Lesson 03

Title of the Experiment: Determination of different fractions of soil by hydrometer test and textural triangle

(Activity number of the GCE Advanced Level practical Guide - 03)

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Introduction:

The percentage of sand, silt and clay in the inorganic fraction of soil is measured using this procedure. The method is based on Stoke's law governing the rate of sedimentation of particles suspended in water.

Learning outcomes:

At the end of the experiment, students will be able to

- develop skills in soil sampling
- obtain accurate readings using the hydrometer
- determine different fractions of soil by textural triangle
- calculate the percentage of sand, silt and clay in a soil sample

Materials/Equipment:

Soil samples
2 mm sieve
Hydrometer
Crucible
Electric burner
10% sodium hydroxide/ammonium hydroxide/sodium hexametaphosphate (calgon solution)
Hydrogen peroxide
Mechanical stirrer/beaker and a glass rod
Amyl alcohol
Wash bottle
Distilled water
Stopwatch
A piece of polythene and rubber bands
Electronic balance
Desiccator
Measuring cylinder, 1000 mL capacity
Textural triangle

Methodology/Procedure:

a. Sieve a soil sample using the 2 mm sieve.
b. Divide the sieved soil sample into two. (to determine the wetting point and texture)
c. Take one soil sample to measure wetting point
d. Measure the empty crucible (a g)
e. Add 50 g of soil to the crucible and weigh. (b g)
f. Leave the crucible with soil in an oven for 8 hours until a constant weight is obtained and weigh (c g)
g. Calculate the moisture of the soil sample

h. Take a proper quantity of soil samples from different soil fraction.
i. Note: take 100 g from a sandy soil and 50 g for other soil varieties
j. Add hydrogen peroxide to the soil sample and heat in a beaker using a water bath.
k. Add 50 mL of 10% of sodium hydroxide/ Ammonium hydroxide or 5% Calgon solution and leave for 12 hours.
l. Put the soil sample into a metal container and stir with an electric stirrer at 1600 rpm for 2 min.
m. Note: use a glass rod for 10 min if an electronic stirrer is not available
n. Add the solution to a 1 L measuring cylinder and add distilled water up to 1 L mark from a wash bottle.
o. Secure the open end of the measuring cylinder with a piece of polythene and rubber bands. Shake the solution upside down carefully.
p. Add few drops of amyl alcohol to remove any air bubbles and pour the solution to a hydrometer.
q. Take the hydrometer readings at 2 min and 2 hrs when necessary and record the temperature of the solution using a thermometer when the readings were taken.
r. Prepare a control experiment. Add 50 mL of 10% of sodium hydroxide/ Ammonium hydroxide or 5% Calgon solution to a measuring cylinder and bring it up to 1 L mark with distilled water.
s. Secure the open end of the measuring cylinder with a piece of polythene and rubber bands. Shake the solution upside down carefully.
t. Add few drops of amyl alcohol to remove any air bubbles and pour the control solution to a hydrometer. Take the hydrometer readings at 2 min and 2 hrs when necessary and record the temperature of the solution using a thermometer when the readings were taken.

Shake the soil solution upside down carefully without any spill.

Addition of sodium hydroxide/ Ammonium hydroxide or Calgon solution can be done on the 1st day of the practical examination and leave for 12 hours. The other half of the experiment can be done on the next day.

Readings/Observations:

1. **Readings of the control experiment**
   Reading of the hydrometer at 2 min = h_1
   Reading of the hydrometer at 2 hrs = h_2
   Temperature of the control solution at 2 min = T_1 °C
   Temperature of the control solution at 2 hrs = T_2 °C

2. **Readings of the soil solution**
   Reading of the hydrometer at 2 min = H_1
   Reading of the hydrometer at 2 hrs = H_2
   Temperature of the control solution at 2 min = T_3 °C
   Temperature of the control solution at 2 hrs = T_4 °C

Calculations:

1. Moisture content (θ) = $\frac{b-c}{c-a}$

2. wetting point = $1 + \theta$

3. Calculate the dry weight of the soil sample. (M_s)

Dry weight of the soil sample = $\frac{wet\ mass\ of\ the\ soil\ sample}{\text{wetting point}}$

4. Calculate the temperature correction for the hydrometer and obtain the corrected readings.

   Temperature correction $=\left\{\left[T_x \frac{9}{5}+32\right]-68\right\}0.2$

   (If the temperature is above 20 °C)

   Temperature correction $=\left\{\left[T_x \frac{9}{5}+32\right]+68\right\}0.2$

   (If the temperature is below 20 °C)

   Corrected reading for the soil solution at 2 min = H_1^1

   Corrected reading for the soil solution at 2 hrs = H_2^1

   Corrected reading for the control solution at 2 min = h_1^1

   Corrected reading for the control solution at 2 hrs = h_2^1

Time	Soil solution			Control solution (Water)		
	Hydrometer reading	Temperature (°C)	Corrected hydrometer reading	Hydrometer reading	Temperature (°C)	Corrected hydrometer reading
2 min	H_1	T_1	$H_1^1 = H_1 +$ correction factor	h_1	T_3	$h_1^1 = h_1 +$ correction factor
2 hrs	H_2	T_2	$H_2^1 = H_2 +$ correction factor	H_2	T_4	$h_2^1 = h_2 +$ correction factor

5. Do the following calculation to find the texture of the soil. (according to ISSS method)

   Percentage of the clay and silt $=\left[\frac{H_1^1-h_1^1}{M_S}\right]\times 100$

   Percentage of sand = 100 – (percentage of silt)

   Percentage of the clay $=\left[\frac{H_2^1-h_2^1}{M_S}\right]\times 100$

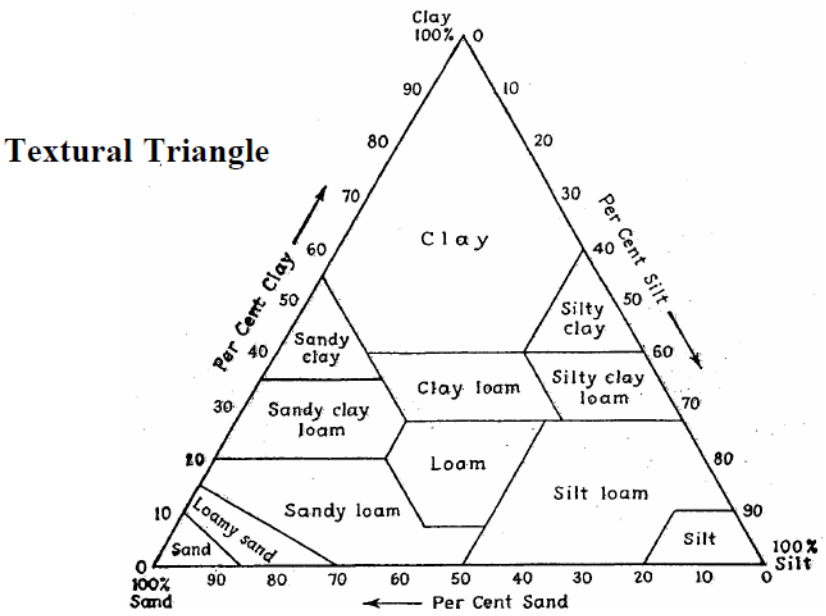
   Percentage of silt = (percentage of clay + silt) – percentage of clay

Discussions:

Use a soil textural triangle to find the soil type.

1. Mark the calculated percentage of soil on the sand base of the triangle.
2. Draw a parallel line to the silt base from the sand base.
3. Mark the calculated percentage of silt on the silt base of the triangle.
4. Draw a parallel line to the clay base from that point.
5. Mark the calculated percentage of clay on the clay base of the triangle.

6. Draw a parallel line to the sand base from that point.
7. The point where all the three lines meet indicates the textural type of the soil used.



References:

Soil Sampling and Methods of Analysis *(Second Edition)* 2006, Edited by M.R. Carter and E.G. Gregorich, Canadian Society of Soil Science, Taylor & Francis Group