<th>Criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low</td>
<td>Only slight pressure is required to roll the thread near the plastic limit. The thread and lump are soft and weak</td>
</tr>
<tr>
<td>Medium</td>
<td>Medium pressure is required to roll the thread to near the plastic limit. The thread and lump have medium stiffness.</td>
</tr>
<tr>
<td>High</td>
<td>Considerable pressure is needed to roll thread near the plastic limit. The thread and lump have very high stiffness</td>
</tr>
</tbody>
</table>

Table 5.8: Criteria for Describing Toughness

**Plasticity** On the basis of observations made during the toughness test, describe the plasticity of the material in accordance with the criteria given in Table 5.9.

<table>
<thead>
<tr>
<th>Description</th>
<th>Criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nonplastic</td>
<td>A 1/8in. thread cannot be rolled at any water content</td>
</tr>
<tr>
<td>Low</td>
<td>The thread can barely be rolled and the lump cannot be formed when drier than the plastic limit</td>
</tr>
<tr>
<td>Medium</td>
<td>The thread is easy to roll and not much time is required to reach the plastic limit. The thread cannot be rolled after reaching the plastic limit. The lump crumbles drier than the plastic limit</td>
</tr>
<tr>
<td>High</td>
<td>It takes considerable time rolling and kneading to reach the plastic limit. The thread can be rolled several times after reaching the plastic limit. The lump can be formed without crumbling when drier than the plastic limit.</td>
</tr>
</tbody>
</table>

Table 5.9: Criteria for Describing Plasticity

### 5.7 Identification of Inorganic Fine-Grained Soils

Identify the soil as follows:

<table>
<thead>
<tr>
<th>Soil Symbol</th>
<th>Dry Strength</th>
<th>Dilatancy</th>
<th>Toughness</th>
</tr>
</thead>
<tbody>
<tr>
<td>ML</td>
<td>None to Low</td>
<td>Slow to rapid</td>
<td>Low or thread cannot be formed</td>
</tr>
<tr>
<td>CL</td>
<td>Medium to High</td>
<td>None to Slow</td>
<td>Medium</td>
</tr>
<tr>
<td>MH</td>
<td>Low to Medium</td>
<td>None to Slow</td>
<td>Medium</td>
</tr>
<tr>
<td>CH</td>
<td>High to Very High</td>
<td>None</td>
<td>High</td>
</tr>
</tbody>
</table>

Table 5.10: Identification of Inorganic Fine-Grained Soils from Manual Test
5.8 Procedure for identifying Coarse-Grained Soils

1. The soil is a gravel if the percentage of gravel is estimated to be more than the percentage of sand.

2. The soil is a sand if the percentage of gravel is estimated to be equal to or less than the percentage of sand.

3. The soil is a clean gravel or clean sand if the percentage of fines is estimated to be 5% or less.

4. Identify the soil as well-graded gravel, GW, or as well-graded sand, SW, if it has a wide range of particle sizes and substantial amounts of the intermediate particle sizes.

5. Identify the soil as a poorly graded gravel, GP, or as a poorly graded sand, SP, if it consists predominantly of one size (uniformly graded), or it has a wide range of sizes with some intermediate sizes obviously missing.

6. The soil is either a gravel with fines or a sand with fines if the percentage of fines is estimated to be 15% or more.

7. Identify the soil as a clayey gravel, GC, or a clayey sand, SC, if the fines have the properties of clays.

8. Identify soil as a silty gravel, GM, or a silty sand, SM, if the fines have the properties of a silt.

9. If the soil is estimated to contain 10% fines, give the soil a dual identification using two group symbols. The first group symbol shall correspond to a clean gravel or sand (GW, GP, SW, SP) and the second symbol shall correspond to a gravel or sand with fines (GC, GM, SC, SM).

10. The group name shall correspond to the first group symbol plus the words "with clay" or "with silt" to indicate the plasticity characteristics of the fines. For example: "well-graded gravel with clay, GW-GC" or "poorly graded sand with silt, SP-SM.”

11. If the specimen is predominantly sand or gravel but contains an estimated 15% or more of the other coarse-grained constituent, the words "with gravel" or "with sand" shall be added to the group name. For example: "poorly graded gravel with sand, GP” or "clayey sand with gravel, SC.”

12. If the specimen is predominantly sand or gravel but contains an estimated 15% or more of the other coarse-grained constituent, the words "with gravel" or "with sand" shall be added to the group name. For example: "poorly graded gravel with sand, GP” or "clayey sand with gravel, SC.”

13. If the field sample contains any cobbles or boulders, or both the words "with cobbles" or "with cobbles and boulders" shall be added to the group name. For example: "silty gravel with cobbles, GM.”

5.9 Check List For Description Of Soil

1. Group Name

2. Group Symbol
3. Percent of cobbles or boulders, or both
4. Percent of gravel, sand or fines, or all three (by dry weight)
5. Particle size range gravel - fine or coarse, sand - fine, medium or coarse
6. Particle angularity: angular, subangular, subrounded, rounded.
7. Particle shape: (if appropriate) flat, elongated, flat and elongated
8. Maximum particle size dimension
9. Hardness of coarse sand and larger particles
10. Plasticity of fines: nonplastic, low, medium, high, very high
11. Dry strength: none, low, medium, high, very, high
12. Dilatancy: none, slow, rapid
13. Toughness: lox, medium, high
14. Color (in moist conditions)
15. Odor (if unusual or organic)
16. Moisture: dry, moist, wet
17. Consistency (fine-grained soils only): very soft, soft, firm, hard, very hard
18. Cementation: weak, moderate, strong
19. Local name (if any)
20. Geologic interpretation
21. Any additional comments