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| **Course Code :** 5620363 | **Date of Testing:** 15.10.2010 |
| **No and Title of Test:** 8 (a) Determination of Dry Density/Moisture Content Relation by the 2.5 kg Rammer (Standard Proctor Compaction Test) | |
| **Year and Section:** 3th year – Section 4 | **Lab. Group:** 3 |
| **SURNAME, Other names of student:** | |

**8 (a) Determination of Dry Density/Moisture Content Relation by the 2.5 kg Rammer (Standard Proctor Compaction Test)**

**Object of the Experiment:** To find out the dry densities of soil when compacted in a particular manner over a range of moisture contents including that giving the maximum dry density.

**Apparatus:**



Figure 1 – Rammer Figure 2 - Mould

**Theory:**

Soil consists of solid particles with different particle size varying from the coarse sandy to the fine clayey fraction. Between the solid particles are pore spaces that also vary in size and shape. The pore space is filled with air and water.

There are three important elements in soil compaction:

- Soil type

- Soil moisture content

- Compaction effort required

Soil compaction is defined as the method of mechanically increasing the density of soil. In construction, this is a significant part of the building process. If performed improperly, settlement of the soil could occur and result in unnecessary maintenance costs or structure failure. Almost all types of building sites and construction projects utilize mechanical compaction techniques.

**Method of Test:**

(a) For soils not susceptible to crushing during compaction

1. Take a 5 kg sample of air-dried soil passing the 20 mm test sieve and mix thoroughly with a suitable amount of water depending on the type of soil.

2. Smear the inside of the compaction mould lightly with Vaseline .Then weigh the mould with base-plate attached. Place the mould on a solid base and compact the moist soil into the mould in three layers of approximately equal mass giving each layer 25 blows of the rammer dropped from a height of 300 mm above the soil. See that the blows are distributed uniformly over the surface of each layer and that the tube of the rammer is kept clear of soil so that the rammer always falls freely. The amount of soil used must be sufficient to fill the mould leaving not more than 6 mm to be struck off when the collar is removed. Remove the collar and carefully level off the compacted soil to top of the mould by means of the straightedge. Then weigh the mould and soil.

3. Remove the compacted soil specimen from the mould and place on the large metal tray. Take a representative sample of the specimen and determine its moisture content.

4. Break up the remainder of the soil specimen rub through the 20 mm sieve and mix the remainder of the original sample. Add suitable increments of water and mix into the sample. Then repeat the above procedure from operations (2) to (4) for each increment of water added. The total number of determinations made must be at least five and the range of moisture contents should be such that the optimum moisture content at which the maximum dry density occurs is within that range.

(b) For soils susceptible to crushing during compaction

1. Take five or more 2.5 kg samples of air-dried soil passing the 20 mm test sieve. Mix the samples thoroughly each with a different amount of water to give a suitable range moisture contents. The range of moisture contents should be such that the optimum moisture content at which the maximum dry density occurs is within that range.

2. Treat each sample as in (a) (2) above

3. Treat the compacted specimen as in (a) (3) above

4. Discard the remainder of each soil specimen

**Calculations:**

* Bulk density (ρ) = (M2 – M1) / V

where M1 = mass of mould and base (g);

M2 = mass of mould, base and wet soil;

V = volume of mould.

1. 1277/943 = 1.35 g/ml
2. 1492/943 = 1.58 g/ml
3. 1652/943 = 1.75 g/ml
4. 1827/943 = 1.93 g/ml
5. 1757/943 = 1.86 g/ml

* Mass of moisture = Mass of [ (container+wet sample)-(container+dry sample) ]

1. 37.99-36.66 = 1.33 g
2. 27.75-26.30 = 1.45 g
3. 32.13-29.41 = 2.72 g
4. 38.69-33.69 = 5.00 g
5. 35.77-30.77 = 5.00 g

* Dry mass= Mass of [ (container+dry sample)-container ]

1) 36.66-13.66=23.00g  
2) 26.30-14.34=11.96g  
3) 29.41-14.36=15.05g  
4) 33.69-13.82=19.87g  
5) 30.77-14.87=15.90g

* Moisture content (m) = [ [(Container + wet sample) – (Container + dry sample)] / [(Container + dry sample) – (mass of container)] ] \* 100

= (mass of moisture / dry mass) \* 100

1. 100\*(1.33 /23.00) = 5.78%
2. 100\*(1.45 /11.96) = 12.12%
3. 100\*(2.72 /15.05) = 18.07%
4. 100\*(5.00/19.87) = 25.16%
5. 100\*(5.00/15.90) = 31.45%

* Dry density (ρd) = 100ρ / (100+m)

1. (100\*1.35) / (100+5.78) = 1.28 g/ml
2. (100\*1.58) / (100+12.12) = 1.41 g/ml
3. (100\*18.07) / (100+18.07) = 1.48 g/ml
4. (100\*25.16) / (100+25.16) = 1.55 g/ml
5. (100\*31.45) / (100+31.45) = 1.42 g/ml

* Air voids

ρd = Gsρw(1 - Va / Vt) / (1+mGs)

Gs = 2.65

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|  | m1 = 5.78 | m2 = 12.12 | m3 = 18.07 | m4 = 25.16 | m5= 31.45 |
| Va / Vt = 0% | 2.30 | 2.01 | 1.79 | 1.59 | 1.45 |
| Va / Vt = 5% | 2.18 | 1.91 | 1.70 | 1.51 | 1.37 |
| Va / Vt = 10% | 2.07 | 1.81 | 1.61 | 1.43 | 1.30 |

**Graph:**

From the graph;

Maximum dry density (ρd)max = 1.55 g/ml

Optimum moisture content, O.M.C. = 25.16 %

**Discussion of Results:**

We calculated five different dry densities for each soil sample. We found maximum dry density value as 1.55 g/ml and optimum moisture content as 25.16%. From the graph that we have plotted, one can see that as moisture content increases, dry densities also increase up to some point; that is maximum dry density. So, by compacting the soil particles with the help of rammer, density of soil is increased until it reaches maximum dry density value.

**Conclusion:**

With soil compaction experiment, we found dry densities of soil when compacted for different moisture contents. Besides, we found the value of maximum dry density from our calculations and from the dry density vs moisture content graph. In addition to these values, we determine the optimum moisture content (O.M.C.) from the graph and made our discussions on the results.

**References**

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