Standard Operating Procedure of Major Equipment

(A) **Measurement of Wet aggregates:**

Principle: Several methods have been proposed to determine size distribution and stability of soil aggregates (Kemper and Rosenau, 1986). R.E. Yoder (1936) first developed wet-sieving techniques by using a nest of six sieved secured to a holder, which can move up and down in standing water in a drum through a distance of 3.18 cm at a rate of 30 cycles/min for 30 min. The amounts of aggregates retained on each of six sieves are determined by drying and weighing. In subsequent developments, the Yoder's apparatus has been modified in several ways to suite various purposes.

Equipment:

1. A wet sieve shaker (it comprises of 4 sets of nested sieves suspended from a bar which is oscillated by a shaft and crank system driven by an electric motor moving at approximately 1 oscillation per 2 seconds or 30 oscillations per minute. The nested sets of sieves move up-and-down through a vertical distance of about 3 cm submerged in tanks.)
2. Sets of sieves each having 20 cm diameter and 5 cm high with sieve openings of 5.0, 2.0, 1.0, 0.5, 0.25 and 0.01 mm diameter stacked in descending order.

Procedure:

1. Take about 50 g of air dried aggregates (passed through 8 mm and retained on 5 mm sieves) of the soil provided. Take about another 50 g of sub-sample of aggregates for water content determination on oven dry weight basis.
2. Place the 50 g of aggregate samples gently onto the top sieve of the nest of sieves.
3. Making sure the shaft and crank are such that the sieves rest in their lowest position, slowly bring the level of the water in the tanks to where they just begin to wet up the aggregates sitting on the top of sieve.
4. Allow the aggregates to gradually wet for 10 minutes. Now switch on the mechanical oscillator to move the nest of sieves up and down with a frequency of 30 cycles per minute and a stroke of 3 cm. Sieving is done for 10 minutes.
5. Remove the nest of sieves from the water and allow it to drain for some time. Separate the sieves by prying them apart gently with a putty knife.
6. Pour and wash out the contents of each sieve into a pre-weighed beaker and let settle for 24h. Then carefully decant off excess water making sure not to lose soil. Dry beakers along with the contents in an oven at 105°C for 24 hrs. After drying for 24 hours, weigh the beaker along with the dry soil aggregates and find out the weight of the dry soil aggregates in each beaker.
7. Add 30-40 ml of H_2O_2 into beaker containing dry soil aggregates for decomposition of organic matter which is a potential binding agent of primary particles. Repeat the process till the complete decomposition of organic matter indicated by stopping of effervescence. After that transfer the contents into the dispersion cup. Add dispersing agent and enough distilled water to fill the cup for easy stirring by a mechanical stirrer. Stir the suspension for 10 minutes. Wash the suspension on an identical set of sieves as used previously by means of a stream of tap water and a brush and transfer it to beakers. The primary particles in each beaker are oven dried and weighed. Calculate the percent

distribution of aggregates in different size ranges by subtracting the primary particles retained in respective sieves.

Calculation:

1. Calculation of Water stable aggregates:

M0: Total mass of aggregates on oven dry basis

M1: oven dry mass of aggregates retained on 5 mm sieve

M2: oven dry mass of aggregates retained on 2 mm sieve

M3: oven dry mass of aggregates retained on 1 mm sieve

M4: oven dry mass of aggregates retained on 0.5 mm sieve

M5: oven dry mass of aggregates retained on 0.25 mm sieve

M6: oven dry mass of aggregates retained on 0.1 mm sieve

M7: oven dry mass of primary particles retained on 5 mm sieve

M8: oven dry mass of primary particles retained on 2 mm sieve

M9: oven dry mass of primary particles retained on 1 mm sieve

M10: oven dry mass of primary particles retained on 0.5 mm sieve

M11: oven dry mass of primary particles retained on 0.25 mm sieve

M12: oven dry mass of primary particles retained on 0.1 mm sieve

M13: oven dry mass of unaggregated material less than 0.1 mm in diameter

% total aggregation = % WSA > 0.25 = [(M1+M2+M3+M4+M5)/M0] ×100

% total aggregation, after correction for primary particles = % WSA > 0.25, after correction for primary particles = [{(M1-M7)+(M2-M8)+(M3-M9)+(M4-M10)+(M5 -M11)}/M0]×100

2. Mean Weight Diameter (MWD) = $\sum_{i=1}^{i=n}(X_i W_i)/\sum_{i=1}^{i=n} W_i$

Where, X_i = Mean opening of the sieve (eg. 0.05, 0.175, 0.375, 0.75, 1.5, 3.5 mm for 0-0.01, 0.1-0.25, 0.25-0.5, 0.5-1.0, 1-2, 2-5 mm size classes, respectively)

Wi = Weight of retained aggregates (g)

n = Number of size classes

3. Geometric Mean Diameter (GMD) = $\exp((\sum_{i=1}^{i=n} W_i \log X_i)/(\sum_{i=1}^{i=n} W_i))$

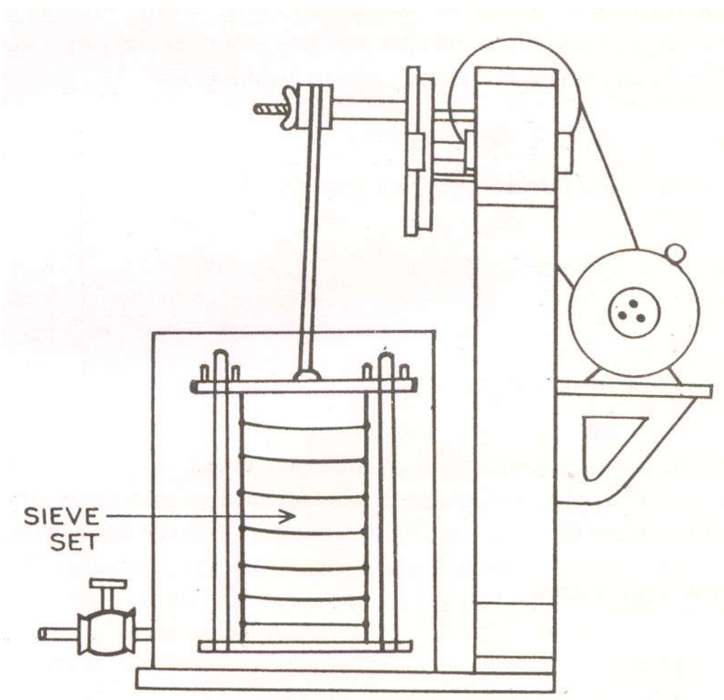

Fig. 1. Schematic diagram of the Yoder type Wet sieve shaker

Determination of soil water characteristics at higher suction using Pressure plate apparatus

Principle

When a ceramic plate, with saturated soil on it is subjected to an air pressure above the atmospheric pressure, the higher pressure forces excess water through the microscopic pores in the ceramic plate and out through the outlet system via the passage offered by the screen. The maximum air pressure that any given wetted porous ceramic plate can withstand before letting the air pass through, is determined by the diameter of the largest pore. The smaller the pore size, the higher air pressure will have to be to let air pass through. The pressure that finally breaks down these water menisci is called as Bubbling pressure or Air entry value. The pressure plate cell must always be used at air plate extraction value below its bubbling pressure.

Apparatus required

1. Pressure plate apparatus
2. Brass or rubber rings of 1 cm height and 6 cm diameter
3. Balance
4. Oven
5. Aluminium moisture cans
6. Pipette

Procedure:

1) Take soil samples from the field with auger and air dry them under shade. Grind the soil samples by striking in wooden hammer and sieve them through a 2 mm opening sieve.
2) Put the soil samples in duplicate inside the brass or rubber rings placed over appropriate ceramic plates and level them. Brass rings attached to core samplers can also be used directly for this purpose. Each plate can accommodate about 12 rings
3) Saturate the samples by placing the plate with the rings in a trough of water for about 24 hours. Water should be just enough to reach the upper edge of the rings.
4) After saturation, transfer the plates to the respective pressure chambers and place them on the hinge in case of less than 5 bar extractor or on the triangular support in case of more than 5 bar extractor.
5) Connect the nylon tube and rubber sleeve to the outlet pipe of the pressure plate apparatus.
6) Remove the excess water from the ceramic plates with a pipette or syringe.
7) Close all the unused outlets with the provided plug bolts and make sure that the “O” ring is in place in case of 15 bar extractor.
8) Fix the lid on the pressure chambers with nuts and bolts.
9) Adjust the pressure to the required level in the pressure chamber by adjusting appropriate regulator.
10) As the pressure builds up inside the pressure chamber, water will come out through the outflow tubes.
11) When soil water pressure equilibrates with air pressure, flow of water ceases.

12) After equilibrium is reached (there is no outflow of water), release the pressure in the chamber by shutting of the regulator gently.
13) Remove clamping bolts and lid to open the chamber.
14) Immediately transfer the samples to moisture boxes and take the weight as soon as possible in order to avoid loss of water due to evaporation.
15) Dry the samples in an oven at 105^0 C till constant weight and record the weight.
16) From these data, find out the moisture content at the corresponding pressure using the formula given below.

Observations and Calculations:

(i) Mass of the empty aluminium moisture box : Mb

(ii) Mass of the moisture box + wet soil = Mbws

(iii) Mass of the moisture box + oven-dry soil = Mbds

(iv) Gravimetric moisture content of soil, w (%) = $\frac{Mbws - Mbds}{Mbds - Mb} \times 100$

(v) Volumetric moisture content of soil θ = (w/100) x Bulk density

(vi) Available water capacity of soil = $\theta_{FC} - \theta_{PWP} = \theta_{0.033\ MPa} - \theta_{1.5MPa}$

Where, θ_{FC} = Volumetric moisture content at field capacity = volumetric moisture content at 0.033 MPa suction (for normal soils), $\theta_{0.033\ MPa}$ = volumetric moisture content at 0.01 MPa suction (for organic and sandy soils), $\theta_{0.01\ MPa}$

(vii) θ_{PWP} = Volumetric moisture content at permanent wilting point = $\theta_{1.5MPa}$

Precautions:

(i) Prevent air leakage from pressure plate assembly

(ii) Increase pressure in the pressure chamber gradually to the desired level

(iii) Before opening the lid assure that all the pressure has been released to avoid accident.

Table 4. Interpretation of available water storage capacity

AWSC (cm/m)	Classes
<5	Very low
5-10	Low
10-15	Medium
15-20	High
>20	Very high

(Source: AICRP SPC Bulletin No. 6, pp5, 1989)

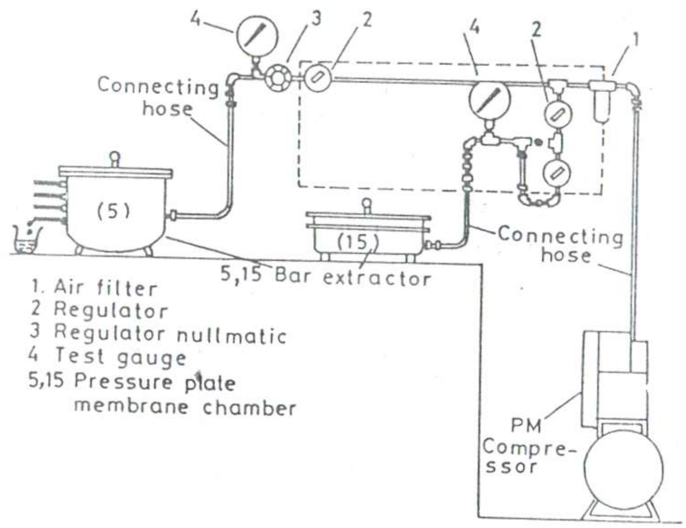

Fig. 2. Schematic diagram of pressure plate apparatus