Al-Mustaqbal University College

Building &Construction Technology Engineering Department

Soil mechanics

By
Dr. Yasir Mohammed Jebur

AASHTO Classification System

American Association of State Highway and Transportation Officials system (For road construction). This classification system is based on the following criteria:

1. Grain size

Definition of Grain Size

a. Gravel: fraction passing the 75-mm sieve and retained on the No. 10 (2-mm) sieve

b. Sand: fraction passing the No. 10 (2-mm) sieve and retained on the No. 200 (0.075-mm) sieve

c. Silt and clay: fraction passing the No. 200 sieve
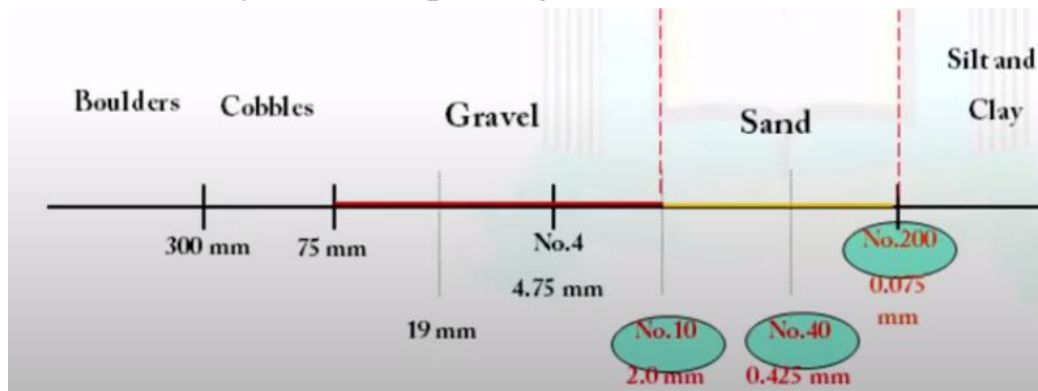
2. Plasticity

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 11 or more.

- The system divided the soils into 8 major groups: A-1~A-7 and organic soils A-8
- According to this system, soil is classified into seven major groups: A-1 through A-7. Soils 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 AASHTO classification is given in Table 5.1.

Table 5.1 Classification of Highway Subgrade Materials

| General classification	Granular materials (35% or less of total sample passing No. 200)						
	A-1		A-3	A-2			
Group classification	A-1-a	A-1-b		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						
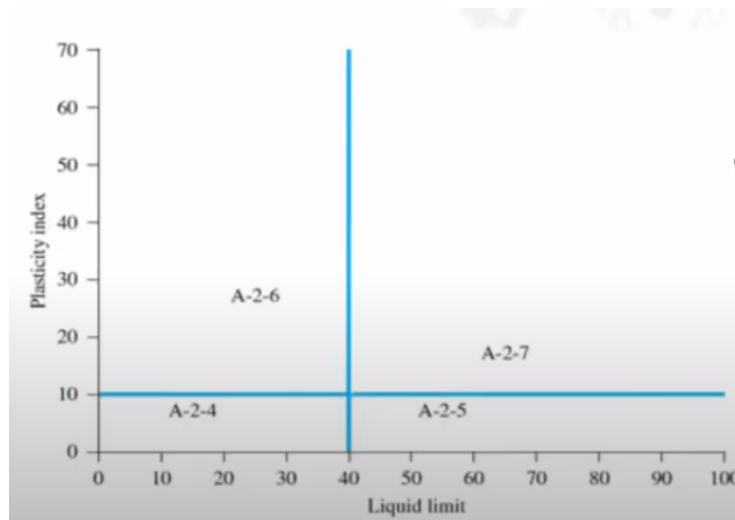
General classification	Silt-clay materials (more than 35% of total sample passing No. 200)			
Group classification	A-4	A-5	A-6	A-7 A-7-5[a] A-7-6[b]
Sieve analysis (percentage passing)				
No. 10				
No. 40				
No. 200	36 min.	36 min.	36 min.	36 min.
Characteristics of fraction passing No. 40				
Liquid 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, $PI \leq LL - 30$
[b]For A-7-6, $PI > LL - 30$

To classify a soil according to Table 5.1, one must apply the test data 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 5.2 shows a plot of the range of the liquid limit and the plasticity index for soils that fall into groups A-2, A-4, A-5, A-6, and A-7.
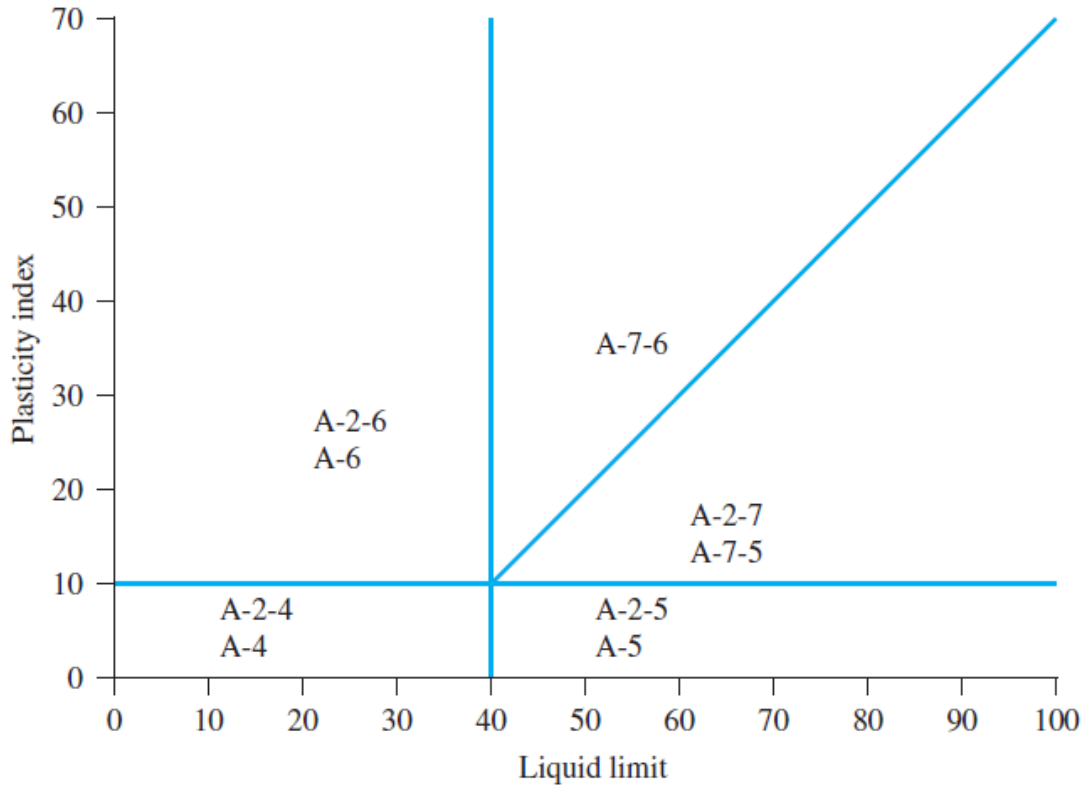
group index (GI)

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

$$GI = (F_{200} - 35)[0.2 + 0.005(LL - 40)] + 0.01(F_{200} - 15)(PI - 10)$$

where F_{200} = percentage passing through the No. 200 sieve
LL = liquid limit
PI = plasticity index

The first term of Eq. (5.1)—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, $0.01(F200 - 15)(PI- 10)$—is the partial group index determined from the plasticity index.

Following are some rules for determining the group index:
1. If Eq. (5.1) yields a negative value for GI, it is taken as 0.
2. The group index calculated from Eq. (5.1) is rounded off to the nearest whole number (for example, GI =3.4 is rounded off to 3; 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

$$GI = 0.01(F_{200} - 15)(PI - 10)$$

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

Example

The results of the particle-size analysis of a soil are as follows:
• Percent passing the No. 10 sieve = 42
• Percent passing the No. 40 sieve = 35
• Percent passing the No. 200 sieve = 20

The liquid limit and plasticity index of the minus No. 40 fraction of the soil are 25 and 20, respectively. Classify the soil by the AASHTO system.

Solution

Since 20% (i.e., less than 35%) of soil is passing No. 200 sieve, it is a granular soil.

Hence it can be A-1, A-2, or A-3. Refer to Table 5.1. Starting from the left of the table, the soil falls under A-1-b (see the table below).

Parameter	Specifications in Table 5.1	Parameters of the given soil
Percent passing sieve		
No. 10	—	
No. 40	50 max	35
No. 200	25 max	20
Plasticity index (PI)	6 max	$PI = LL - PL = 25 - 20 = 5$

The group index of the soil is 0. So, the soil is **A-1-b(0)**.

Example

Ninety-five percent of a soil passes through the No. 200 sieve and has a liquid limit of 60 and plasticity index of 40. Classify the soil by the AASHTO system.

Solution

Ninety-five percent of the soil (which is $\geq 36\%$) is passing through No. 200 sieve. So it is a silty-clay material. Now refer to Table 5.1. Starting from the left of the table, it falls under A-7-6 (see the table below).

Parameter	Specifications in Table 5.1	Parameters of the given soil
Percent passing No. 200 sieve	36 min.	95
Liquid limit (LL)	41 min.	60
Plasticity index (PI)	11 min.	40
PI	> LL − 30	PI = 40 > LL − 30 = 60 − 30 = 30

$$GI = (F_{200} - 35)[0.2 + 0.005(LL - 40)] + 0.01(F_{200} - 15)(PI - 10)$$
$$= (95 - 35)[0.2 + 0.005(60 - 40)] + (0.01)(95 - 15)(40 - 10)$$
$$= 42$$

So, the classification is **A-7-6(42)**.