GEOTECHNICAL ENGG. – I (VI sem)

UNIT-1

(Part-2 Index properties of soil)

(Part-2 (i) Water content)

Index Properties of Soil:

Properties of soil which are used in their identification and classification. These includes the determination of:

1. Water content

2. Specific gravity

3. Particle size distribution

4. Consistency limits

5. In-situ density

6. Density index

1. Water Content (w)- Ratio of weight of water (W_w) to the weight of Soil solids (W_s or W_d). It is generally represented in percentage. Also called as *Moisture content*.

$$\mathbf{w = (W_w / W_d) X 100}$$

Water content of soil sample can be determined by the following methods:

1. Oven-drying method

2. Sand bath method

3. Alcohol method

4. Calcium carbide method

5. Pycnometer method

6. Radiation method

7. Torsion Balance method

1. Oven-drying method:

This is the most accurate method of determining the water content, used in the laboratory. A soil sample is kept in a clean container and put in an oven to maintain the temperature between 105°C to 110°C. For complete drying, sandy soil takes about 4 hours and fat clays take about 14 to 16 hours. The sample is kept for 24 hours in the oven so that complete drying takes place. A temperature higher than 110°C may break crystalline structure clay particles resulting in loss of chemically bond structural water. For highly organic soils, temperature of about 60°C is preferable to prevent the oxidation of the organic matter. If gypsum is present in the soil, the sample is dried at not more than 80°C.

A clean non-corrodible container is taken and its mass is found with its lid, on a balance accurate to 0.01gm. A specimen of moist soil is placed in the container and covered with lid. The mass of the container and the contents is determined. The lid is removed and the container with specimen is kept in the oven for drying. After drying, container is removed from the oven and allowed to cool in a desiccator. The lid is replaced and the mass of container with dry soil is determined.

The water content can be calculated by the expression:

$$\mathbf{w} = \frac{\mathbf{M2 - M3}}{\mathbf{M3 - M1}} \text{ x } \mathbf{100}\ \%$$

Where, M1= Mass of container with lid

M2 = Mass of container with lid+ Moist soil

M3= Mass of container with lid+ dry soil

Sand bath method

This is the field method to determine approximate value of the water content, where the facility of oven is not available. The container with soil is placed on a sand bath. The sand is heated over a kerosene stove. The soil becomes dry within half to one hour. The water content can be determined by the formula. Higher temperature may break the crystalline structure of the soil, this method should not be used for Organic soils and soils having higher percentage of gypsum.

Alcohol method

This is also a field method. The wet soil sample is kept in a evaporating dish and mixed with sufficient quantity of methylated spirit. The dish is then properly covered and the mixture is ignited. The mixture is kept stirred by a wire during ignition. since there is no control over the temperature it should not be used for soil contain large percentage of organic matter or gypsum. The water content is determined by the formula.

Calcium carbide method

This is very quick method results in 5 to 10 minutes. In this method, 6 gm of wet soil sample is placed in an airtight container called Moisture tester and mixed with sufficient quantity of

fresh calcium carbide powder. The mixture is shaken vigorously. The acetylene gas is produced by the reaction of the moisture of the soil and the calcium carbide, exerts pressure on a sensitive diaphragm placed at the end of the container. The dial gauge located at the diaphragm read the water content directly. Calibration of the dial gauge is such that it gives the water content (w') based on the wet weight of the sample.

Knowing the water content (w') based on the wet weight, the water content (w) based on dry weight can be found from:

$$w = \frac{w'}{1 - w'}$$

Pycnometer method

This is also a method of determining the water content of those soils specific gravity (G) is accurately known. The pycnometre is a large size density bottle of about 900 ml capacity. A conical brass cap, having a 6 mm diameter hole at its top is screwed to the open end of the pycnometer. a rubber washer is placed between conical cap and the rim of the bottle so that there is no leakage of water. A soil sample of about 200-400 gm is used for test.

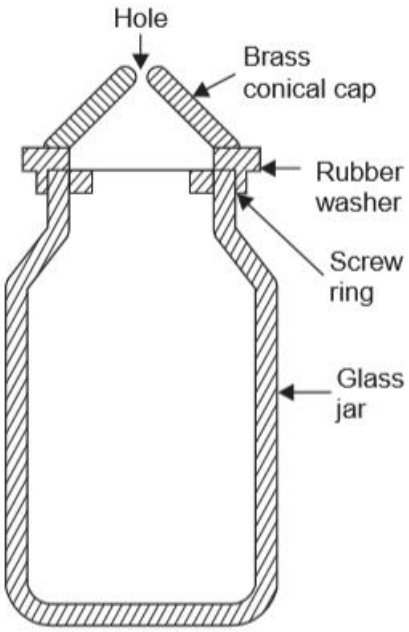

Fig.1 Pycnometer Bottle

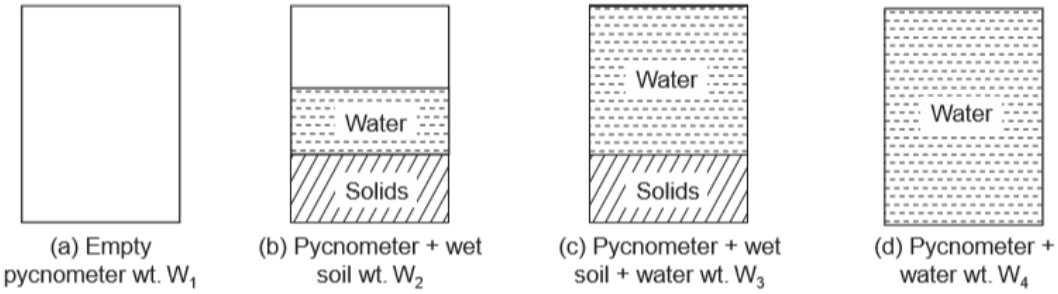

Fig.2 Water content determination by Pycnometer Test

The content is then calculated from the following expression:

$$\mathbf{w} = \left[\left(\frac{\mathbf{W2 - W1}}{\mathbf{W3 - W4}}\right)\left(\frac{\mathbf{G - 1}}{\mathbf{G}}\right) - \mathbf{1}\right] \text{x } \mathbf{100}$$

where, W1= clean and dry pycnometer mass with its cap

W2= mass of wet soil sample+ pycnometer with its cap

W3= mass of wet soil sample+ pycnometer with its cap+ water

W4= mass of pycnometer with its cap+ clean water

Radiation Method

This method is very useful for the determination of water content soil deposit in the in-situ condition. It has two steal casings casing A and casing B which are placed in two bore holes at some distance apart, in the soil deposit the field moisture content of which is to be determined. Device containing some Radioactive isotope material such as Cobalt-60 is placed in a capsule which is lowered into the casing A.

similarly, a detector unit is lowered in steel casing B. Small openings are made in both casings A and B, facing each other. When the radioactive device is activated it emits neutrons. When these neutrons strike the hydrogen atoms of water in the subsoil, they lose energy. The loss of energy is equal to water content in the soil. The detector device is calibrated to give directly the water content of the subsoil, at that level of emission. In this test proper shielding precautions should be taken to avoid radiation problems.

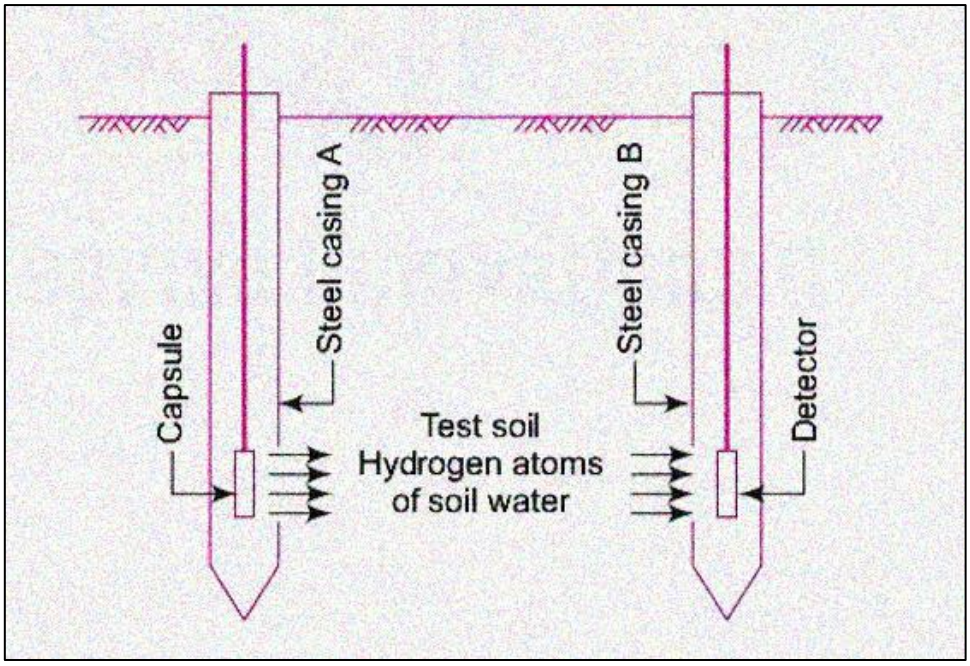

Fig.3 Radiation method

Torsion Balance Method

The equipment has two main parts:

(i) Infra-red lamp

(ii) Torsion balance

The infra-red radiation is provided by 250watt lamp built in the balance for the use with alternating current 220-230 V, 50 cycle, single phase main supply. The weighing mechanism, a torsion balance, has a built-in magnetic damper to reduce pan vibrations during quick drying.

The balance scale is divided in terms of water percentages from 1 to 100 water content in 0.2% division. The moisture meter is generally calibrated to use 25 gm of soil, and hence the maximum size of particles present in the specimen should be less than 2 mm.

The test specimen is kept in a container so that water content to be determined is not affected by ambient conditions. Torque is applied to one end of the Torsion wire by means of calibrated drum to balance the loss of weight of the sample as it dries out under infrared lamp. To determine the percent of mass at any instant, rotate the drum scale turning the drum knob until the point returns to the index. The percent is read directly from the scale. However, this percent (w') is the percent of water based upon the initial mass i.e. wet mass of the sample.

The water content based on dry mass is calculated from:

$$w = \frac{w'}{1 - w'}$$

Normally, the temperature between kept between 110ºC $\pm$ 5ºC. The time required for the test depends upon type of soil, quantity of water present; normally time varies between 15 to 30 minutes. Drying and weighing occurs simultaneously. The criteria for taking final reading is that the pointer should remain steady on the index mark which shows that the sample has dried to constant mass.