In-situ Density Determination by Sand Replacement Method

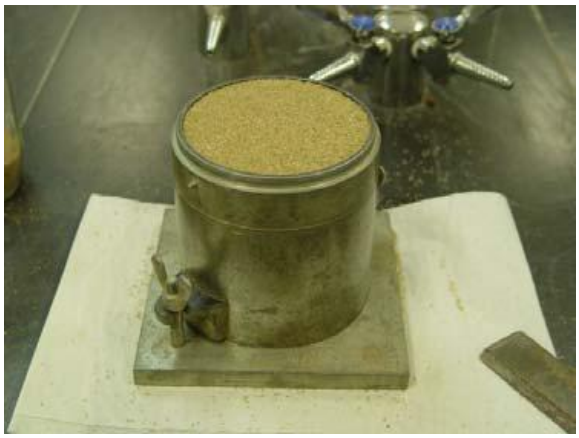
Equipments

- Sand cone apparatus which consists of a one-gallon plastic bottle with a metal cone attached to it.
- One-Gallon plastic can with cap.
- Balance sensitive to 1 g.
- Base plate
- Tools for excavating a hole in the ground
- Clean, uniformly graded sand ranging from #20 to #30 sieve such as Ottawa Sand
- Proctor compaction mold without attached extension (used for calibration)
- Plastic air-tight bag for carrying wet excavated soil from field to the lab.
- Metal tray with a hole in the centre.
- Oven with temperature kept at about 105-110^{o}

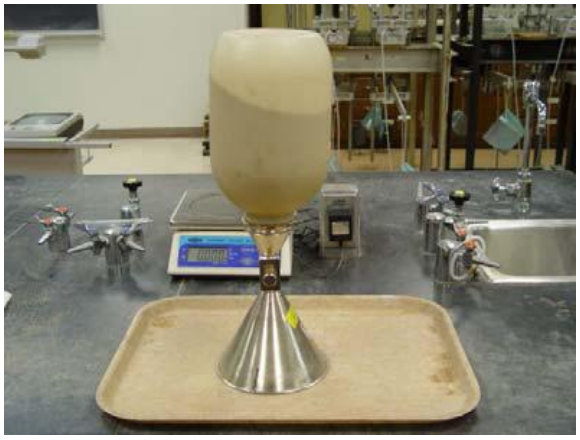
Test procedure

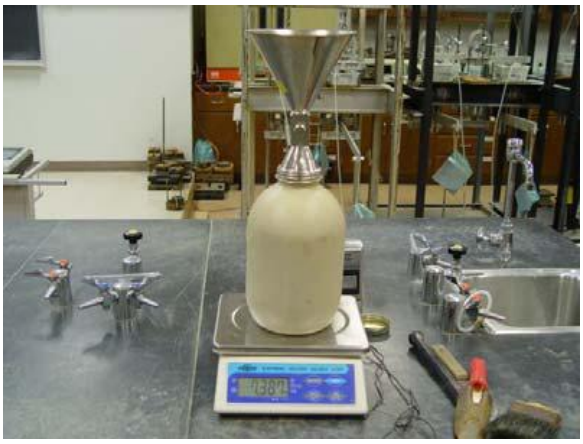
1. Measure the weight of Proctor mold + Base, W_1
2. Pour the sand into the compaction mold.
3. Measure the weight of plastic Gallon+Cone+Sand, W_3 (before use)
4. Close the valve attached to the cone. Turn the cone and gallon upside down on the tray. Open the valve, sand flows from the gallon to the cone, after the flow stops close the valve and take the gallon+cone from the tray. Measure the weight of plastic Gallon+Cone+Sand, W_4 (after use)
5. Weight of plastic Gallon+Cone+Sand, W_5 (before use)
6. Go to the field where the soil's unit weight is to be measured, place the metal tray and fasten the 4 screws.
7. Dig up a 10 to 15 cm deep hole.
8. As you are digging the hole put the retrieved soil into the plastic bag in order that the soil does not lose moisture. All of the soil including the soft soil at the bottom of the hole is poured into the bag as well.
9. Having the valve closed turn the gallon+cone upside down and place the cone in the center hole of tray and open the valve so that sand flows down to the hole.
10. After flow of sand stops close the valve and pick the assembly up, the sand in the cone will be poured into the tray. This sand will be left there in the field. (Notice, Unlike this picture, the plastic bag should be kept closed while transferring to the lab to avoid moisture loss and consequently weight of the soil)
11. Measure the weight of plastic Gallon+Cone+Sand, W_6 (after use)
12. Measure the weigh the evaporating dish, W_7
13. Measure the weigh the evaporating dish + wet soil from the field, W_8
14. Put the evaporating dish + wet soil in the oven and after 24hrs weigh it again, W_9
15. Having the information you got so far in the table, Calculations can be carried out easily. Do the calculations, fill out the table and include the answers to the following questions in your reports.

Obtaining the unit weight of sand used



Calibration of cone





Field test


ELECTRONIC SOLUTION BALANCE
0.507


ELECTRONIC SOLUTION BALANCE
2.334

Use this table for your reports

Test Steps	Quantity
Obtaining the unit weight of sand used	
1. Weight of Proctor mold, W_1	
2. Weight of proctor mold + Sand, W_2	
3. Volume of the mold, V_1 0.00095 m^3	
4. Dry unit weight, $\gamma_{d\ (sand)} = (W_2 - W_1) / V_1$	
Calibration of cone	
5. Weight of plastic Gallon+Cone+Sand (before use), W_3	
6. Weight of plastic Gallon+Cone+Sand (after use), W_4	
7. Weight of the sand to fill the cone, $W_c = W_3 - W_4$	
Results from field test	
8. Weight of plastic Gallon+Cone+Sand (before use), W_5	
9. Weight of plastic Gallon+Cone+Sand (after use), W_6	
10. Volume of hole, $V_2 = (W_5-W_6-W_c)/ \gamma_{d\ (sand)}$	
11.Weight of evaporating dish, W_7	
12. Weight of evaporating dish + wet soil from the field, W_8	
13. Weight of evaporating dish + dry soil after 24hrs, W_9	
14. Moist unit weight of the soil in the field, $\gamma_{t\ (in\text{-}situ\ soil)} = (W_8 - W_7) / V_2$	
15. Water content in the field, $w(\%)= (W_8 - W_9) / (W_9 - W_7)*100$	
16.Dry unit weight in the field, $\gamma_{d\ (in\text{-}situ\ soil)} = [\gamma_t\ (\text{Row 14})] / [1+ w(\%) / 100]$	

Conversion factors (Unit weight):
1000 kg/m^3 = 9.81 KN/m^3 = 62.4 lb/ft^3