ATT-29/95, SOILS IDENTIFICATION, Hand Method

1.0 SCOPE

This method describes the procedures for determining the classification and properties of fine-grained soils using ten simple hand tests and the bottle test.

2.0 EQUIPMENT

wash bottle
0.5 litre medicine bottle
1 kg paper bag

Data Sheet: Field Identification of Soils, MAT 6-20

3.0 PROCEDURE

This procedure is used on grading and subgrade preparation projects. The hand method of soils identification (Section 3.1) and the bottle test (Section 3.2) are used to determine to which standard moisture-density relation curve is the in-place density test compared, to calculate the percent compaction.

The hand tests are also used on preliminary soil surveys to identify similar soils and similar moisture conditions. If similar soils are identified, the number of samples submitted to a testing laboratory for classification can be reduced.

3.1 Hand Tests

1. Obtain approximately 0.5 kg of representative fine grained soil.
2. Enter the project identification on the heading portion of the data sheet, as shown in Figure 1.
3. Record the sample identification data on the column corresponding to the sample being tested.

3.1.1 Dry Strength

1. Crumble the dry soil with your fingers.
2. Distinguish between:

   a) **slight** dry strength - friable, sample crumbles into powder with some finger pressure.

   b) **medium** dry strength - considerable pressure required to powder the sample; and

c) **high** dry strength - the dried sample cannot be powdered with finger pressure.

3. Record the estimated dry strength in line "1" of the data sheet, as shown in Figure 1.

   Usually the soil is tested in the sampled condition. If the sample is wet, "dry strength" cannot be performed. The results of the "toughness at the plastic limit" can be used as an indication of the "dry strength". The "dry strength" of a soil may be obtained if a sample is air or oven dried.

3.1.2 Amount of Water to Wet

1. Use the wash bottle to add water, a few drops at a time, to a small amount of the soil held in the palm of your hand.

2. With each application of water, work the soil so that the moisture will be distributed uniformly throughout the sample.

3. Continue to add water to the sample until it has a thick soupy consistency.

4. Enter on line "2" of the data sheet, an estimation of the amount of water used to wet the sample, e.g. **low**, **medium**, or **high**.

3.1.3 Percentage of Sand

1. Rub your thumb repeatedly through the soupy soil. If no sand can be felt, there is probably less than 20% sand in the sample. If it feels gritty, estimate the percentage of sand, and record the value in line "3".

   NOTE: Coarse-grained sand leads to over estimation, while fine-grained sand leads to under estimation.

3.1.4. Odor Test

1. Smell the sample in the soupy condition. A distinctive odor is characteristic of organic soil.

2. Report the odor as **slight**, **medium**, or **strong** on line "8".

3.1.5 Drying Time of Film on Hand

1. Place your other thumb in the middle of the soupy soil in the palm of your hand.

FIELD IDENTIFICATION OF SOILS

Alberta TRANSPORTATION AND UTILITIES

MAT 6 20

PROJECT NO. *3:16*	CONTRACT NO. 6666/96666/95	DISTRICT *Lethbridge*	
DATE *September 12,1995*		CONTRACTOR *R. Roads*	
FROM *N. of Border Creek*		TO *Jct. Hwy. 21*	

STATION	*10+241*					
LOCATION	*18 m Rt*					
DEPTH	*2.5 m*					
BORROW PIT NO.	*3*					
CONTAINER NO.	*AD*					
HAND TEST						
1. DRY STRENGTH	*HIGH*					
2. AMOUNT OF WATER TO WET SOIL	*HIGH*					
3. PERCENTAGE OF SAND	*- 20%*					
4. DRYING TIME OF FILM ON HAND	*LONG*					
5. EASE OF REMOVING FILM	*HARD*					
6. WORK AND TIME TO DRY FROM LL TO PL	*HIGH*					
7. TOUGHNESS AT PLASTIC LIMIT	*TOUGH*					
8. ODOR TEST	*NIL*					
9. SHAKE TEST (Rapid, Medium, None)	*NONE*					
10. SHINE TEST	*SHINY*					
BOTTLE TEST						
1 COLOUR OF SAND	*NIL*					
2. GRADING OF SAND	*NIL*					
3. GRAIN SHAPE OF SAND	*NIL*					
4. ESTIMATED PERCENTAGE OF SAND	*NIL*					
ESTIMATED UNIFIED SOIL CLASSIFICATION						
ESTIMATED LIQUID LIMIT	*65*					
ESTIMATED PLASTIC LIMIT	*25*					
ESTIMATED PLASTICITY INDEX	*40*					
UNIFIED SOIL CLASSIFICATION	*CH*					

REMARKS *Highly plastic fat clay*

Has an identical sample been forwarded to a testing laboratory? *No* Date Lab Name

MATERIALS TECHNOLOGIST *M. Keen* PROJECT MANAGER *I. Goodman*

FIGURE 1

2. Exerting some pressure, draw your thumb through the crease in your hand, up and onto your wrist so that a thin film of soil is deposited.

3. While waiting for the thin film of soil to dry, manipulate the soupy soil to reduce its moisture content.

4. When the film is dry, enter on line "4" of the data sheet, the estimated drying time as **long**, **medium**, or **short**.

3.1.6 Ease of Removing Film

1. Try to rub the dry film off your wrist, (your hand must be dry). Enter on line "5" of the data sheet, an estimation of the ease of removing the film, as **hard**, **medium**, or **easy.**

3.1.7 Work and Time to Dry from the LL to the PL

1. Manipulate the soil until a ball can be formed.

2. Roll the ball into a thread 3 mm in diameter.

3. Repeat steps 1 and 2 until the thread will just hold together. The soil is now at approximately the plastic limit.

4. Enter on line "6" of the data sheet, an estimation of the work and time required to change the soil from the soupy consistency to the plastic limit. Record as **short**, **medium** or **long**.

   The following criteria can be used to "confirm" the plasticity of the soil at the plastic limit.

   a) **Low**: The thread can not be rolled and the ball can barely be formed when slightly drier than the plastic limit.

   b) **Medium**: The thread is easy to roll and a short time is required to reach the plastic limit. With increased pressure, the thread can be rerolled once, after reaching the plastic limit. The ball can be formed when slightly drier than the plastic limit.

   c) **High**: It takes considerable time rolling and kneading to reach the plastic limit. With increased pressure, the thread can be rerolled several times after reaching the plastic limit. The lump can be formed without crumbling when slightly drier than the plastic limit.

3.1.8 Toughness at the Plastic Limit

1. Remold a ball of the soil at the plastic limit with your fingers.

2. Estimate the toughness (the resistance to deformation), and enter the result on line "7" of the data sheet, using the following criteria:

   a) **Low**: Only slight pressure is required to roll the thread near the plastic limit. The thread and the ball are weak and soft.

   b) **Medium**: Medium pressure is required to roll the thread to near the plastic limit. The thread and the ball have medium stiffness.

   c) **High**: Considerable pressure is required to roll the thread to near the plastic limit. The thread and the ball have very high stiffness.

3.1.9 Shine Test

1. Continue to manipulate the soil until it is close to the plastic limit.

2. Use a pencil, knife, fingernail, or some other smooth object, to rub the soil.

3. Observe the rubbed surface, and enter on line "10" of the data sheet, its appearance, e.g. **shiny**, **medium**, or **dull**.

3.1.10 Shake Test

The shake test is only performed when the soil is granular in texture.

1. Prepare a pat of moist soil above the plastic limit and shake it horizontally in the palm of your hand.

2. Observe if water comes to the surface of the sample making it appear soft and glossy.

3. If no water is observed, report no reaction to the test; if water does appear, continue with steps 4, 5 and 6.

4. Squeeze the sample between your fingers, causing the moisture to disappear from the surface which changes from shiny to dull. At the same time, the sample stiffens and finally crumbles under increased finger pressure.

5. Shake the broken pieces until they flow together.

6. Distinguish between slow, medium, and rapid reaction to the shake test, and record the result in line "9" of the data sheet, using the following criteria:

   a) **None**: No water is observed.

   b) **Slow**: Water appears slowly on the surface of the sample during shaking, but does not disappear or disappears slowly upon squeezing.

   c) **Rapid**: Water appears quickly on the surface of the sample during shaking and disappears quickly upon squeezing.

3.2 Bottle Test

In the field lab, this test is used to compare soils and identify similar soils.

1. Place soil in a medicine bottle up to the 50 cm^3 mark.

2. Add water up to the 150 cm^3 mark, and screw the cap on the bottle.

3. Shake the bottle until no soil remains on the walls or bottom.

4. Allow the particles to settle for 30 seconds. In this time, the sand should have settled to the bottom of the jar.

5. Observe and record:

   a) colour of the sand, e.g., brown, khaki, green, grey, etc.

   b) grading of the sand, e.g., well-graded, poorly-graded, uniformly-graded.

   c) grain shape of the sand, e.g., sharp, sharp to round, round.

   d) the estimated % of sand.

3.3 Interpretation of Results

3.3.1 Dry Strength

The dry "strength" is a measure of plasticity or cohesiveness of a soil. An increase in the clay content increases the dry strength.

Slight dry strength indicates an inorganic silt or silty sand. The sand should feel gritty when the sample is powdered.

Medium dry strength indicates a low to medium plastic inorganic clay.

High dry strength indicates a highly plastic inorganic clay.

3.3.2 Amount of Water to Wet

The "amount of water to wet" is a measure of the water holding capacity of a soil. The smaller the soil particles, the higher the water holding capacity.

3.3.3 Percentage of Sand

The higher the percentage of sand, the lower the soil's water holding capability.

3.3.4 Drying Time of Film on Hand

This test confirms the Work and Time from LL to PL test. It indicates the amount of clay present.

The longer the drying period, the greater the capacity of the soil to hold water.

High drying time indicates a soil of medium to high plasticity.

Low drying time indicates a soil of low plasticity, such as clayey sand or clayey silt.

3.3.5 Ease of Removing Film

This test indicates the type of clay (cohesiveness) and the quantity of clay present.

If the soil dries fast and can be easily powdered clean from the hand but does not exhibit grittiness, the soil is predominantly silt.

If the soil dries fast, is gritty, but will not clean from the hand when dry, even though the sand will brush off readily, the soil is predominantly clayey sand.

If the soil dries slowly and chips from the hand or will not rub off but has to be washed off, the soil is predominantly clay.

3.3.6 Work and Time From the LL to the PL

This test indicates the amount of clay present.

Clay gives plasticity (cohesiveness) to a soil.. Without clay, the liquid limit and plastic limit would be approximately at the same moisture content. Thus, the soil would not have a plastic state.

The estimated amount of water removed from the LL to the PL is a direct estimation of the plasticity index. The longer the drying time and the more work required, the greater the clay content, and the higher the plasticity index.

NOTE: Since it is very difficult to recognize the liquid limit condition in a soil, the soupy condition is used. The quantity of water removed in progressing from the LL to the PL is comparable to the quantity of water removed from the soupy consistency to the PL. Therefore, low, medium, or high will apply in either relationship.

3.3.7 Toughness at the Plastic Limit

This test is an indicator of the amount and type (cohesiveness) of clay particles in a soil.

Slight toughness at the plastic limit indicates a clayey silt or clayey silty sand.

Medium toughness at the plastic limit, indicates a low to medium plastic soil.

High toughness at the plastic limit, indicates a highly plastic soil.

3.3.8 Odor Test

Organic soil has a distinctive odor. The technologist must determine the difference in odor between a normal soil and an organic soil, by obtaining a sample of known organic material and comparing its odor to that of a normal inorganic soil.

A strong organic odor indicates a highly organic material, such as decomposed peat.

A medium organic odor indicates organic and inorganic soil mixtures, such as topsoil.

A slight or no organic odor probably means no organic material.

3.3.9 Shake Test

The shake test indicates the permeability of granular materials.

Rapid reaction indicates a lack of plasticity and the soil is probably a silt, rock flour, or very fine sand.

Slow reaction indicates a slightly plastic silt or clay.

No reaction indicates a clay or an organic material.

3.3.10 Shine Test

This test indicates the relationship of the quantity of clay to the granular materials.

A shiny surface indicates a highly plastic clay.

A dull surface indicates a silty or sandy clay.

3.3.11 Bottle Test

This test is of value in comparing soil samples. It is usually used to correlate in-place filed density tests to the appropriate Moisture-Density Relation tests.

AVERAGE SOIL

LIQUID LIMIT of 39%

Normal LL range from 30% to 60%

PLASTIC LIMIT of 18%
Normal LL range from 12% to 25%

PLASTICITY INDEX of 21%
High Plasticity - PI above 27%
Medium Plasticity - PI 27% to 15%
Low Plasticity - PI below 15%

Average soil composed of:
- 25% sand
- 50% silt
- 25% clay

Addition of the following to the above soil will affect the Plastic Limit as follows:

CLAY	- PL will increase
SILT	- PL will remain the same or increase
SAND	- PL will decrease
ORGANIC	- PL will increase the most

The better the grading of the sand, the lower will be the soil's plastic limit

FIGURE 2

3.4 Estimating the Atterberg Limits

With the help of the chart shown in Figure 2 (developed by the Alberta Transportation) and the test data sheet shown in Figure 1, an estimation of the Atterberg Limits can be made based on the following:

a) Liquid limit

The liquid limit of a soil is that moisture content at which the bottom of a groove in a pat of soil in the liquid limit machine will close for a distance of 12.5 mm when given 25 blows.

Estimate the liquid limit by summarizing the results recorded in the data sheet.

b) Plastic Limit

The plastic limit of a soil is the lowest moisture content at which the soil can be rolled into a thread of 3 mm in diameter without breaking into pieces.

Estimate the plastic limit by summarizing the results on the data sheet.

c) Plasticity Index

Plasticity index is the numerical difference between the liquid limit and the plastic limit. This represents the moisture range of the plastic state.

The plasticity index is determined by subtracting the estimated plastic limit from the estimated liquid limit.

The following table shows the range of values for liquid limit, plastic limit, and plasticity index based on the estimated percent clay and water holding capacity of the soil.

Estimated Percent Clay, Water Holding Capacity, and Plasticity	Atterberg Limits	
low	Liquid Limit	Lower than 30%
low	Plastic Limit	Lower than 12%
low	Plasticity Index	Lower than 15%
high	Liquid Limit	Higher than 60%
high	Plastic Limit	Higher than 25%
high	Plasticity Index	Higher than 27%

Assess the different tests, and assign moisture contents for the LL and PL in relation to those shown for an average soil in Figure 2. Check if all the tests gave corresponding results. If not, determine which estimations were wrong.

For example, clay has a high surface area, silt has a medium surface area and sand has a low surface area. If a soil has a high dry strength, it must have a large amount of clay, thus will have a large surface area, a high liquid limit, take a long time and a lot of work to bring from the LL to the PL, etc.

Similar evaluations should be made for each of the hand tests.

When an estimation of the LL and PL have been made, find the PI. Plot the LL and PI on the plasticity chart as shown in Figure 2, and determine the material classification. Check the determined classification and its known characteristics against the results of the hand tests to be sure that corresponding results have been obtained for each test.

The hand method of soils classification is a learning tool. It should be performed in its entirety until the technologist has a thorough understanding and is proficient with the process. When the technologist has mastered this method, he/she will gradually perform less steps, until the classification of the soil is performed by texture alone, returning to the individual tests only when in doubt as to a soil characteristic.

PLASTICITY CHART

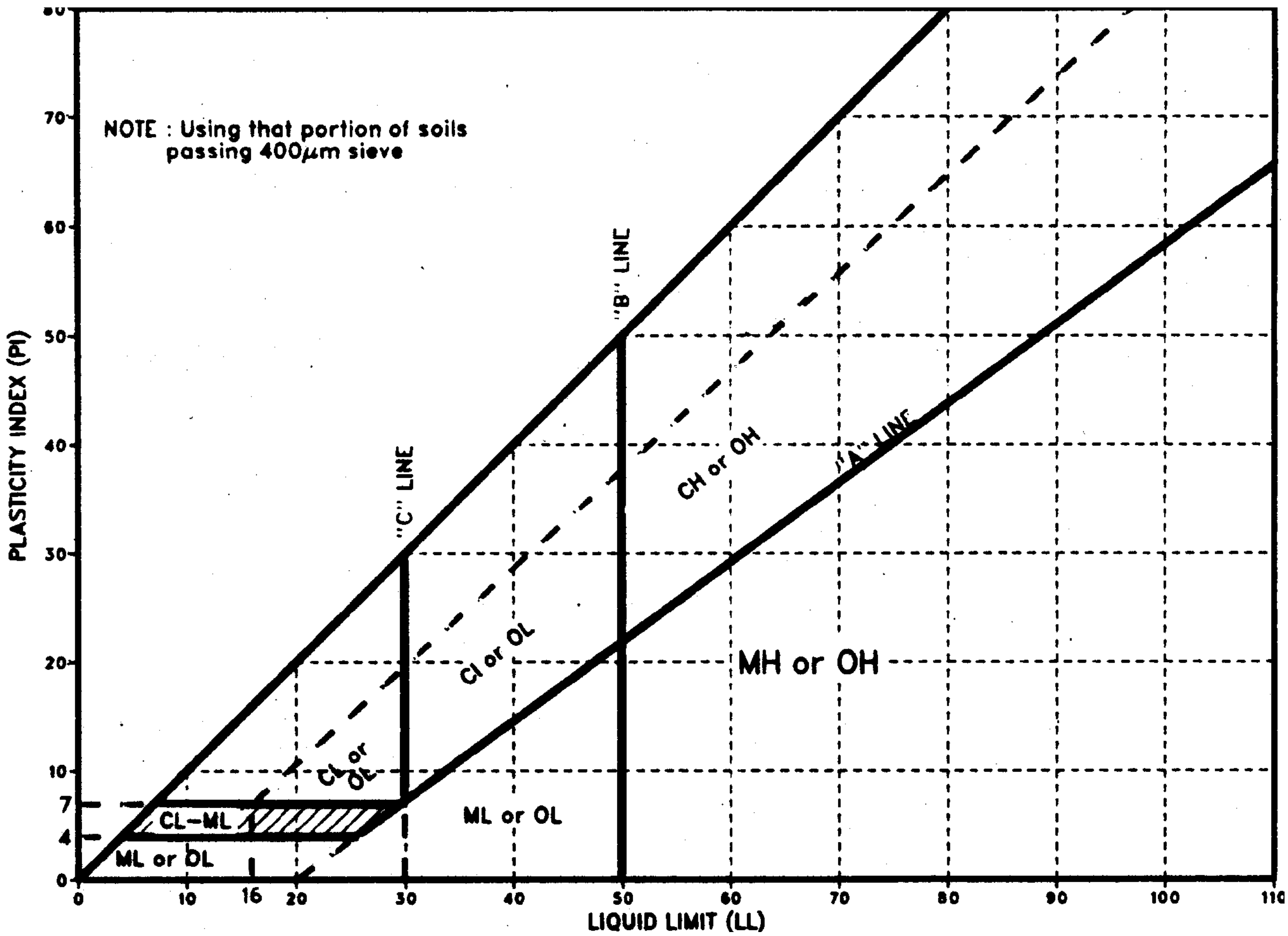

Figure 2