CLASSFICATION FOR ENGINEERING PURPOSES:

The purpose of soil classification is to arrange various types of soils into groups according to their engineering properties or other characteristics. Soil possessing similar characteristics can be placed in the same group. However, from engineering point of view, the classification may be done with the objective of finding suitability of the soil for the construction of dams, highways or foundations etc.

For general engineering purposes, soils may be classified by the following systems:

- Particle size classification
- Textural classification
- Highway research board (HRB) classification
- Unified soil classification
- Indian standard (Bureau of Indian standard) classification (BIS)

FEATURES / REQUIREMENTS OF SOIL CLASSIFICATION :

- It should have a limited number of groups.
- It should be based on the engineering properties which are most relevant for the purpose forwhich the classification has been made.
- It should be simple and should use the terms which are easily understood.
- It should be acceptable to all engineers.
- It should have accuracy in indicating the performance of a soil under certain field conditions.

In this system, soils are arranged according to the grain size. Terms such as gravel, sand, silt, and clay are used to indicate grain sizes. It is preferable to use the word ‘silt size’ and ‘clay size’ in place of simply ‘silt’ or ‘clay’ in this system. There are various grain size classification in use, but the more commonly used systems are,

i) U.S.Bureau of soil and public road administration (PRA) system of united states.
ii) International soil classification

0.005mm 0.05 0.10 0.25 0.75 1.0 2.0mm

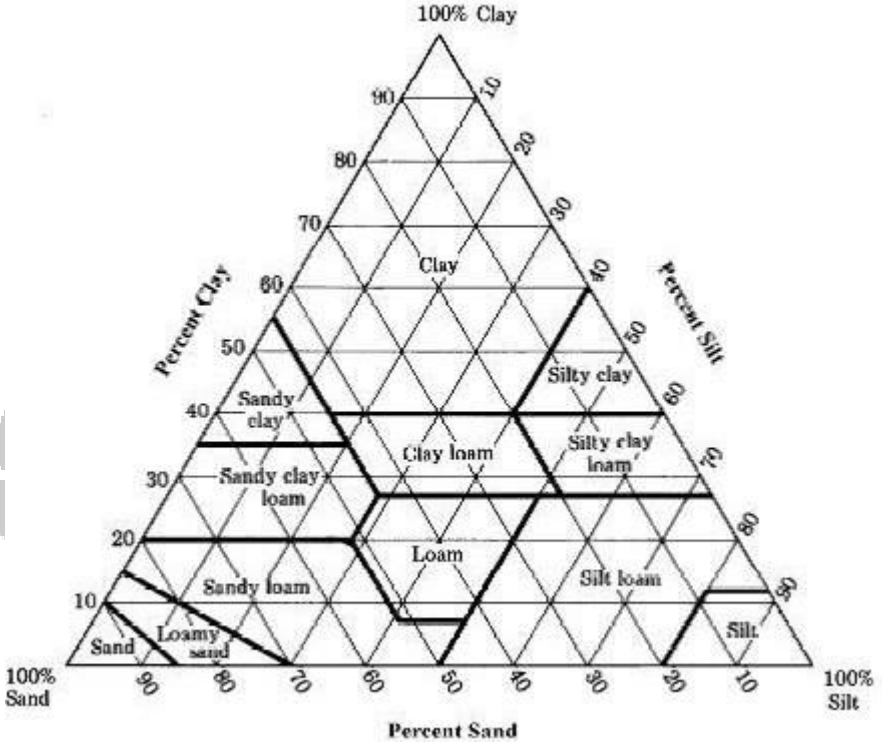
CLAY	SILT (size)	VERY FINE	FINE	MEDIUM	COARSE	FINE GRAVEL	GRAVEL

TEXTURAL CLASSIFICATION :

Soils occurring in nature are composed of different percentage of sand, silt and clay size particles. Soil classification of composite soils exclusively based on the particle size distribution is known as textural classification probably the best known of these textual classification is the triangular classification. Such a classification is more suitable for coarse grained soils than clay soils.

To use the chart, for the given percentage of the three constituents forming a soil lines are drawn parallel to the three sides of the triangle.

TEXTURAL CLASSIFICATION CHART :



HIGHWAY RESEARCH BOARD (HRB) CLASSIFICATION :

The HRB classification system also known as PRA classification system, is based on both the particle size composition as well as the plasticity characteristics. The system is mostly used for pavement construction soils are divided into 7 groups designated as A-1, A-2…… A-7 . A group index is used to describe the performance of the soils when used for pavement construction. The higher the value of the index, the poorer is the quality of the mentioned. The group index of a soil depends upon i) The amount of material passing the 75μ IS sieve. ii) The liquid limit (W_L) and

iii) The plastic limit (W_p)

UNIFIED SOIL CLASSIFICATION :

The system is based on both grain size and plasticity properties of the soil and is therefore applicable to any use. Soils are broadly divided into three divisions such on coarse soil the grainedsoil and highly organic soils.

IS (or) BIS (BUREAU OF INDIAN STANDARD CLASSIFICATION):

Soils are broadly divided into three groups.

- Coarse grained soils
- Fine grained soils
- Highly organic soils

Coarse grained soils:

In these soils, more than half the total material by mass is larger than 75μ IS sieve size.

Fine grained soils:

In these soils, more than half the total material by mass is smaller than 75μ IS sieve size.

Highly organic soils:

These soils certain large percentages of fibrous organic matter, such as peat and the particle ofdecomposed vegetation.

COARSE GRAINED SOILS :

Coarse grained soils are further divided into two sub divisions.

a) Gravel (G) : In these soils, more than half the course fraction is larger than 4.75 mm Is sievesize. This sub division includes gravels and gravelly soil and is designated by symbol G.
b) Sands (S): In these soils, more than half the course fraction is smaller than 4.75 mm Is sievesize. Each sub division is divided into four groups.
   W : Well graded

   P : Poorly graded

   C : Well graded with excellent clay binder

   M : containing fine materials

FINE GRAINED SOILS :

Fine grained soils are further divided into three sub-divisions.

a. Inorganic silts and very fine sands : M
b. Inorganic clays : C
c. Organic silts and clays and organic matter : O

Fine grained soils are further divided into following groups:

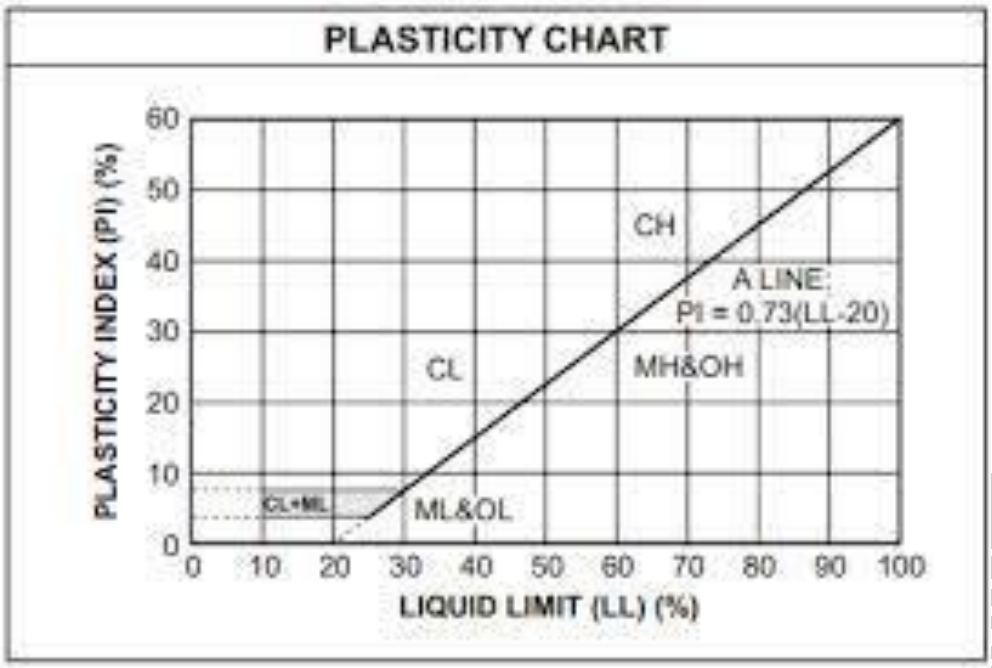
i) Silts and clays of low compressibility LL < 35, represented by 'L'
ii) Silts and clays of medium compressibility LL < 35 | < 50, represented by 'I'
iii) Silts and clays of high compressibility LL > 50, represented by 'H'

Example :

ML – Inorganic silt with low to medium compressibility laboratory classification of fine grained soils is done with the help of plasticity chart shown below. The A –line dividing in organic clay from silt and organic soil has the following equation.

$$I_P = 0.73\ [W_L - 20]$$

PLASTICITY CHART (IS SOIL CLASSIFICATION SYSTEM) :.



IS CLASSIFICATION:

TABLE 4.6. BASIC SOIL COMPONENTS (IS CLASSIFICATION)
(IS : 1498-1970)

Soil	*Soil Component*	*Symbol*	*Particle size range and description*
Coarse-grained components	Boulder	None	Round to angular, buiky hard, rock particle, average diameter more than 30 cm
	Cobble	None	Round to angular, bulky hard, rock particle, average diameter smaller than 30 cm but retained on 80 mm sieve
	Gravel	G	Rounded to angular, bulk, hard, rock particle, passing 80 mm sieve but retained on 4.75 mm sieve *Coarse* : 80 mm to 20 mm sieve *Fine* : 20 mm to 4.75 mm sieve
	Sand	S	Rounded to angular bulky, hard, rocky particle, passing 4.75 mm sieve retained on 75micron sieve *Coarse* : 4.75 mm to 2.0 mm sieve *Medium* : 2.0 mm to 425 micron sieve *Fine* : 425 micron to 75 micron sieve
Fine-grained Components	Silt	M	Particles smaller than 75-micron sieve indentified by behaviour, that it is slightly plastic or non-plastic regardless of moisture and exhibits little or no strength when air dried
	Clay	C	Particles smaller than 75-micron sieve identified by behaviour, that is, it can be made to exhibit plastic properties within a certain range of moisture and exhibits considera ble strength when air dried
	Organic matter	O	Organic matter in various sizes and stages of decomposition.

TABLE 4.8. IS SOIL CLASSIFICATION : LABORATORY CLASSIFICATION CRITERIA FOR COARSE GRAINED SOILS (IS : 1498 –1970)

<table>
<tr><th>Groups Symbols</th><th colspan="2">Laboratory Classlfication Criteria</th><th></th></tr>
<tr><td>GW</td><td colspan="2">C_U Greater than 4
C_C Between 1 and 3</td><td rowspan="8">Determine percentages of gravel and sand from grain sizes curve depending on percentage of fines (fraction smaller than No. 75 micron sieve size) ; coarse-grained soils are classified as follows :

Less than 5% : GW, GP, SW, SP

More than 12% : GM, GC, SM, SC

5% to 12% : Border line cases requiring use of dual symbols

$C_U = \frac{D_{60}}{D_{10}}$ (uniformity coefficient)
$C_C = \frac{(D_{30})^2}{D_{10} \times D_{60}}$ (coefficient of curvature)</td></tr>
<tr><td>GP</td><td colspan="2">Not meeting all gradation requirements for GW</td></tr>
<tr><td>GM</td><td>Atterberg limits below "A" line or I_P less than 4</td><td rowspan="2">Above "A" line with I_P between 4 and 7 are border line cases requiring use of dual symbols.</td></tr>
<tr><td>GC</td><td>Atterberg limit above "A" line with I_P greater than 7</td></tr>
<tr><td>SW</td><td colspan="2">C_U Greater than 6
C_C Between 1 and 3</td></tr>
<tr><td>SP</td><td colspan="2">Not meeting all gradation requirements for SW</td></tr>
<tr><td>SM</td><td>Atterberg limits below "A" line or I_P less than 4</td><td rowspan="2">Limits plotting above "A" line with I_P between 4 and 7 are border line cases requiring use of dual symbols</td></tr>
<tr><td>SC</td><td>Atterberg limit above "A" line with I_P greater than 7</td></tr>
</table>

Procedure for IS soil Classification:

Step :1 check whether it is coarse grained soil or fine grained soil

- coarse grained soil – more than 50% of soil retained above 75 µ
- fine grained soil - less than 50% of soil retained above 75 µ

Step :2 Case 1: If it is coarse grained soil

a)check whether it is gravel or sand

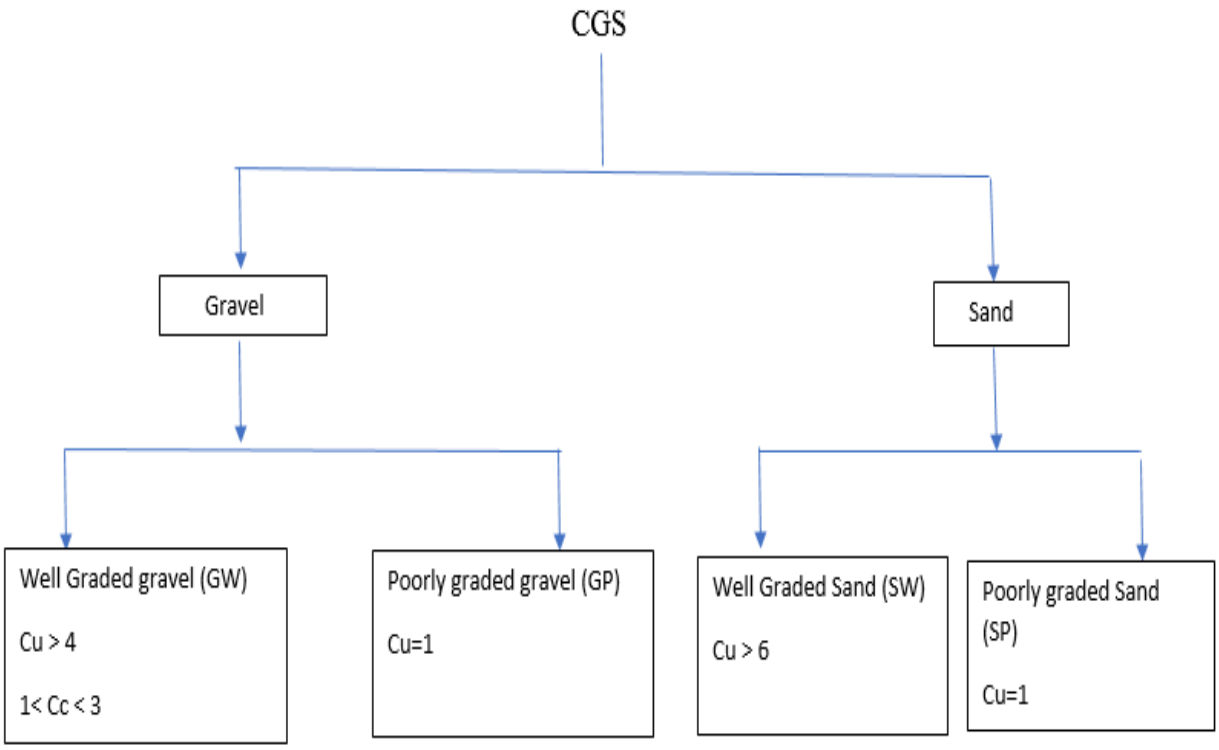
- Gravel – more than 50% of soil retained in 4.75mm IS sieve
- Sand - more than 50% of soil retained in between 4.75mm to 75 µ IS sieve

b)Check the percentage of finer

i) finer <5%

$$C_u = \frac{D_{60}}{D_{10}}$$

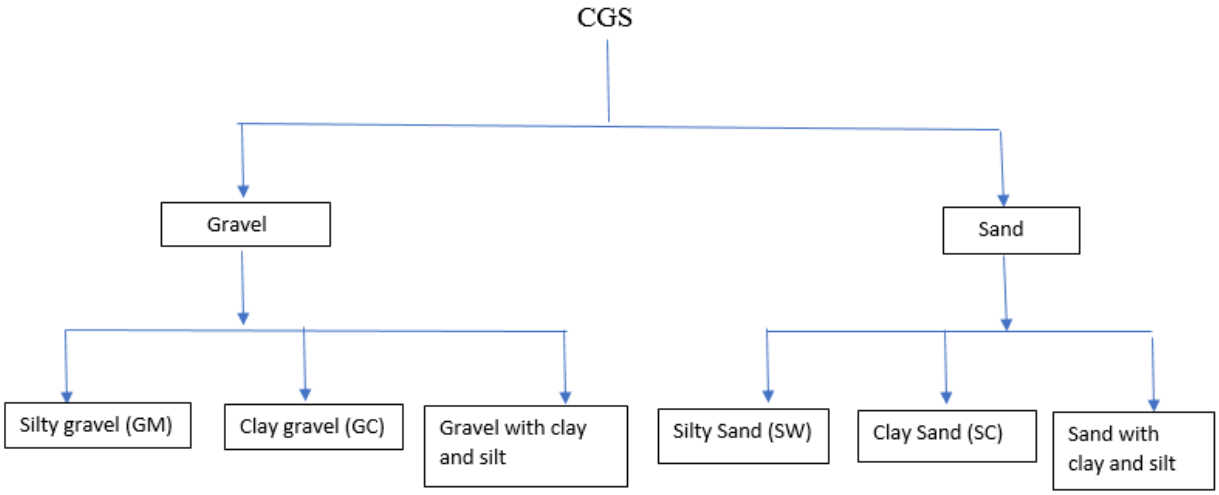
$$C_c = \frac{D_{30}^2}{D_{60} X D_{10}}$$



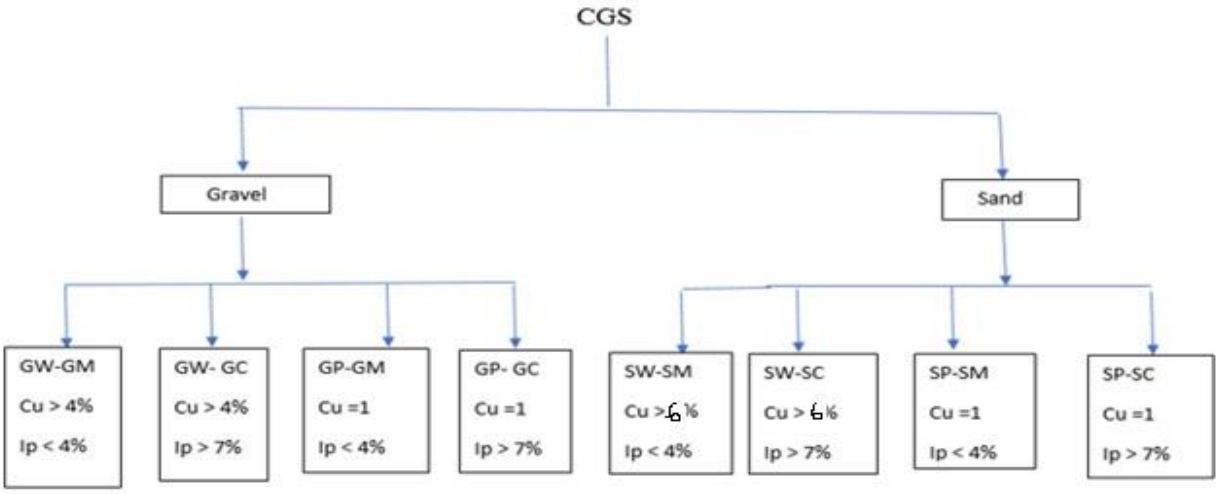
ii) finer >12%

Ip < 4% - Silt

Ip > 7% - Clay

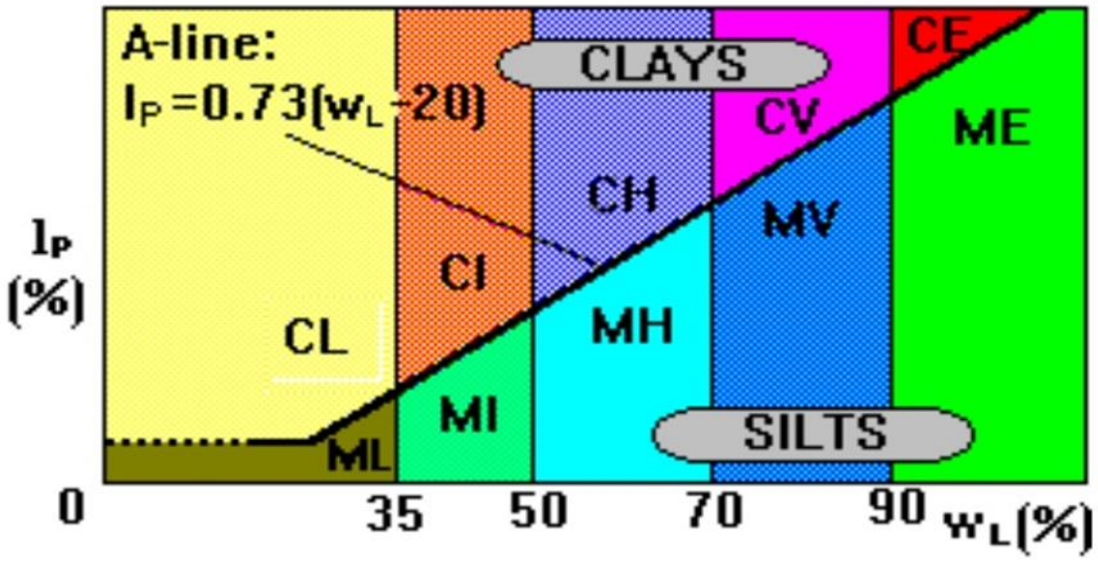


iv) finer 5-12%



Case b)If it is fine grained Soil

- Clay(c) – above A line
- Silt(M) or Organic(o) – Below A line



$I_p > I_{pc}$ ------ clay

$I_p < I_{pc}$ ------ silt or organic

0-35----- low plasticity

35-50---- medium plasticity

>50------ high plasticity

1)The following results are obtained from a soil sample. Percentage passing 4.75mm sieve=70, percentage passing 75-micron sieve =10, uniformity coefficient=8 plasticity index 3.5%. Classify the soil as per IS soil classification

100%

Coarse grained soil(CGS)	=100-(70+10)=20 (4.75mm IS sieve)	Gravel(G)
90%	70 (75micron IS sieve)	Sand(S)
Fine grained soil(FGS)	10	% of finer
10%		

Step :1 check whether it is coarse grained soil or fine grained soil

coarse grained soil –here more than 50% of soil retained above 75 µ

Step :2 Case 1: If it is coarse grained soil

a) check whether it is gravel or sand

Sand - more than 50% of soil retained in between 4.75mm to 75 µ IS sieve

Step3)Check the percentage of finer

Here percentage of finer is between 5-12

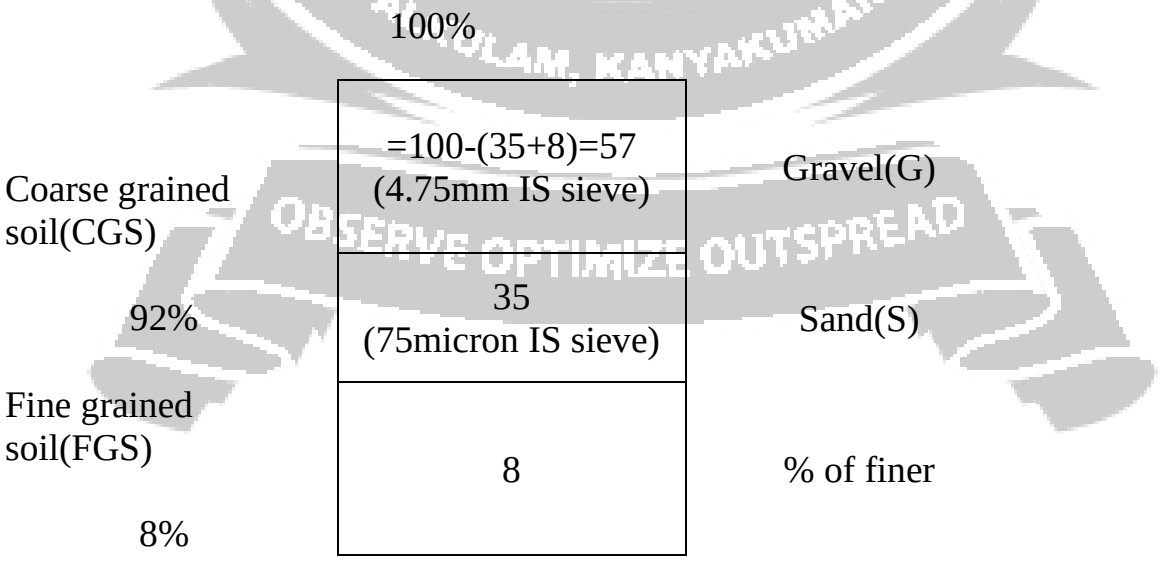
Given C_u=8 and Ip=3.5

Refer the flow chart

Therefore, it is SW-SM type

That is well graded sand and silty Sand

2.The following results are obtained from a soil sample. Percentage passing 4.75mm sieve=35, percentage passing 75 micron sieve =8, size corresponding to 10% finer =0.8mm; 30% finer =3mm; 60% finer =6mm;liquid limit=25%;plastic limit=17%. Classify the soil as per IS soil classification



Step :1 check whether it is coarse grained soil or fine grained soil

- coarse grained soil – Here more than 50% of soil retained above 75 µ

Step :2 Case 1: If it is coarse grained soil

a) check whether it is gravel or sand

- Gravel – more than 50% of soil retained in 4.75mm IS sieve IS sieve

Step3)Check the percentage of finer

Here percentage of finer is between 5-12

$$C_u = \frac{D_{60}}{D_{10}}$$

$$= \frac{6}{0.8} = 7.5$$

Ip=Liquid limit – Plastic limit

=25-17=8

Refer the flow chart

Therefore, it is GW-GC type

That is well graded gravel and claygravel

3. The following results are obtained from a soil sample. Percentage passing 4.75mm sieve=20, percentage passing 75 micron sieve =70, size corresponding to 10% finer =0.5mm; 30% finer =2.5mm ; 60% finer =6mm;liquid limit=30%;plastic limit=20%. Classify the soil as per IS soil classification

100%

Coarse grained soil(CGS)	=100-(20+70)=10 (4.75mm IS sieve)	Gravel(G)
30%	20 (75micron IS sieve)	Sand(S)
Fine grained soil(FGS)	70	% of finer
7s0%		

Step :1 check whether it is coarse grained soil or fine grained soil

fine grained soil –Here less than 50% of soil retained above 75 µ

Step :2 Case 2: If it is Fine grained soil

Ip=WL-WP

=30-20=10

Refer the graph

Therefore, it is ML

That is Low silt