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Department: Civil Engineering

Subject:Geo-Technical Engineering (CE-8002)

Unit: III

Topic: Compaction

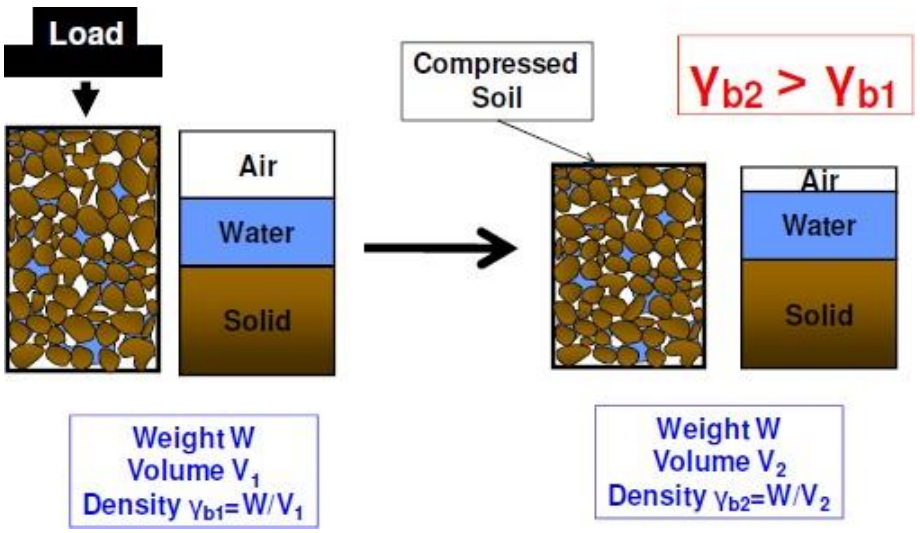
COMPACTION

Introduction:

Compaction is the process of increasing the bulk density of a soil or aggregate by driving out air. For any soil, at a given compactive effort, the density obtained depends on the moisture content. An "Optimum Moisture Content" exists at which it will achieve a maximum density. Compaction is the method of mechanically increasing the density of soil. The densification of soil is achieved by reducing air void space. During compaction, air content reduces, but not water content It is not possible to compact saturated soil. It should be noted that higher the density of soil mass, stronger, stiffer, more durable will be the soil mass.

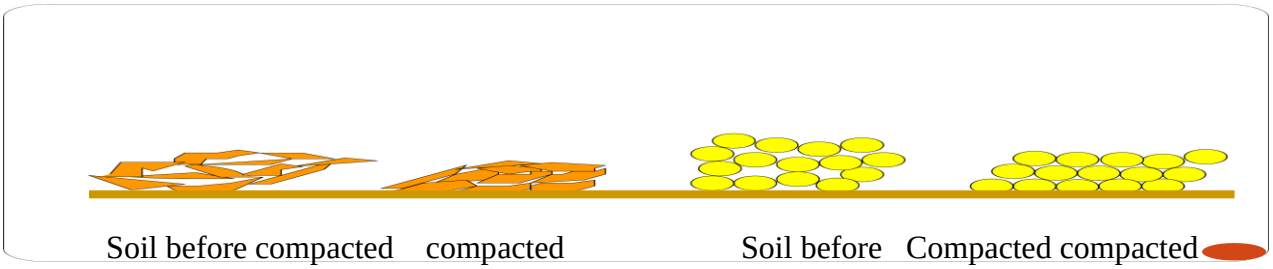
Hence, Compaction

1) Increases density
2) Increases strength characteristics
3) Increases load-bearing capacity
4) Decreases undesirable settlement
5) Increases stability of slopes and embankments
6) Decreases permeability
7) Reduces water seepage
8) Reduces Swelling & Shrinkage
9) Reduces frost damage
10) Reduces erosion damage
11) Develops high negative pore pressures (suctions) increasing effective stress



Hence Compaction, in general, is the densification of soil by removal of air, which requires mechanical energy. Simplistically, compaction may be defined as the process in which soil particles are forced closer together with the resultant reduction in air voids.

Compaction ofsoils is achieved by reducing the volume of voids. It is assumed that the compaction process does not decrease the volume of the solids or soil grains·



Mechanism of Compaction :

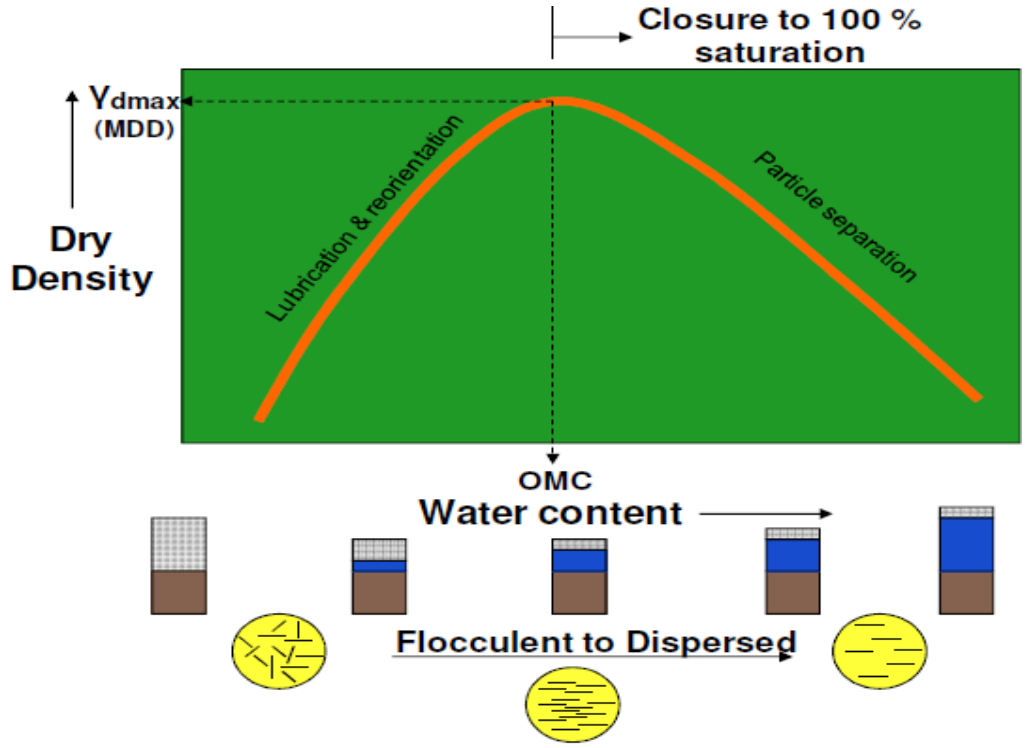
The degree of compaction of a soil is measured by the dry unit weight of the skeleton.

The dry unit weight correlates with the degree of packing of the soil grains.

$$y = yw\ Gc/1 + e$$

The more compacted a soil is:

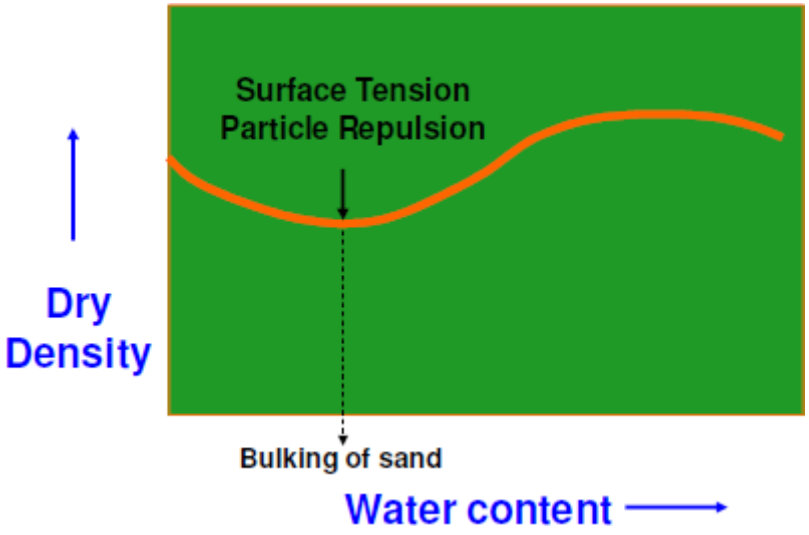
- the smaller its void ratio (e) will be.
- the higher its dry unit weight (yd) will be



Optimum Moisture Content (OMC) is the moisture content at which the maximum possible dry density is achieved for a particular compaction energy or compaction method. The corresponding dry density is called Maximum Dry Density (MDD). Water is added to lubricate the contact surfaces of soil particles and improve the compressibility of the soil matrix. It should be noted that increase in water content increases the dry density inmost soils up to one stage (Dry side). Water acts as lubrication. Beyond thislevel, any further increase in water (Wet side)will only add more void space,there by reducing the dry density. Hence OMC indicates the boundary between the dry side and wet side. Hence the compaction curve as shown in figure indicates the initial upward trend up to OMC and the down ward trend.

Reasons for the shape of curve

1. On dry side of OMC, clayey soil shows high suction, lumps are difficult to break or compact. 2. Increasing the water content reduces suction, softens lumps, lubricates the grains for easy compaction.
3. As water content increases, lubrication improves compaction resulting in higher dry density.
4. Now nearly impossible to drive out the last of the air – further increase in water content results in reduced dry density (curve follows down parallel to the maximum possible density curve – the Zero Air Voids curve)
5. MDD and OMC depend on the compaction energy and are not unique soil properties.
6. For sand, suction at low water contents also prevents compaction (but not if completely dry)
7. In cohesionless soils, MDD is achieved either when completely dry, or when completely saturated.
8. At low water content, grains are held together by suction (water at grain contacts only)
9. This prevents compaction.
10. Laboratory test for MDD on sand requires fully saturated sample, and involves vibration.



Percent Air Voids:

$$\gamma_d - \frac{(1-n_a)G\gamma_\omega}{1+\omega G}$$