United States
Department of
Agriculture

Soil
Conservation
Service

Soil Mechanics Level I

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

Study Guide

SOIL MECHANICS LEVEL I

MODULE 2

AASHTO - (AMERICAN ASSOCIATION OF STATE HIGHWAY AND TRANSPORATION OFFICIALS)

STUDY GUIDE

National Employee Development Staff
Soil Conservation Service
United States Department of Agriculture
Revised February 1987

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SOIL MECHANICS LEVEL I
MODULE 2

AASHTO CLASSIFICATION
STUDY GUIDE

INTRODUCTION

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

1. Unified Soil Classification System

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

3. USDA Textural Soil Classification

INSTRUCTION

The procedure of 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 2 has one major section with specific objectives that you need to accomplish 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 in 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 or Soils Staff, through your supervisor, for assistance.

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1 Slide tray
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MODULE 2 - AASHTO

ACTIVITY 1

Objectives:

1. Write definitions for terms used in the AASHTO classification system.

2. Using lab data and the AASHTO flow chart, correctly classify soils.

3. Explain the engineering interpretations for "local roads and streets" and "roadfill." These interpretations are listed on form SCS-SOILS-5 and in soil survey publications. The explanation must be based on AASHTO criteria and guidelines adopted by the Soil Conservation Service and published in the National Soils Handbook, Part 603.

START THE PLAYER WHEN YOU HAVE FINISHED

ACTIVITY 2 - Common Terms Between AASHTO and USCS

Study the following definitions below. The terms are common to the Unified Soil Classification System and the AASHTO Classification System.

1. LIQUID LIMIT, LL
   (a) The water content corresponding to the arbitrary boundary between the liquid and plastic states of consistency of a soil.
   (b) The water content at which a pat of soil, cut by a groove of standard dimensions, will flow together for a distance of 1/2 inch under the impact of 25 blows in a standard liquid limit apparatus.

2. PLASTIC LIMIT, PL
   (a) The water content corresponding to an arbitrary boundary between the plastic and the semisolid states of consistency of a soil.
   (b) The water content at which a soil being dried will just begin to crumble when rolled into a thread about 1/8 inch (0.32mm) in diameter.

3. PLASTICITY INDEX, PI - Numerical difference between the liquid limit and the plastic limit.

4. PERCENT PASSING - Expresses the percentage of the total sample that is finer than each sieve size, rather than as the percentage retained. Percentage finer is commonly referred to as percent passing. All percentages are calculated on a weight basis.

5. SIEVE - A testing device with screen or wire mesh on the bottom. Finer particles of a soil of various sizes pass through a series of sieves separating them from coarser particles.

6. SIEVE ANALYSIS - The total sample is weighed and then processed through a nested set of sieves. The sieves are progressively finer from top to bottom. The amount retained on each sieve is weighed and recorded. These weights are converted to a percentage of the total sample. These percentages are then converted to a percentage passing for each sieve size.

START THE PLAYER WHEN YOU HAVE FINISHED

ACTIVITY 3 - Terms unique to AASHTO

Terms listed in this activity are unique to the AASHTO classification system.

1. Gravel - Soil particles that are finer than a 3-inch sieve and are retained on a No. 10 sieve.

2. Sand - Soil particles that are finer than a No. 10 sieve and retained on a No. 200 sieve.

3. Coarse sand - A subdivision of sand. The soil particles finer than a No. 10 sieve and retained on a No. 40 sieve.

4. Fine sand - A subdivision of sand. The soil particles finer than a No.40 sieve and retained on a No. 200 sieve.

5. Fines (F) - Soil particles finer than a No. 200 sieve. Expressed in percent of the dry weight of the soil passing a 3-inch sieve.

6. Silty - Refers to soils that have a PI of 10 or less.

7. Clayey - Refers to soils that have a PI more than 10.

8. Subgrade - Material upon which a road, street or highway is constructed. It may be either insitu or fill material.

9. Base and or Sub-base - Materials placed on the subgrade as a supporting medium for improved roads and streets.

10. Granular - Materials that have 35 percent or less finer than the No. 200 sieve. Percentages are on a dry weight basis.

11. Silt-clay - Materials that have more than 35 percent finer than a No. 200 sieve on a dry weight basis.

12. Group Index - A parameter that gives an indication of the load carrying capacity within an AASHTO soil group. It is numerically equal to the equation below.

$$GI = (F - 35)\,[0.2 + 0.005\,(LL - 40)] + 0.01\,(F - 15)\,(PI - 10)$$

Where F = % Fines
LL = Liquid Limit
PI = Plasticity Index

Group index is reported to the nearest whole number. It is listed in parentheses following the group symbol. An example is A-7-6(4).

A group index of (0) indicates the best construction material for sub-base, or subgrade.

A group index of more than (20) indicates a very poor material for sub-base or subgrade.

If the group index calculated is negative it is reported as (0).

Partial Group Index (PGI) - A parameter that may be calculated instead of group index for subgroups A-2-6 and A-2-7. The equation for PGI is the plasticity portion of the GI equation, or

$$PGI = 0.01 (F - 15) (PI - 10)$$

Again, negative values are reported as (0).

Positive PGI values are reported to the nearest whole number.

NOTE:

Study these terms and those listed in Activity 2. Then complete the short quiz on the next page.

ACTIVITY 3

Complete the following questions.

1. Give the sieve size limits for sand.

   _____ < S < _____

2. Write a brief definition for the following terms.

   a. Fines _____

   _____

   b. Granular _____

   _____

   c. Group Index _____

   _____

   d. Base and or Sub-base _____

   _____

   e. Liquid Limit _____

   _____

   f. Plasticity Index _____

   _____

3. A group A-7-6(18) is a good sub-base material. True _____ False _____

Answers for these questions are on the next page.

ACTIVITY 3

Answers:

1. No. 200 S No. 10

2. a. Fines (F) - Soil particles finer than a No. 200 sieve. Expressed in percent of the dry weight of the soil passing a 3-inch sieve.

   b. Granular - Materials that have 35 percent or less finer than the No. 200 sieve. Percentages are on a dry weight basis.

   c. Group Index - Gives indication of the load carrying capacity of the soil.

   d. Base or Sub-base - Materials placed on the subgrade as a supporting structure for improved roads and streets.

   e. Liquid Limit - (1) The water content corresponding to the arbitrary limit between the liquid and plastic states of consistency of a soil. (2) The water content at which a pat of soil, cut by a groove of standard dimensions, will flow together for a distance of 1/2 inch under the impact of 25 blows in a standard liquid limit apparatus.

   f. Plasticity Index PI - Numerical difference between the liquid limit and the plastic limit.

3. False

START THE PLAYER WHEN YOU HAVE FINISHED

MODULE 2 - AASHTO

ACTIVITY 4 - Flow Chart

The AASHTO classification system is contained on the flow chart on the next page.

The flow chart is arranged with the best subgrade, sub-base or base material on the far left (A-1). The poorest road construction material is on the far right (A-7). One group, A-8, is unsuitable for road construction and is not on the flow chart. Group A-8 consists of peats and mucks (highly organic soils).

The group classifications depend on three factors.

1) Sieve Analysis
2) Liquid Limit
3) Plasticity Index

Group A-1 materials are granular, and group A-7 soils are silt-clay materials. Gradation will generally be progressively finer from left to right on the chart.

The reference specification for this system is AASHTO standard M-145-82. A copy of this standard is in Appendix 2.

Study the flow chart on the next page.

FLOW CHART

SML Fort Worth	Soil Mechanics							AASHTO Classification System			
	Granular Materials (35% or less passing No. 200)							Silt-Clay Materials (More than 35% passing No. 200)			
	Group A-1		Group	Group A-2				Group	Group	Group	Group A-7 (A-7-5, A-7-6)
	A-1-a	A-1-b	A-3	A-2-4	A-2-5	A-2-6**	A-2-7**	A-4	A-5	A-6	
Sieve Analysis Percent Passing											
No. 10	50 max	-	-	-	-	-	-	-	-	-	-
No. 40	30 max	50 max	51 min	-	-	-	-	-	-	-	-
No. 200	15 max	25 max	10 max	35 max	35 max	35 max	35 max	36 min	36 min	36 min	36 min
Characteristics of fraction passing No. 40:											
Liquid limit	-		-	40 max	41 min	40 max	41 min	40 max	41 min	40 max	41 min
Plasticity index	6 max		N.P.	10 max	10 max	11 min	11 min	10 max	10 max	11 min	*11 min
Usual types of significant constituent materials	Stone Fragments gravel and sand		Fine sand	Silty or clayey gravel and sand				Silty Soils		Clayey soils	
General rating as subgrade	Excellent to good					Fair to poor					

Group Index (GI) = (F-35) [0.2 + 0.005 (LL - 40)] + 0.01 (F-15) (PI-10)
Where: F = percentage passing a No. 200 sieve,
LL = Liquid Limit, and
PI = Plasticity Index

Group index should be shown in parentheses after group symbol, as: A-2-6(3), A-4(5), A-6(12), A-7-5(17), etc.
When the combined Group Indices are negative, the Group Index should be reported as zero.

* Plasticity index of A-7-5 subgroup is equal to or less than (LL-30). Plasticity index of A-7-6 subgroup is greater than (LL - 30).

** When working with A-2-6 and A-2-7 subgroups the Partial Group Index (PGI) is determined from the PI portion only.

ACTIVITY 5

Questions:

Complete the problems listed below.
Answers are on the next page.

1. Percent Passing

No. 10	90	LL = 45	Group _____
No. 40	70	PI = 17	Sub-Group _____
No. 200	50		

2. Percent Passing

No. 10	75	LL = 20	Group _____
No. 40	60	PI = NP	Sub-Group _____
No. 200	9		

3. Percent Passing

No. 10	60	LL = 20	Group _____
No. 40	45	PI = 5	Sub-Group _____
No. 200	20		

ACTIVITY 5

Answers

1. Group A-7
   Sub-Group A-7-6

2. Group A-3

3. Group A-1
   Sub-Group A-1-b

If you had trouble with these problems, review the flow chart in Activity 4.

START THE PLAYER WHEN YOU HAVE FINISHED.

MODULE 2 - AASHTO

ACTIVITY 6 - Group Index

The group index is an inverse indicator of load carrying capacity. As the group index increases the load carrying capacity decreases. The group index is relative within a single classification group or sub-group. For additional discussion of this, see section 7 of M-145-82 in Appendix 2.

The group index is calculated using the equation below:

$$GI = (F-35)\,[0.2 + 0.005(LL-40)] + 0.01(F-15)(PI-10)$$

Where GI = Group Index
F = Percent passing a No. 200 sieve
LL = Liquid Limit
PI = Plasticity Index

Negative GI is reported as "0"

Complete the three examples on page 16

ACTIVITY 6

Compute the group index (GI) for the following problems. Refer to the flow chart for the equation and terms.

1. F = 43
   LL = 30
   PI = 15

   GI = _____

2. F = 60
   LL = 43
   PI = 20

   GI = _____

3. F = 40
   LL = 42
   PI = 8

   GI = _____

When you have completed this activity, check page 18 for the answers.

NOTES

ACTIVITY 6

Answers:

1. GI = (43-35)[.2 + .005(30-40)] + .01(43-15)(15-10)
= 8[.2 + .005(-10)] + .01(28)(5)
= 8[.2 - .05] + 1.4
= 1.2 + 1.4
= 2.6 ----- 3

2. GI = (60-35)[.2 + .005(43-40)] + .01(60-15)(20-10)
= (25)[.2 + .015] + .01(45)(10)
= 5.375 + 4.5
= 9.875 --- 10

3. GI = (40-35)[.2 + .005(42-40)] + .01(40-15)(8-10)
= (5)[.2 + .005(2)] + .01(25)(-2)
= 1.05 - .5
= 0.55 ---- 1

START THE PLAYER WHEN YOU HAVE FINISHED

ACTIVITY 7

Questions:

Note the double asterisks for subgroups A-2-6 and A-2-7 in the flow chart. Follow instructions given in the footnote for the two subgroups. Compute PGI for the following problems.

1. F = 30 PGI = _____
   PI = 13

2. F = 25 PGI = _____
   PI = 8

Negative PGI is reported as "0"
Also check your answers to this activity and Activity 6 using the nomograph shown as figure 1 in AASHTO Standard M-145-82 located in Appendix 2.

Instructions for using figure 1:

1. Use LL portion of nomograph
2. Use PI portion nomograph
3. Add the values obtained in items 1 and 2 to obtain the GI.

Answers are on the next page.

ACTIVITY 7

Answers:

1. PGI = 0.01(F-15)(PI-10) = 0.01(30-15)(13-10)
= 0.01(15)(3)
= 0.01(45)
= 0.45 = 0

2. PGI = 0.01(F-15)(PI-10)
= 0.01(25-15)(8-10)
= -0.01(10)(-2)
= 0.01(-20)
= -0.20=0

PGI is only calculated for subgroups A-2-6 and A-2-7.

START THE PLAYER WHEN YOU HAVE FINISHED

ACTIVITY 8 - Practice Problems

Determine the correct classification, including group index and partial group index, for the following soils. Answers are on the next page.

		Percent Passing					
No.	3"	No. 10	No. 40	No. 200	LL	PI	AASHTO CLASS
1	100	20	8	0	--	NP*	
2	100	100	96	75	61	34	
3	100	59	29	11	--	NP	
4	100	100	92	66	45	13	
5	100	100	55	8	--	NP	
6	100	100	99	92	40	20	
7	100	100	90	80	50	8	
8	100	92	60	15	34	5	
9	100	99	94	60	25	3	
10	100	75	50	35	42	5	
11	80	60	40	30	45	13	
12	100	24	12	6	38	14	

* NP Nonplastic, or PI=0

ACTIVITY 8

Answers:

No.	3"	Percent Passing No. 10	No. 40	No. 200	LL	PI	AASHTO CLASS
1	100	20	8	0	--	NP*	A - 1 - a (0)
2	100	100	96	75	61	34	A - 7 - 6 (27)
3	100	59	29	11	--	NP	A - 1 - 6 (0)
4	100	100	92	66	45	13	A - 7 - 5 (9)
5	100	100	55	8	--	NP	A - 3 (1)
6	100	100	99	92	40	20	A - 6 (19)
7	100	100	90	80	50	8	A - 5 (10)
8	100	92	60	15	34	5	A - 2 - 4 (0)
9	100	99	94	60	25	3	A - 4 (0)
10	100	75	50	35	42	5	A - 2 - 5 (0)
11	80	60	40	30	45	13	A - 2 - 7 (0)
12	100	24	12	6	38	14	A - 2 - 6 (0)

* NP Nonplastic, or PI=0

START TAPE WHEN YOU HAVE FINISHED

ACTIVITY 9 - Criteria and Example Problem in Engineering Interpretations for Local Roads and Streets

Exhibits 1 and 2 of this activity contain a discussion of the properties that affect a soil's limitation ratings for local roads and streets, the definitions of the applicable terms, and the criteria for determination of the proper rating.

The criteria in Exhibit 2 lists 14 properties to consider for rating soils for this use. Property Number 6, AASHTO Group Index Number, is the only one of concern in this module. Note that the permissible limits for this property are slight, moderate, and severe. The criteria is based on the Group Index Number for the AASHTO Classification System. A "slight" limitation is given for soils with a Group Index less than 5, "moderate" for soils with Group Indices of 5 to 8, and "severe" for Group Indices greater than 8.

Only the thickest layer between a depth of 10 and 40 inches is rated. If a range of values is listed for the percent fines (F), liquid limit (LL), and the plasticity index (PI), use the median values for calculating the Group Index.

Group Index and Group Index Number (GIN) are the same.

If a moderate or severe limitation is given to a soil on the basis of criteria using GIN, a restrictive feature of "low strength" is added. Ex: SEVERE - LOW STRENGTH.

To illustrate the use of typical AASHTO CLassification data, refer to Exhibit 3 of this Activity. This is a copy of the SCS-SOILS-5 Form for the Captina Series. Using a step-by-step procedure, determine the rating of severe that is listed for local roads and streets.

(1) Consider the thickest layer between a depth of 10 to 40 inches. (Refer to Footnote 9 of Exhibit 2). In the example, use the data for the 8- to 24-inch depth.

(2) The range for the percent passing the No. 200 sieve is from 80 to 90. The median value to use would be $\frac{80 + 90}{2} = 85$. (Refer to Footnote 10 in Exhibit 2).

(3) The range for the liquid limit is from 20 to 40. The median value would be $\frac{20 + 40}{2} = 30$.

(4) The range for the plasticity index is 5 to 20. The median value would be $\frac{5 + 20}{2} = \frac{25}{2} = 12.5 = 13$.

(5) Calculate the Group Index Number (GIN) using the equation,

GIN = (F-35)[0.2+0.005(LL-40)]+0.01(F-15)(PI-10)

Where F = 85
LL = 30
PI = 13

GIN = (85-35)[0.2+0.005(30-40)]+0.01(85-15)(13-10)
GIN = (50)[0.2+0.005(-10)]+0.01(70)(3)
GIN = (50)[0.2-0.05]+2.1
GIN = (50)[0.15]+2.1
GIN = 7.5+2.1
GIN = 9.6
GIN = 10

(6) According to the criteria, a GIN greater than 8 would be a severe rating. Therefore, 10 is greater than 8 and the Captina soil should be rated "SEVERE-LOW STRENGTH."

(7) This agrees with the rating shown on the SCS-SOILS-5 for the Captina Series.

EXHIBIT 1

603.03-2(e)

(e) Local roads and streets. See table 603-19. Limitation ratings are given for the use of soils for construction of improved local roads and streets that have all-weather surfacing--commonly of asphalt or concrete--and that are expected to carry automobile traffic all year. The roads and streets consist of (1) the underlying local soil material, whether cut or fill, which is called "the subgrade"; (2) the base material, which may be lime-stabilized soils, soil-cement stabilized soil, gravel, or crushed rock; and (3) the actual road surface or street pavement, which is either flexible (asphalt), rigid (concrete), or gravel with binder in it. These roads and streets are graded to shed water, and conventional drainage measures are provided. With the probable exception of the hard surface, roads and streets are built mainly from the soil at hand.

(1) The properties that affect local roads and streets are those that influence the ease of excavation and grading and traffic supporting capacity. The properties that affect the ease of excavation and grading are depth to bedrock or a cemented pan, depth to the water table, flooding, the amount of large stones, and slope. The properties that affect traffic supporting capacity are soil strength as inferred from AASHTO group index and the Unified classification, subsidence, shrink-swell behavior, potential frost action, and depth to the high water table.

(2) If slippage or pitting is observed or if combinations of soil properties and geologic conditions suggest the susceptibility to or probability of such phenomena, the soil is rated SEVERE and SLIPPAGE or PITTING is listed as the restrictive feature.

From the National Soils Handbook, SCS, Part 603, Paragraph 603.03-2(e), p. 603-78, July 1983.

Table 603-19. Local roads and streets.

PROPERTY	LIMITS			RESTRICTIVE FEATURE
	SLIGHT	MODERATE	SEVERE	
1. USDA TEXTURE	---	---	ICE	PERMAFROST
2. TOTAL SUBSIDENCE	---	---	>12	SUBSIDES
3. DEPTH TO BEDROCK (IN):				DEPTH TO ROCK
HARD	>40	20-40	<20	
SOFT	>20	<20	---	
4. DEPTH TO CEMENTED PAN (IN):				CEMENTED PAN
THICK	>40	20-40	<20	
THIN	>20	<20	---	
5. 2/SHRINK-SWELL	LOW	MODERATE	HIGH, VERY HIGH	SHRINK-SWELL
6. 5/, 9/, 10/AASHTO GROUP INDEX NUMBER	<5	5-8	>8	LOW STRENGTH
7. DEPTH TO HIGH WATER TABLE (FT)	---	---	+	PONDING
	>2.5	1.0-2.5	<1.0	WETNESS
8. SLOPE (PCT)	<8	8-15	>15	SLOPE
9. FLOODING	NONE	RARE	COMMON	FLOODING
10. POTENTIAL FROST ACTION	LOW	MODERATE	HIGH	FROST ACTION
11. 1/FRACTION >3 IN (WT PCT)	<25	25-50	>50	LARGE STONES
12. DOWNSLOPE MOVEMENT	---	---	II/	SLIPPAGE
13. FORMATION OF PITS	---	---	III/	PITTING
14. DIFFERENTIAL SETTLING	---	---	V/	UNSTABLE FILL

1/Weighted average to 40 inches.
2/If in kaolinitic family, rate one class better if experience confirms.
9/Thickest layer between 10 and 40 inches.
10/GIN=(P-35)[.2+.005(LL-40)]+.01(P-15)(PI-10) where P=% passing No. 200 sieve. If P≤35 and PI≥11, use only part 2 of equation. Use median values.
II/If the soil is susceptible to movement downslope when loaded, excavated, or wet, rate "SEVERE-SLIPPAGE."
III/If the soil is susceptible to the formation of pits caused by the melting of ground ice when the ground cover is removed, rate "SEVERE-PITTING."
V/If the soil is susceptible to differential settling, rate "SEVERE-UNSTABLE FILL."

From the National Soils Handbook, SCS, Part 603, Table 603-19, p. 603-79

AR0093

SOIL INTERPRETATIONS RECORD

MLRA(S): 116B, 116A
REV. LAQ, 7-83
TYPIC FRAGIUDULTS, FINE-SILTY, SILICEOUS, MESIC

CAPTINA SERIES
CLAYEY SUBSTRATUM

THIS IS A DEEP,NEARLY LEVEL THROUGH MODERATELY SLOPING,MODERATELY WELL DRAINED, SLOWLY PERMEABLE UPLAND OR TERRACE SOIL IN THE OZARK HIGHLANDS. THE SURFACE LAYER IS DARK BROWN SILT LOAM ABOUT 9 IN. THICK. THE UPPER PART OF THE SUBSOIL IS YELLOWISH BROWN SILT LOAM AND STRONG BROWN SILTY CLAY LOAM TO A DEPTH OF 24 INCHES. THE MIDDLE PART IS FIRM BRITTLE FRAGIPAN OF STRONG BROWN CHERTY SILTY CLAY LOAM AND MOTTLED LIGHT GRAY VERY CHERTY SILTY CLAY LOAM TO A DEPTH TO 44 IN. THE LOWER PART IS RED CLAY OR CHERTY CLAY TO A DEPTH OF 72 INCHES. SLOPES RANGE FROM 1 TO 12 PERCENT.

ESTIMATED SOIL PROPERTIES (A)

DEPTH (IN.)	USDA TEXTURE	UNIFIED	AASHTO	FRACT PERCENT OF MATERIAL LESS THAN 3" PASSING SIEVE NO. (PCT) 4	10	40	200	LIQUID LIMIT	PLASTICITY INDEX
0-8	SIL	ML, CL-ML	A-4	0	95-100	90-100	85-100	75-95	25	NP-7
8-24	SIL, SICL	CL-ML, CL	A-4, A-6	0	95-100	90-100	85-100	80-90	20-40	5-20
24-32	CR-SICL, CR-SIL	CL-ML, CL, GM-GC, GC	A-4, A-6	5-15	80-95	70-90	65-90	45-85	20-40	5-20
32-44	CRV-SICL, CRV-SIC	CL, GC, SC	A-6, A-7	5-45	60-95	55-90	45-90	40-85	30-50	15-30
44-72	C, SIC, CR-C	CL, CH	A-6, A-7	0-10	90-100	85-95	80-95	75-90	30-55	15-30

DEPTH (IN.)	CLAY (PCT)	MOIST BULK DENSITY (G/CM3)	PERMEABILITY (IN/HR)	AVAILABLE WATER CAPACITY (IN/IN)	SOIL REACTION (PH)	SALINITY (MMHOS/CM)	SHRINK-SWELL POTENTIAL	EROSION FACTORS K	EROSION FACTORS T	WIND EROD. GROUP	ORGANIC MATTER (PCT)	CORROSIVITY STEEL	CORROSIVITY CONCRETE
0-8	10-25	1.30-1.50	0.6-2.0	0.16-0.24	5.1-6.5	-	LOW	.43	4	-	1-2	HIGH	HIGH
8-24	20-35	1.30-1.50	0.6-2.0	0.16-0.24	5.1-6.5	-	LOW	.37	-	-	-		
24-32	25-40	1.40-1.60	0.06-0.2	0.04-0.08	3.6-5.5	-	LOW	.32	-	-	-		
32-44	35-45	1.40-1.60	0.06-0.2	0.02-0.08	3.6-5.5	-	MODERATE	.32					
44-72	40-55	1.20-1.40	0.06-0.2	0.05-0.10	3.6-5.5	-	MODERATE	.32					

FLOODING FREQUENCY	FLOODING DURATION	FLOODING MONTHS	HIGH WATER TABLE DEPTH (FT)	HIGH WATER TABLE KIND	HIGH WATER TABLE MONTHS	CEMENTED PAN DEPTH (IN)	CEMENTED PAN HARDNESS	BEDROCK DEPTH (IN)	BEDROCK HARDNESS	SUBSIDENCE INIT. (IN)	SUBSIDENCE TOTAL (IN)	HYD GRP	POTENT'L FROST ACTION
NONE			2.0-3.0	PERCHED	DEC-APR	-		60		-		C	-

SANITARY FACILITIES (B)

SEPTIC TANK ABSORPTION FIELDS	SEVERE-PERCS SLOWLY,WETNESS
SEWAGE LAGOON AREAS	1-2%: SLIGHT 2-7%: MODERATE-SLOPE 7+%: SEVERE-SLOPE
SANITARY LANDFILL (TRENCH)	SEVERE-TOO CLAYEY
SANITARY LANDFILL (AREA)	1-8%: MODERATE-WETNESS 8-12%: MODERATE-WETNESS,SLOPE
DAILY COVER FOR LANDFILL	POOR-TOO CLAYEY,HARD TO PACK

CONSTRUCTION MATERIAL (B)

ROADFILL	POOR-LOW STRENGTH,SHRINK-SWELL
SAND	IMPROBABLE-EXCESS FINES
GRAVEL	IMPROBABLE-EXCESS FINES
TOPSOIL	POOR-SMALL STONES

WATER MANAGEMENT

POND RESERVOIR AREA	SLIGHT

BUILDING SITE DEVELOPMENT (B)

SHALLOW EXCAVATIONS	1-8%: MODERATE-TOO CLAYEY,WETNESS 8+%: MODERATE-TOO CLAYEY,WETNESS,SLOPE
DWELLINGS WITHOUT BASEMENTS	1-8%: MODERATE-WETNESS 8-12%: MODERATE-SLOPE,WETNESS
DWELLINGS WITH BASEMENTS	SEVERE-SHRINK-SWELL,WETNESS
SMALL COMMERCIAL BUILDINGS	1-4%: MODERATE-WETNESS 4-8%: MODERATE-SLOPE,WETNESS 8+%: SEVERE-SLOPE
LOCAL ROADS AND STREETS	SEVERE-LOW STRENGTH
LAWNS, LANDSCAPING AND GOLF FAIRWAYS	1-8%: SLIGHT 8-12%: MODERATE-SLOPE

EMBANKMENTS DIKES AND LEVEES	MODERATE-HARD TO PACK,WETNESS
EXCAVATED PONDS AQUIFER FED	SEVERE-NO WATER
DRAINAGE	1-3%: PERCS SLOWLY 3+%: PERCS SLOWLY,SLOPE
IRRIGATION	1-3%: WETNESS,PERCS SLOWLY,ROOTING DEPTH 3+%: SLOPE,PERCS SLOWLY,ROOTING DEPTH
TERRACES AND DIVERSIONS	1-8%: ROOTING DEPTH,WETNESS,ERODES EASILY 8+%: SLOPE,ROOTING DEPTH,ERODES EASILY
GRASSED WATERWAYS	1-8%: ERODES EASILY,ROOTING DEPTH, PERCS SLOWLY 8+%: SLOPE,ERODES EASILY,ROOTING DEPTH

REGIONAL INTERPRETATIONS

ACTIVITY - 10 - Problem on Engineering Interpretations for Local Roads and Streets

An SCS-SOILS-5 form for the Midco series is shown on the next page. No restrictive feature of LOW STRENGTH is listed in the engineering interpretations for local roads and streets.

Use the AASHTO Group Index and the SCS criteria shown in Exhibit 2, Activity 9, to prove that this soil has a SLIGHT limitation for local roads and streets. You will need to calculate the Group Index Numbers.

If you have trouble with this problem, the answer is included. Compare your logic and computations.

M00108 S O I L I N T E R P R E T A T I O N S R E C O R D

MLRA(S): 116A, 116B
REV. WDB, 6-84
TYPIC UDIFLUVENTS, LOAMY-SKELETAL, SILICEOUS, NONACID, MESIC

MIDCO SERIES

THE MIDCO SERIES CONSISTS OF DEEP, SOMEWHAT EXCESSIVELY DRAINED SOILS FORMED IN RECENT CHERTY ALLUVIUM ON BOTTOM LANDS. THE SURFACE LAYER IS DARK BROWN CHERTY LOAM 8 INCHES THICK. THE SUBSTRATUM IS STRONG BROWN VERY CHERTY SANDY LOAM. SLOPES RANGE FROM 0 TO 4 PERCENT. MOST AREAS ARE USED FOR PASTURE AND HAYLAND.

ESTIMATED SOIL PROPERTIES

DEPTH (IN.)	USDA TEXTURE	UNIFIED	AASHTO	FRACT 3 IN (PCT)	PERCENT OF MATERIAL LESS THAN 3" PASSING SIEVE NO. 4	10	40	200	LIQUID LIMIT	PLASTICITY INDEX
0-8	CR-L, GRV-L, GR-L	SM, SM-SC, GM, GM-GC	A-4, A-2-4	5-20	60-80	45-75	40-70	30-49	>25	2-7
0-8	CR-SL, CRV-SL, GR-SL	SM, SM-SC, GM, GM-GC	A-2-4, A-1-B	5-20	60-80	45-75	25-45	15-30	20	NP-7
0-8	GR-SIL, CR-SIL	CL, CL-ML, ML	A-4	0-5	75-100	65-75	60-70	50-70	20-30	2-10
8-26	GR-L, CRV-L, CRV-SL	SM, SM-SC, GM, GM-GC	A-2-4, A-1-B	5-25	35-70	30-65	30-60	20-35	>25	2-7
26-60	SR-CR-L-CRX-S	GM, GP-GM, GM-GC, SM	A-1, A-2-4	5-30	15-70	10-60	10-50	5-30	<25	NP-5

DEPTH (IN.)	CLAY (PCT)	MOIST BULK DENSITY (G/CM3)	PERMEABILITY (IN/HR)	AVAILABLE WATER CAPACITY (IN/IN)	SOIL REACTION (PH)	SALINITY (MMHOS/CM)	SHRINK-SWELL POTENTIAL	EROSION FACTORS K	T	WIND EROD. GROUP	ORGANIC MATTER (PCT)	CORROSIVITY STEEL	CONCRETE
0-8	15-25	1.10-1.30	2.0-6.0	0.09-0.13	5.6-6.5	-	LOW	.24	4	8	.5-2	LOW	MODERATE
0-8	10-20	1.10-1.30	2.0-6.0	0.07-0.11	5.6-6.5	-	LOW	.24	4	8	.5-2		
0-8	15-25	1.10-1.30	2.0-6.0	0.09-0.13	5.6-6.5	-	LOW	.28	4	6	.5-2		
8-26	15-25	1.20-1.40	2.0-6.0	0.05-0.11	5.1-7.3	-	LOW	.24					
26-60	5-25	1.10-1.30	2.0-6.0	0.02-0.06	5.1-7.3	-	LOW	.24					

FLOODING FREQUENCY	FLOODING DURATION	FLOODING MONTHS	HIGH WATER TABLE DEPTH (FT)	HIGH WATER TABLE KIND	HIGH WATER TABLE MONTHS	CEMENTED PAN DEPTH (IN)	CEMENTED PAN HARDNESS	BEDROCK DEPTH (IN)	BEDROCK HARDNESS	SUBSIDENCE INIT. (IN)	SUBSIDENCE TOTAL (IN)	HYD GRP	POTENTIAL FROST ACTION
COMMON	V.BRIEF	NOV-APR	6.0			-		60		-		A	MODERATE

SANITARY FACILITIES

SEPTIC TANK ABSORPTION FIELDS	SEVERE-FLOODING
SEWAGE LAGOON AREAS	SEVERE-SEEPAGE,FLOODING
SANITARY LANDFILL (TRENCH)	SEVERE-FLOODING,SEEPAGE,TOO SANDY
SANITARY LANDFILL (AREA)	SEVERE-FLOODING,SEEPAGE
DAILY COVER FOR LANDFILL	POOR-SEEPAGE,TOO SANDY,SMALL STONES

CONSTRUCTION MATERIAL

ROADFILL	CR-SIL,GR-SIL: GOOD CR-L,CR-SL,GR-L,GR-SL: FAIR-LARGE STONES GRV,CRV: FAIR-LARGE STONES
SAND	PROBABLE
GRAVEL	PROBABLE
TOPSOIL	POOR-SMALL STONES,AREA RECLAIM

WATER MANAGEMENT

POND RESERVOIR AREA	SEVERE-SEEPAGE
EMBANKMENTS DIKES AND LEVEES	SEVERE-SEEPAGE
EXCAVATED PONDS AQUIFER FED	SEVERE-NO WATER
DRAINAGE	DEEP TO WATER
IRRIGATION	CR-SIL,GR-SIL: DROUGHTY,FLOODING CR-L,CR-CL,GR-L,GR-SL: DROUGHTY,FLOODING, LARGE STONES GRV,CRV: DROUGHTY,FLOODING,LARGE STONES
TERRACES AND DIVERSIONS	LARGE STONES,TOO SANDY
GRASSED WATERWAYS	LARGE STONES,DROUGHTY

BUILDING SITE DEVELOPMENT

SHALLOW EXCAVATIONS	SEVERE-CUTBANKS CAVE
DWELLINGS WITHOUT BASEMENTS	SEVERE-FLOODING
DWELLINGS WITH BASEMENTS	SEVERE-FLOODING
SMALL COMMERCIAL BUILDINGS	SEVERE-FLOODING
LOCAL ROADS AND STREETS	SEVERE-FLOODING
LAWNS, LANDSCAPING AND GOLF FAIRWAYS	OCCAS: SEVERE-DROUGHTY FREQ: SEVERE-DROUGHTY,FLOODING

REGIONAL INTERPRETATIONS

ACTIVITY 10 Computations

ACTIVITY 10 Solution to Problem

(1) Consider the thickest layer between 10 and 40 inches. Use the 8 to 26 inch layer.

(2) $F = \frac{20+35}{2} = \frac{55}{2} = 23$

(3) LL = $\geq$25 (Minimum LL possible is 16.)
Therefore, use 16 to 25.

$LL = \frac{16+25}{2} = \frac{41}{2} = 21$

(4) $PI = \frac{2+7}{2} = \frac{9}{2} = 4.5 = 5$

(5) GIN = (F-35)[0.2+0.005(LL-40)]+0.01(F-15)(PI-10)
GIN = (28.35)[0.2+0.005(21-40)]+0.01(28-15)(5-10)
GIN = -7 [0.2+0.005(-19)] +0.01(13)(-5)
GIN = -7 [0.2-0.095]-(0.65)
GIN = -7 (0.105]-0.65
GIN = -0.735-0.65
GIN = -1.385
GIN = 0

(6) A GIN of 0 indicates that this soil has a SLIGHT limitation for local roads and streets. The SCS-SOILS-5 for the Midco Series has no restrictive feature of LOW STRENGTH listed. Therefore, it would have a SLIGHT limitation because MODERATE and SEVERE ratings would need the LOW STRENGTH restrictive feature listed on the form.

ACTIVITY 11 - Criteria and Example Problem for Determining a Soil's Suitability for Roadfill

Exhibits 4 and 5 of this Activity contain a discussion of the properties that affect a soil's probable source as "roadfill," the definitions of applicable terms, and the criteria to determine the proper rating.

The criteria in Exhibit 5 lists nine properties to consider in rating soils for "roadfill." Property No. 5, AASHTO Group Index Number, is the only one of concern in this module. Note that the permissible limits for this property are good, fair, and poor. A "good" rating is given to soils with a GIN of less than 5, a "fair" rating for GIN of 5 to 8, and "poor" rating for a GIN greater than 8.

Evaluate the thickest layer between 10 and 60 inches and also the bottom layer. Choose the best rating obtained.

If a range of values is listed for the percent fines (F), liquid limit (LL), and the plasticity index (PI), use the median values for calculating the Group Index.

Group Index and the Group Index Number are the same.

If a "fair" or "poor" rating is given to a soil on the basis of GIN criteria, a restrictive feature of "low strength" is added. Example: FAIR - LOW STRENGTH

To illustrate the use of typical AASHTO Classification Captina Series (Exhibit 3, Activity 9). Again, using step-by-step procedure, determine the rating of this soil's suitability for use as roadfill.

(1) Consider both the thickest layer between 10 and 60 inches and the bottom layer. In the example, the layer between 44 and 72 inches is both the thickest layer between 10 and 60 inches and the bottom layer.

(2) The range for the percent fines (F) is from 75 to 90. The median value is 83.

(3) The range for liquid limit (LL) is from 30 to 55. The median value is 43.

(4) The range for plasticity index (PI) is from 15 to 30. The median value is 23.

(5) Calculate the GIN using the equation,

$$GIN = (F-35)[0.2+0.005(LL-40)]+0.01(F-15)(PI-10),$$

where $F = 83$
$LL = 43$
$PI = 23$

GIN = (83-35)[0.2+0.005(43-40)]+0.01(83-15)(23-10)
GIN = (48)[0.2+0.005(3)+0.01(68)(13)
GIN = (48)[0.2+0.015]+8.84
GIN = (48)[0.215]+8.84
GIN = 10.32+8.84=19.16
GIN = 19

(6) According to the criteria, a GIN greater than 8 would result in a poor rating. Therefore, 19 is greater than 8, and the Captina soil should be rated POOR - LOW STRENGTH as a source for roadfill.

(7) This agrees with the rating shown on the SCS-SOILS-5 for the Captina series, Exhibit 3 in Activity 9.

EXHIBIT 4

Part 603 - Application of Soil Information

603.03-3

§603.03-3 Construction material.

Soils are rated as sources for roadfill. Suitability ratings of good, fair, or poor are given for soils used as a source of roadfill.

(a) Roadfill. See table 603-21. Roadfill consists of soil material that is excavated from its original position and used in road embankments elsewhere. The evaluations for roadfill are for low embankments that generally are less than 6 feet in height and are less exacting in design than high embankments such as those along superhighways. The rating is given for the whole soil, from the surface to a depth of about 5 feet, based on the assumption that soil horizons will be mixed in loading, dumping, and spreading. Soils are rated as to the amount of material available for excavation, the ease of excavation, and how well the material performs after it is in place. Soil properties that affect the amount of material available for excavation are thickness of suitable material above bedrock or other material that is not suitable. The percent of coarse fragments more than 3 inches in diameter, the depth to a high water table, and the slope are properties that influence the ease of excavation. How well the soil performs in place is indicated by the AASHTO classification and group index and the shrink-swell potential. A high content of gypsum can cause piping or pitting. Some damage to the borrow area is expected, but if revegetation and erosion control are likely to be difficult, the soil is rated poor.

From the National Soil Handbook, SCS, Part 603, paragraph 603.03-3, p. 603-82, July 1983.

603-82

(430 VI-NH, July 1983)

EXHIBIT 5

Part 603 - Application of Soil Information

603.03-3(a)

PROPERTY	LIMITS			RESTRICTIVE FEATURE
	GOOD	FAIR	POOR	
1. USDA TEXTURE	—	—	ICE	PERMAFROST
2. DEPTH TO BEDROCK (IN)	>60	40-60	<40	DEPTH TO ROCK
3. DEPTH TO CEMENTED PAN (THICK) (IN)	>60	40-60	<40	CEMENTED PAN
4. 12/SHRINK-SWELL	LOW	MODERATE	HIGH, VERY HIGH	SHRINK-SWELL
5. 5/, 10/, 12/AASHTO GROUP INDEX NUMBER	<5	5-8	>8	LOW STRENGTH
6. LAYER THICKNESS (IN)	>60	30-60	<30	THIN LAYER
7. 1/FRACTION >3 IN (WT PCT)	<25	25-50	>50	LARGE STONES
8. DEPTH TO HIGH WATER TABLE (FT)	>3	1-3	<1	WETNESS
9. SLOPE (PCT)	<15	15-25	>25	SLOPE

1/Weighted average to 40 inches.

5/If in kaolinitic family, rate one class better if experience confirms.

10/GIN=(P-35)[.2+.005(LL-40)]+.01(P-15)(PI-10) where P=% passing No. 200 sieve. If P≤35 and PI≥11, use only part 2 of equation. Use median values.

12/Evaluate the thickest layer between 10 and 60 inches and also the bottom layer. Choose the best rating. When rating is based on bottom layer, verify thickness.

XVIII/If the content of gypsum is 10 to 15 percent, rate "FAIR-EXCESS GYPSUM." If it exceeds 15 percent, rate "POOR-EXCESS GYPSUM."

From the National Soils Handbook, SCS, Table 603-21, p.603-83, July 1983.

(430 - VI - NSH, July 1983)

ACTIVITY - 12 - Problem on Engineering Interpretations of Soils as a Source for Roadfill

SCS-SOILS-5 forms for the Bosket series and the Allemands series are shown on the next two pages. Prove that soil in the Bosket Series is a "good" source of material for use as "roadfill" and that soil in the Allemands series is a "poor" source. Use the AASHTO GIN and the SCS criteria in Exhibit 5 of Activity 11 in your solution. (For reference, answers are included after the SCS-SOILS-5 forms.

LA0035

SOIL INTERPRETATIONS RECORD

MLRA(S): 131, 151
REV. JLD, 8-84

ALLEMANDS SERIES

TERRIC MEDISAPRISTS, CLAYEY, MONTMORILLONITIC, EUIC, THERMIC

THE ALLEMANDS SERIES CONSISTS OF POORLY AND VERY POORLY DRAINED, VERY SLOWLY PERMEABLE SOILS. THEY HAVE A VERY DARK GRAY OR BLACK ORGANIC LAYER ABOUT 33 INCHES THICK OVER GRAY CLAY. THESE SOILS FORMED IN DECOMPOSED HERBACEOUS MATERIAL OVER CLAYS. SLOPE IS 0 TO 1 PERCENT.

ESTIMATED SOIL PROPERTIES

DEPTH (IN.)	USDA TEXTURE	UNIFIED	AASHTO	FRACT 3 IN (PCT)	PERCENT OF MATERIAL LESS THAN 3" PASSING SIEVE NO. 4	10	40	200	LIQUID LIMIT	PLASTICITY INDEX
0-9	MUCK, MK-PEAT	PT	A-8	0	-	-	-	-	-	-
9-33	MUCK	PT	A-8	0	-	-	-	-	-	-
33-50	C, MK-C	MH, OH	A-7-5	0	100	100	95-100	80-100	65-90	30-50
50-60	C, VFSL, SICL	CH, CL, ML, MH	A-7-6, A-6, A-4	0	100	100	85-95	75-95	30-75	6-45
-	-	-	-	-	-	-	-	-	-	-

DEPTH (IN.)	CLAY (PCT)	MOIST BULK DENSITY (G/CM3)	PERMEABILITY (IN/HR)	AVAILABLE WATER CAPACITY (IN/IN)	SOIL REACTION (PH)	SALINITY (MMHOS/CM)	SHRINK-SWELL POTENTIAL	EROSION FACTORS K	EROSION FACTORS T	WIND EROD. GROUP	ORGANIC MATTER (PCT)	CORROSIVITY STEEL	CORROSIVITY CONCRETE
0-9	-	0.05-0.25	2.0	0.20-0.50	5.1-7.8	4	LOW	-	-	-	30-85	HIGH	MODERATE
9-33	-	0.05-0.25	2.0	0.20-0.50	6.1-8.4	4	LOW	-	-	-			
33-50	60-95	0.15-1.00	0.06	0.14-0.18	6.1-8.4	4	VERY HIGH	.32	-	-			
50-60	20-95	0.25-1.00	0.6	0.12-0.18	6.1-8.4	4	HIGH	.37	-	-			
-	-	-	-	-	-	-	-	-	-	-			

FLOODING FREQUENCY	FLOODING DURATION	FLOODING MONTHS	HIGH WATER TABLE DEPTH (FT)	HIGH WATER TABLE KIND	HIGH WATER TABLE MONTHS	CEMENTED PAN DEPTH (IN)	CEMENTED PAN HARDNESS	BEDROCK DEPTH (IN)	BEDROCK HARDNESS	SUBSIDENCE INIT. (IN)	SUBSIDENCE TOTAL (IN)	HYD GRP	POTENT'L FROST ACTION
FREQUENT	V.LONG	JAN-DEC	+1-0.5	APPARENT	JAN-DEC	-		60		8-25	16-51	D	-

SANITARY FACILITIES (A)

SEPTIC TANK ABSORPTION FIELDS	SEVERE-FLOODING,PONDING,PERCS SLOWLY
SEWAGE LAGOON AREAS	SEVERE-FLOODING,SEEPAGE,EXCESS HUMUS
SANITARY LANDFILL (TRENCH)	SEVERE-FLOODING,PONDING,EXCESS HUMUS
SANITARY LANDFILL (AREA)	SEVERE-FLOODING,SEEPAGE,PONDING
DAILY COVER FOR LANDFILL	POOR-PONDING,EXCESS HUMUS

CONSTRUCTION MATERIAL (A)

ROADFILL	POOR-WETNESS
SAND	IMPROBABLE-EXCESS FINES
GRAVEL	IMPROBABLE-EXCESS FINES
TOPSOIL	POOR-EXCESS HUMUS,WETNESS

WATER MANAGEMENT (A)

POND RESERVOIR AREA	SEVERE-SEEPAGE
EMBANKMENTS DIKES AND LEVEES	SEVERE-SLOW REFILL
EXCAVATED PONDS AQUIFER FED	SLIGHT
DRAINAGE	FLOODING,PERCS SLOWLY,PONDING
IRRIGATION	FLOODING,PONDING,PERCS SLOWLY
TERRACES AND DIVERSIONS	PONDING
GRASSED WATERWAYS	WETNESS,PERCS SLOWLY

BUILDING SITE DEVELOPMENT (A)

SHALLOW EXCAVATIONS	SEVERE-EXCESS HUMUS,PONDING
DWELLINGS WITHOUT BASEMENTS	SEVERE-FLOODING,PONDING,LOW STRENGTH
DWELLINGS WITH BASEMENTS	SEVERE-FLOODING,PONDING
SMALL COMMERCIAL BUILDINGS	SEVERE-FLOODING,PONDING,LOW STRENGTH
LOCAL ROADS AND STREETS	SEVERE-FLOODING,PONDING
LAWNS, LANDSCAPING AND GOLF FAIRWAYS	SEVERE-FLOODING,PONDING,EXCESS HUMUS

REGIONAL INTERPRETATIONS

MLRA(S): 131
REV. WER, 9-83
MOLLIC HAPLUDALFS, FINE-LOAMY, MIXED, THERMIC

BOSKET SERIES

THIS IS A DEEP, LEVEL AND UNDULATING, WELL DRAINED, MODERATELY PERMEABLE SOIL DEVELOPED IN LOAMY SEDIMENTS OF THE SOUTHERN MISSISSIPPI VALLEY. THE SURFACE LAYER IS DARK BROWN AND THE SUBSURFACE LAYER IS DARK YELLOWISH BROWN FINE SANDY LOAM ABOUT 18 INCHES THICK. THE SUBSOIL IS BROWN AND DARK YELLOWISH BROWN SANDY CLAY LOAM ABOUT 16 INCHES THICK. THE UNDERLYING MATERIAL IS DARK YELLOWISH BROWN FINE SANDY LOAM. SLOPES RANGE FROM 0 TO 14 PERCENT.

ESTIMATED SOIL PROPERTIES (A)

DEPTH (IN.)	USDA TEXTURE	UNIFIED	AASHTO	FRACT 3 IN (PCT)	PERCENT OF MATERIAL LESS THAN 3" PASSING SIEVE NO. 4	10	40	200	LIQUID LIMIT	PLASTICITY INDEX
0-18	FSL, SL	SM	A-2, A-4	0	100	100	75-100	25-45	20	NP-3
18-34	SCL, CL, SL	SC, SM-SC, CL, CL-ML	A-2, A-4, A-6	0	100	100	85-100	30-70	25-40	5-17
34-48	FSL, SL	SM	A-2, A-4	0	100	100	75-100	25-45	>20	NP-3
48-60	FSL, SL, S	SM	A-2, A-4	0	100	100	65-100	15-45	>20	NP-3

DEPTH (IN.)	CLAY (PCT)	MOIST BULK DENSITY (G/CM3)	PERMEABILITY (IN/HR)	AVAILABLE WATER CAPACITY (IN/IN)	SOIL REACTION (PH)	SALINITY (MMHOS/CM)	SHRINK-SWELL POTENTIAL	EROSION FACTORS K	EROSION FACTORS T	WIND EROD. GROUP	ORGANIC MATTER (PCT)	CORROSIVITY STEEL	CORROSIVITY CONCRETE
0-18	5-15	1.30-1.50	2.0-6.0	0.10-0.15	5.1-6.5	-	LOW	.24	5	-	.5-2	LOW	MODERATE
18-34	18-30	1.25-1.50	0.6-2.0	0.10-0.20	5.1-6.5	-	LOW	.32	-	-	-		
34-48	8-15	1.30-1.50	2.0-6.0	0.10-0.15	5.1-6.5	-	LOW	.32					
48-60	4-15	1.30-1.60	2.0	0.02-0.15	5.1-6.5	-	LOW	.24					

FLOODING FREQUENCY	FLOODING DURATION	FLOODING MONTHS	HIGH WATER TABLE DEPTH (FT)	HIGH WATER TABLE KIND	HIGH WATER TABLE MONTHS	CEMENTED PAN DEPTH (IN)	CEMENTED PAN HARDNESS	BEDROCK DEPTH (IN)	BEDROCK HARDNESS	SUBSIDENCE INIT. (IN)	SUBSIDENCE TOTAL (IN)	HYD GRP	POTENT'L FROST ACTION
NONE-RARE			6.0			-		60		-		B	-

SANITARY FACILITIES (B)

SEPTIC TANK ABSORPTION FIELDS 1	SEVERE-POOR FILTER
SEWAGE LAGOON AREAS 1	0-7% NONE: SEVERE-SEEPAGE 7+% NONE: SEVERE-SEEPAGE,SLOPE 0-7% RARE: SEVERE-SEEPAGE,FLOODING 7+% RARE: SEVERE-SEEPAGE,FLOODING,SLOPE
SANITARY LANDFILL (TRENCH)	SEVERE-SEEPAGE
SANITARY LANDFILL (AREA)	SEVERE-SEEPAGE
DAILY COVER FOR LANDFILL	0-8%: GOOD 8-14%: FAIR-SLOPE

CONSTRUCTION MATERIAL (B)

ROADFILL	GOOD
SAND	IMPROBABLE-EXCESS FINES
GRAVEL	IMPROBABLE-EXCESS FINES
TOPSOIL	0-8%: GOOD 8-14%: FAIR-SLOPE

WATER MANAGEMENT (B)

POND RESERVOIR AREA	SEVERE-SEEPAGE
EMBANKMENTS DIKES AND LEVEES	SEVERE-PIPING
EXCAVATED PONDS AQUIFER FED	SEVERE-NO WATER
DRAINAGE	DEEP TO WATER
IRRIGATION	0-3%: FAVORABLE 3+%: SLOPE
TERRACES AND DIVERSIONS	0-8%: FAVORABLE 8+%: SLOPE
GRASSED WATERWAYS	0-8%: FAVORABLE 8+%: SLOPE

BUILDING SITE DEVELOPMENT (B)

SHALLOW EXCAVATIONS	SEVERE-CUTBANKS CAVE
DWELLINGS WITHOUT BASEMENTS	0-8% NONE: SLIGHT 8-14% NONE: MODERATE-SLOPE RARE: SEVERE-FLOODING
DWELLINGS WITH BASEMENTS	0-8% NONE: SLIGHT 8-14% NONE: MODERATE-SLOPE RARE: SEVERE-FLOODING
SMALL COMMERCIAL BUILDINGS	0-4% NONE: SLIGHT 4-8% NONE: MODERATE-SLOPE 8+% NONE: SEVERE-SLOPE 0-8% RARE: SEVERE-FLOODING 8+% RARE: SEVERE-FLOODING,SLOPE
LOCAL ROADS AND STREETS	0-8% NONE: SLIGHT 8-14% NONE: MODERATE-SLOPE 0-8% RARE: MODERATE-FLOODING 8-14% RARE: MODERATE-FLOODING,SLOPE
LAWNS, LANDSCAPING AND GOLF FAIRWAYS	0-8%: SLIGHT 8-14%: MODERATE-SLOPE

REGIONAL INTERPRETATIONS

ACTIVITY 12 - Solution to Roadfill Suitability Problem for Bosket Series

(1) The thickest layer between 10 and 60 inches is the 18 to 34 inch layer. Also use the bottom layer that is from 48 to 60 inches. Work with the 18 to 34 inch layer first.

(2) The median value for F is $\frac{30+70}{2} = \frac{100}{2} = 50.$

(3) The median value for LL is $\frac{25+40}{2} = \frac{65}{2} = 32.5 = 33$

(4) The median value for PI is $\frac{5+17}{2} = \frac{22}{2} = 11$

(5) The GIN = (50-35)[0.2+0.005(33-40)]+0.01(50-15)(11-10)
GIN = (15)[0.2+0.005(-7)]+0.01(35)(1)
GIN = (15)[0.2-0.035]+0.35
GIN = (15)[0.165]+0.35
GIN = 2.475+0.35 = 2.825
GIN = 3

(6) The GIN value obtained is 3 which is less than 5. Therefore the Bosket series would be a GOOD source of material to use as roadfill. By only considering the 18 to 34 inch layer in the calculations, a rating of GOOD is obtained. Therefore, checking the bottom layer from 48 to 60 inch is not necessary. This reasoning is valid because one is to pick the best rating of the two depths, and GOOD is the best rating possible.

ACTIVITY 12 - Solution to Roadfill Suitability Problem for Allemands Series

(1) The thickest layer between 10 and 60 inch is the 0 to 33 inch layer. The bottom layer is 50 to 60 inches. Work with the top layer first.

(2) The 0 to 33 inch layer is classified as a Peat or A-8 in the AASHTO System. A-8 soils are completely unsuitable for roadfill.

(3) Let's now look at the 50- to 60-inch layer.

(4) The median value for F is $\frac{75+95}{2} = \frac{178}{2} = 85$

(5) The median value for LL is $\frac{30+75}{2} = \frac{105}{2} = 53$

(6) The median value for PI is $\frac{6+45}{2} = \frac{51}{2} = 26$

(7) The GIN = (85-35)[0.2+0.005(53-40)]+0.01(-85-15)(26-10)
GIN = (50)[0.2+0.005(13)]+0.01(70)(16)
GIN = (50)[0.2+0.065]+11.2
GIN = (50)[0.265]+11.2
GIN = 13.25+11.2=24.45
GIN = 25

(8) The compute GIN of 25 is greater than 8. Therefore, the rating for this depth is POOR-LOW STRENGTH.

(9) This is the rating shown on the SCS-SOILS-5 for the Allemands series for roadfill.

SOIL MECHANICS - LEVEL I

MODULE 2

AASHTO CLASSIFICATION SYSTEM

APPENDIX 1

REFERENCES

REFERENCES

1. Glossary, Symbols, Abbreviations and Conversion Factors, Soil Mechanics Note 6, Soil Conservation Service, U.S. Department of Agriculture, March 1976.

2. Recommended Practice for the Classification of Soils and Soil-Aggregate Mixtures for Highway Construction Purposes, AASHTO Designation: M145-82, American Association of State Highway and Transportation Officials, 1983.

SOIL MECHANICS - LEVEL I

MODULE 2

AASHTO CLASSIFICATION SYSTEM

APPENDIX 2

AASHTO: M 145-82

The Classification of Soils and Soils Aggregate

Mixture for Highway Construction Program

Recommended Practice for

The Classification of Soils and Soil-Aggregate Mixtures for Highway Construction Purposes

AASHTO DESIGNATION: M 145-82

1. SCOPE

1.1 This recommended practice describes a procedure for classifying soils into seven groups based on laboratory determination of particle-size distribution, liquid limit and plasticity index. Evaluation of soils within each group is made by means of a "group index," which is a value calculated from an empirical formula. The group classification including group index, should be useful in determining the relative quality of the soil material for use in earthwork structures, particularly embankments, subgrades, subbases and bases. However, for the detailed design of important structures additional data concerning strength or performance characteristics of the soil under field conditions will usually be required.

2. TEST PROCEDURES

2.1 The classification is based on the results of tests made in accordance with the following standard methods of AASHTO:

2.1.1	Amount of Material Finer Than 0.075 mm (No. 200) Sieve in Aggregate	T 11
2.1.2	Sieve Analysis of Fine and Coarse Aggregates	T 27
2.1.3	Dry Preparation of Disturbed Soil and Soil Aggregate Samples for Test	T 87
2.1.4	Mechanical Analysis of Soils	T 88
2.1.5	Determining the Liquid Limit of Soils	T 89
2.1.6	Determining the Plastic Limit and Plasticity Index of Soils	T 90
2.1.7	Wet Preparation of Disturbed Soil Samples for Test	T146

NOTE 1. Either Method T 88 or Methods T 11 and T 27 will be used to determine the particle-size distribution as a basis for classification.

3. CLASSIFICATION

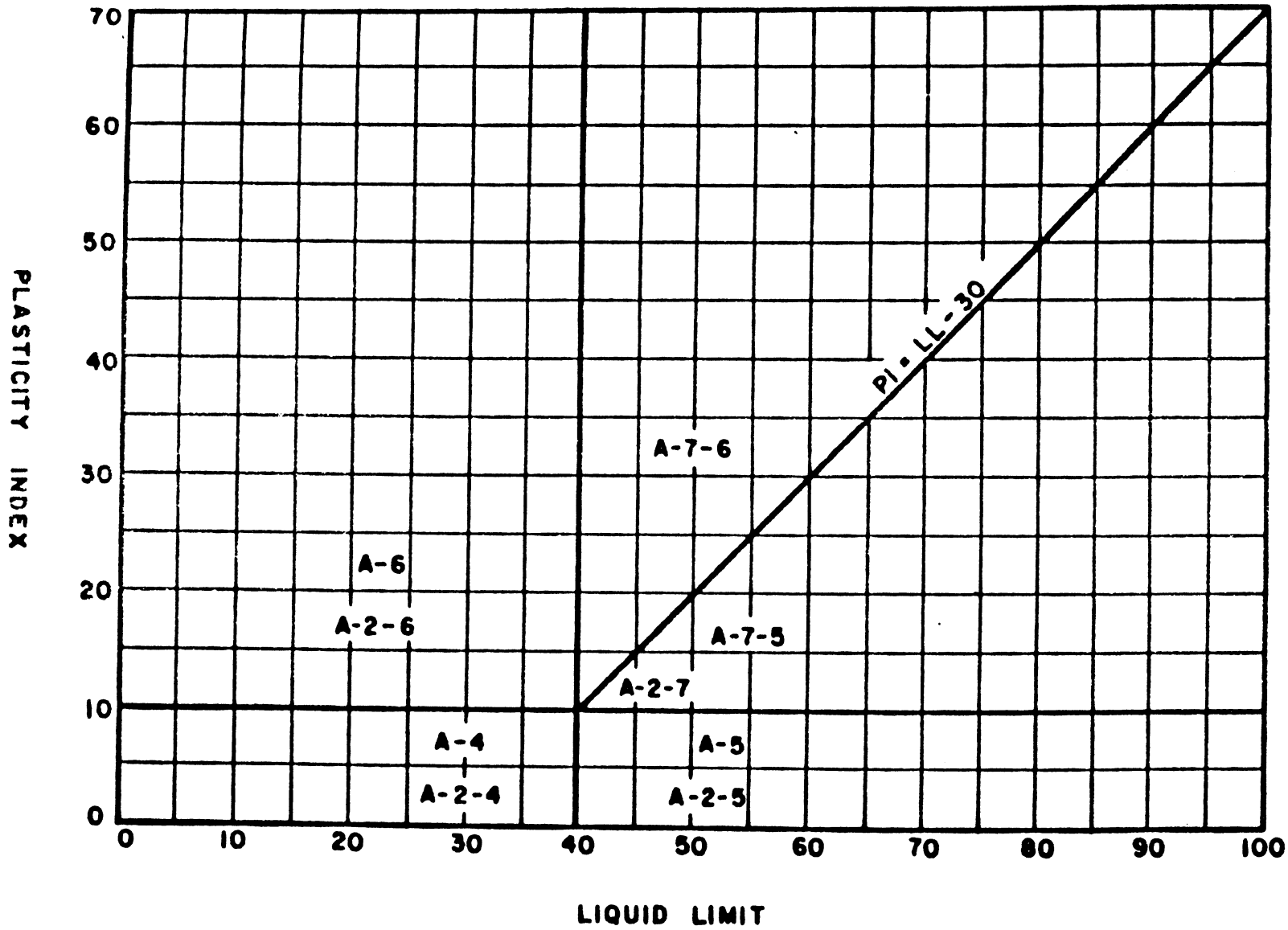
3.1 The classification is made by using the test limits and group index values shown in Table 1. If a more detailed classification is desired, a further subdivision of the groups shown in Table 1 may be made. An example of the classification with such subgroups is shown in Table 1 may be made. An example of the classification with such subgroups is shown in Table 2. The liquid limit and plasticity index ranges for the A-4, A-5, A-6, and A-7 soil groups are shown graphically in Figure 2.

3.2 *Classification Procedure.*—With required test data available, proceed from left to right in Table 1 or Table 2 and the correct group will be found by process of elimination. The first group from the left into which the test data will fit is the correct classification. All limiting test values are shown as whole number. If fractional numbers appear on test reports, convert to nearest whole number for purposes of classification. Group index values should always be shown in parentheses after group symbol as: A-2-6(3), A-4(5), A-6(12), A-7-5(17), etc.

4. DEFINITIONS OF GRAVEL, SAND, AND SILT-CLAY

4.1 The terms "gravel," "coarse sand," and "silt-clay," as determinable from the minimum test data required in this classification arrangement and as used in subsequent word descriptions, are defined as follows:

4.1.1 *Gravel.*—Material passing sieve with 75 mm (3-in.) square openings and retained on the 2.00 mm (No. 10) sieve.



NOTE—A-2 soils contain less than 35 % finer than 200 sieve.

FIG. 2 Liquid Limit and Plasticity Index Ranges for Silt-Clay Materials.

TABLE 1
Classification of Soils and Soil-Aggregate Mixtures

General Classification	Granular Materials (35% or less passing 0.075 mm)			Silt-Clay Materials (More than 35% passing 0.075 mm)			
Group Classification	A-1	A-3[a]	A-2	A-4	A-5	A-6	A-7
Sieve Analysis, Percent passing							
2.00 mm (No. 10)	50 max.	51 min.	....	....	....	....	....
0.425 mm (No. 40)	25 max.	10 max.	35 max.	36 min.	36 min.	36 min.	36 min.
0.075 mm (No. 200)							
Characteristics of Fraction passing 0.425 mm (No. 40)							
Liquid limit	6 max.	N.P.	[b]	40 max.	41 min.	40 max.	41 min.
Plasticity index				10 max.	10 max.	11 min.	11 min.
General Rating as Subgrade	Excellent to Good			Fair to Poor			

[a] The placing of A-3 before A-2 is necessary in the "left to right elimination process" and does not indicate superiority of A-3 over A-2.
[b] See Table 2 for values

TABLE 2
Classification of Soils and Soil-Aggregate Mixtures

General Classification	Granular Materials (35% or less passing 0.075 mm)							Silt-Clay Materials (More than 35% passing 0.075 mm)			
	A-1			A-2							A-7
Group Classification	A-1-a	A-1-b	A-3	A-2-4	A-2-5	A-2-6	A-2-7	A-4	A-5	A-6	A-7-5, A-7-6
Sieve Analysis, Percent passing											
2.00 mm (No. 10)	50 max.			....	....	....	....	....	....	....	....
0.425 mm (No. 40)	30 max.	50 max.	51 min.								
0.075 mm (No. 200)	15 max.	25 max.	10 max.	35 max.	35 max.	35 max.	35 max.	36 min.	36 min.	36 min.	36 min.
Characteristics of Fraction passing 0.425 mm (No. 40)											
Liquid limit	6 max.		N.P.	40 max.	41 min.	40 max.	41 min.	40 max.	41 min.	40 max.	41 min.
Plasticity index				10 max.	10 max.	11 min.	11 min.	10 max.	10 max.	11 min.	11 min.[a]
Usual Types of Significant Constituent Materials	Stone Fragments, Gravel and Sand		Fine Sand	Silty or Clayey Gravel and Sand				Silty Soils		Clayey Soils	
General Rating as Subgrade	Excellent to Good							Fair to Poor			

[a] Plasticity index of A-7-5 subgroup is equal to or less than L.L. minus 30. Plasticity index of A-7-6 subgroup is greater than L.L. minus 30 (see Figure 2)

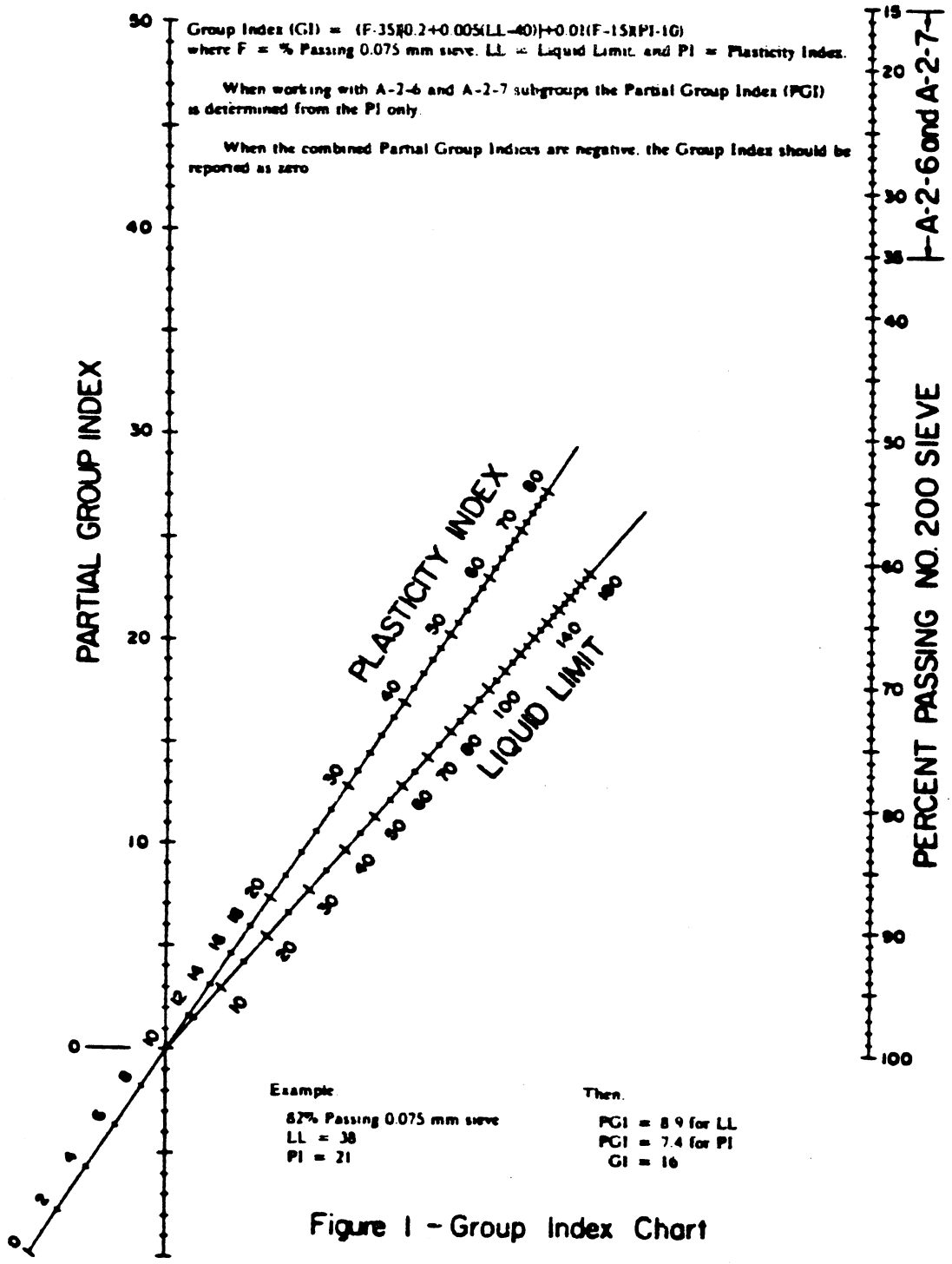


Figure 1 - Group Index Chart

4.1.2 *Coarse Sand.*—Material passing the 2.00 mm (No. 10) sieve and retained on the 0.425 mm (No. 40) sieve.

4.1.3 *Fine Sand.*—Material passing the 0.425 mm (No. 40) sieve and retained on the 0.075 mm (No. 200) sieve.

4.1.4 *Silt Clay (Combined silt and clay).*—Material passing the 0.075 mm (No. 200) sieve.

4.1.5 Boulders (retained on 75 mm (3 in.) sieve) should be excluded from the portion of the sample to which the classification is applied, but the percentage of such material, if any, in the sample should be recorded.

4.1.6 The term "silty" is applied to fine material having plasticity index of 10 or less and the term "clayey" is applied to fine material having plasticity index of 11 or greater.

5. DESCRIPTION OF CLASSIFICATION GROUPS

5.1 *Granular Materials.*—Containing 35 percent or less passing 0.075 mm (No. 200) sieve, Note 2.

5.1.1 *Group A-1.*—The typical material of this group is a well-graded mixture of stone fragments or gravel, coarse sand, fine sand and a nonplastic or feebly plastic soil binder. However, this group includes also stone fragments, gravel, coarse sand, volcanic cinders, etc. without soil binder.

5.1.1.1 Subgroup A-1-a includes those materials consisting predominantly of stone fragments or gravel, either with or without a well-graded binder of fine material.

5.1.1.2 Subgroup A-1-b includes those materials consisting predominantly of coarse sand either with or without a well-graded soil binder.

5.1.2 *Group A-3.*—The typical material of this group is fine beach sand or fine desert blow sand without silty or clay fines or with a very small amount of nonplastic silt. The group includes also stream-deposited mixtures of poorly-graded fine sand and limited amounts of coarse sand and gravel.

5.1.3 *Group A-2.*—This group includes a wide variety of "granular" materials which are border-line between the materials falling in Groups A-1 and A-3 and silt-clay materials of Groups A-4, A-5, A-6, and A-7. It includes all materials containing 35 percent or less passing the 0.075 mm (No. 200) sieve which cannot be classified as A-1 or A-3, due to fines content or plasticity or both, in excess of the limitations for those groups.

5.1.3.1 Subgroups A-2-4 and A-2-5 include various granular materials containing 35 percent or less passing the 0.075 mm (No. 200) sieve and with a minus 0.425 mm (No. 40) portion having the characteristics of the A-4 and A-5 groups. These groups include such materials as gravel and coarse sand with silt contents or plasticity indexes in excess of the limitations of Group A-1, and fine sand with nonplastic silt content in excess of the limitations of Group A-3.

5.1.3.2 Subgroups A-2-6 and A-2-7 include materials similar to those described under Subgroups A-2-4 and A-2-5 except that the fine portion contains plastic clay having the characteristics of the A-6 or A-7 group.

NOTE 2: Classification of materials in the various groups applies only to the fraction passing the 75 mm sieve. Therefore, any specification regarding the use of A-1, A-2, or A-3 materials in construction should state whether boulders (retained on 3-in. sieve) are permitted.

5.2 *Silt-Clay Materials.*—Containing more than 35 percent passing the 0.075 mm (No. 200) sieve.

5.2.1 *Group A-4.*—The typical material of this group is a nonplastic or moderately plastic silty soil usually having the 75 percent or more passing the 0.075 mm (No. 200) sieve. The group includes also mixtures of fine silty soil and up to 64 percent of sand and gravel retained on 0.075 mm (No. 200) sieve.

5.2.2 *Group A-5.*—The typical material of this group is similar to that described under Group A-4, except that it is usually of diatomaceous or micaceous character and may be highly elastic as indicated by the high liquid limit.

5.2.3 *Group A-6.*—The typical material of this group is a plastic clay soil usually having 75 percent or more passing the 0.075 mm (No. 200) sieve. The group includes also mixtures of fine clayey soil and up to 64 percent of sand and gravel retained on the 0.075 mm (No. 200) sieve. Materials of this group usually have high volume change between wet and dry states.

5.2.4 *Group A-7.*—The typical material of this group is similar to that described under Group A-6, except that it has the high liquid limits characteristic of the A-5 group and may be elastic as well as subject to high volume change.

5.2.4.1 Subgroup A-7-5 includes those materials with moderate plasticity indexes in relation to liquid limit and which may be highly elastic as well as subject to considerable volume change.

5.2.4.2 Subgroup A-7-6 includes those materials with high plasticity indexes in relation to liquid limit and which are subject to extremely high volume change.

Note 3 Highly organic soils (peat or muck) may be classified in an A-8 group. Classification of these materials is based on visual inspection, and is not dependent on percentage passing the 0.075 mm (No. 200) sieve, liquid limit or plasticity index. The material is composed primarily of partially decayed organic matter, generally has a fibrous texture, dark brown or black color and odor of decay. These organic materials are unsuitable for use in embankments and subgrades. They are highly compressible and have low strength.

6. GROUP INDEX

6.1 The group index is calculated from the following formula:

Group index = (F-35) [0.2 + 0.005 (LL-40)] + 0.01 (F-15) (PI-10), in which

F = percentage passing 0.075 mm (No. 200) sieve, expressed as a whole number. This percentage is based only on the material passing the 75 mm (3 in.) sieve.

LL = liquid limit

PI = plasticity index

6.1.1 When the calculated group index is negative, the group index shall be reported as zero (0).

6.1.2 The group index should be reported to the nearest whole number.

6.2 Figure 1 may be used in estimating the group index, by determining the partial group index due to liquid limit and that due to plasticity index, then obtaining the total of the two partial group indexes.

6.3 When calculating the group index of A-2-6 and A-2-7 subgroups, only the PI portion of the formula (or of Figure 1) shall be used.

6.4 The following are examples of calculations of the group index:

6.4.1 Assume that an A-6 material has 55 percent passing the 0.075 mm (No. 200) sieve, liquid limit of 40, and plasticity index of 25. Then

Group index = (55-35) [0.2 + 0.005 (40-40)] + 0.01 (55-15) (25-10)
= 4.0 + 6.0 = 10

6.4.2 Assume that an A-7 material has 80 percent passing the 0.075 mm (No. 200) sieve, liquid limit of 90, and plasticity index of 50. Then,

Group index = (80-35) [0.2 + 0.005 (90-40)] + 0.01 (80-15) (50-10)
= 20.3 + 26.0, or 46.3

6.4.3 Assume that an A-4 material has 60 percent passing the 0.075 mm (No. 200) sieve, liquid limit of 25, and plasticity index of 1. Then

Group index = (60-35) [0.2 + 0.005 (25-40)] + 0.01 (60-15) (1-10)
= 25 X (0.2 — 0.075) + 0.01 (45) (—9)
= 3.1 — 4.1 = —1.0 Report as 0

6.4.4 Assume that an A-2-7 material has 30 percent passing the 0.075 mm (No. 200) sieve, liquid limit of 50, and plasticity index of 30. Then

Group index = 0.01 (30-15) (30-10)
= 3.0 or 3 (Note that only the PI portion of formula was used)

7. BASIS FOR GROUP INDEX FORMULA

7.1 The empirical group index formula devised for approximately within-group evaluation of the "clayey granular materials" and the "silt-clay materials" is based on the following assumptions:

7.1.1 Materials falling within Groups A-1-a, A-1-b, A-2-4, A-2-5, and A-3 are satisfactory as

subgrade when properly drained and compacted under moderate thickness pavement (base and/or surface course) of a type suitable for the traffic to be carried, or can be made satisfactory by additions of small amounts of natural or artificial binders.

7.1.2 Materials falling within the "clayey granular" Groups A-2-6 and A-2-7 and the "silt-clay" Groups A-4, A-5, A-6, and A-7 will range in quality as subgrade from the approximate equivalent of the good A-2-4 and A-2-5 subgrades to fair and poor subgrades requiring a layer of subbase material or an increased thickness of base course over that required under 7.1.1 in order to furnish adequate support for traffic loads.

7.1.3 The assumed critical minimum percentage passing the 0.075 mm (No. 200) sieve is 35 neglecting plasticity, and 15 as affected by plasticity indexes greater than 10.

7.1.4 Liquid limits of 40 and above are assumed to be critical.

7.1.5 Plasticity indexes of 10 and above are assumed to be critical.

7.1.6 For soils that are non-plastic and when the liquid limit cannot be determined, the group index shall be considered zero (0).

7.2 There is no upper limit of group index value obtained by use of the formula. The adopted critical values of percentage passing the 0.075 mm (No. 200) sieve, liquid limit and plasticity index, are based on an evaluation of subgrade, subbase and base course materials by several highway organizations that use the tests involved in this classification system.

7.3 Under average conditions of good drainage and thorough compaction, the supporting value of a material as subgrade may be assumed as an inverse ratio to its group index, that is, a group index of 0 indicates a "good" subgrade material and group index of 20 or greater indicates a "very poor" subgrade material.

SOIL MECHANICS - LEVEL I

MODULE 2

AASHTO CLASSIFICATION SYSTEM

STORYBOARD

Module 2
The AASHTO Soil Classification System

(1)

This module describes the soil classification system developed by the American Association of State Highway and Transportation Officials.

Slide of highway interchange

(2)

It is applicable to the classification of soils used in the construction of roads, streets and highways. The original purpose of the system was to evaluate soils on the basis of their capability to support vehicular traffic. This system was formerly known as the AASHO System.

Objectives:
1. Write definitions for terms.

(3)

Upon completion of this module you will be able to accomplish the following objectives.
Objective number
1. Write definitions for terms used in the AASHTO Classification System.

Objectives:
1. Write definitions for terms.
2. Classify soils.

(4)

Objective number
2. Using lab data and the AASHTO flow chart, correctly classify soils.

Objectives:
1. Write definitions for terms.
2. Classify soils.
3. Explain engineering interpretations.

(5)

Objective number
3. Explain the engineering interpretations for "local roads and streets" and "roadfill". These interpretations are listed on form SCS-SOILS-5 and in soil survey publications. The explanation must be based on the AASHTO classification criteria and guidelines adopted by the Soil Conservation Service. These objectives are also listed in your Study Guide in Activity 1.

Common terms

(6)

Many terms are common to more than one classification system. Such terms are listed in Activity 2 of your Study Guide. Pause and review these common terms before proceeding. Press the pause button to stop the tape. When you are ready to continue, release the pause button to start the tape.

"Unique" terms for AASHTO

(7)

There are several terms unique to the AASHTO Classification System. The first of these is gravel.

3"
Gravel
#10
(8)

Gravels are soil particles that are finer than 3 inches in diameter and retained on a number 10 sieve. If a 3 inch sieve is stacked on top of a number 10 sieve and soil material passed through the top, the materials retained on the number 10 sieve are gravels.

#10
Sand
#200
(9)

Sands are soil particles finer than the number 10 sieve but retained on a number 200 sieve. Sands are subdivided into coarse and fine fractions.

#10
Coarse sand #40
#200
(10)

Coarse sands are soil particles finer than a number 10 sieve and retained on a number 40 sieve.

#10
#40 Fine sand
#200
(11)

Fine sands are soil particles finer than a number 40 sieve and retained on a number 200 sieve.

FINES ("F")
(12)

Fines are soil particles that are finer than a number 200 sieve. The percent of fines is denoted as "F." Fines are often referred to as "binder" when using the AASHTO Classification System.

SILTY
(Plasticity index of 10 or less)
(13)

Silty is a term applied to "fines" that have a plasticity index of 10 or less. Plasticity index is abbreviated as PI.

CLAYEY
(Plasticity index greater than 10)
(14)

Clayey is a term applied to "fines" that have a plasticity index greater than 10.

Subgrade
(15)

Subgrade is the material upon which a road, street or highway is constructed. It may be either insitu material or fill material.

Base Sub-base (16)	Base and sub-base are the materials placed on a subgrade as a supporting medium for improved roads, streets, and highways.
Granular Materials #200 35% or less (17)	Granular materials have 35 percent or less of the soil particles finer than a number 200 sieve.
Silt-clay (18)	Silt-clay materials have more than 35 percent of the soil finer than a number 200 sieve.
Group Index ("GI") GI = (F-35) [0.2+0.005(LL-40)] +0.01(F-15)(PI-10) (19)	Group index is an empirical relationship used to categorize the load carrying capacity of a soil. The index is based on the percent fines, liquid limit, and and plasticity index. It is calculated using this equation where: GI = Group Index, F = Percent Fines, LL = Liquid Limit, and PI = Plasticity Index. When the group index is calculated as a negative, it is reported as zero.
Partial Group Index (PGI) PGI= .01 (F-15) (PI-10) (20)	Partial group index is calculated for certain soils from the portion of the group index equation that is based only on the percen fines and the plasticity index. Negative partial group index values are reported as zero. Both the group index and the partial group index are used to compare the load carrying ability of soils within the same AASHTO class. They should not be used to compare the load carrying ability of soils in different AASHTO classes.
STOP! Do Activity 3 (21)	Press the pause button to stop the tape and complete Activity 3 in your Student Guide.
AASHTO Standard M-145-82 (22)	This classification system is described in AASHTO Standard M-145-82. A copy of this standard is in the appendix of your Study Guide.
Classification Groups A-1 = Best A-8 = Worst (23)	Classification groups range from A-1 to A-8. Group A-1 is the best material for supporting traffic loads and group A-8 is the worst.

Classification Groups
A-1 thru A-3 = granular
A-4 thru A-7 = silt/clay
A-8 = Peat or muck
(24)

Groups A-1 through A-3 are granular materials. Group A-4 through A-7 are silt/clay materials. Peats and mucks are classified as group A-8 and are unsuitable for supporting traffic.

AASHTO Flow Chart
(25)

The heart of the AASHTO Classification System is the flow chart shown in Activity 4 of the Study Guide. This flow chart is also listed as Table 2 in AASHTO Standard M-145-82 located in the appendix of your study guide. Press the pause button to stop the tape and locate the flow chart in Activity 4. When you are ready, release the pause button to continue.

Required Lab Data
1. Sieve analysis
2. Liquid limit
3. Plasticity Index
(26)

Laboratory data consisting of sieve analysis, liquid limit, and plasticity index are required to use the flow chart.
The flow chart is read from left to right until the data meets the criteria in a column headed by a group or subgroup. That column is the group or subgroup that properly classifies the soil. Pause now and review Activity 4.

Sieve Analysis

Sieve	Passing %
#10	89
#40	69
#200	42

(27)

Let's work an example problem! A soils laboratory has supplied the following sieve analysis data. Percent passing the number 10 sieve is 89. Percent passing the number 40 sieve is 69. Percent passing the number 200 sieve is 42.

Atterberg Limits
LL = 43
PL = 24
PI = LL - PL
= 19
(28)

The liquid limit of the soil is 43. The plastic limit is 24 and the plasticity index is 19.

Flow chart with silt-clay material highlighted
(29)

Now let's classify the soil. Refer to the flow chart. Step 1 - At the top of the flow chart, classify the soil either as granular or silt-clay. Remember that a silt-clay material has more than 35 percent passing the number 200 sieve. Because the soil has 42 percent passing the number 200 sieve, it is silt-clay material.

Slide of flow chart with A-4, A-5, A-6, A-7-5, A-7-6 groups highlighted
(30)

As a silt-clay material, there are only 5 possible classifications. These are A-4, A-5, A-6, A-7-5, and A-7-6.

Slide of flow chart with sieve analysis criteria for A-4, A-5, A-6, A-7-5, and A-7-6 groups highlighted
(31)

Step 2. Working from left to right in the flow chart, check group A-4 sieve analysis requirements. There are no requirements for the number 10 and number 40 sieves. Because 42 percent of the soil passes the number 200 sieve, the requirement is met. Note that the sieve analysis requirements for A-4 and all the groups to the right have been met and you need not check these again. Step 3.

Slide of Flow Chart with LL for A-4 highlighted
(32)

Step 3. Check the liquid limit requirement for group A-4. The maximum allowable liquid limit is 40. This soil has a liquid limit of 43. Because the liquid limit requirement is not met, move to the next column to the right and check group A-5.

Show Chart with highlight of LL for A-5
(33)

Step 4. You have already determined that the sieve analysis requirements have been met for group A-5. The liquid limit requirement for group A-5 is 41 or more. This example soil satisfies the requirement because 43 is greater than 41.

Show Chart with PI for A-5 highlighted
(34)

Step 5. Now compare the plasticity index requirements for Group A-5. The chart shows that group A-5 may have a maximum plasticity index of 10. The soil fails to meet this criteria so move right and check group A-6.

Show Chart with LL for A-6 highlighted
(35)

Step 6. Again, you have already determined that the sieve analysis requirements have been met. The next requirement you must check is liquid limit. The maximum allowable liquid limit for group A-6 is 40. Because the soil has a liquid limit of 43, the requirement is not met. Move right and check group A-7.

Show Chart with LL for A-7 highlighted
(36)

Step 7. The minimum liquid limit is 41 for group A-7. Because 43 is greater than 41, the soil meets this requirement.

Show Chart with PI for A-7 highlighted

(37)

Step 8. Compare the plasticity index of this soil to the plasticity index requirement for Group A-7 in the flow chart. Nineteen is greater than eleven, therefore, the soil is properly classified as group A-7. Note the asterisk by the plasticity index requirement

Show bottom of chart - highlight note on plasticity index

(38)

This asterisk refers to the note near the bottom of the flow chart. The note gives requirements for subdividing group A-7 into subgroups A-7-5 and A-7-6 on the basis of plasticity index.

Value of LL-30
Value = 43 - 30
Value = 13

PI of 19 - 13

(39)

Step 9. Calculate the value for the quantity of liquid limit minus 30. This value is 13. Compare this value to the plasticity index. Because the plasticity index of 19 is greater than 13, the soil is correctly classified as subgroup A-7-6.
Now it is your turn. Locate Activity 5 and complete the examples using the AASHTO flow chart. Press the pause button to stop the tape. When you have finished, check your answers, then continue.

GI equation near bottom of chart

(40)

The group index is one more quantity you must calculate to complet the classification of a soil in the AASHTO system. The equation for calculating group index is shown near the bottom of the flow chart.

Example
F = 42
LL = 43
PI = 19

(41)

The values to be used in this next example are percent fines = 42, liquid limit = 43, and plasticity index = 19

GI = (42-35)
[0.2 + 0.005(43-40)]
+ 0.01 (42-15)(19-10)
GI=3.9 A-7-6(4)

(42)

After substituting these values into the equation, the group index that is calculated is 3.9. The group index is reported to the nearest whole number or 4. The complete classification for this soil is A-7-6(4). Notice the group index is reported in parentheses following the group symbol.

Best Worst

A-1 A-7

(43)

Let's review the flow chart. Moving from left to right on the flow chart, the desirability for use for "local roads and streets" and "roadfill" decreases.

Within a soil group
Group index
0 20+
Best Worst
(44)

Within a soil group, the desirability for "local roads and streets" and "roadfill" decreases as the group index increases.

Activity 6
(45)

Press the button to stop the tape and complete activity 6 in your Study Guide. When you are ready, start the tape.

0.01 (F-15)(PI-10) portion of entire GI equation highlighted
(46)

Partial group index must be calculated only for two soil classifications--A-2-6 and A-2-7. The partial group index or PGI, is calculated using only the portion of the group index equation based on plasticity index and fines. The PGI is reported to the nearest whole number.
Press the button to stop the tape and complete activity 7. When you are ready, release the pause button to continue.

Do Problem Set in Activity 8
(47)

You can now classify a soil using the AASHTO Classification System. Activity 8 contains a set of problems. Press the pause button and complete this activity. When you are ready, release the button to continue.

Soil Survey Publications use AASHTO
(48)

The Soil Conservation Service uses the AASHTO Classification System to make engineering interpretations for "local roads and streets" and "roadfill". These engineering interpretations are used on the SCS-Soils-5 form to provide information for the tables in soil survey publications. Builders, developers, highway departments, and others, outside SCS use soil surveys and the AASHTO Classification System.

AASHTO Classification aids in the engineering interpretations for local roads and streets and for roadfill
(49)

To work with these groups outside SCS, you need to know how the engineering interpretations for certain uses in soil survey publications are developed.

Activity 9
(50)

Activity 9 in your Study Guide will demonstrate how the SCS-SOILS-5 Form is developed for the engineering interpretations involving local roads and streets. This activity also includes a description of the use, properties affecting that use, definitions of associated terms, and the criteria. Press the pause button to stop the tape and study this Activity that also includes an example problem.

Activity 10 (51)	You can now determine and explain how engineering interpretations are made for local roads and streets using AASHTO Group Index Number and SCS criteria. Prove it by completing Activity 10 in the Study Guide.
Slide of hauling borrow from one location to a road construction project (52)	The Group Index portion of the AASHTO Classification is also used to rate soils as a source of "roadfill." Roadfill consists of soil material that is excavated from its original position and used in road construction at a different location.
Activity 11 (53)	Activity 11 in the Study Guide demonstrates how the SCS-SOILS-5 Form is developed for the engineering interpretations involving soil as a source for roadfill. This activity contains a description of the use, properties to be evaluated, applicable terminology and criteria. It also includes an example problem. Press the pause button to study this example.
Activity 12 (54)	You can now determine and explain how engineering interpretations are made for the use of soil as a roadfill material. Complete Activity 12 in the Study Guide to demonstrate your new skills.
Objectives: 1. Write definitions (55)	Let's check to see if you have met the original objectives. Objective number 1 - Write definitions for terms used in the AASHTO Classification System.
Objectives: 1. Write definitions. 2. Correctly classify soil using lab data and the AASHTO flow chart (56)	Objective number 2 was -- Correctly classify soils using lab data and the AASHTO flow chart.
Objectives: 1. _____ 2. _____ 3. Explain engineering interpretations for local roads and streets and for roadfill (57)	Objective number 3 Explain the engineering interpretations for "local roads and streets and for "roadfill."

Congratulations Proceed to Module 3 and drive carefully. (58)	Congratulations, you have completed all these objectives. If for some reason you have any questions or had a problem with a particular activity, review the module. If not, you are ready to continue to Module 3, and "Drive Carefully."