INTRODUCTION

This training module on the Unified Soil Classification is one of 3 modules of the Soil Mechanics Level I course. The modules in this course are listed below:

1. Unified Soil Classification System

2. AASHTO (American Association of State Highway and Transportation Officials)

3. USDA Textural Soil Classification

INSTRUCTION

The procedure used in a slide/audio cassette presentation is to project a picture while playing the accompanying cassette. The narration corresponds with what you see on the screen. During the presentation you will be asked to STOP the machine and do activities in your Study Guide. These activities offer a variety of learning experiences and give you feedback on your ability to accomplish the related module objectives.

Module 1 has been divided into three basic parts, A - C. Each part has specific objectives that need to be accomplished before continuing to the next part. The ability to review and study your material at your desk, while traveling, or in an easy chair is what makes a self-paced training package so beneficial. If you have difficulty with a specific area, study, re-study, and, if necessary, get someone to help you. DO NOT continue until you can complete each part.

You should complete each part of this module as follows;

1. Read the objectives.

2. Run the slide/audio cassette, stopping it when you need to work in the Study Guide.

3. Study and review all references.

If you have difficulty in a specific area, contact your State Engineering Staff, through your supervisor, for assistance on Modules 1 and 2 or the Soils Staff, again through your supervisor, for Module 3.

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SOIL MECHANICS -- LEVEL I
MODULE 1

UNIFIED SOIL CLASSIFICATION SYSTEM

PART A

TERMS AND DEFINITIONS

STUDY GUIDE

PART A - TERMS AND DEFINITIONS

ACTIVITY 1 - Objectives

At the completion of Part A you will be able to:

1. State conceptually from a list of terms all standard definitions needed to classify a soil in the Unified Soil Classification System.

2. Define the four states of consistency of a soil mass.

3. Describe how each of the four basic soil properties needed to classify a soil in the Unified Soil Classification System are determined in the laboratory.

START THE PLAYER WHEN YOU HAVE FINISHED

PART A - TERMS AND DEFINITIONS

ACTIVITY 2 - TABLE OF COMMONLY USED GRAVEL SIEVE SIZES

3 inch

2 inch

1-1/2 inch

1 inch

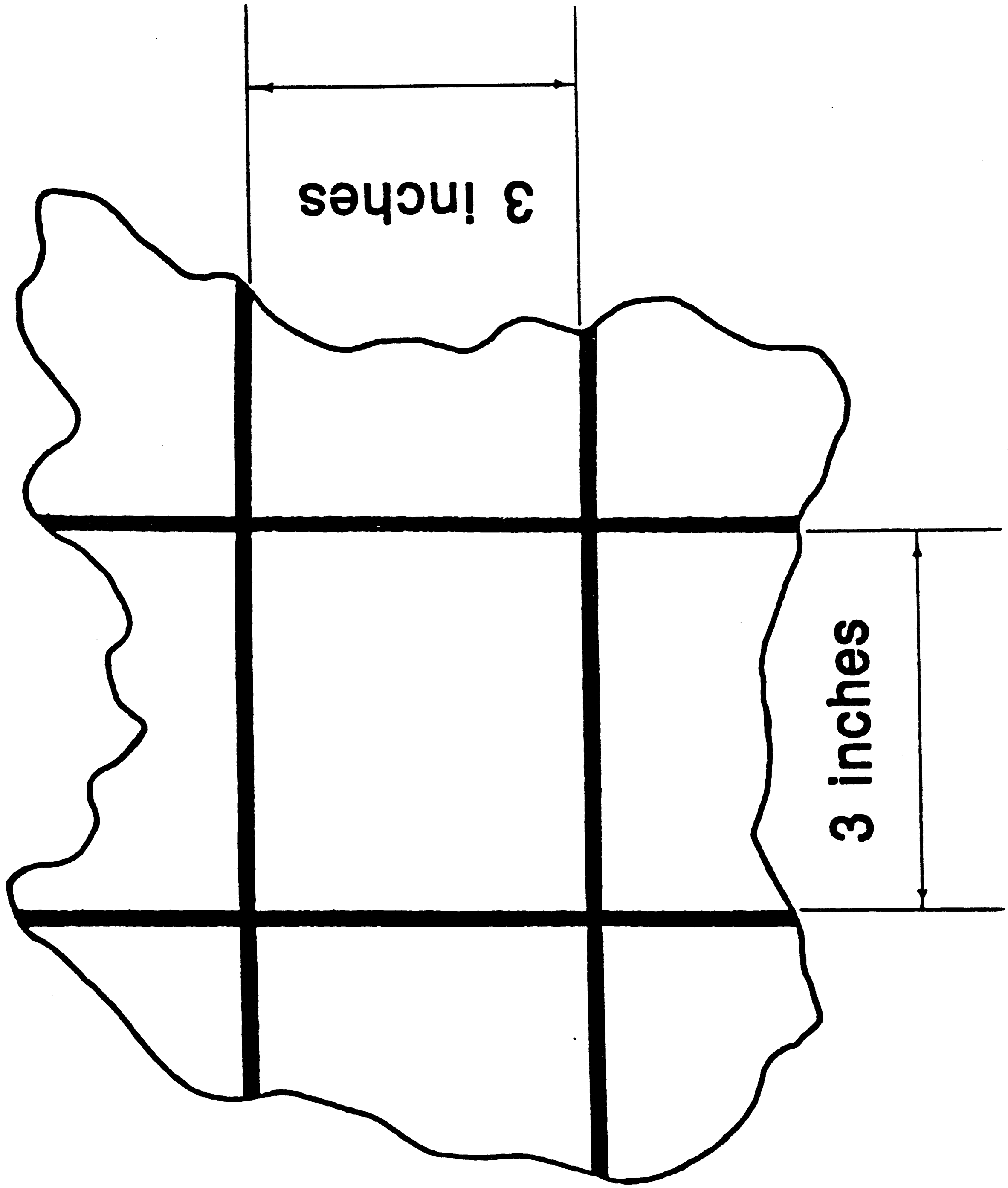
3/4 inch

1/2 inch

3/8 inch

An illustration of a 3-inch sieve is shown on the next page.

3-Inch Sieve



START PLAYER WHEN YOU HAVE FINISHED

ACTIVITY 3 - TABLE OF COMMONLY USED SAND SIEVE SIZES

Listed below are sieves and their sizes commonly used by Soil Conservation Service soil mechanics laboratories for sand sieve analysis:

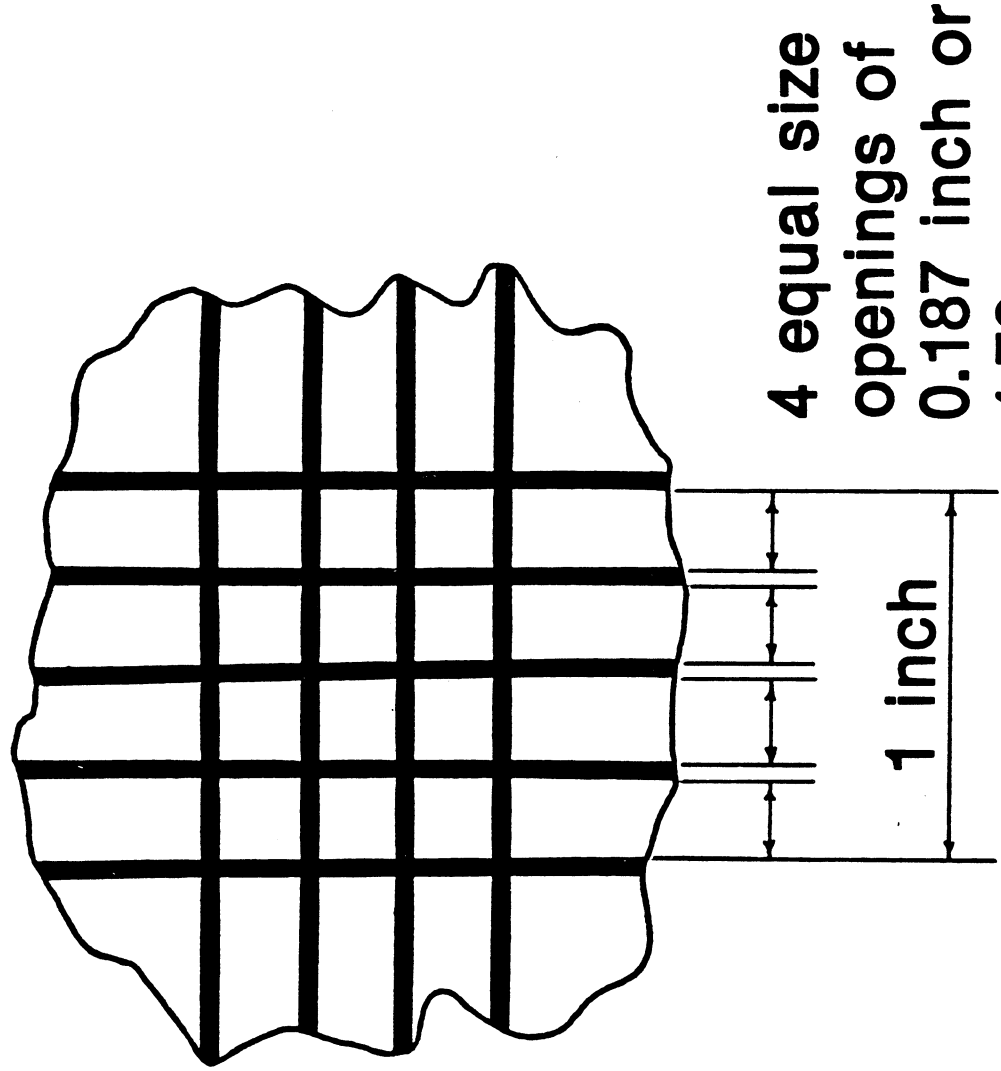
Sieve number	Opening size, millimeters
No. 4	4.76
No. 10	2.0
No. 20	0.84
No. 40	0.42
No. 60	0.25
No. 140	0.105

Many other testing organizations use different sieve series, such as No. 8, No. 16, No. 30, No. 50, No. 100. The difference is not important in the information obtained. As long as the entire range of particle sizes present is represented, and the sieves are about equally spaced in sizes, any standard set of sieves is satisfactory.

An illustration of the dimensions of a No. 4 sieve is shown on the next page.

CONTINUE TO NEXT PAGE

Number 4 Sieve



START PLAYER WHEN YOU HAVE FINISHED

PART A - TERMS AND DEFINITIONS

ACTIVITY 4 - PERCENT RETAINED SIEVE ANALYSIS DATA PRESENTATION

These data are typical results of those from a sieve analysis of a soil. The percentage of the dry weight of the total soil sample retained on each sieve is calculated as shown:

Sieve	Weight retained, pounds	Percent retained
3 inch	0	0
2 inch	10	2
1-1/2 inch	10	2
1 inch	20	4
3/4 inch	10	2
1/2 inch	29	5
3/8 inch	20	4
No. 4	45	9
No. 10	45	9
No. 20	55	11
No. 40	35	7
No. 60	25	5
No. 140	40	8
No. 200	10	2
Pan	150	30
TOTAL	500 lbs.	100%

Example Computation: 40 lbs were retained on the No. 140 sieve. Divide 40 by the total weight of the sample (500 lbs). $\frac{40}{500} = 0.08$.

To convert to percent, multiply by 100. 0.08 x 100 = 8%.

ACTIVITY 5 - CONVERSION OF PERCENT RETAINED TO PERCENT FINER

The conversion of percentage of soil retained on each sieve to percentage finer than each sieve follows:

For example, the 3-inch sieve: If 100 percent of the soil sample is placed into the set of sieves, and 0 percent was retained on the 3-inch sieve, then 100 percent passed through the 3-inch sieve, or 100 percent was finer than the 3-inch sieve.

For the 2-inch sieve: Note the percentage of the soil that passed through the 3-inch sieve, and was retained on this sieve. Subtract the percentage that was retained on the 2-inch sieve from the percentage passing the 3-inch sieve to obtain the percent finer, or 100-2 = 98 percent.

In another example, 72 percent was finer than the No. 4 sieve and 9 percent was retained on the No. 10 sieve. In converting to percent finer for the No. 10, 72 percent - 9 percent = 63 percent.

The process is completed for all the sieves, with the following results:

SIEVE	PERCENT RETAINED	PERCENT FINER
3 inch	0	100
2 inch	2	98
1-1/2 inch	2	96
1 inch	4	92
3/4 inch	2	90
1/2 inch	5	85
3/8 inch	4	81
No. 4	9	72
No. 10	9	63
No. 20	11	52
No. 40	7	45
No. 60	5	40
No. 140	8	32
No. 200	2	30
Pan	30	0

Complete the problem on the next page.

PART A - TERMS AND DEFINITIONS

PROBLEM

A dry soil sample weighing 4.8 lbs was sieved and the following data obtained. Using the procedures in Activities 4 and 5, complete the following:

(1) Convert the weight retained on each sieve to a percent retained, and

(2) Convert percent retained to percent finer. Round answers to nearest 0.1 percent.

Data

Sieve	Weight Retained, pounds	Percent Retained	Percent Finer
3 inch	0		
1½ inch	0.19		
1 inch	0.10		
3/4 inch	0.20		
1/2 inch	0.24		
3/8 inch	0.14		
No. 4	0.43		
No. 10	0.53		
No. 20	0.58		
No. 40	0.42		
No. 60	0.40		
No. 140	0.67		
No. 200	0.23		
Pan	0.67		
Total	4.8		

PART A - TERMS AND DEFINITIONS

NOTES

SOLUTION

Sieve	Weight Retained, pounds	Percent Retained	Percent Finer
3 inch	0	0	100
1½ inch	0.19	4.0	96.0
1 inch	0.10	2.1	93.9
3/4 inch	0.20	4.2	89.7
1/2 inch	0.24	5.0	84.7
3/8 inch	0.14	2.9	81.8
No. 4	0.43	9.0	72.8
No. 10	0.53	11.0	61.8
No. 20	0.58	12.1	49.7
No. 40	0.42	8.8	40.9
No. 60	0.40	8.3	32.6
No. 140	0.67	14.0	18.6
No. 200	0.23	4.8	13.8*
Pan	0.67	14.0*	
Total	4.8	100.2	

* Normally, these two entries are the same. However, because of round off error, the 0.2 percent difference is negligible. Differences greater than 0.5 percent however, should be resolved.

START THE PLAYER WHEN YOU HAVE FINISHED

ACTIVITY 6 - COMPLETE GRAIN SIZE ANALYSIS

A grain-size distribution analysis is the combination of three separate analyses. The gravel sieve analysis is performed on the particles smaller than 3 inches and larger than No. 10 sieve. The sand sieve analysis is performed on particles smaller than the No. 10 sieve and larger than the No. 200 sieve. The hydrometer analysis is also performed on the portion of the sample smaller than No. 10 sieve. Typical data follow:

Gravel sieve analysis	Percent finer
3 inch	100
2 inch	98
1-1/2 inch	96
1 inch	92
3/4 inch	90
1/2 inch	85
3/8 inch	81
No. 4	72
No. 10 *	61
Sand sieve analysis	
No. 10	100
No. 20	82
No. 40	70.5
No. 60	62.3
No. 140	49.2
No. 200	45.9
Hydrometer analysis	
No. 200	46
0.05 millimeter	41
0.02 millimeter	29.5
0.005 millimeter	16.4
0.002 millimeter	11.5

Because the sand sieve and hydrometer analyses were not performed on the entire sample, but just on the portion smaller than the No. 10 sieve, the percentages for the smaller sieves must be adjusted. The adjustment is made by multiplying each of these figures by 61 percent. (THE PERCENT OF THE SAMPLE FINER THAN THE NO. 10 SIEVE). The corrected total gradation is tabulated on the next page.

*Note that the break between gravels and sands is the No. 4 sieve. However the No. 10 sieve is used for both the gravel and sand sieve analysis.

ACTIVITY 6 - Contd.

Size	Adjusted percent finer for 61 percent finer than No. 10 SIEVE
3 inch	100
2 inch	98
1-1/2 inch	96
1 inch	92
3/4 inch	90
1/2 inch	85
3/8 inch	81
No. 4	72
No. 10	61
No. 20	50
No. 40	43
No. 60	38
No. 140	30
No. 200	28
0.05	25
0.02	18
0.005	10
0.002	7

START THE PLAYER WHEN YOU HAVE FINISHED

PART A - TERMS AND DEFINITIONS

ACTIVITY 7 - GRAIN-SIZE DISTRIBUTION CURVE PLOT

PROBLEM

Using the data given below, the results of a grain-size analysis of a soil, plot the gradation curve of the soil: Use the blank data form on the next page, and draw a smooth curve through the plotted points. Compare your curve with that shown on the page following the blank form.

SIZE	PERCENT FINER
3 inch	100
2 inch	-
1-1/2 inch	96
1 inch	92
3/4 inch	90
1/2 inch	85
3/8 inch	81
No. 4	72
No. 10	61
No. 20	50
No. 40	43
No. 60	38
No. 140	30
No. 200	28
0.05 millimeter	25
0.02 millimeter	18
0.005 millimeter	10
0.002 millimeter	7

SCS-ENG-353 (REV. 3-70)
FILE CODE ENG-22

ACTIVITY 7 - PROBLEM

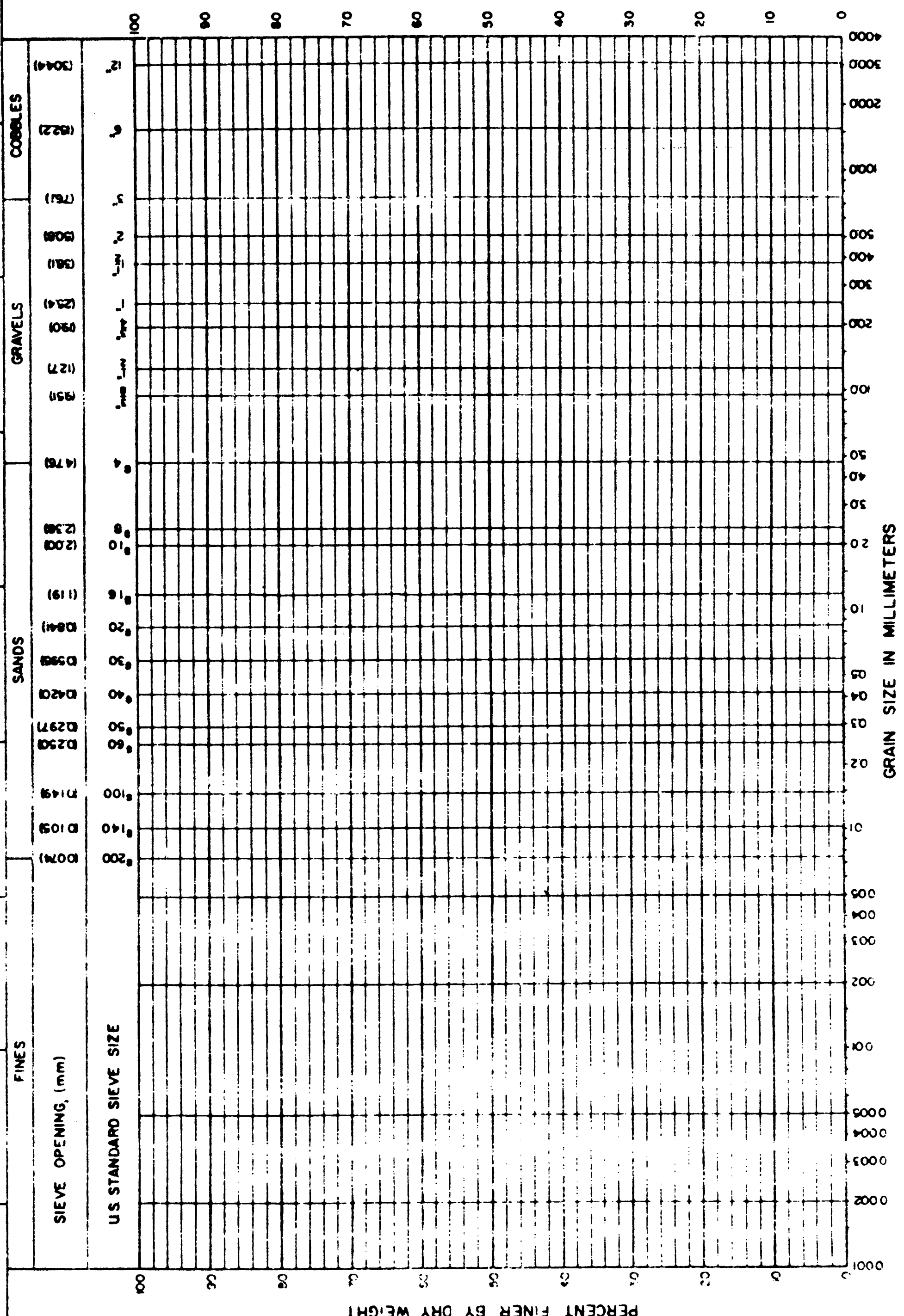
LABORATORY NO. ______

MATERIALS TESTING REPORT	U. S. DEPARTMENT of AGRICULTURE SOIL CONSERVATION SERVICE	SOIL CLASSIFICATION

PROJECT and STATE			SAMPLE LOCATION
FIELD SAMPLE NO.	DEPTH	GEOLOGIC ORIGIN	
TYPE OF SAMPLE	TESTED AT	APPROVED BY	DATE
SYMBOL	DESCRIPTION		

GRAIN SIZE DISTRIBUTION

C_c	C_u	$D_{MAX.}$	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}



UNDISTURBED CONDITION

DRY UNIT WEIGHT	g/cc	pcf
MOISTURE	%	

SHRINKAGE LIMIT	%
SOLUBLE SALTS	%

ATTERBERG LIMITS

	LL	PI
OVEN DRY		
AIR DRY		
NATURAL MOISTURE		

SPECIFIC GRAVITY (G_s)

(+) #4	(-) #4

REMARKS:

SCS-ENG-353 (REV. 3-70)
FILE CODE ENG-22

ACTIVITY 7 - SOLUTION

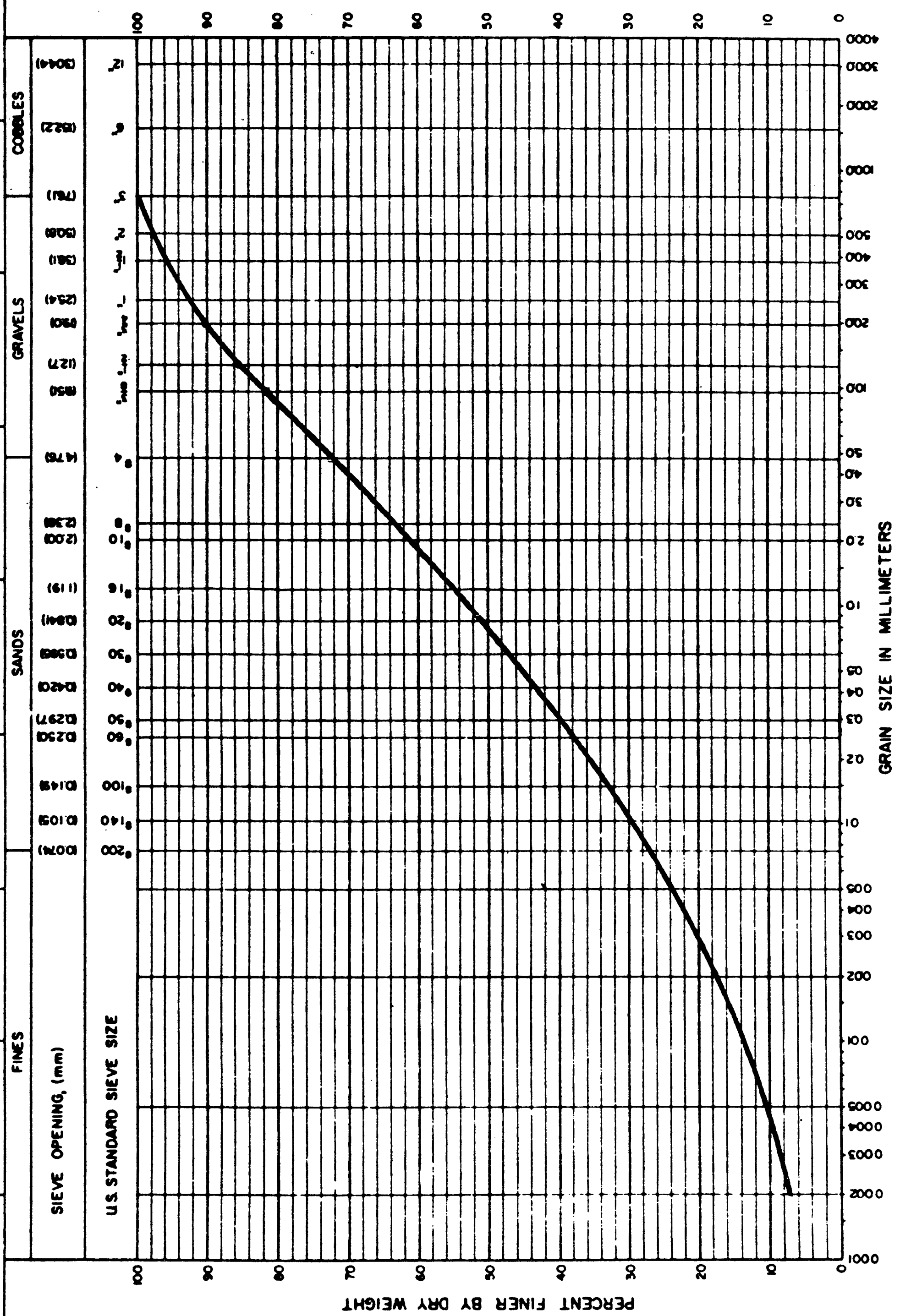
LABORATORY NO ______

MATERIALS TESTING REPORT	U. S. DEPARTMENT of AGRICULTURE SOIL CONSERVATION SERVICE	SOIL CLASSIFICATION

PROJECT and STATE		SAMPLE LOCATION
FIELD SAMPLE NO.	DEPTH	GEOLOGIC ORIGIN
TYPE OF SAMPLE	TESTED AT	APPROVED BY / DATE
SYMBOL	DESCRIPTION	

GRAIN SIZE DISTRIBUTION

C_c | C_u | D_{MAX} | D_{85} | D_{60} | D_{50} | D_{30} | D_{15} | D_{10}



UNDISTURBED CONDITION: MOISTURE % | DRY UNIT WEIGHT g/cc pcf

SHRINKAGE LIMIT %

SOLUBLE SALTS %

ATTERBERG LIMITS: NATURAL MOISTURE LL PI | AIR DRY LL PI | OVEN DRY LL PI

SPECIFIC GRAVITY (G_s): (+) #4 | (−) #4

REMARKS:

PART A - TERMS AND DEFINITIONS

ACTIVITY 8 - WATER CONTENT

DEFINITION AND DISCUSSION

Water content is the ratio, expressed as a percentage, of the weight of water in a given soil mass to the weight of solid particles in the mass.

To determine the water content of a soil sample, a metal moisture can, a scale, and a drying oven are needed. A moist sample is weighed in a metal can. The weight of the can has been predetermined. The sample is then placed in a drying oven that maintains 110 degrees Centigrade for at least 12 hours or until a constant weight is obtained. The can and dry soil are then weighed. The difference between the weight of the wet soil and can and the weight of the dry soil and can is the weight of the water that was in the sample. The weight of dry soil is obtained by subtracting the weight of the can from the final weight of the can plus dry soil.

$$\text{Water content, } w\% = \frac{(\text{weight moist soil + can}) - (\text{weight dry soil + can})}{(\text{weight dry soil + can}) - (\text{weight of can})} \times 100$$

PROBLEMS

Given the following information, calculate the water contents in each sample:

Sample 1

Weight Moist Soil + Can	Weight Dry Soil + Can	Can Weight	Weight of Water	Weight of Dry Soil	Water Content, %
514.2 g	335.3 g	124.6 g			

Sample 2

1.25 lbs	1.03 lbs	0.23 lbs			

To check your answer, or if you have difficulty completing the exercise, refer to the next page for the solution.

ACTIVITY 8 - Continued

SOLUTIONS

Sample 1

$$w\% = [(514.2-335.3)/(335.3-124.6)]\ 100$$

$$= [(178.9)/(210.7)]\ 100$$

$$= 84.9\%$$

Sample 2

$$w\% = [(1.25-1.03)/(1.03-0.23)]\ 100$$

$$= [(0.22)/(0.80)]\ 100$$

$$= 27.5\%$$

Note: There are no upper limits on water content. A soil's water content may be greater than 100 percent. Some very plastic clay soils may have water contents over 400 percent.

START THE PLAYER WHEN YOU HAVE FINISHED

PART A - TERMS AND DEFINITIONS

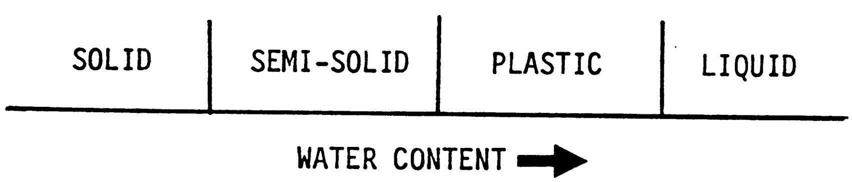
ACTIVITY 9 - PLASTICITY AND CONSISTENCY DEFINITIONS

DEFINITIONS AND DISCUSSION

PLASTICITY - is the property of soil that allows it to be deformed beyond the point of recovery without cracking or appreciable volume change. It may be described as a "putty-like" behavior where a soil mass may be shaped into different configurations without the soil body cracking and the soil mass holds its shape unsupported after reshaping. Modeling clay would be a type of material that exhibits this property very well. Very sandy soils, very silty soils, and some clay soils cannot be formed into coherent masses at any water content and then re-shaped and remolded. They are non-plastic soils. All soils will have plastic characteristics only over a limited range of water content.

CONSISTENCY - is the relative ease with which a soil can be deformed. Consistency terms are used to describe plastic soils and how their consistency varies with water content. At a high water content, soils will have a liquid-like consistency. At somewhat lesser water content, the soils will be in a plastic state of consistency. At very low water contents, soils will not deform without cracking and are in a semi-solid state of consistency. At extremely low water contents, soils are in a solid state of consistency because further drying of the soils does not result in shrinkage of the soil mass.

Consistency terms may be illustrated with a diagram:

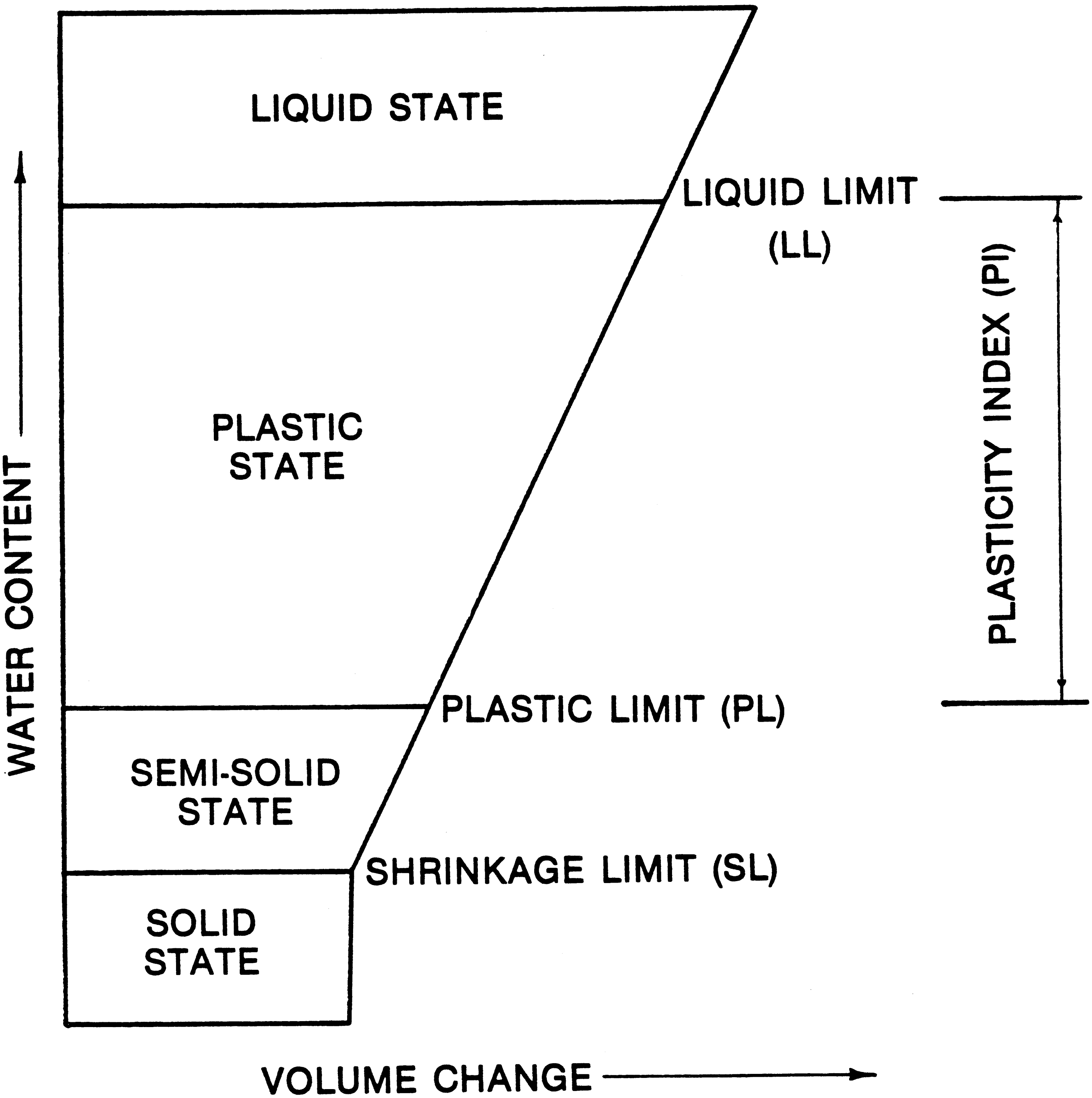


The water content at which a soil changes from one state of consistency to another has been arbitrarily defined by a series of laboratory tests. Each test will be described in detail and the significance of each test explained.

Consistency evaluations are based on only the portion of a sample that is finer than the No. 40 sieve.

Note: A diagram that relates consistency, water content, and volume change can also be developed. Such a diagram is shown on the next page. It shows that a soil and water mixture shrinks or reduces in volume as the soil is dried. This occurs from water content above the liquid limit down to the shrinkage limit. No further volume change occurs as the soil is dried to water content below the shrinkage limit.

CONSISTENCY DIAGRAM RELATING WATER CONTENT AND VOLUME CHANGE



START THE PLAYER WHEN YOU HAVE FINISHED

PART A - TERMS AND DEFINITIONS

ACTIVITY 10 - LIQUID LIMIT

DEFINITION AND DISCUSSION

LIQUID LIMIT - is the water content at which a soil changes from liquid to a plastic state of consistency. Obviously, this change in consistency is not an abrupt one. The liquid limit is consequently a somewhat arbitrary definition. It still has considerable use, however, in the classification of soils.

The liquid limit water content is the water content at which a pat of soil, cut by a groove of standard dimensions, will come together for a distance of one-half inch under the impact of 25 blows in a standard liquid limit device. If the test is performed at a water content less than the liquid limit of the soil, it will take more than 25 blows of the device to close the groove cut in the soil; if the soil is at a water content greater than the liquid limit of that soil, fewer than 25 blows will be required to close the groove in the soil. By performing the test at several different water contents, you can develop a plotted graph of water content versus number of blows, and interpolate the water content at which it would take 25 blows to close the groove. This is the procedure that soils mechanics laboratories use to determine the liquid limit of soils.

Remember that only the portion of a sample smaller than the No. 40 sieve is used for this test.

If this test cannot be successfully performed at any water content, the soil is non-plastic.

A shortcut method of determining the liquid limit is also available. In this procedure, only one water content and blow count is used to perform a test. The liquid limit is then extrapolated by using the equation:

$$LL = (N/25)^{0.12} \times w(\%)_N$$

where

- LL = extrapolated value of liquid limit, in percent
- N = number of blows in one point test
- $w(\%)_N$ = water content at which N blows are required to close groove

Many useful correlations have been developed which use soils' liquid limit values as an index property for correlation.

The ASTM procedure for performing the liquid limit test is ASTM D4318.

Work the problem on the following page before continuing.

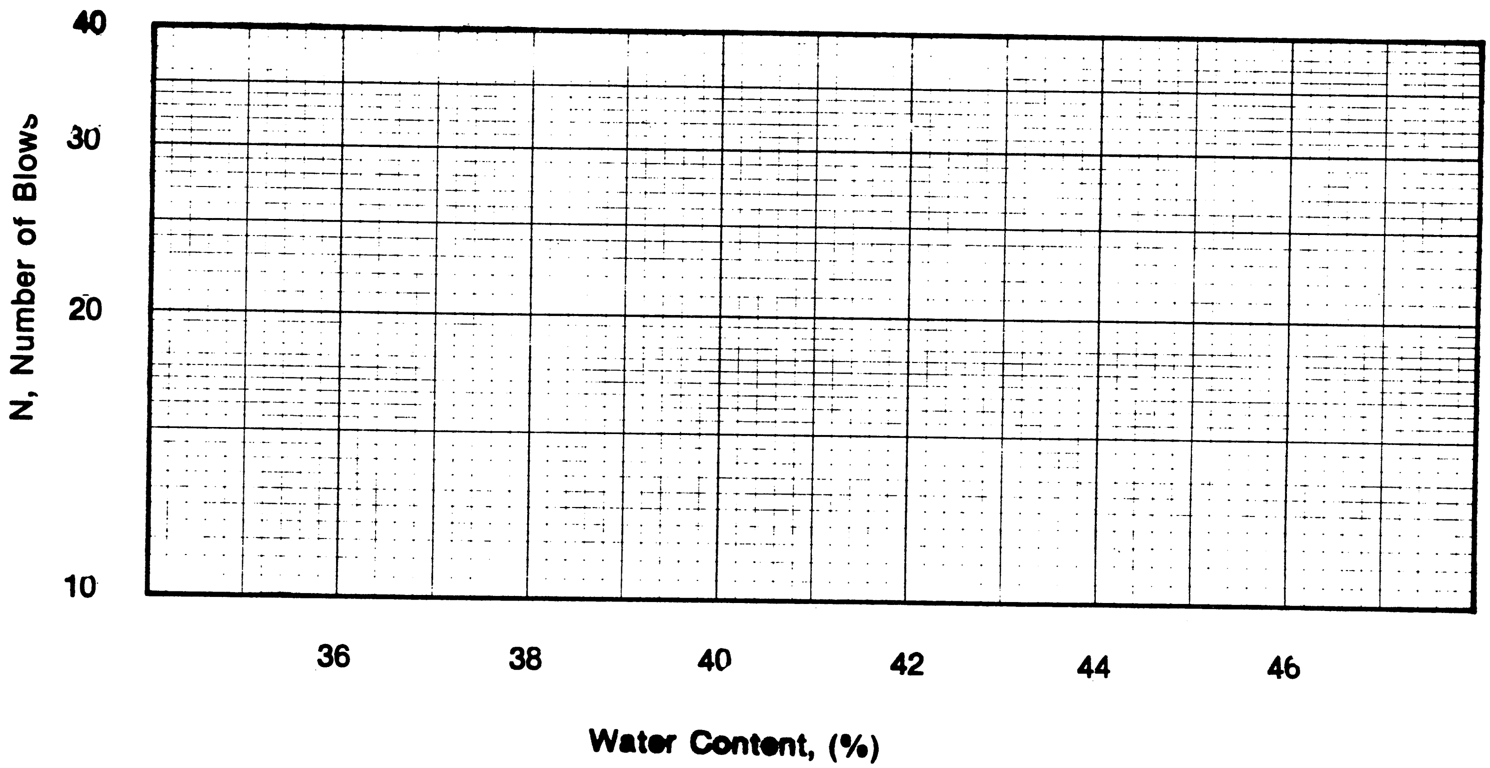
ACTIVITY 10 - Continued

PROBLEM

A laboratory has performed the liquid limit test procedure on a soil sample at four different water contents. The results are as follows:

Number of Blows	Water Content, (%)
34	39.9
29	40.7
21	42.3
15	44.0

Using the graph below, plot up this data, and interpolate a value for the liquid limit of the soil.

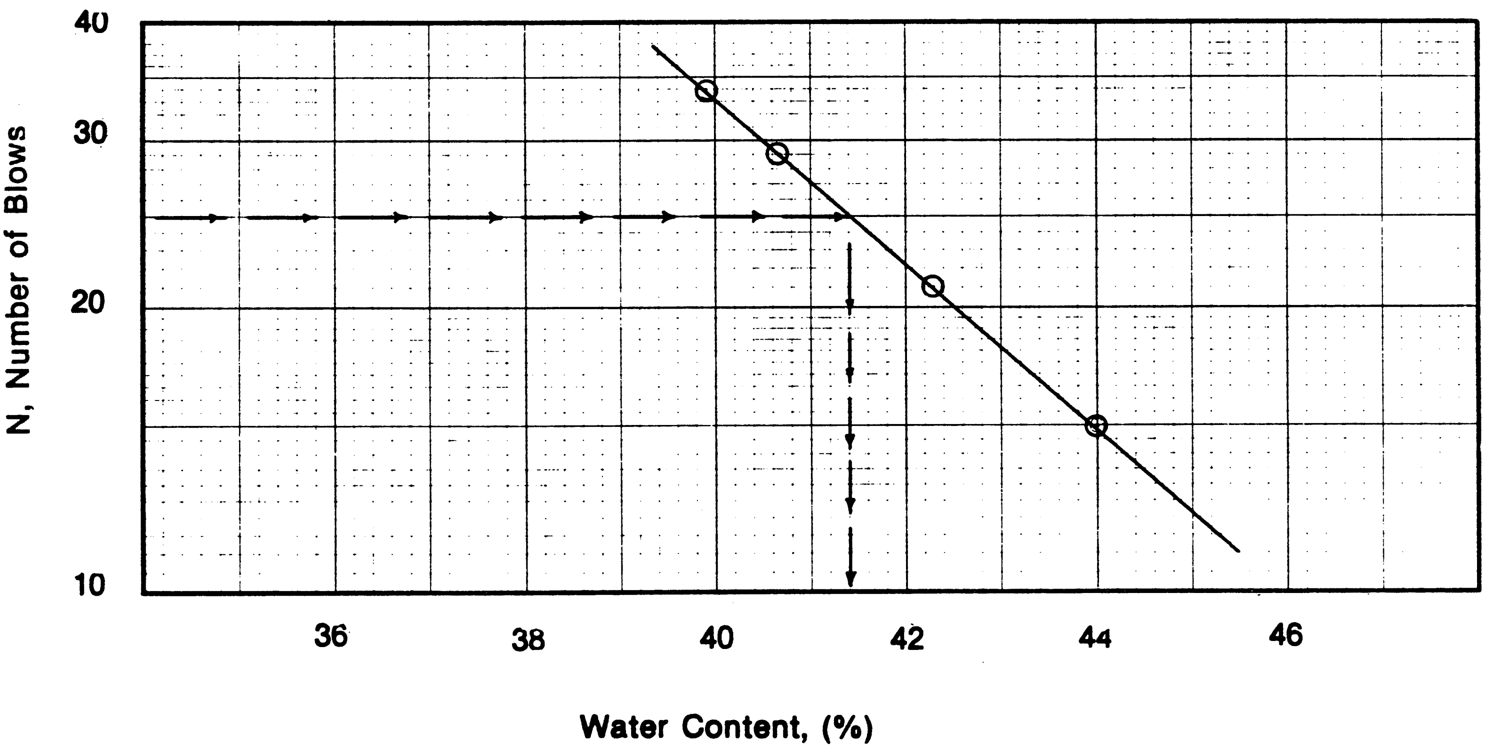


If you have difficulty in completing this Activity, or you wish to check your solution, refer to the following page.

ACTIVITY 10 - Cont'd

SOLUTION

The liquid limit is equal to 41.4% or 41%



This data is typical of well performed liquid limit procedures. The different water content trials should plot virtually on a straight line on semi-logarithmic graph paper.

PART A - TERMS AND DEFINITIONS

ACTIVITY 11 - PLASTIC LIMIT AND PLASTICITY INDEX

DEFINITIONS AND DISCUSSION

PLASTIC LIMIT - is the water content at which a soil changes from the plastic to the semi-solid state of consistency. This change is not an abrupt change. The plastic limit consequently is somewhat arbitrary by definition.

The plastic limit is the water content at which a soil being dried begins to crumble when rolled into a thread approximately 1/8-inch in diameter. To determine a soils' plastic limit, the portion of the sample finer than the No. 40 sieve is used. A sample is wetted to a water content within the plastic state of consistency - that is to a water content at which a 1/8-inch thread can be rolled without the sample cracking or crumbling. Then, the sample is gradually dried by adding small amounts of dry soil and thoroughly mixing, or by continuous kneading of the soil. Periodically, a 1/8-inch thread is rolled out as the sample is dried. After a certain amount of drying, you will no longer be able to roll out the 1/8-inch diameter thread without it crumbling, and you will not be able to reform a ball of soil. At that point, the plastic limit of the soil has been reached, and a water content test is performed on the sample. This water content is the plastic limit of the soil.

If a 1/8-inch thread cannot be rolled out at any water content tried, then the soil is described as non-plastic.

The ASTM procedure for performing the plastic limit test is ASTM D4318.

PLASTICITY INDEX - is the numerical difference between the liquid limit and plastic limit water contents of a soil:

$$PI = LL - PL$$

This value identifies the range of water content over which a soil has plastic behavior characteristics. Soils with PI values less than 8 are low in plasticity. Soils with PI values greater than 30-40 are high in plasticity.

Complete the problems on the following page before continuing.

PART A - TERMS AND DEFINITIONS

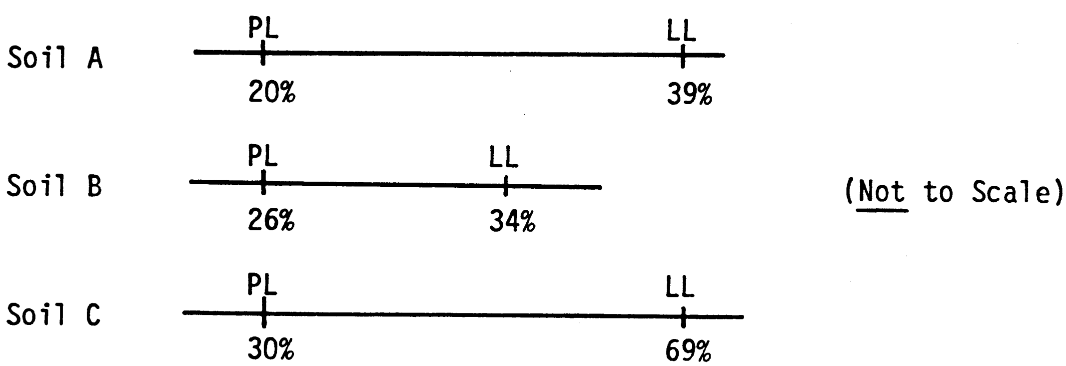
ACTIVITY 11 - Continued

PROBLEMS

Answer the following questions concerning plastic limit and plasticity index:

1. A laboratory plastic limit test was performed on the soil in Activity 10. It was determined that a 1/8-inch thread of soil could be rolled out and it just began to crumble when the water content of the soil was 19.8 percent. What is the value of the plasticity index of the soil?

2. The following diagrams represent consistency diagrams for three different soils, based on laboratory test results. Which of the three soils is the most plastic? Which is the least plastic?



3. Tests were performed on a soil and reported as: Liquid Limit = 23 percent, Plastic Limit = 22 percent. Is this possible? What does this say about the plasticity characteristics of the soil?

If you have difficulty in completing this Activity, or wish to check your solution, refer to the next page.

ACTIVITY 11 - Continued

SOLUTION

1. Plasticity Index is equal to the liquid limit minus the plastic limit.

$$PI = LL - PL$$

$$PI = 41 - 20$$

$$= 21$$

2. Soil C is the most plastic soil, with a PI value of 39. Soil B is the least plastic, with a PI of 8.

3. Yes, it is possible. It means that the soil has very low plasticity. It would not be possible for the plastic limit water content to be greater than the liquid limit water content, but they could be very close together, or even the same.

START THE PLAYER WHEN YOU HAVE FINISHED

PART A - TERMS AND DEFINITIONS

ACTIVITY 12 - SHRINKAGE LIMIT

DEFINITION AND DISCUSSION

SHRINKAGE LIMIT - is the water content at which a soil changes from a semi-solid to the solid state of consistency. This change is defined by a laboratory test.

The shrinkage limit is the water content below which further drying of a soil mass does not produce further shrinkage in volume. With an initial water content above the shrinkage limit, drying of the soil results in shrinkage or volume change; at water contents below the shrinkage limit, drying of a soil mass does not result in additional shrinkage.

The test is performed on the portion of a soil sample finer than the No. 40 sieve.

To perform the shrinkage limit test, a sample is prepared at a water content slightly above the liquid limit of that soil. The sample is placed in a stainless steel dish with a precisely known volume. It is then oven-dried thoroughly. The soil pat in the dish will shrink appreciably, and a new volume is determined for the soil pat by immersing the soil pat in mercury. The initial water content of the soil pat can be determined by knowing the initial weight of the soil pat and the weight after oven drying. The shrinkage limit of the soil is then defined by the equation:

$$SL = w(\%) - [(V-V_0)/W_0] \times 100$$

where

$w(\%)$ = initial water content of sample, in percent

SL = shrinkage limit water content, in percent

V = initial volume of wet soil pat

V_0 = volume of dry soil pat

W_0 = mass of oven-dried soil pat

The value of shrinkage limit is not used in the Unified Soil Classification System. Its primary use is in correlating shrink-swell behavior of plastic clay soils.

The shrinkage index of a soil is defined as the numerical difference between the soil's plastic limit and shrinkage limit:

$$SI = PL-SL$$

Complete the problem on the next page before continuing.

ACTIVITY 12 - Continued

PROBLEM

A shrinkage limit test was performed on a soil sample. The results of the test are:

The initial water content of the soil pat was 57.2 percent.

The volume of the wet soil pat was 13.46 cubic centimeters.

The volume of the dry soil pat was 7.43 cubic centimeters.

The mass of the oven dry soil pat was 14.3 grams.

What was the value of the shrinkage limit of the soil?

If the soil had a liquid limit of 57 percent and a plasticity index of 30 percent, calculate the shrinkage index of the sample.

If you have difficulty in completing this activity, or wish to check your solution, refer to the following page.

ACTIVITY 12 - Continued

SOLUTION

Shrinkage limit is calculated with the formula:

$$SL(\%) = w(\%) - [(V - V_0)/W_0] \times 100$$

$$= 57.2 - [(13.46-7.43)/14.3] \times 100$$

$$= 57.2 - 42.2$$

$$= 15.0\%$$

Shrinkage Index (SI) = PL-SL

PL = LL-PI=57-30=27%

SI=27-15=12%

START THE PLAYER WHEN YOU HAVE FINISHED

ACTIVITY 13 - COMPREHENSIVE PROBLEM

To evaluate your accomplishments concerning the objectives in Part A of this module, please complete the following exercise:

1. In your own words briefly define the following

Sieve -

No. 4 Sieve -

Grain Size Distribution Graph -

Percent Finer -

Plasticity -

Water Content -

Consistency -

2. List the four states of consistency of a soil and water mixture.

____________________ ____________________

____________________ ____________________

3. Define:

Liquid Limit -

Plastic Limit -

Plasticity Index -

ACTIVITY 13 - Continued

4. Answer True or False.

   a. A soil cannot have a liquid limit greater than 100 percent. ________

   b. A soil can have a water content in excess of 200 percent. ________

   c. A certain soil had a liquid limit of 38 when the test was run on an air-dried sample. When oven-dried, the liquid limit obtained was 34. This soil is considered to be organic. ________

5. List the six sieves commonly used by the SCS for reporting gravel sizes.

   _____ _____ _____ _____ _____ _____

6. List the seven sieves commonly used by the SCS for reporting sand sizes.

   _____ _____ _____ _____ _____ _____ _____

7. Describe briefly how the percentage of sand-size and gravel-size particles in a given soil are obtained.

8. Describe how the Atterberg limits are obtained in the laboratory.

Did you have trouble on any question? Check your answers with those on the next page(s).

The completion of this Activity wraps up Part A of this module. You are now ready for Part B. Good luck.

ACTIVITY 13 - NOTES

ACTIVITY 13 - Continued

SOLUTION

1. Sieve - A piece of equipment with sized openings that will retain particles larger than a given size and let the smaller particles pass through the opening.

   No. 4 Sieve - A sieve that has four equal openings per lineal inch.

   Grain-size distribution graph - A curve developed from the results of gravel, sand and hydrometer analyses that show the percentages of a soil sample smaller than given particle sizes.

   Percent Finer - The amount of the soil particles that will pass a given sieve size computed on a dry weight basis as a percentage of the total sample.

   Plasticity - A property of a soil which allows it to be deformed beyond the point of recovery without cracking or appreciable volume change.

   Water Content - The amount of water in a soil expressed as a percent and based on the dry weight of the total sample.

   Consistency - The relative ease with which a soil can be deformed.

2. Four states of consistency are:

   Liquid
   Plastic
   Semi-solid
   Solid

3. Liquid Limit - The water content at which a soil changes from the liquid to the plastic state of consistency.

   Plastic Limit - The water content at which a soil changes from the plastic state to the semi-solid state of consistency.

   Plasticity Index - The numerical difference between the LL and the PL. It is the range of water contents over which a soil has plastic behavior.

ACTIVITY 13 - Continued

4. a. False. - A soil can have a liquid limit of any value greater than 16%.

   b. True. - A soil can have a water content of any value. Again there is no upper limit.

   c. False. - The reduction must be at least 25%.

5. 3 inch, 2 inch, 1-1/2 inch, 3/4 inch, 1/2 inch, 3/8 inch, No. 4

6. No. 4, No. 10, No. 20, No. 40, No. 60, No. 140.

7. Review Activities 6 and 7, Part A, of your Study Guide.

8. Review Activities 10 and 11, Part A, of your Study Guide.

START THE PLAYER WHEN YOU HAVE FINISHED