EXPERIMENT NO. DATE:

DETERMINATION OF GRAIN SIZE DISTRIBUTION BY HYDROMETER ANALYSIS

(IS: 2720 (Part 4) – 1985: grain size analysis)

Objective: The objective of the experiment is to determine the grain size distribution of the given soil sample.

Apparatus: **Hydrometer:** There should not be any abrupt change in cross section which may hinder the cleaning or drying or may permit the air bubbles to be trapped. The graduation of the stem of the hydrometer should be done on the basis of a liquid having a surface tension of 55 dynes/cm. Moreover the interval of the graduation should be 0.0005; the hydrometer is generally calibrated at 27^{o}C. It should also be ensured that the maximum permissible error of the hydrometer should be within plus or minus one scale division.

Glass measuring cylinder: Two of 1000 ml capacity with ground glass or rubber stoppers about 7 cm diameter and 33 cm high marked at 1000 ml volume.

Thermometer: To measure temperature ranging from 0 to 50^{o}C with accuracy of 0.5^{o}C.

Water bath or constant temperature room:

Stirring apparatus:

I.S. Sieve:

Balance: accuracy up to 0.01 g.

Oven: Thermostatically controlled to maintain temperature of 105^{o}C to 110^{o}C, with interior of non-corroding metal.

Stop watch:

Desiccator:

Centimetre-scale:

Porcelain evaporating dishes: Four dishes, about 15 cm in diameter.

Wide mouth conical flask or conical beaker of 1000 ml capacity:

Thick funnel-about 10 cm in diameter: About 10 cm in diameter.

Measuring cylinder: About 100 ml capacity.

Wash bottle: to contain distilled water.

Filter paper:

Glass rod: About 15 to 20 cm long and 4 to 5 mm in diameter.

Sodium hexametaphosphate solution: Dissolve 33 g of sodium hexametaphosphate and 7 g of sodium carbonate in distilled water to make one litre of solution. The amount may slightly vary.

Calibration:

1. Take approximately 800 ml water in a 1000 ml measuring cylinder. Note down the water level in the measuring cylinder.
2. Immerse the hydrometer in the water within the measuring cylinder. Note down once again the water level in the measuring cylinder.
3. The difference of readings between step 1 and step 2 gives the estimate of the volume of the hydrometer bulb (V_H) in ml plus volume of that part of the stem that is submerged. For practical purposes the error to the inclusion of this stem volume may be neglected.
4. Measure the weight of the hydrometer to the nearest 0.1 g. This is weight is due to the volume of the bulb plus the volume of the stem below the 1000 ml graduation mark. For practical purposes the error due to the inclusion of this stem may be neglected.
5. Determine the cross sectional area (A) of the 1000 ml measuring cylinder in which the hydrometer is to be used. The sectional area is equal to the volume include between the two graduations divided by the measured distance between them.
6. Place the hydrometer on the paper and sketch it. On the sketch note the lowest and highest readings which are on the hydrometer and also mark the neck of the bulb. Mark the center of the bulb which is half of the distance between neck of the bulb and tip of the bulb.
7. Record the distance (H_{e1}) from the lowest calibration mark (R_{h1}) on the stem to the centre of hydrometer bulb.
8. Record the distance (H_{e2}) from the highest calibration (R_{h2}) i.e. neck of the hydrometer bulb to the centre of hydrometer bulb.
9. Plot a curve (C_1) of H_e vs R_h on the graph paper using the following equation:

$$H_e = H_{e1} - \frac{(H_{e1} - H_{e2})R_h}{(R_{h2} - R_{h1})}$$

   This equation can be used to find out any distance H_e corresponds to the hydrometer reading R_h for sedimentation period up to 4 minutes.
10. Plot another curve (C_2) H_e vs R_h on the graph paper using the following equation:

$$H_e = H_{e1} - \frac{(H_{e1} - H_{e2})R_h}{(R_{h2} - R_{h1})} - \frac{V_H}{2A}$$

    This equation can be used to find out any distance H_e corresponds to the hydrometer reading R_h for sedimentation period after 4 minutes.

Corrections over hydrometer reading:

$$R_c = R_h + C_m \pm C_t - C_d$$

Where, C_m: Meniscus correction

C_t: Temperature correction (if temperature is more than calibration temperature then C_t will be added to R_h else C_t will be subtracted from R_h)

C_d: Dispersing agent correction

Only meniscus correction will be applied on R_h for calibrating the hydrometer reading.

Procedure:

1. Take around 50 g or 40 g (W_s) dry soil passing through 75 μ I.S. sieve. Mix it with approximately 100 cc distilled water and prepare a thin paste.
2. Add suitable quantity (around 100 cc) of deflocculating agent with the paste. It is then allowed to soak for five minutes.
3. Transfer the sample into a dispersion cup.
4. Fill the cup three-fourths by using distilled water. Stir the suspension for minutes.
5. Transfer the suspension into a 1000 cc jar of uniform cross section. Add y more water so that total volume will become 1000 cc.
6. Mix the suspension in the jar thoroughly by firmly placing the palm of the hand on the open end and turning the jar upside down and back.
7. Now place the jar on the table and immerse the hydrometer into the suspension. Start the stop watch. Take the reading of the hydrometer immediately after inserting the hydrometer, ½ , 1, 2 and 4 minutes.
8. Take the hydrometer out from the suspension.
9. Mix the soil suspension thoroughly once again and re-start the stop watch.
10. Note down the reading of the hydrometer after 5, 10, 15, 30, 60, 120, 240 minutes etc from. Insert the hydrometer only about 30 seconds before each hydrometer reading. Precautions should be taken while inserting the hydrometer into the suspension so that it becomes stable at the time the reading is due. The hydrometer should be taken out as soon as the reading is taken without disturbing the suspension.

[*Note:* Soil sample amount may slightly vary in laboratory experiment]

Observations:

Table: Hydrometer Analysis

Elapsed time (seconds)	Hydrometer reading (r_h)	Hydrometer reading [$R_h = (r_h - 1)X1000$]	$R_h + C_m$	H_e (cm)	$D = \sqrt{\frac{1.8\mu}{(G-1)}}\sqrt{\frac{H_e}{60t}}$	$R_c = R_h + C_m \pm C_t - C_d$	$N'(\%) = \frac{G}{(G-1)}\frac{R_c}{W_s} \times 100$	$N\ (\%) = N' \times \frac{W_1}{W}$

Where W_1 is the total mass of soil sample passing through 75μ I.S. sieve from which 50 g dry soil is taken from test.

W is the total mass of soil sample taken for combined sieve and hydrometer analysis.

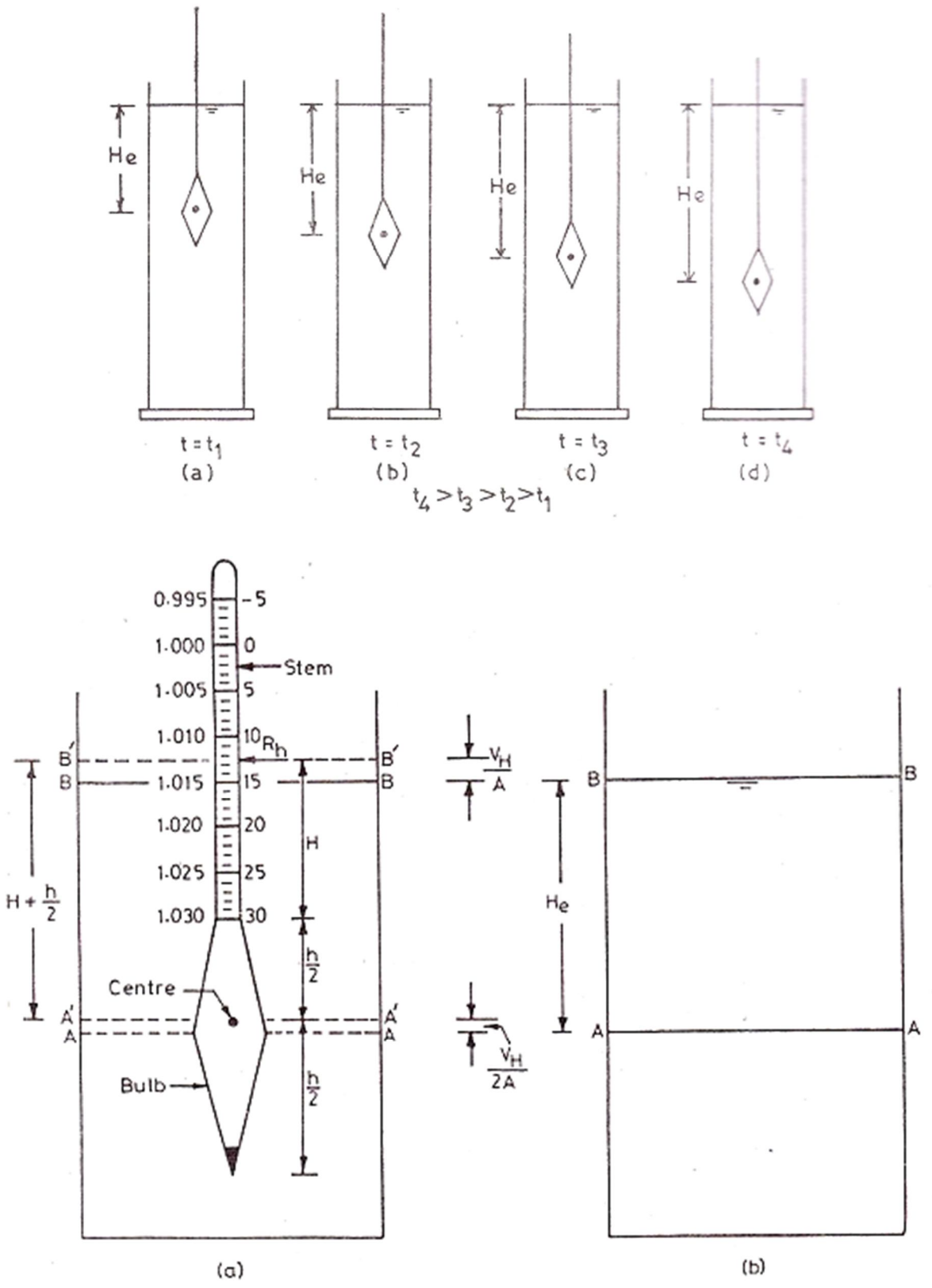

Figure: Glass cylinder and Hydrometer bulb

Discussions: