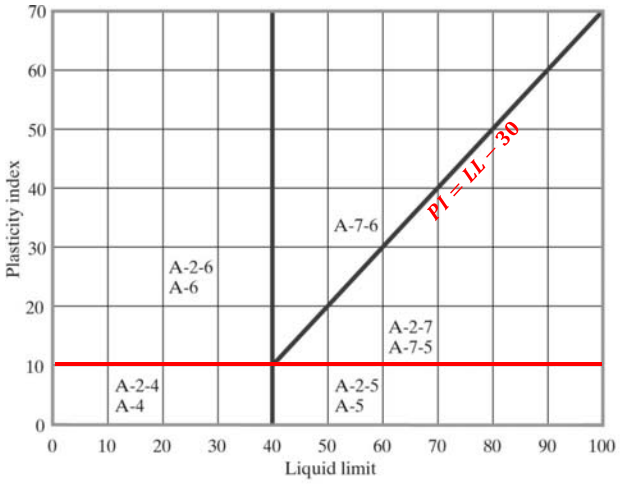
Soil Classification

Chapter 4

AASHTO

	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-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 (A-7-5, A-7-6)
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					

AASHTO



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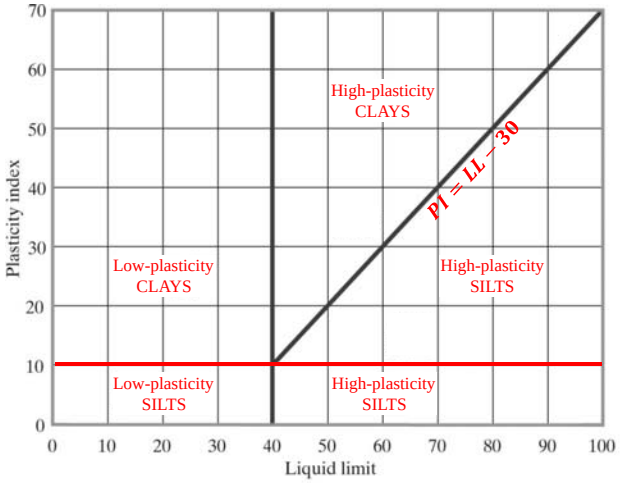

Group Index

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

% passing No. 200

Partial Index for A-2-6 and A-2-7

Group index is always reported as a non-negative integer value
Group index is always zero for groups A-1, A-3, A-2-4, A-2-5

AASHTO

	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-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 (A-7-5, A-7-6)
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:											
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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			

Example

- Classify the following soil using AASHTO:
  - 98% passing the No. 10 sieve
  - 80% passing the No. 40 sieve
  - 50% passing the No. 200 sieve
  - LL = 38
  - PL = 29

PI = 38 – 9 = 9

AASHTO

	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-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 (A-7-5, A-7-6)
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
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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

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

% passing No. 200

Partial Index for A-2-6 and A-2-7

Group index is always reported as a non-negative integer value
Group index is always zero for groups A-1, A-3, A-2-4, A-2-5

USCS

G = gravel	W = well-graded
S = sand	P = poorly graded
M = silt	L = low plasticity
C = clay	H = high plasticity
O = organic	
Pt = peat	

USCS

- Percent gravel (retained on No. 4 sieve)
- Percent sand
- Percent fines (passing No. 200 sieve)
- C_u and C_c
- LL and PI of portion passing No. 40 sieve

USCS

Table 4.2 Unified Soil Classification System (Based on Material Passing 75-mm Sieve)

Criteria for Assigning Group Symbols				Group Symbol
Coarse-Grained Soils More than 50% of retained on No. 200 sieve	**Gravels** More than 50% of coarse fraction retained on No. 4 sieve	Clean Gravels Less than 5% fines[a]	$C_u \geq 4$ and $1 \leq C_c \leq 3$[c]	GW
			$C_u < 4$ and/or $1 > C_c > 3$[c]	GP
		Gravels with Fines More than 12% fines[a,d]	$PI < 4$ or plots below "A" line (Figure 4.2)	GM
			$PI > 7$ and plots on or above "A" line (Figure 4.2)	GC
	Sands 50% or more of coarse fraction passes No. 4 sieve	Clean Sands Less than 5% fines[b]	$C_u \geq 6$ and $1 \leq C_c \leq 3$[c]	SW
			$C_u < 6$ and/or $1 > C_c > 3$[c]	SP
		Sands with Fines More than 12% fines[b,d]	$PI < 4$ or plots below "A" line (Figure 4.2)	SM
			$PI > 7$ and plots on or above "A" line (Figure 4.2)	SC
Fine-Grained Soils 50% or more passes No. 200 sieve	**Silts and Clays** Liquid limit less than 50	Inorganic	$PI > 7$ and plots on or above "A" line (Figure 4.2)[e]	CL
			$PI < 4$ or plots below "A" line (Figure 4.2)[e]	ML
		Organic	$\frac{\text{Liquid limit—oven dried}}{\text{Liquid limit—not dried}} < 0.75$; see Figure 4.2; OL zone	OL
	Silts and Clays Liquid limit 50 or more	Inorganic	PI plots on or above "A" line (Figure 4.2)	CH
			PI plots below "A" line (Figure 4.2)	MH
		Organic	$\frac{\text{Liquid limit—oven dried}}{\text{Liquid limit—not dried}} < 0.75$; see Figure 4.2; OH zone	OH
Highly Organic Soils	Primarily organic matter, dark in color, and organic odor			Pt

[a] Gravels with 5 to 12% fine require dual symbols: GW-GM, GW-GC, GP-GM, GP-GC.
[b] Sands with 5 to 12% fines require dual symbols: SW-SM, SW-SC, SP-SM, SP-SC.
[c] $C_u = \frac{D_{60}}{D_{10}}$; $C_c = \frac{(D_{30})^2}{D_{60} \times D_{10}}$
[d] If $4 \leq PI \leq 7$ and plots in the hatched area in Figure 4.2, use dual symbol GC-GM or SC-SM.
[e] If $4 \leq PI \leq 7$ and plots in the hatched area in Figure 4.2, use dual symbol CL-ML.

USCS

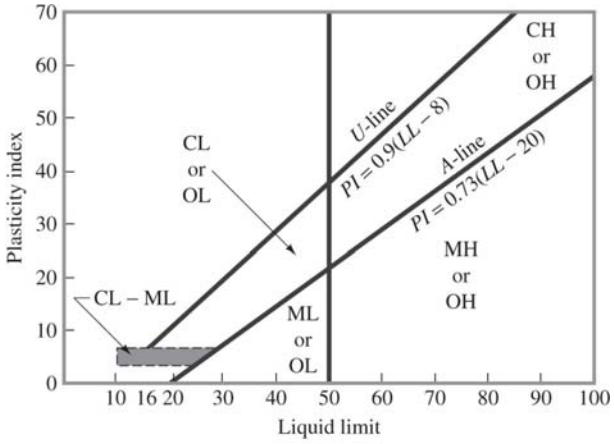

Figure 4.2 Plasticity chart

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 gravel 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 gavel (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 4.3 Flowchart group names for gravelly and sandy soil (Reprinted with permission from Annual Book of ASTM Standards, 2010, copyright ASTM International, 100 Barr Harbor Drive, West Conshohocken, PA, 19428.)

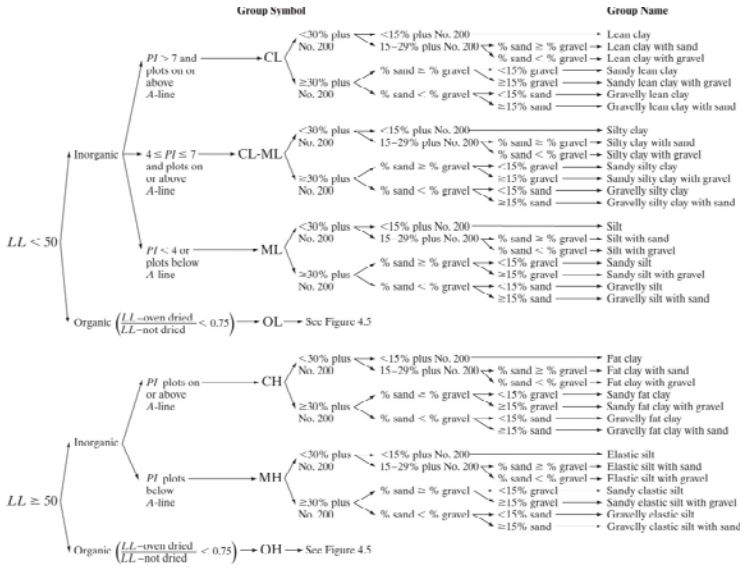

Figure 4.4 Flowchart group names for inorganic silty and clayey soils (Reprinted with permission from Annual Book of ASTM Standards, 2010, copyright ASTM International, 100 Barr Harbor Drive, West Conshohocken, PA, 19428.)

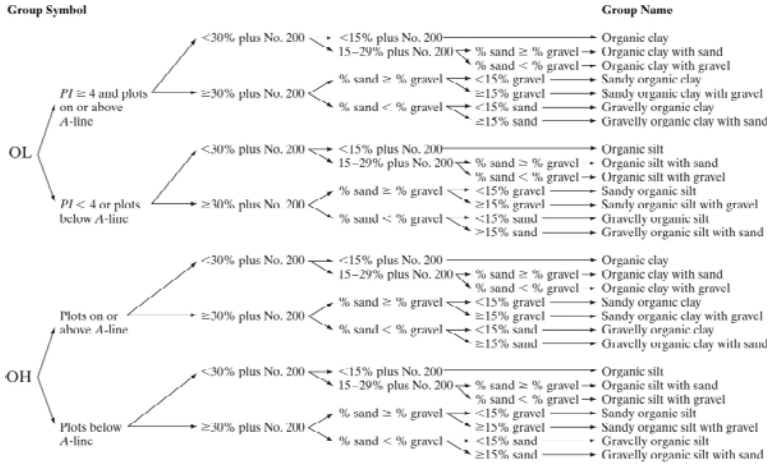

Figure 4.5 Flowchart group names for organic silty and clayey soils (Reprinted with permission from Annual Book of ASTM Standards, 2010, copyright ASTM International, 100 Barr Harbor Drive, West Conshohocken, PA, 19428.)