CHAPTER 7

CORRECTING DENSITY TESTS FOR MATERIAL RETAINED ON THE NO. 4 SIEVE

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 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.

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 (ie., > 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.

DENSITY

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 materials' specific gravity, and the maximum density of the minus 4 material.

MOISTURE

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 & 3 percent. Compare that to typical values for optimum moisture of soils which run 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 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.

Virginia Test Method

For

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:

12. 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.

12.3 Add:

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:

\[ D = \frac{D_f \times D_c}{P_c D_f + P_f D_c} \]

Where:

\[ D_f = \text{Maximum dry laboratory density of minus No. 4 material (by AASHTO Designation: T 99), in lb/ft}^3 \]

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

\[ P_c = \text{Percent plus No. 4 material, expressed as a decimal, and} \]

\[ P_f = \text{Percent minus No. 4 material, expressed as a decimal or by nomograph (Figure 1)} \]
(2) The optimum moisture for the total soil will be determined by the formula:

$$W_t = \left( P_c W_c + P_f W_f \right) \times 100$$

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.
### DENSITY DETERMINATION

<p>| | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>A.</td>
<td>Unit wt. (lbs/ft³) or Unit mass (kg/m³) of sand (calibrated value)</td>
<td>87.3</td>
</tr>
<tr>
<td>B.</td>
<td>Wt. (mass) sand + wt. (mass) of jar and cone, lb. (kg)</td>
<td>13.32</td>
</tr>
<tr>
<td>C.</td>
<td>Wt. (mass) sand left in jar + wt. (mass) of jar and cone, lb. (kg)</td>
<td>5.12</td>
</tr>
<tr>
<td>D.</td>
<td>Wt. (mass) of sand in cone and base plate, lb. (kg) (calibrated value)</td>
<td>2.72</td>
</tr>
<tr>
<td>E.</td>
<td>Wt. (mass) sand left in jar + wt. (mass) of jar and cone + wt. sand in cone and base plate (C + D), lb. (kg)</td>
<td>7.84</td>
</tr>
<tr>
<td>F.</td>
<td>Wt. (mass) of sand in test hole (B - E), lb. (kg)</td>
<td>5.48</td>
</tr>
<tr>
<td>G.</td>
<td>Volume of test hole (F ÷ A), ft³ (m³)</td>
<td>0.0628</td>
</tr>
<tr>
<td>H.</td>
<td>Wt. (mass) of wet soil from test hole + (wt.) mass of pan, lb. (kg)</td>
<td>10.05</td>
</tr>
<tr>
<td>I.</td>
<td>Wt. (mass) of pan, lb. (kg)</td>
<td>1.69</td>
</tr>
<tr>
<td>J.</td>
<td>Wt. (mass) of wet soil from test hole (H - I), lb. (kg)</td>
<td>8.36</td>
</tr>
<tr>
<td>K.</td>
<td>Unit wt. (lbs/ft³) or Unit mass (kg/m³) of wet soil in fill (J ÷ G)</td>
<td>133.1</td>
</tr>
</tbody>
</table>
| L. | Unit wt. (lbs/ft³) or Unit mass (kg/m³) of dry soil in fill = K 

\[
\{ 1 + \left[ \text{Moisture Content (T) ÷ 100} \right] \}
\] |
| M. | Max. Dry Unit Wt. (lbs/ft³) or Unit mass (kg/m³) from LAB PROCTOR OR ONE POINT PROCTOR (TL-125a) | 114.6 |
| N. | Optimum Moisture Content from LAB PROCTOR OR ONE POINT PROCTOR (TL-125a) | 14.1 |
| O. | Percent of +No. 4 (plus 4.75 mm) Material |   |
| P. | Corrected Maximum Dry Unit wt. (lbs/ft³) or Unit mass (kg/m³) |   |
| Q. | Corrected Optimum Moisture (%) |   |
| R. | % Compaction (L ÷ M) × 100 or (L ÷ P) × 100 | 104.9 |
| S. | % Minimum density (unit mass) required (from specifications) | 95 |

### MOISTURE DETERMINATION (For Field Dried Method)

<p>| | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>a.</td>
<td>Dish and damp soil, lb. (kg)</td>
<td></td>
</tr>
<tr>
<td>b.</td>
<td>Dish and dried soil, lb. (kg)</td>
<td></td>
</tr>
<tr>
<td>c.</td>
<td>Wt. (mass) moisture in soil, lbs. (kg)</td>
<td></td>
</tr>
<tr>
<td>d.</td>
<td>Wt. (mass) dish, lb. (kg)</td>
<td>1.69</td>
</tr>
<tr>
<td>e.</td>
<td>Wt. (mass) dry soil (b - d), lb. (kg)</td>
<td>7.56</td>
</tr>
<tr>
<td>f.</td>
<td>Moisture Content (c ÷ e) × 100 or from “Speedy” Moisture Test</td>
<td>10.6</td>
</tr>
</tbody>
</table>

**Effects of +4 Material On Compaction Tests**

- **False High Density**
- **False Low Moisture**

**Acceptable Moisture Range ±20% of Optimum 14.1**

11.3 - 16.9
**Worksheet for One-Point Proctor**

**Route No.:** 637  
**County:** Pittsylvania  
**Project No.:** 0637-071-241,C501  
**Inspected by:**  
**F.H.W.A. No.:** AC-RS-14911

### English ☐  Metric ☐

<table>
<thead>
<tr>
<th>Field Test No.</th>
<th>Date</th>
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<tbody>
<tr>
<td>1</td>
<td>10-1-00</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Location of test</th>
<th>Station ft. (m)</th>
<th>Ref. to center line ft.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>170 + 00</td>
<td>2’ Rt. C/L</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Elevation</th>
<th>Original ground ft.</th>
<th>Finished grade ft.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>+3’</td>
<td>-8’</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Type of roller</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sheepfoot</td>
</tr>
</tbody>
</table>

| A. Weight (mass) of mold and wet soil. lb. (kg) | = 13.57 |
| B. Weight (mass) of mold lb. (kg) | = 9.34 |
| C. Weight (mass) of wet soil. A - B lb. (kg) | = 4.23 |
| D. Wet density of soil. C x 30 lb/ft³  (C x 1060 kg/m³) | = 126.9 |
| E. “Speedy” Dial Reading | = 11.6 |
| F. Moisture Content, %, from “Speedy” chart. | = 13.2 |
| G. Maximum Dry Density lbs/ft³ (kg/m³) from Fig. 1 | = 114.6 |
| H. Optimum Moisture Content, %, from Fig. 1. | = 14.1 |

| I. Field Density lbs/ft³ (kg/m³) from TL-125 |
| J. No. 4 (+4.75 mm) material from field density hole. |
| K. Corrected Maximum Density lbs/ft³ (kg/m³) |
| L. % Compaction |

**Remarks:**

________________________________________________________________________________________
________________________________________________________________________________________

**CC:** District Materials Engineer  
By:  
**Project File**  
**Report No.:**  
**Title:**
Steps to Follow for +4 Calculations

1 - Test & calculate percent of plus 4 material

2 - Calculate corrected maximum density

3 - Calculate corrected optimum moisture & moisture limits

4 - Apply corrected values to field density test
   a) calculate actual percent density
   b) compare actual moisture to corrected moisture limits
Procedure for Determining Amount of +4 Material in Total Soil
(This procedure for Soil and Aggregates)

1. Obtain representative sample - Use material from sandcone hole or a minimum of 5.5 lbs. from location of nuclear test. (Remember when using the sandcone, sample should be weighed prior to drying for calculation of moisture as Speedy moisture tester can only be used on -4 material.)

2. Dry total sample

3. Weigh total sample

4. Pass dried material over the No. 4 sieve - saving material retained on the No. 4 sieve.

5. Weigh retained +4 material

6. Calculation:

\[
\frac{\text{Weight of +4 Material}}{\text{Total Weight of Dried Material}} \times 100 = \% +4
\]

Note: Round answer to nearest whole percent.
Calculation for Amount of +4 Material in Total Soil

(This procedure for Soil and Aggregates)

9.25 lb. Weight of Dry Soil + Dish
- 1.69 lb. Weight of Dish

7.56 lb. Total Weight of Dry Soil

3.20 lb. Weight of +4 Material + Dish
- 1.69 lb. Weight of Dish

1.51 lb. Weight of +4 Material

Calculation:

\[
\text{Weight of +4 Material } \frac{1.51 \text{ lb.}}{\text{Total Weight of Dried Material } 7.56 \text{ lb.}} \times 100 = 20\%
\]

Enter 20% on Line O.
Calculation for Total Density of Soils with +4 Material

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

\[
\frac{D_f \times D_c}{P_c D_f + P_f D_c}
\]

Needed Information:
- \( P_c \) = Percent +4 Material expressed as a decimal = 0.2 (from Sieve Analysis)
- \( D_c = 2.65 \text{(Sp. Gr. of +4 Material from Materials Div.)} \times 62.4 \text{ lb/ft}^3 = 165.4 \text{ lb/ft}^3 \)
- \( P_f \) = Percent -4 Material expressed as a decimal = 0.8 (determined from Sieve Analysis)
- \( D_f \) = Maximum Dry Density -4 Material = 114.6 lb/ft\(^3\) (from Proctor)

\[
\frac{114.6 \times 165.4}{(0.2 \times 114.6) + (0.8 \times 165.4)} = \frac{18,954.8}{22.9 + 132.3} = 122.1 \text{ lb/ft}^3 = \text{Maximum Density of Total Soil}
\]

Enter 122.1 on Line P.
Calculation for Optimum Moisture of Soils with +4 Material

The optimum moisture content for the total soil is expressed as follows:

\[ W_t = (P_c W_c + P_f W_f) \times 100 \]

Needed Information:

- \( P_c = \) Percent +4 Material expressed as a decimal = 0.2 (from Sieve Analysis)
- \( W_c = \) Absorption of +4 Material expressed as a decimal = 0.02 (from Materials Division)
- \( P_f = \) Percent -4 Material expressed as a decimal = 0.8 (determined from Sieve Analysis)
- \( W_f = \) Optimum Moisture of -4 Material expressed as a decimal = 0.141 (from Proctor)

\[
\left[ (0.2 \times 0.02) + (0.8 \times 0.141) \right] \times 100
\]
\[
\left[ (0.004 + 0.113) \right] \times 100
\]
\[
[0.117] \times 100
\]

11.7% = Optimum Moisture of Total Soil

Enter 11.7 on Line Q.
## Report of Sand Cone Density (Unit Mass of Soil)

**Report No.:** OC-0637-071-241, C501  
**Date:** 10-1-00  
**Route No.:** 637  
**County:** Pittsylvania  
**Project No.:** 0637-071-241, C501  
**FHWA No.:** AC-RS-1491(101)

### Field Test No. 1

<table>
<thead>
<tr>
<th>Location of Test</th>
<th>Station ft. (m.)</th>
<th>170 + 00</th>
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<tbody>
<tr>
<td>Ref. To Center Line ft. (m.)</td>
<td>2' Rt. C/L</td>
<td></td>
</tr>
<tr>
<td>Elevation</td>
<td>Original Ground ft. (m.)</td>
<td></td>
</tr>
<tr>
<td>Finished Grade ft. (m.)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Compacted Depth of Lift in. (mm.)</td>
<td>6&quot;</td>
<td></td>
</tr>
</tbody>
</table>

### Method of Compaction (Type of Roller)

Sheepsfoot

### Density Determination

<table>
<thead>
<tr>
<th>Description</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>A. Unit wt. (lbs/ft³) or Unit mass (kg/m³) of sand (calibrated value)</td>
<td>87.3</td>
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<tr>
<td>B. Wt. (mass) sand + wt. (mass) of jar and cone, lb. (kg)</td>
<td>13.32</td>
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<td>C. Wt. (mass) sand left in jar + wt. (mass) of jar and cone, lb. (kg)</td>
<td>5.12</td>
</tr>
<tr>
<td>D. Wt. (mass) of sand in cone and base plate, lb. (calibrated value)</td>
<td>2.72</td>
</tr>
<tr>
<td>E. Wt. (mass) sand left in jar + wt. (mass) of jar and cone + wt. (mass)</td>
<td>7.84</td>
</tr>
<tr>
<td>F. Wt. (mass) of sand in test hole (B - E), lb. (kg)</td>
<td>5.48</td>
</tr>
<tr>
<td>G. Volume of test hole (F ÷ A), ft³ (m³)</td>
<td>0.0628</td>
</tr>
<tr>
<td>H. Wt. (mass) of wet soil from test hole + (wt.) mass of pan, lb. (kg)</td>
<td>10.05</td>
</tr>
<tr>
<td>I. Wt. (mass) of pan, lb. (kg)</td>
<td>1.69</td>
</tr>
<tr>
<td>J. Wt. (mass) of wet soil from test hole (H - I), lb. (kg)</td>
<td>8.36</td>
</tr>
<tr>
<td>K. Unit wt. (lbs/ft³) or Unit mass (kg/m³) of wet soil in fill (J ÷ G)</td>
<td>133.1</td>
</tr>
<tr>
<td>L. Unit wt. (lbs/ft³) or Unit mass (kg/m³) of dry soil in fill = K (1 + [Moisture Content (T) ÷ 100])</td>
<td>120.3</td>
</tr>
</tbody>
</table>

### Density Determination (For Field Dried Method)

<table>
<thead>
<tr>
<th>Description</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>M. Max. Dry Unit Wt. (lbs/ft³) or Unit mass (kg/m³) from LAB PROCTOR or ONE POINT PROCTOR (TL-125a)</td>
<td>114.6</td>
</tr>
<tr>
<td>N. Optimum Moisture Content from LAB PROCTOR OR ONE POINT PROCTOR (TL-125a)</td>
<td>14.1</td>
</tr>
<tr>
<td>O. Percent of +No. 4 (plus 4.75 mm) Material</td>
<td>20</td>
</tr>
<tr>
<td>P. Corrected Maximum Dry Unit wt. (lbs/ft³) or Unit mass (kg/m³)</td>
<td>122.1</td>
</tr>
<tr>
<td>Q. Corrected Optimum Moisture (%)</td>
<td>11.7</td>
</tr>
<tr>
<td>R. % Compaction (L ÷ M) × 100 or (L ÷ P) × 100</td>
<td>98.5</td>
</tr>
<tr>
<td>S. % Minimum density (unit mass) required (from specifications)</td>
<td>95</td>
</tr>
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</table>

### Moisture Determination

<table>
<thead>
<tr>
<th>Description</th>
<th>Value</th>
</tr>
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<tbody>
<tr>
<td>a. Dish and damp soil, lb. (kg)</td>
<td>10.05</td>
</tr>
<tr>
<td>b. Dish and dried soil, lb. (kg)</td>
<td>9.25</td>
</tr>
<tr>
<td>c. Wt. (mass) moisture (a - b), lb. (kg)</td>
<td>0.80</td>
</tr>
<tr>
<td>d. Wt. (mass) dish, lb. (kg)</td>
<td>1.69</td>
</tr>
<tr>
<td>e. Wt. (mass) dry soil (b - d), lb. (kg)</td>
<td>7.56</td>
</tr>
<tr>
<td>T. Moisture Content (c ÷ e) × 100 or from “Speedy” Moisture Test</td>
<td>10.6</td>
</tr>
</tbody>
</table>
## Report of Sand Cone Density (Unit Mass of Soil)

**English**

Report No.:          Date:               10-1-00
Route No.:          County:           Pittsylvania
Project No.:         FHWA No.:     AC-RS-1491(101)

### Field Test No.

<table>
<thead>
<tr>
<th>Location of Test</th>
<th>Station ft. (m.)</th>
<th>Ref. To Center Line ft. (m.)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>170 + 00</td>
<td>2' Rt. C/L</td>
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### Elevation

<table>
<thead>
<tr>
<th>Original Ground ft. (m.)</th>
<th>Finished Grade ft. (m.)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Compacted Depth of Lift in (mm.)

6"

### Method of Compaction (Type of Roller)

Sheepsfoot

### Density Determination

| A. Unit wt. (lbs/ft³) or Unit mass (kg/m³) of sand (calibrated value) | 87.3 |
| B. Wt. (mass) sand + wt. (mass) of jar and cone, lb. (kg)             | 13.32 |
| C. Wt. (mass) sand left in jar + wt. (mass) of jar and cone, lb. (kg) | 5.12  |
| D. Wt. (mass) of sand in cone and base plate, lb. (kg) (calibrated value) | 2.72 |
| E. Wt. (mass) sand left in jar + wt. (mass) of jar and cone + wt. (mass) of sand in cone and base plate (C + D), lb. (kg) | 7.84 |
| F. Wt. (mass) of sand in test hole (B - E), lb. (kg)                  | 5.48  |
| G. Volume of test hole (F ÷ A), ft³ (m³)                              | 0.0628 |
| H. Wt. (mass) of wet soil from test hole + (wt.) mass of pan, lb. (kg) | 10.05 |
| I. Wt. (mass) of pan, lb. (kg)                                       | 1.69  |
| J. Wt. (mass) of wet soil from test hole (H - I), lb. (kg)            | 8.36  |
| K. Unit wt. (lbs/ft³) or Unit mass (kg/m³) of wet soil in fill (J ÷ G) | 133.1 |
| L. Unit wt. (lbs/ft³) or Unit mass (kg/m³) of dry soil in fill = K ÷ { 1 + [ Moisture Content (T) ÷ 100 ] } | 120.3 |
| M. Max. Dry Unit Wt. (lbs/ft³) or Unit mass (kg/m³) from LAB PROCTOR OR ONE POINT PROCTOR (TL-125a) | 114.6 |
| N. Optimum Moisture Content from LAB PROCTOR OR ONE POINT PROCTOR (TL-125a) | 14.1 |
| O. Percent +4 Correction % Density = 120.3 x 100 = 98.5               | 20    |
| P. Corrected Optimum % Density = 122.1                                 | 122.1 |
| Q. Corrected Optimum % Compaction (L ÷ M) × 100 or (L ÷ P) × 100      | 98.5  |
| S. % Minimum density (unit mass) required (from specifications)        | 95    |

### Moisture Determination (For Field Dried Method)

| a. Dish and damp soil, lb. (kg)                                      | 10.05 |
| b. Dish and dried soil, lb. (kg)                                    | 9.25  |
| c. Wt. (mass) moisture in pan (A)                                    | 0.80  |
| d. Wt. (mass) dried soil                                            | 1.69  |
| e. Wt. (mass) dry soil                                              | 7.56  |
| T. Moisture Content % Density = 122.1                                 | 10.6  |

**Acceptable Moisture Range**

±20% of Optimum 11.7

9.4 - 14.0

O.K.
+4 Corrections for the Nuclear Gauge

Basically, the same criteria apply to correction for +4 material when using the nuclear gauge as when using the sandcone: **high density & low moisture**.

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**

As you will recall, the sample of soil dug from the sandcone hole was used as the sample for determining the percentage of +4 material. 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.

**TL-124A**

The 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).

The calculations are identical to those previously discussed in this chapter.
**VIRGINIA DEPARTMENT OF TRANSPORTATION**
**MATERIALS DIVISION**
**REPORT OF NUCLEAR EMBANKMENT DENSITIES (UNIT MASSES)**

<table>
<thead>
<tr>
<th>English</th>
<th>Metric</th>
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</thead>
</table>

Test No.: 1 of 1

**Route No.: 17**

**Project No.: 0017-015-104,C503**

**F.H.W.A. No.: None**

**Test For:** Embankment

**Nuclear Gauge Model No.: 3440**

**Serial No.: 23456**

**Calibration Date:**

<table>
<thead>
<tr>
<th>DENSITY</th>
<th>2830</th>
</tr>
</thead>
<tbody>
<tr>
<td>MOISTURE</td>
<td>701</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Test No.</th>
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</table>

<table>
<thead>
<tr>
<th>Location</th>
<th>Station ft. (m)</th>
<th>585 + 00</th>
</tr>
</thead>
<tbody>
<tr>
<td>of</td>
<td>Ref. to center line ft. (m)</td>
<td>At C/L</td>
</tr>
<tr>
<td>Test</td>
<td>Elevation</td>
<td>+8 / -4</td>
</tr>
</tbody>
</table>

- **Compacted Depth of Lift in. (mm):** 6”
- **Method of Compaction:**
  - A. Wet Density (lbs/ft³), Wet Unit Mass (kg/m³) = 134.2
  - B. Moisture Unit Mass (lbs/ft³), Moisture Unit Mass (kg/m³) = 11.0
  - C. Dry Density (lbs/ft³), Dry Unit Mass (kg/m³) (A - B) = 123.2
  - D. Moisture Content (B ÷ C) x 100 = 8.9
  - E. Maximum Dry Density (lbs/ft³), Dry Unit Mass (kg/m³) Lab Proctor or One Point Proctor = 118.2
  - F. Percent Optimum Moisture from Lab or One Point Proctor = 12.4
  - G. Percent of plus #4, (plus 4.75mm) =
  - H. Corrected Maximum Dry Density (lbs/ft³) Dry Unit Mass (kg/m³) =
  - I. Corrected Optimum Moisture =
  - J. Percent Dry Density (lbs/ft³), Dry Unit Mass (kg/m³) (C ÷ E) x 100 or (C ÷ H) x 100 = 104.2
  - K. Percent Minimum Density Required = 95

**Remarks:**

**CC:** District Materials Engineer

**By:**

**Title:**
## Laboratory Proctor on -4 Material

**Weight of Mold in (Grams):** 2027

<table>
<thead>
<tr>
<th>Wet Weight of Compact Sample, (lbs./cu.ft.)</th>
<th>Dish Number</th>
<th>Weight of Dish</th>
<th>Weight of Dish and Wet Soil</th>
<th>Weight of Dish and Dry Soil</th>
<th>Weight of Water</th>
<th>Weight of Dry Soil</th>
<th>Water Content</th>
<th>Dry Weight, (lbs./cu.ft.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>3851</td>
<td>120.6</td>
<td>18</td>
<td>59.8</td>
<td>135.2</td>
<td>128.9</td>
<td>6.3</td>
<td>69.1</td>
<td>9.1%</td>
</tr>
<tr>
<td>3966.4</td>
<td>128.3</td>
<td>54</td>
<td>60.2</td>
<td>163.8</td>
<td>153.7</td>
<td>10.1</td>
<td>93.5</td>
<td>10.8%</td>
</tr>
<tr>
<td>4036</td>
<td>132.9</td>
<td>a</td>
<td>61.0</td>
<td>165.2</td>
<td>153.7</td>
<td>11.5</td>
<td>92.7</td>
<td>12.4%</td>
</tr>
<tr>
<td>4024.3</td>
<td>132.1</td>
<td>d</td>
<td>60.6</td>
<td>173.5</td>
<td>164.8</td>
<td>14.7</td>
<td>104.2</td>
<td>14.1%</td>
</tr>
</tbody>
</table>

**Graph:**

- **Y-axis:** Dry Unit Weight
- **X-axis:** Percent Moisture
- Data points indicating the relationship between dry unit weight and percent moisture for different samples.
CALCULATION #1
Amount of +4 Material in Total Soil

Weight of Dry Soil + Dish       9.25 lb.  
- Weight of Dish                1.69 lb.  
Total Weight of Dried Soil      7.56 lb.  

Weight of +4 Material + Dish    3.20 lb.  
- Weight of Dish                1.69 lb.  

Total Weight of Dried Material  7.56 lb.  

\[
\frac{1.51}{7.56} \times 100 = 20\% 
\]

Enter on Line G

CALCULATION #2
Total Density of Soils with +4 Material

Needed Information:

- \(P_c = \% +4 \text{ Material expressed as a decimal} = 0.2\) (from Sieve Analysis)
- \(D_c = 2.68 (\text{Sp. Gr.of +4 Material from Materials Division}) = 167.2 \text{ lb/ft}^3\)
- \(P_f = \% -4 \text{ Material expressed as a decimal} = 0.8\) (determined from Sieve Analysis)
- \(D_f = \text{Maximum Dry Density of -4 Material} = 118.2 \text{ lb/ft}^3\) (from Proctor)

\[
\frac{D_f \times D_c}{(P_c \times D_f) + (P_f \times D_c)} = \frac{118.2 \text{ lb/ft}^3 \times 167.2 \text{ lb/ft}^3}{(0.2 \times 118.2 \text{ lb/ft}^3) + (0.8 \times 167.2 \text{ lb/ft}^3)} = 125.6 \text{ lb/ft}^3
\]

Maximum Dry Density of Total Soil

Enter on Line H

CALCULATION #3
Optimum Moisture Content of Soils with +4 Material

Needed Information:

- \(P_c = \% +4 \text{ Material expressed as a decimal} = 0.2\) (from Sieve Analysis)
- \(W_c = \text{Absorption of +4 Material expressed as a decimal} = 0.02\) (from Materials Division)
- \(P_f = \% -4 \text{ Material expressed as a decimal} = 0.8\) (determined from Sieve Analysis)
- \(W_f = \text{Optimum Moisture of -4 Material expressed as a decimal} = 0.124\) (from Proctor)

\[
\frac{(P_cW_c + P_fW_f) \times 100}{[(0.2 \times 0.02) + (0.8 \times 0.124)] \times 100} = \frac{0.103 \times 100}{0.103} = 10.3\% 
\]

Enter on Line I
**REPORT OF NUCLEAR EMBANKMENT DENSITIES (UNIT MASSES)**

**English**

<table>
<thead>
<tr>
<th>Report No.:</th>
<th>Sheet No.:</th>
<th>1 of 1</th>
</tr>
</thead>
<tbody>
<tr>
<td>Route No.:</td>
<td>County:</td>
<td>Campbell</td>
</tr>
<tr>
<td>Project No.:</td>
<td></td>
<td>0017-015-104,C503</td>
</tr>
<tr>
<td>F.H.W.A. No.:</td>
<td>None</td>
<td></td>
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<tr>
<td>Test For:</td>
<td>Embankment</td>
<td></td>
</tr>
<tr>
<td>Nuclear Gauge Model No.:</td>
<td>3440</td>
<td>Serial No.: 23456</td>
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<table>
<thead>
<tr>
<th><strong>STANDARD COUNT</strong></th>
<th><strong>MOISTURE</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>DENSITY</strong></td>
<td><strong>MOISTURE</strong></td>
</tr>
<tr>
<td>2830</td>
<td>701</td>
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</table>

<table>
<thead>
<tr>
<th>Test No.</th>
<th>Location Station ft. (m)</th>
<th>585 + 00</th>
<th>of Ref. to center line ft. (m)</th>
<th>At C/L</th>
<th>Test Elevation</th>
<th>+8 / -4</th>
</tr>
</thead>
</table>

- Compacted Depth of Lift in. (mm): 6”
- Method of Compaction: Sheepsfoot

| A. Wet Density (lbs/ft³), Wet Unit Mass (kg/m³) | = 134.2 |
| B. Moisture Unit Mass (lbs/ft³), Moisture Unit Mass (kg/m³) | = 11.0 |
| C. Dry Density (lbs/ft³), Dry Unit Mass (kg/m³) (A - B) | = 123.2 |
| D. Moisture Content (B ÷ C) x 100 | = 8.9 |
| E. Maximum Dry Density (lbs/ft³), Dry Unit Mass (kg/m³) Lab Proctor or One Point Proctor | = 118.2 |
| F. Percent Optimum Moisture from Lab or One Point Proctor | = 12.4 |
| G. Percent of plus #4, (plus 4.75mm) | = 20 |
| H. Corrected Maximum Dry Density (lbs/ft³) Dry Unit Mass (kg/m³) | = 125.6 |
| I. Corrected Optimum Moisture | = 10.3 |
| J. Percent Dry Density (lbs/ft³), Dry Unit Mass (kg/m³) (C ÷ E) x 100 or (C ÷ H) x 100 | = 98.2 |
| K. Percent Minimum Density Required | = 95 |

**Remarks:**

CC: District Materials Engineer

By: ______________________________

Title: ______________________________

**With +4 Correction**
**English**

**Test No.**

<table>
<thead>
<tr>
<th>Location</th>
<th>Station ft. (m)</th>
<th>Test of</th>
<th>Ref. to center line ft. (m)</th>
<th>Test Elevation</th>
<th>Compacted Depth of Lift in. (mm)</th>
<th>Method of Compaction</th>
<th>A. Wet Density (lbs/ft³), Wet Unit Mass (kg/m³)</th>
<th>B. Moisture Unit Mass (lbs/ft³), Moisture Unit Mass (kg/m³)</th>
<th>C. Dry Density (lbs/ft³), Dry Unit Mass (kg/m³) (A - B)</th>
<th>D. Moisture Content (B ÷ C) x 100</th>
<th>E. Maximum Dry Density (lbs/ft³), Dry Unit Mass (kg/m³) Lab Proctor or One Point Proctor</th>
<th>F. Percent Optimum Moisture from Lab or One Point Proctor</th>
<th>G. Percent of plus #4, (plus 4.75mm)</th>
<th>H. Corrected Maximum Dry Density (lbs/ft³) Dry Unit Mass (kg/m³)</th>
<th>I. Corrected Optimum Moisture</th>
<th>J. Percent Dry Density (lbs/ft³), Dry Unit Mass (kg/m³)</th>
<th>K. Percent Minimum Density Required</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>585 + 00</td>
<td>At C/L</td>
<td>+8 / -4</td>
<td>6&quot;</td>
<td>Sheepsfoot</td>
<td>A. Wet Density (lbs/ft³), Wet Unit Mass (kg/m³): 134.2</td>
<td>B. Moisture Unit Mass (lbs/ft³), Moisture Unit Mass (kg/m³): 11.0</td>
<td>C. Dry Density (lbs/ft³), Dry Unit Mass (kg/m³) (A - B): 123.2</td>
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<td>I. Corrected Optimum Moisture: 10.3</td>
<td>J. Percent Dry Density (lbs/ft³), Dry Unit Mass (kg/m³) (C ÷ E) x 100 or (C ÷ H) x 100: 98.2</td>
<td>K. Percent Minimum Density Required: 95</td>
<td></td>
</tr>
</tbody>
</table>

**Acceptable Moisture Range**

+/-20% of Optimum 10.3 (8.2-12.4) Passes on Moisture

**Minimum Percent Density Required**

95% Passes on Density
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.

There are two different methods by which this can be done:

1) Roller Pattern (VTM-10) - This test procedure is indicated when the area to be approved is relatively long (1/2 a mile or longer).

2) Sand Cone Compaction Testing - This test is more appropriate for shorter sections of roadway (less than 1/2 a mile).

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

Section 303.04(h) of the Road and Bridge Specifications stipulates that field density determinations are to be performed in accordance with the following AASHTO tests:

T191 - Density Testing of Soil in Place by the Sand Cone Method

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)
Density Testing of Aggregates with the Sand Cone

This section of the Manual will cover compaction testing of aggregates with the sand cone. This method is used to determine the density in place of a compacted lift of aggregate in lieu of the roller pattern. The procedure for testing aggregates is similar to that for testing soils. **Steps unique to aggregate testing appear in bold.** The one major difference is in the method used to determine the **Maximum Theoretical Density.** Critical data must be obtained from the Materials Division before this test can be performed.

In order to determine the percent compaction, we will have to find three things:

1) Density of the Compacted Aggregate Layer in Place (Sand Cone Test)

2) Oven or Stove Dried Moisture Content

3) Maximum Dry Density (per VTM-1)

All calculations and information for the sand cone test will be recorded on the TL-125, which also will serve as a guide to the procedure.

PRETEST CALIBRATIONS

A. First, calibrate the sand. This is typically done in the lab, and these results can be used as long as the same sand is being utilized.

1. Determine the weight per cubic foot of sand. Record the empty weight of the mold and base plate. Invert and support the sand cone apparatus over a four inch proctor mold. Open the valve and allow the mold to fill until it just overflows, then close the valve. See Page 6-2 for sand requirements.

2. Strike off the top with a straight edge, being VERY CAREFUL to cause no vibration. Clean the excess sand off of the mold.

3. Weigh the sand, mold and base plate.

4. Subtract the weight of the mold to obtain the weight of the sand in the mold.

5. Calculate the unit weight of the sand by multiplying the weight of the sand in the mold by 30.

6. Repeat this three times and average the results. There should be no more than 1% variation. Record this weight on line A of the TL-125.

B. Determine the weight of sand in the cone and base plate

1. Fill the sand cone apparatus with clean dry sand. Weigh the apparatus and record the weight.
2. Place the base plate on a clean, level surface. Invert the sand cone apparatus and place the cone in the flanged hole in the base plate. Mark the apparatus and base plate so that they can be matched and reseated in the same position during testing.

3. Open the valve fully. When the sand stops running, close the valve.

4. Lift the sand cone apparatus and determine the mass of the apparatus and remaining sand. Subtract this mass from the original mass. This is the weight of the sand that fills the cone and base plate.

5. Repeat this three times and average the results. There should be no more than 1% variation. Record on line D.

Before beginning the next step, weigh the pan and record on line I.

TEST PROCEDURE

A. Determine the weight of the aggregates in the hole used for the test

1. Prepare an area on the compacted lift to run the actual density test. The area will need to be flat and about a foot square.

2. Seat the base plate on the leveled test site, making sure the center of the hole is in contact with the ground surface. Mark the outline of the base plate to check for movement during the test. The base plate may be secured by pushing nails in the soils adjacent to the edge of the base plate.

3. Dig a hole through the hole in the base plate. Test hole depth should approximate the thickness of the lift being tested. The sides of the hole should be straight or taper slightly inward to a flat or conical bottom. Avoid overhangs and pockets in the sides of the test hole.

Note: The minimum volume of the hole is dependent upon maximum particle size of the material to be tested (see table listed below). When the volume exceeds 0.1 cubic feet a larger jar and cone may be needed. For the problems in this chapter assume the maximum particle size is a No. 4. Therefore, a hole that is approximately 4½” in diameter by 6” deep will fulfill this requirement.

<table>
<thead>
<tr>
<th>Maximum Particle Size</th>
<th>Minimum test hole Volume, ft³</th>
<th>Minimum Mass for Moisture Content, g</th>
</tr>
</thead>
<tbody>
<tr>
<td>4.75 mm (No. 4)</td>
<td>0.025</td>
<td>100</td>
</tr>
<tr>
<td>12.5 mm (0.5 inch)</td>
<td>0.05</td>
<td>250</td>
</tr>
<tr>
<td>25 mm (1 inch)</td>
<td>0.075</td>
<td>500</td>
</tr>
<tr>
<td>50 mm (2 inches)</td>
<td>0.1</td>
<td>1000</td>
</tr>
</tbody>
</table>
4. As the aggregate is removed, place it in pans so that it can be weighed. Make sure ALL the aggregate taken out gets into the pan. Cover the aggregate as it is removed so that it doesn’t dry out.

5. After the aggregate is removed, weight it and record this weight on line H. Protect the sample from moisture loss until a moisture sample can be taken.

Note: Sample obtained from the hole will be used to determine the: a) wet density, b) moisture content and c) percentage of +4 material.

B. Determine the volume of the hole.

The sand will be used to determine the volume of the hole:

1. First fill the jar with sand and weigh the sand cone apparatus. Record this weight on line B.

2. Invert the sand cone apparatus over the base plate and hole. Place the bottom of the cone in the flanged hole in the base plate in the same position used during calibration of the apparatus. Eliminate or minimize vibrations in the test area due to personnel or equipment. Turn the valve to the open position.

3. Let the sand run into the hole and when the sand stops running, close the valve.

4. Remove the apparatus with the remaining sand in it and weigh it. Record this on line C, then add this to line D (the weight of the sand in the cone and base plate). Record on line E.

5. The weight of the sand required to fill the test hole is determined by subtracting line E from line B. Record this on line F.

\[
\text{Wt. of sand, jar & cone} - \text{wt. of jar, sand left in jar and sand in cone and base plate} = \text{weight of sand in hole}
\]

6. The volume of the hole equals the weight of sand required to fill the hole divided by the weight per cubic foot of the sand.

\[
\text{Volume of test hole} = \frac{\text{weight of sand (line F)}}{\text{weight per cubic foot of sand (line A)}}
\]

Record this on line G.

C. Determine the wet unit weight of the aggregate

1. Find the weight of the wet aggregate from the test hole by subtracting the weight of the pan (line I) from the weight of the aggregate and pan (line H). Record this on line J.
2. Calculate the unit weight per cubic foot of the wet aggregate by dividing the weight of the wet aggregate by the volume of the hole and record this on line K.

\[
\text{Wet Density (line K)} = \frac{\text{weight of wet aggregate (line J)}}{\text{volume of hole (line G)}}
\]

3. Whether or not the density achieved by the compaction effort passes is based on comparing the dry unit weight of the aggregate to the maximum dry unit weight of the aggregate.

**Note:** This is where the procedure for sand cone density testing of aggregates varies greatly from soil testing. There are two (2) primary differences:

1. The moisture content is obtained by drying the sample.
2. The maximum dry density is derived differently. The dry density is dependent upon the actual amount of +4 material present and will vary from test to test.

D. Determine the moisture content of the aggregate

**Note:** Use the total sample from the hole for the moisture determination. Calculations are made at the bottom of the TL-125 under the heading “MOISTURE DETERMINATION”.

**Note:** Retain the dried sample for determination of the % +4 material.

1. Note the recorded weight of AGGREGATE + PAN on line H. Record this weight on line a.
2. Note the recorded weight of the PAN on line I. Record this weight on line d.
3. Dry the total sample over a propane stove or in an oven. This step may be aided by carefully stirring the aggregate with a spoon. Be careful not to lose any of the sample. The sample is totally dry when a constant weight is obtained. (A visual aid for dryness is when no vapors are seen rising from the pan and fine particles do not stick to the spoon when stirred.)
4. Weigh the PAN + DRIED AGGREGATE and record on line b.
5. Calculate the weight of moisture (line a - line b). Record on line c.
6. Calculate the weight of dried aggregate (line b - line d). Record on line e.
7. Calculate the moisture content. \((\text{line c ÷ line e}) \times 100\). Record on line T.
E. Determine the dry unit weight of aggregate

1. Using this moisture, the dry unit weight per cubic foot of the aggregate can be determined. Divide the wet weight per cubic foot by 1 plus the moisture content expressed as a decimal:

   \[
   \text{Dry unit weight} = \frac{\text{wet unit weight of aggregate (K)}}{1 + \left[\frac{\text{moisture content (T)}}{100}\right]}
   \]

   This is the dry unit weight per cubic foot. Enter on line L.

F. Determine the percentage of +4 material and enter on line O. (See Page 7-8)

Note: This is the material that was removed from the hole and was used for the moisture determination. The dried sample was retained to determine the percentage of +4 material.

G. Determine the Corrected Maximum Dry Unit Weight

Three numbers are necessary for this exercise:

1) Percent of +4 material (from sieve analysis)
2) Bulk Specific Gravity of +4 material (from Materials Division or Plant)
3) Maximum Dry Density of -4 material (from Materials Division or Plant)

Note: Values for 2 & 3 above will be different for each source of aggregate.

To obtain the corrected maximum dry density you can perform the calculation used earlier (See Page 7-9) or you can use the “TOTAL DENSITY CHART” from VTM-1. To maintain accuracy, this exercise must be performed with utmost care using a straight edge and a fine point pencil.

1. Position the chart with the title at the top.

2. Mark the dry density (lb/ft³) on the left side of the graph.

3. Mark the bulk specific gravity on the right side of the graph.

4. Using a straightedge, draw a line between these two points. This is the “maximum dry density line”. This line may be used for all tests on material from this source until 2 & 3 above are revised by the Materials Division.

5. Locate the % +4 material along the line at the top of the graph.

6. Using a straightedge, follow the angled lines on the graph down to the “maximum dry density line”.


7. Using a sharp pencil, mark where this line intersects the “maximum dry density line”.

8. Using the straightedge, follow the horizontal lines from the intersection point to the left-hand edge of the graph.

9. This is the corrected maximum dry density for this test. Accurately determine the maximum dry density to the nearest 0.1 lb. Record this on line P of the TL-125.

H. Determine the Corrected Optimum Moisture

Three numbers are necessary for this exercise:

1) Percent of +4 material (from Sieve Analysis)
2) Absorption of +4 material (Materials Division or Plant)
3) Optimum Moisture of -4 material (Materials Division or Plant)

To obtain the corrected Optimum Moisture use the formula on Page 7-10. Enter on line Q.

In accordance with Section 308 Subbase Course and Section 309 Aggregate Base Course of the Road and Bridge Specifications, during the compaction process each layer is to be compacted at optimum moisture within ±2 percentage points of optimum.

I. Now, determine the percent compaction: Divide the dry unit weight of the dry aggregate by the corrected maximum dry unit weight. Multiply by 100.

\[
\text{Percent Compaction (line R)} = \frac{\text{dry unit weight of aggregate (line L)}}{\text{corrected maximum dry unit weight (line P)}} \times 100
\]

This is the percent compaction. Record on line R.

J. Locate minimum percent density from specifications. Record on line S.

K. Compare the percent compaction on line R to the minimum percent density required on line S and determine if the material passes or fails on density.

Compare the actual moisture content on line T to ±2 percentage points of the corrected optimum moisture on line P and determine if the material passes or fails on moisture.
Calculation for Actual Moisture Content (%)

Moisture Determination

a. Weight of Dish + Damp Soil = \(9.50\) lb.
b. Weight of Dish + Dry Soil = \(9.22\) lb.
c. Weight of Moisture (a-b) = \(0.28\) lb.
d. Weight of Dish = \(2.54\) lb.
e. Weight of Dry Soil (b-d) = \(6.68\) lb.

T. % Moisture \((c ÷ e) \times 100\) = \(4.2\)%

Calculation:

\[
\text{Weight of Moisture } 0.28 \text{lb. } \times 100 = 4.2\% \\
\text{Weight of Dry Soil } 6.68 \text{lb.}
\]
### FIELD TEST NO. 1

- **Location of Test**: Station ft. (m.) 170 + 00
- **Ref. To Center Line ft. (m.)**: 2’ Rt. C/L
- **Elevation**
  - Original Ground ft. (m.)
  - Finished Grade ft. (m.) At TOE
- **Compacted Depth of Lift in. (mm.)**: 6"
- **Method of Compaction**: Sheepsfoot

### DENSITY DETERMINATION

<table>
<thead>
<tr>
<th>Step</th>
<th>Description</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>Unit wt. (lbs/ft³) or Unit mass (kg/m³) of sand (calibrated value)</td>
<td>85.7</td>
</tr>
<tr>
<td>B</td>
<td>Wt. (mass) sand + wt. (mass) of jar and cone, lb. (kg)</td>
<td>12.55</td>
</tr>
<tr>
<td>C</td>
<td>Wt. (mass) sand left in jar + wt. (mass) of jar and cone, lb. (kg)</td>
<td>5.89</td>
</tr>
<tr>
<td>D</td>
<td>Wt. (mass) of sand in cone and base plate, lb. (kg) (calibrated value)</td>
<td>2.69</td>
</tr>
<tr>
<td>E</td>
<td>Wt. (mass) sand left in jar + wt. (mass) of jar and cone + wt. (mass) of sand in cone and base plate (C + D), lb. (kg)</td>
<td>8.58</td>
</tr>
<tr>
<td>F</td>
<td>Wt. (mass) of sand in test hole (B - E), lb. (kg)</td>
<td>3.97</td>
</tr>
<tr>
<td>G</td>
<td>Volume of test hole (F ÷ A), ft³ (m³)</td>
<td>0.0463</td>
</tr>
<tr>
<td>H</td>
<td>Wt. (mass) of wet soil from test hole + (wt.) mass of pan, lb. (kg)</td>
<td>9.50</td>
</tr>
<tr>
<td>I</td>
<td>Wt. (mass) of pan, lb. (kg)</td>
<td>2.54</td>
</tr>
<tr>
<td>J</td>
<td>Wt. (mass) of wet soil from test hole (H - I), lb. (kg)</td>
<td>6.96</td>
</tr>
<tr>
<td>K</td>
<td>Unit wt. (lbs/ft³) or Unit mass (kg/m³) of wet soil in fill (J ÷ G)</td>
<td>150.3</td>
</tr>
<tr>
<td>L</td>
<td>Unit wt. (lbs/ft³) or Unit mass (kg/m³) of dry soil in fill = K [1 + \left(\frac{\text{Moisture Content (T)}}{100}\right)]</td>
<td></td>
</tr>
<tr>
<td>M</td>
<td>Max. Dry Unit Wt. (lbs/ft³) or Unit mass (kg/m³) from LAB PROCTOR OR ONE POINT PROCTOR (TL-125a)</td>
<td>127.7</td>
</tr>
<tr>
<td>N</td>
<td>Optimum Moisture Content from LAB PROCTOR OR ONE POINT PROCTOR (TL-125a)</td>
<td>8.5</td>
</tr>
<tr>
<td>O</td>
<td>Percent of +No. 4 (plus 4.75 mm) Material</td>
<td></td>
</tr>
<tr>
<td>P</td>
<td>Corrected Maximum Dry Unit wt. (lbs/ft³) or Unit mass (kg/m³)</td>
<td></td>
</tr>
<tr>
<td>Q</td>
<td>Corrected Optimum Moisture (%)</td>
<td></td>
</tr>
<tr>
<td>R</td>
<td>% Compaction ((L ÷ M) \times 100) or ((L ÷ P) \times 100)</td>
<td></td>
</tr>
<tr>
<td>S</td>
<td>% Minimum density (unit mass) required (from specifications)</td>
<td></td>
</tr>
</tbody>
</table>

### MOISTURE DETERMINATION (For Field Dried Method)

- **a. Dish and damp soil, lb. (kg)** | 9.50 |
- **b. Dish and dried soil, lb. (kg)** | 9.22 |
- **c. Wt. (mass) moisture (a - b), lb. (kg)** | 0.28 |
- **d. Wt. (mass) dish, lb. (kg)** | 2.54 |
- **e. Wt. (mass) dry soil (b - d), lb. (kg)** | 6.68 |
- **T. Moisture Content (c ÷ e) × 100 or from “Speedy” Moisture Test** | 4.2 |
Calculation for Actual Dry Density

\[
\text{Unit Weight of Wet Soil } (K) = \frac{1}{1 + \left(\frac{\% \text{ Moisture } (T)}{100}\right)}
\]

\[
\begin{align*}
\text{Unit Weight of Wet Soil } (K) & = 150.3 \text{ lb/ft}^3 \\
1 + \left(\frac{4.2}{100}\right) & = 150.3 \text{ lb/ft}^3 = 144.2 \text{ lb/ft}^3
\end{align*}
\]

Enter 144.2 lb/ft\(^3\) on Line L.

Calculation for Amount of +4 Material in Aggregate

- 9.22 lb.  Total Weight of Dry Aggregate + Dish
- 2.54 lb.  Weight of Dish
  
  \[
  6.68 \text{ lb. } \text{Total Weight of Dry Aggregate}
  \]

- 5.68 lb.  Weight of +4 Material + Dish
- 2.54 lb.  Weight of Dish
  
  \[
  3.14 \text{ lb. } \text{Weight of +4 Material}
  \]

Calculation:

\[
\text{Weight of +4 Material } \times 100 = 47\%
\]

Enter 47\% on Line O.
**VIRGINIA DEPARTMENT OF TRANSPORTATION**

**REPORT OF SAND CONE DENSITY (UNIT MASS OF SOIL)**

**English ☐ Metric ☐**

**Report No.:** __________  **Date:** ________________  **10-1-00**

**Route No.:** 637  **County:** Pittsylvania

**Project No.:** 0637-071-241.C501  **FHWA No.:** AC-RS-1491(101)

---

**Field Test No.** 1  
**Location of Test**  
**Station ft. (m.)** 170 + 00  
**Ref. To Center Line ft. (m.)** 2' Rt. C/L  
**Elevation**  
**Original Ground ft. (m.)**  
**Finished Grade ft. (m.)** At TOE  
**Compacted Depth of Lift in. (mm.)** 6"  
**Method of Compaction** Sheepsfoot

### DENSITY DETERMINATION

<table>
<thead>
<tr>
<th>Step</th>
<th>Formula</th>
</tr>
</thead>
<tbody>
<tr>
<td>A.</td>
<td>Unit wt. (lbs/ft³) or Unit mass (kg/m³) of sand (calibrated value)</td>
</tr>
<tr>
<td>B.</td>
<td>Wt. (mass) sand + wt. (mass) of jar and cone, lb. (kg)</td>
</tr>
<tr>
<td>C.</td>
<td>Wt. (mass) sand left in jar + wt. (mass) of jar and cone, lb. (kg)</td>
</tr>
<tr>
<td>D.</td>
<td>Wt. (mass) of sand in cone and base plate, lb. (kg) (calibr. value)</td>
</tr>
<tr>
<td>E.</td>
<td>Wt. (mass) sand left in jar + wt. (mass) of jar and cone + wt. (mass) of sand in cone and base plate (C + D), lb. (kg)</td>
</tr>
<tr>
<td>F.</td>
<td>Wt. (mass) of sand in test hole (B - E), lb. (kg)</td>
</tr>
<tr>
<td>G.</td>
<td>Volume of test hole (F ÷ A), ft³ (m³)</td>
</tr>
<tr>
<td>H.</td>
<td>Wt. (mass) of wet soil from test hole + (wt.) mass of pan, lb. (kg)</td>
</tr>
<tr>
<td>I.</td>
<td>Wt. (mass) of pan, lb. (kg)</td>
</tr>
<tr>
<td>J.</td>
<td>Wt. (mass) of wet soil from test hole (H - I), lb. (kg)</td>
</tr>
<tr>
<td>K.</td>
<td>Unit wt. (lbs/ft³) or Unit mass (kg/m³) of dry soil in fill (J ÷ G)</td>
</tr>
</tbody>
</table>
| L. | Unit wt. (lbs/ft³) or Unit mass (kg/m³) of dry soil in fill = \[
\frac{K}{1 + \left[\frac{\text{Moisture Content (T)}}{100}\right]}
\]
| M. | Max. Dry Unit Wt. (lbs/ft³) or Unit mass (kg/m³) from LAB PROCTOR OR ONE POINT PROCTOR (TL-125a) |
| N. | Optimum Moisture Content from LAB PROCTOR OR ONE POINT PROCTOR (TL-125a) |
| O. | Percent of +No. 4 (plus 4.75 mm) Material |
| P. | Corrected Maximum Dry Unit wt. (lbs/ft³) or Unit mass (kg/m³) |
| Q. | Corrected Optimum Moisture (%) |
| R. | % Compaction \( \left(\frac{L}{M}\right) \times 100 \) or \( \left(\frac{L}{P}\right) \times 100 \) |
| S. | % Minimum density (unit mass) required (from specifications) |

### MOISTURE DETERMINATION (For Field Dried Method)

<table>
<thead>
<tr>
<th>Step</th>
<th>Formula</th>
</tr>
</thead>
<tbody>
<tr>
<td>a.</td>
<td>Dish and damp soil, lb. (kg)</td>
</tr>
<tr>
<td>b.</td>
<td>Dish and dried soil, lb. (kg)</td>
</tr>
<tr>
<td>c.</td>
<td>Wt. (mass) moisture (a - b), lb. (kg)</td>
</tr>
<tr>
<td>d.</td>
<td>Wt. (mass) dish, lb. (kg)</td>
</tr>
<tr>
<td>e.</td>
<td>Wt. (mass) dry soil (b - d), lb. (kg)</td>
</tr>
<tr>
<td>T.</td>
<td>Moisture Content ( \left(\frac{c}{e}\right) \times 100 ) or from “Speedy” Moisture Test</td>
</tr>
</tbody>
</table>

2012 v1.0  7-29
Aggregate Data from Materials Division or Plant

Produce: Vulcan Materials, Shelton, NC

Density:

Bulk Specific Gravity = 2.63

Unit Weight of -4 Material = 127.7 lb.

Note: Use these values with “Total Density Chart”. Enter result on line P.

Optimum Moisture Data:

Absorption of +4 Material = 0.3 %

Optimum Moisture of -4 Material = 8.5 %

Note: Use these values for Optimum Moisture Calculation. Enter result on line Q.
NOMOGRAPh FOR DETERMINING 
TOTAL DENSITIES OF SOILS

VTM-1

EXAMPLE:
Given: Specific Gravity 2.63
Dry Density -4 Matl. 127.7
Percent of +4 Matl. 47%

Find: Total Dry Density
1. Plot A, B and C
2. Using a straight edge
draw a line from A to B
3. From C draw a line at the same
slant as the nomograph lines to
intersect line AB
4. Draw a straight line from the
point of intersection to the
left edge of the nomograph
5. Total Dry Density = 142.6
Calculation for Total Density of Soils with +4 Material

\[
\frac{D_f \times D_c}{P_c D_f + P_i D_c}
\]

Needed Information:

- \( P_c \) = Percent +4 Material expressed as a decimal = 0.47 (from Sieve Analysis)
- \( D_c = 2.63(Sp. \ Gr. \ of \ +4 \ Material \ from \ Materials \ Div.) \times 62.4 \text{ lb/ft}^3 = 164.1 \text{ lb/ft}^3 
- \( P_i \) = Percent -4 Material expressed as a decimal = 0.53 (determined from Sieve Analysis)
- \( D_f = \) Maximum Dry Density -4 Material = 127.7 lb/ft\(^3\) (from Proctor)

\[
\frac{127.7 \times 164.1}{(0.47 \times 127.7) + (0.53 \times 164.1)}
\]

\[
\frac{20,955.6}{60 + 87} = 142.6 \text{ lb/ft}^3 = \text{Maximum Density of Total Soil}
\]

Enter 142.6 on Line P.
### Field Test No.

<table>
<thead>
<tr>
<th>No.</th>
<th>Location of Test</th>
<th>Elevation</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Station ft. (m.)</td>
<td>Original Ground ft. (m.)</td>
</tr>
<tr>
<td></td>
<td>Ref. To Center Line ft. (m.)</td>
<td>Finished Grade ft. (m.)</td>
</tr>
<tr>
<td></td>
<td>2' Rt. C/L</td>
<td>At TOE</td>
</tr>
</tbody>
</table>

### Compacted Depth of Lift in. (mm.)

- 6"

### Method of Compaction (Type of Roller)

- Sheepsfoot

### DENSITY DETERMINATION

A. Unit wt. (lbs/ft³) or Unit mass (kg/m³) of sand (calibrated value) | 85.7
---
B. Wt. (mass) sand + wt. (mass) of jar and cone, lb. (kg) | 12.55
C. Wt. (mass) sand left in jar + wt. (mass) of jar and cone, lb. (kg) | 5.89
D. Wt. (mass) of sand in cone and base plate, lb. (kg) (calibr. value) | 2.69
E. Wt. (mass) sand left in jar + wt. (mass) of jar and cone + wt. (mass) of sand in cone and base plate (C + D), lb. (kg) | 8.58
F. Wt. (mass) of sand in test hole (B - E), lb. (kg) | 3.97
G. Volume of test hole (F ÷ A), ft³ (m³) | 0.0463
H. Wt. (mass) of wet soil from test hole + (wt.) mass of pan, lb. (kg) | 9.50
I. Wt. (mass) of pan, lb. (kg) | 2.54
J. Wt. (mass) of wet soil from test hole (H - I), lb. (kg) | 6.96
K. Unit wt. (lbs/ft³) or Unit mass (kg/m³) of wet soil in fill (J ÷ G) | 150.3
L. Unit wt. (lbs/ft³) or Unit mass (kg/m³) of dry soil in fill = \( \frac{K}{1 + \left[ \text{Moisture Content (T)} ÷ 100 \right]} \) | 144.2
M. Max. Dry Unit Wt. (lbs/ft³) or Unit mass (kg/m³) from LAB PROCTOR OR ONE POINT PROCTOR (TL-125a) | 127.7
N. Optimum Moisture Content from LAB PROCTOR OR ONE POINT PROCTOR (TL-125a) | 8.5
O. Percent of +No. 4 (plus 4.75 mm) Material | 47
P. Corrected Maximum Dry Unit wt. (lbs/ft³) or Unit mass (kg/m³) | 142.6
Q. Corrected Optimum Moisture (%) | 4.2
R. % Compaction (L ÷ M) × 100 or (L ÷ P) × 100
S. % Minimum density (unit mass) required (from specifications)

### MOISTURE DETERMINATION (For Field Dried Method)

- a. Dish and damp soil, lb. (kg) | 9.50
- b. Dish and dried soil, lb. (kg) | 9.22
- c. Wt. (mass) moisture (a - b), lb. (kg) | 0.28
- d. Wt. (mass) dish, lb. (kg) | 2.54
- e. Wt. (mass) dry soil (b - d), lb. (kg) | 6.68
- T. Moisture Content (c ÷ e) × 100 or from “Speedy” Moisture Test | 4.2
Calculation for Optimum Moisture of Dense Graded Aggregates

**Needed Information:**
- \( P_c = \% +4 \text{ Material expressed as a decimal} = 0.47 \) (from Sieve Analysis)
- \( W_c = \text{Absorption of } +4 \text{ Matl. plus 1 expressed as a decimal} = 0.013 \) (from Matl’s.Div.)
- \( P_f = \% -4 \text{ Material expressed as a decimal} = 0.53 \) (determined from Sieve Analysis)
- \( W_f = \text{Optimum Moisture of } -4 \text{ Material expressed as a decimal} = 0.085 \) (from Proctor)

\[
\left( P_c W_c + P_f W_f \right) \times 100 \\
\left( 0.47 \times 0.013 \right) + \left( 0.53 \times 0.085 \right) \\
0.006 + 0.045 \\
0.051 \times 100 = 5.1\% \text{ Enter on Line I}
\]

Calculation for Actual Percentage of Maximum Density (Percent Compaction)

\[
\text{Percent Compaction (R)} = \frac{\text{Actual Dry Density (L)}}{\text{Theoretical Maximum Dry Density (P)}} \times 100
\]

\[
\frac{144.2}{142.6} \times 100 = 101.1\% 
\]

Enter 101.1% on Line R.

Locate minimum percent density from specifications or appendix.

In this case - 100%. Enter on line S.
**REPORT OF SAND CONE DENSITY (UNIT MASS OF SOIL)**

**Field Test No.** 1

<table>
<thead>
<tr>
<th>Location of Test</th>
<th>Station ft. (m.)</th>
<th>170 + 00</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ref. To Center Line ft. (m.)</td>
<td>2' Rt. C/L</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Elevation</th>
<th>Original Ground ft. (m.)</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Finished Grade ft. (m.)</td>
<td>At TOE</td>
<td></td>
</tr>
</tbody>
</table>

| Compacted Depth of Lift in. (mm.) | 6” |

**Method of Compaction (Type of Roller)** Sheepsfoot

### DENSITY DETERMINATION

A. Unit wt. (lbs/ft³) or Unit mass (kg/m³) of sand (calibrated value) 85.7

B. Wt. (mass) sand + wt. (mass) of jar and cone, lb. (kg) 12.55

C. Wt. (mass) sand left in jar + wt. (mass) of jar and cone, lb. (kg) 5.89

D. Wt. (mass) of sand in cone and base plate, lb. (kg) (calibr. value) 2.69

E. Wt. (mass) sand left in jar + wt. (mass) of jar and cone + wt. (mass) of sand in cone and base plate (C + D), lb. (kg) 8.58

F. Wt. (mass) of sand in test hole (B - E), lb. (kg) 3.97

G. Volume of test hole (F ÷ A), ft³ (m³) 0.0463

H. Wt. (mass) of wet soil from test hole + (wt.) mass of pan, lb. (kg) 9.50

I. Wt. (mass) of pan, lb. (kg) 2.54

J. Wt. (mass) of wet soil from test hole (H - I), lb. (kg) 6.96

K. Unit wt. (lbs/ft³) or Unit mass (kg/m³) of dry soil in fill = \[
\frac{1}{A} + \left[\frac{\text{Moisture Content (T) ÷ 100}}{A}\right]
\]

L. Unit wt. (lbs/ft³) or Unit mass (kg/m³) of dry soil in fill = 144.2

M. Max. Dry Unit Wt. (lbs/ft³) or Unit mass (kg/m³) from LAB PROCTOR OR ONE POINT PROCTOR (TL-125a) 127.7

N. Optimum Moisture Content from LAB PROCTOR OR ONE POINT PROCTOR (TL-125a) 8.5

O. Percent of +No. 4 (plus 4.75 mm) Material 47

P. Corrected Maximum Dry Unit wt. (lbs/ft³) or Unit mass (kg/m³) 142.6

Q. Corrected Optimum Moisture (%) 5.1

R. % Compaction \(\frac{(L ÷ M)}{100} \times 100\) or \(\frac{(L ÷ P)}{100} \times 100\) 101.1

S. % Minimum density (unit mass) required (from specifications) 100

### MOISTURE DETERMINATION (For Field Dried Method)

a. Dish and damp soil, lb. (kg) 9.50

b. Dish and dried soil, lb. (kg) 9.22

c. Wt. (mass) moisture (a - b), lb. (kg) 0.28

d. Wt. (mass) dish, lb. (kg) 2.54

e. Wt. (mass) dry soil (b - d), lb. (kg) 6.68

T. Moisture Content \((c ÷ e) \times 100\) or from “Speedy” Moisture Test 4.2

### Corrected Optimum Moisture

5. Corrected Optimum Moisture

6. Actual % Density

5. Corrected Optimum Moisture

6. Actual % Density and Required % Density
## REPORT OF SAND CONE DENSITY (UNIT MASS OF SOIL)

### Field Test No.

<table>
<thead>
<tr>
<th>Location of Test</th>
<th>Station ft. (m.)</th>
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</tr>
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<td>Finished Grade ft. (m.)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Compacted Depth of Lift in. (mm.)</td>
<td>6&quot;</td>
<td></td>
</tr>
<tr>
<td>Method of Compaction (Type of Roller)</td>
<td>Sheepsfoot</td>
<td></td>
</tr>
</tbody>
</table>

### DENSITY DETERMINATION

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</tr>
<tr>
<td>L. Unit wt. (lbs/ft³) or Unit mass (kg/m³) of dry soil in fill = K ( { 1 + \left[ \text{Moisture Content (T)} ÷ 100 \right] } )</td>
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<td>N. Optimum Moisture Content from LAB PROCTOR OR ONE POINT PROCTOR (TL-125a)</td>
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</tr>
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<td>O. Percent of +No. 4 (plus 4.75 mm) Material</td>
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</tr>
<tr>
<td>P. Corrected Maximum Dry Unit wt. (lbs/ft³) or Unit mass (kg/m³)</td>
<td>142.6</td>
</tr>
<tr>
<td>Q. Corrected Optimum Moisture (%)</td>
<td>5.1</td>
</tr>
<tr>
<td>R. % Compaction (L ÷ M) ( \times 100 ) or (L ÷ P) ( \times 100 )</td>
<td>101.1</td>
</tr>
<tr>
<td>S. % Minimum density (unit mass) required (from specifications)</td>
<td>100</td>
</tr>
</tbody>
</table>

### MOISTURE DETERMINATION (For Field Dried Method)

<table>
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<tr>
<th>Description</th>
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<td>e. Wt. (mass) from Speedy Moisture Test</td>
<td>6.68</td>
</tr>
<tr>
<td>T. Moisture Content (c ÷ e) ( \times 100 ) or from Speedy Moisture Test</td>
<td>4.2</td>
</tr>
</tbody>
</table>

Acceptable Moisture Range ±2 Percentage Points of Optimum: 5.1 (3.1 - 7.1)
**Nuclear Density Testing on Dense Graded Aggregate**

**TL-124**

**VIRGINIA DEPARTMENT OF TRANSPORTATION**

**MATERIALS DIVISION**

**REPORT OF NUCLEAR EMBANKMENT DENSITIES (UNIT MASSES)**

<table>
<thead>
<tr>
<th>English</th>
<th>Metric</th>
</tr>
</thead>
<tbody>
<tr>
<td>Report No.: 1-21A-3</td>
<td>Sheet No.: 1 of 1</td>
</tr>
</tbody>
</table>

**Route No.: County: Campbell**

**Project No.: 0017-015-104,C503**

**F.H.W.A. No.: None**

**Test For: 21A**

**Nuclear Gauge Model No.: 3440**

**Serial No.: 23456**

**Calibration Date:**

<table>
<thead>
<tr>
<th>Test No.</th>
<th>Location</th>
<th>Station ft. (m)</th>
<th>of</th>
<th>Ref. to center line ft. (m)</th>
<th>Test Elevation</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td></td>
<td>585 + 00</td>
<td></td>
<td>5’ Rt.C/L</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Compacted Depth of Lift in. (mm)</th>
<th>Standard Count</th>
<th>Moisture</th>
</tr>
</thead>
<tbody>
<tr>
<td>6”</td>
<td>2830</td>
<td>701</td>
</tr>
</tbody>
</table>

| Method of Compaction | Vibratory Roller |

| A. Wet Density (lbs/ft³), Wet Unit Mass (kg/m³) | = 145.2 |
| B. Moisture Unit Mass (lbs/ft³), Moisture Unit Mass (kg/m³) | = 7.0 |
| C. Dry Density (lbs/ft³), Dry Unit Mass (kg/m³) (A - B) | = 138.2 |
| D. Moisture Content (B ÷ C) x 100 | = 5.1 |
| E. Maximum Dry Density (lbs/ft³), Dry Unit Mass (kg/m³) 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 4.75mm) | = 47 |
| H. Corrected Maximum Dry Density (lbs/ft³) Dry Unit Mass (kg/m³) | = 142.6 |
| I. Corrected Optimum Moisture | = 5.1 3.1 – 7.1 |
| J. Percent Dry Density (lbs/ft³), Dry Unit Mass (kg/m³) (C ÷ E) x 100 or (C ÷ H) x 100 | = 96.9 |
| K. Percent Minimum Density Required | = 95 |

**Remarks:** Direct Transmission at End of Control Strip

**%+4 Material**: Corrected Maximum Density

**Corrected Optimum Moisture**

**CC:** District Materials Engineer

**Project File**

**Title:**

2012 v1.0

7-37
**CALCULATION #1**

**Amount of +4 Material in Total Soil**

<table>
<thead>
<tr>
<th>Description</th>
<th>Amount</th>
</tr>
</thead>
<tbody>
<tr>
<td>Weight of Dry Soil + Dish</td>
<td>9.22 lb.</td>
</tr>
<tr>
<td>Weight of +4 Material + Dish</td>
<td>5.68 lb.</td>
</tr>
<tr>
<td>Weight of Dish</td>
<td>2.54 lb.</td>
</tr>
<tr>
<td>Total Weight of Dried Soil</td>
<td>6.68 lb.</td>
</tr>
<tr>
<td>Weight of +4 Material</td>
<td>3.14 lb.</td>
</tr>
</tbody>
</table>

\[
\frac{\text{Weight of +4 Material}}{\text{Total Weight of Dried Material}} \times 100 = 47\%
\]

**Enter on Line G**

**CALCULATION #2**

**Total Density of Soils with +4 Material**

**Needed Information:**

- \(P_c = \text{Percent } +4\text{ Material expressed as a decimal} = 0.47\) (from Sieve Analysis)
- \(D_c = 2.63(\text{Sp. Gr. of } +4\text{ Material from Materials Div.}) \times 62.4 \text{ lb/ft}^3 = 164.1 \text{ lb/ft}^3\)
- \(P_f = \text{Percent } -4\text{ Material expressed as a decimal} = 0.53\) (determined from Sieve Analysis)
- \(D_f = \text{Maximum Dry Density } -4\text{ Material} = 127.7 \text{ lb/ft}^3\) (from Proctor)

\[
\frac{D_f \times D_c}{(P_c \times D_f) + (P_f \times D_c)} = \frac{127.7 \text{ lb/ft}^3 \times 164.1 \text{ lb/ft}^3}{(0.47 \times 127.7 \text{ lb/ft}^3) + (0.53 \times 164.1 \text{ lb/ft}^3)} = \frac{20955.6}{142.6 \text{ lb/ft}^3}
\]

**Maximum Dry Density of Total Soil**

**Enter on Line H**

**CALCULATION #3**

**Optimum Moisture Content of Dense Graded Aggregate**

**Needed Information:**

- \(P_c = \% +4\text{ Material expressed as a decimal} = 0.47\) (from Sieve Analysis)
- \(W_c = \text{Absorption of } +4\text{ Matl. plus 1 expressed as a decimal} = 0.013\) (from Matl's.Div.)
- \(P_f = \% -4\text{ Material expressed as a decimal} = 0.53\) (determined from Sieve Analysis)
- \(W_f = \text{Optimum Moisture of } -4\text{ Material expressed as a decimal} = 0.085\) (from Proctor)

\[
\frac{(P_cW_c + P_fW_f)}{100} = \frac{[(0.47 \times 0.013) + (0.53 \times 0.085)]}{100} = \frac{(0.006 + 0.045)}{100} = 5.1\%
\]

**Enter on Line I**
**VIRGINIA DEPARTMENT OF TRANSPORTATION**
**MATERIALS DIVISION**
**REPORT OF NUCLEAR EMBANKMENT DENSITIES (UNIT MASSES)**

**English**
**Metric**

**Report No.:** 1-21A-3  
**Sheet No.:** 1 of 1

**Route No.:**  
**County:** Campbell

**Project No.:** 0017-015-104.C503

**F.H.W.A. No.:** None

**Test For:** 21A

**Nuclear Gauge Model No.:** 3440  
**Serial No.:** 23456  
**Calibration Date:**

---

### STANDARD COUNT

<table>
<thead>
<tr>
<th>Test No.</th>
<th>Location</th>
<th>Station ft. (m)</th>
<th>Ref. to center line ft. (m)</th>
<th>Test</th>
<th>Elevation</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>585 + 00</td>
<td>5' Rt.C/L</td>
<td></td>
<td></td>
<td>6&quot;</td>
</tr>
</tbody>
</table>

**Compacted Depth of Lift in. (mm):** 6"

**Method of Compaction:** Vib. Roller

#### DENSITY

<table>
<thead>
<tr>
<th>2830</th>
</tr>
</thead>
</table>

#### MOISTURE

| 701  |

---

**A. Wet Density (lbs/ft³), Wet Unit Mass (kg/m³):** 145.2

**B. Moisture Unit Mass (lbs/ft³), Moisture Unit Mass (kg/m³):** 7.0

**C. Dry Density (lbs/ft³), Dry Unit Mass (kg/m³) (A - B):** 138.2

**D. Moisture Content (B ÷ C) x 100:** 5.1

**E. Maximum Dry Density (lbs/ft³), Dry Unit Mass (kg/m³) Lab Proctor or One Point Proctor:** 127.7

**F. Percent Optimum Moisture from Lab or One Point Proctor:** 8.5  
**Acceptable Moisture Range +/−2 Percentage Points of Optimum:** 5.1 (3.1-7.1)  
**Passes on Moisture:**

**G. Percent of plus #4, (plus 4.75mm):** 47

**H. Corrected Maximum Dry Density (lbs/ft³) Dry Unit Mass (kg/m³):** 142.6

**I. Corrected Optimum Moisture:** 5.1  
**Minimum Percent Density Required = 95%:**

**J. Percent Dry Density (lbs/ft³), Dry Unit Mass (kg/m³) (C ÷ E) x 100 or (C ÷ H) x 100:** 96.9  
**Required = 95%:**

**K. Percent Minimum Density Required:** 95

**Remarks:** Direct Transmission at End of Control Strip

---

**CC:** District Materials Engineer  
**By:**

**Project File**

---

**CC:** District Materials Engineer  
**By:**

**Title:**

---

2012 v1.0  
7-39
CHAPTER 7
Practice Problem 1

+4 Correction for the Sand Cone Test on Soil

1) Complete the embankment density test (Form TL-125) using the calculation sheet and the information provided below.

- WEIGHT OF WET SOIL AND DISH = 9.30 lb.
- WEIGHT OF DRY SOIL AND DISH = 8.41 lb.
- WEIGHT OF DISH = 1.67 lb.
- WEIGHT OF +4 MATERIAL AND DISH = 3.23 lb.

SPECIFIC GRAVITY OF +4 MATERIAL = 2.63
ABSORPTION OF +4 MATERIAL = 2.0%

MAXIMUM DRY DENSITY OF -4 MATERIAL = 107.1 lb/ft³
OPTIMUM MOISTURE OF -4 MATERIAL = 17.6%

2) Indicate in the remarks if the test passes or fails and why.
**REPORT OF SAND CONE DENSITY (UNIT MASS OF SOIL)**

- **Field Test No.**: 5
- **Location of Test**: Station ft. (m.) 77 + 50
- **Reference**: Ref. To Center Line ft. (m.) 5' Lt.
- **Elevation**: Original Ground ft. (m.) +6'
- **Compacted Depth of Lift in. (mm.)**: 6"
- **Method of Compaction**: Sheepsfoot

### DENSITY DETERMINATION

<table>
<thead>
<tr>
<th>Step</th>
<th>Formula</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>A.</td>
<td>Unit wt. or Unit mass of sand</td>
<td>86.5</td>
</tr>
<tr>
<td>B.</td>
<td>Wt. (mass) sand + wt. (mass) of jar and cone, lb. (kg)</td>
<td>15.8</td>
</tr>
<tr>
<td>C.</td>
<td>Wt. (mass) sand left in jar + wt. (mass) of jar and cone, lb. (kg)</td>
<td>7.89</td>
</tr>
<tr>
<td>D.</td>
<td>Wt. (mass) of sand in cone and base plate, lb. (kg)</td>
<td>2.77</td>
</tr>
<tr>
<td>E.</td>
<td>Wt. (mass) sand left in jar + wt. (mass) of jar and cone + wt. (mass) of sand in cone and base plate (C + D), lb. (kg)</td>
<td>10.66</td>
</tr>
<tr>
<td>F.</td>
<td>Wt. (mass) of sand in test hole (B - E), lb. (kg)</td>
<td>5.14</td>
</tr>
<tr>
<td>G.</td>
<td>Volume of test hole (F ÷ A), ft³ (m³)</td>
<td>0.0594</td>
</tr>
<tr>
<td>H.</td>
<td>Wt. (mass) of wet soil from test hole + (wt.) mass of pan, lb. (kg)</td>
<td>9.30</td>
</tr>
<tr>
<td>I.</td>
<td>Wt. (mass) of pan, lb. (kg)</td>
<td>1.67</td>
</tr>
<tr>
<td>J.</td>
<td>Wt. (mass) of wet soil from test hole (H - I), lb. (kg)</td>
<td>7.63</td>
</tr>
<tr>
<td>K.</td>
<td>Unit wt. or Unit mass of wet soil in fill (J ÷ G)</td>
<td>128.5</td>
</tr>
<tr>
<td>L.</td>
<td>Unit wt. or Unit mass of dry soil in fill = K ({1 + [\text{Moisture Content (T)} ÷ 100]})</td>
<td></td>
</tr>
<tr>
<td>M.</td>
<td>Max. Dry Unit Wt. or Unit mass of LAB PROCTOR or ONE POINT PROCTOR (TL-125a)</td>
<td>107.1</td>
</tr>
<tr>
<td>N.</td>
<td>Optimum Moisture Content from LAB PROCTOR or ONE POINT PROCTOR (TL-125a)</td>
<td>17.6</td>
</tr>
<tr>
<td>O.</td>
<td>Percent of +No. 4 (plus 4.75 mm) Material</td>
<td></td>
</tr>
<tr>
<td>P.</td>
<td>Corrected Maximum Dry Unit wt. or Unit mass of dry soil</td>
<td></td>
</tr>
<tr>
<td>Q.</td>
<td>Corrected Optimum Moisture (%)</td>
<td></td>
</tr>
<tr>
<td>R.</td>
<td>% Compaction (L ÷ M) × 100 or (L ÷ P) × 100</td>
<td></td>
</tr>
<tr>
<td>S.</td>
<td>% Minimum density (unit mass) required (from specifications)</td>
<td></td>
</tr>
</tbody>
</table>

### MOISTURE DETERMINATION (Field Dried Method)

<table>
<thead>
<tr>
<th>Step</th>
<th>Formula</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>a.</td>
<td>Dish and damp soil, lb. (kg)</td>
<td></td>
</tr>
<tr>
<td>b.</td>
<td>Dish and dried soil, lb. (kg)</td>
<td></td>
</tr>
<tr>
<td>c.</td>
<td>Wt. (mass) moisture (a - b), lb. (kg)</td>
<td></td>
</tr>
<tr>
<td>d.</td>
<td>Wt. (mass) dish, lb. (kg)</td>
<td></td>
</tr>
<tr>
<td>e.</td>
<td>Wt. (mass) dry soil (b - d), lb. (kg)</td>
<td></td>
</tr>
<tr>
<td>T.</td>
<td>Moisture Content (c ÷ e) × 100 or from &quot;Speedy&quot; Moisture Test</td>
<td></td>
</tr>
</tbody>
</table>

Remarks: ____________________________________________  By: _________________________________________
_________________________________________________________  Title:  ________________________________________
_________________________________________________________  cc: District Materials Engineer
CALCULATION #1
Amount of +4 Material in Total Soil

Weight of Dry Soil + Dish \[\text{______ lb.}\]  Weight of +4 Material + Dish \[\text{______ lb.}\]

- Weight of Dish \[\text{______ lb.}\]  - Weight of Dish \[\text{______ lb.}\]

Total Weight of Dried Soil \[\text{______ lb.}\]  Weight of +4 Material \[\text{______ lb.}\]

\[
\frac{\text{Weight of +4 Material}}{\text{Total Weight of Dried Material}} \times 100 = \text{______} \% \ \text{Enter on Line O}
\]

CALCULATION #2
Total Density of Soils with +4 Material

Needed Information:

\(P_c\) = Percent +4 Material expressed as a decimal = \[\text{______}\] (from Sieve Analysis)
\(D_c\) = \[\text{_____}\] (Sp. Gr. of +4 Material from Materials Div.) \[x 62.4 \text{ lb/ft}^3\]
\(P_f\) = Percent -4 Material expressed as a decimal = \[\text{______}\] (determined from Sieve Analysis)
\(D_f\) = Maximum Dry Density -4 Material = \[\text{______ lb/ft}^3\] (from Proctor)

\[
\frac{D_f \times D_c}{(P_c \times D_f) + (P_f \times D_c)} = \frac{\text{______ lb/ft}^3 \times \text{______ lb/ft}^3}{\text{______ x \text{______ lb/ft}^3} + \text{______ x \text{______ lb/ft}^3}}
\]

\[
\text{______} + \text{______} = \text{______ lb/ft}^3 \ \text{Maximum Dry Density of Total Soil} \ \text{Enter on Line P}
\]

CALCULATION #3
Optimum Moisture Content of Soils with +4 Material

Needed Information:

\(P_c\) = % +4 Material expressed as a decimal = \[\text{______}\] (from Sieve Analysis)
\(W_c\) = Absorption of +4 Matl. expressed as a decimal = \[\text{______}\] (from Matl’s.Div.)
\(P_f\) = % -4 Material expressed as a decimal = \[\text{______}\] (determined from Sieve Analysis)
\(W_f\) = Optimum Moisture of -4 Material expressed as a decimal = \[\text{______}\] (from Proctor)

\[
\left(\frac{P_cW_c + P_fW_f}{100}\right)
\]

\[
\left[\left(\text{______ x \text{______}}\right) + \left(\text{______ x \text{______}}\right)\right] 100
\]

\[
\left(\text{______} + \text{______}\right) 100
\]

\[
\text{______} \times 100 = \text{______} \% \ \text{Enter on Line Q}
\]
CHAPTER 7
Practice Problem 2

+4 Correction for the Sand Cone Test on Soil

1) Complete the embankment density test (Form TL-125) using the calculation sheet and the information provided below.

WEIGHT OF WET SOIL AND DISH = 9.10 lb.
WEIGHT OF DRY SOIL AND DISH = 8.25 lb.
WEIGHT OF DISH = 1.63 lb.
WEIGHT OF +4 MATERIAL AND DISH = 3.10 lb.

SPECIFIC GRAVITY OF +4 MATERIAL = 2.60
ABSORPTION OF +4 MATERIAL = 2.0%

MAXIMUM DRY DENSITY OF -4 MATERIAL = 107.1 lb/ft³
OPTIMUM MOISTURE OF -4 MATERIAL = 17.6%

2) Indicate in the remarks if the test passes or fails and why.
### Field Test No.

1

### Location of Test

<table>
<thead>
<tr>
<th>Station ft. (m.)</th>
<th>Ref. To Center Line ft. (m.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>77 + 50</td>
<td>7' Lt.</td>
</tr>
</tbody>
</table>

### Reference Elevation

<table>
<thead>
<tr>
<th>Original Ground ft. (m.)</th>
<th>Finished Grade ft. (m.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>+10'</td>
<td>-23'</td>
</tr>
</tbody>
</table>

### Compacted Depth of Lift in. (mm.)

6"

### Method of Compaction (Type of Roller)

Sheepsfoot

#### DENSITY DETERMINATION

<table>
<thead>
<tr>
<th>A. Unit wt. (lbs/ft³) or Unit mass (kg/m³) of sand (calibrated value)</th>
<th>86.5</th>
</tr>
</thead>
<tbody>
<tr>
<td>B. Wt. (mass) sand + wt. (mass) of jar and cone, lb. (kg)</td>
<td>15.8</td>
</tr>
<tr>
<td>C. Wt. (mass) sand left in jar + wt. (mass) of jar and cone, lb. (kg)</td>
<td>7.89</td>
</tr>
<tr>
<td>D. Wt. (mass) of sand in cone and base plate, lb. (kg) (calibrated value)</td>
<td>2.77</td>
</tr>
<tr>
<td>E. Wt. (mass) sand left in jar + wt. (mass) of jar and cone + wt. (mass) of sand in cone and base plate (C + D), lb. (kg)</td>
<td>10.66</td>
</tr>
<tr>
<td>F. Wt. (mass) of sand in test hole (B - E), lb. (kg)</td>
<td>5.14</td>
</tr>
<tr>
<td>G. Volume of test hole (F ÷ A), ft³ (m³)</td>
<td>0.0594</td>
</tr>
<tr>
<td>H. Wt. (mass) of wet soil from test hole + (wt.) mass of pan, lb. (kg)</td>
<td>9.10</td>
</tr>
<tr>
<td>I. Wt. (mass) of pan, lb. (kg)</td>
<td>1.63</td>
</tr>
<tr>
<td>J. Wt. (mass) of wet soil from test hole (H - I), lb. (kg)</td>
<td>7.47</td>
</tr>
<tr>
<td>K. Unit wt. (lbs/ft³) or Unit mass (kg/m³) of wet soil in fill (J ÷ G)</td>
<td>125.8</td>
</tr>
</tbody>
</table>

L. Unit wt. (lbs/ft³) or Unit mass (kg/m³) of dry soil in fill = \( \frac{1 + [ \text{Moisture Content} (T) ÷ 100 ]}{K} \)

M. Max. Dry Unit Wt. (lbs/ft³) or Unit mass (kg/m³) from LAB PROCTOR OR ONE POINT PROCTOR (TL-125a)

N. Optimum Moisture Content from LAB PROCTOR OR ONE POINT PROCTOR (TL-125a)

O. Percent of +No. 4 (plus 4.75 mm) Material

P. Corrected Maximum Dry Unit wt. (lbs/ft³) or Unit mass (kg/m³)

Q. Corrected Optimum Moisture (%)

R. % Compaction (L ÷ M) × 100 or (L ÷ P) × 100

S. % Minimum density (unit mass) required (from specifications)

#### MOISTURE DETERMINATION (Field Dried Method)

<table>
<thead>
<tr>
<th>a. Dish and damp soil, lb. (kg)</th>
<th>b. Dish and dried soil, lb. (kg)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>c. Wt. (mass) moisture (a - b), lb. (kg)</td>
<td>d. Wt. (mass) dish, lb. (kg)</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>e. Wt. (mass) dry soil (b - d), lb. (kg)</td>
<td>T. Moisture Content (c ÷ e) × 100 or from &quot;Speedy&quot; Moisture Test</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Remarks:

By: ____________________________

Title: __________________________

cc: District Materials Engineer
CALCULATION #1

Amount of +4 Material in Total Soil

Weight of Dry Soil + Dish ________ lb.  Weight of +4 Material + Dish ________ lb.

- Weight of Dish ________ lb.  - Weight of Dish ________ lb.

Total Weight of Dried Soil ________ lb.  Weight of +4 Material ________ lb.

Weight of +4 Material ________ lb.

______________________________________________ x 100 = ________ % Enter on Line O
Total Weight of Dried Material ________ lb.

CALCULATION #2

Total Density of Soils with +4 Material

Needed Information:

\[ P_c = \text{Percent +4 Material expressed as a decimal} = \quad (\text{from Sieve Analysis}) \]

\[ D_c = \quad (\text{Sp. Gr. of +4 Material from Materials Div.}) \times 62.4 \text{ lb/ft}^3 = \quad \text{lb/ft}^3 \]

\[ P_f = \text{Percent -4 Material expressed as a decimal} = \quad (\text{determined from Sieve Analysis}) \]

\[ D_f = \text{Maximum Dry Density -4 Material} = \quad \text{lb/ft}^3 \quad (\text{from Proctor}) \]

\[ \frac{D_f 	imes D_c}{(P_c \times D_f) + (P_f \times D_c)} \]

\[ \frac{\quad \text{lb/ft}^3 \times \quad \text{lb/ft}^3}{(\quad \text{lb/ft}^3 \times \quad \text{lb/ft}^3) + (\quad \text{lb/ft}^3 \times \quad \text{lb/ft}^3)} \]

\[ \frac{\quad \text{lb/ft}^3}{\quad \text{lb/ft}^3} = \quad \text{lb/ft}^3 \quad \text{Maximum Dry Density of Total Soil Enter on Line P} \]

CALCULATION #3

Optimum Moisture Content of Soils with +4 Material

Needed Information:

\[ P_c = \% +4 \text{ Material expressed as a decimal} = \quad (\text{from Sieve Analysis}) \]

\[ W_c = \text{Absorption of +4 Matl. expressed as a decimal} = \quad (\text{from Matl’s.Div.}) \]

\[ P_f = \% -4 \text{ Material expressed as a decimal} = \quad (\text{determined from Sieve Analysis}) \]

\[ W_f = \text{Optimum Moisture of -4 Material expressed as a decimal} = \quad (\text{from Proctor}) \]

\[ \frac{(P_c \times W_c + P_f \times W_f)}{100} \]

\[ [(\quad \times \quad) + (\quad \times \quad)] \quad 100 \]

\[ (\quad + \quad) \quad 100 \]

\[ (\quad) \quad 100 = \quad \% \quad \text{Enter on Line Q} \]
CHAPTER 7
Practice Problem 3

+4 Correction for the Sand Cone Test on Soil

1) Complete the embankment density test (Form TL-125) using the calculation sheet and the information provided below.

WEIGHT OF WET SOIL AND DISH = 9.38 lb.
WEIGHT OF DRY SOIL AND DISH = 8.35 lb.
WEIGHT OF DISH = 1.67 lb.
WEIGHT OF +4 MATERIAL AND DISH = 3.23 lb.

SPECIFIC GRAVITY OF +4 MATERIAL = 2.65
ABSORPTION OF +4 MATERIAL = 2.0%

MAXIMUM DRY DENSITY OF -4 MATERIAL = 102.4 lb/ft³
OPTIMUM MOISTURE OF -4 MATERIAL = 20.3%

2) Indicate in the remarks if the test passes or fails and why.
**REPORT OF SAND CONE DENSITY (UNIT MASS OF SOIL)**

**Location of Test:**
- Station ft. (m.): 120+40
- Ref. To Center Line ft. (m.): 5' Lt.

**Reference Elevation:**
- Original Ground ft. (m.): +16'
- Finished Grade ft. (m.): -7'

**Compacted Depth of Lift in. (mm.):** 6"

**Method of Compaction (Type of Roller):** Sheepsfoot

**Density Determination:**

<table>
<thead>
<tr>
<th>Step</th>
<th>Description</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>A.</td>
<td>Unit wt. (lbs/ft³) of sand (calibrated value)</td>
<td>86.5</td>
</tr>
<tr>
<td>B.</td>
<td>Wt. (mass) sand + wt. (mass) of jar and cone, lb. (kg)</td>
<td>13.29</td>
</tr>
<tr>
<td>C.</td>
<td>Wt. (mass) sand left in jar + wt. (mass) of jar and cone, lb. (kg)</td>
<td>5.09</td>
</tr>
<tr>
<td>D.</td>
<td>Wt. (mass) of sand in cone and base plate, lb. (kg) (calibrated value)</td>
<td>2.76</td>
</tr>
<tr>
<td>E.</td>
<td>Wt. (mass) sand left in jar + wt. (mass) of jar and cone + wt. (mass) of sand in cone and base plate (C + D), lb. (kg)</td>
<td>7.85</td>
</tr>
<tr>
<td>F.</td>
<td>Wt. (mass) of sand in test hole (B - E), lb. (kg)</td>
<td>5.44</td>
</tr>
<tr>
<td>G.</td>
<td>Volume of test hole (F ÷ A), ft³ (m³)</td>
<td>0.0629</td>
</tr>
<tr>
<td>H.</td>
<td>Wt. (mass) of wet soil from test hole + (wt.) mass of pan, lb. (kg)</td>
<td>9.38</td>
</tr>
<tr>
<td>I.</td>
<td>Wt. (mass) of pan, lb. (kg)</td>
<td>1.67</td>
</tr>
<tr>
<td>J.</td>
<td>Wt. (mass) of wet soil from test hole (H - I), lb. (kg)</td>
<td>7.71</td>
</tr>
<tr>
<td>K.</td>
<td>Unit wt. (lbs/ft³) or Unit mass (kg/m³) of wet soil in fill (J ÷ G)</td>
<td>122.6</td>
</tr>
</tbody>
</table>
| L.   | Unit wt. (lbs/ft³) or Unit mass (kg/m³) of dry soil in fill = \[
\frac{K}{1 + \text{Moisture Content (T) ÷ 100}}
\] | |
| M.   | Max. Dry Unit Wt. (lbs/ft³) or Unit mass (kg/m³) from LAB PROCTOR OR ONE POINT PROCTOR (TL-125a) | 102.4 |
| N.   | Optimum Moisture Content from LAB PROCTOR OR ONE POINT PROCTOR (TL-125a) | 20.3 |
| O.   | Percent of +No. 4 (plus 4.75 mm) Material | |
| P.   | Corrected Maximum Dry Unit wt. (lbs/ft³) or Unit mass (kg/m³) | |
| Q.   | Corrected Optimum Moisture (%) | |
| R.   | % Compaction (L ÷ M) × 100 or (L ÷ P) × 100 | |
| S.   | % Minimum density (unit mass) required (from specifications) | |

**Moisture Determination (Field Dried Method):**

<table>
<thead>
<tr>
<th>Step</th>
<th>Description</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>a.</td>
<td>Dish and damp soil, lb. (kg)</td>
<td></td>
</tr>
<tr>
<td>b.</td>
<td>Dish and dried soil, lb. (kg)</td>
<td></td>
</tr>
<tr>
<td>c.</td>
<td>Wt. (mass) moisture (a - b), lb. (kg)</td>
<td></td>
</tr>
<tr>
<td>d.</td>
<td>Wt. (mass) dish, lb. (kg)</td>
<td></td>
</tr>
<tr>
<td>e.</td>
<td>Wt. (mass) dry soil (b - d), lb. (kg)</td>
<td></td>
</tr>
</tbody>
</table>

| T.   | Moisture Content (c ÷ e) × 100 or from "Speedy" Moisture Test | |

Remarks: ______________________________________________________ ____________________________
Title: ______________________________________________________
cc: District Materials Engineer

By: ______________________________________________________
CALCULATION #1

Amount of +4 Material in Total Soil

Weight of Dry Soil + Dish ________ lb.  Weight of +4 Material + Dish ________ lb.

- Weight of Dish ________ lb.  - Weight of Dish ________ lb.

Total Weight of Dried Soil ________ lb.  Weight of +4 Material ________ lb.

\[
\frac{\text{Weight of +4 Material}}{\text{Total Weight of Dried Material}} \times 100 = \text{Enter on Line O}
\]

Total Weight of Dried Material ________ lb.

CALCULATION #2

Total Density of Soils with +4 Material

Needed Information:

\[ P_c = \text{Percent +4 Material expressed as a decimal} = \] (from Sieve Analysis)

\[ D_c = \] (Sp. Gr. of +4 Material from Materials Div.) \times 62.4 \text{ lb/ft}^3 = \] \text{lb/ft}^3

\[ P_f = \text{Percent -4 Material expressed as a decimal} = \] (determined from Sieve Analysis)

\[ D_f = \text{Maximum Dry Density -4 Material} = \] \text{lb/ft}^3 (from Proctor)

\[
\frac{D_f \times D_c}{(P_c \times D_f) + (P_f \times D_c)}
\]

\[
\frac{\text{________ \text{lb/ft}^3} \times \text{________ \text{lb/ft}^3}}{\text{________ \text{lb/ft}^3} \times \text{________ \text{lb/ft}^3}}
\]

\[
\frac{\text{________} + \text{________}}{\text{________} + \text{________}} = \text{________ \text{lb/ft}^3} \text{ Maximum Dry Density of Total Soil Enter on Line P}
\]

CALCULATION #3

Optimum Moisture Content of Soils with +4 Material

Needed Information:

\[ P_c = \% \text{ +4 Material expressed as a decimal} = \] (from Sieve Analysis)

\[ W_e = \text{Absorption of +4 Matl. expressed as a decimal} = \] (from Matl’s.Div.)

\[ P_f = \% \text{ -4 Material expressed as a decimal} = \] (determined from Sieve Analysis)

\[ W_f = \text{Optimum Moisture of -4 Material expressed as a decimal} = \] (from Proctor)

\[
\frac{(P_c W_c + P_f W_f) \times 100}{[(\text{________} \times \text{________}) + (\text{________} \times \text{________})] \times 100}
\]

\[
\left[\frac{\text{________} + \text{________}}{\text{________} + \text{________}}\right] \times 100
\]

\[
\text{________} \times 100 = \text{________ \% Enter on Line Q}
\]
CHAPTER 7
Practice Problem 4
+4 Correction for the Nuclear Density Test on Soil

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

WEIGHT OF DRY SOIL AND DISH = 9.29 lb.
WEIGHT OF DISH = 2.62 lb.
WEIGHT OF +4 MATERIAL AND DISH = 3.63 lb.

SPECIFIC GRAVITY OF +4 MATERIAL = 2.63
ABSORPTION OF +4 MATERIAL = 3.0%

MAXIMUM DRY DENSITY OF -4 MATERIAL = 112.6 lb/ft³
OPTIMUM MOISTURE OF -4 MATERIAL = 14.5%

3440 Display Screen

<table>
<thead>
<tr>
<th>%PR = 102.0</th>
</tr>
</thead>
<tbody>
<tr>
<td>DD = 114.8</td>
</tr>
<tr>
<td>WD = 127.4</td>
</tr>
<tr>
<td>M = 12.6</td>
</tr>
</tbody>
</table>

2) Indicate in the remarks if the test passes or fails and why.
**VIRGINIA DEPARTMENT OF TRANSPORTATION**  
**MATERIALS DIVISION**  
**REPORT OF NUCLEAR EMBANKMENT DENSITIES (UNIT MASSES)**

<table>
<thead>
<tr>
<th>English</th>
<th>Metric</th>
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</thead>
<tbody>
<tr>
<td>Report No.:</td>
<td>Date:</td>
</tr>
<tr>
<td>Route No.:</td>
<td>117</td>
</tr>
<tr>
<td>Project No.:</td>
<td>0117-080-105,C501</td>
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<tr>
<td>Test For:</td>
<td>Embankment</td>
</tr>
<tr>
<td>Nuclear Gauge Model No.:</td>
<td>3440</td>
</tr>
</tbody>
</table>

### STANDARD COUNT

<table>
<thead>
<tr>
<th>Test No.:</th>
<th>Compacted Depth of Lift in. (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>6</td>
<td>6&quot;</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Location</th>
<th>Station ft. (m)</th>
<th>Ref. to center line ft. (m)</th>
</tr>
</thead>
<tbody>
<tr>
<td>90+45</td>
<td>6' Rt.</td>
<td>+8 / -6</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Test</th>
<th>Elevation</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>+8 / -6</td>
</tr>
</tbody>
</table>

### DENSITY

<table>
<thead>
<tr>
<th>Test No.</th>
<th>Location</th>
<th>Station ft. (m)</th>
<th>Ref. to center line ft. (m)</th>
<th>Elevation</th>
<th>Compacted Depth of Lift in. (mm)</th>
<th>Method of Compaction</th>
</tr>
</thead>
<tbody>
<tr>
<td>6</td>
<td>90+45</td>
<td>6' Rt.</td>
<td>+8 / -6</td>
<td>6&quot;</td>
<td>Sheepsfoot</td>
<td></td>
</tr>
</tbody>
</table>

### MOISTURE

<table>
<thead>
<tr>
<th>Test No.</th>
<th>Location</th>
<th>Station ft. (m)</th>
<th>Ref. to center line ft. (m)</th>
<th>Elevation</th>
<th>Compacted Depth of Lift in. (mm)</th>
<th>Method of Compaction</th>
</tr>
</thead>
<tbody>
<tr>
<td>6</td>
<td>90+45</td>
<td>6' Rt.</td>
<td>+8 / -6</td>
<td>6&quot;</td>
<td>Sheepsfoot</td>
<td></td>
</tr>
</tbody>
</table>

**Remarks:**

**CC:** District Materials Engineer  
By: ________________________________  
Project File  
Title: ________________________________
**CALCULATION #1**
Amount of +4 Material in Total Soil

<table>
<thead>
<tr>
<th>Description</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Weight of Dry Soil + Dish</td>
<td>lb.</td>
</tr>
<tr>
<td>Weight of +4 Material + Dish</td>
<td>lb.</td>
</tr>
<tr>
<td>Weight of Dish</td>
<td>lb.</td>
</tr>
<tr>
<td>Total Weight of Dried Soil</td>
<td>lb.</td>
</tr>
<tr>
<td>Weight of +4 Material</td>
<td>lb.</td>
</tr>
<tr>
<td>Total Weight of Dried Material</td>
<td>lb.</td>
</tr>
</tbody>
</table>

\[
\text{Weight of +4 Material} \times \text{Total Weight of Dried Material} \times 100 = \% \text{ Enter on Line G}
\]

**CALCULATION #2**
Total Density of Soils with +4 Material

**Needed Information:**

\[P_c = \text{Percent +4 Material expressed as a decimal} = \] (from Sieve Analysis)

\[D_c = \] (Sp. Gr. of +4 Material from Materials Div.) \times 62.4 lb/ft³ = \(\) lb/ft³

\[P_f = \text{Percent -4 Material expressed as a decimal} = \] (determined from Sieve Analysis)

\[D_f = \text{Maximum Dry Density -4 Material} = \] (from Proctor)

\[
\frac{D_f \times D_c}{(P_c \times D_f) + (P_f \times D_c)} = \text{Maximum Dry Density of Total Soil} \text{ Enter on Line H}
\]

**CALCULATION #3**
Optimum Moisture Content of Soils with +4 Material

**Needed Information:**

\[P_c = \% \text{ +4 Material expressed as a decimal} = \] (from Sieve Analysis)

\[W_c = \text{Absorption of +4 Matl. expressed as a decimal} = \] (from Matl’s.Div.)

\[P_f = \% \text{ -4 Material expressed as a decimal} = \] (determined from Sieve Analysis)

\[W_f = \text{Optimum Moisture of -4 Material expressed as a decimal} = \] (from Proctor)

\[
\frac{(P_c W_c + P_f W_f) 100}{[(P_c \times W_c) + (P_f \times W_f)] 100} = \% \text{ Enter on Line I}
\]

2012 v1.0
CHAPTER 7
Practice Problem 5
+4 Correction for the Nuclear Density Test on Soil

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

WEIGHT OF DRY SOIL + DISH = 9.30 lb.
WEIGHT OF DISH = 2.62 lb.
WEIGHT OF +4 MATERIAL + DISH = 3.65 lb.

SPECIFIC GRAVITY OF +4 MATERIAL = 2.70
ABSORPTION OF +4 MATERIAL = 2.0%

MAXIMUM DRY DENSITY OF -4 MATERIAL = 110.5 lb/ft³
OPTIMUM MOISTURE OF -4 MATERIAL = 14.3%

3440 Display Screen

<table>
<thead>
<tr>
<th>%PR</th>
<th>104.7</th>
</tr>
</thead>
<tbody>
<tr>
<td>DD</td>
<td>115.7</td>
</tr>
<tr>
<td>WD</td>
<td>127.9</td>
</tr>
<tr>
<td>M</td>
<td>12.2</td>
</tr>
<tr>
<td>% M</td>
<td>10.5</td>
</tr>
</tbody>
</table>

2) Indicate in the remarks if the test passes or fails and why.
# REPORT OF NUCLEAR EMBANKMENT DENSITIES (UNIT MASSES)

**English**

**Metric**

<table>
<thead>
<tr>
<th>Report No.:</th>
<th>Date:</th>
<th>Sheet No.: 1 of 1</th>
</tr>
</thead>
<tbody>
<tr>
<td>Route No.:</td>
<td>117</td>
<td>County: Roanoke</td>
</tr>
<tr>
<td>Project No.:</td>
<td>0117-080-105,C501</td>
<td></td>
</tr>
<tr>
<td>F.H.W.A. No.:</td>
<td>None</td>
<td></td>
</tr>
<tr>
<td>Test For:</td>
<td>Embankment</td>
<td></td>
</tr>
<tr>
<td>Nuclear Gauge Model No.:</td>
<td>3440</td>
<td></td>
</tr>
<tr>
<td>Serial No.:</td>
<td>23456</td>
<td></td>
</tr>
</tbody>
</table>

---

### DENSITY

<table>
<thead>
<tr>
<th>STANDART COUNT</th>
<th>MOISTURE</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>2844</strong></td>
<td><strong>701</strong></td>
</tr>
</tbody>
</table>

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<table>
<thead>
<tr>
<th>Test No.</th>
<th>Location</th>
<th>Station ft. (m)</th>
<th>Ref. to center line ft. (m)</th>
<th>Test</th>
<th>Elevation</th>
<th>Compacted Depth of Lift in. (mm)</th>
<th>Method of Compaction</th>
</tr>
</thead>
<tbody>
<tr>
<td>6</td>
<td>90+45</td>
<td>6 Rt.</td>
<td>+8 / -6</td>
<td>Sheepsfoot</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

---

| A. Wet Density (lbs/ft³), Wet Unit Mass (kg/m³) | = 127.9 |
| B. Moisture Unit Mass (lbs/ft³), Moisture Unit Mass (kg/m³) | = 12.2 |
| C. Dry Density (lbs/ft³), Dry Unit Mass (kg/m³) (A - B) | = 115.7 |
| D. Moisture Content (B ÷ C x 100) | = 10.5 |
| E. Maximum Dry Density (lbs/ft³), Dry Unit Mass (kg/m³) Lab Proctor or One Point Proctor | = 110.5 |
| F. Percent Optimum Moisture from Lab or One Point Proctor | = 14.3 |
| G. Percent of plus #4, (plus 4.75mm) | = |
| H. Corrected Maximum Dry Density (lbs/ft³) Dry Unit Mass (kg/m³) | = |
| I. Corrected Optimum Moisture | = |
| J. Percent Dry Density (lbs/ft³), Dry Unit Mass (kg/m³) (C + E) x 100 or (C ÷ H) x 100 | = |
| K. Percent Minimum Density Required | = |

---

Remarks:

---

**CC:** District Materials Engineer

**By:** __________________________

**Project File**

**Title** __________________________
CALCULATION #1
Amount of +4 Material in Total Soil

Weight of Dry Soil + Dish ________ lb.  Weight of +4 Material + Dish ________ lb.

- Weight of Dish ________ lb.  - Weight of Dish ________ lb.

Total Weight of Dried Soil ________ lb.  Weight of +4 Material ________ lb.

\[
\text{Weight of +4 Material} \quad \text{lb.} \quad \times 100 = \quad \% \quad \text{Enter on Line G}
\]

CALCULATION #2
Total Density of Soils with +4 Material

Needed Information:

\[
P_c = \text{Percent +4 Material expressed as a decimal} = \quad \text{(from Sieve Analysis)}
\]

\[
D_c = \quad \text{(Sp. Gr. of +4 Material from Materials Div.)} \times 62.4 \text{ lb/ft}^3 = \quad \text{lb/ft}^3
\]

\[
P_f = \text{Percent -4 Material expressed as a decimal} = \quad \text{(determined from Sieve Analysis)}
\]

\[
D_f = \text{Maximum Dry Density -4 Material} = \quad \text{lb/ft}^3 \quad \text{(from Proctor)}
\]

\[
\frac{D_i \times D_c}{(P_c \times D_f) + (P_f \times D_c)} = \quad \text{lb/ft}^3 \quad \text{Maximum Dry Density of Total Soil}
\]

Enter on Line H

CALCULATION #3
Optimum Moisture Content of Soils with +4 Material

Needed Information:

\[
P_c = \% \text{ +4 Material expressed as a decimal} = \quad \text{(from Sieve Analysis)}
\]

\[
W_c = \text{Absorption of +4 Matl. expressed as a decimal} = \quad \text{(from Matl’s.Div.)}
\]

\[
P_f = \% \text{-4 Material expressed as a decimal} = \quad \text{(determined from Sieve Analysis)}
\]

\[
W_f = \text{Optimum Moisture of -4 Material expressed as a decimal} = \quad \text{(from Proctor)}
\]

\[
\frac{(P_cW_c + P_fW_f) \times 100}{[(\frac{P_cW_c}{P_c} + \frac{P_fW_f}{P_f}) \times 100] + (\frac{P_cW_c}{P_c} + \frac{P_fW_f}{P_f}) 100} = \quad \% \quad \text{Enter on Line I}
\]
CHAPTER 7
Practice Problem 6
+4 Correction for the Nuclear Density Test on Soil

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

WEIGHT OF DRY SOIL AND DISH = 9.29 lb.
WEIGHT OF DISH = 2.62 lb.
WEIGHT OF +4 MATERIAL AND DISH = 3.51 lb.

MAXIMUM DRY DENSITY OF -4 MATERIAL = 109.9 lb/ft³
OPTIMUM MOISTURE OF -4 MATERIAL = 13.9%

SPECIFIC GRAVITY OF +4 MATERIAL = 2.68
ABSORPTION OF +4 MATERIAL = 2.0%

3440 Display Screen

<table>
<thead>
<tr>
<th>%PR</th>
<th>DD</th>
<th>WD</th>
<th>M</th>
<th>% M</th>
</tr>
</thead>
<tbody>
<tr>
<td>104.4</td>
<td>114.7</td>
<td>127.5</td>
<td>12.8</td>
<td>11.2</td>
</tr>
</tbody>
</table>

2) Indicate in the remarks if the test passes or fails and why.
### REPORT OF NUCLEAR EMBANKMENT DENSITIES (UNIT MASSES)

#### English Metric

<table>
<thead>
<tr>
<th>Report No.:</th>
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<th>Sheet No.:</th>
<th>1 of 1</th>
</tr>
</thead>
<tbody>
<tr>
<td>Route No.:</td>
<td>County:</td>
<td>Roanoke</td>
<td></td>
</tr>
<tr>
<td>Project No.:</td>
<td>F.H.W.A. No.:</td>
<td>None</td>
<td></td>
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<tr>
<td>Test For:</td>
<td>Nuclear Gauge Model No.:</td>
<td>3440</td>
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<table>
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<tr>
<th>Test No.</th>
<th>Location</th>
<th>Station ft. (m)</th>
<th>Ref. to center line ft. (m)</th>
<th>Test</th>
<th>Elevation</th>
</tr>
</thead>
<tbody>
<tr>
<td>6</td>
<td>90+40</td>
<td>6 Rt.</td>
<td>+8.9 / -6.2</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

- **Compacted Depth of Lift in. (mm)**: 6”
- **Method of Compaction**: Sheepsfoot

<table>
<thead>
<tr>
<th>DENSITY</th>
<th>MOISTURE</th>
</tr>
</thead>
<tbody>
<tr>
<td>2844</td>
<td>701</td>
</tr>
</tbody>
</table>

<table>
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<th>Test No.</th>
<th>Location</th>
<th>Station ft. (m)</th>
<th>Ref. to center line ft. (m)</th>
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<th>Elevation</th>
</tr>
</thead>
<tbody>
<tr>
<td>6</td>
<td>90+40</td>
<td>6 Rt.</td>
<td>+8.9 / -6.2</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

- **A. Wet Density (lbs/ft³), Wet Unit Mass (kg/m³)** =
- **B. Moisture Unit Mass (lbs/ft³), Moisture Unit Mass (kg/m³)** =
- **C. Dry Density (lbs/ft³), Dry Unit Mass (kg/m³) (A - B)** =
- **D. Moisture Content (B ÷ C) x 100** =
- **E. Maximum Dry Density (lbs/ft³), Dry Unit Mass (kg/m³) Lab Proctor or One Point Proctor** =
- **F. Percent Optimum Moisture from Lab or One Point Proctor** =
- **G. Percent of plus #4, (plus 4.75mm)** =
- **H. Corrected Maximum Dry Density (lbs/ft³) Dry Unit Mass (kg/m³)** =
- **I. Corrected Optimum Moisture** =
- **J. Percent Dry Density (lbs/ft³), Dry Unit Mass (kg/m³) (C ÷ E) x 100 or (C ÷ H) x 100** =
- **K. Percent Minimum Density Required** =

#### Remarks:

**CC:** District Materials Engineer  
**By:** ______________________  
**Title:** ______________________
CALCULATION #1
Amount of +4 Material in Total Soil

Weight of Dry Soil + Dish ________ lb.  Weight of +4 Material + Dish ________ lb.

- Weight of Dish ________ lb.  - Weight of Dish ________ lb.

Total Weight of Dried Soil ________ lb.  Weight of +4 Material ________ lb.

Weight of +4 Material ________ lb.

-------------------------------------------------------------

x 100 = ________ % Enter on Line G

Total Weight of Dried Material ________ lb.

CALCULATION #2
Total Density of Soils with +4 Material

Needed Information:

\[ P_c = \text{Percent +4 Material expressed as a decimal} = \text{______ (from Sieve Analysis)} \]

\[ D_c = \text{Sp. Gr. of +4 Material from Materials Div.)} \times 62.4 \text{ lb/ft}^3 = \text{______ lb/ft}^3 \]

\[ P_f = \text{Percent -4 Material expressed as a decimal} = \text{______ (determined from Sieve Analysis)} \]

\[ D_f = \text{Maximum Dry Density -4 Material} = \text{______ lb/ft}^3 \text{ (from Proctor)} \]

\[ \frac{D_f \times D_c}{(P_c \times D_f) + (P_f \times D_c)} \]

\[ \frac{______ \text{ lb/ft}^3 \times ______\text{ lb/ft}^3}{______ \text{ lb/ft}^3 \times ______\text{ lb/ft}^3 + ______ \text{ lb/ft}^3} \]

\[ \frac{______}{______ + ______} = ______ \text{ lb/ft}^3 \text{ Maximum Dry Density} \]

Enter on Line H

CALCULATION #3
Optimum Moisture Content of Soils with +4 Material

Needed Information:

\[ P_c = \text{% +4 Material expressed as a decimal} = \text{______ (from Sieve Analysis)} \]

\[ W_c = \text{Absorption of +4 Matl. expressed as a decimal} = \text{______ (from Matl’s.Div.)} \]

\[ P_f = \text{% -4 Material expressed as a decimal} = \text{______ (determined from Sieve Analysis)} \]

\[ W_f = \text{Optimum Moisture of -4 Material expressed as a decimal} = \text{______ (from Proctor)} \]

\[ \frac{(P_cW_c + P_fW_f) 100}{[(______ \times ______) + (______ \times ______)] 100} \]

\[ \frac{______}{______ + ______} 100 \]

\[ (______) 100 = _____ \% \text{ Enter on Line I} \]
Density Testing with the Sand Cone on Aggregate

1) Complete the dense graded aggregate (21A) density test (Form TL-125) using the calculation sheet and the information provided below.

WEIGHT OF WET AGGREGATE + DISH = 9.82 lb.
WEIGHT OF DRIED AGGREGATE + DISH = 9.46 lb.
WEIGHT OF DISH = 2.60 lb.

WEIGHT OF +4 MATERIAL + DISH = 6.08 lb.

AGGREGATE DATA:
MAXIMUM DRY DENSITY OF -4 MATERIAL = 131.7 lb/ft³
OPTIMUM MOISTURE OF -4 MATERIAL = 7.8%

SPECIFIC GRAVITY OF +4 MATERIAL = 2.63
ABSORPTION of +4 MATERIAL = 0.3%

2) Indicate in the remarks if the test passes or fails and why.
**Report of Sand Cone Density (Unit Mass of Soil)**

**Field Test No.**
3

**Location of Test**
- Station ft. (m.)
  - 105 + 00
- Ref. To Center Line ft. (m.)
  - 3' Lt.

**Reference Elevation**
- Original Ground ft. (m.)
- Finished Grade ft. (m.)
  - At TOE

**Compacted Depth of Lift in. (mm.)**
6"

**Method of Compaction**
- Vib. Roller

### DENSITY DETERMINATION

<table>
<thead>
<tr>
<th>Step</th>
<th>Description</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>A.</td>
<td>Unit wt. (lbs/ft³) or Unit mass (kg/m³) of sand</td>
<td>86.0</td>
</tr>
<tr>
<td>B.</td>
<td>Wt. (mass) sand + wt. (mass) of jar and cone, lb. (kg)</td>
<td>12.52</td>
</tr>
<tr>
<td>C.</td>
<td>Wt. (mass) sand left in jar + wt. (mass) of jar and cone, lb. (kg)</td>
<td>5.76</td>
</tr>
<tr>
<td>D.</td>
<td>Wt. (mass) of sand in cone and base plate, lb. (kg) (calibrated value)</td>
<td>2.64</td>
</tr>
<tr>
<td>E.</td>
<td>Wt. (mass) sand left in jar + wt. (mass) of jar and cone + wt. (mass) of sand in cone and base plate (C + D), lb. (kg)</td>
<td>8.40</td>
</tr>
<tr>
<td>F.</td>
<td>Wt. (mass) of sand in test hole (B - E), lb. (kg)</td>
<td>4.12</td>
</tr>
<tr>
<td>G.</td>
<td>Volume of test hole (F ÷ A), ft³ (m³)</td>
<td>0.0479</td>
</tr>
<tr>
<td>H.</td>
<td>Wt. (mass) of wet soil from test hole + (wt.) mass of pan, lb. (kg)</td>
<td>9.82</td>
</tr>
<tr>
<td>I.</td>
<td>Wt. (mass) of pan, lb. (kg)</td>
<td>2.60</td>
</tr>
<tr>
<td>J.</td>
<td>Wt. (mass) of wet soil from test hole (H - I), lb. (kg)</td>
<td>7.22</td>
</tr>
<tr>
<td>K.</td>
<td>Unit wt. (lbs/ft³) or Unit mass (kg/m³) of dry soil in fill = ( \frac{K}{1 + \frac{[\text{Moisture Content (T)}]}{100}} )</td>
<td>150.7</td>
</tr>
</tbody>
</table>

**MOISTURE DETERMINATION**

<table>
<thead>
<tr>
<th>Step</th>
<th>Description</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>a.</td>
<td>Dish and damp soil, lb. (kg)</td>
<td></td>
</tr>
<tr>
<td>b.</td>
<td>Dish and dried soil, lb. (kg)</td>
<td></td>
</tr>
<tr>
<td>c.</td>
<td>Wt. (mass) moisture (a - b), lb. (kg)</td>
<td></td>
</tr>
<tr>
<td>d.</td>
<td>Wt. (mass) dish, lb. (kg)</td>
<td></td>
</tr>
<tr>
<td>e.</td>
<td>Wt. (mass) dry soil (b - d), lb. (kg)</td>
<td></td>
</tr>
<tr>
<td>T.</td>
<td>Moisture Content ( \frac{c + e}{100} ) or from “Speedy” Moisture Test</td>
<td></td>
</tr>
</tbody>
</table>

**Remarks:**

By:

Title:

cc: District Materials Engineer

Project File
CALCULATION #1
Amount of +4 Material in Total Soil

Weight of Dry Soil + Dish ________ lb.  Weight of +4 Material + Dish ________ lb.

- Weight of Dish ________ lb.  - Weight of Dish ________ lb.

Total Weight of Dried Soil ________ lb.  Weight of +4 Material ________ lb.

Weight of +4 Material ________ lb.

--------------------------------- x 100 = ________ % Enter on Line O

Total Weight of Dried Material ________ lb.

CALCULATION #2
Total Density of Soils with +4 Material

Needed Information:

\[ P_c = \text{Percent +4 Material expressed as a decimal} = \quad \text{(from Sieve Analysis)} \]
\[ D_c = \quad \text{(Sp. Gr. of +4 Material from Materials Div.)} \times 62.4 \text{ lb/ft}^3 = \quad \text{lb/ft}^3 \]
\[ P_f = \text{Percent -4 Material expressed as a decimal} = \quad \text{(determined from Sieve Analysis)} \]
\[ D_f = \text{Maximum Dry Density -4 Material} = \quad \text{lb/ft}^3 \quad \text{(from Proctor)} \]

\[ \frac{D_f \times D_c}{(P_c \times D_f) + (P_f \times D_c)} \]

\[ \quad \text{lb/ft}^3 \times \quad \text{lb/ft}^3 \]

\[ \frac{(\quad \times \quad \text{lb/ft}^3) + (\quad \times \quad \text{lb/ft}^3)}{\quad + \quad} \]

\[ \quad = \quad \text{lb/ft}^3 \quad \text{Maximum Dry Density} \]

\text{of Total Soil Enter on Line P}

CALCULATION #3
Optimum Moisture Content of Dense Graded Aggregate

Needed Information:

\[ P_c = \% +4 \text{ Material expressed as a decimal} = \quad \text{(from Sieve Analysis)} \]
\[ W_c = \text{Absorption of +4 Matl. plus 1 expressed as a decimal} = \quad \text{(from Matl’s.Div.)} \]
\[ P_f = \% -4 \text{ Material expressed as a decimal} = \quad \text{(determined from Sieve Analysis)} \]
\[ W_f = \text{Optimum Moisture of -4 Material expressed as a decimal} = \quad \text{(from Proctor)} \]

\[ \frac{(P_c W_c + P_f W_f) \times 100}{\left[ \left( \frac{(\quad \times \quad)}{\quad + \quad\text{lb/ft}^3} \right) \right] 100} \]

\[ (\quad + \quad) \times 100 \]

\[ \quad \text{lb/ft}^3 \quad \text{Optimum Moisture Content of Dense Graded Aggregate} \]

Enter on Line Q
Density Testing with the Sand Cone on Aggregate

1) Complete the following dense graded aggregate (21A) density test (Form TL-125) using the calculation sheet and the information provided below.

WEIGHT OF WET AGGREGATE + DISH = 8.72 lb.
WEIGHT OF DRIED AGGREGATE + DISH = 8.44 lb.
WEIGHT OF DISH = 1.63 lb.

WEIGHT OF +4 MATERIAL + DISH = 4.95 lb.

AGGREGATE DATA:
MAXIMUM DRY DENSITY OF -4 MATERIAL = 127.0 lb/ft³
OPTIMUM MOISTURE OF -4 MATERIAL = 8.2%

SPECIFIC GRAVITY OF +4 MATERIAL = 2.65
ABSORPTION OF +4 MATERIAL = 0.3%

2) Indicate in the remarks if the test passes or fails and why.
**VIRGINIA DEPARTMENT OF TRANSPORTATION**

**REPORT OF SAND CONE DENSITY (UNIT MASS OF SOIL)**

**English □ Metric □**

**Report No.:** [Redacted]  
**Date:** [Redacted]  
**Route No.:** 265  
**County:** Pittsylvania  
**Project No.:** 6265-071-102.C502  
**FHWA No.:** F-045-1(113)

<table>
<thead>
<tr>
<th>Field Test No.</th>
<th>3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Location of Test</td>
<td>Station ft. (m.)</td>
</tr>
<tr>
<td>Ref. To Center Line ft. (m.)</td>
<td>105 + 00</td>
</tr>
<tr>
<td>Reference</td>
<td>Original Ground ft. (m.)</td>
</tr>
<tr>
<td>Elevation</td>
<td>Finished Grade ft. (m.)</td>
</tr>
<tr>
<td>Compact. Depth of Lift in. (mm.)</td>
<td>6&quot;</td>
</tr>
<tr>
<td>Method of Compaction (Type of Roller)</td>
<td>Vib. Roller</td>
</tr>
</tbody>
</table>

**DENSITY DETERMINATION**

A. Unit wt. (lbs/ft³) or Unit mass (kg/m³) of sand (calibrated value) 87.0

B. Wt. (mass) sand + wt. (mass) of jar and cone, lb. (kg) 14.92

C. Wt. (mass) sand left in jar + wt. (mass) of jar and cone, lb. (kg) 8.10

D. Wt. (mass) of sand in cone and base plate, lb. (kg) (calibrated value) 2.72

E. Wt. (mass) sand left in jar + wt. (mass) of jar and cone + wt. (mass) of sand in cone and base plate (C + D), lb. (kg) 10.82

F. Wt. (mass) of sand in test hole (B - E), lb. (kg) 4.10

G. Volume of test hole \((F ÷ A)\), ft³ (m³) 0.0471

H. Wt. (mass) of wet soil from test hole + (wt.) mass of pan, lb. (kg) 8.72

I. Wt. (mass) of pan, lb. (kg) 1.63

J. Wt. (mass) of wet soil from test hole (H - I), lb. (kg) 7.09

K. Unit wt. (lbs/ft³) or Unit mass (kg/m³) of wet soil in fill \((J ÷ G)\) 150.5

L. Unit wt. (lbs/ft³) or Unit mass (kg/m³) of dry soil in fill = \(K \cdot \left\{ 1 + \left\{ \text{Moisture Content (T) ÷ 100} \right\} \right\} \)

M. Max. Dry Unit Wt. (lbs/ft³) or Unit mass (kg/m³) from LAB PROCTOR OR ONE POINT PROCTOR (TL-125a) 127.0

N. Optimum Moisture Content from LAB PROCTOR OR ONE POINT PROCTOR (TL-125a) 8.2

O. Percent of +No. 4 (plus 4.75 mm) Material

P. Corrected Maximum Dry Unit wt. (lbs/ft³) or Unit mass (kg/m³)

Q. Corrected Optimum Moisture (%)

R. % Compaction \((L ÷ M) \times 100\) or \((L ÷ P) \times 100\)

S. % Minimum density (unit mass) required (from specifications)

**MOISTURE DETERMINATION** (For Field Dried Method)

a. Dish and damp soil, lb. (kg)

b. Dish and dried soil, lb. (kg)

c. Wt. (mass) moisture (a - b), lb. (kg)

d. Wt. (mass) dish, lb. (kg)

e. Wt. (mass) dry soil (b - d), lb. (kg)

T. Moisture Content \((c ÷ e) \times 100\) or from “Speedy” Moisture Test

Remarks: ____________________________  
By: ____________________________  
Title: ____________________________  
cc: District Materials Engineer  
Project File
CALCULATION #1
Amount of +4 Material in Total Soil

Weight of Dry Soil + Dish  __________ lb.  Weight of +4 Material + Dish  __________ lb.
- Weight of Dish  __________ lb.  - Weight of Dish  __________ lb.
Total Weight of Dried Soil  __________ lb.  Weight of +4 Material  __________ lb.

Weight of +4 Material  __________ lb.
--------------------------------------------- x 100 =  __________ % Enter on Line O
Total Weight of Dried Material  __________ lb.

CALCULATION #2
Total Density of Soils with +4 Material

Needed Information:
P_c = Percent +4 Material expressed as a decimal = ________ (from Sieve Analysis)
D_c = ________ (Sp. Gr. of +4 Material from Materials Div.) x 62.4 lb/ft³ = ________ lb/ft³
P_f = Percent -4 Material expressed as a decimal = ________ (determined from Sieve Analysis)
D_f = Maximum Dry Density -4 Material = ________ lb/ft³ (from Proctor)

\[
D_f \times D_c \over (P_c \times D_f) + (P_f \times D_c) \times (\text{lb/ft}^3) \times (\text{lb/ft}^3)
\]

\[
(\text{lb/ft}^3) \text{ Maximum Dry Density of Total Soil Enter on Line P}
\]

CALCULATION #3
Optimum Moisture Content of Dense Graded Aggregates

Needed Information:
P_c = % +4 Material expressed as a decimal = __________ (from Sieve Analysis)
W_c = Absorption of +4 Matl. plus 1 expressed as a decimal = __________ (from Matl’s.Div.)
P_f = % -4 Material expressed as a decimal = __________ (determined from Sieve Analysis)
W_f = Optimum Moisture of -4 Material expressed as a decimal = __________ (from Proctor)

\[
(P_c W_c + P_f W_f) \over 100
\]

\[
[(\text{lb/ft}^3) + (\text{lb/ft}^3)] \times 100
\]

\[
(\text{lb/ft}^3) \times 100 = \text{lb/ft}^3 \text{ Optimum Moisture Enter on Line Q}
\]
CHAPTER 7
Practice Problem 9

Density Testing with the Sand Cone on Aggregate

1) Complete the dense graded aggregate (21A) density test (Form TL-125) using the calculation sheet and the information provided below.

WEIGHT OF WET AGGREGATE + DISH = 8.67 lb.
WEIGHT OF DRIED AGGREGATE + DISH = 8.42 lb
WEIGHT OF DISH = 1.63 lb.

WEIGHT OF +4 MATERIAL + DISH = 4.89 lb.

AGGREGATE DATA:
MAXIMUM DRY DENSITY OF -4 MATERIAL = 128.5 lb/ft³
OPTIMUM MOISTURE OF -4 MATERIAL = 9.0%

SPECIFIC GRAVITY OF +4 MATERIAL = 2.62
ABSORPTION OF +4 MATERIAL = 0.3%

2) Indicate in the remarks if the test passes or fails and why.
**VIRGINIA DEPARTMENT OF TRANSPORTATION**

**REPORT OF SAND CONE DENSITY (UNIT MASS OF SOIL)**

<table>
<thead>
<tr>
<th>Field Test No.</th>
<th>3</th>
</tr>
</thead>
</table>

**Location of Test**  
Station ft. (m.): 105 + 00  
Ref. To Center Line ft. (m.): 3' Lt.

**Reference**  
Original Ground ft. (m.):  
Finished Grade ft. (m.): At TOE

**Compacted Depth of Lift in. (mm.)**  
6"

**Method of Compaction** (Type of Roller)  
Vib. Roller

### DENSITY DETERMINATION

A. **Unit wt.( lbs/ft³) or Unit mass (kg/m³) of sand** (calibrated value)  
   86.1

B. **Wt. (mass) sand + wt. (mass) of jar and cone, lb. (kg)**  
   14.81

C. **Wt. (mass) sand left in jar + wt. (mass) of jar and cone, lb. (kg)**  
   7.94

D. **Wt. (mass) of sand in cone and base plate , lb. (kg) (calibrated value)**  
   2.71

E. **Wt. (mass) sand left in jar + wt. (mass) of jar and cone + wt. (mass) of sand in cone and base plate (C + D), lb.(kg)**  
   10.65

F. **Wt. (mass) of sand in test hole (B - E), lb. (kg)**  
   4.16

G. **Volume of test hole (F ÷ A), ft³ (m³)**  
   0.0483

H. **Wt. (mass) of wet soil from test hole + (wt.) mass of pan, lb. (kg)**  
   8.67

I. **Wt. (mass) of pan, lb. (kg)**  
   1.63

J. **Wt. (mass) of wet soil from test hole (H - I), lb. (kg)**  
   7.04

K. **Unit wt.( lbs/ft³) or Unit mass (kg/m³) of wet soil in fill (J ÷ G)**  
   145.8

L. **Unit wt.( lbs/ft³) or Unit mass (kg/m³) of dry soil in fill = (K ÷ [ 1 + [ Moisture Content (T) ÷ 100 ] ] )**

M. **Max. Dry Unit Wt.( lbs/ft³) or Unit mass (kg/m³) from LAB PROCTOR OR ONE POINT PROCTOR (TL-125a)**  
   128.5

N. **Optimum Moisture Content from LAB PROCTOR OR ONE POINT PROCTOR (TL-125a)**  
   9.0

O. **Percent of +No. 4 (plus 4.75 mm) Material**

P. **Corrected Maximum Dry Unit wt. ( lbs/ft³) or Unit mass (kg/m³)**

Q. **Corrected Optimum Moisture (%)**

R. **% Compaction (L ÷ M) × 100 or (L ÷ P) × 100**

S. **% Minimum density (unit mass) required (from specifications)**

### MOISTURE DETERMINATION (For Field Dried Method)

a. **Dish and damp soil, lb. (kg)**

b. **Dish and dried soil, lb. (kg)**

c. **Wt. (mass) moisture (a - b), lb. (kg)**

d. **Wt. (mass) dish, lb. (kg)**

e. **Wt. (mass) dry soil (b - d), lb. (kg)**

T. **Moisture Content (c + e) ÷ 100 or from “Speedy” Moisture Test**

Remarks:  
By:  
Title:  
cc: District Materials Engineer  
Project File
CALCULATION #1
Amount of +4 Material in Total Soil

Weight of Dry Soil + Dish ________ lb.  Weight of +4 Material + Dish ________ lb.

- Weight of Dish ________ lb.  - Weight of Dish ________ lb.

Total Weight of Dried Soil ________ lb.  Weight of +4 Material ________ lb.

Weight of +4 Material ____ lb.

-------------------------------------------------------------

x 100 = ________ % Enter on Line O

Total Weight of Dried Material ________ lb.

CALCULATION #2
Total Density of Soils with +4 Material

Needed Information:

P_c = Percent +4 Material expressed as a decimal = ________ (from Sieve Analysis)

D_c = ________ (Sp. Gr. of +4 Material from Materials Div.) x 62.4 lb/ft^3 = ________ lb/ft^3

P_f = Percent -4 Material expressed as a decimal = ________ (determined from Sieve Analysis)

D_f = Maximum Dry Density -4 Material = ________ lb/ft^3 (from Proctor)

\[
\frac{D_f \times D_c}{(P_c \times D_f) + (P_f \times D_c)} = \frac{_______ \text{lb/ft}^3 \times _______ \text{lb/ft}^3}{(_______ \times _______ \text{lb/ft}^3) + (_______ \times _______ \text{lb/ft}^3)}
\]

\[
\text{Maximum Dry Density of Total Soil} = ________ \text{lb/ft}^3
\]

Enter on Line P

CALCULATION #3
Optimum Moisture Content of Dense Graded Aggregates

Needed Information:

P_c = % +4 Material expressed as a decimal = ________ (from Sieve Analysis)

W_c = Absorption of +4 Matl. plus 1 expressed as a decimal = ________ (from Matl’s.Div.)

P_f = % -4 Material expressed as a decimal = ________ (determined from Sieve Analysis)

W_f = Optimum Moisture of -4 Material expressed as a decimal = ________ (from Proctor)

\[
(P_cW_c + P_fW_f) \times 100
\]

\[
[(_______ \times ______) + (_______ \times ______)] \times 100
\]

\[
(_______ + _______) \times 100
\]

\[
(_______) 100 = ________ % \text{ Enter on Line Q}
\]
1) Complete the direct transmission test on aggregate (Form TL-124) using the calculation sheet and the information provided below.

WEIGHT OF DRY AGGREGATE AND DISH = 5.41 lb.
WEIGHT OF DISH = 1.61 lb.
WEIGHT OF +4 MATERIAL AND DISH = 3.01 lb.

AGGREGATE DATA FROM PLANT
MAXIMUM DRY DENSITY OF -4 MATERIAL = 124.4 lbs/ft³
OPTIMUM MOISTURE OF -4 MATERIAL = 7.4%
SPECIFIC GRAVITY OF +4 MATERIAL = 2.73
ABSORPTION OF +4 MATERIAL = 0.3%

3440 Display Screen

% 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.
### Report of Nuclear Embankment Densities (Unit Masses)

**English**

- **Report No.:** 1-21A-3
- **Date:**
- **Sheet No.:** 1 of 1

**Metric**

- **Route No.:** 95
- **County:** Fairfax
- **Project No.:** 0095-029-F14,C502
- **F.H.W.A. No.:** NH(95)-1
- **Test For:** Direct Transmission of 21A in Control Strip
- **Nuclear Gauge Model No.:** 3440
- **Serial No.:** 23456

### Standard Count

<table>
<thead>
<tr>
<th>Test No.</th>
<th>Location</th>
<th>Station ft. (m)</th>
<th>Ref. to center line ft. (m)</th>
<th>Test Depth of Lift in. (mm)</th>
<th>Compacted Depth of Lift in. (mm)</th>
<th>Method of Compaction</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>24+35</td>
<td>5' Rt.</td>
<td>24+35</td>
<td>6&quot;</td>
<td>Vib.Roller</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>DENSITY</th>
<th>MOISTURE</th>
</tr>
</thead>
<tbody>
<tr>
<td>2847</td>
<td>695</td>
</tr>
</tbody>
</table>

- **Test No.:**
- **Location:**
  - Station ft. (m): 24+35
  - Ref. to center line ft. (m): 5' Rt.
  - Test Depth of Lift in. (mm): 6"
  - Compacted Depth of Lift in. (mm): 6"
- **Method of Compaction:** Vib.Roller

### Density

<table>
<thead>
<tr>
<th>D. Moisture Content (B - C) x 100</th>
</tr>
</thead>
<tbody>
<tr>
<td>E. Maximum Dry Density (lbs/ft³), Dry Unit Mass (kg/m³)</td>
</tr>
<tr>
<td>Lab Proctor or One Point Proctor</td>
</tr>
<tr>
<td>F. Percent Optimum Moisture from Lab or One Point Proctor</td>
</tr>
<tr>
<td>G. Percent of plus #4, (plus 4.75mm)</td>
</tr>
<tr>
<td>H. Corrected Maximum Dry Density (lbs/ft³) Dry Unit Mass (kg/m³)</td>
</tr>
<tr>
<td>I. Corrected Optimum Moisture</td>
</tr>
<tr>
<td>J. Percent Dry Density (lbs/ft³), Dry Unit Mass (kg/m³)</td>
</tr>
<tr>
<td>K. Percent Minimum Density Required</td>
</tr>
</tbody>
</table>

### Remarks:

- CC: District Materials Engineer
- By: ______________
- Project File

Title: ______________

---

**Notes:**

- English        Metric
- Report No.:         1-21A-3                           Date:                                Sheet No.:      1        of 1
- Route No.:                   95                                                                      County:            Fairfax
- Project No.:              0095-029-F14,C502
- F.H.W.A. No.:: NH(95)-1
- Test For: Direct Transmission of 21A in Control Strip
- Nuclear Gauge Model No.: 3440 Serial No.: 23456
CALCULATION #1
Amount of +4 Material in Total Soil

Weight of Dry Soil + Dish _________ lb.  Weight of +4 Material + Dish _________ lb.

- Weight of Dish _________ lb.  - Weight of Dish _________ lb.

Total Weight of Dried Soil _________ lb.  Weight of +4 Material _________ lb.

\[\frac{\text{Weight of +4 Material}}{\text{Total Weight of Dried Material}} \times 100 = \text{_____ \% Enter on Line G}\]

CALCULATION #2
Total Density of Soils with +4 Material

Needed Information:

\[P_c = \text{Percent +4 Material expressed as a decimal = ________ (from Sieve Analysis)}\]

\[D_c = \text{(Sp. Gr. of +4 Material from Materials Div.)} \times 62.4 \text{ lb/ft}^3 = \text{_______ lb/ft}^3\]

\[P_f = \text{Percent -4 Material expressed as a decimal = ________ (determined from Sieve Analysis)}\]

\[D_f = \text{Maximum Dry Density -4 Material = ________ lb/ft}^3 \text{ (from Proctor)}\]

\[\frac{D_f \times D_c}{(P_c \times D_f) + (P_f \times D_c)}\]

\[\frac{\text{_______ lb/ft}^3 \times \text{_______ lb/ft}^3}{(\text{_______ x _________ lb/ft}^3) + (\text{_______ x _________ lb/ft}^3)}\]

\[\frac{\text{_______}}{\text{_______ + _________}} = \text{_______ lb/ft}^3 \text{ Maximum Dry Density}\]

Enter on Line H

CALCULATION #3
Optimum Moisture Content of Dense Graded Aggregates

Needed Information:

\[P_c = \% +4 Material expressed as a decimal = \_________ (from Sieve Analysis)\]

\[W_c = \text{Absorption of +4 Matl. plus 1 expressed as a decimal = \_________ (from Matl's.Div.)}\]

\[P_f = \% -4 Material expressed as a decimal = \_________ (determined from Sieve Analysis)\]

\[W_f = \text{Optimum Moisture of -4 Material expressed as a decimal = \_________ (from Proctor)}\]

\[\frac{(P_cW_c + P_fW_f) \times 100}{[(\text{_______ x _________}) + (\text{_______ x _________})] \times 100}\]

\[\frac{(\text{_______ + _________}) \times 100}{(\text{_______}) 100 = \text{_______\% Enter on Line I}}\]
CHAPTER 7
Practice Problem 11
Direct Transmission on Aggregate

1) Complete the direct transmission on aggregate (Form TL-124) using the calculation sheet and the information provided below.

WEIGHT OF DRY AGGREGATE AND DISH = 8.43 lb.
WEIGHT OF DISH = 1.61 lb.
WEIGHT OF +4 MATERIAL AND DISH = 5.71 lb.

AGGREGATE DATA FROM PLANT
MAXIMUM DRY DENSITY OF -4 MATERIAL = 134.6 lbs/ft$^3$
OPTIMUM MOISTURE OF -4 MATERIAL = 8.4%
SPECIFIC GRAVITY OF +4 MATERIAL = 2.81
ABSORPTION OF +4 MATERIAL = 0.3%

3440 Display Screen

<table>
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<th>% M</th>
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<td>3.4</td>
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2) Indicate in the remarks if the test passes or fails and why.
**VIRGINIA DEPARTMENT OF TRANSPORTATION**  
**MATERIALS DIVISION**  
**REPORT OF NUCLEAR EMBANKMENT DENSITIES (UNIT MASSES)**

### English
- **Report No.:** 1-21A-3  
- **Date:**  
- **Sheet No.:** 1 of 1

### Metric
- **Route No.:** 7  
- **County:** Loudoun  
- **FHWA No.:** None

### Test For: Direct Transmission of 21A in Control Strip

### Nuclear Gauge Model No.: 3440  
### Serial No.: 23456

#### STANDARD COUNT

<table>
<thead>
<tr>
<th>DENSITY</th>
<th>MOISTURE</th>
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<tr>
<td>2864</td>
<td>709</td>
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<table>
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<tbody>
<tr>
<td>Location</td>
<td>Station ft. (m)</td>
</tr>
<tr>
<td></td>
<td>of Ref. to center line ft. (m)</td>
</tr>
<tr>
<td>Test Elevation</td>
<td></td>
</tr>
<tr>
<td>Compacted Depth of Lift in. (mm)</td>
<td>6”</td>
</tr>
<tr>
<td>Method of Compaction</td>
<td>Vib.Roller</td>
</tr>
</tbody>
</table>

- **A.** Wet Density (lbs/ft³), Wet Unit Mass (kg/m³) =  
- **B.** Moisture Unit Mass (lbs/ft³), Moisture Unit Mass (kg/m³) =  
- **C.** Dry Density (lbs/ft³), Dry Unit Mass (kg/m³) (A - B) =  
- **D.** Moisture Content (B ÷ C) x 100 =  
- **E.** Maximum Dry Density (lbs/ft³), Dry Unit Mass (kg/m³) Lab Proctor or One Point Proctor =  
- **F.** Percent Optimum Moisture from Lab or One Point Proctor =  
- **G.** Percent of plus #4, (plus 4.75mm) =  
- **H.** Corrected Maximum Dry Density (lbs/ft³) Dry Unit Mass (kg/m³) =  
- **I.** Corrected Optimum Moisture =  
- **J.** Percent Dry Density (lbs/ft³), Dry Unit Mass (kg/m³) (C ÷ E) x 100 or (C ÷ H) x 100 =  
- **K.** Percent Minimum Density Required =

### Remarks:

---

CC: District Materials Engineer  
By:  
Project File  
Title:

---

2012 v1.0
CALCULATION #1
Amount of +4 Material in Total Soil

Weight of Dry Soil + Dish ________ lb.  Weight of +4 Material + Dish ________ lb.

- Weight of Dish ________ lb.  - Weight of Dish ________ lb.

Total Weight of Dried Soil ________ lb.  Weight of +4 Material ________ lb.

\[
\frac{\text{Weight of +4 Material} \times 100}{\text{Total Weight of Dried Material}} = \% \text{ Enter on Line G}
\]

CALCULATION #2
Total Density of Soils with +4 Material

Needed Information:

\[ P_c = \text{Percent +4 Material expressed as a decimal} = \text{ (from Sieve Analysis)} \]
\[ D_c = \text{(Sp. Gr. of +4 Material from Materials Div.)} \times 62.4 \text{ lb/ft}^3 = \text{ lb/ft}^3 \]
\[ P_f = \text{Percent -4 Material expressed as a decimal} = \text{ (determined from Sieve Analysis)} \]
\[ D_f = \text{Maximum Dry Density -4 Material} = \text{ lb/ft}^3 \text{ (from Proctor)} \]

\[
\frac{D_f \times D_c}{(P_c \times D_f) + (P_f \times D_c)} \]

\[
\frac{\text{_______ lb/ft}^3 \times \text{_______ lb/ft}^3}{(_______ \times \text{_______ lb/ft}^3) + (_______ \times \text{_______ lb/ft}^3)}
\]

\[
\text{_______ + _______ _______ } = \frac{\text{_______ lb/ft}^3}{\text{Maximum Dry Density of Total Soil}} \text{ Enter on Line H}
\]

CALCULATION #3
Optimum Moisture Content of Dense Graded Aggregates

Needed Information:

\[ P_c = \% +4 Material expressed as a decimal = \text{ (from Sieve Analysis)} \]
\[ W_c = \text{Absorption of +4 Matl. plus 1 expressed as a decimal} = \text{ (from Matl’s.Div.)} \]
\[ P_f = \% -4 Material expressed as a decimal = \text{ (determined from Sieve Analysis)} \]
\[ W_f = \text{Optimum Moisture of -4 Material expressed as a decimal} = \text{ (from Proctor)} \]

\[
(P_cW_c + P_fW_f) \times 100
\]

\[
[(\text{_______ } \times \text{_______}) + (\text{_______ } \times \text{_______})] \times 100
\]

\[
(\text{_______ } + \text{_______}) \times 100
\]

\[
\text{_______} \times 100 = \% \text{ Enter on Line I}
\]
CHAPTER 7
Practice Problem 12
Direct Transmission on Aggregate

1) Complete the following direct transmission on aggregate (Form TL-124) using the calculation sheet and the information provided below.

- WEIGHT OF DRY aggregates AND DISH = 8.40 lb.
- WEIGHT OF DISH = 1.63 lb.
- WEIGHT OF +4 MATERIAL AND DISH = 4.75 lb.

**AGGREGATE DATA FROM PLANT**
- MAXIMUM DRY DENSITY OF -4 MATERIAL = 132.1 lbs/ft$^3$
- OPTIMUM MOISTURE OF -4 MATERIAL = 7.2%
- SPECIFIC GRAVITY OF +4 MATERIAL = 2.80
- ABSORPTION OF +4 MATERIAL = 0.6%

*3440 Display Screen*

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<td>144.1</td>
<td>150.2</td>
<td>6.1</td>
<td>4.2</td>
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</table>

2) Indicate in the remarks if the test passes or fails and why.
# Report of Nuclear Embankment Densities (Unit Masses)

**Virginia Department of Transportation**  
Materials Division  

**Report No.**: 1-21A-3  
**Date**:  
**Sheet No.**: 1 of 1  

**Route No.**: 265  
**County**: Pittsylvania  

**Project No.**: 6265-071-102, G302  
**F.H.W.A. No.**: F-045-1(113)  

**Test For**: Direct Transmission of 21A in Control Strip  
**Nuclear Gauge Model No.**: 3440  
**Serial No.**: 23456

<table>
<thead>
<tr>
<th>Test No.</th>
<th>Location</th>
<th>Station ft. (m)</th>
<th>Ref. to center line ft. (m)</th>
<th>Test Elevation</th>
<th>Compacted Depth of Lift in. (mm)</th>
<th>Method of Compaction</th>
<th>A. Wet Density (lbs/ft³), Wet Unit Mass (kg/m³)</th>
<th>B. Moisture Unit Mass (lbs/ft³), Moisture Unit Mass (kg/m³)</th>
<th>C. Dry Density (lbs/ft³), Dry Unit Mass (kg/m³) (A - B)</th>
<th>D. Moisture Content (B ÷ C) x 100</th>
<th>E. Maximum Dry Density (lbs/ft³), Dry Unit Mass (kg/m³) Lab Proctor or One Point Proctor</th>
<th>F. Percent Optimum Moisture from Lab or One Point Proctor</th>
<th>G. Percent of plus #4, (plus 4.75mm)</th>
<th>H. Corrected Maximum Dry Density (lbs/ft³) Dry Unit Mass (kg/m³)</th>
<th>I. Corrected Optimum Moisture</th>
<th>J. Percent Dry Density (lbs/ft³), Dry Unit Mass (kg/m³) (C ÷ E) x 100 or (C ÷ H) x 100</th>
<th>K. Percent Minimum Density Required</th>
</tr>
</thead>
</table>

**Remarks:**

CC: District Materials Engineer  
By:  
Title:

---

*7-74 2012 v1.0*
CALCULATION #1
Amount of +4 Material in Total Soil

Weight of Dry Soil + Dish  __________ lb.  
- Weight of Dish  __________ lb.  
Total Weight of Dried Soil  __________ lb.

Weight of +4 Material  __________ lb.  
________________________________________ x 100 = __________ % Enter on Line G

Total Weight of Dried Material  __________ lb.

CALCULATION #2
Total Density of Soils with +4 Material

Needed Information:

Pc = Percent +4 Material expressed as a decimal = ________ (from Sieve Analysis)
Dc = (Sp. Gr. of +4 Material from Materials Div.) x 62.4 lb/ft³ = ________ lb/ft³
Pf = Percent -4 Material expressed as a decimal = ________ (determined from Sieve Analysis)
Df = Maximum Dry Density -4 Material = ________ lb/ft³ (from Proctor)

\[
\frac{D_f \times D_c}{(P_c \times D_f) + (P_f \times D_c)}
\]

\[
\frac{_______ lb/ft³ \times _______ lb/ft³}{(_______ \times _______ lb/ft³) + (_______ \times _______ lb/ft³)}
\]

\[
\frac{_______}{_______ + _______} = \frac{_______}{_______ + _______} \quad \text{lb/ft³} \quad \text{Maximum Dry Density of Total Soil}
\]

Enter on Line H

CALCULATION #3
Optimum Moisture Content of Dense Graded Aggregates

Needed Information:

Pc = % +4 Material expressed as a decimal = ________ (from Sieve Analysis)
Wc = Absorption of +4 Matl. plus 1 expressed as a decimal = ________ (from Matl’s.Div.)
Pf = % -4 Material expressed as a decimal = ________ (determined from Sieve Analysis)
Wf = Optimum Moisture of -4 Material expressed as a decimal = ________ (from Proctor)

\[
\frac{(P_c W_c + P_f W_f) 100}{[(_______ \times _______) + (_______ \times _______)] 100}
\]

\[
(_______ + _______) 100
\]

\[
(_______) 100 = \text{_______} \% \quad \text{Enter on Line I}
\]