Procedure

1. Clean, dry and weigh (M_1) the weighing bottle or appropriate container with lid to the accuracy of 0.01 g, 0.1 g and 1 g for *FG*, *MG* and *CG* soils respectively.

2. Take crumbled soil sample in amounts of at least 30 g for *FG* soil, 300 g for *MG* soil and 2.5 kg for *CG* soil. Place loosely in the container or bottle. Replace the lid or stopper and weigh (M_2) to the accuracy of Step 1.

Note: The IS:2720-II recommends a weighing accuracy of 0.04 per cent of the mass of soil sample.

3. Remove the lid. Place the container with its contents and the lid in the oven and dry at 105-110°C.

Note: The drying period varies with the type and quantity of soil. The soil may be deemed to be dry when the difference in successive weighings of the cooled sample does not exceed about 0.1 per cent of the original mass of the sample (BS: 1377). A 16-24 hours period is usually sufficient for most soils.

4. After drying, remove the container from the oven and place in a desiccator for cooling. Replace the lid and weigh (M_3).

Note: Containers with airtight lids need not be placed in the desiccator to cool, unless glass weighing bottle with ground glass stopper is used. The sample is allowed to cool in its container with the lid in place and weighed as soon as it is cool enough to handle.

Calculation

The water content w (%) is given by:

$$w = \frac{M_w}{M_s} = \frac{M_2 - M_3}{M_3 - M_1} \times 100 \qquad (2\,6)$$

The result is reported to the nearest 0.1 for water content upto 10 per cent and to the nearest whole number for higher values.

Note

Use a well designed oven as the temperature variations may lead to errors due to overheating. Higher drying temperatures may burn the organic matter and change the composition of mineral grains. Soils containing gypsum or significant amount of organic matter should be dried at about 60-80°C. Gypsum loses its water of crystallization at high temperatures and will affect the result by about 0.2 per cent for each 1 per cent of its quantity.

wash off carefully any adhering particles with a few drops of water. Close the desiccator and apply the vacuum again. Repeat Steps 4 and 5 until no more air is removed from the soil water mixture.

6. Remove the bottle from the desiccator. Fill completely with water. Record the temperature of contents (T°C) and insert the stopper. Wipe dry and weigh (M_3).

7. Empty the bottle, rinse thoroughly, refill with distilled water at the same temperature T°C, wipe dry on the outside and weigh (M_4).

8. Repeat the test on a second sample of the same soil.

Calculation

The specific gravity G of soil based on distilled water at the test temperature T°C is given by:

$$G = \frac{M_2 - M_1}{(M_2 - M_1) - (M_3 - M_4)} \tag{3.5}$$

The result is reported as an average of the two tests to the nearest 0.01. If the difference between the two test results is more than 0.03, the tests are repeated. Erratic values may be obtained for soils having a substantial proportion of heavier or lighter particles and a number of repeat tests may be necessary to get a good average.

OBSERVATION SHEET 3.1
SPECIFIC GRAVITY BY DENSITY BOTTLE

1. Sample description:
2. Capacity of bottle = 50 ml (approx.)
3. Test temperature = 28°C

TEST No.		1	2
1. Bottle No.		5	
2. Mass bottle + dry soil (M_2)	(g)	25.573	
3. Mass bottle empty (M_1)	(g)	16.705	
4. Mass dry soil ($M_2 - M_1$)	(g)	8.868	
5. Mass bottle + Soil + water (M_3)	(g)	74.215	
6. Mass bottle + water (M_4)	(g)	68.605	
7. ($M_3 - M_4$)	(g)	5.610	
8. ($M_2 - M_1$) − ($M_3 - M_4$)	(g)	3.258	
9. Specific gravity = (4)/(8)	(g)	2.72	

The methods are not applicable if the soil fines are less than 10 per cent of the total mass.

$$v' = \frac{g(G-1)D^2}{1.8 \times 10^{-2}\,\eta'} \tag{4.1}$$

where: v' = velocity of settlement (mm/s)
D = equivalent diameter (mm)
g = gravitational acceleration (9.8 m/s^2)
G = specific gravity of particles
η = viscosity of water (mN-s/m^2 or centipoise)

$$\text{or} \qquad D = 10^{-2}\sqrt{\frac{30\,\eta'}{g(G-1)}}\ \sqrt{\frac{H_e}{10t}} \tag{4.2}$$

where: H_e = depth of settlement (mm)
t = time of settlement (min)

Eq. 4.2 may also be written as

$$D = M\sqrt{\frac{H_e}{t}} \tag{4.3}$$

where :
$$M = 10^{-2}\sqrt{\frac{30\,\eta'}{g(G-1)}} \tag{4.4}$$

Expressing v in cm/sec, η in poise (dyne-sec/cm^2), g in m/sec^2 and H_e in cm, the above equations may be written as:

$$v = \frac{g(G-1)\,D^2}{18\,\eta} \tag{4.5}$$

and
$$D = M\sqrt{\frac{H_e}{t}} \tag{4.6}$$

where :
$$M = \sqrt{\frac{0.3\,\eta}{g(G-1)}} \tag{4.7}$$

Typical values of viscosity are given in Table 4.2 and those of factor M in Table 4.3.

TABLE 4.2
VISCOSITY OF DISTILLED WATER
(1 mN-s/m^2 = centipoise = 0.01 poise)

TEMP. (°C)	VISCOSITY (mN-s/m^2)	TEMP (°C)	VISCOSITY (mN-s/m^2)
4	1.568	23	0.938
16	1.116	24	0.916
17	1 088	25	0.895
18	1.060	26	0.875
19	1.034	27	0.855
20	1.009	28	0.836
21	0.984	29	0.818
22	0.961	30	0.800

of initial mass should be considered unsatisfactory and the test should be repeated. If within limits, the loss in mass may either be reported separately neglecting its effect on the other calculations or it may be suitably distributed in the observations.

The size fractions are as follows:

1.	Coarse gravel	= 100 — 85.6	= 14.4%
2.	Fine gravel	= 85.6 — 71.9	= 13.7%
3.	Coarse sand	= 71.9 — 67.0	= 4.9%
4.	Medium sand	= 67.0 — 31.2	= 35.8%
5.	Fine sand	= 31.2 — 9.7	= 21.5%
6.	Silt and clay		= 9.7%
		Total	= 100%

From graph (Fig. 4.1), $D_{10} = 0.08$mm, $D_{30} = 0.4$ mm, $D_{60} = 1.1$ mm,

Eq. 4.13 : $$C_u = \frac{1.1}{0.08} = 13.8$$

Eq. 4.14 : $$C_c = \frac{(0.4)^2}{1.1 \times 0.08} \simeq 2$$

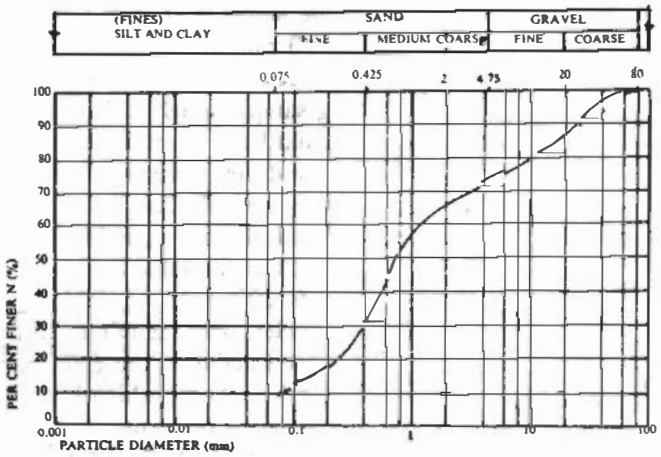

Fig. 4.1
Particle Size Distribution Curve