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| **Course No. :** CE 363 | **Date of Testing :** 22.10.2010 |
| **No. And Title of Test :** 5(a) Determination of Dry Density of Soil (Water Displacement Method) | |
| **Year and Section :** 3 / 4 | **Lab. Group :** 3 |
| **SURNAME, Other names of student :** | |

**Determination of Dry Density of Soil (Water Displacement Method)**

**1. Object of Experiment**

The object of this experiment is to determine the dry density of a sample of natural or compacted soil by recording its mass and the amount of water it displaces after coating with a known volume of wax.

**2. Apparatus**

* A cylindrical metal container with a siphon tube
* A watertight container to act as a receiver for the water siphoning over from the container explained above
* A balance readable and accurate to 1 g
* Paraffin warmer
* Apparatus for moisture content determination

**3. Theory**

Soils consist of grains with water and air in the voids between grains. The water and air contents are readily changed by changes in conditions and location: soils can be perfectly dry or be fully saturated or be partly saturated . It is not a coherent solid material like steel and concrete, but is a particulate material. It is important to understand the significance of particle size, shape and composition, and of a soil's internal structure or fabric.

**4. Method of Test**

* Soil sample was trimmed to a non-corner condition and weighed
* The paraffin was warmed and the specimen was coated by that warmed paraffin
* Water was filled to metal cylindrical tube until the level of siphon tube.
* Sample was put inside water in metal tube
* The water spilled out because of the volume of the specimen was collected to a watertight collector by using siphon tube
* Water inside a watertight collector was measured
* The sample was taken out of water, dried and the paraffin layer over the specimen was peeled off
* A representative sample of the soil was taken to determine its moisture content

**5. Results**

Results sheet is attached to the end of this report

**6. Calculations**

Some values determined or assumed during the experiment are as follows;

Mass of soil specimen, Ms = 300.5 g

Mass of specimen after waxing, Mw = 318.27 g

Mass of receiver + displaced water, M2 = 353.21 g

Mass of receiver empty, M1 = 192.64 g

Spesific gravity of soil particles, Gs = 2.7

Mass of box + wet soil, M3 = 20.92 g

Mass of box + dry soil, M4 = 20.69 g

Mass of box, M5 = 19.35 g

Density of paraffin wax = 0.903 g/ml

Using these values, the followings were calculated;

1. Moisture content, m (%)

m = 100 \* (M3 – M4) / (M4 – M5) = 100 \* (20.92– 20.69) / (20.69 – 19.35)

m = 17.16 %

2. Mass of wax, M

M = Mw - Ms = 318.27 – 300.5 = 17.77 g

3. Volume of specimen, Vs

Vs = M2 – M1 – M / 0.903 = 353.21 – 192.64 – 17.77 / 0.903 = 140.89 ml

4. Bulk density of soil, ρ

ρ = Ms / Vs = 300.5 / 140.89 = 2.13 g/ml

5. Dry density, ρd

ρd = (100 \* ρ) / (100 + m) = (100 \* 2.13) / (100 + 17.16) = 1.82 g/ml

6. Mass of dry soil, MD

MD = (100 \* Ms) / (100 + m) = (100 \* 300.5) / (100 + 17.16) = 256.49 g

7. Volume of solids, VD

VD = MD / Gs = 256.49 / 2.70 = 95 ml

8. Volume of voids, VV

VV = Vs – VD = 140.89 – 95 = 45.89 ml

9. Void ratio, e

e = 100 \* VV / VD = 100 \* 45.89 / 95 = 48.31 %

10. Porosity, n

n = 100 \* VV / Vs = 100 \* 45.89 / 140.89 = 32.57 %

11. Degree of saturation, Sr

Sr = (m \* Gs) / e = (17.16 \* 2.70) / 48.31 = 0.96 %

**7. Discussion of Results**

From the results, it can be concluded that the sample tested was almost fully saturated. The main features such as porosity, void ratio, dry density and bulk density of the soil can be predicted by generalizing this experiment. Although there may have occurred some errors, results are satisfying to be able to receive information about general properties of soil.

**8. Conclusion**

Dry density, moisture content, void ratio, porosity and the degree of saturation of soil is calculated as 1.82 g/ml, 17.16 %, 48.31 %, 32.57 % and 0.96 respectively in this experiment.

**9. References**

Mirata, T. (2009). *Laboratory Instructions for Soil Mechanics Students*. Department of Civil Engineering, Middle East Technical University, Ankara.