Standard Proctor Compaction Test

Determination of Dry Unit Weight

3/3/2010

1. **Objective:**

To determine the optimum moisture content vs. the dry density relationship.

2. **List of Equipment:**

- Soil
- Mold (volume of 1/30 ft^3) (including a baseplate and an extension)
- Plastic squeeze bottle
- Tap water
- Hammer (weight of 6.5 lb)
- Moisture cans
- Balance
- Spatula/knife

3. **Procedure:**

- Determine the Weight of Mold, W_1 using a balance.
- Obtain a sample of soil and mix it with water.
- Place the first layer of the soil-water mixture into the mold. Compact the first layer by applying 25 blows with the hammer, which falls through a height of 12 inches. Scratch the first layer with a spatula/knife to form a grid before adding the second layer.
- Place the second layer of the soil-water mixture into the mold. Compact the second layer by applying 25 blows with the hammer. Scratch the second layer with a knife/spatula to form a grid before adding the third layer.
- Place the third layer of the soil-water mixture into the mold. Compact the third layer by applying 25 blows with the hammer. Scrape the excess soil at the top of the mold with a spatula/knife to level the mold.
- Determine the Weight of Mold + Moist Soil, W_2 using a balance.
- Obtain an empty moisture can and determine the Mass of Moisture Can, W_3 using a balance.
- Take a sample of the soil-water mixture from the mold and place it in the moisture content can. Determine the Mass of Can + Moist Soil, W_4 using a balance. Place in an oven heated to 110°C for 24 hours to determine moisture content.
- Repeat this process for a total of 6 tests. Keep adding a little more water to the soil-water mixture for each test.
- After 24 hours, remove the six moisture cans from the oven. For each of the six cans, determine the Mass of Can + Dry Soil, W_5 using a balance.

4. **Data:**

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Description of soil CLAYEY SILT Sample No. 3

Location UNO LAB

Volume of mold 1/30 ft³ Weight of hammer 5.5 lb Number of blows/ layer 25 Number of layers 3

Tested by ____ Date 02.24.2010

Test	1	2	3	4	5	6
1. Weight of mold, W_1 (lb)	10.35	10.35	10.35	10.35	10.35	10.35
2. Weight of mold + moist soil, W_2 (lb)	14.19	14.41	14.53	14.63	14.51	14.47
3. Weight of moist soil, $W_2 - W_1$ (lb)	3.84	4.06	4.18	4.28	4.16	4.12
4. Moist unit weight, $\gamma = \frac{W_2 - W_1}{1/30}$ (lb / ft³)	115.2	121.8	125.4	128.4	124.8	123.6
5. Moisture can number	1	2	3	4	5	6
6. Mass of moisture can, W_3 (g)	54.0	53.3	53.3	54.0	54.8	40.8
7. Mass of can + moist soil, W_4 (g)	253.0	354.0	439.0	490.0	422.8	243.0
8. Mass of can + dry soil, W_5 (g)	237.0	326.0	401.0	441.5	374.7	211.1
9. Moisture content, $w\,(\%) = \frac{W_4 - W_5}{W_5 - W_3} \times 100$	8.74	10.27	10.93	12.52	15.04	18.73
10. Dry unit weight of compaction $\gamma_d\ (\text{lb / ft}^3) = \frac{\gamma}{1 + \frac{w\,(\%)}{100}}$	105.9	110.5	113.0	114.1	108.5	104.1

ASSUME $G_s = 2.7$ and PLOT ZERO AIR VOID CURVE. SHOW COMPUTATIONS.

DRAW CURVE (FIG 6.3)

Moisture can number	1	2	3	4	5	6
11. Zero-air-void unit weight $\gamma_{zav}(lb/ft^3) = \frac{\gamma_w}{w + \frac{1}{G_s}}$	136.3	131.9	130.1	125.9	119.8	111.9

5. Analysis of Data:

- **Weight of Moist Soil** = (Weight of Mold + Moist Soil) – (Weight of Mold) = $W_2 - W_1$

  Ex: Weight of Moist Soil = 14.19 lb – 10.35 lb = 3.84 lb

- **Moist Unit Weight, γ** = $\frac{W}{V_{(m)}}$ = (Weight of Moist Soil) / (Volume of the Mold) = $\frac{W_2 - W_1}{\frac{1}{30} ft^3}$

  Ex: Moist Unit Weight, $\gamma = \frac{3.84 lb}{\frac{1}{30} ft^3}$ = 115.2 lb/ft³

- **Moisture Content, w (%)** = $\frac{W_w}{W_s}$ = {[(Mass of Can + Moist Soil) – (Mass of Can + Dry Soil)]/[(Mass of Can + Dry Soil) – (Mass of Moisture Can)]} x 100 $= \frac{W_4 - W_5}{W_5 - W_3} x100$

  Ex: Moisture Content, w (%) = $\frac{(253.0g - 237.0g)}{(237.0g - 54.0g)} x100$ = 8.74%

- **Dry Unit Weight of Compaction, γ_d** = $\frac{\gamma}{1 + \frac{w(\%)}{100}}$

  Ex: Dry Unit Weight of Compaction, $\gamma_d = \frac{115.2 lb/ft^3}{1 + \frac{8.74\%}{100}}$ = 105.9 lb/ft³

- **Zero-Air-Void Unit Weight, γ_{zav}** $= \dfrac{\gamma_w}{w + \dfrac{1}{G_s}}$

Can #1: $\gamma_{zav} = \dfrac{62.4 lb/ft^3}{0.0874 + \dfrac{1}{2.7}} = \boxed{136.3 \text{ lb/ft}^3}$

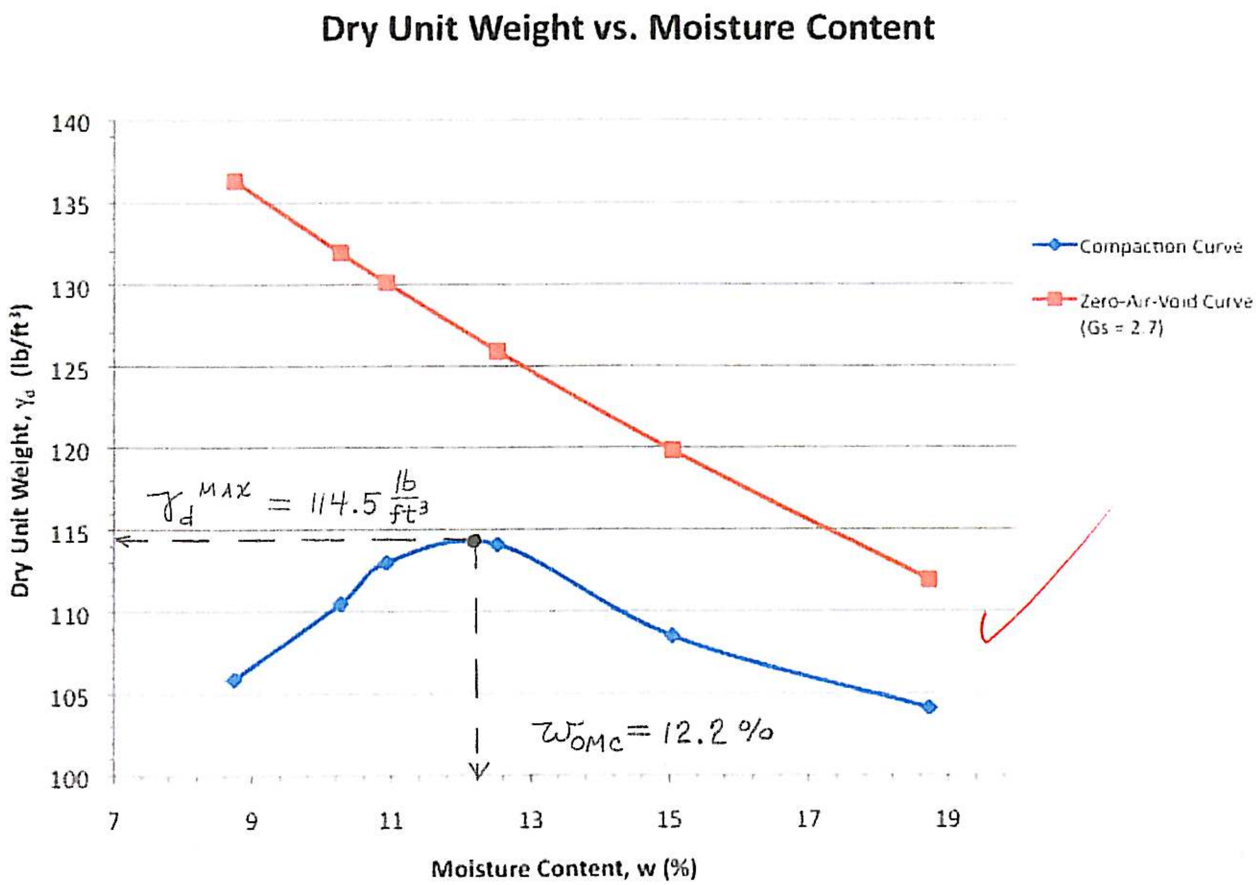
Can #2: $\gamma_{zav} = \dfrac{62.4 lb/ft^3}{0.1027 + \dfrac{1}{2.7}} = \boxed{131.9 \text{ lb/ft}^3}$

Can #3: $\gamma_{zav} = \dfrac{62.4 lb/ft^3}{0.1093 + \dfrac{1}{2.7}} = \boxed{130.1 \text{ lb/ft}^3}$

Can #4: $\gamma_{zav} = \dfrac{62.4 lb/ft^3}{0.1252 + \dfrac{1}{2.7}} = \boxed{125.9 \text{ lb/ft}^3}$

Can #5: $\gamma_{zav} = \dfrac{62.4 lb/ft^3}{0.1504 + \dfrac{1}{2.7}} = \boxed{119.8 \text{ lb/ft}^3}$

Can #6: $\gamma_{zav} = \dfrac{62.4 lb/ft^3}{0.1873 + \dfrac{1}{2.7}} = \boxed{111.9 \text{ lb/ft}^3}$



6. Conclusion:

From the results of the Standard Proctor Compaction Test and my graph of Dry Unit Weight vs. Moisture Content (including both a compaction curve and a zero-air-void curve), I can conclude that the optimum moisture content for this set of data is 12.2% and the maximum dry unit weight is 114.5 lb/ft^3. In addition, the compaction curve is bell shaped which further supports that the soil sample in this lab experiment is a clayey soil.

Standard Proctor Compaction Test

February 24th, 2010

Objective:
To determine the maximum dry unit weight of compaction and the optimum moisture content.

Equipment:
mold of volume 1/30th ft^3
hammer weighing 5.5 lbs
distilled water
spatula

Procedure:
1. Take a large soil sample that has been air-dried and add water to increase the moisture content.
2. Place 1/3rd of the soil sample into the mold.
3. Delivering 25 blows with the hammer at a height of 12 inches, compact the soil sample.
4. Scratch the surface of the newly created layer of soil with the spatula, creating a grid to distribute the compacting power to the next layer.
5. Repeat step 3 for two more layers, creating a total of 3 layers. Scratch the surface of the 2nd layer with the spatula as in step 4 as well.

Data:

Test #	1	2	3	4	5	6
Weight of Mold, W_1 (lb)	10.35	10.35	10.35	10.35	10.35	10.35
Weight of Mold + Moist Soil, W_2 (lb)	14.19	14.41	14.53	14.63	14.51	14.47
Weight of Moist Soil, W_2-W_1 (lb)	3.84	4.06	4.18	4.28	4.16	4.12
Moist Unit Weight (lb/ft^3)	115.2	121.8	125.4	128.4	124.8	123.6
Moisture Can Number	1	2	3	4	5	6
Mass of Moisture Can, W_3 *(g)*	54.0	53.3	53.3	54.0	54.8	40.8
Mass of Can + Moist Soil, W_4 (g)	253.0	354.0	439.0	490.0	422.8	243.0
Mass of Can + Dry Soil, W_5 (g)	237.0	326.0	401.0	441.5	374.7	211.1
Moisture Content (%)	8.7	10.3	10.9	12.5	15.0	18.7
Dry Unit Weight of Compaction (lb/ft^3)	106.0	110.4	113.1	114.1	108.5	104.1

Calculations:

To get the zero air void curve: $\gamma_{ZAV} = \gamma_w/[w + (1/G_s)]$

γ_{ZAV} (G_s=2.7)	136.4	131.8	130.2	126.0	119.9	112.0

To get the dry unit weight of compaction: γ_d (lb/ft^3)= $\gamma_w/[1+ (w\%/100)]$

*See last row in chart for γ_d calculations.

Conclusion:

From the data plot, the maximum dry unit weight, $\gamma_{d(max)}$ =114.1 lb/ft^3 and the optimum moisture content is **12.5%**.

OMC & $\gamma_{d\,max}$ →	Dry Unit Weight (lb/ft3)	Moisture Content %	γ_{ZAV}
	105.98	8.7	136.4
	110.43	10.3	131.8
	113.08	10.9	130.2
OMC & $\gamma_{d\,max}$ →	**114.13**	**12.5**	126.0
	108.52	15	119.9
	104.13	18.7	112.0