1.4 Compaction Test

● Definition

- Compaction is the densification of soils by the application of mechanical energy.

1.4.1 Advantages which occur through compaction

1.4.2 Testing method

- Standard Compaction Test (Proctor Test)

  * Compacting soil samples ((-)No.4 sieve) into a 944cm^3 mold in three layers with 25 blows per layer, using a 24.5 N compaction rammer dropping 0.305m (Compacting Energy = 593.kJ/m^3)

    Repeat it for samples with different water contents.

  * On the dry side of the optimum, the compact process becomes more efficient at any given compaction effort as the water content increases because of the increase of the lubrication effect. Contrarily, on the wet side, the blows of rammer simply increase the excess pore pressure and accordingly decrease the shear strength, and the rammer energy shears the

soil rather than increasing the unit weight further.

* Compaction curve (Relation between dry unit weight and water content) is obtained. ⇒ Can determine maximum dry unit weight and optimum water content.

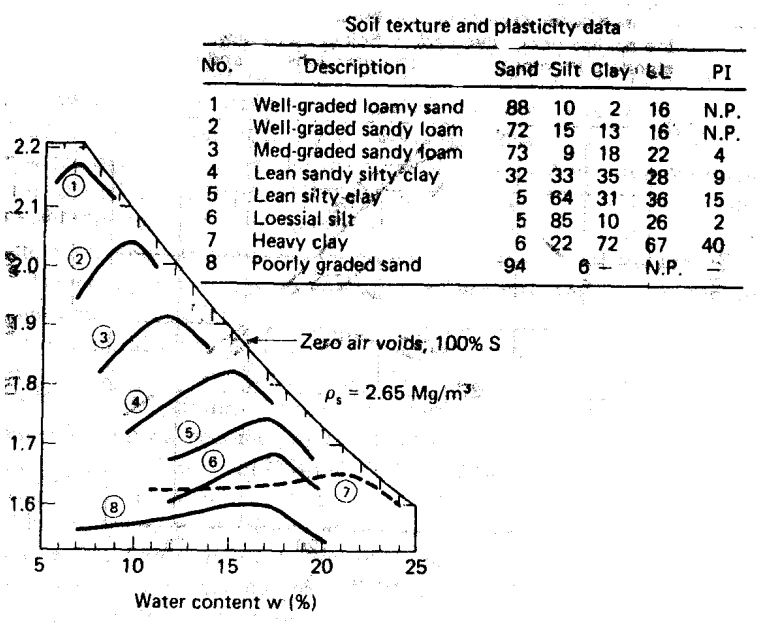
* 5 well placed points (2% spacing of water contents and 2-3 on wet side and 2-3 on dry side) are appropriate. (Fig.9-6)

- Comments on test results

1) Typical results

● Typically, $\gamma_{d(\max)}$ = 1.6 – 2.0 t/m^3, OMC = 10% - 20%

● Typical Compaction Curves



<Fig. Water content-dry density relationships for eight soils compacted according to the standard Proctor method>

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2) Reproducible? (Possibility of inconsistent test conditions.)

● Fresh samples or the reusing samples, temperature, whether layers are of about equal thickness, excess quantity of soil in mold, distribution of blows on any layer, and how well the water is distributed within sample, curing time for dry soils after mixing soils with water, and so on.

● $\gamma_{d(\max)}$ can vary by as much as 0.8 to 1.2 kN/m^3 (0.08 ~0.12 t/m^3) without some attentions.

1.4.3 Compaction in the field

- Rolling with sheep foot, or smoothed wheel or wobble-wheel rollers with pressure and/or vibration
- Relative compaction, RC (can be more or less than 100 and should be specified with referencing test such as standard compaction test and modified compaction test).

$$RC = \gamma_{df}/\gamma_{dL} \times 100\ (\%)$$

1.4.4 Soil structure and behavior associated with the compacting process and water content

- Wet side of OMC
    1) Dispersed structure (parallel particle orientations) :
    2) Has somewhat lower shear strength and can undergo larger settlements without cracking and has a lower permeability.
    3) Useful condition for the clay core of earth dam.
- Dry side of compaction
    1) Flocculated structure (random particle orientation)
    2) Has higher shear strength at lower strains (Brittle behavior) and higher permeability.
    3) Desirable condition for road works and the soil shell around clay core in earth dam

1.4.5 The modified compaction test

1) Increase the use of heavy military (or civil) aircraft (or vehicle) after World War II. ⇒ Require a higher subgrade density than that provided by the standard compaction unit weight. ⇒ Introducing a modified test with higher input energy (rather than use the relative compaction higher than 100%).

2) Details of the test are as follows ;

Mold : 944^3cm

Rammer : 44.5 N

Soil layers : 5 layers and 25 blows per layer

Rammer fall : 0.46 m

Compaction energy: 2710.5 kJ/m^3

- Higher compaction energy (about 5 times than that in standard compaction) results in a 5 to 10 percent increase in unit weight and decrease in OMC.

1.4.6 The Harvard Miniature Compaction Test

- To duplicate more closely field compaction.
- Consisting of a mold with 15/16 inch diameter and 2.816 inch length (a volume of 1/454 ft^3 (62.4 cm^3).
- Compacting soils by tamping. (3 layers at 25 tamps per layer) A tamper employing a spring loaded plunger (89N and 178N).
- No direct correlation between the proctor test and Harvard miniature test. (OMC at Harvard miniature test is less than that at standard compaction test.)

- Advantages :