Period #25: Compaction of Soils (I)

A. What is Compaction?

In most instances in civil engineering and/or construction practice, whenever soils are imported or excavated and re–applied, they are **compacted**.

The terms **compaction** and **consolidation** may sound as though they describe the same thing, but in reality they do not.

consolidation: Static loads are applied to saturated soils, and over a period of time the increased stresses are transferred to the soil skeleton, leading to a reduction in void ratio.

Depending on the permeability of the soil and the magnitude of the drainage distance, this can be a very time–consuming process.

Tyically applies to existing, undisturbed soil deposits.

compaction: When loose soils are applied to a construction site, compressive mechanical energy is applied to the soil using special equipment to densify the soil (or reduce the void ratio).

Typically applies to soils that are being applied or re–applied to a site.

B. Motivation for Compaction:

- Compaction increases the skeletal (or dry) density of soils for a wide range of construction applications. As examples:
  - highway embankments
  - earthen dams
  - backfilled trenches
  - sub–foundation soils
- Compaction generally leads to the following desirable effects on soils:

1) increased shear strength;

   This means that larger loads can be applied to compacted soils since they are typically stronger.

2) reduced compressibility;

   This also means that larger loads can be applied to compacted soils since they will produce smaller settlements.

3) reduced permeability;

   This inhibits soils' ability to absorb water, and therefore reduces the tendency to expand/shrink and potentially liquefy.

C. Measuring Compaction of Soils in the Laboratory

1. The Standard Proctor Test

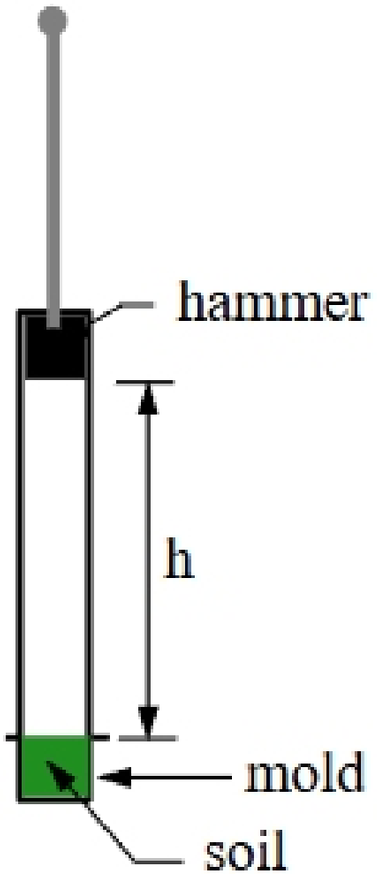
- Soil is compacted in a mold having a volume of $(1/30)ft^3$ or $944cm^3$, and a diameter of 4in or 10.16cm.
- The soil is mixed with varying amounts of water to achieve different water contents.
- For each different water content, w:

  a) The soil is placed into the mold in three lifts (or layers) .

  b) For each lift, the soil is compacted by dropping a hammer of mass 2.5kg = 5.5lbs 25 times onto the confined soil from a height of 12in = 30.48cm.

  c) The compacted soil is removed from the mold and its dry density (or dry unit weight) is measured.

  d) Optionally, the unconfined compressive strength of the soil is also measured.



- Compactive Energy (E) applied to soil per unit volume:

$$E = \frac{(\#\ \text{blows/layer}) * (\#\ \text{of layers}) * (\text{hammer weight}) * (\text{height of drop})}{\text{Volume of mold}}$$

$$E_{SP} = \frac{(25\ \text{blows/layer}) * (3\ \text{layers}) * (5.5\text{lbs}) * (1.0\text{ft})}{(1/30)ft^3} = 12{,}375 ft\text{–}lb/ft^3 = 594 kJ/m^3$$