

7

CORRECTING DENSITY TEST RESULTS FOR MATERIAL RETAINED ON THE NO. 4 SIEVE

LEARNING OUTCOMES

- Understand how +4 material impacts the measurement of material moisture and density
- Understand the procedures for correcting target values and test results for +4 material in soils
- Understand the procedures for correcting target values and test results for dense graded aggregate

INTRODUCTION

A "golden rule" of compaction testing is: **The proctor used to calculate percent density must match the soil being tested.** This fact is restated here because it is the single most important factor why plus 4 corrections are necessary.

VTM-1 states when soil materials contain 10% or more material retained on the No. 4 sieve (3 or more dime size stones), it is necessary to correct the proctor results which are calculated on the minus 4 portion of the material. Basically, this is why: **Rocks are heavier than soil.** This sounds pretty simple, but this simple fact actually sets up a fairly complex relationship when +4 material is present in a soil.

Effects on Density Measurement

Since rocks are heavier than soil, the more present in a soil, the higher the maximum density. To calculate the corrected maximum density three figures are needed: the percentage of +4 material present; the material's specific gravity, and the maximum density of the minus 4 material.

Effects on Moisture Measurement

A very interesting thing happens with regard to moisture when +4 material is present in a soil. Think about this a moment: If we could separate the +4 from the minus 4 material, we would basically have a soil and some open graded aggregate. When working with aggregates we use the term absorption. This term is "kin" to optimum moisture because it represents Saturated Surface Dry (SSD) conditions. At SSD, aggregates neither add nor take water from whatever they're mixed with. Optimum moisture for +4 soil materials is generally between 1 and 3 percent. Compare that to the typical values for optimum moisture of soils, which often vary from as low as 6% to over 30%.

The optimum moisture for the total soil is a weighted average of the "optimums" for the two materials we've separated. Knowing the typical values for these optimums, we can understand why **the more +4 material present, the lower the optimum moisture**.

When these *corrected* values for maximum density and optimum moisture are applied to field densities, the relationships discussed here will be readily apparent as well as consistent.

This following information is included for your convenience (it is for instructional purposes only). For use outside this class, obtain the current VTM from the State Materials Engineer.

Laboratory Determination of Theoretical Maximum Density Optimum Moisture Content of Soils, Granular Subbase, and Base Materials.

Designation: VTM-1

AASHTO T 99 Method A shall be followed, except as modified below:

Moisture-Density Relationship

Note 12a: If there is 10% or greater material retained on the No. 4 sieve, use the following corrective procedure for determining the theoretical maximum dry density and optimum moisture content.

Material Containing Plus No. 4 Sieve Particles

AASHTO T 99 Method A procedure is applicable to soil that contains little or no material retained on the No. 4 sieve. Since the maximum density curve determined in the laboratory is obtained by utilizing only that material passing the No. 4 sieve, any appreciable amount of larger material contained in the embankment, which is being checked for compaction, will increase the apparent density, due to the higher specific gravity of the stone as compared to the bulk gravity of the compacted dry soil. At the same time, the optimum moisture content will be less, because some of the material passing the No. 4 sieve is replaced with coarser material (the void space is reduced and the total surface area is decreased).

- (1) The theoretical maximum density, "D" of mixtures containing coarse aggregate larger than a No. 4 sieve will be determined by the formula:

$$\text{Total Density } (D_t) = \frac{D_f \times D_c}{(P_c \times D_f) + (P_f \times D_c)}$$

Where:

D_f = Maximum dry laboratory density of minus No. 4 material (by AASHTO Designation: T 99), in lb/ft³

D_c = Maximum density of Plus No. 4 material ($62.4 \text{ lb/ft}^3 \times$ bulk specific gravity by AASHTO Designation: T85 or as estimated by the Engineer), in lb/ft^3

P_c = Percent plus No. 4 material, expressed as a decimal, and

P_f = Percent minus No. 4 material, expressed as a decimal or by nomograph (see Figure 1).

- (2) The optimum moisture for the total soil will be determined by the formula:

$$W_t = (P_c W_c + P_f W_f) 100$$

Where:

W_t = Optimum moisture content for total soil,

W_c = Optimum moisture content (absorption), expressed as a decimal, for material retained on No. 4 sieve (estimated between 1% and 3%),

W_f = Optimum moisture content, expressed as a decimal, for material passing No. 4 sieve,

P_c = Percent, expressed as a decimal, of material retained on a No. 4 sieve, and

P_f = Percent, expressed as a decimal, of material passing a No. 4 sieve.

General Notes:

1. The density required in the work will be a variable percentage of the theoretical maximum density, "D", depending upon variations in the percentage of plus No. 4 material in the mixture and upon the position of the material in the work, and will be specified in the applicable section of the specifications.
2. The District Materials Engineer will inform the Inspector of the results of the compaction tests on the minus 4 material and the specific gravity of the +4 material. With this information, the Inspector can then prepare a chart showing the density of the total sample for varying percentages of the +4 material.

+4 CORRECTIONS FOR THE NUCLEAR GAUGE

It is worth noting here the difference between the presence of +4 material and a “rock fill”. Generally, nuclear density can be performed on compacted material with up to about 35% +4 material, as long as there are minimum large rocks present (i.e. > 8 inches).

When +4 material is encountered with the nuclear gauge, a number of trial test locations (4 to 5) may be necessary in order to find a suitable test site.

+4 Sampling

When using a nuclear gauge, it is extremely important that a representative sample be obtained. This is accomplished by taking the total soil sample from **directly beneath the location of the gauge where the density test was taken**. A minimum sample of 5.5 lb. is necessary.

The Form TL-124A

The Form TL-124A (Report of Nuclear Embankment Densities) contains spaces for both the Proctor data (Lines E & F), as well as a space for the Corrected Maximum Density (Line H) and Corrected Optimum Moisture (Line I).

Steps to Follow for +4 Calculations

- 1) Test and calculate the percent of +4 material
- 2) Calculate the corrected maximum density
- 3) Calculate the corrected optimum moisture and moisture limits
- 4) Apply corrected values to the field density test:
 - a. Calculate the actual percent density
 - b. Compare actual moisture to corrected moisture limits

Form TL-124 (Rev. 07/15)

**VIRGINIA DEPARTMENT OF TRANSPORTATION
MATERIALS DIVISION
REPORT ON NUCLEAR EMBANKMENT DENSITIES (UNIT MASSES)**

Report No. 1-017-1 Date 06/22/2015 Sheet No. 1 of 1
 Route No. 17 County Campbell
 Project No. 0017-015-104, C503
 FHWA No. None
 Testing for Embankment
 Model No. 3440 Serial No. 23456 Calibration Date 02/10/2015

| STANDARD COUNT DATA | | | | | |
|-----------------------------------|--|----------------------|---|---|---|
| Density <u>2830</u> | | Moisture <u>701</u> | | | |
| Test No. | | 1 | 2 | 3 | 4 |
| Location | Station ft. (m) | 585+00 | | | |
| of | Ref. to center line ft. (m) | At C/L | | | |
| Test | Elevation | +8 / -4 | | | |
| Compaction Depth of Lift in. (mm) | | 6" | | | |
| Method of Compaction | | Sheepsfoot | | | |
| A. | Wet Density (lbs/ft ³), Wet Unit Mass (kg/m ³) | = 134.2 | | | |
| B. | Moisture Unit Mass (lbs/ft ³ or kg/m ³) | = 11.0 | | | |
| C. | Dry Density (lbs/ft ³), Dry Unit Mass (kg/m ³) (A-B) | = 123.2 | | | |
| D. | Moisture Content (B ÷ C) x 100 | = 8.9 | | | |
| E. | Maximum Dry Density (lbs/ft ³), Dry Unit Mass (kg/m ³) Lab Proctor or One Point Proctor | = 118.2 | | | |
| F. | Percent Optimum Moisture from Lab or One Point Proctor | = 12.4 9.9 – 14.9 | | | |
| G. | Percent of Plus #4, (plus 4.75 mm) | = | | | |
| H. | Corrected Max. Dry Density (lbs/ft ³), Dry Unit Mass (kg/m ³) | = | | | |
| I. | Corrected Optimum Moisture | = | | | |
| J. | Percent Dry Density (lbs/ft ³), Dry Unit Mass (kg/m ³) (C ÷ E) x 100 or (C ÷ H) x 100 | = 104.2 | | | |
| K. | Percent Minimum Density Required | = 95.0 | | | |

False "Low" Moisture

Proctor Values Based on the -4 Material

False "High" Density
Density = (123.2 ÷ 118.2) x 100
Density = 104.2%

Comments:

BY: _____

TITLE: _____

PROCEDURE FOR DETERMINING AMOUNT OF +4 MATERIAL IN TOTAL SOIL
(This Procedure is for Soil and Aggregates)

Testing Procedure

- 1) Obtain a representative sample (Use a minimum of 5.5 pounds from location of proposed nuclear test).
- 2) Dry the total sample.
- 3) Weigh the total dry sample.
- 4) Pass the dried material over the No. 4 Sieve.
- 5) Weigh the material retained on the No. 4 Sieve
- 6) Calculate the percent of +4 material:

$$\text{Percent of +4 Material} = (\text{Weight of +4 Material} \div \text{Weight of total Sample}) \times 100$$

Note: Round answer to the nearest whole percent.

Example Problem

| | | | | |
|--------|---------------------------|------|------|------|
| Step 1 | Weight of Dry Soil + Dish | 9.25 | | lbs. |
| | Weight of Dish Only | - | 1.69 | lbs. |
| | Total Weight of Dry Soil | | 7.56 | lbs. |

| | | | | |
|--------|------------------------------|------|------|------|
| Step 2 | Weight of +4 Material + Dish | 3.20 | | lbs. |
| | Weight of Dish Only | - | 1.69 | lbs. |
| | Weight of +4 Material | | 1.51 | lbs. |

| | | | |
|--------|------------------------|---|---------------------|
| Step 3 | Percent of +4 Material | = | (1.51 ÷ 7.56) x 100 |
| | | = | (0.199) x 100 |
| | | = | 19.9 or 20% |

Step 4 Enter 20% on Line G (Form TL-124)

CALCULATING THE TOTAL DENSITY OF SOILS WITH +4 MATERIAL

The equation for calculating the corrected total density of soils (D_t) containing +4 material may be expressed as follows:

$$\text{Total Density } (D_t) = \frac{D_f \times D_c}{(P_c \times D_f) + (P_f \times D_c)}$$

Needed Information:

P_c = Percent of +4 material expressed as a decimal = 0.2 (from sieve analysis)

D_c = Specific gravity of +4 material (2.68) x 62.4 lbs/ft³ = 167.2 lbs/ft³

P_f = Percent of -4 material expressed as a decimal = 0.8 (from sieve analysis)

D_f = Maximum Dry Density of the -4 material = 118.2 lbs/ft³ (from proctor)

$$\begin{aligned} \text{Total Density } (D_t) &= \frac{118.2 \times 167.2}{(0.2 \times 118.2) + (0.8 \times 167.2)} \\ &\quad \downarrow \\ &\quad \frac{19,763}{(23.6) + (133.8)} \\ &\quad \downarrow \\ &\quad \frac{19,763}{157.4} \\ &\quad \downarrow \\ \text{Total Density } (D_t) &= 125.6 \text{ lbs/ft}^3 \\ &\quad \text{(Enter on Line H of TL-124)} \end{aligned}$$

CALCULATING THE OPTIMUM MOISTURE OF SOILS WITH +4 MATERIAL

The Optimum Moisture content for the total soil is expressed as follows:

$$\text{Optimum Moisture } (W_t) = [(P_c W_c + P_f W_f)] \times 100$$

Needed Information:

P_c = Percent of +4 material expressed as a decimal = 0.2 (from sieve analysis)

W_c = Absorption of +4 material expressed as a decimal = 0.02 (Materials Division)

P_f = Percent of -4 material expressed as a decimal = 0.8 (from sieve analysis)

W_f = Optimum Moisture of the -4 material expressed as a decimal = 0.124 (from proctor)

$$\begin{array}{l} \text{Optimum Moisture } (W_t) = \quad [(0.2 \times 0.02) + (0.8 \times 0.124)] \times 100 \\ \quad \downarrow \\ \quad \quad [(0.004) + (0.099)] \times 100 \\ \quad \quad \downarrow \\ \quad \quad \quad 0.103 \times 100 \\ \quad \quad \quad \downarrow \\ \text{Optimum Moisture } (W_t) = \quad \quad 10.3\% \\ \quad \quad \quad \text{(Enter on Line I of TL-124)} \end{array}$$

Form TL-124 (Rev. 07/15)

DENSITY AND MOISTURE OF TOTAL SOIL CORRECTED FOR +4 MATERIAL

Report No. 1-017-1 Date 06/22/2015 Sheet No. 1 of 1
 Route No. 17 County Campbell
 Project No. 0017-015-104, C503
 FHWA No. None
 Testing for Embankment
 Model No. 3440 Serial No. 23456 Calibration Date 02/10/2015

| STANDARD COUNT DATA | | | | | |
|-----------------------------------|--|----------------------|---|---|---|
| Density <u>2830</u> | | Moisture <u>701</u> | | | |
| Test No. | | 1 | 2 | 3 | 4 |
| Location | Station ft. (m) | 585+00 | | | |
| of | Ref. to center line ft. (m) | At C/L | | | |
| Test | Elevation | +8 / -4 | | | |
| Compaction Depth of Lift in. (mm) | | 6" | | | |
| Method of Compaction | | Sheepsfoot | | | |
| A. | Wet Density (lbs/ft ³), Wet Unit Mass (kg/m ³) | = 134.2 | | | |
| B. | Moisture Unit Mass (lbs/ft ³ or kg/m ³) | = 11.0 | | | |
| C. | Dry Density (lbs/ft ³), Dry Unit Mass (kg/m ³) (A-B) | = 123.2 | | | |
| D. | Moisture Content (B ÷ C) x 100 | = 8.9 | | | |
| E. | Maximum Dry Density (lbs/ft ³), Dry Unit Mass (kg/m ³) Lab Proctor or One Point Proctor | = 118.2 | | | |
| F. | Percent Optimum Moisture from Lab or One Point Proctor | = 12.4 9.9 - 14.9 | | | |
| G. | Percent of Plus #4, (plus 4.75 mm) | = 20 | | | |
| H. | Corrected Max. Dry Density (lbs/ft ³), Dry Unit Mass (kg/m ³) | = 125.6 | | | |
| I. | Corrected Optimum Moisture | = 10.3 8.2 - 12.4 | | | |
| J. | Percent Dry Density (lbs/ft ³), Dry Unit Mass (kg/m ³) (C ÷ E) x 100 or (C ÷ H) x 100 | = 98.1 | | | |
| K. | Percent Minimum Density Required | = 95.0 | | | |

Percent +4 Material

Corrected Maximum Density

Corrected Optimum Moisture

Correct Percent Density
 Density = (123.2 + 125.6) x 100
 Density = 98.1%

Comments:

BY: _____

TITLE: _____

DENSITY TESTING OF DENSE GRADED AGGREGATES

After placement of the embankment material and compaction and approval of the subgrade, the Contractor will apply the dense graded aggregate layer to the subgrade. After sufficient compactive effort has been applied to densify the aggregate, the inspector conducts field density tests to determine if the contractor's operations have satisfactorily densified these materials.

The minimum rates of testing for these procedures are outlined in the Appendix.

Section 303.04(h) of the 2007 Road and Bridge Specification stipulates that all field density determinations are to be performed in accordance with the following testing procedures:

- AASHTO T310 - In-Place Density and Moisture Content of Soil-Aggregate by Nuclear Method (Shallow Depth)
- VTM-10 - Determining Percent of Moisture and Density of Soils and Asphalt (Nuclear Method)

Form TL-124 (Rev. 07/15)

**VIRGINIA DEPARTMENT OF TRANSPORTATION
MATERIALS DIVISION
REPORT ON NUCLEAR EMBANKMENT DENSITIES (UNIT MASSES)**

Report No. 1-017-1 Date 06/22/2015 Sheet No. 1 of 1
 Route No. 17 County Campbell
 Project No. 0017-015-104, C503
 FHWA No. None
 Testing for Aggregate Base Type I (21A)
 Model No. 3440 Serial No. 23456 Calibration Date 02/10/2015

| STANDARD COUNT DATA | | | | | |
|---|-----------------------------|---------------------|---|---|---|
| Density <u>2830</u> | | Moisture <u>701</u> | | | |
| Test No. | | 1 | 2 | 3 | 4 |
| Location | Station ft. (m) | 585+00 | | | |
| of | Ref. to center line ft. (m) | 5' Rt. C/L | | | |
| Test | Elevation | | | | |
| Compaction Depth of Lift in. (mm) | | 6" | | | |
| Method of Compaction | | Vibratory | | | |
| A. Wet Density (lbs/ft ³), Wet Unit Mass (kg/m ³) | | = 145.2 | | | |
| B. Moisture Unit Mass (lbs/ft ³ or kg/m ³) | | = 7.0 | | | |
| C. Dry Density (lbs/ft ³), Dry Unit Mass (kg/m ³) (A-B) | | = 138.2 | | | |
| D. Moisture Content (B ÷ C) x 100 | | = 5.1 | | | |
| E. Maximum Dry Density (lbs/ft ³), Dry Unit Mass (kg/m ³) Lab Proctor or One Point Proctor | | = 127.7 | | | |
| F. Percent Optimum Moisture from Lab or One Point Proctor | | = 8.5 6.5 – 10.5 | | | |
| G. Percent of Plus #4, (plus 4.75 mm) | | = | | | |
| H. Corrected Max. Dry Density (lbs/ft ³), Dry Unit Mass (kg/m ³) | | = | | | |
| I. Corrected Optimum Moisture | | = | | | |
| J. Percent Dry Density (lbs/ft ³), Dry Unit Mass (kg/m ³) (C ÷ E) x 100 or (C ÷ H) x 100 | | = 108.2 | | | |
| K. Percent Minimum Density Required | | = 95.0 | | | |

False "Low" Moisture

Proctor Values Based on the -4 Material

False "High" Density
 Density = $(138.2 \div 127.7) \times 100$
 Density = 108.2%

Comments:

BY: _____

TITLE: _____

PROCEDURE FOR DETERMINING AMOUNT OF +4 MATERIAL IN AGGREGATE
(This Procedure is for Soil and Aggregates)

- 1) Obtain a representative sample (Use a minimum of 5.5 pounds from location of proposed nuclear test).
- 2) Dry the total sample.
- 3) Weigh the total dry sample.
- 4) Pass the dried material over the No. 4 Sieve.
- 5) Weigh the material retained on the No. 4 Sieve
- 6) Calculate the percent of +4 material:

$$\text{Percent of +4 Material} = (\text{Weight of +4 Material} \div \text{Weight of total Sample}) \times 100$$

Note: Round answer to the nearest whole percent.

Example Problem

| | | | | |
|--------|--------------------------------|------|------|------|
| Step 1 | Weight of Dry Aggregate + Dish | 9.22 | | lbs. |
| | Weight of Dish Only | - | 2.54 | lbs. |
| | Total Weight of Dry Aggregate | 6.68 | | lbs. |

| | | | | |
|--------|------------------------------|------|------|------|
| Step 2 | Weight of +4 Material + Dish | 5.68 | | lbs. |
| | Weight of Dish Only | - | 2.54 | lbs. |
| | Weight of +4 Material | 3.14 | | lbs. |

| | | | |
|--------|------------------------|---|---------------------|
| Step 3 | Percent of +4 Material | = | (3.14 ÷ 6.68) x 100 |
| | | = | (0.470) x 100 |
| | | = | 47.0% |

Step 4 Enter 47% on Line G (Form TL-124)

CALCULATING THE TOTAL DENSITY OF AGGREGATE WITH +4 MATERIAL

The equation for calculating the corrected total density of aggregate (D_t) containing +4 material may be expressed as follows:

$$\text{Total Density } (D_t) = \frac{D_f \times D_c}{(P_c \times D_f) + (P_f \times D_c)}$$

Needed Information:

P_c = Percent of +4 material expressed as a decimal = 0.47 (from sieve analysis)

D_c = Specific gravity of +4 material (2.63) x 62.4 lbs/ft³ = 164.1 lbs/ft³

P_f = Percent of -4 material expressed as a decimal = 0.53 (from sieve analysis)

D_f = Maximum Dry Density of the -4 material = 127.7 lbs/ft³ (from proctor)

$$\begin{array}{r} \text{Total Density } (D_t) = \frac{127.7 \times 164.1}{(0.47 \times 127.7) + (0.53 \times 164.1)} \\ \downarrow \\ \frac{20,955.6}{(60.0) + (87.0)} \\ \downarrow \\ \frac{20,955.6}{147.0} \\ \downarrow \\ \text{Total Density } (D_t) = 142.6 \text{ lbs/ft}^3 \\ \text{(Enter on Line H of TL-124)} \end{array}$$

CALCULATING THE OPTIMUM MOISTURE OF AGGREGATE WITH +4 MATERIAL

The Optimum Moisture content for the aggregate is expressed as follows:

$$\text{Optimum Moisture } (W_t) = [(P_c W_c + P_f W_f)] \times 100$$

Needed Information:

P_c = Percent of +4 material expressed as a decimal = 0.47 (taken from sieve analysis)

W_c = Absorption of +4 material (+ 1) expressed as a decimal = 0.013 (Materials Division)

P_f = Percent of -4 material expressed as a decimal = 0.53 (from sieve analysis)

W_f = Optimum Moisture of the -4 material expressed as a decimal = 0.085 (from proctor)

$$\begin{array}{l} \text{Optimum Moisture } (W_t) = \quad [(0.47 \times 0.013) + (0.53 \times 0.085)] \times 100 \\ \quad \downarrow \\ \quad \quad \quad [(0.006) + (0.045)] \times 100 \\ \quad \quad \quad \downarrow \\ \quad \quad \quad 0.051 \times 100 \\ \quad \quad \quad \downarrow \\ \text{Optimum Moisture } (W_t) = \quad 5.1\% \\ \quad \quad \quad \text{(Enter on Line I of TL-124)} \end{array}$$

Form TL-124 (Rev. 07/15)

DENSITY AND MOISTURE OF AGGREGATE CORRECTED FOR +4 MATERIAL

Report No. 1-017-1 Date 06/22/2015 Sheet No. 1 of 1
 Route No. 17 County Campbell
 Project No. 0017-015-104, C503
 FHWA No. None
 Testing for Aggregate Base Type I (21A)
 Model No. 3440 Serial No. 23456 Calibration Date 02/10/2015

| STANDARD COUNT DATA | | | | | |
|---|-----------------------------|---------------------|---|---|---|
| Density <u>2830</u> | | Moisture <u>701</u> | | | |
| Test No. | | 1 | 2 | 3 | 4 |
| Location | Station ft. (m) | 585+00 | | | |
| of | Ref. to center line ft. (m) | 5' Rt. C/L | | | |
| Test | Elevation | | | | |
| Compaction Depth of Lift in. (mm) | | 6" | | | |
| Method of Compaction | | Vibratory | | | |
| A. Wet Density (lbs/ft ³), Wet Unit Mass (kg/m ³) | = | 145.2 | | | |
| B. Moisture Unit Mass (lbs/ft ³ or kg/m ³) | = | 7.0 | | | |
| C. Dry Density (lbs/ft ³), Dry Unit Mass (kg/m ³) (A-B) | = | 138.2 | | | |
| D. Moisture Content (B ÷ C) x 100 | = | 5.1 | | | |
| E. Maximum Dry Density (lbs/ft ³), Dry Unit Mass (kg/m ³) Lab Proctor or One Point Proctor | = | 127.7 | | | |
| F. Percent Optimum Moisture from Lab or One Point Proctor | = | 8.5 6.5 – 10.5 | | | |
| G. Percent of Plus #4, (plus 4.75 mm) | = | 47 | | | |
| H. Corrected Max. Dry Density (lbs/ft ³), Dry Unit Mass (kg/m ³) | = | 142.6 | | | |
| I. Corrected Optimum Moisture | = | 5.1 3.1 – 7.1 | | | |
| J. Percent Dry Density (lbs/ft ³), Dry Unit Mass (kg/m ³) (C ÷ E) x 100 or (C ÷ H) x 100 | = | 96.9 | | | |
| K. Percent Minimum Density Required | = | 95.0 | | | |

Percent +4 Material

Corrected Maximum Density

Corrected Optimum Moisture

Correct Percent Density
 Density = (138.2 ÷ 142.6) x 100
 Density = 96.9%

Comments:

BY: _____

TITLE: _____

CHAPTER 7 – PRACTICE PROBLEMS

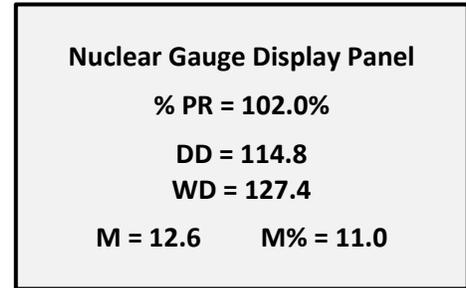
Practice Problem Number 1 Nuclear Density Testing of Soils (Correcting for +4 Material)

- 1) Complete the embankment density test (Form TL-124) using the calculation sheet and information provided below.

Weight of Dry Soil and Dish = 9.29 lbs.
 Weight of Dish Only = 2.62 lbs.
 Weight of +4 Material and Dish = 3.63 lbs.

Specific Gravity of +4 Material = 2.63
 Absorption of +4 Material = 3.0%

Maximum Dry Density of -4 Material = 112.6 lbs/ft³
 Optimum Moisture of -4 Material = 14.5%



- 2) Indicate in the remarks if the test passes or fails and why.

Form TL-124 (Rev. 07/15)

**VIRGINIA DEPARTMENT OF TRANSPORTATION
MATERIALS DIVISION
REPORT ON NUCLEAR EMBANKMENT DENSITIES (UNIT MASSES)**

Report No. 1-117-1 Date 06/22/2015 Sheet No. 1 of 1
 Route No. 117 County Roanoke
 Project No. 0117-080-105, C501
 FHWA No. None
 Testing for Embankment
 Model No. 3440 Serial No. 23456 Calibration Date 02/10/2015

| STANDARD COUNT DATA | | | | |
|---|-----------------------------|---|---------------------|---|
| | Density <u>2844</u> | | Moisture <u>701</u> | |
| Test No. | 1 | 2 | 3 | 4 |
| Location | Station ft. (m) | | 90+45 | |
| of | Ref. to center line ft. (m) | | 6' Rt. C/L | |
| Test | Elevation | | +8 / -6 | |
| Compaction Depth of Lift in. (mm) | | | 6" | |
| Method of Compaction | | | Sheepsfoot | |
| A. Wet Density (lbs/ft ³), Wet Unit Mass (kg/m ³) | = | | | |
| B. Moisture Unit Mass (lbs/ft ³ or kg/m ³) | = | | | |
| C. Dry Density (lbs/ft ³), Dry Unit Mass (kg/m ³) (A-B) | = | | | |
| D. Moisture Content (B ÷ C) x 100 | = | | | |
| E. Maximum Dry Density (lbs/ft ³), Dry Unit Mass (kg/m ³) Lab Proctor or One Point Proctor | = | | | |
| F. Percent Optimum Moisture from Lab or One Point Proctor | = | | | |
| G. Percent of Plus #4, (plus 4.75 mm) | = | | | |
| H. Corrected Max. Dry Density (lbs/ft ³), Dry Unit Mass (kg/m ³) | = | | | |
| I. Corrected Optimum Moisture | = | | | |
| J. Percent Dry Density (lbs/ft ³), Dry Unit Mass (kg/m ³) (C ÷ E) x 100 or (C ÷ H) x 100 | = | | | |
| K. Percent Minimum Density Required | = | | | |

Comments:

BY: _____

TITLE: _____

CHAPTER 7 – PRACTICE PROBLEMS

Practice Problem Number 2 Nuclear Density Testing of Soils (Correcting for +4 Material)

- 1) Complete the embankment density test (Form TL-124) using the calculation sheet and information provided below.

Weight of Dry Soil and Dish = 9.30 lbs.
 Weight of Dish Only = 2.62 lbs.
 Weight of +4 Material and Dish = 3.65 lbs.

Specific Gravity of +4 Material = 2.70
 Absorption of +4 Material = 2.0%

Maximum Dry Density of -4 Material = 110.5 lbs/ft³
 Optimum Moisture of -4 Material = 14.3%

| Nuclear Gauge Display Panel | |
|-----------------------------|-----------|
| % PR = 104.7% | |
| DD = 115.7 | |
| WD = 127.9 | |
| M = 12.2 | M% = 10.5 |

- 2) Indicate in the remarks if the test passes or fails and why.

Form TL-124 (Rev. 07/15)

**VIRGINIA DEPARTMENT OF TRANSPORTATION
MATERIALS DIVISION
REPORT ON NUCLEAR EMBANKMENT DENSITIES (UNIT MASSES)**

Report No. 1-117-1 Date 06/22/2015 Sheet No. 1 of 1
 Route No. 117 County Roanoke
 Project No. 0117-080-105, C501
 FHWA No. None
 Testing for Embankment
 Model No. 3440 Serial No. 23456 Calibration Date 02/10/2015

| STANDARD COUNT DATA | | | | | |
|---|-----------------------------|---------------------|---|---|---|
| Density <u>2844</u> | | Moisture <u>701</u> | | | |
| Test No. | | 1 | 2 | 3 | 4 |
| Location | Station ft. (m) | 90+45 | | | |
| of | Ref. to center line ft. (m) | 6' Rt. C/L | | | |
| Test | Elevation | +8 / -6 | | | |
| Compaction Depth of Lift in. (mm) | | 6" | | | |
| Method of Compaction | | Sheepsfoot | | | |
| A. Wet Density (lbs/ft ³), Wet Unit Mass (kg/m ³) | | = | | | |
| B. Moisture Unit Mass (lbs/ft ³ or kg/m ³) | | = | | | |
| C. Dry Density (lbs/ft ³), Dry Unit Mass (kg/m ³) (A-B) | | = | | | |
| D. Moisture Content (B ÷ C) x 100 | | = | | | |
| E. Maximum Dry Density (lbs/ft ³), Dry Unit Mass (kg/m ³) Lab Proctor or One Point Proctor | | = | | | |
| F. Percent Optimum Moisture from Lab or One Point Proctor | | = | | | |
| G. Percent of Plus #4, (plus 4.75 mm) | | = | | | |
| H. Corrected Max. Dry Density (lbs/ft ³), Dry Unit Mass (kg/m ³) | | = | | | |
| I. Corrected Optimum Moisture | | = | | | |
| J. Percent Dry Density (lbs/ft ³), Dry Unit Mass (kg/m ³) (C ÷ E) x 100 or (C ÷ H) x 100 | | = | | | |
| K. Percent Minimum Density Required | | = | | | |

Comments:

BY: _____

TITLE: _____

CHAPTER 7 – PRACTICE PROBLEMS

Practice Problem Number 3 Nuclear Density Testing of Soils (Correcting for +4 Material)

- 1) Complete the embankment density test (Form TL-124) using the calculation sheet and information provided below.

Weight of Dry Soil and Dish = 9.29 lbs.
 Weight of Dish Only = 2.62 lbs.
 Weight of +4 Material and Dish = 3.51 lbs.

Specific Gravity of +4 Material = 2.68
 Absorption of +4 Material = 2.0%

Maximum Dry Density of -4 Material = 109.9 lbs/ft³
 Optimum Moisture of -4 Material = 13.9%

| Nuclear Gauge Display Panel | |
|-----------------------------|-----------|
| % PR = 104.4% | |
| DD = 114.7 | |
| WD = 127.5 | |
| M = 12.8 | M% = 11.2 |

- 2) Indicate in the remarks if the test passes or fails and why.

Form TL-124 (Rev. 07/15)

**VIRGINIA DEPARTMENT OF TRANSPORTATION
MATERIALS DIVISION
REPORT ON NUCLEAR EMBANKMENT DENSITIES (UNIT MASSES)**

Report No. 1-117-1 Date 06/22/2015 Sheet No. 1 of 1
 Route No. 117 County Roanoke
 Project No. 0117-080-105, C501
 FHWA No. None
 Testing for Embankment
 Model No. 3440 Serial No. 23456 Calibration Date 02/10/2015

| STANDARD COUNT DATA | | | | |
|---|-----------------------------|---|---------------------|---|
| | Density <u>2844</u> | | Moisture <u>701</u> | |
| Test No. | 1 | 2 | 3 | 4 |
| Location | Station ft. (m) | | 90+45 | |
| of | Ref. to center line ft. (m) | | 6' Rt. C/L | |
| Test | Elevation | | +8 / -6 | |
| Compaction Depth of Lift in. (mm) | | | 6" | |
| Method of Compaction | | | Sheepsfoot | |
| A. Wet Density (lbs/ft ³), Wet Unit Mass (kg/m ³) | = | | | |
| B. Moisture Unit Mass (lbs/ft ³ or kg/m ³) | = | | | |
| C. Dry Density (lbs/ft ³), Dry Unit Mass (kg/m ³) (A-B) | = | | | |
| D. Moisture Content (B ÷ C) x 100 | = | | | |
| E. Maximum Dry Density (lbs/ft ³), Dry Unit Mass (kg/m ³) Lab Proctor or One Point Proctor | = | | | |
| F. Percent Optimum Moisture from Lab or One Point Proctor | = | | | |
| G. Percent of Plus #4, (plus 4.75 mm) | = | | | |
| H. Corrected Max. Dry Density (lbs/ft ³), Dry Unit Mass (kg/m ³) | = | | | |
| I. Corrected Optimum Moisture | = | | | |
| J. Percent Dry Density (lbs/ft ³), Dry Unit Mass (kg/m ³) (C ÷ E) x 100 or (C ÷ H) x 100 | = | | | |
| K. Percent Minimum Density Required | = | | | |

Comments:

BY: _____

TITLE: _____

CHAPTER 7 – PRACTICE PROBLEMS

Practice Problem Number 4 Nuclear Density Testing of Aggregate (Correcting for +4 Material)

- 1) Complete the embankment density test (Form TL-124) using the calculation sheet and information provided below.

Weight of Dry Soil and Dish = 5.41 lbs.
 Weight of Dish Only = 1.61 lbs.
 Weight of +4 Material and Dish = 3.01 lbs.

Specific Gravity of +4 Material = 2.73
 Absorption of +4 Material = 0.3%

Maximum Dry Density of -4 Material = 124.4 lbs/ft³
 Optimum Moisture of -4 Material = 7.4%

| Nuclear Gauge Display Panel | |
|-----------------------------|----------|
| % PR = 107.0% | |
| DD = 133.1 | |
| WD = 140.0 | |
| M = 6.9 | M% = 5.2 |

- 2) Indicate in the remarks if the test passes or fails and why.

Form TL-124 (Rev. 07/15)

**VIRGINIA DEPARTMENT OF TRANSPORTATION
MATERIALS DIVISION
REPORT ON NUCLEAR EMBANKMENT DENSITIES (UNIT MASSES)**

Report No. 1-21A-1 Date 06/22/2015 Sheet No. 1 of 1
 Route No. 95 County Fairfax
 Project No. 0095-029-F15, C502
 FHWA No. None
 Testing for Direct Transmission on Aggregate Base Type I (21A)
 Model No. 3440 Serial No. 23456 Calibration Date 02/10/2015

| STANDARD COUNT DATA | | | | | |
|---|-----------------------------|---------------------|---|---|---|
| Density <u>2844</u> | | Moisture <u>701</u> | | | |
| Test No. | | 1 | 2 | 3 | 4 |
| Location | Station ft. (m) | 24+35 | | | |
| of | Ref. to center line ft. (m) | 5' Rt. C/L | | | |
| Test | Elevation | | | | |
| Compaction Depth of Lift in. (mm) | | 6" | | | |
| Method of Compaction | | Vibratory | | | |
| A. Wet Density (lbs/ft ³), Wet Unit Mass (kg/m ³) | | = | | | |
| B. Moisture Unit Mass (lbs/ft ³ or kg/m ³) | | = | | | |
| C. Dry Density (lbs/ft ³), Dry Unit Mass (kg/m ³) (A-B) | | = | | | |
| D. Moisture Content (B ÷ C) x 100 | | = | | | |
| E. Maximum Dry Density (lbs/ft ³), Dry Unit Mass (kg/m ³) Lab Proctor or One Point Proctor | | = | | | |
| F. Percent Optimum Moisture from Lab or One Point Proctor | | = | | | |
| G. Percent of Plus #4, (plus 4.75 mm) | | = | | | |
| H. Corrected Max. Dry Density (lbs/ft ³), Dry Unit Mass (kg/m ³) | | = | | | |
| I. Corrected Optimum Moisture | | = | | | |
| J. Percent Dry Density (lbs/ft ³), Dry Unit Mass (kg/m ³) (C ÷ E) x 100 or (C ÷ H) x 100 | | = | | | |
| K. Percent Minimum Density Required | | = | | | |

Comments:

BY: _____

TITLE: _____

CHAPTER 7 – PRACTICE PROBLEMS

Practice Problem Number 5 Nuclear Density Testing of Aggregate (Correcting for +4 Material)

- 1) Complete the embankment density test (Form TL-124) using the calculation sheet and information provided below.

Weight of Dry Soil and Dish = 8.43 lbs.
 Weight of Dish Only = 1.61 lbs.
 Weight of +4 Material and Dish = 5.71 lbs.

Specific Gravity of +4 Material = 2.81
 Absorption of +4 Material = 0.3%

Maximum Dry Density of -4 Material = 134.6 lbs/ft³
 Optimum Moisture of -4 Material = 8.4%

| Nuclear Gauge Display Panel | |
|-----------------------------|----------|
| % PR = 111.6% | |
| DD = 150.2 | |
| WD = 155.3 | |
| M = 5.1 | M% = 3.4 |

- 2) Indicate in the remarks if the test passes or fails and why.

Form TL-124 (Rev. 07/15)

**VIRGINIA DEPARTMENT OF TRANSPORTATION
MATERIALS DIVISION
REPORT ON NUCLEAR EMBANKMENT DENSITIES (UNIT MASSES)**

Report No. 1-21A-1 Date 06/22/2015 Sheet No. 1 of 1
 Route No. 7 County Loudon
 Project No. 0007-053-121, C501
 FHWA No. None
 Testing for Direct Transmission on Aggregate Base Type I (21A)
 Model No. 3440 Serial No. 23456 Calibration Date 02/10/2015

| STANDARD COUNT DATA | | | | | |
|---|-----------------------------|---------------------|---|---|---|
| Density <u>2864</u> | | Moisture <u>709</u> | | | |
| Test No. | | 1 | 2 | 3 | 4 |
| Location | Station ft. (m) | 901+25 | | | |
| of | Ref. to center line ft. (m) | 3' Lt. C/L | | | |
| Test | Elevation | | | | |
| Compaction Depth of Lift in. (mm) | | 6" | | | |
| Method of Compaction | | Vibratory | | | |
| A. Wet Density (lbs/ft ³), Wet Unit Mass (kg/m ³) | | = | | | |
| B. Moisture Unit Mass (lbs/ft ³ or kg/m ³) | | = | | | |
| C. Dry Density (lbs/ft ³), Dry Unit Mass (kg/m ³) (A-B) | | = | | | |
| D. Moisture Content (B ÷ C) x 100 | | = | | | |
| E. Maximum Dry Density (lbs/ft ³), Dry Unit Mass (kg/m ³) Lab Proctor or One Point Proctor | | = | | | |
| F. Percent Optimum Moisture from Lab or One Point Proctor | | = | | | |
| G. Percent of Plus #4, (plus 4.75 mm) | | = | | | |
| H. Corrected Max. Dry Density (lbs/ft ³), Dry Unit Mass (kg/m ³) | | = | | | |
| I. Corrected Optimum Moisture | | = | | | |
| J. Percent Dry Density (lbs/ft ³), Dry Unit Mass (kg/m ³) (C ÷ E) x 100 or (C ÷ H) x 100 | | = | | | |
| K. Percent Minimum Density Required | | = | | | |

Comments:

BY: _____

TITLE: _____

CHAPTER 7 – PRACTICE PROBLEMS**Practice Problem Number 6
Nuclear Density Testing of Aggregate
(Correcting for +4 Material)**

- 1) Complete the embankment density test (Form TL-124) using the calculation sheet and information provided below.

Weight of Dry Soil and Dish = 8.40 lbs.
Weight of Dish Only = 1.63 lbs.
Weight of +4 Material and Dish = 4.75 lbs.

Specific Gravity of +4 Material = 2.80
Absorption of +4 Material = 0.6%

Maximum Dry Density of -4 Material = 132.1 lbs/ft³
Optimum Moisture of -4 Material = 7.2%

| Nuclear Gauge Display Panel | |
|------------------------------------|-----------------|
| % PR = 109.1% | |
| DD = 144.1 | |
| WD = 150.2 | |
| M = 6.1 | M% = 4.2 |

- 2) Indicate in the remarks if the test passes or fails and why.

Form TL-124 (Rev. 07/15)

**VIRGINIA DEPARTMENT OF TRANSPORTATION
MATERIALS DIVISION
REPORT ON NUCLEAR EMBANKMENT DENSITIES (UNIT MASSES)**

Report No. 1-21A-1 Date 06/22/2015 Sheet No. 1 of 1
 Route No. 265 County Pittsylvania
 Project No. 6265-071-102, G302
 FHWA No. None
 Testing for Direct Transmission on Aggregate Base Type I (21A)
 Model No. 3440 Serial No. 23456 Calibration Date 02/10/2015

| STANDARD COUNT DATA | | | | | |
|---|-----------------------------|---------------------|---|---|---|
| Density <u>2844</u> | | Moisture <u>701</u> | | | |
| Test No. | | 1 | 2 | 3 | 4 |
| Location | Station ft. (m) | 609+10 | | | |
| of | Ref. to center line ft. (m) | 6' Rt. C/L | | | |
| Test | Elevation | | | | |
| Compaction Depth of Lift in. (mm) | | 6" | | | |
| Method of Compaction | | Vibratory | | | |
| A. Wet Density (lbs/ft ³), Wet Unit Mass (kg/m ³) | | = | | | |
| B. Moisture Unit Mass (lbs/ft ³ or kg/m ³) | | = | | | |
| C. Dry Density (lbs/ft ³), Dry Unit Mass (kg/m ³) (A-B) | | = | | | |
| D. Moisture Content (B ÷ C) x 100 | | = | | | |
| E. Maximum Dry Density (lbs/ft ³), Dry Unit Mass (kg/m ³) Lab Proctor or One Point Proctor | | = | | | |
| F. Percent Optimum Moisture from Lab or One Point Proctor | | = | | | |
| G. Percent of Plus #4, (plus 4.75 mm) | | = | | | |
| H. Corrected Max. Dry Density (lbs/ft ³), Dry Unit Mass (kg/m ³) | | = | | | |
| I. Corrected Optimum Moisture | | = | | | |
| J. Percent Dry Density (lbs/ft ³), Dry Unit Mass (kg/m ³) (C ÷ E) x 100 or (C ÷ H) x 100 | | = | | | |
| K. Percent Minimum Density Required | | = | | | |

Comments:

BY: _____

TITLE: _____

