APPENDIX I

ANSWERS TO STUDY QUESTIONS

CHAPTER 1

1. True or False. The voids in a saturated soil are partly filled with water and partly filled with air. False - They are completely filled with water.

2. VDOT uses AASHTO and Unified Soil Classification Systems to classify soils.

3. Consistency refers to texture and firmness of a soil.

4. Silt and clay are made up of particles that are smaller than the No. 200 sieve.

5. The gradation is the distribution of various particle sizes within the material.

6. Dense graded means that the particles in a mixture are sized so that they fill most of the voids; there is very little space in between soil or stone particles.

7. The moisture content at which a soil begins to behave like a liquid is called the liquid limit.

8. The behavior of a material where the material deforms under load and does not go back to its original shape is called plasticity.

9. The moisture content at which a soil can be compacted to its maximum dry density with the least amount of compactive effort is called the optimum moisture content.

10. True or False. A soil that contains a high percentage of fines is more affected by water than one with a low percentage of fines. True

11. True or False. Open graded aggregates are used in a pavement to give the structure more strength. False – Dense graded aggregates are used in a pavement to give the structure more strength.

ANSWERS TO STUDY QUESTIONS
CHAPTER 2

1. True or False. Clearing and Grubbing is required in fill sections less than 5 ft. in depth, in borrow areas before excavation can begin, and in all cut sections. True

2. In fill sections where stumps may be left in place, they must be no more than 6 inches high.

3. Grading to Drain means to crown surface of embankment, roll surface of embankment smooth, direct water to appropriate erosion and siltation controls.

4. The first lift of embankment material placed in swampy areas is called a work platform.

5. Layers of embankment material should be placed with uniform thickness and parallel to finished grade.

6. a. For a fill with a height of 8 feet, a length of 1500 feet, and a volume of 61,200 cubic yards, what is the minimum number of density tests required? 45 tests - 1 per 2,500 cubic yard increment = 25, 2 per 6" layer within top 5' of fill = 20.

   b. For a fill with a height of 8 feet, a length of 400 feet, and a volume of 61,200 cubic yards, what is the minimum number of density tests required? 33 tests - 1 per 2,500 cubic yard increment = 25, plus 1 for every other layer from bottom of fill to top of fill starting with the second lift = 8.

   c. For a fill with a height of 10 feet, a length of 2200 feet, and a volume of 80,000 cubic yards, what is the minimum number of density tests required? Volumetric requirement is 80,000 cuft./2500 = 32 test. Greater than 2,000 feet split into two equal parts. For first 1100 feet, 2 per 6" layer within top 5' of fill = 20; and for last 1100 feet, 2 per 6" layer within top 5' of fill = 20 Total = 32+20+20 = 72

7. Material is being placed 15 feet below proposed subgrade in a rock fill. The maximum nominal size of the rocks is 3 feet. The maximum lift thickness in this case is 3 feet.

8. True or False. In building an embankment on a hillside , benching provides a place to test. False – In building an embankment on a hillside, benching provides a foundation for the new embankment and a bond to the existing slope.

9. Is frozen embankment material acceptable to use in embankments? No

10. Is 108% compaction acceptable for embankment? No

11. True or False. For subgrade and embankment, the specifications require that each lift be compacted at optimum moisture content, with a tolerance of ±40%. False - ±20%

12. True or False. Embankment is a structure of soil, soil aggregate, soil-like materials, or broken rock between the existing ground and the subgrade. True

13. 6 feet is the minimum bench width for a slope of steeper than 4:1 and less steep than 1 ½ :1.

14. What is the density testing rate for fills less than 500 feet long?

    one test per 2,500 yd^3 plus one test every other 6" layer in the embankment from the bottom of the fill to the top starting with the second lift

15. What is the density testing rate for fills between 500 feet and 2000 feet?

    one test per 2,500 yd^3 plus two tests every 6" layer within the top 5 feet of fill

16. What is the maximum distance from the heel of an abutment/gravity or cantilever retaining wall that is to be tested by the specified rates for walls if the structure is 12 feet high?

    The height of the structure plus 10 feet (12+10 = 22)

17. Material having a moisture content more than 30% above optimum cannot be placed on a previously placed layer for drying, unless it is shown that it will not detrimentally affect the previously placed layer due to the downward migration of water.

18. The typical lift thickness for soil fill is 8 inches loose, 6 inches compacted.

19. The maximum diameter of the material placed in the top 12 inches of an embankment is 3 inches.

20. The maximum diameter of material that can be placed 9 feet under the embankment surface is 2 feet.

ANSWERS TO PRACTICE PROBLEMS
CHAPTER 2

Practice Problem 1

Using the given information determine the surface elevation at Sta.25+35.

Finished Grade Elevation at Sta.25+00 = 260.6 ft.
Reference Elevation = F 4.9
Height of Instrument = 5.2 ft.

Finished Grade Elevation - Reference Elevation = Target Elevation
260.6 ft. - 4.9 ft. = 255.7 ft.

Target Elevation - Height of Instrument (HI) = Surface Elevation
255.7 ft. - 5.2 ft. = 250.5 ft.

Practice Problem 2

Using the given information determine the surface elevation at Sta.36+25.

Finished Grade Elevation at Sta.36+00 = 321.4 ft.
Reference Elevation = F 5.1
Height of Instrument = 4.8 ft.

Finished Grade Elevation - Reference Elevation = Target Elevation
321.4 ft. - 5.1 ft. = 316.3 ft.

Target Elevation - Height of Instrument (HI) = Surface Elevation
316.3 ft. - 4.8 ft. = 311.5 ft.

CHAPTER 2
Practice Problem 3

The known elevation is greater than 50 feet away. Using the given information determine the Surface Elevation at Test 295, the thickness of the lift, and if it meets specifications.

Reading on Sta. 27+50 O/S Stake = F 15.8
Finished Grade at Sta.27+50 = 625.3 ft.
Previous Elevation at Test 295 = 600.9 ft.

Location	Surface Ele.	HI Reading	Target Height	Target Ele.
Test 295	601.3 ft.	5.1 ft.		
TBM1		4.0 ft.	2.7 ft.	606.4 ft.
TBM2		4.8 ft.	3.0 ft.	607.7 ft.
St. 27+50 O/S Stake				609.5 ft.

Target Elevation Sta. 27+50 = 625.3 ft. - 15.8 ft. = 609.5 ft.
Target Elevation TBM2 = 609.5 ft. - (4.8 ft. - 3.0 ft.) = 607.7 ft.
Target Elevation TBM1 = 607.7 ft. - (4.0 ft. - 2.7 ft.) = 606.4 ft.
Surface Elevation Test 295 = 606.4 ft. - 5.1 ft. = 601.3 ft.

Surface Elevation Test 295 - Previous Elevation Test 295 = Thickness of lift
601.3 ft. - 600.9 ft. = 0.4 ft.

0.4 feet x 12 = 4.8″

Lift thickness of 4.8″ meets specifications as it is 6 inches or less.

CHAPTER 2
Practice Problem 4

The known elevation is greater than 50 feet away. Using the given information determine the Surface Elevation at Test 212, the thickness of the lift, and if it meets specifications.

Reading on Sta. 32+00 O/S Stake = F 5.8
Finished Grade at Sta.32+00 = 595.5 ft.
Previous Elevation at Test 212 = 580.1 ft.

Location	Surface Ele.	HI Reading	Target Height	Target Ele.
Test 212	580.8 ft.	5.0 ft.		
TBM1		4.5 ft.	2.8 ft.	585.8 ft.
TBM2		5.2 ft.	3.0 ft.	587.5 ft.
St. 32+00 O/S Stake				589.7 ft.

Target Elevation Sta. 32+00 = 595.5 ft. - 5.8 ft. = 589.7 ft.
Target Elevation TBM2 = 589.7 ft. - (5.2 ft. - 3.0 ft.) = 587.5 ft.
Target Elevation TBM1 = 587.5 ft. - (4.5 ft. - 2.8 ft.) = 585.8 ft.
Surface Elevation Test 212 = 585.8 ft. - 5.0 ft. = 580.8 ft.

Surface Elevation Test 212 - Previous Elevation Test 212 = Thickness of lift
580.8 ft. - 580.1 ft. = 0.7 ft.

0.7 feet x 12 = 8.4″

Lift thickness of 8.4″ does not meet specifications as it is greater than 6 inches.

ANSWERS TO STUDY QUESTIONS
CHAPTER 3

1. Subgrade is the top surface of the embankment and the foundation for the pavement structure.

2. Subgrade must be scarified for a distance of 2 feet beyond the proposed edges of pavement to a depth of 6 inches and recompacted to the original requirements.

3. Seven days after placement of the Cement Stabilized Subgrade the next course of pavement or approved cover material must be applied.

4. True or False. Cement is used with soil or aggregate to make the soil or aggregate more workable. False. It is used to add strength to the mixture.

5. Lime is used with soil to add strength to the mixture, to raise the pH of the mixture, to assist in drying out soils, and to reduce plasticity.

6. The tolerance on the optimum moisture content at which aggregate must be compacted is ± 2 percentage points.

7. The tolerance on the optimum moisture content for cement treated subgrade is optimum to 20% above optimum.

8. The most common type of geosynthetic used is a geotextile.

9. True or False. Sewing of embankment stabilization fabric seams is not required. False. Sewing of the seams is required in all cases.

10. 5 Tests - 1 for each 2,000 feet of subgrade full width.

    Station 553+60
    - Station 453+60
    100+00 = 10,000 feet

11. Minimum number of tests required is 24, 100% density, Optimum Moisture to 20% above optimum moisture.

    Station 550+60
    - Station 392+20
    158+40 = 15,840 feet ÷ 5,280 feet in a mile = 3 miles

    48′ wide ÷ 12′ paver width = 4 pulls

    1 test per 1/2 mile per paver width 3 miles x 4 pulls = 12 x 2 = 24

ANSWERS TO PRACTICE PROBLEMS
CHAPTER 3

Practice Problem 1
Cement Application Rate

The plans call for 9.5% cement by weight, 6" depth. There are two 12' lanes. The base aggregate is to extend 1 foot beyond the edge of pavement on each side. The width to be treated is 1 foot beyond the edge of the base stone on each side. The Dry Density of the soil to be treated is 103.5 lb/ft^3.

The contractor plans to spread the cement for the entire width in four sections or pulls. The load of cement in question contains 20.28 tons.

How many feet of roadway should this load of cement treat?

Solution: 24.0 ft. (Two 12' lanes)
\+ 2.0 ft. (base aggr.)
2.0 ft. (beyond base)
28.0 ft. width of treatment

28.0 ft. width of treatment ÷ 4 sections (1/4 width) = 7' pulls

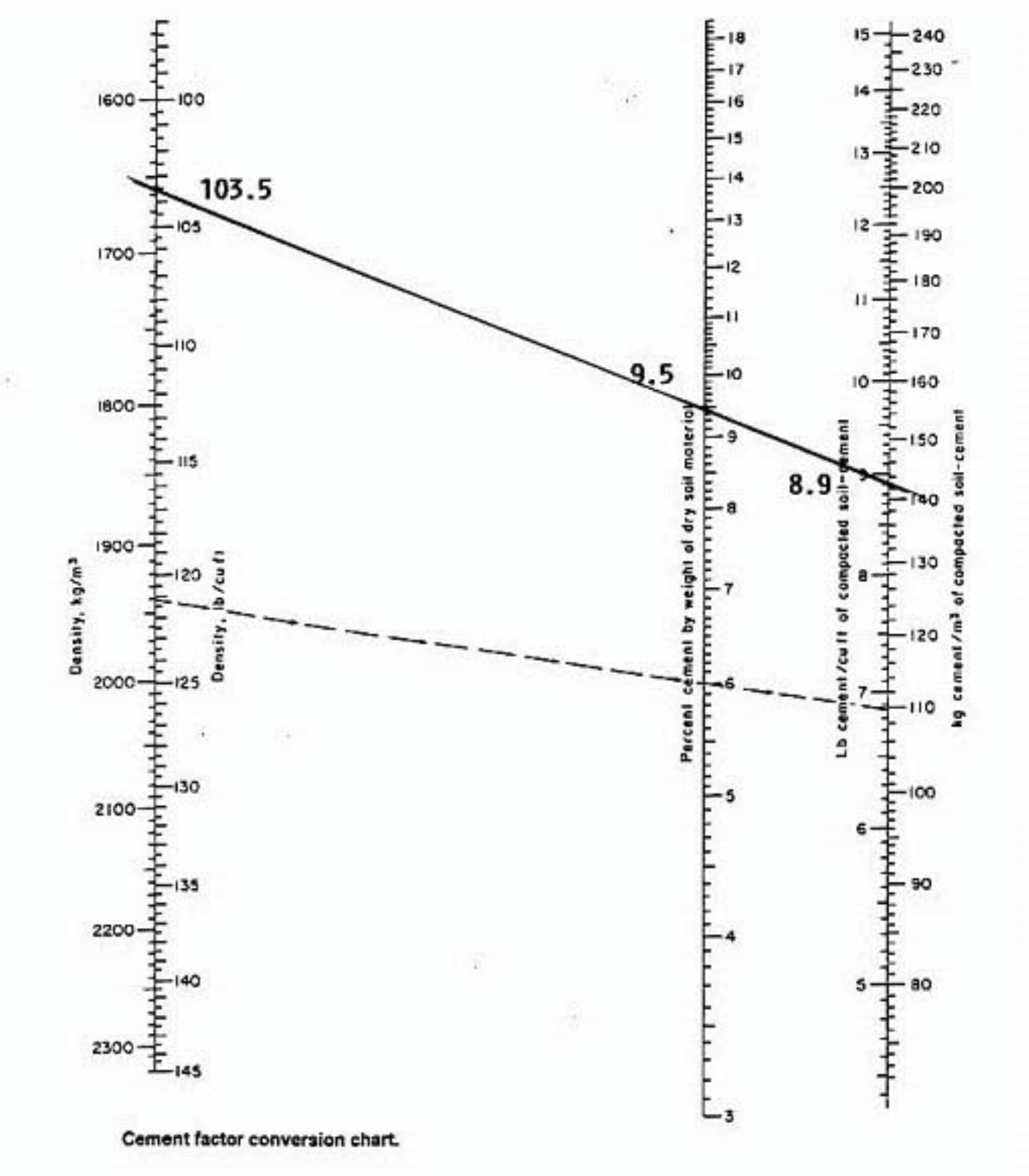
Use the nomograph with 103.5 lb/ft^3 and 9.5 % cement. This yields 8.9 lbs. of cement per cubic foot of compacted soil-cement. Then go to the nomograph with 8.9 lbs. of cement per cubic foot of compacted soil-cement, to 6"depth, and 7' pull width. This yields 32 lbs. of cement per foot per pull.

20.28 tons x 2000 lbs. = 40,560 lbs. on this load

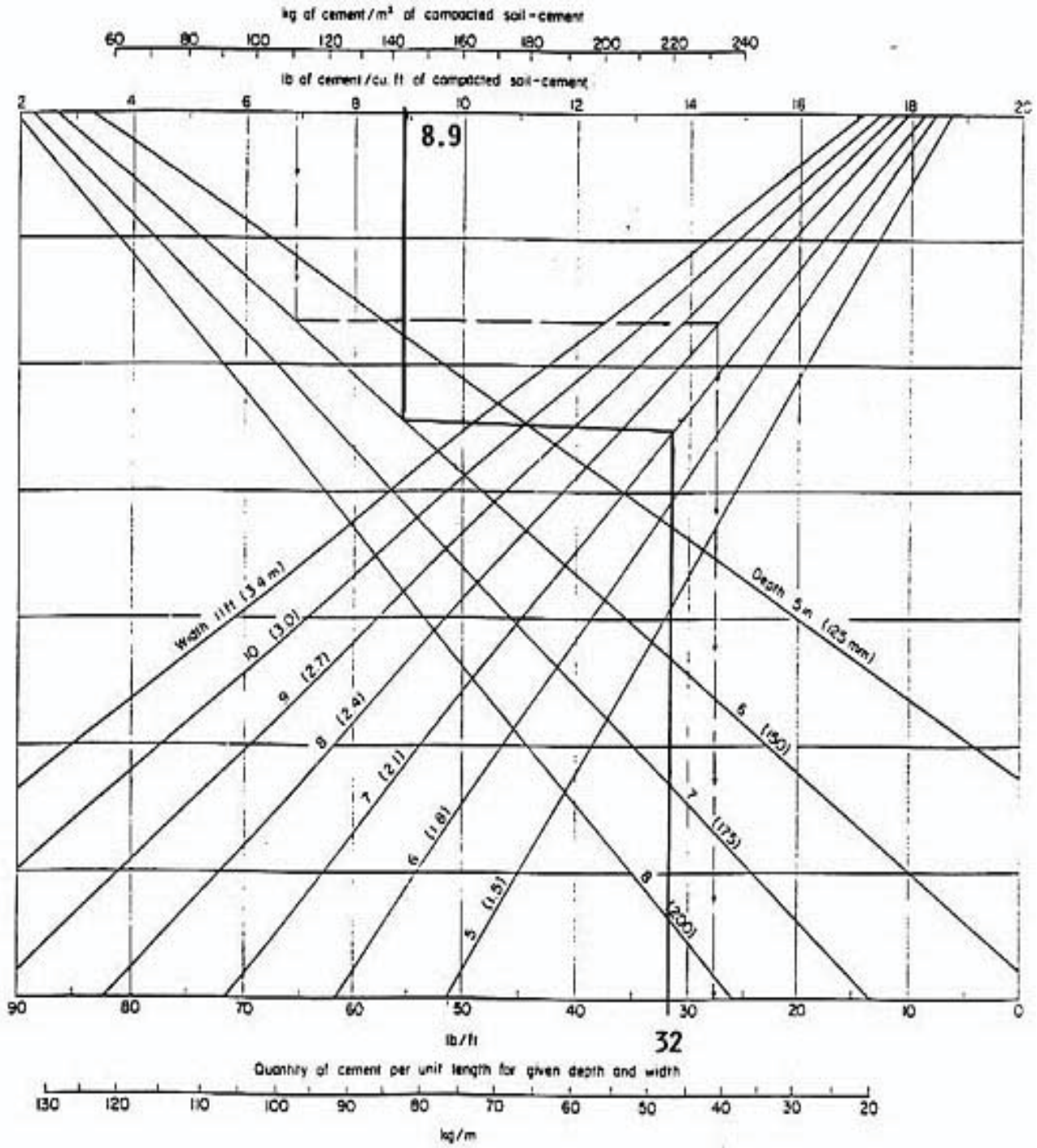
Since the contractor will make four pulls this figure needs to be quartered to 10,140 lbs. per pull.

10,140 lb./pull ÷ 32 lb/ft. = 316.9 ft. per pull

Answer: Making four pulls from a 20.28 ton load of cement should cover 316.9 feet by 28 feet in width with the contractor applying cement at the specified application rate of 9.5% cement by weight for 6" depth of treatment.



Cement factor conversion chart.



Quantity of cement per unit length for given depth and width of treatment for specified cement contents.

CHAPTER 3
Practice Problem 2
Cement Application Rate

The plans call for 6.5% cement by weight, 7" depth. There are two 10-foot lanes. The base aggregate is to extend 1 foot beyond the edge of pavement on each side. The width to be treated is 1 foot beyond the edge of the base stone on each side. The Dry Density of the soil to be treated is 115.5 lb/ft^3.

The contractor plans to spread the cement for the entire width in three sections or pulls. The load of cement in question contains 22.2 tons.

How many feet of roadway should this load of cement treat?

Solution:
20.0 ft. (Two 10' lanes)
\+ 2.0 ft. (base aggr.)
2.0 ft. (beyond base)
24.0 ft. width of treatment

24.0 ft. width of treatment ÷ 3 sections = 8 ft. pulls

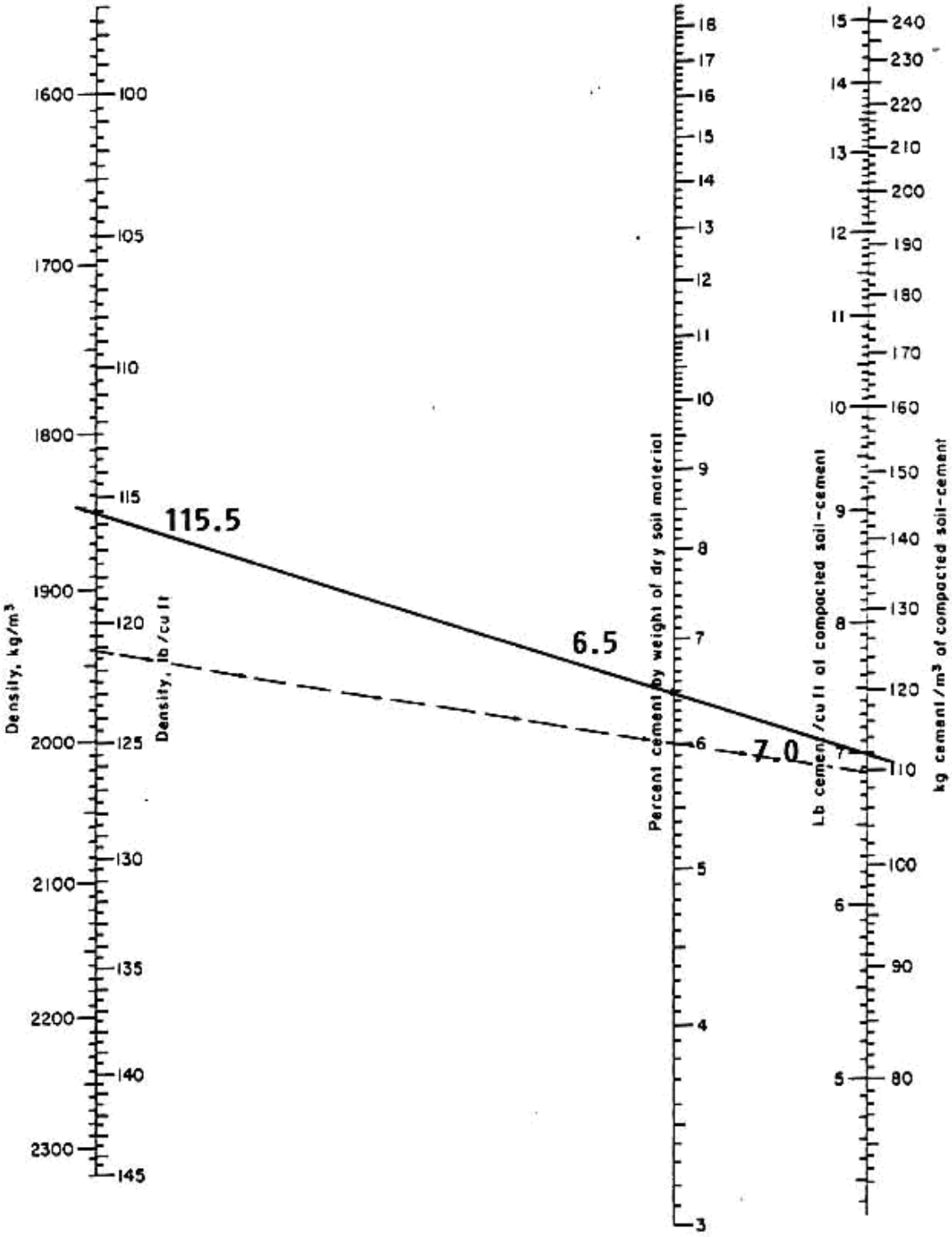
Use the nomograph with 115.5 lb/ft^3 and 6.5% cement. This yields 7 lbs. of cement per cubic foot of compacted soil-cement. Then go to the nomograph with 7 lbs. of cement per cubic foot of compacted soil-cement, to 7" depth, and 8 foot pull width. This yields 33.5 lbs. of cement per foot per pull.

22.2 tons x 2000 lbs. = 44400 lbs. on this load

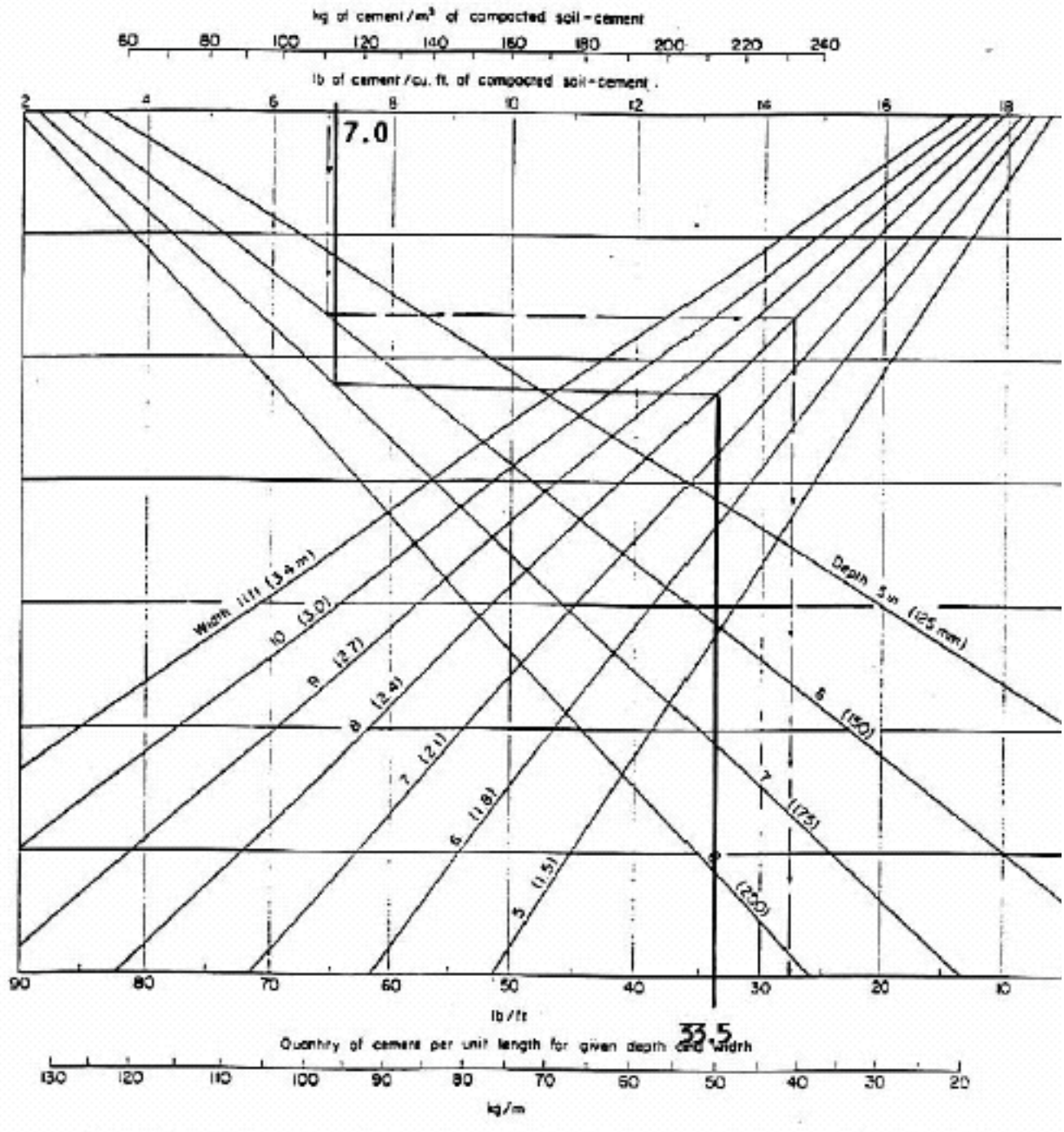
Since the contractor will make three pulls this figure needs to be divided into thirds to 14800 lbs. per pull.

14800 lb./pull ÷ 33.5 lb/ft = 441.8 ft. per pull

Answer: Making three pulls from a 22.2 ton load of cement should cover 441.8 ft. by 24 ft. in width with the contractor applying cement at the specified application rate of 6.5% cement by weight for 7" depth of treatment.



Cement factor conversion chart.


kg of cement/m³ of compacted soil-cement
80 100 120 140 160 180 200 220 240
lb of cement/cu. ft. of compacted soil-cement
2 4 6 8 10 12 14 16 18
7.0
Width 11ft (3.4m)
10 (3.0)
9 (2.7)
8 (2.4)
7 (2.1)
6 (1.8)
5 (1.5)
Depth 5in (125 mm)
8 (150)
7 (175)
6 (200)
90 80 70 60 50 40 30 20 10
lb/ft
33.5
Quantity of cement per unit length for given depth and width
130 120 110 100 90 80 70 60 50 40 30 20
kg/m

CHAPTER 3
Cement Application Rate

Practice Problem 3

The plans call for 12% cement **by volume**, 6" depth. Width of treatment is 26 feet. The net weight of the cement in the tanker is 23.09 tons. How many feet of roadway should this load of cement treat?

Solution: Application Rate = $[(W_T)\ (D_T)]\ \ [(D_C)\ (94)]$

$= [(26\ ft.)\ (0.5\ ft.)]\ \ [(0.12)\ (94\ lb/ft^3)]$

$= [13\ ft^2]\ \ [11.28\ lbs/ft^3]$

$= 146.64\ lbs/ft$

$$\text{Application Length} = \frac{\text{Net Weight of Cement}}{\text{Application Rate}}$$

$$= \frac{23.09\ \text{tons} \times 2000\ \text{lbs/ton}}{146.64\ \text{lbs/ft}}$$

$$= \frac{46180\ \text{lbs}}{146.63\ \text{lb/ft}}$$

$= \mathbf{315\ Feet}$

Practice Problem 4

The plans call for 6.5% cement **by volume**, 6" depth. Width of treatment is 24 feet. The net weight of the cement in the tanker is 22 tons. How many feet of roadway should this load of cement treat?

Solution: Application Rate = $[(W_T)\ (D_T)]\ \ [(D_C)\ (94)]$

$= [(24\ ft.)\ (0.5\ ft.)]\ \ [(0.065)\ (94\ lbs/ft^3)]$

$= [12\ ft^2]\ \ [6.11\ lbs/ft^3]$

$= 73.32\ lbs/ft$

$$\text{Application Length} = \frac{\text{Net Weight of Cement}}{\text{Application Rate}}$$

$$= \frac{22\ \text{tons} \times 2000\ \text{lbs/ton}}{73.32\ \text{lbs/ft}}$$

$$= \frac{44000\ \text{lbs}}{73.32\ \text{lbs/ft}}$$

$= \mathbf{600\ Feet}$

ANSWERS TO STUDY QUESTIONS
CHAPTER 4

1. Before starting to dig what should be located? Utilities

2. True or False. When moving concrete pipe you should pick it up by one end. False. You should use leather or nylon slings or a pipe fork

3. The foundation for the pipe should be shaped to a minimum of 1/10 the diameter.

4. When backfilling around pipe test every lift on alternating sides beginning after the first 4" compacted layer above the structure's bedding and continue until backfill is 1 foot above pipe for a maximum of 300 feet of pipe length.

5. Use of a template is the best way to shape the bedding material for a pipe.

6. To be placed within 12 inches of a pipe, the maximum size a rock can be is 2 inches.

7. True of False. You do not have to place pipe bedding material down first when installing a UD-4. True

8. Where can typical underdrain drawings be found? Road and Bridge Standards

9. The maximum height of cover for a 48 inch diameter Class IV concrete pipe culvert is 21 feet.

10. A 36 inch diameter pipe 290 feet long is placed on a project as a drainage culvert. What is the minimum number of density tests that should be run on the backfill material? 11 Tests

11. When can No. 57 stone be used? sub-bedding when standing water is encountered

12. What is the maximum backfill lift thickness? 6 inches loose compacted to 4 inches

13. Pipe openings in precast drainage structures shall not exceed the outside cross sectional dimensions of the pipe by more than 8 inches.

14. The video inspection can be done 30 days after installation is complete.

15. The maximum allowed crack size of rigid pipe is 0.1 inches.

16. The maximum deflection allowed for flexible pipe is 7.5%.

17. At what end of the pipe installation do you start installation? Downstream

18. For pipe backfill, the level of compaction required is 95 percent.

ANSWERS TO STUDY QUESTIONS
CHAPTER 5

1. What are the three differences between AASHTO T-99 and AASHTO T-180?

   a. Weight of the rammer
   b. Height of drop of the rammer
   c. Number of layers of soil compacted in the mold

2. 3 layers of soil are required to make a standard proctor mold and each layer must be compacted 25 blows with a 5.5 lb. hammer dropped 12 inches.

3. The target increase in moisture content for each "point" is 2 percent.

4. The moisture content corresponding to the peak of the curve will be termed the optimum moisture content and the density corresponding to the peak of the curve will be termed the maximum dry density.

5. 3 scoops of reagent are placed in the body of the "speedy" moisture tester.

6. According to AASHTO, the base on which the proctor test molds are made must weigh at least 200 lbs.

7. If the dial on the Speedy exceeds 20 a half-size sample must be used and the dial reading must be multiplied by 2.

8. The proctor is run on soil which passes the No. 4 sieve.

9. Rotate the Speedy for 10 seconds, rest for 20 seconds for a period of 3 minutes.

10. Calculate the moisture content using the following information:

    $W_{wet} = 10.85 \quad W_{dry} = 10.05 \quad W_{con} = 1.69$

    $$\frac{10.85 - 10.05}{10.05 - 1.69} = \frac{0.80}{8.36} \times 100 = 9.569 = 9.6$$

11. Using the graph on the next page, determine the optimum moisture and maximum dry density given the following laboratory information.

	Moisture Content	Dry Density lb/ft^3
Sample 1	22.3	85.5
Sample 2	25.0	88.7
Sample 3	28.1	90.6
Sample 4	32.1	88.0
Sample 5	34.8	84.6

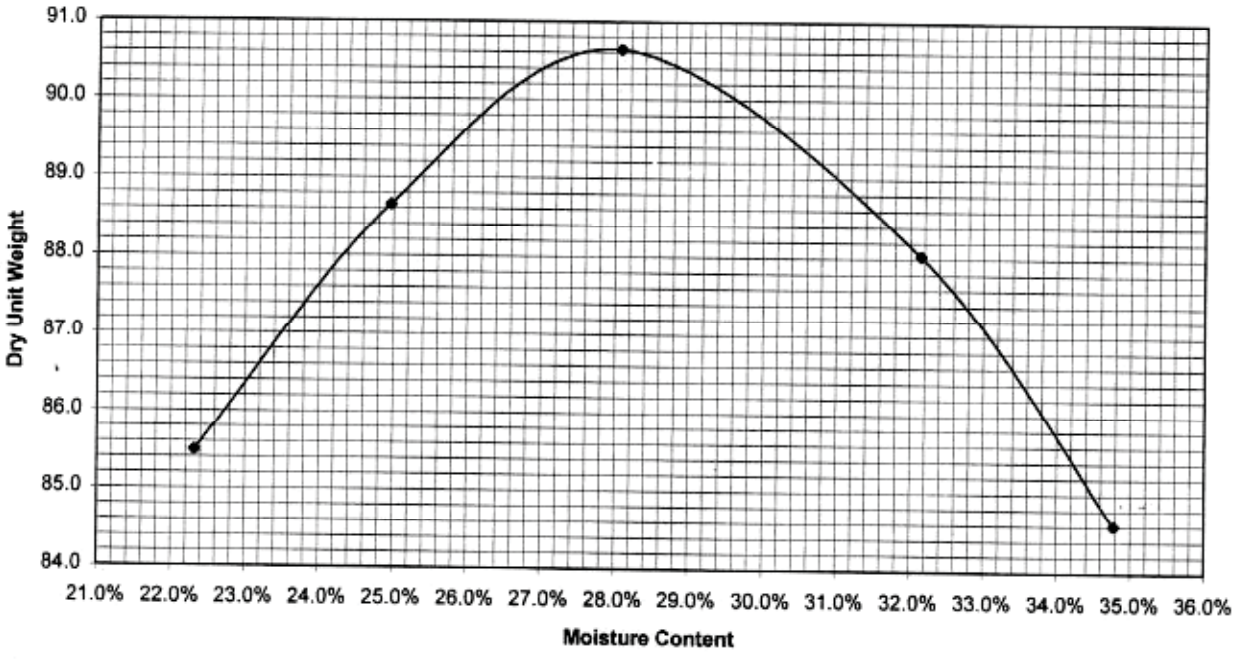
Weight of Mold in (Grams): 2042

COMPACTION DATA

Weight of Compacted Sample, (Grams)	Wet Weight of Sample, (lbs./cu.ft.)	Dish Number	Weight of Dish	Weight of Dish and Wet Soil	Weight of Dish and Dry Soil	Weight of Water	Weight of Dry Soil	Percent of Moisture	Dry Weight, (lbs./cu.ft.)
3623	104.6	10	59.3	130.0	117.1	12.9	57.8	22.3%	85.5
3717	110.8	12*	53.2	139.3	122.1	17.2	68.9	25.0%	88.7
3797	116.1	R	62.4	138.6	121.9	16.7	59.5	28.1%	90.6
3801	116.3	X	60.9	139.0	120.0	19.0	59.1	32.1%	88.0
3766	114.0	36	58.2	157.8	132.1	25.7	73.9	34.8%	84.6

Maximum Density: 90.6 lbs./cu. ft. Optimum Moisture: 28.10%

COMPACTION GRAPH



ANSWERS TO PRACTICE PROBLEMS
CHAPTER 5

Practice Problem 1
One-Point Proctor

1) Complete the following one-point proctor on the TL-125A using the information provided.

2) Answer the following questions.

a) What is the maximum dry density?

107.1 lb/ft^3

b) What is the optimum moisture and moisture limits?

17.6% 14.1 - 21.1

17.6 x .20 = 3.52
17.6 - 3.52 = 14.1
17.6+ 3.52 = 21.1

c) A nuclear density test determines the dry density to be 102 lbs/ft^3 with a moisture content of 18.2. Does this test pass?

Yes it meets the density and moisture requirements.

102 ÷ 107.1 = 95.2 lbs/ft^3 which is equal to or greater than 95.

18.2 falls within optimum moisture range of 14.1 to 21.1.

TL-125

VIRGINIA DEPARTMENT OF TRANSPORTATION
MATERIALS DIVISION
WORKSHEET FOR ONE-POINT PROCTOR

Route No. : 635 County : Amherst
Project No. : 0635-005-187,C501 Inspected by : _____
F.H.W.A. No. : FH-151(102)

English ☐ Metric ☐

Field Test No.		**1**			
Date					
Location of test	Station ft. (m)	**77 + 50**			
	Ref. to center line ft. (m)	**7' Lt. C/L**			
Reference Elevation	Original ground ft. (m)	**+10'**			
	Finished grade ft. (m)	**-23'**			
Type of roller		**Sheepsfoot**			

A. Weight (mass) of mold and wet soil. lb. (kg)	=	**8.45**			
B. Weight (mass) of mold lb. (kg)	=	**4.41**			
C. Weight (mass) of wet soil. A - B lb. (kg)	=	**4.04**			
D. Wet density of soil. C x 30 lb/ft^3 (C x 1060 kg/m^3)	=	**121.2**			
E. "Speedy " Dial Reading	=	**13.2**			
F. Moisture Content, %, from "Speedy" chart.	=	**15.3**			
G. Maximum Dry Density lb/ft^3 (kg/m^3)	=	**107.1**			
H. Optimum Moisture Content, %	=	**17.6**			
I. Field Density lb/ft^3 (kg/m^3) from TL-125	=				
J. No. 4 (+4.75 mm) material from field density hole.	=				
K. Corrected Maximum Density lb/ft^3 (kg/m^3)	=				
L. % Compaction	=				

Remarks: _____

CC: District Materials Engineer
Project File

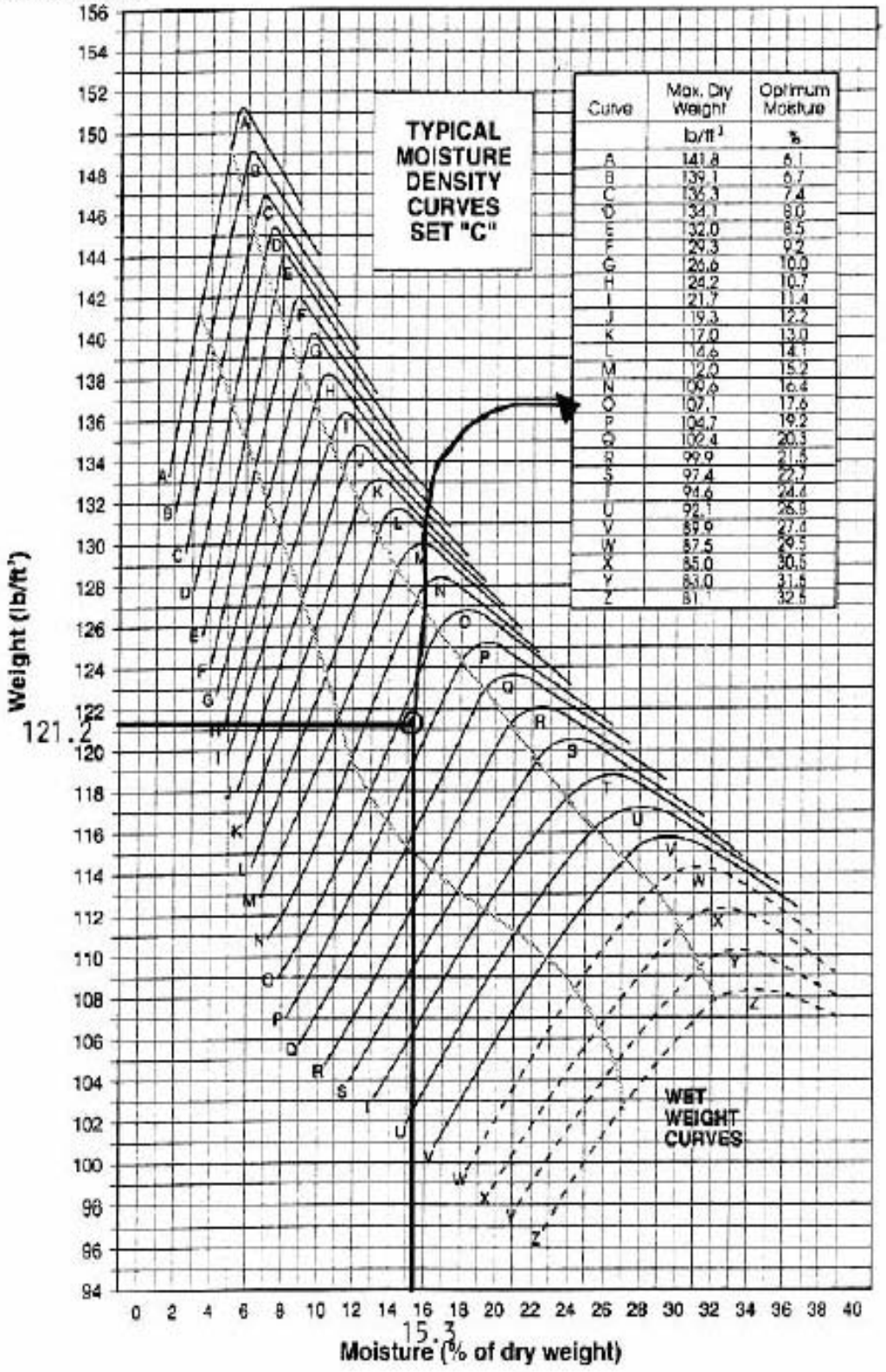
By: _____

Title: _____

Report No. : _____

VIRGINIA
VTRC
TRANSPORTATION RESEARCH COUNCIL

ONE-POINT PROCTOR
VTM-12



Curve	Max. Dry Weight lb/ft³	Optimum Moisture %
A	141.8	5.1
B	139.1	6.7
C	136.3	7.4
D	134.1	8.0
E	132.0	8.5
F	129.3	9.2
G	126.6	10.0
H	124.2	10.7
I	121.7	11.4
J	119.3	12.2
K	117.0	13.0
L	114.6	14.1
M	112.0	15.2
N	109.6	16.4
O	107.1	17.6
P	104.7	19.2
Q	102.4	20.3
R	99.9	21.5
S	97.4	22.7
T	94.6	24.4
U	92.1	25.9
V	89.9	27.4
W	87.5	29.5
X	85.0	30.5
Y	83.0	31.5
Z	81.1	32.5

SPEEDY READ.	MOIST. CONT.	SPEEDY READ.	MOIST. CONT.	SPEEDY READ.	MOIST. CONT.	SPEEDY READ.	MOIST. CONT.	SPEEDY READ.	MOIST. CONT.	SPEEDY READ.	MOIST. CONT.	SPEEDY READ.	MOIST. CONT.
1.0	1.0	8.2	9.0	15.2	18.0	22.4	28.9	29.6	42.1	36.8	58.3	44.0	78.6
1.2	1.3	8.4	9.2	15.4	18.3	22.6	29.2	29.8	42.5	37.0	58.8	44.2	79.2
1.4	1.5	8.6	9.5	15.6	18.5	22.8	29.6	30.0	42.9	37.2	59.3	44.4	79.9
1.6	1.8	8.8	9.7	15.8	18.8	23.0	30.2	30.2	43.3	37.4	59.8	44.6	80.5
1.8	2.0	9.0	9.9	16.0	19.1	23.2	30.6	30.4	43.8	37.6	60.3	44.8	81.2
2.0	2.2	9.2	10.1	16.2	19.4	23.4	30.9	30.6	44.2	37.8	60.8	45.0	81.8
2.2	2.4	9.4	10.4	16.4	19.6	23.6	31.3	30.8	44.6	38.0	61.3	45.2	82.5
2.4	2.6	9.6	10.6	16.6	19.9	23.8	31.6	31.0	45.0	38.2	61.8	45.4	83.2
2.6	2.9	9.8	10.8	16.8	20.2	24.0	31.9	31.2	45.4	38.4	62.4	45.6	83.8
2.8	3.1	10.0	11.1	17.0	20.5	24.2	32.3	31.4	45.8	38.6	62.9	45.8	84.5
3.0	3.3	10.2	11.4	17.2	20.8	24.4	32.7	31.6	46.2	38.8	63.5	46.0	85.2
3.2	3.5	10.4	11.6	17.4	21.1	24.6	33.0	31.8	46.6	39.0	64.0	46.2	85.9
3.4	3.7	10.6	11.9	17.6	21.4	24.8	33.4	32.0	47.1	39.2	64.5	46.4	86.6
3.6	4.0	10.8	12.1	17.8	21.7	25.0	33.7	32.2	47.5	39.4	65.0	46.6	87.3
3.8	4.2	11.0	12.4	18.0	22.0	25.2	34.1	32.4	48.0	39.6	65.6	46.8	88.0
4.0	4.4	11.2	12.7	18.2	22.3	25.4	34.5	32.6	48.4	39.8	66.1	47.0	88.7
4.2	4.6	11.4	12.9	18.4	22.6	25.6	34.9	32.8	48.8	40.0	66.7	47.2	89.4
4.4	4.8	11.6	13.2	18.6	23.0	25.8	35.4	33.0	49.3	40.2	67.2	47.4	90.2
4.6	5.1	11.8	13.4	18.8	23.2	26.0	35.7	33.2	49.7	40.4	67.8	47.6	90.8
4.8	5.3	12.0	13.7	19.0	23.5	26.2	35.9	33.4	50.2	40.6	68.4	47.8	91.6
5.0	5.5	12.2	13.9	19.2	23.8	26.4	36.3	33.6	50.6	40.8	68.9	48.0	92.3
5.2	5.7	12.4	14.2	19.4	24.1	26.6	36.6	33.8	51.1	41.0	69.5	48.2	93.1
5.4	5.9	12.6	14.4	19.6	24.4	26.8	37.0	34.0	51.6	41.2	70.1	48.4	93.8
5.6	6.2	12.8	14.7	19.8	24.8	27.0	37.4	34.2	52.0	41.4	70.7	48.6	94.6
5.8	6.4	13.0	15.0	20.0					2.5	41.6	71.3	48.8	95.3
6.0	6.6	**13.2**	**15.3**	~~20.2~~					2.9	41.8	71.9	49.0	96.1
6.2	6.8	13.4	15.5	20.4	25.7	27.6	38.5	34.8	53.4	42.0	72.5	49.2	96.9
6.4	7.0	13.6	15.8	20.6	26.0	27.8	38.9	35.0	53.9	42.2	73.0	49.4	97.6
6.6	7.3	13.8	16.1	20.8	26.3	28.0	39.3	35.2	54.4	42.4	73.6	49.6	98.4
6.8	7.5	14.0	16.4	21.0	26.6	28.2	39.7	35.4	54.8	42.6	74.2	49.8	99.2
7.0	7.7	14.2	16.6	21.2	26.9	28.4	40.1	35.6	55.3	42.8	74.8	50.0	100.0
7.2	7.9	14.4	16.9	21.4	27.3	28.6	40.5	35.8	55.8	43.0	75.5		
7.4	8.1	14.6	17.1	21.6	27.6	28.8	40.9	36.0	56.3	43.2	76.1		
7.6	8.4	14.8	17.4	21.8	28.0	29.0	41.3	36.2	56.8	43.4	76.7		
7.8	8.6	15.0	17.7	22.0	28.3	29.2	41.5	36.4	57.2	43.6	77.3		
8.0	8.8	15.2	18.0	22.2	28.6	29.4	41.7	36.6	57.5	43.8	78.0		

Speedy Reading for Proctor

CHAPTER 5
Practice Problem 2
One-Point Proctor

1) Complete the following one-point proctor on the TL-125A using the information provided.

2) Answer the following questions.

a) What is the maximum dry density?

102.4 lb/ft^3

b) What is the optimum moisture and moisture limits?

20.3% 16.2 - 24.4

20.3 x .20 = 4.06
20.3 - 4.06 = 16.2
20.3 + 4.06 = 24.4

c) A nuclear density test determines the dry density to be 96.2 lbs/ft^3 with a moisture content of 15.8. Does this test pass?

No it doesn't meet the density or moisture requirements.

96.2 ÷ 102.4 = 93.9 lbs/ft^3 which is not equal to or greater than 95.

15.8 does not fall within optimum moisture range of 16.2 to 24.4.

TL-125A (Rev. 7/00)

VIRGINIA DEPARTMENT OF TRANSPORTATION
MATERIALS DIVISION
WORKSHEET FOR ONE-POINT PROCTOR

Route No. : 635 County : Amherst
Project No. : 0635-005-187,C501 Inspected by : _____
F.H.W.A. No. : FH-151(102)

English ☐ Metric ☐

Field Test No.		**2**			
Date					
Location of test	Station ft. (m)	**87 + 50**			
	Ref. to center line ft. (m)	**10' Rt. C/L**			
Reference Elevation	Original ground ft. (m)	**+20'**			
	Finished grade ft. (m)	**-23'**			
Type of roller		**Sheepsfoot**			

A. Weight (mass) of mold and wet soil. lb. (kg)	=	**13.56**			
B. Weight (mass) of mold lb. (kg)	=	**9.51**			
C. Weight (mass) of wet soil. A - B lb. (kg)	=	**4.05**			
D. Wet density of soil. C x 30 lb/ft³ (C x 1060 kg/m³)	=	**121.5**			
E. "Speedy " Dial Reading	=	**16.0**			
F. Moisture Content, %, from "Speedy" chart.	=	**19.1**			
G. Maximum Dry Density lb/ft³ (kg/m³)	=	**102.4**			
H. Optimum Moisture Content, %	=	**20.3**			
I. Field Density lb/ft³ (kg/m³) from TL-125	=				
J. No. 4 (+4.75 mm) material from field density hole.	=				
K. Corrected Maximum Density lb/ft³ (kg/m³)	=				
L. % Compaction	=				

Remarks: _____

CC: District Materials Engineer
Project File

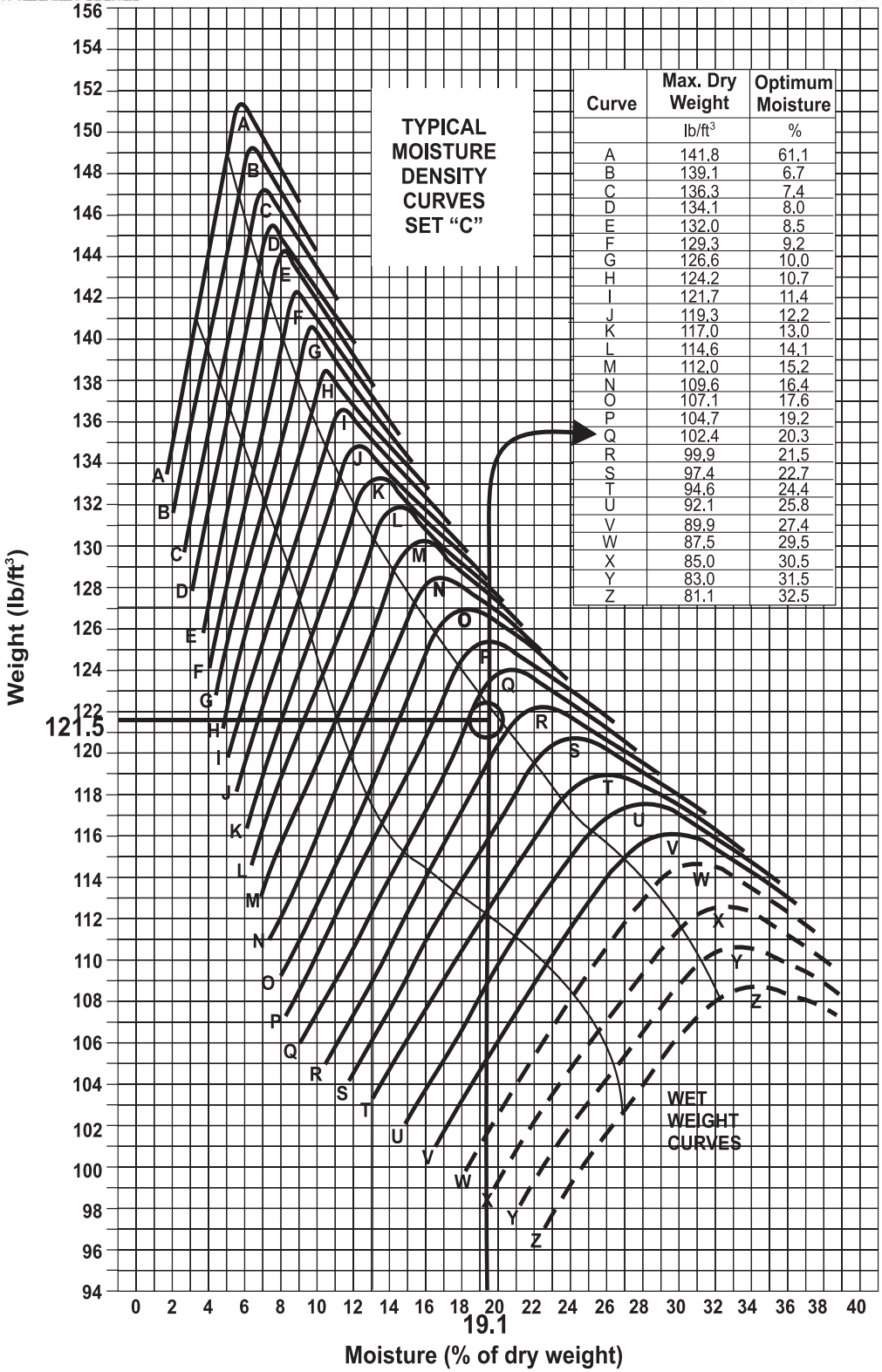
_____
Title: _____

Report No.: _____

V·I·R·G·I·N·I·A
VTRC
TRANSPORTATION RESEARCH COUNCIL

Rev. 2000

ONE-POINT PROCTOR
VTM-12



Curve	Max. Dry Weight	Optimum Moisture
	lb/ft³	%
A	141.8	6.1
B	139.1	6.7
C	136.3	7.4
D	134.1	8.0
E	132.0	8.5
F	129.3	9.2
G	126.6	10.0
H	124.2	10.7
I	121.7	11.4
J	119.3	12.2
K	117.0	13.0
L	114.6	14.1
M	112.0	15.2
N	109.6	16.4
O	107.1	17.6
P	104.7	19.2
Q	102.4	20.3
R	99.9	21.5
S	97.4	22.7
T	94.6	24.4
U	92.1	25.8
V	89.9	27.4
W	87.5	29.5
X	85.0	30.5
Y	83.0	31.5
Z	81.1	32.5

SPEEDY READ.	MOIST. CONT.	SPEEDY READ.	MOIST. CONT.	SPEEDY READ.	MOIST. CONT.	SPEEDY READ.	MOIST. CONT.	SPEEDY READ.	MOIST. CONT.	SPEEDY READ.	MOIST. CONT.	SPEEDY READ.	MOIST. CONT.
1.0	1.0	8.2	9.0	15.2	18.0	22.4	28.9	29.6	42.1	36.8	58.3	44.0	78.6
1.2	1.3	8.4	9.2	15.4	18.3	22.6	29.2	29.8	42.5	37.0	58.8	44.2	79.2
1.4	1.5	8.6	9.5	15.6	18.5	22.8	29.6	30.0	42.9	37.2	59.3	44.4	79.9
1.6	1.8	8.8	9.7	15.8	18.8	23.0	30.2	30.2	43.3	37.4	59.8	44.6	80.5
1.8	2.0	9.0	9.9	**16.0**	**19.1**	23.2					.3	44.8	81.2
2.0	2.2	9.2	10.1	16.2	19.4	23.4					.8	45.0	81.8
2.2	2.4	9.4	10.4	16.4	19.6	23.6	31.3	30.8	44.6	38.0	61.3	45.2	82.5
2.4	2.6	9.6	10.6	16.6	19.9	23.8	31.6	31.0	45.0	38.2	61.8	45.4	83.2
2.6	2.9	9.8	10.8	16.8	20.2	24.0	31.9	31.2	45.4	38.4	62.4	45.6	83.8
2.8	3.1	10.0	11.1	17.0	20.5	24.2	32.3	31.4	45.8	38.6	62.9	45.8	84.5
3.0	3.3	10.2	11.4	17.2	20.8	24.4	32.7	31.6	46.2	38.8	63.5	46.0	85.2
3.2	3.5	10.4	11.6	17.4	21.1	24.6	33.0	31.8	46.6	39.0	64.0	46.2	85.9
3.4	3.7	10.6	11.9	17.6	21.4	24.8	33.4	32.0	47.1	39.2	64.5	46.4	86.6
3.6	4.0	10.8	12.1	17.8	21.7	25.0	33.7	32.2	47.5	39.4	65.0	46.6	87.3
3.8	4.2	11.0	12.4	18.0	22.0	25.2	34.1	32.4	48.0	39.6	65.6	46.8	88.0
4.0	4.4	11.2	12.7	18.2	22.3	25.4	34.5	32.6	48.4	39.8	66.1	47.0	88.7
4.2	4.6	11.4	12.9	18.4	22.6	25.6	34.9	32.8	48.8	40.0	66.7	47.2	89.4
4.4	4.8	11.6	13.2	18.6	23.0	25.8	35.4	33.0	49.3	40.2	67.2	47.4	90.2
4.6	5.1	11.8	13.4	18.8	23.2	26.0	35.7	33.2	49.7	40.4	67.8	47.6	90.8
4.8	5.3	12.0	13.7	19.0	23.5	26.2	35.9	33.4	50.2	40.6	68.4	47.8	91.6
5.0	5.5	12.2	13.9	19.2	23.8	26.4	36.3	33.6	50.6	40.8	68.9	48.0	92.3
5.2	5.7	12.4	14.2	19.4	24.1	26.6	36.6	33.8	51.1	41.0	69.5	48.2	93.1
5.4	5.9	12.6	14.4	19.6	24.4	26.8	37.0	34.0	51.6	41.2	70.1	48.4	93.8
5.6	6.2	12.8	14.7	19.8	24.8	27.0	37.4	34.2	52.0	41.4	70.7	48.6	94.6
5.8	6.4	13.0	15.0	20.0	25.1	27.2	37.8	34.4	52.5	41.6	71.3	48.8	95.3
6.0	6.6	13.2	15.3	20.2	25.4	27.4	38.2	34.6	52.9	41.8	71.9	49.0	96.1
6.2	6.8	13.4	15.5	20.4	25.7	27.6	38.5	34.8	53.4	42.0	72.5	49.2	96.9
6.4	7.0	13.6	15.8	20.6	26.0	27.8	38.9	35.0	53.9	42.2	73.0	49.4	97.6
6.6	7.3	13.8	16.1	20.8	26.3	28.0	39.3	35.2	54.4	42.4	73.6	49.6	98.4
6.8	7.5	14.0	16.4	21.0	26.6	28.2	39.7	35.4	54.8	42.6	74.2	49.8	99.2
7.0	7.7	14.2	16.6	21.2	26.9	28.4	40.1	35.6	55.3	42.8	74.8	50.0	100.0
7.2	7.9	14.4	16.9	21.4	27.3	28.6	40.5	35.8	55.8	43.0	75.5		
7.4	8.1	14.6	17.1	21.6	27.6	28.8	40.9	36.0	56.3	43.2	76.1		
7.6	8.4	14.8	17.4	21.8	28.0	29.0	41.3	36.2	56.8	43.4	76.7		
7.8	8.6	15.0	17.7	22.0	28.3	29.2	41.5	36.4	57.2	43.6	77.3		
8.0	8.8	15.2	18.0	22.2	28.6	29.4	41.7	36.6	57.5	43.8	78.0		

CHAPTER 5
Practice Problem 3
One-Point Proctor

1) Complete the following one-point proctor on the TL-125A using the information provided.

2) Answer the following questions.

   a) What is the maximum dry density?

      104.7 lb/ft^3

   b) What is the optimum moisture and moisture limits?

      19.2% 15.4-23.0

      19.2 x .20 = 3.84
      19.2 - 3.84 = 15.4
      19.2 + 3.84 = 23.0

TL-125A (Rev. 7/00)

VIRGINIA DEPARTMENT OF TRANSPORTATION
MATERIALS DIVISION
WORKSHEET FOR ONE-POINT PROCTOR

Route No. : 615 County : Campbell
Project No. : 0615-015-186,C501 Inspected by : _____
F.H.W.A. No. : FH-132(104)

English ☐ Metric ☐

Field Test No.		**20**			
Date					
Location of test	Station ft. (m)	**87 + 40**			
	Ref. to center line ft. (m)	**10' Rt. C/L**			
Reference Elevation	Original ground ft. (m)	**+13'**			
	Finished grade ft. (m)	**-7'**			
Type of roller		**Sheepsfoot**			

A. Weight (mass) of mold and wet soil lb. (kg)	=	**8.43**			
B. Weight (mass) of mold lb. (kg)	=	**4.40**			
C. Weight (mass) of wet soil A - B lb. (kg)	=	**4.03**			
D. Wet density of soil. C x 30 lb/ft^3 (C x 1060 kg/m^3)	=	**120.9**			
E. "Speedy " Dial Reading	=	**14.0**			
F. Moisture Content, %, from "Speedy" chart.	=	**16.4**			
G. Maximum Dry Density lb/ft^3 (kg/m^3)	=	**104.7**			
H. Optimum Moisture Content, %	=	**19.2**			
I. Field Density lb/ft^3 (kg/m^3) from TL-125	=				
J. No. 4 (+4.75 mm) material from field density hole.	=				
K. Corrected Maximum Density lb/ft^3 (kg/m^3)	=				
L. % Compaction	=				

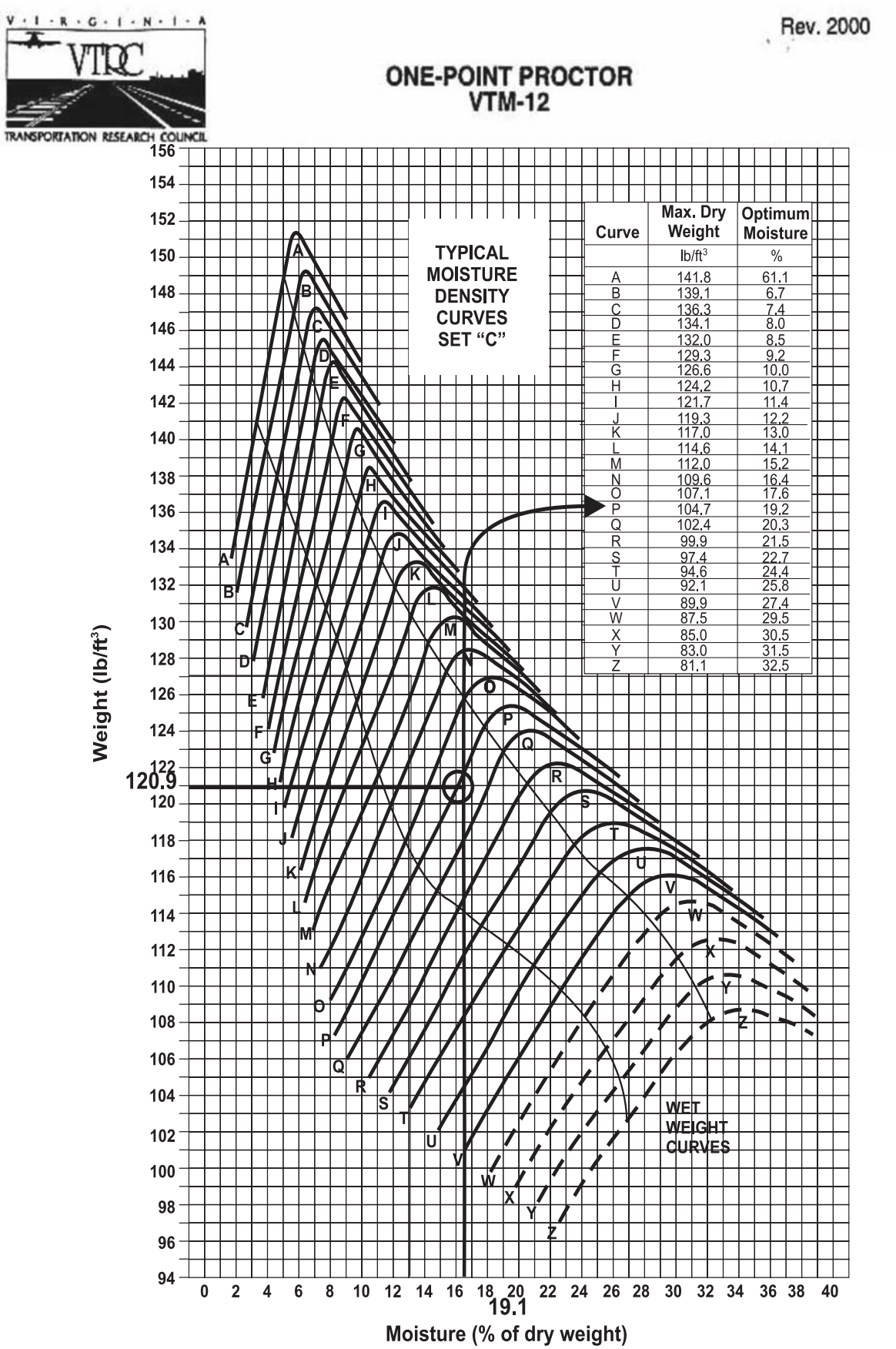
Remarks: _____

CC: District Materials Engineer
Project File

By: _____

Title: _____

Report No. : _____


V·I·R·G·I·N·I·A
VTRC
TRANSPORTATION RESEARCH COUNCIL
Rev. 2000
ONE-POINT PROCTOR
VTM-12
TYPICAL MOISTURE DENSITY CURVES SET "C"
Curve | Max. Dry Weight lb/ft3 | Optimum Moisture %
A 141.8 61.1
B 139.1 6.7
C 136.3 7.4
D 134.1 8.0
E 132.0 8.5
F 129.3 9.2
G 126.6 10.0
H 124.2 10.7
I 121.7 11.4
J 119.3 12.2
K 117.0 13.0
L 114.6 14.1
M 112.0 15.2
N 109.6 16.4
O 107.1 17.6
P 104.7 19.2
Q 102.4 20.3
R 99.9 21.5
S 97.4 22.7
T 94.6 24.4
U 92.1 25.8
V 89.9 27.4
W 87.5 29.5
X 85.0 30.5
Y 83.0 31.5
Z 81.1 32.5
WET WEIGHT CURVES
120.9
19.1
Weight (lb/ft3)
Moisture (% of dry weight)

SPEEDY READ.	MOIST. CONT.	SPEEDY READ.	MOIST. CONT.	SPEEDY READ.	MOIST. CONT.	SPEEDY READ.	MOIST. CONT.	SPEEDY READ.	MOIST. CONT.	SPEEDY READ.	MOIST. CONT.	SPEEDY READ.	MOIST. CONT.
1.0	1.0	8.2	9.0	15.2	18.0	22.4	28.9	29.6	42.1	36.8	58.3	44.0	78.6
1.2	1.3	8.4	9.2	15.4	18.3	22.6	29.2	29.8	42.5	37.0	58.8	44.2	79.2
1.4	1.5	8.6	9.5	15.6	18.5	22.8	29.6	30.0	42.9	37.2	59.3	44.4	79.9
1.6	1.8	8.8	9.7	15.8	18.8	23.0	30.2	30.2	43.3	37.4	59.8	44.6	80.5
1.8	2.0	9.0	9.9	16.0	19.1	23.2	30.6	30.4	43.8	37.6	60.3	44.8	81.2
2.0	2.2	9.2	10.1	16.2	19.4	23.4	30.9	30.6	44.2	37.8	60.8	45.0	81.8
2.2	2.4	9.4	10.4	16.4	19.6	23.6	31.3	30.8	44.6	38.0	61.3	45.2	82.5
2.4	2.6	9.6	10.6	16.6	19.9	23.8	31.6	31.0	45.0	38.2	61.8	45.4	83.2
2.6	2.9	9.8	10.8	16.8	20.2	24.0	31.9	31.2	45.4	38.4	62.4	45.6	83.8
2.8	3.1	10.0	11.1	17.0	20.5	24.2	32.3	31.4	45.8	38.6	62.9	45.8	84.5
3.0	3.3	10.2	11.4	17.2	20.8	24.4	32.7	31.6	46.2	38.8	63.5	46.0	85.2
3.2	3.5	10.4	11.6	17.4	21.1	24.6	33.0	31.8	46.6	39.0	64.0	46.2	85.9
3.4	3.7	10.6	11.9	17.6	21.4	24.8	33.4	32.0	47.1	39.2	64.5	46.4	86.6
3.6	4.0	10.8	12.1	17.8	21.7	25.0	33.7	32.2	47.5	39.4	65.0	46.6	87.3
3.8	4.2	11.0	12.4	18.0	22.0	25.2	34.1	32.4	48.0	39.6	65.6	46.8	88.0
4.0	4.4	11.2	12.7	18.2	22.3	25.4	34.5	32.6	48.4	39.8	66.1	47.0	88.7
4.2	4.6	11.4	12.9	18.4	22.6	25.6	34.9	32.8	48.8	40.0	66.7	47.2	89.4
4.4	4.8	11.6	13.2	18.6	23.0	25.8	35.4	33.0	49.3	40.2	67.2	47.4	90.2
4.6	5.1	11.8	13.4	18.8	23.2	26.0	35.7	33.2	49.7	40.4	67.8	47.6	90.8
4.8	5.3	12.0	13.7	19.0	23.5	26.2	35.9	33.4	50.2	40.6	68.4	47.8	91.6
5.0	5.5	12.2	13.9	19.2	23.8	26.4	36.3	33.6	50.6	40.8	68.9	48.0	92.3
5.2	5.7	12.4	14.2	19.4	24.1	26.6	36.6	33.8	51.1	41.0	69.5	48.2	93.1
5.4	5.9	12.6	14.4	19.6	24.4	26.8	37.0	34.0	51.6	41.2	70.1	48.4	93.8
5.6	6.2	12.8	14.7	19.8	24.8	27.0	37.4	34.2	52.0	41.4	70.7	48.6	94.6
5.8	6.4	13.0	15.0	20.0	25.1	27.2	37.8	34.4	52.5	41.6	71.3	48.8	95.3
6.0	6.6	13.2	15.3	20.2	25.4	27.4	38.2	34.6	52.9	41.8	71.9	49.0	96.1
6.2	6.8	13.4	15.5	20.4	25.7	27.6	38.5	34.8	53.4	42.0	72.5	49.2	96.9
6.4	7.0	13.6	15.8	20.6	26.0	27.8	38.9	35.0	53.9	42.2	73.0	49.4	97.6
6.6	7.3	13.8	16.1	20.8	[illegible]	[illegible]	[illegible]	[illegible].4		42.4	73.6	49.6	98.4
6.8	7.5	**14.0**	**16.4**	21.0	[illegible]	[illegible]	[illegible]	[illegible].8		42.6	74.2	49.8	99.2
7.0	7.7	14.2	16.6	21.2	26.9	28.4	40.1	35.6	55.3	42.8	74.8	50.0	100.0
7.2	7.9	14.4	16.9	21.4	27.3	28.6	40.5	35.8	55.8	43.0	75.5		
7.4	8.1	14.6	17.1	21.6	27.6	28.8	40.9	36.0	56.3	43.2	76.1		
7.6	8.4	14.8	17.4	21.8	28.0	29.0	41.3	36.2	56.8	43.4	76.7		
7.8	8.6	15.0	17.7	22.0	28.3	29.2	41.5	36.4	57.2	43.6	77.3		
8.0	8.8	15.2	18.0	22.2	28.6	29.4	41.7	36.6	57.5	43.8	78.0		

Speedy Reading for Proctor

CHAPTER 5
Practice Problem 4
One-Point Proctor

1) Complete the following one-point proctor on the TL-125A using the information provided.

2) Answer the following questions.

a) What is the maximum dry density?

102.4 lb/ft^3

b) What is the optimum moisture and moisture limits?

20.3% 16.2-24.4

20.3 x .20 = 4.06
20.3 - 4.06 = 16.2
20.3 + 4.06 = 24.4

VIRGINIA DEPARTMENT OF TRANSPORTATION
MATERIALS DIVISION
WORKSHEET FOR ONE-POINT PROCTOR

Route No. : 32 County : Amherst
Project No. : 0632-005-184,C501 Inspected by : _____
F.H.W.A. No. : FH-130(101)

English ☐ Metric ☐

Field Test No.		**34**			
Date					
Location of test	Station ft. (m)	**120 + 40**			
	Ref. to center line ft. (m)	**13' Rt. C/L**			
Reference Elevation	Original ground ft. (m)	**+16'**			
	Finished grade ft. (m)	**-7'**			
Type of roller		**Sheepsfoot**			

A. Weight (mass) of mold and wet soil lb. (kg)	=	**13.56**			
B. Weight (mass) of mold lb. (kg)	=	**9.51**			
C. Weight (mass) of wet soil A - B lb. (kg)	=	**4.05**			
D. Wet density of soil. C x 30 lb/ft³ (C x 1060 kg/m³)	=	**121.5**			
E. "Speedy " Dial Reading	=	**16.2**			
F. Moisture Content, %, from "Speedy" chart.	=	**19.4**			
G. Maximum Dry Density lb/ft³ (kg/m³)	=	**102.4**			
H. Optimum Moisture Content, %	=	**20.3**			
I. Field Density lb/ft³ (kg/m³) from TL-125	=				
J. No. 4 (+4.75 mm) material from field density hole.	=				
K. Corrected Maximum Density lb/ft³ (kg/m³)	=				
L. % Compaction	=				

Remarks: _____

CC: District Materials Engineer
Project File

By: _____

Title: _____

Report No.: _____

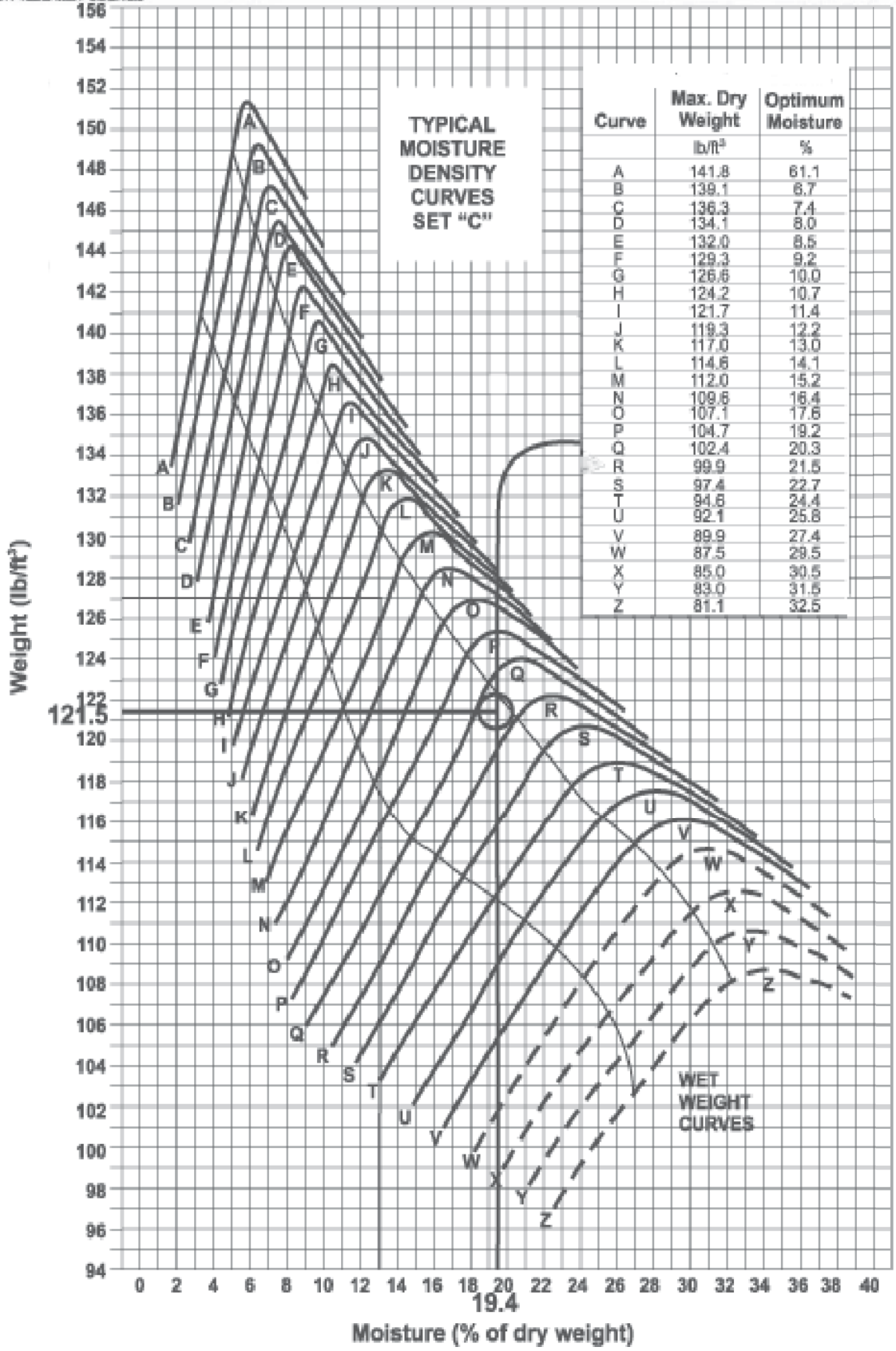
V · I · R · G · I · N · I · A

VTRC

TRANSPORTATION RESEARCH COUNCIL

Rev. 2000

ONE-POINT PROCTOR
VTM-12



Curve	Max. Dry Weight lb/ft³	Optimum Moisture %
A	141.8	6.1
B	139.1	6.7
C	136.3	7.4
D	134.1	8.0
E	132.0	8.5
F	129.3	9.2
G	126.6	10.0
H	124.2	10.7
I	121.7	11.4
J	119.3	12.2
K	117.0	13.0
L	114.6	14.1
M	112.0	15.2
N	109.6	16.4
O	107.1	17.6
P	104.7	19.2
Q	102.4	20.3
R	99.9	21.5
S	97.4	22.7
T	94.6	24.4
U	92.1	25.8
V	89.9	27.4
W	87.5	29.5
X	85.0	30.5
Y	83.0	31.5
Z	81.1	32.5

SPEEDY READ.	MOIST. CONT.	SPEEDY READ.	MOIST. CONT.	SPEEDY READ.	MOIST. CONT.	SPEEDY READ.	MOIST. CONT.	SPEEDY READ.	MOIST. CONT.	SPEEDY READ.	MOIST. CONT.	SPEEDY READ.	MOIST. CONT.
1.0	1.0	8.2	9.0	15.2	18.0	22.4	28.9	29.6	42.1	36.8	58.3	44.0	78.6
1.2	1.3	8.4	9.2	15.4	18.3	22.6	29.2	29.8	42.5	37.0	58.8	44.2	79.2
1.4	1.5	8.6	9.5	15.6	18.5	22.8	29.6	30.0	42.9	37.2	59.3	44.4	79.9
1.6	1.8	8.8	9.7	15.8	18.8	23.0	30.2	30.2	43.3	37.4	59.8	44.6	80.5
1.8	2.0	9.0	9.9	16.0	19.1	23.2	30.6	30.4	43.8	37.6	60.3	44.8	81.2
2.0	2.2	9.2	10.1	**16.2**	**19.4**	**Speedy Reading for Proctor**			.8	60.8	45.0	81.8
2.2	2.4	9.4	10.4	16.4	19.6	23.6	31.3	30.8	44.6	38.0	61.3	45.2	82.5
2.4	2.6	9.6	10.6	16.6	19.9	23.8	31.6	31.0	45.0	38.2	61.8	45.4	83.2
2.6	2.9	9.8	10.8	16.8	20.2	24.0	31.9	31.2	45.4	38.4	62.4	45.6	83.8
2.8	3.1	10.0	11.1	17.0	20.5	24.2	32.3	31.4	45.8	38.6	62.9	45.8	84.5
3.0	3.3	10.2	11.4	17.2	20.8	24.4	32.7	31.6	46.2	38.8	63.5	46.0	85.2
3.2	3.5	10.4	11.6	17.4	21.1	24.6	33.0	31.8	46.6	39.0	64.0	46.2	85.9
3.4	3.7	10.6	11.9	17.6	21.4	24.8	33.4	32.0	47.1	39.2	64.5	46.4	86.6
3.6	4.0	10.8	12.1	17.8	21.7	25.0	33.7	32.2	47.5	39.4	65.0	46.6	87.3
3.8	4.2	11.0	12.4	18.0	22.0	25.2	34.1	32.4	48.0	39.6	65.6	46.8	88.0
4.0	4.4	11.2	12.7	18.2	22.3	25.4	34.5	32.6	48.4	39.8	66.1	47.0	88.7
4.2	4.6	11.4	12.9	18.4	22.6	25.6	34.9	32.8	48.8	40.0	66.7	47.2	89.4
4.4	4.8	11.6	13.2	18.6	23.0	25.8	35.4	33.0	49.3	40.2	67.2	47.4	90.2
4.6	5.1	11.8	13.4	18.8	23.2	26.0	35.7	33.2	49.7	40.4	67.8	47.6	90.8
4.8	5.3	12.0	13.7	19.0	23.5	26.2	35.9	33.4	50.2	40.6	68.4	47.8	91.6
5.0	5.5	12.2	13.9	19.2	23.8	26.4	36.3	33.6	50.6	40.8	68.9	48.0	92.3
5.2	5.7	12.4	14.2	19.4	24.1	26.6	36.6	33.8	51.1	41.0	69.5	48.2	93.1
5.4	5.9	12.6	14.4	19.6	24.4	26.8	37.0	34.0	51.6	41.2	70.1	48.4	93.8
5.6	6.2	12.8	14.7	19.8	24.8	27.0	37.4	34.2	52.0	41.4	70.7	48.6	94.6
5.8	6.4	13.0	15.0	20.0	25.1	27.2	37.8	34.4	52.5	41.6	71.3	48.8	95.3
6.0	6.6	13.2	15.3	20.2	25.4	27.4	38.2	34.6	52.9	41.8	71.9	49.0	96.1
6.2	6.8	13.4	15.5	20.4	25.7	27.6	38.5	34.8	53.4	42.0	72.5	49.2	96.9
6.4	7.0	13.6	15.8	20.6	26.0	27.8	38.9	35.0	53.9	42.2	73.0	49.4	97.6
6.6	7.3	13.8	16.1	20.8	26.3	28.0	39.3	35.2	54.4	42.4	73.6	49.6	98.4
6.8	7.5	14.0	16.4	21.0	26.6	28.2	39.7	35.4	54.8	42.6	74.2	49.8	99.2
7.0	7.7	14.2	16.6	21.2	26.9	28.4	40.1	35.6	55.3	42.8	74.8	50.0	100.0
7.2	7.9	14.4	16.9	21.4	27.3	28.6	40.5	35.8	55.8	43.0	75.5		
7.4	8.1	14.6	17.1	21.6	27.6	28.8	40.9	36.0	56.3	43.2	76.1		
7.6	8.4	14.8	17.4	21.8	28.0	29.0	41.3	36.2	56.8	43.4	76.7		
7.8	8.6	15.0	17.7	22.0	28.3	29.2	41.5	36.4	57.2	43.6	77.3		
8.0	8.8	15.2	18.0	22.2	28.6	29.4	41.7	36.6	57.5	43.8	78.0		

ANSWERS TO PRACTICE PROBLEMS CHAPTER 6
Practice Problem 1

TL-125 Rev. 6/00

VIRGINIA DEPARTMENT OF TRANSPORTATION
REPORT OF SAND CONE DENSITY (UNIT MASS OF SOIL)

English ☐ Metric ☐
Report No.: **1** Date: _____
Route No.: **635** County: **Amherst**
Project No.: **0635-005-187,C501** FHWA No.: **FH-151(102)**

Field Test No.		**1**		
Location of Test	Station ft. (m.)	**77 + 50**		
	Ref. To Center Line ft. (m.)	**7' Lt. C/L**		
Reference Elevation	Original Ground ft. (m.)	**+10'**		
	Finished Grade ft. (m.)	**-23'**		
Compacted Depth of Lift in. (mm.)		**6"**		
Method of Compaction (Type of Roller)		**Sheepsfoot**		
DENSITY DETERMINATION				
A. Unit wt.(lbs/ft^3) or Unit mass (kg/m^3) of sand (calibrated value)		**86.5**		
B. Wt. (mass) sand + wt. (mass) of jar and cone, lb. (kg)		**15.80**		
C. Wt. (mass) sand left in jar + wt. (mass) of jar and cone, lb. (kg)		**7.89**		
D. Wt. (mass) of sand in cone and base plate, lb. (kg) (calibrated value)		**2.77**		
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)		**10.66**		
F. Wt. (mass) of sand in test hole (B - E), lb. (kg)		**5.14**		
G. Volume of test hole (F ÷ A), ft^3 (m^3)		**0.0594**		
H. Wt. (mass) of wet soil from test hole + (wt.) mass of pan, lb. (kg)		**9.10**		
I. Wt. (mass) of pan, lb. (kg)		**1.67**		
J. Wt. (mass) of wet soil from test hole (H - I), lb. (kg)		**7.43**		
K. Unit wt.(lbs/ft^3) or Unit mass (kg/m^3) of wet soil in fill (J ÷ G)		**125.1**		
L. Unit wt.(lbs/ft^3) or Unit mass (kg/m^3) of dry soil in fill = $\frac{K}{\{ 1 + [\text{Moisture Content (T)} \div 100] \}}$		**109.1**		
M. Max. Dry Unit Wt.(lbs/ft^3) or Unit mass (kg/m^3) from LAB PROCTOR OR ONE POINT PROCTOR (TL-125a)		**107.1**		
N. Optimum Moisture Content from LAB PROCTOR OR ONE POINT PROCTOR (TL-125a)		**17.6** **14.1 – 21.1**		
O. Percent of +No. 4 (plus 4.75 mm) Material				
P. Corrected Maximum Dry Unit wt. (lbs/ft^3) or Unit mass (kg/m^3)				
Q. Corrected Optimum Moisture (%)				
R. % Compaction (L ÷ M) × 100 or (L ÷ P) × 100		**101.9**		
S. % Minimum density (unit mass) required (from specifications)		**95.0**		
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		**14.7**		

Remarks: **Test Passes** By: _____

Moisture Content of 14.7% falls wtihin optimum moisture range. Title: _____

Density achieved is 101.9 and minimum density required is 95.0%. cc: District Materials Engineer
Project File

CHAPTER 6
Practice Problem 2

TL-125 Rev. 6/00 **VIRGINIA DEPARTMENT OF TRANSPORTATION**
REPORT OF SAND CONE DENSITY (UNIT MASS OF SOIL)

English ☐ Metric ☐
Report No.: **1** Date:
Route No.: **635** County: **Amherst**
Project No.: **0635-005-187,C501** FHWA No.: **FH-151(102)**

Field Test No.		**2**		
Location of Test	Station ft. (m.)	**87 + 50**		
	Ref. To Center Line ft. (m.)	**10' Rt. C/L**		
Reference Elevation	Original Ground ft. (m.)	**+ 20'**		
	Finished Grade ft. (m.)	**- 23'**		
Compacted Depth of Lift in. (mm.)		**6"**		
Method of Compaction (Type of Roller)		**Sheepsfoot**		
DENSITY DETERMINATION				
A. Unit wt.(lbs/ft^3) or Unit mass (kg/m^3) of sand (calibrated value)		**86.5**		
B. Wt. (mass) sand + wt. (mass) of jar and cone, lb. (kg)		**13.30**		
C. Wt. (mass) sand left in jar + wt. (mass) of jar and cone, lb. (kg)		**5.10**		
D. Wt. (mass) of sand in cone and base plate, lb. (kg) (calibrated value)		**2.77**		
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)		**7.87**		
F. Wt. (mass) of sand in test hole (B - E), lb. (kg)		**5.43**		
G. Volume of test hole (F ÷ A), ft^3 (m^3)		**0.0628**		
H. Wt. (mass) of wet soil from test hole + (wt.) mass of pan, lb. (kg)		**9.36**		
I. Wt. (mass) of pan, lb. (kg)		**1.67**		
J. Wt. (mass) of wet soil from test hole (H - I), lb. (kg)		**7.69**		
K. Unit wt.(lbs/ft^3) or Unit mass (kg/m^3) of wet soil in fill (J ÷ G)		**122.5**		
L. Unit wt.(lbs/ft^3) or Unit mass (kg/m^3) of dry soil in fill = $\frac{K}{\{ 1 + [\text{Moisture Content (T)} \div 100] \}}$		**102.6**		
M. Max. Dry Unit Wt.(lbs/ft^3) or Unit mass (kg/m^3) 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** **16.2 – 24.4**		
O. Percent of +No. 4 (plus 4.75 mm) Material				
P. Corrected Maximum Dry Unit wt. (lbs/ft^3) or Unit mass (kg/m^3)				
Q. Corrected Optimum Moisture (%)				
R. % Compaction (L ÷ M) × 100 or (L ÷ P) × 100		**100.2**		
S. % Minimum density (unit mass) required (from specifications)		**95.0**		
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		**19.4**		

Remarks: **Test Passes** By:

Moisture Content of 19.4% falls within optimum moisture range. Title:

Density achieved is 100.1 and minimum density required is 95.0%. cc: District Materials Engineer
Project File

CHAPTER 6
Practice Problem 3

TL-125 Rev. 6/00 **VIRGINIA DEPARTMENT OF TRANSPORTATION**
REPORT OF SAND CONE DENSITY (UNIT MASS OF SOIL)

English ☐ Metric ☐
Report No.: **1** Date:
Route No.: **615** County: **Campbell**
Project No.: **0615-015-186,C501** FHWA No.: **FH-132(104)**

Field Test No.		**20**		
Location of Test	Station ft. (m.)	**87 + 40**		
	Ref. To Center Line ft. (m.)	**10' Rt. C/L**		
Reference Elevation	Original Ground ft. (m.)	**+ 13'**		
	Finished Grade ft. (m.)	**- 7'**		
Compacted Depth of Lift in. (mm.)		**6"**		
Method of Compaction (Type of Roller)		**Sheepsfoot**		
DENSITY DETERMINATION				
A. Unit wt.(lbs/ft^3) or Unit mass (kg/m^3) of sand (calibrated value)		**86.2**		
B. Wt. (mass) sand + wt. (mass) of jar and cone, lb. (kg)		**16.0**		
C. Wt. (mass) sand left in jar + wt. (mass) of jar and cone, lb. (kg)		**7.69**		
D. Wt. (mass) of sand in cone and base plate, lb. (kg) (calibrated value)		**2.75**		
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)		**10.44**		
F. Wt. (mass) of sand in test hole (B - E), lb. (kg)		**5.56**		
G. Volume of test hole (F ÷ A), ft^3 (m^3)		**0.0645**		
H. Wt. (mass) of wet soil from test hole + (wt.) mass of pan, lb. (kg)		**8.77**		
I. Wt. (mass) of pan, lb. (kg)		**1.65**		
J. Wt. (mass) of wet soil from test hole (H - I), lb. (kg)		**7.12**		
K. Unit wt.(lbs/ft^3) or Unit mass (kg/m^3) of wet soil in fill (J ÷ G)		**110.4**		
L. Unit wt.(lbs/ft^3) or Unit mass (kg/m^3) of dry soil in fill = $\frac{K}{\{ 1 + [\text{Moisture Content (T)} \div 100] \}}$		**95.3**		
M. Max. Dry Unit Wt.(lbs/ft^3) or Unit mass (kg/m^3) from LAB PROCTOR OR ONE POINT PROCTOR (TL-125a)		**104.7**		
N. Optimum Moisture Content from LAB PROCTOR OR ONE POINT PROCTOR (TL-125a)		**19.2** **15.4 – 23.0**		
O. Percent of +No. 4 (plus 4.75 mm) Material				
P. Corrected Maximum Dry Unit wt. (lbs/ft^3) or Unit mass (kg/m^3)				
Q. Corrected Optimum Moisture (%)				
R. % Compaction (L ÷ M) × 100 or (L ÷ P) × 100		**91.0**		
S. % Minimum density (unit mass) required (from specifications)		**95.0**		
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		**15.8**		

Remarks: **Test Fails** By:

Moisture Content of 15.8% falls within optimum moisture range. Title:
Density achieved is 91.0% and minimum required density is 95.0%.

CHAPTER 6
Practice Problem 4

TL-125 Rev. 6/00

VIRGINIA DEPARTMENT OF TRANSPORTATION
REPORT OF SAND CONE DENSITY (UNIT MASS OF SOIL)

English ☐ Metric ☐

Report No.: **1** Date:

Route No.: **632** County: **Amherst**

Project No.: **0632-005-184,C501** FHWA No.: **FH-130(101)**

Field Test No.		**34**		
Location of Test	Station ft. (m.)	**120 + 40**		
	Ref. To Center Line ft. (m.)	**13' Rt. C/L**		
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				
A. Unit wt.(lbs/ft^3) or Unit mass (kg/m^3) of sand (calibrated value)		**86.5**		
B. Wt. (mass) sand + wt. (mass) of jar and cone, lb. (kg)		**13.29**		
C. Wt. (mass) sand left in jar + wt. (mass) of jar and cone, lb. (kg)		**5.09**		
D. Wt. (mass) of sand in cone and base plate, lb. (kg) (calibrated value)		**2.76**		
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)		**7.85**		
F. Wt. (mass) of sand in test hole (B - E), lb. (kg)		**5.44**		
G. Volume of test hole (F ÷ A), ft^3 (m^3)		**0.0629**		
H. Wt. (mass) of wet soil from test hole + (wt.) mass of pan, lb. (kg)		**9.38**		
I. Wt. (mass) of pan, lb. (kg)		**1.67**		
J. Wt. (mass) of wet soil from test hole (H - I), lb. (kg)		**7.71**		
K. Unit wt.(lbs/ft^3) or Unit mass (kg/m^3) of wet soil in fill (J ÷ G)		**122.6**		
L. Unit wt.(lbs/ft^3) or Unit mass (kg/m^3) of dry soil in fill = $\frac{K}{\{ 1 + [\text{Moisture Content (T)} \div 100] \}}$		**103.2**		
M. Max. Dry Unit Wt.(lbs/ft^3) or Unit mass (kg/m^3) 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** **16.2 – 24.4**		
O. Percent of +No. 4 (plus 4.75 mm) Material				
P. Corrected Maximum Dry Unit wt. (lbs/ft^3) or Unit mass (kg/m^3)				
Q. Corrected Optimum Moisture (%)				
R. % Compaction (L ÷ M) × 100 or (L ÷ P) × 100		**100.8**		
S. % Minimum density (unit mass) required (from specifications)		**95.0**		
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		**18.8**		

Remarks: **Test Passes** By:

Moisture Content of 18.8% falls within optimum moisture range. Title:

Density achieved is 100.8% and minimum density required is 95.0%. cc: District Materials Engineer
Project File

ANSWERS TO STUDY QUESTIONS
CHAPTER 6

1. Batteries should be charged when the battery indicator light comes on.

2. True or False. The nuclear gauge should be warmed-up first thing in the morning before using it. True

3. True or False. The only maintenance performed in the field is cleaning the nuclear gauge and charging the batteries. True

4. When taking a standard count the nuclear gauge should be a minimum of 10 feet from any structure and 33 feet from any other radioactive source.

5. True or False. Cesium-137 is located in the tip of the stainless steel rod which is used in taking moisture determinations and Americium-241:Beryllium is located inside the nuclear gauge and is used for density testing. False – Cesium-137 is located in the tip of the stainless steel rod and is used for density determinations and Americium-241: Beryllium is located inside the gauge and is used for moisture determinations.

6. When taking Standard Counts the Reference Standard should be placed on what type of surface?

   Smooth, flat, dry, and with a minimum density of 100 lb/ft^3

7. Three ways to limit exposure to radiation are time, distance, and shielding.

8. If the soil material fails a nuclear test because of excessive moisture, the first step taken is run another test checking test methods.

9. A testing method for testing densities whereby the source rod is inserted into the material to be tested to a depth of either 4, 6 or 8 inches is direct transmission.

10. If, during construction, the density results either change suddenly, or simply don't make sense to you, you should check your math and the test itself and if the sand cone was used was the sand properly calibrated or was there vibration nearby.

11. If the moisture results from the Nuclear test appear high, the Speedy Moisture Test could be used to check the moisture.

12. When a nuclear gauge is operated within 24 inches of a vertical structure, the moisture and density counts are influenced by the structure.

ANSWERS TO PRACTICE PROBLEMS CHAPTER 6
PROBLEM 5, PROBLEM 6, AND PROBLEM 7
Field Density Testing of Soil - Nuclear Method

TL-124

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

English Metric
Report No.: **45** Date: _____ Sheet No.: **1** of **1**
Route No.: **252** County: **Augusta**
Project No.: **07-0252-132-101,C501**
F.H.W.A. No.: **None**
Test For: **Embankment**
Nuclear Gauge Model No.: **3440** Serial No.: **23456**

STANDARD COUNT

DENSITY	MOISTURE
2844	**701**

		Problem 5	Problem 6	Problem 7
Test No.		**1**	**2**	**3**
Location	Station ft. (m)	**305 + 00**	**305 + 60**	**306 + 20**
Of	Ref. to center line ft. (m)	**@ CL**	**10 Ft. Lt.**	**7 Ft. Lt.**
Test	Elevation	**+10/-7**	**+3 / -10**	**+3 / -3**
Compacted Depth of Lift in. (mm)		**6”**	**6”**	**6”**
Method of Compaction		**Sheepsfoot**	**Sheepsfoot**	**Sheepsfoot**
A. Wet Density (lbs/ft^3), Wet Unit Mass (kg/m^3)	=	**133.3**	**123.6**	**128.2**
B. Moisture Unit Mass (lbs/ft^3), Moisture Unit Mass (kg/m^3)	=	**19.1**	**17.9**	**18.6**
C. Dry Density (lbs/ft^3), Dry Unit Mass (kg/m^3) (A - B)	=	**114.2**	**105.7**	**109.6**
D. Moisture Content (B ÷ C) x 100	=	**16.7**	**16.9**	**17.0**
E. Maximum Dry Density (lbs/ft^3), Dry Unit Mass (kg/m^3) Lab Proctor or One Point Proctor	=	**114.6**	**106.9**	**112.1**
F. Percent Optimum Moisture from Lab or One Point Proctor	=	**14.1** **11.3 – 16.9**	**17.6** **14.1 – 21.1**	**15.2** **12.2 – 18.2**
G. Percent of plus #4, (plus 4.75mm)	=			
H. Corrected Maximum Dry Density (lbs/ft^3) Dry Unit Mass (kg/m^3)	=			
I. Corrected Optimum Moisture	=			
J. Percent Dry Density (lbs/ft^3), Dry Unit Mass (kg/m^3) (C ÷ E) x 100 or (C ÷ H) x 100	=	**99.7**	**98.9**	**97.8**
K. Percent Minimum Density Required	=	**95.0**	**95.0**	**95.0**

Remarks:

Problem 5 - Passes - Moisture Content of 16.7% falls within optimum moisture range of 11.3 - 16.9 and minimum percent density required is 95% and 99.7% was achieved.
Problem 6 - Passes - Moisure Content of 16.9% falls within optimum moisture range of 14.1-21.1 and minimum percent density required is 95% and 98.9% was achieved.
Problem 7 - Passes - Moisture Content of 17.0% falls within optimum moisture range of 12.2 - 18.2 and minimum percent density required is 95% and 97.8% was achieved.

CC: District Materials Engineer
Project File

By: Robert Casper
Title: Engr. Tech.

ANSWERS TO PRACTICE PROBLEMS
CHAPTER 7
Practice Problem 1
+4 Correction for the Sand Cone Test on Soil

TL-125 Rev. 6/00 **VIRGINIA DEPARTMENT OF TRANSPORTATION**
REPORT OF SAND CONE DENSITY (UNIT MASS OF SOIL)

English ☐ Metric ☐
Report No.: Date:
Route No.: 635 County: Amherst
Project No.: 0635-005-187,C501 FHWA No.: FH-151(102)

Field Test No.		5		
Location of Test	Station ft. (m.)	**77 + 50**		
	Ref. To Center Line ft. (m.)	**5' Lt.**		
Reference Elevation	Original Ground ft. (m.)	**+6'**		
	Finished Grade ft. (m.)	**-10'**		
Compacted Depth of Lift in. (mm.)		**6"**		
Method of Compaction (Type of Roller)		**Sheepsfoot**		
DENSITY DETERMINATION				
A. Unit wt.(lbs/ft^3) or Unit mass (kg/m^3) of sand (calibrated value)		**86.5**		
B. Wt. (mass) sand + wt. (mass) of jar and cone, lb. (kg)		**15.8**		
C. Wt. (mass) sand left in jar + wt. (mass) of jar and cone, lb. (kg)		**7.89**		
D. Wt. (mass) of sand in cone and base plate, lb. (kg) (calibrated value)		**2.77**		
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)		**10.66**		
F. Wt. (mass) of sand in test hole (B - E), lb. (kg)		**5.14**		
G. Volume of test hole (F ÷ A), ft^3 (m^3)		**0.0594**		
H. Wt. (mass) of wet soil from test hole + (wt.) mass of pan, lb. (kg)		**9.30**		
I. Wt. (mass) of pan, lb. (kg)		**1.67**		
J. Wt. (mass) of wet soil from test hole (H - I), lb. (kg)		**7.63**		
K. Unit wt.(lbs/ft^3) or Unit mass (kg/m^3) of wet soil in fill (J ÷ G)		**128.5**		
L. Unit wt.(lbs/ft^3) or Unit mass (kg/m^3) of dry soil in fill = $\frac{K}{\{ 1 + [\text{Moisture Content (T)} \div 100] \}}$		**113.5**		
M. Max. Dry Unit Wt.(lbs/ft^3) or Unit mass (kg/m^3) from LAB PROCTOR OR ONE POINT PROCTOR (TL-125a)		**107.1**		
N. Optimum Moisture Content from LAB PROCTOR OR ONE POINT PROCTOR (TL-125a)		**17.6**		
O. Percent of +No. 4 (plus 4.75 mm) Material		**23**		
P. Corrected Maximum Dry Unit wt. (lbs/ft^3) or Unit mass (kg/m^3)		**116.4**		
Q. Corrected Optimum Moisture (%)	11.3 - 16.9	**14.1**		
R. % Compaction (L ÷ M) × 100 or (L ÷ P) × 100		**97.5**		
S. % Minimum density (unit mass) required (from specifications)		**95**		
MOISTURE DETERMINATION (Field Dried Method)				
a. Dish and damp soil, lb. (kg)		**9.30**		
b. Dish and dried soil, lb. (kg)		**8.41**		
c. Wt. (mass) moisture (a - b), lb. (kg)		**0.89**		
d. Wt. (mass) dish, lb. (kg)		**1.67**		
e. Wt. (mass) dry soil (b - d), lb. (kg)		**6.74**		
T. Moisture Content (c ÷ e) × 100 or from "Speedy" Moisture Test		**13.2**		

Remarks: Test passes. Minimum density required 95% and density achieved is 97.5% Moisture content of 13.2 falls within ± 20% of optimum (11.3 - 16.9)

By: _____

Title: _____

cc: District Materials Engineer

CALCULATION #1

Amount of +4 Material in Total Soil

Weight of Dry Soil + Dish	8.41 lb.	Weight of +4 Material + Dish	3.23 lb.
- Weight of Dish	1.67 lb.	- Weight of Dish	1.67 lb.
Total Weight of Dried Soil	6.74 lb.	Weight of +4 Material	1.56 lb.

$$\frac{\text{Weight of +4 Material } 1.56 \text{ lb.}}{\text{Total Weight of Dried Material } 6.74 \text{ lb.}} \times 100 = \mathbf{23}\ \%$$ **Enter on Line O**

CALCULATION #2

Total Density of Soils with +4 Material

Needed Information:

P_c = % +4 Material expressed as a decimal = 0.23 *(from Sieve Analysis)*

D_c = 2.63 (*Sp. Gr.of +4 Material from Materials Division)* x 62.4 lb/ft³ = 164.1 lb/ft³

P_f = % -4 Material expressed as a decimal = 0.77 *(determined from Sieve Analysis)*

D_f = Maximum Dry Density of -4 Material = 107.1 lb/ft³ *(from Proctor)*

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

$$\frac{107.1 \text{ lb/ft}^3 \times 164.1 \text{ lb/ft}^3}{(0.23 \times 107.1 \text{ lb/ft}^3) + (0.77 \times 164.1 \text{ lb/ft}^3)}$$

$$\frac{17575.1}{24.6 + 126.4} = \frac{17575.1}{151.0} = \mathbf{116.4}\ \text{lb/ft}^3$$ Maximum Dry Density of Total Soil **Enter on Line P**

CALCULATION #3

Optimum Moisture Content of Dense Graded Aggregate

Needed Information:

P_c = % +4 Material expressed as a decimal = 0.23 *(from Sieve Analysis)*

W_c = Absorption of +4 Material expressed as a decimal = 0.02 *(from Materials Division)*

P_f = % -4 Material expressed as a decimal = 0.77 *(determined from Sieve Analysis)*

W_f = Optimum Moisture of -4 Material expressed as a decimal = 0.176 *(from Proctor)*

$$(P_cW_c + P_fW_f)\ 100$$

$$[(0.23 \times 0.02) + (0.77 \times 0.176)]\ 100$$

$$(0.005 + 0.136)\ 100$$

$$(0.141)\ 100 = \mathbf{14.1}\ \%$$ **Enter on Line Q**

14.1 x .20 = 2.8 14.1 - 2.8 = 11.3 14.1 + 2.8 = 16.9 Optimum Moisture Range = 11.3 - 16.9

CHAPTER 7
Practice Problem 2
+4 Correction for the Sand Cone Test on Soil

TL-125 Rev. 6/00 **VIRGINIA DEPARTMENT OF TRANSPORTATION**
REPORT OF SAND CONE DENSITY (UNIT MASS OF SOIL)

English ☐ Metric ☐
Report No.: Date:
Route No.: 635 County: Amherst
Project No.: 0635-005-187,C501 FHWA No.: FH-151(102)

Field Test No.		**1**		
Location of Test	Station ft. (m.)	**77 + 50**		
	Ref. To Center Line ft. (m.)	**7' Lt.**		
Reference Elevation	Original Ground ft. (m.)	**+10'**		
	Finished Grade ft. (m.)	**-23'**		
Compacted Depth of Lift in. (mm.)		**6"**		
Method of Compaction (Type of Roller)		**Sheepsfoot**		
DENSITY DETERMINATION				
A. Unit wt.(lbs/ft^3) or Unit mass (kg/m^3) of sand (calibrated value)		**86.5**		
B. Wt. (mass) sand + wt. (mass) of jar and cone, lb. (kg)		**15.8**		
C. Wt. (mass) sand left in jar + wt. (mass) of jar and cone, lb. (kg)		**7.89**		
D. Wt. (mass) of sand in cone and base plate, lb. (kg) (calibrated value)		**2.77**		
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)		**10.66**		
F. Wt. (mass) of sand in test hole (B - E), lb. (kg)		**5.14**		
G. Volume of test hole (F ÷ A), ft^3 (m^3)		**0.0594**		
H. Wt. (mass) of wet soil from test hole + (wt.) mass of pan, lb. (kg)		**9.10**		
I. Wt. (mass) of pan, lb. (kg)		**1.63**		
J. Wt. (mass) of wet soil from test hole (H - I), lb. (kg)		**7.47**		
K. Unit wt.(lbs/ft^3) or Unit mass (kg/m^3) of wet soil in fill (J ÷ G)		**125.8**		
L. Unit wt.(lbs/ft^3) or Unit mass (kg/m^3) of dry soil in fill = $\frac{K}{\{ 1 + [\text{Moisture Content (T)} \div 100] \}}$		**111.5**		
M. Max. Dry Unit Wt.(lbs/ft^3) or Unit mass (kg/m^3) from LAB PROCTOR OR ONE POINT PROCTOR (TL-125a)		**107.1**		
N. Optimum Moisture Content from LAB PROCTOR OR ONE POINT PROCTOR (TL-125a)		**17.6**		
O. Percent of +No. 4 (plus 4.75 mm) Material		**22**		
P. Corrected Maximum Dry Unit wt. (lbs/ft^3) or Unit mass (kg/m^3)		**115.7**		
Q. Corrected Optimum Moisture (%) 11.3 - 16.9		**14.1**		
R. % Compaction (L ÷ M) × 100 or (L ÷ P) × 100		**96.4**		
S. % Minimum density (unit mass) required (from specifications)		**95**		
MOISTURE DETERMINATION (Field Dried Method)				
a. Dish and damp soil, lb. (kg)		**9.10**		
b. Dish and dried soil, lb. (kg)		**8.25**		
c. Wt. (mass) moisture (a - b), lb. (kg)		**0.85**		
d. Wt. (mass) dish, lb. (kg)		**1.63**		
e. Wt. (mass) dry soil (b - d), lb. (kg)		**6.62**		
T. Moisture Content (c ÷ e) × 100 or from "Speedy" Moisture Test		**12.8**		

Remarks: Test passes. Minimum required density 95% and density achieved is 96.4%. Moisture Content 12.8 falls within ± 20% of optimum (11.3 - 16.9)

By: _____

Title: _____

cc: District Materials Engineer

CALCULATION #1

Amount of +4 Material in Total Soil

Weight of Dry Soil + Dish	8.25 lb.	Weight of +4 Material + Dish	3.10 lb.
- Weight of Dish	1.63 lb.	- Weight of Dish	1.63 lb.
Total Weight of Dried Soil	6.62 lb.	Weight of +4 Material	1.47 lb.

$$\frac{\text{Weight of +4 Material } 1.47 \text{ lb.}}{\text{Total Weight of Dried Material } 6.62 \text{ lb.}} \times 100 = \mathbf{22}\ \%$$ **Enter on Line O**

CALCULATION #2

Total Density of Soils with +4 Material

Needed Information:

P_c = % +4 Material expressed as a decimal = 0.22 *(from Sieve Analysis)*

D_c = 2.60 (*Sp. Gr.of +4 Material from Materials Division)* x 62.4 lb/ft³ = 162.2 lb/ft³

P_f = % -4 Material expressed as a decimal = 0.78 *(determined from Sieve Analysis)*

D_f = Maximum Dry Density of -4 Material = 107.1 lb/ft³ *(from Proctor)*

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

$$\frac{107.1 \text{ lb/ft}^3 \times 162.2 \text{ lb/ft}^3}{(0.22 \times 107.1 \text{ lb/ft}^3) + (0.78 \times 162.2 \text{ lb/ft}^3)}$$

$$\frac{17371.6}{23.6 + 126.5} = \frac{17371.6}{150.1} = \mathbf{115.7\ lb/ft^3}$$ Maximum Dry Density of Total Soil **Enter on Line P**

CALCULATION #3

Optimum Moisture Content of Dense Graded Aggregate

Needed Information:

P_c = % +4 Material expressed as a decimal = 0.22 *(from Sieve Analysis)*

W_c = Absorption of +4 Material expressed as a decimal = 0.02 *(from Materials Division)*

P_f = % -4 Material expressed as a decimal = 0.78 *(determined from Sieve Analysis)*

W_f = Optimum Moisture of -4 Material expressed as a decimal = 0.176 *(from Proctor)*

$$(P_c W_c + P_f W_f)\ 100$$

$$[(0.22 \times 0.02) + (0.78 \times 0.176)]\ 100$$

$$(0.004 + 0.137)\ 100$$

$$(0.141)\ 100 = \mathbf{14.1}\ \%$$ **Enter on Line Q**

14.1 x .20 = 2.8 14.1 - 2.8 = 11.3 14.1 + 2.8 = 16.9 Optimum Moisture Range = 11.3 - 16.9

CHAPTER 7
Practice Problem 3
+4 Correction for the Sand Cone Test on Soil

TL-125 Rev. 6/00 **VIRGINIA DEPARTMENT OF TRANSPORTATION**
REPORT OF SAND CONE DENSITY (UNIT MASS OF SOIL)

English ☐ Metric ☐
Report No.: Date:
Route No.: 635 County: Amherst
Project No.: 0635-005-187,C501 FHWA No.: FH-151(102)

Field Test No.		34		
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				
A. Unit wt.(lbs/ft^3) or Unit mass (kg/m^3) of sand (calibrated value)		**86.5**		
B. Wt. (mass) sand + wt. (mass) of jar and cone, lb. (kg)		**13.29**		
C. Wt. (mass) sand left in jar + wt. (mass) of jar and cone, lb. (kg)		**5.09**		
D. Wt. (mass) of sand in cone and base plate, lb. (kg) (calibrated value)		**2.76**		
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)		**7.85**		
F. Wt. (mass) of sand in test hole (B - E), lb. (kg)		**5.44**		
G. Volume of test hole (F ÷ A), ft^3 (m^3)		**0.0629**		
H. Wt. (mass) of wet soil from test hole + (wt.) mass of pan, lb. (kg)		**9.38**		
I. Wt. (mass) of pan, lb. (kg)		**1.67**		
J. Wt. (mass) of wet soil from test hole (H - I), lb. (kg)		**7.71**		
K. Unit wt.(lbs/ft^3) or Unit mass (kg/m^3) of wet soil in fill (J ÷ G)		**122.6**		
L. Unit wt.(lbs/ft^3) or Unit mass (kg/m^3) of dry soil in fill = $\frac{K}{\{ 1 + [\text{Moisture Content (T)} \div 100] \}}$		**106.2**		
M. Max. Dry Unit Wt.(lbs/ft^3) or Unit mass (kg/m^3) 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		**23**		
P. Corrected Maximum Dry Unit wt. (lbs/ft^3) or Unit mass (kg/m^3)		**112.2**		
Q. Corrected Optimum Moisture (%) 12.9 - 19.3		**16.1**		
R. % Compaction (L ÷ M) × 100 or (L ÷ P) × 100		**94.7**		
S. % Minimum density (unit mass) required (from specifications)		**95**		
MOISTURE DETERMINATION (Field Dried Method)				
a. Dish and damp soil, lb. (kg)		**9.38**		
b. Dish and dried soil, lb. (kg)		**8.35**		
c. Wt. (mass) moisture (a - b), lb. (kg)		**1.03**		
d. Wt. (mass) dish, lb. (kg)		**1.67**		
e. Wt. (mass) dry soil (b - d), lb. (kg)		**6.68**		
T. Moisture Content (c ÷ e) × 100 or from "Speedy" Moisture Test		**15.4**		

Remarks: Test failed. Minimum required density 95% and density achieved is 94.7%. Moisture content of 15.4 falls within ± 20% of optimum (12.9 - 19.3)

By: _____

Title: _____

cc: District Materials Engineer

CALCULATION #1

Amount of +4 Material in Total Soil

Weight of Dry Soil + Dish	8.35	lb.	Weight of +4 Material + Dish	3.23	lb.
- Weight of Dish	1.67	lb.	- Weight of Dish	1.67	lb.
Total Weight of Dried Soil	6.68	lb.	Weight of +4 Material	1.56	lb.

$$\frac{\text{Weight of +4 Material } 1.56 \text{ lb.}}{\text{Total Weight of Dried Material } 6.68 \text{ lb.}} \times 100 = \mathbf{23}\ \%$$ **Enter on Line O**

CALCULATION #2

Total Density of Soils with +4 Material

Needed Information:

P_c = % +4 Material expressed as a decimal = 0.23 *(from Sieve Analysis)*

D_c = 2.65 (*Sp. Gr.of +4 Material from Materials Division)* x 62.4 lb/ft³ = 165.4 lb/ft³

P_f = % -4 Material expressed as a decimal = 0.77 *(determined from Sieve Analysis)*

D_f = Maximum Dry Density of -4 Material = 102.4 lb/ft³ *(from Proctor)*

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

$$\frac{102.4 \text{ lb/ft}^3 \times 165.4 \text{ lb/ft}^3}{(0.23 \times 102.4 \text{ lb/ft}^3) + (0.77 \times 165.4 \text{ lb/ft}^3)}$$

$$\frac{16937.0}{23.6 + 127.4} = \frac{16937.0}{151.0} = \mathbf{112.2\ lb/ft^3}$$ Maximum Dry Density of Total Soil **Enter on Line P**

CALCULATION #3

Optimum Moisture Content of Dense Graded Aggregate

Needed Information:

P_c = % +4 Material expressed as a decimal = 0.23 *(from Sieve Analysis)*

W_c = Absorption of +4 Material expressed as a decimal = 0.02 *(from Materials Division)*

P_f = % -4 Material expressed as a decimal = 0.77 *(determined from Sieve Analysis)*

W_f = Optimum Moisture of -4 Material expressed as a decimal = 0.203 *(from Proctor)*

$$(P_c W_c + P_f W_f)\ 100$$

$$[(0.23 \times 0.02) + (0.77 \times 0.203)]\ 100$$

$$(0.005 + 0.156)\ 100$$

$$(0.161)\ 100 = \mathbf{16.1}\ \%$$ **Enter on Line Q**

16.1 x .20 = 3.2 16.1 - 3.28 = 12.9 16.1 + 3.2 = 19.3 Optimum Moisture Range = 12.9 - 19.3

CHAPTER 7
Practice Problem 4
+4 Correction for the Nuclear Density Test on Soil

TL-124

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

English Metric
Report No.: _____ Date: _____ Sheet No.: 1 of 1
Route No.: 117 County: Roanoke
Project No.: 0117-080-105,C501 F.H.W.A. No.: None
Test For: Embankment
Nuclear Gauge Model No.: 3440 Serial No.: 23456

STANDARD COUNT
DENSITY 2844 MOISTURE 701

Test No.		**6**		
Location of Test	Station ft. (m)	**90+45**		
	Ref. to center line ft. (m)	**6' Rt.**		
	Elevation	**+8 / -6**		
Compacted Depth of Lift in. (mm)		**6"**		
Method of Compaction		**Sheepsfoot**		
A. Wet Density (lbs/ft³), Wet Unit Mass (kg/m³)	=	**127.4**		
B. Moisture Unit Mass (lbs/ft³), Moisture Unit Mass (kg/m³)	=	**12.6**		
C. Dry Density (lbs/ft³), Dry Unit Mass (kg/m³) (A - B)	=	**114.8**		
D. Moisture Content (B ÷ C) x 100	=	**11.0**		
E. Maximum Dry Density (lbs/ft³), Dry Unit Mass (kg/m³) Lab Proctor or One Point Proctor	=	**112.6**		
F. Percent Optimum Moisture from Lab or One Point Proctor	=	**14.5**		
G. Percent of plus #4, (plus 4.75mm)	=	**15.0**		
H. Corrected Maximum Dry Density (lbs/ft³) Dry Unit Mass (kg/m³)	=	**118.1**		
I. Corrected Optimum Moisture	=	**12.8 10.2 – 15.4**		
J. Percent Dry Density (lbs/ft³), Dry Unit Mass (kg/m³) (C ÷ E) x 100 or (C ÷ H) x 100	=	**97.2**		
K. Percent Minimum Density Required	=	**95.0**		

Remarks:

Test passes: Moisture Content of 11.0% falls within optimum moisture range of 10.2-15.4%. Density achieved is 97.2% and minimum required density is 95.0%.

CC: District Materials Engineer By: _____

Project File Title _____

CALCULATION #1

Amount of +4 Material in Total Soil

Weight of Dry Soil + Dish	9.29	lb.	Weight of +4 Material + Dish	3.63	lb.
- Weight of Dish	2.62	lb.	- Weight of Dish	2.62	lb.
Total Weight of Dried Soil	6.67	lb.	Weight of +4 Material	1.01	lb.

$$\frac{\text{Weight of +4 Material } 1.01 \text{ lb.}}{\text{Total Weight of Dried Material } 6.67 \text{ lb.}} \times 100 = \mathbf{15}\ \%$$ **Enter on Line G**

CALCULATION #2

Total Density of Soils with +4 Material

Needed Information:

P_c = % +4 Material expressed as a decimal = 0.15 *(from Sieve Analysis)*

D_c = 2.63 (*Sp. Gr.of +4 Material from Materials Division)* x 62.4 lb/ft³ = 164.1 lb/ft³

P_f = % -4 Material expressed as a decimal = 0.85 *(determined from Sieve Analysis)*

D_f = Maximum Dry Density of -4 Material = 112.6 lb/ft³ *(from Proctor)*

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

$$\frac{112.6 \text{ lb/ft}^3 \times 164.1 \text{ lb/ft}^3}{(0.15 \times 112.6 \text{ lb/ft}^3) + (0.85 \times 164.1 \text{ lb/ft}^3)}$$

$$\frac{18477.7}{16.9 + 139.5} = \frac{18477.7}{156.4} = \mathbf{118.1\ lb/ft^3}$$ 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 Material expressed as a decimal = 0.15 *(from Sieve Analysis)*

W_c = Absorption of +4 Material expressed as a decimal = 0.03 *(from Materials Division)*

P_f = % -4 Material expressed as a decimal = 0.85 *(determined from Sieve Analysis)*

W_f = Optimum Moisture of -4 Material expressed as a decimal = 0.145 *(from Proctor)*

$$(P_cW_c + P_fW_f)\ 100$$

$$[(0.15 \times 0.03) + (0.85 \times 0.145)]\ 100$$

$$(0.005 + 0.123)\ 100$$

$$(0.128)\ 100 = \mathbf{12.8}\ \%$$ **Enter on Line I**

12.8 x .20 = 2.6 12.8 - 2.6 = 10.2 12.8 + 2.6 = 15.4 Optimum Moisture Range = 10.2 - 15.4

CHAPTER 7
Practice Problem 5
+4 Correction for the Nuclear Density Test

TL-124

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

English Metric
Report No.: _____ Date: _____ Sheet No.: 1 of 1
Route No.: 117 County: Roanoke
Project No.: 0117-080-105,C501
F.H.W.A. No.: None
Test For: Embankment
Nuclear Gauge Model No.: 3440 Serial No.: 23456

STANDARD COUNT

DENSITY 2844 MOISTURE 701

Test No.		**6**		
Location of Test	Station ft. (m)	**90+45**		
	Ref. to center line ft. (m)	**6' Rt.**		
	Elevation	**+8 / -6**		
Compacted Depth of Lift in. (mm)		**6"**		
Method of Compaction		**Sheepsfoot**		
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)	=	**15.0**		
H. Corrected Maximum Dry Density (lbs/ft³) Dry Unit Mass (kg/m³)	=	**116.5**		
I. Corrected Optimum Moisture	=	**12.5** **10.0 – 15.0**		
J. Percent Dry Density (lbs/ft³), Dry Unit Mass (kg/m³) (C ÷ E) x 100 or (C ÷ H) x 100	=	**99.3**		
K. Percent Minimum Density Required	=	**95.0**		

Remarks: **Test passes - Moisture Content 10.5% falls within optimum moisture range of 10.0-15.0%. Density achieved is 99.3% and minimum required density is 95%.**

CC: District Materials Engineer
Project File

CALCULATION #1
Amount of +4 Material in Total Soil

Weight of Dry Soil + Dish	9.30	lb.	Weight of +4 Material + Dish	3.65	lb.
- Weight of Dish	2.62	lb.	- Weight of Dish	2.62	lb.
Total Weight of Dried Soil	6.68	lb.	Weight of +4 Material	1.03	lb.

$$\frac{\text{Weight of +4 Material } 1.03 \text{ lb.}}{\text{Total Weight of Dried Material } 6.68 \text{ lb.}} \times 100 = \mathbf{15}\ \%$$ **Enter on Line G**

CALCULATION #2
Total Density of Soils with +4 Material

Needed Information:
P_c = % +4 Material expressed as a decimal = 0.15 *(from Sieve Analysis)*

D_c = 2.70 (*Sp. Gr.of +4 Material from Materials Division)* x 62.4 lb/ft³ = 168.5 lb/ft³

P_f = % -4 Material expressed as a decimal = 0.85 *(determined from Sieve Analysis)*

D_f = Maximum Dry Density of -4 Material = 110.5 lb/ft³ *(from Proctor)*

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

$$\frac{110.5 \text{ lb/ft}^3 \times 168.5 \text{ lb/ft}^3}{(0.15 \times 110.5 \text{ lb/ft}^3) + (0.85 \times 168.5 \text{ lb/ft}^3)}$$

$$\frac{18619.3}{16.6 + 143.2} = \frac{18619.3}{159.8} = \mathbf{116.5\ lb/ft^3}$$ 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 Material expressed as a decimal = 0.15 *(from Sieve Analysis)*

W_c = Absorption of +4 Material expressed as a decimal = 0.02 *(from Materials Division)*

P_f = % -4 Material expressed as a decimal = 0.85 *(determined from Sieve Analysis)*

W_f = Optimum Moisture of -4 Material expressed as a decimal = 0.143 *(from Proctor)*

$$(P_c W_c + P_f W_f)\ 100$$

$$[(0.15 \times 0.02) + (0.85 \times 0.143)]\ 100$$

$$(0.003 + 0.122)\ 100$$

$$(0.125)\ 100 = \mathbf{12.5}\ \%$$ **Enter on Line I**

12.5 x .20 = 2.5 12.5 - 2.5 = 10.0 12.5 + 2.5= 15.0 Optimum Moisture Range = 10.0 - 15.0

CHAPTER 7
Practice Problem 6
+4 Correction for the Nuclear Density Test on Soil

TL-124

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

English Metric
Report No.: _____ Date: _____ Sheet No.: 1 of 1
Route No.: 117 County: Roanoke
Project No.: 0117-080-105,C501
F.H.W.A. No.: None
Test For: Embankment
Nuclear Gauge Model No.: 3440 Serial No.: 23456

STANDARD COUNT
DENSITY 2844 MOISTURE 701

Test No.		**6**		
Location of Test — Station ft. (m)		**90+40**		
Location of Test — Ref. to center line ft. (m)		**6' Rt.**		
Location of Test — Elevation		**+8.9 / -6.2**		
Compacted Depth of Lift in. (mm)		**6"**		
Method of Compaction		**Sheepsfoot**		
A. Wet Density (lbs/ft³), Wet Unit Mass (kg/m³)	=	**127.5**		
B. Moisture Unit Mass (lbs/ft³), Moisture Unit Mass (kg/m³)	=	**12.8**		
C. Dry Density (lbs/ft³), Dry Unit Mass (kg/m³) (A - B)	=	**114.7**		
D. Moisture Content (B ÷ C) x 100	=	**11.2**		
E. Maximum Dry Density (lbs/ft³), Dry Unit Mass (kg/m³) Lab Proctor or One Point Proctor	=	**109.9**		
F. Percent Optimum Moisture from Lab or One Point Proctor	=	**13.9**		
G. Percent of plus #4, (plus 4.75mm)	=	**13.0**		
H. Corrected Maximum Dry Density (lbs/ft³) Dry Unit Mass (kg/m³)	=	**115.0**		
I. Corrected Optimum Moisture	=	**12.4** **9.9 – 14.9**		
J. Percent Dry Density (lbs/ft³), Dry Unit Mass (kg/m³) (C ÷ E) x 100 or (C ÷ H) x 100	=	**99.7**		
K. Percent Minimum Density Required	=	**95.0**		

Remarks: **Test passes. Moisture content of 11.2% falls within optimum moisture range of 9.9-14.9%. Minimum density required is 95.0% and 99.7% was achieved.**

CC: District Materials Engineer
Project File

Title _____

CALCULATION #1

Amount of +4 Material in Total Soil

Weight of Dry Soil + Dish	9.29	lb.	Weight of +4 Material + Dish	3.51	lb.
- Weight of Dish	2.62	lb.	- Weight of Dish	2.62	lb.
Total Weight of Dried Soil	6.67	lb.	Weight of +4 Material	0.89	lb.

$$\frac{\text{Weight of +4 Material } 0.89 \text{ lb.}}{\text{Total Weight of Dried Material } 6.67 \text{ lb.}} \times 100 = \mathbf{13}\ \%$$ **Enter on Line G**

CALCULATION #2

Total Density of Soils with +4 Material

Needed Information:

P_c = % +4 Material expressed as a decimal = 0.13 *(from Sieve Analysis)*

D_c = 2.68 (*Sp. Gr.of +4 Material from Materials Division)* x 62.4 lb/ft³ = 167.2 lb/ft³

P_f = % -4 Material expressed as a decimal = 0.87 *(determined from Sieve Analysis)*

D_f = Maximum Dry Density of -4 Material = 109.9 lb/ft³ *(from Proctor)*

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

$$\frac{109.9 \text{ lb/ft}^3 \times 167.2 \text{ lb/ft}^3}{(0.13 \times 109.9 \text{ lb/ft}^3) + (0.87 \times 167.2 \text{ lb/ft}^3)}$$

$$\frac{18375.3}{14.3 + 145.5} = \frac{18375.3}{159.8} = \mathbf{115.0\ lb/ft^3}$$ 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 Material expressed as a decimal = 0.13 *(from Sieve Analysis)*

W_c = Absorption of +4 Material expressed as a decimal = 0.02 *(from Materials Division)*

P_f = % -4 Material expressed as a decimal = 0.87 *(determined from Sieve Analysis)*

W_f = Optimum Moisture of -4 Material expressed as a decimal = 0.139 *(from Proctor)*

$$(P_c W_c + P_f W_f)\ 100$$

$$[(0.13 \times 0.02) + (0.87 \times 0.139)]\ 100$$

$$(0.003 + 0.121)\ 100$$

$$(0.124)\ 100 = \mathbf{12.4}\ \%$$ **Enter on Line I**

12.4 x .20 = 2.5 12.4 - 2.5 = 9.9 12.4 + 2.5= 14.9 Optimum Moisture Range = 9.9 - 14.9

CHAPTER 7
Practice Problem 7
Density Testing with the Sand Cone on Aggregate

TL-125 Rev. 6/00 **VIRGINIA DEPARTMENT OF TRANSPORTATION**
REPORT OF SAND CONE DENSITY (UNIT MASS OF SOIL)

English ☐ Metric ☐
Report No.:_____ Date: _____
Route No.: 265 County: Pittsylvania
Project No.: 6265-071-102,C502 FHWA No.: F-045-1(113)

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 (Type of Roller)		**Vib. Roller**		
DENSITY DETERMINATION				
A. Unit wt.(lbs/ft^3) or Unit mass (kg/m^3) of sand (calibrated value)		**86.0**		
B. Wt. (mass) sand + wt. (mass) of jar and cone, lb. (kg)		**12.52**		
C. Wt. (mass) sand left in jar + wt. (mass) of jar and cone, lb. (kg)		**5.76**		
D. Wt. (mass) of sand in cone and base plate, lb. (kg) (calibrated value)		**2.64**		
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)		**8.40**		
F. Wt. (mass) of sand in test hole (B - E), lb. (kg)		**4.12**		
G. Volume of test hole (F ÷ A), ft^3 (m^3)		**0.0479**		
H. Wt. (mass) of wet soil from test hole + (wt.) mass of pan, lb. (kg)		**9.82**		
I. Wt. (mass) of pan, lb. (kg)		**2.60**		
J. Wt. (mass) of wet soil from test hole (H - I), lb. (kg)		**7.22**		
K. Unit wt.(lbs/ft^3) or Unit mass (kg/m^3) of wet soil in fill (J ÷ G)		**150.7**		
L. Unit wt.(lbs/ft^3) or Unit mass (kg/m^3) of dry soil in fill = $\frac{K}{\{ 1 + [\text{Moisture Content (T)} \div 100] \}}$		**143.3**		
M. Max. Dry Unit Wt.(lbs/ft^3) or Unit mass (kg/m^3) from LAB PROCTOR OR ONE POINT PROCTOR (TL-125a)		**131.7**		
N. Optimum Moisture Content from LAB PROCTOR OR ONE POINT PROCTOR (TL-125a)		**7.8**		
O. Percent of +No. 4 (plus 4.75 mm) Material		**51**		
P. Corrected Maximum Dry Unit wt. (lbs/ft^3) or Unit mass (kg/m^3)		**146.4**		
Q. Corrected Optimum Moisture (%)	2.5 - 6.5	**4.5**		
R. % Compaction (L ÷ M) × 100 or (L ÷ P) × 100		**97.9**		
S. % Minimum density (unit mass) required (from specifications)		**95**		
MOISTURE DETERMINATION (Field Dried Method)				
a. Dish and damp soil, lb. (kg)		**9.82**		
b. Dish and dried soil, lb. (kg)		**9.46**		
c. Wt. (mass) moisture (a - b), lb. (kg)		**0.36**		
d. Wt. (mass) dish, lb. (kg)		**2.60**		
e. Wt. (mass) dry soil (b - d), lb. (kg)		**6.86**		
T. Moisture Content (c ÷ e) × 100 or from "Speedy" Moisture Test		**5.20**		

Remarks: Test passes. Minimum density required is 95% - density achieved is 97.9%. Moisture Content of 5.2 falls within optimum range of 2.5 - 6.5.

By: _____
Title: _____
cc: District Materials Engineer
Project File

CALCULATION #1

Amount of +4 Material in Total Soil

Weight of Dry Soil + Dish	9.46	lb.	Weight of +4 Material + Dish	6.08	lb.
- Weight of Dish	2.60	lb.	- Weight of Dish	2.60	lb.
Total Weight of Dried Soil	6.86	lb.	Weight of +4 Material	3.48	lb.

$$\frac{\text{Weight of +4 Material } 3.48 \text{ lb.}}{\text{Total Weight of Dried Material } 6.86 \text{ lb.}} \times 100 = \mathbf{51}\ \%$$ **Enter on Line O**

CALCULATION #2

Total Density of Soils with +4 Material

Needed Information:

P_c = Percent +4 Material expressed as a decimal = 0.51 (from Sieve Analysis)
D_c = 2.63(Sp. Gr. of +4 Material from Materials Div.) x 62.4 lb/ft^3 = 164.1 lb/ft^3
P_f = Percent -4 Material expressed as a decimal = 0.49 (determined from Sieve Analysis)
D_f = Maximum Dry Density -4 Material = 131.7 lb/ft^3 (from Proctor)

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

$$\frac{131.7 \text{ lb/ft}^3 \times 164.1 \text{ lb/ft}^3}{(0.51 \times 131.7 \text{ lb/ft}^3) + (0.49 \times 164.1 \text{ lb/ft}^3)}$$

$$\frac{21612.0}{67.2 + 80.4} = \frac{21612.0}{147.6} = \mathbf{146.4}\ \text{lb/ft}^3$$ 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 = 0.51 (from Sieve Analysis)
W_c = Absorption of +4 Matl. plus 1 expressed as a decimal = 0.013 (from Matl's.Div.)
P_f = % -4 Material expressed as a decimal = 0.49 (determined from Sieve Analysis)
W_f = Optimum Moisture of -4 Material expressed as a decimal = 0.078 (from Proctor)

$$(P_cW_c + P_fW_f)\ 100$$

$$[(0.51 \times 0.013) + (0.49 \times 0.078)]\ 100$$

$$(0.007 + 0.038)\ 100$$

$$(0.045)\ 100 = \mathbf{4.5}\ \%$$ **Enter on Line Q**

4.5 - 2 = 2.5 4.5 + 2 = 6.5 Optimum Moisture Range = 2.5 - 6.5

CHAPTER 7
Practice Problem 8
Density Testing with the Sand Cone on Aggregate

TL-125 Rev. 6/00 **VIRGINIA DEPARTMENT OF TRANSPORTATION**
REPORT OF SAND CONE DENSITY (UNIT MASS OF SOIL)

English ☐ Metric ☐
Report No.: _____ Date: _____
Route No.: 265 County: Pittsylvania
Project No.: 6265-071-102,C502 FHWA No.: F-045-1(113)

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 (Type of Roller)		**Vib. Roller**		
DENSITY DETERMINATION				
A. Unit wt.(lbs/ft^3) or Unit mass (kg/m^3) 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), ft^3 (m^3)		**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/ft^3) or Unit mass (kg/m^3) of wet soil in fill (J ÷ G)		**150.5**		
L. Unit wt.(lbs/ft^3) or Unit mass (kg/m^3) of dry soil in fill = $\frac{K}{\{ 1 + [\text{Moisture Content (T)} \div 100] \}}$		**144.6**		
M. Max. Dry Unit Wt.(lbs/ft^3) or Unit mass (kg/m^3) 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		**49**		
P. Corrected Maximum Dry Unit wt. (lbs/ft^3) or Unit mass (kg/m^3)		**143.3**		
Q. Corrected Optimum Moisture (%) 2.8 - 6.8		**4.8**		
R. % Compaction (L ÷ M) × 100 or (L ÷ P) × 100		**100.9**		
S. % Minimum density (unit mass) required (from specifications)		**100**		
MOISTURE DETERMINATION (For Field Dried Method)				
a. Dish and damp soil, lb. (kg)		**8.72**		
b. Dish and dried soil, lb. (kg)		**8.44**		
c. Wt. (mass) moisture (a - b), lb. (kg)		**0.28**		
d. Wt. (mass) dish, lb. (kg)		**1.63**		
e. Wt. (mass) dry soil (b - d), lb. (kg)		**6.81**		
T. Moisture Content (c ÷ e) × 100 or from "Speedy" Moisture Test		**4.1**		

Remarks: Test passes. Minimum density required is 100%. Density achieved is 100.9%. Moisture Content 4.1 falls within optimum moisture range of 2.8 - 6.8.

By: _____
Title: _____
cc:District Materials Engineer
Project File

CALCULATION #1

Amount of +4 Material in Total Soil

Weight of Dry Soil + Dish	8.44	lb.	Weight of +4 Material + Dish	4.95	lb.
- Weight of Dish	1.63	lb.	- Weight of Dish	1.63	lb.
Total Weight of Dried Soil	6.81	lb.	Weight of +4 Material	3.32	lb.

$$\frac{\text{Weight of +4 Material } 3.32 \text{ lb.}}{\text{Total Weight of Dried Material } 6.81 \text{ lb.}} \times 100 = \mathbf{49}\ \%$$ **Enter on Line O**

CALCULATION #2

Total Density of Soils with +4 Material

Needed Information:

P_c = Percent +4 Material expressed as a decimal = 0.49 (from Sieve Analysis)
D_c = 2.65(Sp. Gr. of +4 Material from Materials Div.) x 62.4 lb/ft^3 = 165.4 lb/ft^3
P_f = Percent -4 Material expressed as a decimal = 0.51 (determined from Sieve Analysis)
D_f = Maximum Dry Density -4 Material = 127.0 lb/ft^3 (from Proctor)

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

$$\frac{127.0 \text{ lb/ft}^3 \times 165.4 \text{ lb/ft}^3}{(0.49 \times 127.0 \text{ lb/ft}^3) + (0.51 \times 165.4 \text{ lb/ft}^3)}$$

$$\frac{21005.8}{62.2 + 84.4} = \frac{21005.8}{146.6} = \mathbf{143.3 \text{ lb/ft}^3}$$ 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 = 0.49 (from Sieve Analysis)
W_c = Absorption of +4 Matl. plus 1 expressed as a decimal = 0.013 (from Matl's.Div.)
P_f = % -4 Material expressed as a decimal = 0.51 (determined from Sieve Analysis)
W_f = Optimum Moisture of -4 Material expressed as a decimal = 0.082 (from Proctor)

$$(P_c W_c + P_f W_f)\ 100$$

$$[(0.49 \times 0.013) + (0.51 \times 0.082)]\ 100$$

$$(0.006 + 0.042)\ 100$$

$$(0.048)\ 100 = \mathbf{4.8}\ \%$$ **Enter on Line Q**

4.8 - 2 = 2.8 4.8 + 2 = 6.8 Optimum Moisture Range = 2.8 - 6.8

CHAPTER 7
Practice Problem 9
Density Testing with the Sand Cone on Aggregate

TL-125 Rev. 6/00 **VIRGINIA DEPARTMENT OF TRANSPORTATION**
REPORT OF SAND CONE DENSITY (UNIT MASS OF SOIL)

English ☐ Metric ☐
Report No.: _____ Date: _____
Route No.: 265 County: Pittsylvania
Project No.: 6265-071-102,G302 FHWA No.: F-045-1(113)

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 (Type of Roller)		**Vib. Roller**		
DENSITY DETERMINATION				
A. Unit wt.(lbs/ft^3) or Unit mass (kg/m^3) 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), ft^3 (m^3)		**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/ft^3) or Unit mass (kg/m^3) of wet soil in fill (J ÷ G)		**145.8**		
L. Unit wt.(lbs/ft^3) or Unit mass (kg/m^3) of dry soil in fill = $\frac{K}{\{ 1 + [\text{Moisture Content (T)} \div 100] \}}$		**140.6**		
M. Max. Dry Unit Wt.(lbs/ft^3) or Unit mass (kg/m^3) 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		**48**		
P. Corrected Maximum Dry Unit wt. (lbs/ft^3) or Unit mass (kg/m^3)		**143.2**		
Q. Corrected Optimum Moisture (%)	3.3 - 7.3	**5.3**		
R. % Compaction (L ÷ M) × 100 or (L ÷ P) × 100		**98.2**		
S. % Minimum density (unit mass) required (from specifications)		**100**		
MOISTURE DETERMINATION (For Field Dried Method)				
a. Dish and damp soil, lb. (kg)		**8.67**		
b. Dish and dried soil, lb. (kg)		**8.42**		
c. Wt. (mass) moisture (a - b), lb. (kg)		**0.25**		
d. Wt. (mass) dish, lb. (kg)		**1.63**		
e. Wt. (mass) dry soil (b - d), lb. (kg)		**6.79**		
T. Moisture Content (c ÷ e) × 100 or from "Speedy" Moisture Test		**3.7**		

Remarks: Test fails. Minimum density required is 100% and density achieved is 98.2%. Moisture content 3.7 falls within optimum moisture range of 3.3 - 7.3.

By: _____
Title: _____
cc: District Materials Engineer
Project File

CALCULATION #1

Amount of +4 Material in Total Soil

Weight of Dry Soil + Dish	8.42 lb.	Weight of +4 Material + Dish	4.89 lb.
- Weight of Dish	1.63 lb.	- Weight of Dish	1.63 lb.
Total Weight of Dried Soil	6.79 lb.	Weight of +4 Material	3.26 lb.

$$\frac{\text{Weight of +4 Material } 3.26 \text{ lb.}}{\text{Total Weight of Dried Material } 6.79 \text{ lb.}} \times 100 = \mathbf{48}\ \%$$ **Enter on Line O**

CALCULATION #2

Total Density of Soils with +4 Material

Needed Information:

P_c = Percent +4 Material expressed as a decimal = 0.48 (from Sieve Analysis)
D_c = 2.62(Sp. Gr. of +4 Material from Materials Div.) x 62.4 lb/ft^3 = 163.5 lb/ft^3
P_f = Percent -4 Material expressed as a decimal = 0.52 (determined from Sieve Analysis)
D_f = Maximum Dry Density -4 Material = 128.5 lb/ft^3 (from Proctor)

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

$$\frac{128.5 \text{ lb/ft}^3 \times 163.5 \text{ lb/ft}^3}{(0.48 \times 128.5 \text{ lb/ft}^3) + (0.52 \times 163.5 \text{ lb/ft}^3)}$$

$$\frac{21009.8}{61.7 + 85.0} = \frac{21009.8}{146.7} = \mathbf{143.2}\ \text{lb/ft}^3$$ 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 = 0.48 (from Sieve Analysis)
W_c = Absorption of +4 Matl. plus 1 expressed as a decimal = 0.013 (from Matl's.Div.)
P_f = % -4 Material expressed as a decimal = 0.52 (determined from Sieve Analysis)
W_f = Optimum Moisture of -4 Material expressed as a decimal = 0.09 (from Proctor)

$$(P_cW_c + P_fW_f)\ 100$$

$$[(0.48 \times 0.013) + (0.52 \times 0.09)]\ 100$$

$$(0.006 + 0.047)\ 100$$

$$(0.053)\ 100 = \mathbf{5.3}\ \%$$ **Enter on Line Q**

5.3 - 2 = 3.3 5.3 + 2 = 7.3 Optimum Moisture Range = 3.3 - 7.3

CHAPTER 7
Practice Problem 10
Direct Transmission on Aggregate

TL-124

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

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

STANDARD COUNT

DENSITY 2847 MOISTURE 695

Test No.		**1**		
Location of Test: Station ft. (m)		**24+35**		
Ref. to center line ft. (m)		**5' Rt.**		
Elevation				
Compacted Depth of Lift in. (mm)		**6"**		
Method of Compaction		**Vib.Roller**		
A. Wet Density (lbs/ft³), Wet Unit Mass (kg/m³)	=	**140.0**		
B. Moisture Unit Mass (lbs/ft³), Moisture Unit Mass (kg/m³)	=	**6.9**		
C. Dry Density (lbs/ft³), Dry Unit Mass (kg/m³) (A - B)	=	**133.1**		
D. Moisture Content (B ÷ C) x 100	=	**5.2**		
E. Maximum Dry Density (lbs/ft³), Dry Unit Mass (kg/m³) Lab Proctor or One Point Proctor	=	**124.4**		
F. Percent Optimum Moisture from Lab or One Point Proctor	=	**7.4**		
G. Percent of plus #4, (plus 4.75mm)	=	**37.0**		
H. Corrected Maximum Dry Density (lbs/ft³) Dry Unit Mass (kg/m³)	=	**138.2**		
I. Corrected Optimum Moisture	=	**5.2** **3.2 – 7.2**		
J. Percent Dry Density (lbs/ft³), Dry Unit Mass (kg/m³) (C ÷ E) x 100 or (C ÷ H) x 100	=	**96.3**		
K. Percent Minimum Density Required	=	**95.0**		

Remarks: **Test passes. Minimum density required is 95% and 96.3% was achieved. Moisture content of 5.2% falls within optimum moisture range of 3.2 - 7.2.**

CC: District Materials Engineer
Project File

Title _____

CALCULATION #1

Amount of +4 Material in Total Soil

Weight of Dry Soil + Dish	5.41	lb.	Weight of +4 Material + Dish	3.01	lb.
- Weight of Dish	1.61	lb.	- Weight of Dish	1.61	lb.
Total Weight of Dried Soil	3.80	lb.	Weight of +4 Material	1.40	lb.

$$\frac{\text{Weight of +4 Material } 1.40 \text{ lb.}}{\text{Total Weight of Dried Material } 3.80 \text{ lb.}} \times 100 = \mathbf{37}\ \%$$ **Enter on Line G**

CALCULATION #2

Total Density of Soils with +4 Material

Needed Information:

P_c = Percent +4 Material expressed as a decimal = 0.37 (from Sieve Analysis)
D_c = 2.73(Sp. Gr. of +4 Material from Materials Div.) x 62.4 lb/ft^3 = 170.4 lb/ft^3
P_f = Percent -4 Material expressed as a decimal = 0.63 (determined from Sieve Analysis)
D_f = Maximum Dry Density -4 Material = 124.4 lb/ft^3 (from Proctor)

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

$$\frac{124.4 \text{ lb/ft}^3 \times 170.4 \text{ lb/ft}^3}{(0.37 \times 124.4 \text{ lb/ft}^3) + (0.63 \times 170.4 \text{ lb/ft}^3)}$$

$$\frac{21197.8}{46.0 + 107.4} = \frac{21197.8}{153.4} = \mathbf{138.2\ lb/ft^3}$$ Maximum Dry Density of Total Soil **Enter on Line H**

CALCULATION #3

Optimum Moisture Content of Dense Graded Aggregates

Needed Information:

P_c = % +4 Material expressed as a decimal = 0.37 (from Sieve Analysis)
W_c = Absorption of +4 Matl. plus 1 expressed as a decimal = 0.013 (from Matl's.Div.)
P_f = % -4 Material expressed as a decimal = 0.63 (determined from Sieve Analysis)
W_f = Optimum Moisture of -4 Material expressed as a decimal = 0.074 (from Proctor)

$$(P_cW_c + P_fW_f)\ 100$$

$$[(0.37 \times 0.013) + (0.63 \times 0.074)]\ 100$$

$$(0.005 + 0.047)\ 100$$

$$(0.052)\ 100 = \mathbf{5.2}\ \%$$ **Enter on Line I**

5.2 - 2 = 3.2 5.2 + 2 = 7.2 Optimum Moisture Range = 3.2 - 7.2

CHAPTER 7
Practice Problem 11
Direct Transmission on Aggregate

TL-124

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

English Metric
Report No.: 1-21A-3 Date: _____ Sheet No.: 1 of 1
Route No.: 7 County: Loudoun
Project No.: 0007-053-121,C501
F.H.W.A. No.: None
Test For: Direct Transmission of 21A in Control Strip
Nuclear Gauge Model No.: 3440 Serial No.: 23456

STANDARD COUNT
DENSITY 2864 MOISTURE 709

Test No.		**1**		
Location of Test: Station ft. (m)		**901+25**		
Ref. to center line ft. (m)		**3' Lt.**		
Elevation				
Compacted Depth of Lift in. (mm)		**6"**		
Method of Compaction		**Vib.Roller**		
A. Wet Density (lbs/ft³), Wet Unit Mass (kg/m³)	=	**155.3**		
B. Moisture Unit Mass (lbs/ft³), Moisture Unit Mass (kg/m³)	=	**5.1**		
C. Dry Density (lbs/ft³), Dry Unit Mass (kg/m³) (A - B)	=	**150.2**		
D. Moisture Content (B ÷ C) x 100	=	**3.4**		
E. Maximum Dry Density (lbs/ft³), Dry Unit Mass (kg/m³) Lab Proctor or One Point Proctor	=	**134.6**		
F. Percent Optimum Moisture from Lab or One Point Proctor	=	**8.4**		
G. Percent of plus #4, (plus 4.75mm)	=	**60.0**		
H. Corrected Maximum Dry Density (lbs/ft³) Dry Unit Mass (kg/m³)	=	**156.4**		
I. Corrected Optimum Moisture	=	**4.2** **2.2 – 6.2**		
J. Percent Dry Density (lbs/ft³), Dry Unit Mass (kg/m³) (C ÷ E) x 100 or (C ÷ H) x 100	=	**96.0**		
K. Percent Minimum Density Required	=	**90.0**		

Remarks: **Test passes. Minimum density required is 90% and 96.0% was achieved. Moisture Content of 3.4% falls within optimum moisture range of 2.2 - 6.2.**

CC: District Materials Engineer
Project File

Title _____

CALCULATION #1

Amount of +4 Material in Total Soil

Weight of Dry Soil + Dish	8.43	lb.	Weight of +4 Material + Dish	5.71	lb.
- Weight of Dish	1.61	lb.	- Weight of Dish	1.61	lb.
Total Weight of Dried Soil	6.82	lb.	Weight of +4 Material	4.10	lb.

$$\frac{\text{Weight of +4 Material } 4.10 \text{ lb.}}{\text{Total Weight of Dried Material } 6.82 \text{ lb.}} \times 100 = \mathbf{60}\ \%$$ **Enter on Line G**

CALCULATION #2

Total Density of Soils with +4 Material

Needed Information:

P_c = Percent +4 Material expressed as a decimal = 0.60 (from Sieve Analysis)
D_c = 2.81(Sp. Gr. of +4 Material from Materials Div.) x 62.4 lb/ft^3 = 175.3 lb/ft^3
P_f = Percent -4 Material expressed as a decimal = 0.40 (determined from Sieve Analysis)
D_f = Maximum Dry Density -4 Material = 134.6 lb/ft^3 (from Proctor)

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

$$\frac{134.6 \text{ lb/ft}^3 \times 175.3 \text{ lb/ft}^3}{(0.60 \times 134.6 \text{ lb/ft}^3) + (0.40 \times 175.3 \text{ lb/ft}^3)}$$

$$\frac{23595.4}{80.8 + 70.1} = \frac{23595.4}{150.9} = \mathbf{156.4\ lb/ft^3}$$ Maximum Dry Density of Total Soil **Enter on Line H**

CALCULATION #3

Optimum Moisture Content of Dense Graded Aggregates

Needed Information:

P_c = % +4 Material expressed as a decimal = 0.60 (from Sieve Analysis)
W_c = Absorption of +4 Matl. plus 1 expressed as a decimal = 0.013 (from Matl's.Div.)
P_f = % -4 Material expressed as a decimal = 0.40 (determined from Sieve Analysis)
W_f = Optimum Moisture of -4 Material expressed as a decimal = 0.084 (from Proctor)

$$(P_cW_c + P_fW_f)\ 100$$

$$[(0.60 \times 0.013) + (0.40 \times 0.084)]\ 100$$

$$(0.008 + 0.034)\ 100$$

$$(0.042)\ 100 = \mathbf{4.2}\ \%$$ **Enter on Line I**

4.2 - 2 = 2.2 4.2 + 2 = 6.2 Optimum Moisture Range = 2.2 - 6.2

CHAPTER 7
Practice Problem 12
Direct Transmission on Aggregate

TL-124

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

English Metric
Report No.: 1-21A-3 Date: _____ Sheet No.: 1 of 1
Route No.: 117 County: Roanoke
Project No.: 0117-080-105,C501
F.H.W.A. No.: None
Test For: Direct Transmission of 21A in Control Strip
Nuclear Gauge Model No.: 3440 Serial No.: 23456

STANDARD COUNT

DENSITY 2864 MOISTURE 709

Test No.		**1**		
Location of Test — Station ft. (m)		**935+00**		
Ref. to center line ft. (m)		**5' Lt.**		
Elevation				
Compacted Depth of Lift in. (mm)		**6"**		
Method of Compaction		**Vib.Roller**		
A. Wet Density (lbs/ft³), Wet Unit Mass (kg/m³)	=	**150.2**		
B. Moisture Unit Mass (lbs/ft³), Moisture Unit Mass (kg/m³)	=	**6.1**		
C. Dry Density (lbs/ft³), Dry Unit Mass (kg/m³) (A - B)	=	**144.1**		
D. Moisture Content (B ÷ C) x 100	=	**4.2**		
E. Maximum Dry Density (lbs/ft³), Dry Unit Mass (kg/m³) Lab Proctor or One Point Proctor	=	**132.1**		
F. Percent Optimum Moisture from Lab or One Point Proctor	=	**7.2**		
G. Percent of plus #4, (plus 4.75mm)	=	**46.0**		
H. Corrected Maximum Dry Density (lbs/ft³) Dry Unit Mass (kg/m³)	=	**148.8**		
I. Corrected Optimum Moisture	=	**4.6** **2.6 – 6.6**		
J. Percent Dry Density (lbs/ft³), Dry Unit Mass (kg/m³) (C ÷ E) x 100 or (C ÷ H) x 100	=	**96.8**		
K. Percent Minimum Density Required	=	**95.0**		

Remarks: **Test passes. Minimum density required is 95% and density achieved is 96.8%. Moisture Content of 4.2% falls within optimum moisture range of 2.6 - 6.6.**

CC: District Materials Engineer _____

Project File Title _____

CALCULATION #1

Amount of +4 Material in Total Soil

Weight of Dry Soil + Dish	8.40	lb.	Weight of +4 Material + Dish	4.75	lb.
- Weight of Dish	1.63	lb.	- Weight of Dish	1.63	lb.
Total Weight of Dried Soil	6.77	lb.	Weight of +4 Material	3.12	lb.

$$\frac{\text{Weight of +4 Material } 3.12 \text{ lb.}}{\text{Total Weight of Dried Material } 6.77 \text{ lb.}} \times 100 = \mathbf{46}\ \%$$ **Enter on Line G**

CALCULATION #2

Total Density of Soils with +4 Material

Needed Information:

P_c = Percent +4 Material expressed as a decimal = 0.46 (from Sieve Analysis)
D_c = 2.81(Sp. Gr. of +4 Material from Materials Div.) x 62.4 lb/ft^3 = 174.7 lb/ft^3
P_f = Percent -4 Material expressed as a decimal = 0.54 (determined from Sieve Analysis)
D_f = Maximum Dry Density -4 Material = 132.1 lb/ft^3 (from Proctor)

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

$$\frac{132.1 \text{ lb/ft}^3 \times 174.7 \text{ lb/ft}^3}{(0.46 \times 132.1 \text{ lb/ft}^3) + (0.54 \times 174.7 \text{ lb/ft}^3)}$$

$$\frac{23077.9}{60.8 + 94.3} = \frac{23077.9}{155.1} = \mathbf{148.8\ lb/ft^3}$$ Maximum Dry Density of Total Soil **Enter on Line H**

CALCULATION #3

Optimum Moisture Content of Dense Graded Aggregates

Needed Information:

P_c = % +4 Material expressed as a decimal = 0.46 (from Sieve Analysis)
W_c = Absorption of +4 Matl. plus 1 expressed as a decimal = 0.016 (from Matl's.Div.)
P_f = % -4 Material expressed as a decimal = 0.54 (determined from Sieve Analysis)
W_f = Optimum Moisture of -4 Material expressed as a decimal = 0.072 (from Proctor)

$$(P_cW_c + P_fW_f)\ 100$$

$$[(0.46 \times 0.016) + (0.54 \times 0.072)]\ 100$$

$$(0.007 + 0.039)\ 100$$

$$(0.046)\ 100 = \mathbf{4.6}\ \%$$ **Enter on Line I**

4.6 - 2 = 2.6 4.6 + 2 = 6.6 Optimum Moisture Range = 2.6 - 6.6

ANSWERS TO STUDY QUESTIONS
CHAPTER 8

1. Before a Roller Pattern can be set the subgrade must be tested, compaction equipment must be approved, and material to be tested must be placed at uniform depth.

   True

2. Roller Pattern compares compactive effort vs. density

3. When must a new Roller Pattern be set up?
   Multiple lifts of material
   Change in Source of Materials
   Change in compaction equipment
   Visual change in subsurface or subgrade
   Change in the gradation or type of material

4. Backscatter Method is the testing method in which the gauge is placed on the surface of the material to be tested and the source rod is lowered to the first notch.

5. When taking a nuclear reading near an unsupported edge, 18 inches is the minimum distance from the edge that an accurate nuclear reading can be taken.

6. A direct transmission test is taken at the end of the control strip to verify the results.

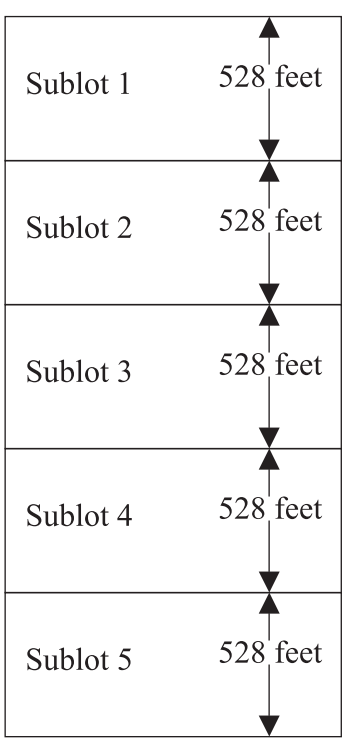
7. The control strip dry density must be within 3.0 lb/ft^3 of the roller pattern peak density.

8. A roller pattern on aggregate covers 75 feet, a control strip covers 300 feet and a test section covers half a mile per paver width.

9. The Contractor has applied the dense graded aggregate layer to the right lane of a two-lane roadway beginning at Station 25 + 25. Using the numbers from the Random Number Table given below, calculate and determine the test location for each density and moisture reading for this test section, which is 12 feet wide. Remember not to test any closer than 18 inches to an unsupported edge.

Distance from Start of Sublot	Distance from Reference Line
181	3
252	3
96	2
43	6
71	4

5,280 feet in a mile. A Test Section is ½ mile per paver width or 2,640 feet. Five tests will be performed in the test section. 2640 ÷ 5 = 528 feet per sublot.



Beginning Station No. 25 + 25
+ 5 + 28
30 + 53

Station No. 30 + 53
+ 5 + 28
35 + 81

Station No. 35 + 81

Station No. 41 + 09

Station No. 46 + 37

Ending Station No. 51 + 65

Test No.	Station No. at start of sublot	Distance from start of sublot (feet)	Test at Station No.	Distance from reference line (feet)
1	25 + 25	181	27 + 06	3
2	30 + 53	252	33 + 05	3
3	35 + 81	96	36 + 77	2
4	41 + 09	43	41 + 52	6
5	46 + 37	71	47 + 08	4

25 + 25 Station No. at Start of Sublot 1
\+ 1 81 Feet from Start of Sublot
27 + 06 Test at Station No.

ANSWERS TO PRACTICE PROBLEMS
CHAPTER 8

Practice Problem 1
Nuclear Field Testing of Aggregates
Step 1 - Roller Pattern

A. Given the following information, complete the following worksheet (TL-53).

See following pages.

B. How many passes should be made for test 5? Why?
How many passes should be made for test 6? Why?

Two more passes should be made for Test 5 for a total of 10v passes because increase in density was greater than 1 lb/ft^3 between Test No. 3 and 4.

One more pass should be made for Test 6 for a total of 11s passes because increase in density was less than 1 lb/ft^3 between Test No. 4 and 5.

C. Should this be considered an acceptable roller pattern and why?

Yes. The density curve drops off properly without dropping over 1.5 lb/ft^3.

TL-53

VIRGINIA DEPARTMENT OF TRANSPORTATION
MATERIALS DIVISION
REPORT OF NUCLEAR ROLLER PATTERN

English Metric

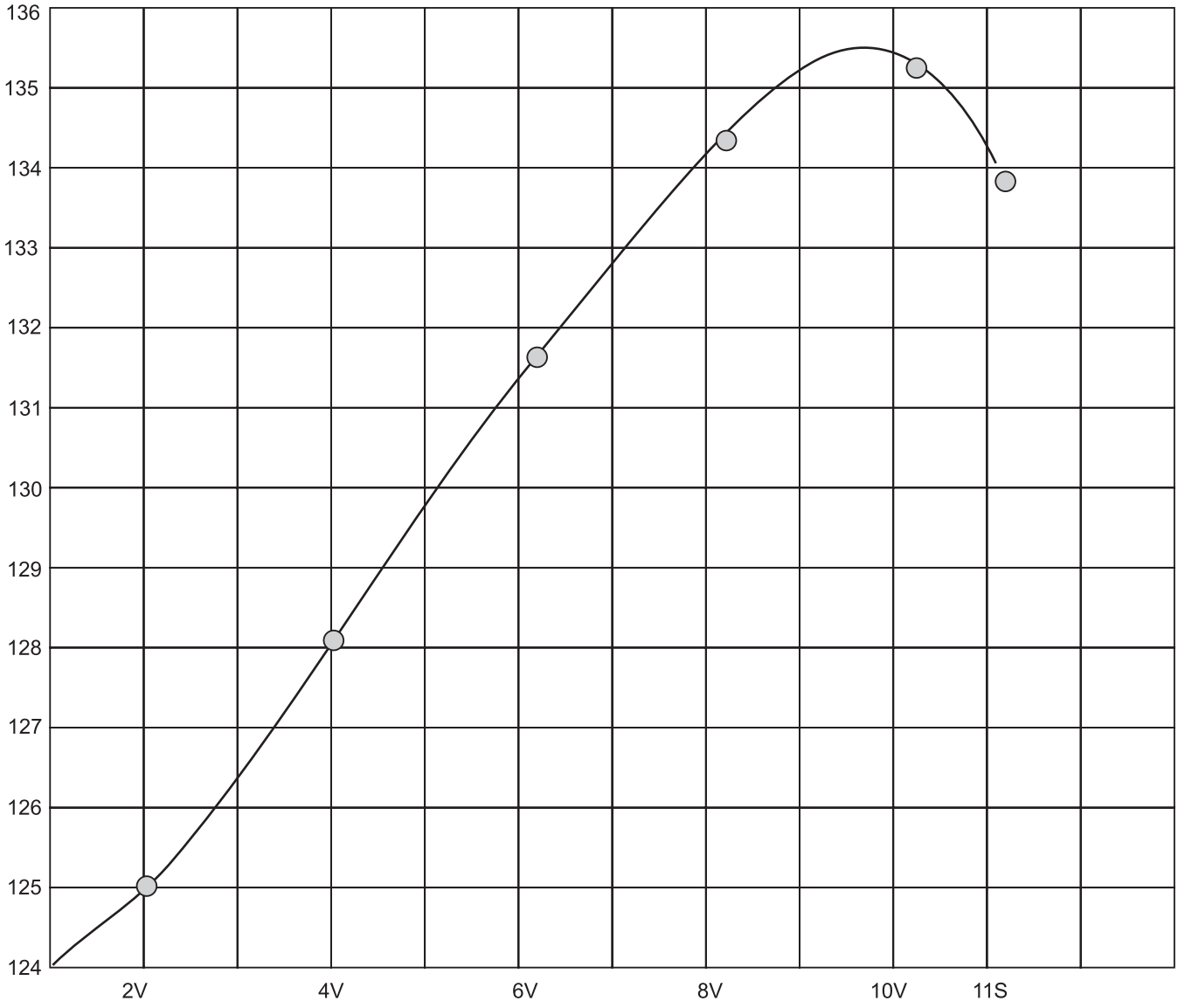
Report No. 1-21A-1 **Nuclear Gauge Model No.** 3440 **Serial No.** 23456
Date Today **Route No.** 95 **Project No.** 0095-029-F14,C502
FHWA No. NH(95)1 **County** Fairfax
Section No. 1 **Station** 21+00 **ft. (m.) to Station** 21+75 **ft. (m.)**
Type Material 21A **Width** 12 **ft. (m.)**
Optimum Moisture 5.3 **Optimum Moisture Range** 3.3 – 7.3
Remarks:
1st lift 6" compacted depth, roller pattern no. 1, vibratory roller

STANDARD COUNTS

DENSITY 2847 **MOISTURE** 695

TEST NO.	DRY DENSITY	MOISTURE CONTENT	TEST NO.	DRY DENSITY	MOISTURE CONTENT
Test No. 1 No. of Passes 2V			Test No. 6 No. of Passes 11S		
Sta. 21+00	125.4	5.1	Sta. 21+00	134.0	4.9
Sta. 21+35	124.9	5.2	Sta. 21+35	133.5	5.0
Sta. 21+75	125.3	5.6	Sta. 21+75	134.1	5.1
Total	375.6	15.9	Total	401.6	15.0
Average	125.2	5.3	Average	133.9	5.0
Test No. 2 No. of Passes 4V			Test No. 7 No. of Passes		
Sta. 21+00	128.4	5.4	Sta.		
Sta. 21+35	127.5	5.1	Sta.		
Sta. 21+75	128.5	4.9	Sta.		
Total	384.4	15.4	Total		
Average	128.1	5.1	Average		
Test No. 3 No. of Passes 6V			Test No. 8 No. of Passes		
Sta. 21+00	131.8	5.1	Sta.		
Sta. 21+35	131.0	5.0	Sta.		
Sta. 21+75	132.1	4.9	Sta.		
Total	394.9	15.0	Total		
Average	131.6	5.0	Average		
Test No. 4 No. of Passes 8V			Test No. 9 No. of Passes		
Sta. 21+00	134.7	5.5	Sta.		
Sta. 21+35	133.7	4.9	Sta.		
Sta. 21+75	134.8	5.1	Sta.		
Total	403.2	15.5	Total		
Average	134.4	5.2	Average		
Test No. 5 No. of Passes 10V			Test No. 10 No. of Passes		
Sta. 21+00	135.5	5.2	Sta.		
Sta. 21+35	135.0	5.1	Sta.		
Sta. 21+75	135.4	4.9	Sta.		
Total	405.9	15.2	Total		
Average	135.3	5.1	Average		

ROLLER PATTERN CURVE



CHAPTER 8
Practice Problem 1
Nuclear Field Density Testing of Aggregates
Step #2 - Control Strip

A. Complete the following worksheet (TL-54) and answer the following questions.

See following page.

B. How many roller passes were required to attain maximum density on the Control Strip? (use info from Step #1 TL-53).

10 – that is the number determined by the roller pattern.

C. Does test pass the moisture criteria?

Yes each Moisture Content falls within ±2 percentage points of Optimum (3.3 to 7.3).

D. Is Control Strip within tolerance of roller pattern?

Yes Maximum Dry Density of 135.3 lb/ft^3 is within 3.0 lb/ft^3 of roller pattern peak density which was 135.3 lb/ft^3.

TL-54 (Rev. 12/99)

VIRGINIA DEPARTMENTS OF TRANSPORTATION
MATERIALS DIVISION
REPORT OF NUCLEAR CONTROL STRIP

English **Metric**

Report No. 1-21A-2 **Date** Today

Route 95 **Project** 0095-029-F14,C502

F.H.W.A. No. NH(95)-1 **County** Fairfax

Type Material 21A **Width** 12 **ft. (m)**

Station 22+25 **ft. (m)** **to Station** 25+25 **ft. (m)**

Nuclear Gauge Model No. 3440 **Serial No** 23456

Remarks 1st lift 6" compacted depth, roller pattern no. 1

STANDARD COUNT

DENSITY 2847 **MOISTURE** 695

	STATION	REFERNCE TO CENTER LINE ft. (m)	LANE	DRY DENSITY (lbs/ft³) DRY UNIT MASS (kg/m³)	MOISTURE CONTENT
1	22+25	3' Rt.	WBL	134.8	5.4
2	22+65	9' Rt.	WBL	135.2	5.3
3	23+00	6' Rt.	WBL	135.6	5.4
4	23+35	9' Rt.	WBL	135.5	5.4
5	23+70	3' Rt.	WBL	135.3	5.4
6	24+00	9' Rt.	WBL	135.3	5.1
7	24+35	6' Rt.	WBL	135.2	5.5
8	24+70	9' Rt.	WBL	135.8	5.4
9	25+00	6' Rt.	WBL	135.3	5.1
10	25+25	3' Rt.	WBL	134.7	5.0
				TOTAL: 1352.7	
				AVERAGE: 135.3	

5.3 **MOISTURE REQUIRED (From Producer or Materials Division)**

3.3 – 7.3 **OPTIMUM MOISTURE RANGE**

(135.3) x 0.95 = Dens.Avg. 128.5 **INDIVIDUAL DRY DENSITY (lbs/ft³), DRY UNIT MASS (kg/m³) REQUIREMENT FOR TEST SECTION**

(135.3) x 0.98 = Dens.Avg. 132.6 **AVERAGE DRY DENSITY (lbs/ft³), DRY UNIT MASS (kg/m³) REQUIREMENT FOR TEST SECTION**

By Carolyn Mason
Title Engr.Tech.

Cc: District Materials Engineer
Project File

CHAPTER 8
Practice Problem 1
Nuclear Field Density Testing of Aggregates
Step #3 – Direct Transmission

A. Using the information below complete the TL-124A and then answer the questions.

Information from Quarry or Materials Lab

Percent Passing No. 4 sieve = 46%
Therefore Percent +4 material = 54%
Specific Gravity of +4 material = 2.4
Absorption of +4 material = 0.2
Max.Dry Density from Lab Proctor on –4 material = 133.0 lb/ft^3
Optimum Moisture from Lab Proctor on –4 material = 10.1

Gauge Display Panel

% PR = 91.9
WD = 137.1
DD = 130.2
M = 6.9 %M = 5.3

B. What is the minimum density required?

90% because 54% of material was +4 material (See Appendix D).

C. Does this test pass?

Yes – 91.9% Density.

D. Does this test validate the control strip?

Yes

TL-124

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

English Metric
Report No.: 1-21A-3 Date: Today 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

STANDARD COUNT

DENSITY	MOISTURE
2847	695

Test No.		1	
Location of Test	Station ft. (m)	24 + 35	
	Ref. to center line ft. (m)	5' Rt.	
	Elevation		
Compacted Depth of Lift in. (mm)		6"	
Method of Compaction		Vib.Roller	
A. Wet Density (lbs/ft³), Wet Unit Mass (kg/m³)	=	137.1	
B. Moisture Unit Mass (lbs/ft³), Moisture Unit Mass (kg/m³)	=	6.9	
C. Dry Density (lbs/ft³), Dry Unit Mass (kg/m³) (A - B)	=	130.2	
D. Moisture Content (B ÷ C) x 100	=	5.3	
E. Maximum Dry Density (lbs/ft³), Dry Unit Mass (kg/m³) Lab Proctor or One Point Proctor	=	133.0	
F. Percent Optimum Moisture	=	10.1	
G. Percent of plus #4, (plus 4.75mm)	=	54	
H. Corrected Maximum Dry Density (lbs/ft³) Dry Unit Mass (kg/m³)	=	141.6	
I. Corrected Optimum Moisture	=	5.3 3.3 – 7.3	
J. Percent Dry Density (lbs/ft³), Dry Unit Mass (kg/m³) (C ÷ E) x 100 or (C ÷ H) x 100	=	91.9	
K. Percent Minimum Density Required	=	90.0	

Calculations for Corrected Maximum Density

$$\frac{1}{\frac{0.54}{2.4 \times 62.4 = 149.8} + \frac{0.46}{133.0}} =$$

$$\frac{1}{.00360 + .00346} =$$

$$\frac{1}{.00706} =$$

141.6 lb/ft³

Calculations for Corrected Optimum Moisture

[(0.2 + 1) x 0.54] + [10.1 + 0.46]

0.648 + 4.646

5.294 = 5.3

Remarks:
Direct Transmission at end of Control Strip

CC: District Materials Engineer
Project File

By: **Carolyn Mason**

Title: **Engr. Tech.**

CHAPTER 8
Practice Problem 1
Nuclear Field Density Testing of Aggregates
Step #4 – Test Section

A. Transfer the OPTIMUM MOISTURE, OPTIMUM MOISTURE RANGE, INDIVIDUAL DRY DENSITY REQUIREMENT AND AVERAGE DRY DENSITY REQUIREMENT from the control strip to the proper location on the TL-55.

B. Given the following information , complete the TL-55.

See following page.

C. Does this test pass? **Yes** Why?

Each moisture content falls within the optimum moisture range. Each individual test exceeds the minimum density requirement, and the average of 5 readings exceeds the average density requirement.

D. If the test does not pass, what corrective action should be taken ?

Retest the area, checking math and testing procedures before advising the contractor.

E. What are the beginning and ending station numbers of your 1st acceptance testing test section?

1 mile = 5,280 feet. Test section = 1/2 mile or 2,640 feet.

Beginning Station	**25+25**
+	**26 40**
Ending Station	**51+65**

TL-55

VIRGINIA DEPARTMENT OF TRANSPORTATION
MATERIALS DIVISION
REPORT OF NUCLEAR TEST SECTION

English Metric

Report No. 1-21A-4 Date Today

Route No. 95 Project No. 0095-029-F14,C502

FHWA No. NH(95)-1 County Fairfax

Type Material 21-A Width 12 ft. (m)

Section No. 1 Station 25+25 ft (m.) to Station 51+65 ft (m.)

Nuclear Gauge Model No. 3440 Serial No. 23456

Remarks 1st lift 6" compacted depth, roller pattern no. 1

STANDARD COUNT	
DENSITY	MOISTURE
2847	695

5.3 OPTIMUM MOISTURE REQUIRED %
(from Producer or Materials Division)

3.3 - 7.3 OPTIMUM MOISTURE RANGE

128.5 INDIVIDUAL DRY DENSITY (lbs/ft³), DRY UNIT MASS (kg/m³) REQUIRED
(95% of Control Strip Dry Density from TL-54)

132.6 AVERAGE DRY DENSITY (lbs/ft³), DRY UNIT MASS (kg/m³) REQUIRED
(98% of Control Strip Dry Density from TL-54)

TEST NO.	Station ft (m)	Lane	Dry Density (lbs/ft³) Dry Unit Mass kg/m³	Moisture Content	(P) Pass (F) Fail
1	25+25	WBL	136.4	5.1	P
2	29+25	WBL	135.0	5.4	P
3	35+50	WBL	136.5	5.0	P
4	43+00	WBL	133.2	5.3	P
5	51+65	WBL	136.0	5.1	P
Average			135.4		P

Comments:

CC: District Materials Engineer
Project File

By Carolyn Mason
Title Engr.Tech.

CHAPTER 8
Practice Problem 2
Nuclear Field Testing of Aggregates
Step 1 - Roller Pattern

A. Given the following information, complete the following worksheet (TL-53).

See following pages.

B. Should this be considered an acceptable roller pattern and why?

Yes. The density curve drops off properly without dropping over 1.5 lb/ft^3.

VIRGINIA DEPARTMENT OF TRANSPORTATION
MATERIALS DIVISION
REPORT OF NUCLEAR ROLLER PATTERN

English **Metric**

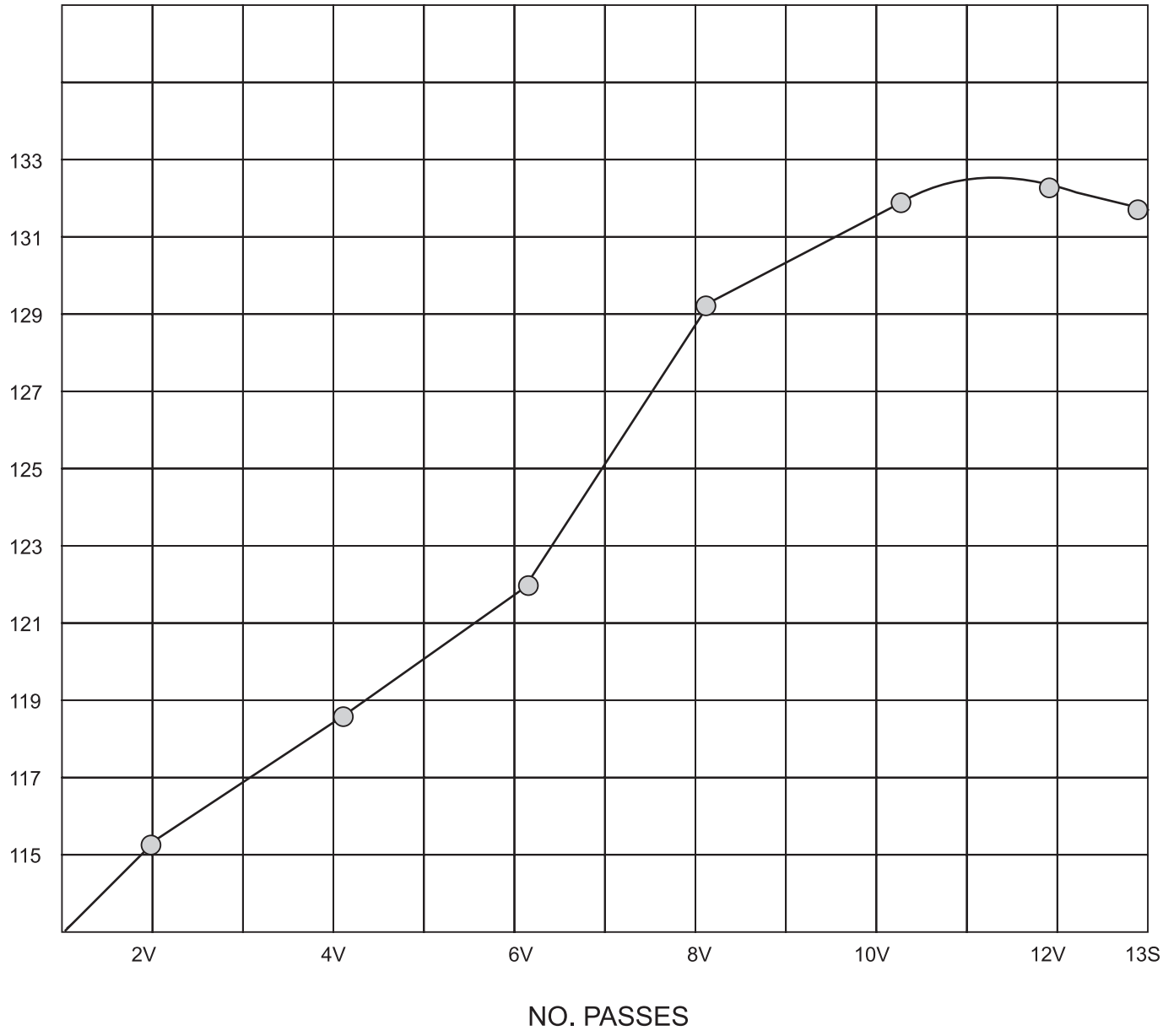
Report No. 3-21ACTA-1 **Nuclear Gauge Model No.** 3440 **Serial No.** 23456
Date Today **Route No.** 7 **Project No.** 0007-053-121,C501
FHWA No. None **County** Loudoun
Section No. 1 **Station** 900+00 **ft. (m.) to Station** 900+75 **ft. (m.)**
Type Material Type I 21A w/4% cement **Width** 12 **ft. (m.)**
Optimum Moisture 5.1 **Optimum Moisture Range** 5.1 - 7.1
Remarks:
6" depth, roller pattern no. 3

STANDARD COUNTS

DENSITY 2864 **MOISTURE** 709

TEST NO.	DRY DENSITY	MOISTURE CONTENT	TEST NO.	DRY DENSITY	MOISTURE CONTENT
Test No. 1 No. of Passes 2V			Test No. 6 No. of Passes 12V		
Sta. 900+00	115.4	5.3	Sta. 900+00	132.2	5.2
Sta. 900+35	114.6	5.1	Sta. 900+35	131.7	5.0
Sta. 900+75	116.1	4.9	Sta. 900+75	132.8	5.2
Total	346.1	15.3	Total	396.7	15.4
Average	115.4	5.1	Average	132.2	5.1
Test No. 2 No. of Passes 4V			Test No. 7 No. of Passes 13S		
Sta. 900+00	118.9	5.3	Sta. 900+00	131.8	4.4
Sta. 900+35	118.6	5.2	Sta. 900+35	131.7	5.2
Sta. 900+75	119.1	5.3	Sta. 900+75	131.8	5.8
Total	356.6	15.8	Total	395.3	15.4
Average	118.9	5.3	Average	131.8	5.1
Test No. 3 No. of Passes 6V			Test No. 8 No. of Passes		
Sta. 900+00	121.9	5.1	Sta.		
Sta. 900+35	121.0	4.9	Sta.		
Sta. 900+75	122.9	5.3	Sta.		
Total	365.8	15.3	Total		
Average	121.9	5.1	Average		
Test No. 4 No. of Passes 8V			Test No. 9 No. of Passes		
Sta. 900+00	129.2	5.5	Sta.		
Sta. 900+35	128.1	4.8	Sta.		
Sta. 900+75	130.2	5.0	Sta.		
Total	387.5	15.3	Total		
Average	129.2	5.1	Average		
Test No. 5 No. of Passes 10V			Test No. 10 No. of Passes		
Sta. 900+00	132.1	5.3	Sta.		
Sta. 900+35	131.6	4.3	Sta.		
Sta. 900+75	132.6	5.9	Sta.		
Total	396.3	15.5	Total		
Average	132.1	5.2	Average		

ROLLER PATTERN CURVE



CHAPTER 8
Practice Problem 2
Nuclear Field Density Testing of Aggregates
Step #2 - Control Strip

A. Using the same "Header" information in Step #1 plus the information given below, complete the following worksheet (TL-54).

See following page.

B. How many roller passes were required to attain maximum density on the Control Strip? (use info from Step #1 TL-53) Why?

12 - that is the optimum number determined by the roller pattern

C. Does test pass the moisture criteria?

Yes – individual moisture contents fall within the optimum moisture range of 5.1 to 7.1. (Range = Optimum to 2 whole percentage points above optimum.

D. Is Control Strip within tolerance of roller pattern?

Yes – Maximum Dry Density of 132.7 lb/ft^3 is within 3.0 lb/ft^3 of roller pattern peak density of 132.2 lb/ft^3.

E. Does Direct Transmission Test validate Control Strip dry density? (Worked for you on Page 93)

Yes – it achieved 92% density.

TL-54 (Rev. 12/99)

VIRGINIA DEPARTMENTS OF TRANSPORTATION
MATERIALS DIVISION
REPORT OF NUCLEAR CONTROL STRIP

English **Metric**

Report No. 3-21ACTA-2 **Date** Today

Route 7 **Project No.** 0007-053-121,C501

F.H.W.A. No. None **County** Loudoun

Type Material Type 21A w/4% cement **Width** 12 ft. (m)

Station 901+25 ft. (m.) **to Station** 904+25 ft. (m.)

Nuclear Gauge Model No. 3440 **Serial No.** 23456

Remarks 6" depth, roller pattern no. 3

STANDARD COUNT

DENSITY	MOISTURE
2864	709

	STATION	REFERNCE TO CENTER LINE ft. (m)	LANE	DRY DENSITY (lbs/ft^3) DRY UNIT MASS (kg/m^3)	MOISTURE CONTENT
1	901+25	3' Lt.	WBL	132.8	5.6
2	901+75	9' Lt.	WBL	132.7	5.7
3	902+00	6' Lt.	WBL	132.9	5.6
4	902+30	3' Lt.	WBL	132.6	5.8
5	902+70	6' Lt.	WBL	133.0	5.2
6	903+00	9' Lt.	WBL	132.5	5.7
7	903+35	9' Lt.	WBL	132.7	5.1
8	903+70	3' Lt.	WBL	132.7	5.8
9	904+00	6' Lt.	WBL	132.5	5.2
10	904+25	9' Lt.	WBL	132.8	5.5
				TOTAL: 1327.2	
				AVERAGE: 132.7	

5.1 **OPTIMUM MOISTURE REQUIRED (From Producer or Materials Division)**

5.1 - 7.1 **OPTIMUM MOISTURE RANGE**

(132.7) x 0.95 = 126.1 **INDIVIDUAL DRY DENSITY (lbs/ft^3), DRY UNIT MASS (kg/m^3)**
Dens.Avg. **REQUIREMENT FOR TEST SECTION**

(132.7) x 0.98 = 130.0 **AVERAGE DRY DENSITY (lbs/ft^3), DRY UNIT MASS (kg/m^3)**
Dens.Avg **REQUIREMENT FOR TEST SECTION**

By Carolyn Mason
Title Engr.Tech.

Cc: District Materials Engineer
Project File

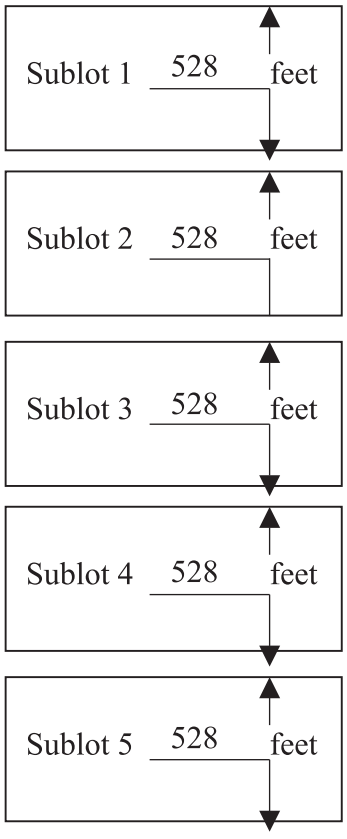
CHAPTER 8
Practice Problem 2
Nuclear Field Density Testing of Aggregates
Step #4 – Test Section

A. Testing at the minimum frequency: With the Test Section beginning at Sta 904+25 and 12 feet wide, choose 5 random sites to complete your test stations using the following random numbers.

Distance from Start of Sublot	Distance from Reference Line
101	4
106	8
27	3
140	3
182	10

5,280 feet in a mile. A Test Section is half a mile per paver width or 2,640 feet.

5 tests will be performed in the test section. 2,640 ÷ 5 = 528 feet per sublot.



Beginning Station No. 904+25

Station No. 909+53

Station No. 914+81

Station No. 920+09

Station No. 925+37

Ending Station No. 930+65

Test No.	Station No. at start of sublot	Distance from start of sublot (feet)	Test at Station No.	Distance from reference line (feet)
1	904 + 25	101	905 + 26	4
2	909 + 53	106	910 + 59	8
3	914 + 81	27	915 + 08	3
4	920 + 09	140	921 + 49	3
5	925 + 37	182	927 + 19	10

B. Transfer the OPTIMUM MOISTURE, OPTIMUM MOISTURE RANGE, INDIVIDUAL DRY DENSITY REQUIREMENT AND AVERAGE DRY DENSITY REQUIREMENT from the control strip to the proper location on the TL-55.

C. Given the following information, complete the TL-55 using the same header information as the preceding problems (except use correct report number).

See following page.

D. Does this test pass? **Yes** Why?

Each individual test exceeds the minimum requirement, and the average of 5 readings exceeds the average requirement and all moisture contents fall within optimum moisture range.

E. At what Station Number is Test No. 4 to be taken?

921 + 49

F. At what Station Number does Sublot 2 begin?

909 + 53

G. How many feet from the reference line is Test No. 5 to be taken?

10

TL-55

VIRGINIA DEPARTMENT OF TRANSPORTATION
MATERIALS DIVISION
REPORT OF NUCLEAR TEST SECTION

English Metric
Report No. 3-21ACTA-4 Date Today
Route No. 7 Project No. 0007-053-121,C501
FHWA No. None County Loudoun
Type Material Type I 21A w/4% cement Width 12 ft. (m)
Section No. 1 Station 904+25 ft (m.) to Station 930+65 ft (m.)
Nuclear Gauge Model No. 3440 Serial No. 23456
Remarks 6" depth, roller pattern no. 3

STANDARD COUNT	
DENSITY	MOISTURE
2864	709

5.1 OPTIMUM MOISTURE REQUIRED %
(from Producer or Materials Division)

5.1 - 7.1 OPTIMUM MOISTURE RANGE

126.1 INDIVIDUAL DRY DENSITY (lbs/ft^3), DRY UNIT MASS (kg/m^3) REQUIRED
(95% of Control Strip Dry Density from TL-54)

130.0 AVERAGE DRY DENSITY (lbs/ft^3), DRY UNIT MASS (kg/m^3) REQUIRED
(98% of Control Strip Dry Density from TL-54)

TEST NO.	Station ft (m)	Lane	Dry Density lbs/ft^3 Dry Unit Mass (kg/m^3)	Moisture Content	(P) Pass (F) Fail
1	905+26	WBL	132.3	5.7	P
2	910+59	WBL	131.2	5.5	P
3	915+08	WBL	130.6	5.2	P
4	921+49	WBL	131.3	5.1	P
5	927+19	WBL	129.6	6.0	P
Average			131.0		P

Comments:

CC: District Materials Engineer
Project File

By Carolyn Mason
Title Engr.Tech.