SOIL CLASSIFICATION

PREPARED BY

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پرۆسیسی راست کردنەوە لە کاری ئاست پێویکردن (لیڤل کردن)ی داخراو

(Level Loop Adjustments)

لەزۆربەی کارو پرۆژە ئەندازیاریەکان وا پێویست دەکات کەکار بەم جۆرە لە ئاست پێویکردن (لیڤل کردن) بکەین بەتایبەت لە دروست کردنی پرۆژەی گەورەی داخراو وەك نیشتەجێ یان بازرگانی یان هەر پرۆژەیەکی ڕێگاو بان ...ئامانج لەبەکارهێنانی ئەم ڕێگەیە دروست کردنی تۆڕێکی داخراوە لە خالی بنەرەتی Benchmark (BM) لەناو یان لەنزیکی پرۆژەکە کە ئەم خالانە بەرزیان لە ئاستی ڕووی دەریاوە زانراو دەبێت وە لەم خالانەوە هەموو کارەکانی تری تایبەت بەڕووپێوی کردن لە پرۆژەکە ئەنجام دەدریت ،واتا دەبێت بە پێوەر بۆ هەموو کارەکان لە پرۆژەکە وەك پێوانی لاری وجیاوازی بەرزی ودروستکردنی نەخشەی کەنتۆری لێیانەوە .

هەربۆیە پێویستە پێشتر لەگرنگی و واتای خالی بنەرەت (BM) Vertical control surveys زیاتر تێبیگەین کەبریتیە لە پرۆسەی ڕووپێوی کردن ودابەزاندنی کۆمەڵێك خاڵ کە بەرزیان لەئاستی ڕووی دەریاوە(Elevation) کانیان زانراوە بەئامێری لیڤل،وەهەروەها دەکرێت جێگەی خاڵەکانیش (Location) لەڕێگەی سیستەمی پۆتان (Coordinate System) وە (x,y,z) یان پێوانە بکەین بەئامێرەکانی سیۆدۆلایت یان تۆتەڵ ستەیشن یا GPS،دەکرێت (BM) بەدوو جۆر دروست بکرێت ولە جیهاندا دوو سیستەم پەیڕەو دەکرێت یان سوود لە ڕەگەزە سروشتیەکان وەك درەخت یان لووتکەی شاخ وبەردە زەبەلاحەکان یان هەر ڕەگەزێك کە جێگیروهاوسەنگ بێت لە سروشتدا دەکرێت بکریت بە (BM) و هەموو داتا کانی لەسەر تۆماربکریت بەشێوەیەك کە قابیلی کوژانەوە نەبیت ،وەجۆری دووەم لە (BM) بریتیە لەو سیستەمەی کەخۆمان لە پرۆژەکان یان سنورە نێودەوڵەتیەکان یان بە شێوەی تۆڕێك لەناو وولات وشاروشارۆچکەکان دروست دەکریت بە شیوە ستاندارد کە بە ئاسانی تێکنەدرێت و هەڵنەکەنرێت لە لایەن مرۆڤەکانەوە بەزۆریی لەشێوەی یەندازەی بە کۆنکریت دروست دەکرێت .

دامەزراندنی باشترین سیستەمی (BM) بە ئامێری لیڤل Level ئەو سیستەمەیە کە راست کرنەوەی بۆ بکرێت هەربۆیە پێش راست کردنەوە پێویستە زانیاری تەواومان هەبیت لەئەنجامدانی پرۆسیجەری کاری ڕووپیویەکە کەبەم هەنگاوانەی لای خوارەوە دەست پێدەکات :

1-سەردانیکردن وگەران و پشکنین بە پرۆژەکەدا بۆ هەڵبژاردنی شوینی گونجاو بۆ(BM) ەکان کەلە پاشدا ببێتە خالی مەرجەع (Reference point) ی گرنگ بۆ پرۆژەکە.

2-دەست نیشان کردنی (BM)ی یەکەم وتۆمارکردنی داتاکان ئەکرێت نرخەکەی گریمانەی بۆ بکەین واتا خۆمان ژمارەیەك فەرز بکەین یان بیبەستینەوە بە (BM) ناسراو و فیکسی کەین ، پاشان بە شێوەیەکی سیستەماتیك دووری نێوانیان بپێوین بەم شیوەیە تا دەگاتە کۆتا (BM) کارەکە دووبارە دەبیتەوە بە شیوەیەك کە زووترین ووردبینی وتیژبینی تیا بەکاربێت (High accurses)،وخۆمان لە هەڵە باوەکان بپاریزین لەکارەکەداوەك هەڵە تەکنیکیەکان وهەڵەکانی تۆمارکردن .

3-دیاری کردنی ڕێڕەوی کاری ڕوو پێویکردنەکە بەجۆرێك چەندلاکە دا بخەینەوە و ببەسترێتەوە لەگەڵ یەکەم خاڵ و خویندنەوەی داتا لەسەری جاریکی تر وەربگرینەوە بۆ مەبەستی کاری چێك کردنەوە وراست کرنەوە Level Loop Adjustments.

4-پرۆسەی راستکردنەوە Correction کاتێك دەست پێدەکەین کەجیاوازی هەبیت لە هەردوو نرخی هەمان پێنج مارکی یەکەم واتا ژمارەکان یەکسان نەبن وەك لەم نمونەیەی خوارەوە هاتووە.

5-ئەگەر هاتوو بری جیاوازی (هەڵە) لە رادەی ڕێگا پیدراو یەکسان یان کەمتر بوو راست کردنەوەی بۆ ئەکەین ئەگەر نا کاری ڕوو پیویەکە دووبارە دەکەینەوە.وەك لەم نمونەیەی خوارەوە ڕوون کراوەتەوە:

بۆ نمونە کارێکی ئاست پێوی لیڤل کرنمان بۆ پرۆژەیەکی ئەندازیاری لۆکەڵ کرد کە بە BM1 دەست مان پێکرد وبەستمانەوە (فیکس) مان کرد بەنرخەکەیەوە کە 187.273م بوو کەتۆمار کرابوو لەسەری، پاشان بەشێوەی چەند لایەکی داخراو هەریەك لە BM2,BM3, BM4 مان دیاری کرد خوێندنەوەمان لەسەر وەرگرتن بۆ دیاری کردنی نرخەکانیان وە پێوانەی دووری نێوان پینج مارکەکانمان وەرگرت بە شریتی پیوانە کردن.بەلام گرنگترین کار لەم پرۆسەیە خویندنەوەی BM1 ە دووبارە جارێکی تر ئەمەش بۆ ئە نجامدانی کاری راستکردنەوەی پینچمارکەکانە.

BM	Loop Distance: Cumulative (km)	Filed Elevation (m)	Correction: Cumulative Distance/total Distance ×E*	Adjusted Elevation (m)
1		187.273 (Fixed)		187.273
2	0.8	184.242	+0.8/4.7 ×0.015=+0.003=	184.245
3	2.4	182.297	+2.4/4.7 ×0.015=+0.008=	182.305
4	3.0	184.227	+3.0/4.7 ×0.015=+0.010=	184.237
1	4.7	186.258	+4.7/4.7 ×0.015=+0.015=	187.273

E*=186.273-186.258=-0.015m

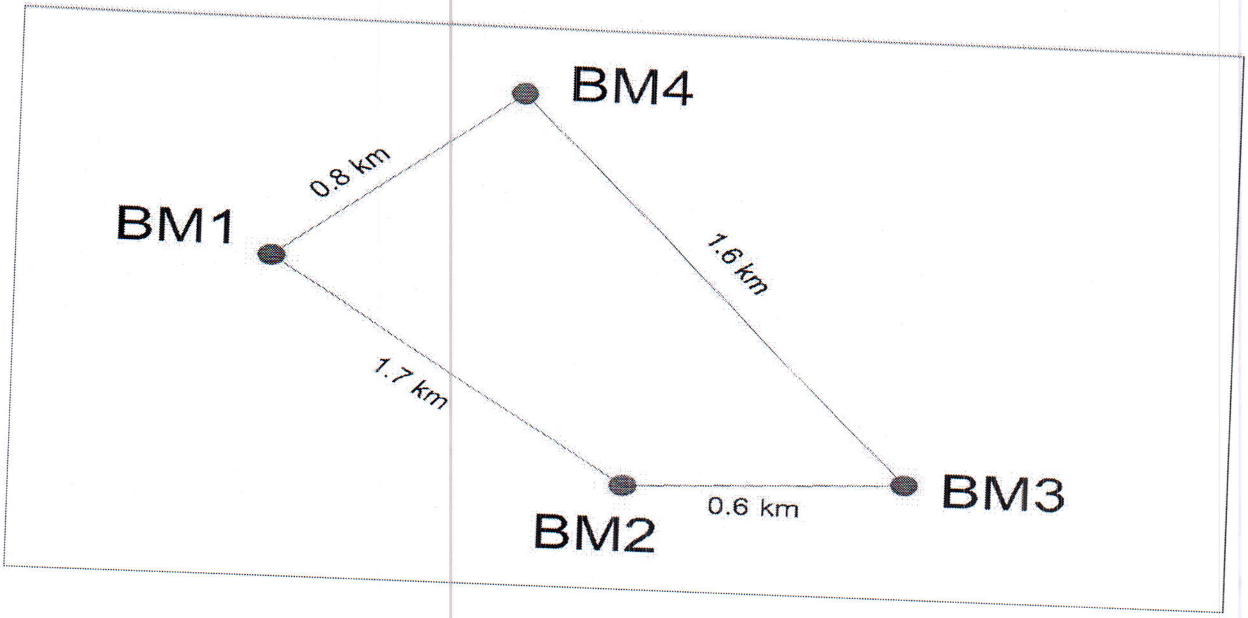
هەڵەی ڕێگە پێدراولە کارەکەمان بە پێی خشتەی ووردبینی کە ستانداردا وە ئامادە کراوە لەلایەنە فەرمییەکان وە تایبەتە بە کونترۆلی بەرزی تیایدا بری هەلەکەمان بۆ دەست نیشان دەکات کەتایبەتە بە کاری ڕووپیوی لە پرۆژەی ئەندازیاری لۆکاڵی Local Engineering Projects بە پێی خشتەکە کارەکەما لە کلاسی دووە Second order class ە وە برەکەی دیاری کردووە کە یەکسانە بە :

$$0.008\sqrt{K}$$

$$0.008\sqrt{4.7} = 0.017$$

K= دریژی چەندلاکە

لەبەر ئەوەی 0.015 >0.017 کەواتە راست کردنەوە بۆ بری هەڵەکە دەکەین وەك لە خشتەکەی سەرەوە روونکراوەتەوە وڕاست کردنەوە مان بۆ سەرجەم پینچمارکەکان کردوە بەجۆرێك بری هەڵەکەمان دابەش کردووە بەسەریاندا بەنیشانەی کۆ (+) بە پیچەوانەی نیشانەی *Eکە (-) لە ئەنجامدا جیاوازی نرخی BM1 یەکسان بێت بەسفرو کاری راست کردنەوەکە سەرکەوتوودەبیت .



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Surveying –Principle and Application................ by Barry F. Kavanagh

Abstract

In this research I talk about the classification of soil and the two kinds of classification, AASHTO classification system and Unified Soil classification system with summary comparison between them.

For engineering purposes, Soil is defined as the uncemented aggregate of mineral grains decayed organic matter (solid particles) with liquid and gas in the empty spaces between the solid particles.

Soil is used as a construction material in various civil engineering projects, and it supports structural foundations.

Thus, civil engineering must study the properties of soil, such as its origin, grain-size distribution, ability to drain water, compressibility, shear strength, and load-bearing capacity.

Soil mechanics is the branch of science that deals with the study of the physical properties of soil and the behavior of soil masses subjected to various types of forces.

Soils engineering is the application of the principles of soil mechanics to practical problems.

Geotechnical engineering is the subdiscipline of civil engineering that involves natural materials found close to the surface of the earth.

It includes the application of the principles of soil mechanics and rock mechanics to the design of foundations, retaining structures, and earth structures.

Recorded history tells us that ancient civilizations flourished along the banks of rivers, such as the Nile (Egypt), the Tigris and Euphrates (Mesopotamia), the Huang Ho (Yellow River, China), and the Indus (India).

Dykes dating back to about 2000 B.C. were built in the basin of the Indus to protect the town of Mohenjo Dara (in what became Pakistan after 1947).

During the Chan dynasty in China (1120B.C. to 249B.C.) many dykes were built for irrigation purposes. There is no evidence that measure were taken to stabilize the foundations or check erosion caused by floods.

One of the most famous examples of problems related to soil-bearing capacity is the leaning Tower of Pisa in Italy.

After encountering several foundation-related problems during construction over centuries past, engineers and scientists began to address the properties and behavior of soils in a more methodical manner starting in the early part of the 18th century.

Based on the emphasis and the nature of study in the area of geotechnical engineering, the time span extending from 1700-1927 can be divided into four major periods:

1. Pre-classical (1700-1776A.D.).
2. Classical soil mechanics- phase I (1776-1856A.D.).
3. Classical soil mechanics- phase II (1856-1910A.D.).
4. Modern soil mechanics (1910-1927A.D.).

In the period after 1927, results of research conducted on clays were published in which the fundamental properties and parameters of clay were established.

The publication of *Erdbaumechanik auf Bodenphysikalisher Grundlage* by Karl Terzaghi in 1925 gave birth to a new era in the development of soil mechanics.

Terzaghi is known as the father of the modern soil mechanics, and rightfully so, he was the clearing house for research and application throughout the world.

The first conference of the International Society of Soil Mechanics and foundation Engineering (ISSMFE) was held at Harvard University in 1936 with Terzaghi presiding.

Following are some highlights in the development of soil mechanics and geotechnical engineering that evolved after the first conference of the IISSMFE in 1936:

- Publication of the book *Theoretical Soil Mechanics* by Karl Terzaghi in 1943 (Wily, New York).

- Publication of the book *Soil Mechanics in Engineering Practice* by Karl Terzaghi and Ralph Peck in 1948 (Wily, New York).

- Publication of the book *Fundamentals of Soil Mechanics* by Donald W. Taylor in 1948 (Wily, New York).

- Start of the publication of *Geotechnique,* the international journal of soil mechanics in 1948 in England.

- Presentation of the paper on Ø=0 concept for clays by A. Skempton in 1948.

- Publication of A.W. Skempton´s paper on A and B pore water pressure parameters in 1954.

- Publication of the book *The Measurement of Soil Properties in the Triaxial Test* by A.W. Bishop and B.J Henkel in 1957.

- ASCE S Research Conference on shear strength of cohesive soils held in Boulder 1960.

Engineering Classification of Soil

Different soils with similar properties may be classified into groups and sub-groups according to their engineering behavior.

Classification systems provide a common language to concisely express the general characteristics of soils, which are infinitely varied, without detailed descriptions.

Currently, two elaborate classification systems are commonly used by soils engineers.

Both systems take into consideration the particle-size distribution and Atterberg limits.

They are the American Association of State Highway and Transportation Officials (AASHTO) classification system and the Unified Soil Classification System.

The AASHTO classification system is used mostly by state and county highway departments.

Geotechnical engineers generally prefer the unified system

ASSHTO Classification System

The AASHTO system of soil classification was developed in 1929 as the Public Road Administration Classification System.

It has undergone several revisions, with the present version proposed by the Committee on Classification of Materials for sub-graded and Granular Type Roads of the Highway Research Board in 1945 (ASTM designation D-3282; AASHTO method M145).

The AASHTO classification in present use is given in Table 4.1 According to this system, soil is classified into seven major groups: A-1 through A-7.

Soil classified under groups A-1, A-2, and A-3 are granular materials of which 35% or less of the particles pass through the No.200 sieve. Soils of which more than 35% pass through the No.200 sieve are classified under groups A-4, A-5, A-6, and A-7.

These soils are mostly silt and clay-type materials.

The classification system is based on the following:

1. *Grain size*
   a- Gravel: fraction passing the75-mm (3-in.) sieve and retained on the No.10 (2-mm) U.S. sieve.
   b- Sand: fraction passing the No. 10(2-mm)U.S. sieve and retained on the No.200 (0.075-mm) U.S. sieve.
   c- Silt and Clay: fraction passing the No.200 U.S. sieve

Classification of Highway Subgrade Materials

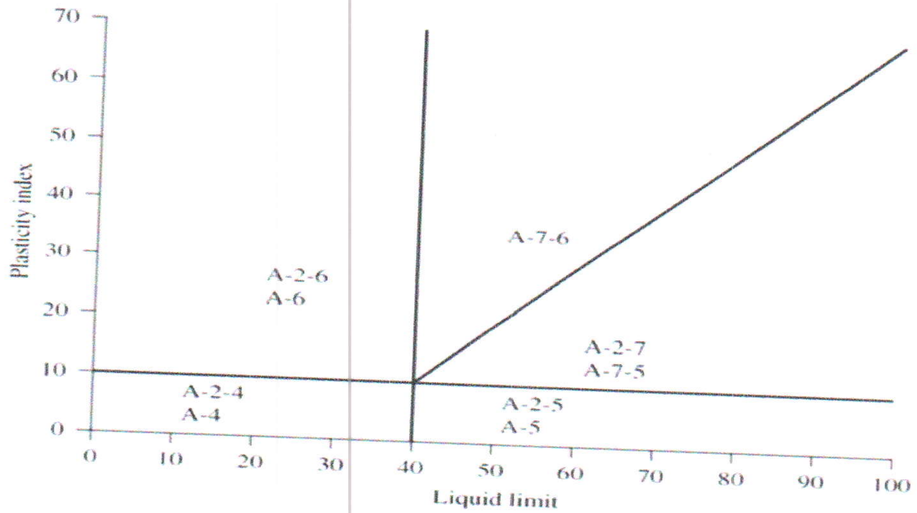
General classification	Granular materials (35% or less of total sample passing No. 200)						
	A-1			A-2			
Group classification	A-1-a	A-1-b	A-3	A-2-4	A-2-5	A-2-6	A-2-7
Sieve analysis (percentage passing)							
No. 10	50 max.						
No. 40	30 max.	50 max.	51 min.				
No. 200	15 max.	25 max.	10 max.	35 max.	35 max.	35 max.	35 max.
Characteristics of fraction passing No. 40							
Liquid limit				40 max.	41 min.	40 max.	41 min.
Plasticity index	6 max.		NP	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			
General subgrade rating	Excellent to good						

General classification	Silt-clay materials (more than 35% of total sample passing No. 200)			
Group classification	A-4	A-5	A-6	A-7 A-7-5[a] A-7-6[b]
Sieve analysis (percentage passing)				
No. 10				
No. 40				
No. 200	36 min.	36 min.	36 min.	36 min.
Characteristics of fraction passing No. 40				
Liquid limit	40 max.	41 min.	40 max.	41 min.
Plasticity index	10 max.	10 max.	11 min.	11 min.
Usual types of significant constituent materials	Silty soils		Clayey soils	
General subgrade rating	Fair to poor			

[a]For A-7-5, $PI < LL - 30$

[b]For A-7-6, $PI > LL - 30$

Table 1 Classification of Highway Subgrade Materials



2. Plasticity: The term Silty is applied when the fine fractions of the soil have a plasticity index of 10 or less.
   The term Clayey is applied when the fine fractions have a plasticity index of 11or more.
3. If cobbles and boulders (size larger than 75mm) are encountered, they are excluded from the portion of the soil sample from which classification is made.
   However, the percentage of such material is recorded.
   To classify a soil according to table 1, one must apply the test date from left to right. By process of elimination, the first group from the left into which the test data fit is the correct classification. Figure 1 shows a plot of the range of the liquid limit and the plasticity index for soils that fall into groups A-2, A-3, A-4, A-5, A6 and A7.

Range of liquid limit and plasticity index for soils in groups A-2, A-3, A-4, A-5, A6 and A7.

To evaluate the quality of a soil as a highway subgrade material, one must also incorporate a number called the group index (GI) with the groups and subgroups of the soil. This index is written in parentheses after the group or subgroup designation.

The group index is given by the equation

GI= (F200- 35) [0.2+0.005(LL-40)] +0.01(F200-15) (PI-10) Eq....1

Where F200= percentage passing through the No.200 sieve

LL=liquid

PI=plasticity index

The first of Eq. (1) - that is, (F200-35) [0.2+0.005(LL-40)] - is the partial group index determined from the liquid limit.

The second term- that is, 0.01(F200-15) -is the partial group index determined from the plasticity index.

Following are some rules for determining the group index:

1. If Eq. (1) yields a negative value for GI, it is taken as 0.
2. The group index calculated from Eq. (1) is rounded off to the nearest whole number (for example, GI=3.4 is rounded off to; GI=3.5 is rounded off to 4).
3. There is no upper limit for the group index.
4. The group index of soils belonging to groups A-1-a, A-1-b, A-2-4, A-2-5, and A-3 is always 0.

5. When calculating the group index for soils that belong to groups A-2-6 and A-2-7, use the partial group index for PI, or

   GI=0.01(F200-15) (PI-10).... Eq (2)

   In general, the quality of performance of a subgrade material is inversely proportional to the group index.

Unified Soil Classification System

The original from of the unified soil classification system was proposed by Casagrande in 1942 during World War II for use in airfield construction undertaken by the Army Corps of Engineers.

In cooperation with the US Bureau of Reclamation, the Corps revised this system in 1952.

At present, it is widely used by engineers (ASTM designation D-2487).

In order to use the classification system, the following points must be kept in mind:

1. The classification is based on material passing a 75mm (3in) sieve.
2. Coarse fraction= percent retained above No.200 sieve=100-F200=R200.

Table 2 Unified Classification System (Based on Materials Passing 75 mm (3 in.) Sieve (Based on ASTM-2487)

Major division		Group symbol	Criteria
$F_{200} < 50$	Gravels $\frac{R_4}{R_{200}} > 0.5$	GW	$F_{200} < 5$; $C_u \geq 4$; $1 \leq C_z \leq 3$
		GP	$F_{200} < 5$; Not meeting the GW criteria of C_u and C_z
		GM	$F_{200} > 12$; $PI < 4$ or plots *below* A-line (Fig. 4.2)
		GC	$F_{200} > 12$; $PI > 7$ and plots *on or above* A-line (Fig. 4.2)
		GM-GC	$F_{200} > 12$; PI plots in the hatched area (Fig. 4.2)
		GW-GM	$5 \leq F_{200} \leq 12$; satisfies C_u and C_z criteria of GW and meets the PI criteria for GM
		GW-GC	$5 \leq F_{200} \leq 12$; satisfies C_u and C_z criteria of GW and meets the PI criteria for GC
		GP-GM	$5 \leq F_{200} \leq 12$; does not satisfy C_u and C_z criteria of GW and meets the PI criteria for GM
		GP-GC	$5 \leq F_{200} \leq 12$; does not satisfy C_u and C_z criteria of GW and meets the PI criteria for GC
	Sands $\frac{R_4}{R_{200}} \leq 0.5$	SW	$F_{200} < 5$; $C_u \geq 6$; $1 \leq C_z \leq 3$
		SP	$F_{200} < 5$; Not meeting the SW criteria of C_u and C_z
		SM	$F_{200} > 12$; $PI < 4$ or plots *below* A-line (Fig. 4.2)
		SC	$F_{200} > 12$; $PI > 7$ and plots *on or above* A-line (Fig. 4.2)
		SM-SC	$F_{200} > 12$; PI plots in the hatched area (Fig. 4.2)
		SW-SM	$5 \leq F_{200} \leq 12$; satisfies C_u and C_z criteria of SW and meets the PI criteria for SM
		SW-SC	$5 \leq F_{200} \leq 12$; satisfies C_u and C_z criteria of SW and meets the PI criteria for SC
		SP-SM	$5 \leq F_{200} \leq 12$; does not satisfy C_u and C_z criteria of SW and meets the PI criteria for SM
		SP-SC	$5 \leq F_{200} \leq 12$; does not satisfy C_u and C_z criteria of SW and meets the PI criteria for SC
$F_{200} \geq 50$	Silts and Clays $LL < 50$	ML	$PI < 4$ or plots *below* A-line (Fig. 4.2)
		CL	$PI > 7$ and plots *on or above* A-line (Fig. 4.2)
		CL-ML	PI plots in the hatched area (Fig. 4.2)
		OL	$\frac{LL_{\text{oven dried}}}{LL_{\text{not dried}}} < 0.75$; PI plots in the OL area in Fig. 4.2
	Silts and Clays $LL \geq 50$	MH	PI plots *below* A-line (Fig. 4.2)
		CH	PI plots *on or above* A-line (Fig. 4.2)
		OH	$\frac{LL_{\text{oven dried}}}{LL_{\text{not dried}}} < 0.75$; PI plots in the OH area in Fig. 4.2
	Highly organic matter	Pt	Peat

Note: C_u = uniformity coefficient = $\frac{D_{60}}{D_{10}}$; C_z = coefficient of gradation = $\frac{D_{30}^2}{D_{60} \times D_{10}}$

LL = liquid limit on minus 40 sieve fraction

PI = plasticity index on minus 40 sieve fraction

3. Fine fraction=percent No.200sieve=F200.
4. Gravel fraction=percent retained above No.4sieve=R4.

According to the Unified Soil Classification System, the soils are divided into two major categories:

1. Coarse-grained soils that are gravelly and sandy in nature with less than 50% passing through the No.200 sieve (that is, F200<50).
2. The group symbols start with prefixes of either G or S. G stands for gravel or gravelly soil, and S for sand soil. Other symbols used for the classification are:
   . W-well graded.
   . P-poorly graded.
   . L-low plasticity (liquid limit less than 50)
   . H-high plasticity (liquid limit more than 50)

   Table (2) gives the details of the soil classification system to determine the group symbols.
   More recently, ASTM designation D-2487 created an elaborate system to assign group names to soils.
   These names are summarized in Figure 3, 4 and 5.
   In using these figures, it is important to remember that, in a given soil, percentage of gravel=R4 and percentage of sand=R200-R4.

Group Symbol		Group Name
GW	<15% sand	Well-graded gravel
	≥15% sand	Well-graded gravel with sand
GP	<15% sand	Poorly graded gravel
	≥15% sand	Poorly graded gravel with sand
GW-GM	<15% sand	Well-graded sand with silt
	≥15% sand	Well-graded gravel with silt and sand
GW-GC	<15% sand	Well-graded gravel with clay (or silty clay)
	≥15% sand	Well-graded gravel with clay and sand (or silty clay and sand)
GP-GM	<15% sand	Poorly graded gravel with silt
	≥15% sand	Poorly graded gravel with silt and sand
GP-GC	<15% sand	Poorly graded gravel with clay (or silty clay)
	≥15% sand	Poorly graded gravel with clay and sand (or silty clay and sand)
GM	<15% sand	Silty gravel
	≥15% sand	Silty gravel with sand
GC	<15% sand	Clayey gravel
	≥15% sand	Clayey gravel with sand
GC-GM	<15% sand	Silty clayey gravel
	≥15% sand	Silty clayey gravel with sand
SW	<15% gravel	Well-graded sand
	≥15% gravel	Well-graded sand with gravel
SP	<15% gravel	Poorly graded sand
	≥15% gravel	Poorly graded sand with gravel
SW-SM	<15% gravel	Well-graded sand with silt
	≥15% gravel	Well-graded sand with silt and gravel
SW-SC	<15% gravel	Well-graded sand with clay (or silty clay)
	≥15% gravel	Well-graded sand with clay and gravel (or silty clay and gravel)
SP-SM	<15% gravel	Poorly graded sand with silt
	≥15% gravel	Poorly graded sand with silt and gravel
SP-SC	<15% gravel	Poorly graded sand with clay (or silty clay)
	≥15% gravel	Poorly graded sand with clay and gravel (or silty clay and gravel)
SM	<15% gravel	Silty sand
	≥15% gravel	Silty sand with gravel
SC	<15% gravel	Clayey sand
	≥15% gravel	Clayey sand with gravel
SC-SM	<15% gravel	Silty clayey sand
	≥15% gravel	Silty clayey sand with gravel

Figure 3 Flowchart group names for gravelly and sandy soil. *Source:* From "Annual Book of ASTM Standards, 04.08." Copyright © 1999 American Society for Testing and Materials. Reprinted with permission.

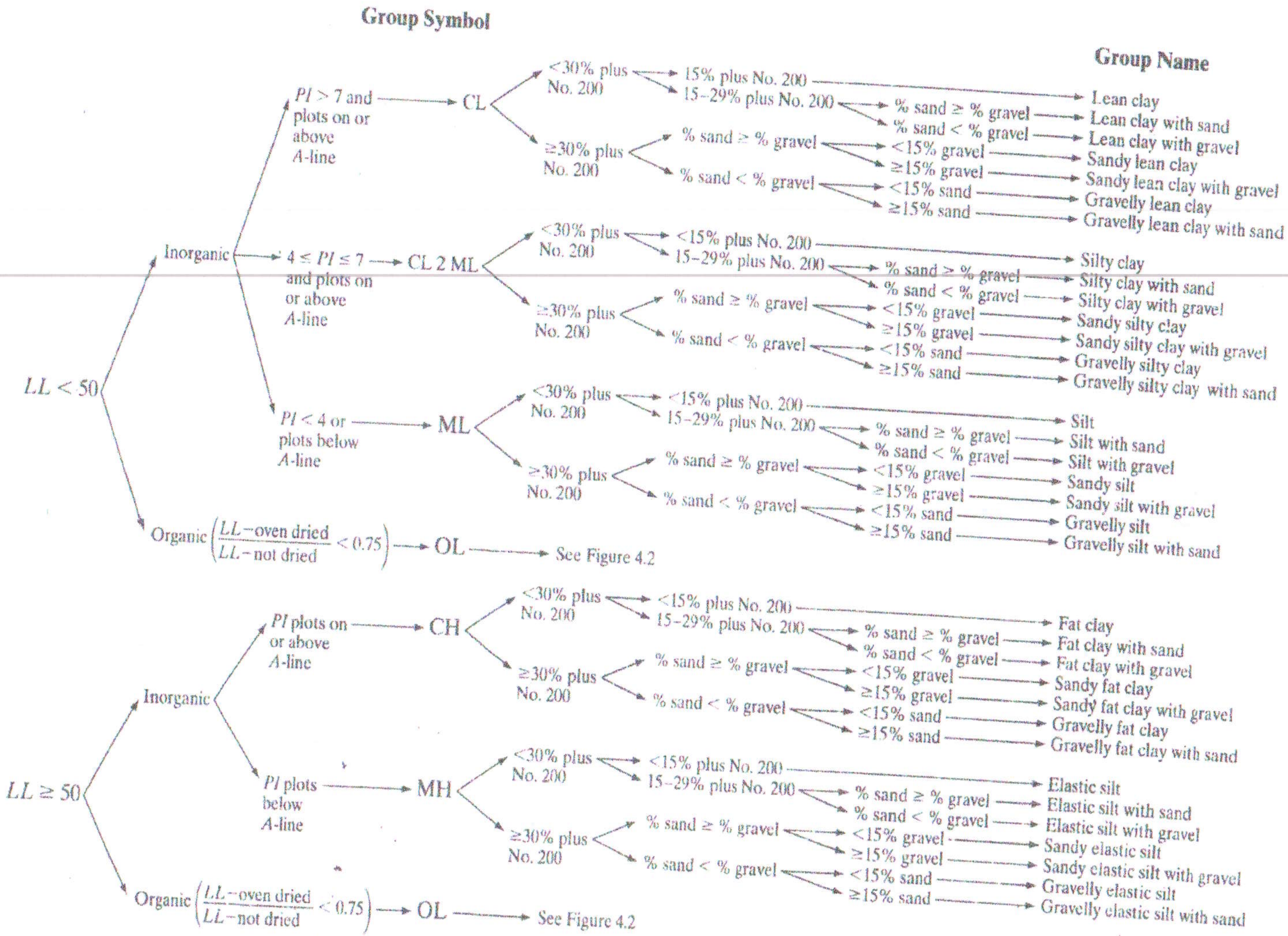


Figure Flowchart group names for inorganic silty and clayey soils. *Source:* From "Annual Book of ASTM Standards, 04.08." Copyright © 1999 American Society for Testing and Materials. Reprinted with permission.

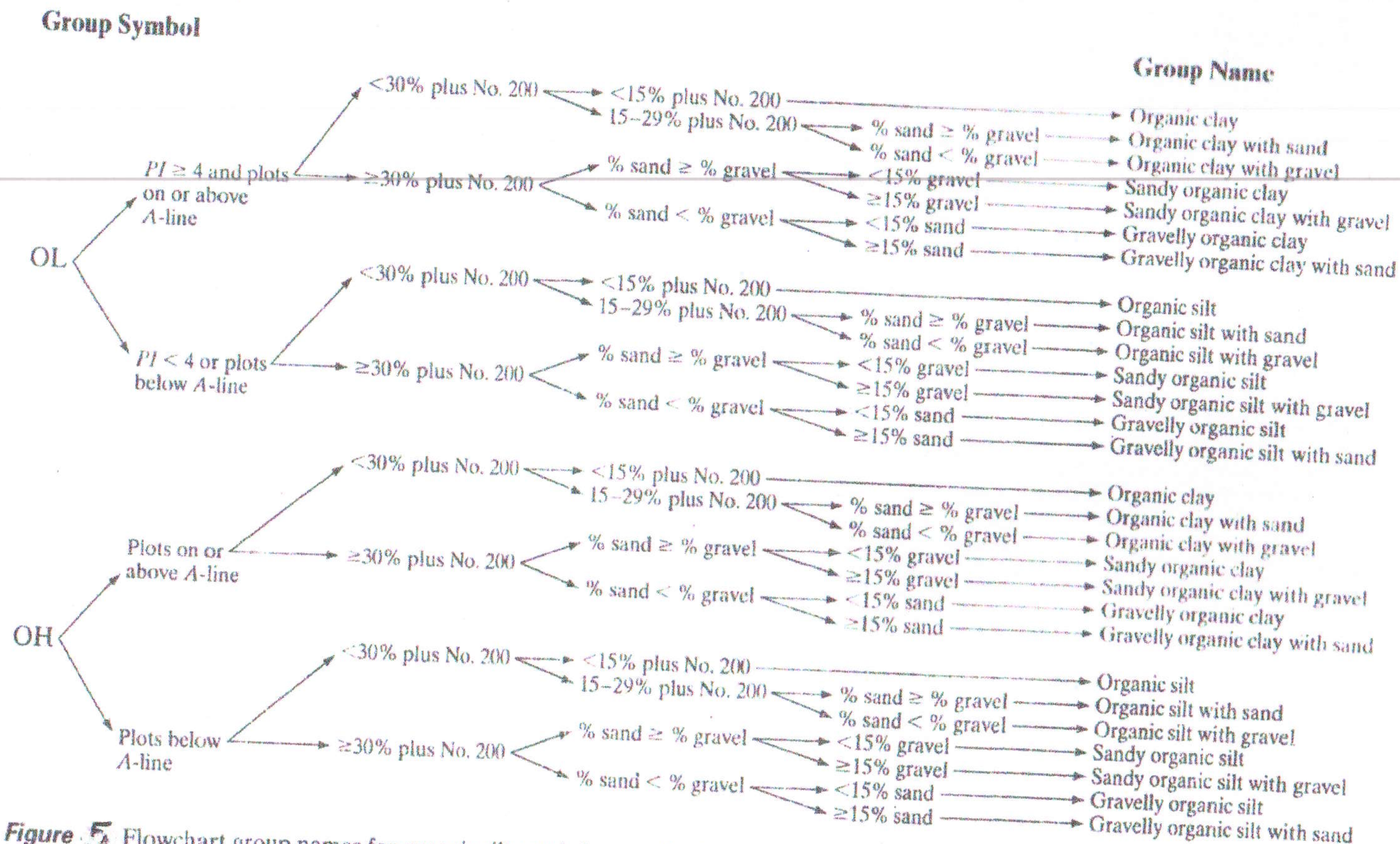


Figure 5 Flowchart group names for organic silty and clayey soils. *Source:* From "Annual Book of ASTM Standards, 04.08." Copyright © 1999 American Society for Testing and Materials. Reprinted with permission.

Summary and Comparison between the ASTM and Unified Systems

Both soil classification systems, AASHTO and Unified, are based on the texture and plasticity of soil, Also, both system divide the soils into two major categories, coarse grained and fine grained, as separated by the No.200 sieve.

According to the Unified System, a soil is considered fine grained when more than 50% passes through the No.200 sieve.

A coarse-grained soil that has about 35% fine grains will behave like a fine-grained material.

This is because enough fine grains exist to fill the voids between the coarse grains and hold them apart.

In this respect, the AASHTO system appears to be more appropriate.

In the AASHTO system, the No.10 sieve used to separate gravel from sand; In the Unified system, the No.4 sieve is used.

From the viewpoint of soil-separate size limits, the No.10 sieve is the more accepted upper limit for sand.

This limit is used in concrete and highway based-course technology.

In the Unified System, the gravelly and sandy soils are clearly separated; in the AASHTO system, they are not.

The A-2 group, in particular, contains a large variety of soils.

Symbols like GW, SM, CH, and others that are used in the Unified System are more descriptive of the soil properties than the A symbols used in the AASHTO system.

The classification of organic soils as OL, OH, and Pt is provided in the Unified system.

Under the AASHTO system, there is no place for organic soils.

Peats usually have a high moisture content, low specific gravity of soil solids, and low unit weight.

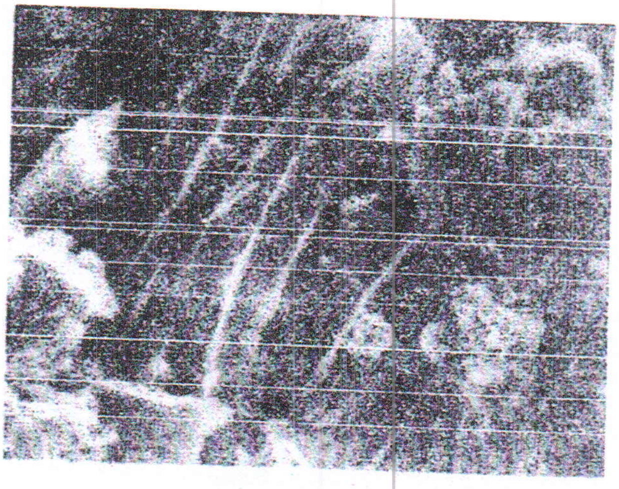
The Figure below shows the scanning electron micrographs of four peat samples collected in Wisconsin.

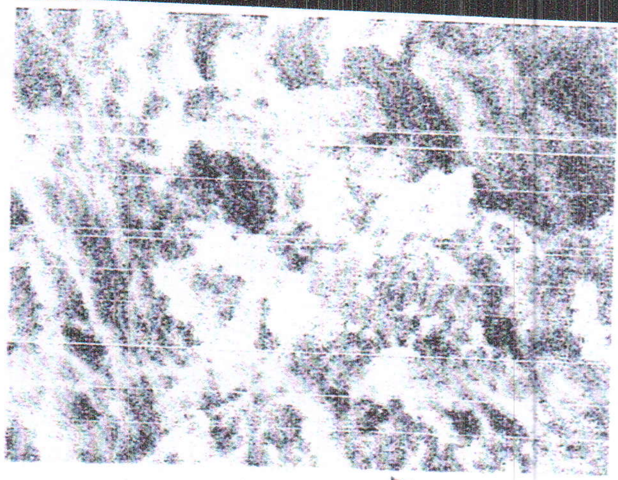
Some of the properties of the peats are given in table 6.

Liu (1967) compared the AASHTO and unified systems.

The results of his study are presented in Table 7 and 8.

[redacted]





MIDDLETON PEAT

WAUPACA PEAT

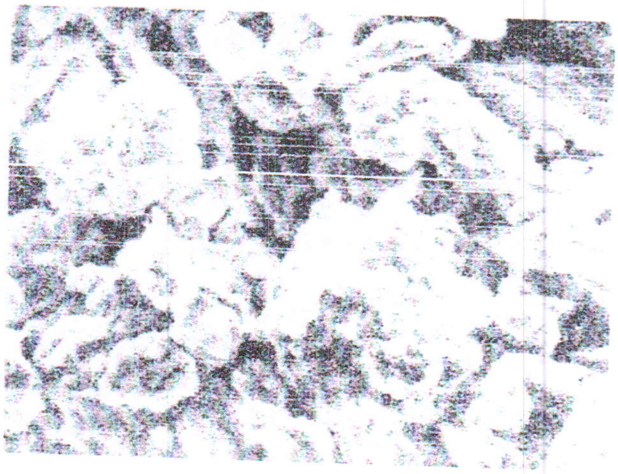


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Table 6 Properties of the Peats Shown in Figure 4.8

Source of peat	Moisture content (%)	Unit weight kN/m³	Unit weight lb/ft³	Specific gravity, G_s	Ash content (%)
Middleton	510	9.1	57.9	1.41	12.0
Waupaca County	460	9.6	61.1	1.68	15.0
Portage	600	9.6	61.1	1.72	19.5
Fond du Lac County	240	10.2	64.9	1.94	39.8

Table 7 Comparison of the AASHTO System with the Unified System*

Soil group in AASHTO system	Comparable soil groups in Unified system: Most probable	Possible	Possible but improbable
A-1-a	GW, GP	SW, SP	GM, SM
A-1-b	SW, SP, GM, SM	GP	—
A-3	SP	—	SW, GP
A-2-4	GM, SM	GC, SC	GW, GP, SW, SP
A-2-5	GM, SM	—	GW, GP, SW, SP
A-2-6	GC, SC	GM, SM	GW, GP, SW, SP
A-2-7	GM, GC, SM, SC	—	GW, GP, SW, SP
A-4	ML, OL	CL, SM, SC	GM, GC
A-5	OH, MH, ML, OL	—	SM, GM
A-6	CL	ML, OL, SC	GC, GM, SM
A-7-5	OH, MH	ML, OL, CH	GM, SM, GC, SC
A-7-6	CH, CL	ML, OL, SC	OH, MH, GC, GM, SM

*After Liu (1967)

Table 8 Comparison of the Unified System with the AASHTO System*

Soil group in Unified system	Comparable soil groups in AASHTO system: Most probable	Possible	Possible but improbable
GW	A-1-a	—	A-2-4, A-2-5, A-2-6, A-2-7
GP	A-1-a	A-1-b	A-3, A-2-4, A-2-5, A-2-6, A-2-7
GM	A-1-b, A-2-4, A-2-5, A-2-7	A-2-6	A-4, A-5, A-6, A-7-5, A-7-6, A-1-a
GC	A-2-6, A-2-7	A-2-4	A-4, A-6, A-7-6, A-7-5
SW	A-1-b	A-1-a	A-3, A-2-4, A-2-5, A-2-6, A-2-7
SP	A-3, A-1-b	A-1-a	A-2-4, A-2-5, A-2-6, A-2-7
SM	A-1-b, A-2-4, A-2-5, A-2-7	A-2-6, A-4	A-5, A-6, A-7-5, A-7-6, A-1-a
SC	A-2-6, A-2-7	A-2-4, A-6, A-4, A-7-6	A-7-5
ML	A-4, A-5	A-6, A-7-5, A-7-6	—
CL	A-6, A-7-6	A-4	—
OL	A-4, A-5	A-6, A-7-5, A-7-6	—
MH	A-7-5, A-5	—	A-7-6
CH	A-7-6	A-7-5	—
OH	A-7-5, A-5	—	A-7-6
Pt	—	—	—

References

- Principles of Geotechnical Engineering/ Broia M. Das.
- Soil Mechanics in Engineering practice/ Karl Terzaghi.
- ASTM D2487.