GEOTECHNICAL ENGG.-I (VI Sem)

Unit-2

(Part-3 Short notes)

(Contact Moisture, Contact Pressure, Shrinkage and Swelling of soils, Slaking of Clay, Bulking of Sand, Frost action- Frost heave and Frost boil)

Contact Moisture:

Water can also be held by surface tension round the point of contact of two particles (spheres). Capillary water in this form is known as contact moisture or contact capillary water. Because of this the tension in the contact capillary water, the two particle tend to press against Each Other giving rise to a force known as **Contact Pressure**.

Various factors affecting the contact pressure are:

(i) Particle size

(ii) Density of packing

(iii) Angle of contact

(iv) Water content

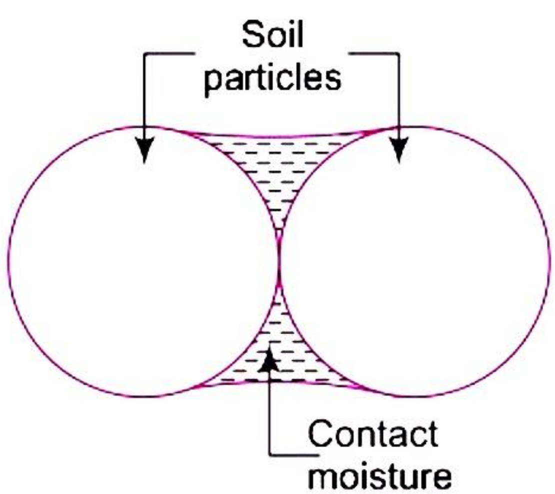

Fig 1. Contact Moisture

Shrinkage and Swelling of soils:

Soils undergo volume change when the water content is changed, decrease in water content cause shrinkage while increase of water content cause swelling. Large volume changes of soils, specially clayey soils have resulted in extensive structural damages. Coarse grained soils have very little shrinkage and swelling.

The degree of change in volume depends upon factors such as:

(i) type and amount of clay minerals present in the soil

(ii) specific surface area of clay

(iii) structure of the soil

(iv) pore water salt concentration

(v) valence of exchangeable cation etc.

Shrinkage of Soil:

Shrinkage takes place due to decrease in water content in the soils. When a saturated soil is allowed to dry a meniscus develops in each void at the soil surface. Formation of such a meniscus cause tension in the soil water leading to a compression in the soil structure and consequent reduction in the volume.

The ***degree of shrinkage*** depends upon several factors such as:

(i) Initial water content
(ii) Type and amount of clay content
(iii) Mode and environment, of geological deposition

Shrinkage occurs horizontally as well as vertically, causing vertical shrinkage cracks. Shrinkage is more prominent in clay soils. Presence of sand and silt size particles in a clay deposit reduce the total shrinkage.

Swelling of Soil:

When water is added to a soil which has shrunk, menisci are destroyed resulting in tension in pore water and consequent reduction in compressive stresses in solid grains. This result in elastic expansion of soil mass, causing swelling.

Swelling is mainly caused due to repulsive forces which separate the clay particles, causing volume change.

The ***degree of swelling*** depends upon several factors such as:

(i) Amount of clay minerals present in the soil
(ii) Affinity of clay minerals for water

(iii) Cation exchange capacity and electrical repulsive forces
(iv) Expansion of entrapped air
(v) Specific surface
(vi) Structure of soil
(vii) Elastic rebound of soil grains etc.

When Illite and Kaolinite clay minerals are present in a clay soil, the soil exhibit large volume decrease on drying with only a limited swelling or rewetting.

Slaking of Clay:

Clayey soil which has been dried well below the shrinkage limit, thus attaining the minimum value volume. When this mass of soil is suddenly immersed in water, it will cause its slaking, resulting in its disintegration into a soft wet mass. Such slaking is due to the entry of air into the void space during the drying of soil below the shrinkage limit. When water enters these voids, due to immersion menisci will be formed, causing high pressures and subsequent explosion of the void leading to the disintegration of the soil structure.

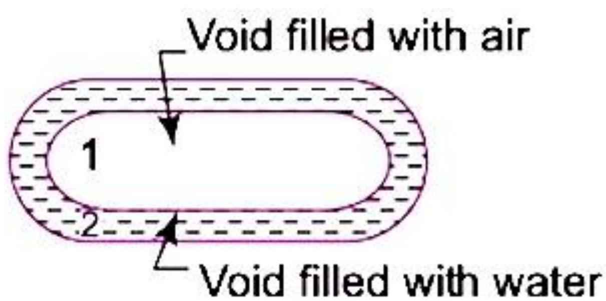

Fig 2. Slaking of Clay

Bulking of Sand:

If a dry mass of sand is moistened slightly and then shovelled or dumped lose into heap, its volume will increase consider relative to dry state. This phenomena is called bulking of sands. As a result of inter particle adhesion due to capillary action of water, apparent cohesion is developed. This apparent cohesion hold the particles together in clusters and enclosing honeycombs especially when was the soil is loosely dumbed or poured. The finer the grains, greater is the increase in volume. The volume change depends also upon the water content, its maximum value being when w = 5 to 6% . When water content is slightly below complete saturation, no such bulking occurs.

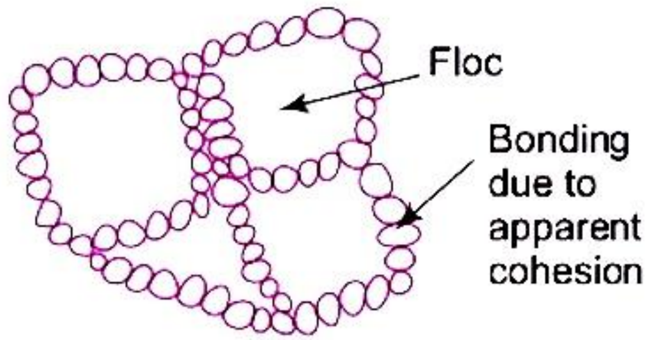

Fig. 3. Bulking of Moist Sand

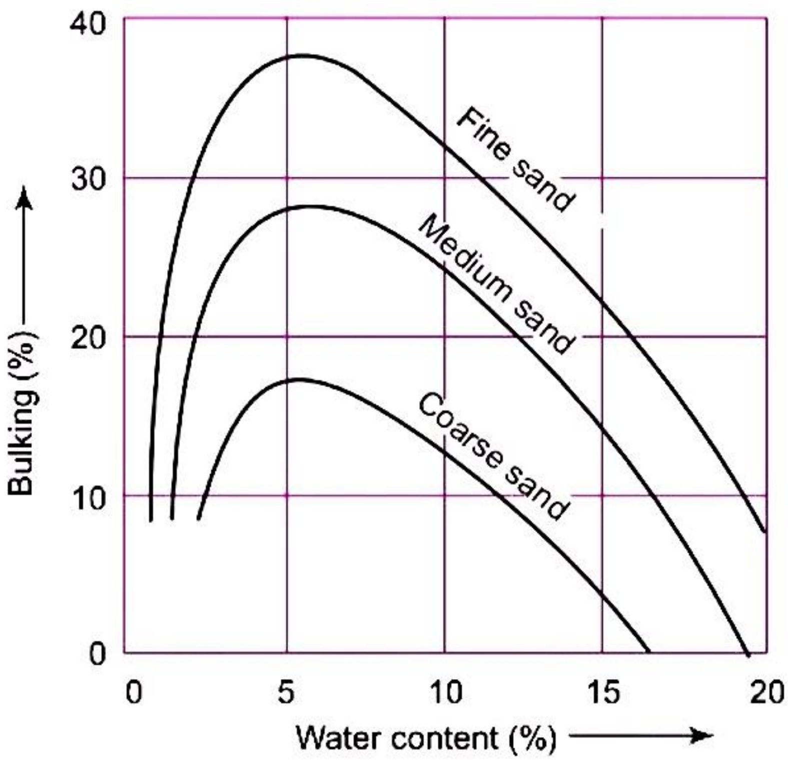

Fig 4. Bulking of Sands

<u>Frost Action:</u>

Freezing and thawing of water present in a soil and the resultant effects on soil and on structure founded in this soil is known as Frost action.

Frost action consists of two processes:

(i) Frost Heave
(ii) Frost Boil

Frost Heave:

Frost heave defined as rise of groundwater due to frost action. The atmospheric temperature falls to the freezing point, the water present in the capillary fringe may freeze, leading to the formation of ice. When water is converted into ice there is an increase of about 9% in the volume.

Temperature at which water freezes in the pores of the soil depends on the pore size, smaller the pore size lower the freezing temperature. Silt and fine sands are prone to frost action because these soils have large capillary rise due to relatively fine particles. Similarly, in clayey soils there capillary rise is very high, their permeability is very low resulting in limited water migration and hence limited frost heave.

The depth or boundary below the ground surface up to which water may freeze is called ***Frost line***.

Following are the conditions for the formation of ice lens and marked frost heave.

1. Soil to be saturated in the beginning and during the freezing period
2. Proximity of groundwater reservoir so that water may move in the zone of freezing
3. High capillarity of soil
4. Moderate permeability of the soil
5. Gradual dropping of seasonal temperature

Frost Boil:

If the temperature rises in the soil in which frost heave has occurred, the frozen soil mass thaws and free water is liberated. When thrawing takes place, the soil previously frozen will contain an excess of water with the result that it will become soft and its strength is reduced. These effects and known as frost boil.

Silty soils are most susceptible to frost boil than sand and clayey soils.

Effects of frost boil:

1. Settlement of structures resting on the ground surface
2. Settlement of Highway pavements

3. Formation of pot holes due to extrusion of soft soil and water under the dynamic action of wheel loads
4. Eventual breaking of pavement and ejection of subgrade soil in a soft and soapy condition, under moving wheel loads

Preventive measures:

1. Founding building below frost depth to avoid possible frost heave.
2. Insulating blankets of 15 to 30 cm thick layer of sand and gravel on the ground surface above frost susceptible soil strata to prevent deep frost penetration.
3. Interposing a pervious gravel blanket between the frost line and highest water table, to prevent considerably the capillary saturation of frost zone.
4. Providing proper drainage to lower table and to allow quick escape of water during thawing.
5. Removing the frost susceptible soil up to the frost depth and substituting by less susceptible soil.

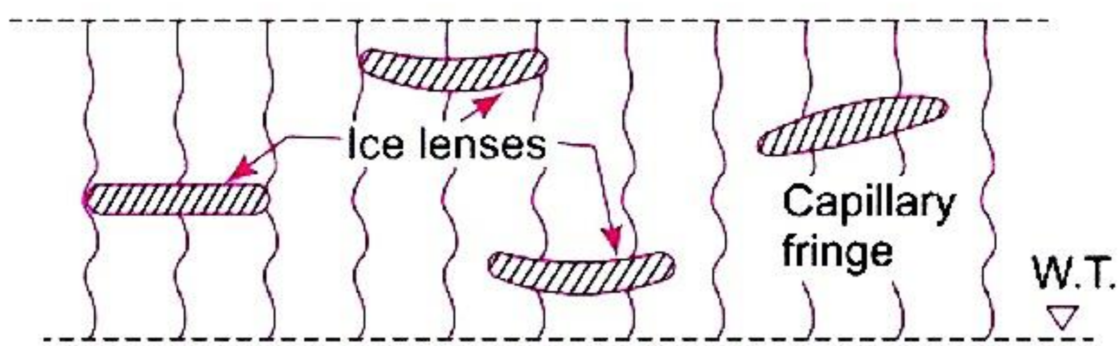

Fig. 5. Formation of Ice lenses due to Frost