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ESTABLISHING THEORETICAL AND TARGET VALUES FOR DENSITY AND MOISTURE CONTENT

LEARNING OUTCOMES

- Understand how the moisture-density relationship impacts soils and soil-aggregate mixtures
- Understand the procedures for determining the wet density of soil using the one-point proctor method
- Understand the procedures for determining moisture using a “hot plate” or “speedy” moisture device
- Understand how to establish target values for field testing using the moisture-density curves method

INTRODUCTION

When soil is being placed as fill material it must be put down in layers called lifts and compacted with some form of compaction equipment before the next lift is placed. Specifications for this work are given in the Virginia Department of Transportation’s Road and Bridge Specifications, Section 303.04 (h), Sec. 305.02 (a) 1 and are summarized in Appendices B and C of this Study Guide. Generally, the specifications call for the soil to be compacted to a minimum of 95% of the theoretical maximum density, with a moisture content of $\pm 20\%$ of the theoretical optimum moisture. These theoretical values are referred to as the testing targets.

Refer to the flow chart below to see the overall procedure for determining if fill material meets the specifications. First, the target values for density and moisture content must be determined. This chapter will discuss the various methods for determining the target values of various soil materials.

SOILS DENSITY TESTING FLOW CHART



LABORATORY PROCTOR

AASHTO T 99/T 180 – MOISTURE-DENSITY RELATIONSHIP OF SOILS AND SOIL-AGGREGATE MIXTURES

SUMMARY OF PROCEDURE

This procedure determines the moisture-density relationship of soils and soil-aggregate mixtures. It is sometimes referred to as the standard proctor or the modified proctor test. A quantity of soil or soil and aggregate mixture is prepared at a determinable moisture content and compacted in a standard mold using a manual or mechanical rammer. The wet mass of this compacted sample is divided by the volume of the mold to determine the wet density. Moisture content testing on the material from the compacted mass is used to determine the dry density of this material. This procedure is repeated at varied moisture contents and the results are plotted on a graph as shown in Figure 5.1. A smooth line is drawn through the points to obtain a curve. The maximum density and optimum moisture content are determined by selecting a point at the peak of the curve.

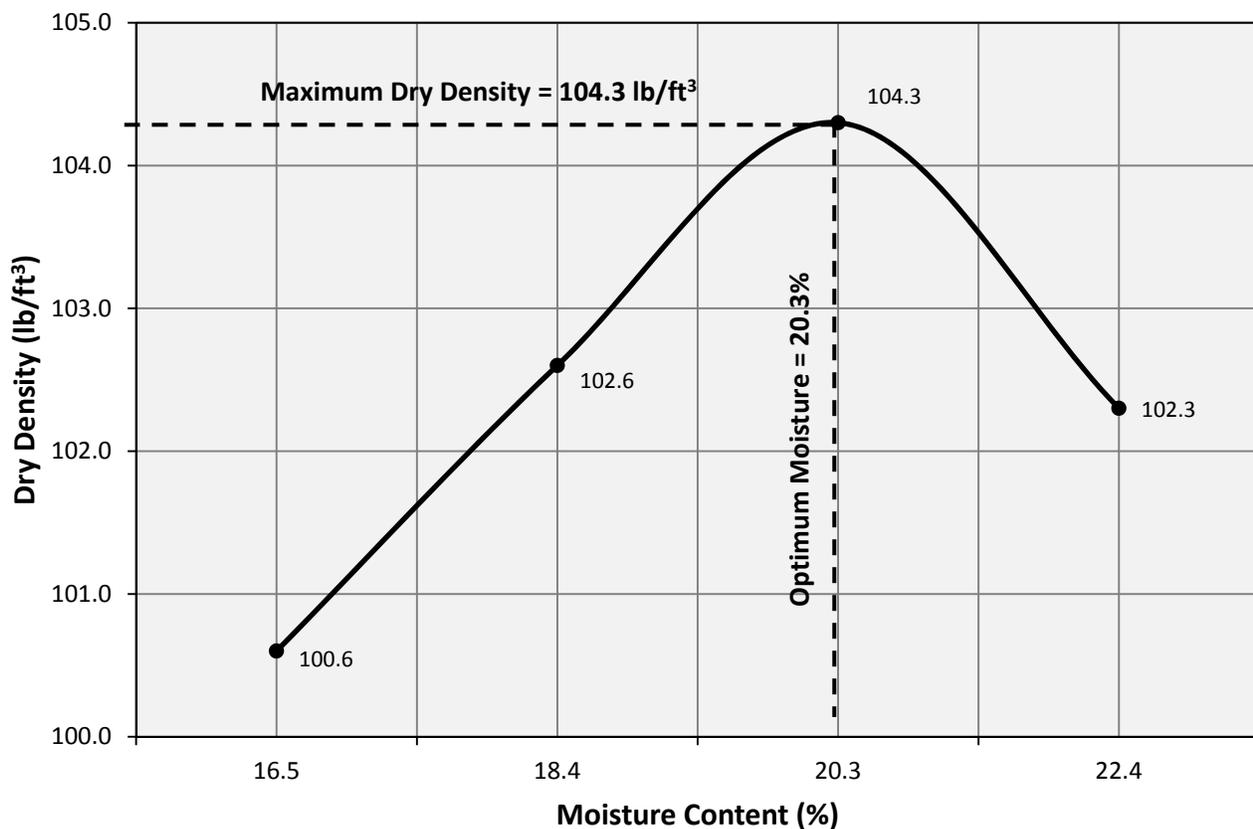


Figure 5.1: Example Moisture-Density Curve

TYPICAL TEST RESULTS

Typical maximum density and optimum moisture that can be expected as the result of a standard compaction test (AASHTO T 99) are given below (Table 5.1). A modified compaction test (AASHTO T 180) will yield 10 to 15 percent higher maximum densities and 20 to 30 percent lower optimum moisture due to the greater compactive effort used (as described in Table 5.2).

TABLE 5.1 Typical Values of Maximum Density and Optimum Moisture for Common Types of Soil (AASHTO T-99)			
Unified Soil	Soil Description	Maximum Density Range kg/m ³ (lb/ft ³)	Optimum Moisture Range (%)
CH	Highly Plastic Clays	1200-1680 (75-105)	19-36
CL	Silty Clays	1520-1920 (95-120)	12-24
ML	Silty and Clayey Silts	1520-1920 (95-120)	12-24
SC	Clayey Sands	1680-2000 (105-125)	11-19
SM	Silty Sands	1760-2000 (110-125)	11-16
SP	Poorly-graded Sands	1600-1920 (100-120)	12-21
SW	Well-graded Sands	1760-2080 (110-130)	9-16
GC	Clayey Gravel w/sands	1840-2080 (115-130)	9-14
GP	Poorly-graded gravels	1840-2000 (115-125)	11-14
GW	Well-graded Gravels	2000-2160 (125-135)	8-11

TABLE 5.2 Differences Between Standard (T 99) and Modified (T 180) Moisture- Density Tests		
Equipment/Procedures	Standard	Modified
Rammers Mass (Manual and Mechanical)	2.495 kg (5.5 lb)	4.536 kg (10.0 lb)
Drop of Rammer to Soil Surface	305 mm (12.0 in)	475 mm (18.0 in)
Number of Layers Placed when Filling Mold	3	5

TESTING EQUIPMENT

Before beginning any procedure, you must first assemble all the equipment you will need to perform the test. You will need the following equipment per AASHTO T 99/T 180 as shown in Figure 5.2 above, Tables 5.2 and 5.3, and as indicated below.

- 1) Rammers: The difference between the two procedures (standard and modified) is the mass and freefall of the rammer used to compact the soil or soil and aggregate mixture in the mold and the number of layers placed into the compaction mold for compaction.
- 2) Mechanical compacting ram: If a mechanical compacting ram is used, it must be calibrated to produce results repeatable with the manual methods using ASTM method D2168.
- 3) Compaction block, with a mass not less than 90 kg (200 lb).
- 4) Molds: Depending on the method, either a 101.6 mm (4 in.) or a 152.4 mm (6 in.) mold, solid wall metal cylinder, with dimensions and capacities as shown in Table 5.3.
- 5) Scales and balances meeting state requirements.
- 6) Oven, stove or other drying device, meeting state requirements.
- 7) Straightedge: At least 250 mm (10 in.) length, made of hardened steel with one beveled edge. The straightedge is used to plane the surface of the soil even with the top of the mold. The straightedge should not be so flexible that it leaves a concave surface when trimming the soil from the top of the compacted sample.
- 8) Engineering Curve
- 9) Sieves: 50.0 mm (2 in.), 19.0 mm (3/4 in.), and a 4.75 mm (No. 4) conforming to the requirements of AASHTO M92.
- 10) Mixing Tools: Sample pans, spoons, scoops, trowels, used for mixing the sample with water.
- 11) Containers: Corrosion resistant with close fitting lids to retain moisture content of prepared soil samples.
- 12) Graduated cylinders for adding water.



Figure 5.2 Apparatus for T 99 and T 180

TESTING METHODS

AASHTO T 99 and T 180 stipulate four distinct test methods for these procedures, which are Method A, Method B, Method C, and Method D (Table 5.3). The method to be used should be indicated in the applicable specification.

TABLE 5.3				
Moisture-Density Methods and Associated Mold Sizes				
	Method A	Method B	Method C	Method D
Mold Size	101.6 mm (4 in)	152.4 mm (6 in)	101.6 mm (4 in)	152.4 mm (6 in)
Material Size	Passing 4.75 mm (No. 4)	Passing 4.75 mm (No. 4)	Passing 19.0 mm (3/4 in)	Passing 19.0 mm (3/4 in)
Blow Per Layer	25	56	25	56
Standard (T 99)	3 Layers using 2.495 kg (5.5 lb) rammer, 305 mm (12 in) drop			
Modified (T 180)	5 Layers using 4.536 kg (10 lb) rammer, 457 mm (18 in) drop			

Use caution when selecting the test method to be used. AASHTO test method designations are distinct from ASTM methods listed in D 698 and D 1557. ASTM also contains three Methods (A, B, or C) which correspond to different mold dimensions than the AASHTO counterparts.

The step by step procedures for AASHTO T 99 and T 180 are essentially the same. The differences in the two procedures are indicated in Table 5.3. AASHTO T 99 will always use 3 layers and a 2.495 kg (5.5 lb) rammer with 305 mm (12 in) drop for all methods. AASHTO T 180 will always use 5 layers and a 4.536 kg (10 lb) rammer with 457 mm (18 in.) drop.

AASHTO stipulates for each method that material must pass the designated sieve (Table 5.3). Any material retained on the designated sieves is discarded, unless the oversize correction procedure is to be used, (See "Oversize Material Replacement" on next page.)

Sample Preparation

- 1) If the sample is wet, dry it until it becomes friable under a trowel. Aggregations in a friable soil sample will break apart easily. Avoid breaking apart the natural particles when breaking up the soil aggregations.
- 2) Sieve the sample over the specified sieve for the method being performed. Discard any oversize material retained on the specified sieve.

NOTE: Oversize Material Replacement - It may be necessary to maintain the same percentage of coarse material in the lab sample as was found in the field. If oversize material replacement is required, the material to be tested should be screened through a 50 mm (2 in.) and 19 mm (3/4 in.) sieve, to ascertain the amount of material retained on the 19 mm (3/4 in.) sieve. An equal mass of material which passes the 19 mm (3/4 in.) sieve, but is retained on the 4.75 mm (No. 4) sieve, is then obtained from the remaining portion of the sample. This material is recombined with the test sample prior to compaction. When this procedure is followed, it is necessary to prepare a larger quantity of material for testing.

- 3) Thoroughly mix the remaining sample. Obtain at least enough material to fill the mold when compacted and provide enough extra material to ensure adequate material for the determination of moisture content and increase in density as more water is added.

NOTE: This method uses the same soil or soil-aggregate sample for each “point” on the density curve. If the soil or soil-aggregate mixture to be tested is a clayey material which will not easily mix with water, or where the soil material is fragile and will break apart from the repeated blows of the compaction rammer, it may be necessary to prepare individual portions for each density point. In most cases enough material should be sampled from the field to permit four individual “points” starting 4% below the anticipated optimum moisture content, and then each subsequent “point” increased by 2% moisture. Optimum moisture content should be “bracketed” by the prepared samples in order to provide a more accurate moisture-density curve.

- 4) Prepare the sample(s) and mix with water to produce the desired moisture content. If the four "points" are prepared in advance, store the prepared material in moisture tight containers. The following example illustrates how to calculate the amount of water to be added to the soil or soil-aggregate material as a percentage of the sample’s original mass.

A sample of 6090 g needs to be prepared with approximately 2% additional moisture. Therefore, 6090 g is multiplied by 1.02 to yield a sample mass of 6210 g.

$$6090 \times 1.02 = 6210 \text{ g}$$

$$6210 - 6090 = 120 \text{ g}$$

Therefore, 120 g of water should be added to bring the moisture content up by approximately 2%. Since water has a mass of one gram per milliliter, 120 mL of water should be added.

Test Procedure

- 1) Record the mass of the mold and base plate (without the extension collar) to the nearest 5 grams.

NOTE: While compacting the sample, make sure the mold rests on a rigid and stable foundation or base which will not move.

- 2) Place a representative portion of the sample into the mold. Place material layers using three approximately equal lifts, to give a total compacted depth of about 127 mm (5 in.) for the standard method (AASHTO T 99). Place five approximately equal layers to give a total compacted depth of about 127 mm (5 in.) for the modified method (AASHTO T 180).
- 3) Use the 2.495 kg (5.5 lb) rammer for standard moisture density test (AASHTO T 99) or the 4.536 kg (10 lb) rammer for modified moisture density test (AASHTO T 180).
- 4) Apply the required number of blows to the specimen layer (25 blows for Methods A and C, 56 blows for Methods B and D).
- 5) When compacting the specimen using the manual rammer, uniformly distribute the blows over the entire surface area of the sample.

NOTE: Do not lift the rammer and sleeve from the surface of the sample while compacting. Also, hold the rammer perpendicular to the sample and mold during compaction.

- 6) Repeat Steps 1 through 5 for each subsequent layer.
- 7) Remove the extension collar from the mold and trim the sample even with the top edge of the mold using a straightedge. Clean the mold and base plate of any loose particles. If there are voids in the surface of the compacted sample, fill them with loose soil collected from around the baseplate. Re-trim the sample even with the top edge of the mold. Clean mold of loose particles if necessary.
- 8) Weigh the mold with sample and record to the nearest 5 grams.
- 9) Remove the compacted soil or soil-aggregate sample from the mold and slice vertically through the center of the specimen. Obtain a representative sample from one of the cut faces, determine the moist mass immediately and record. Dry in accordance with MARTCP SA 1.3, to determine moisture content.
- 10) Break up the remainder of the sample from the mold. Add the broken up sample to the remainder of the sample being used for the test.
- 11) Add additional water to the sample to increase the overall moisture content by about 2% (as described in Step 4 of Sample Preparation). The increased moisture content should never be more than 4%. If separate density points were prepared prior to performing the procedure, skip this step. Continue compacting samples with moisture contents increasing by roughly 2% until there is a drop or no change in the calculated wet density.

Calculations

1) Calculate the wet density of the material as follows:

a. Methods A & C: (volume of four inch mold = 0.0333 ft³)

$$W_{\text{wet}} = \frac{(W_{s+m} - W_m)}{0.0333 \text{ ft}^3} \times \frac{2.205 \text{ lb}}{1 \text{ kg}} = (W_{s+m} - W_m) \times 66.22$$

b. Methods B & D: (volume of six inch mold = 0.075 ft³)

$$W_{\text{wet}} = \frac{(W_{s+m} - W_m)}{0.075 \text{ ft}^3} \times \frac{2.205 \text{ lb}}{1 \text{ kg}} = (W_{s+m} - W_m) \times 29.40$$

Where:

W_{wet} = Wet Density (lb/ft³)

W_{s+m} = Mass of the wet sample and mold (kg)

W_m = Mass of the mold (kg)

2.205 lb = 1 kg

2) Calculate the moisture content for each compacted sample by dividing the water content (loss between wet mass and dry mass of moisture sample) by the dry mass of the sample and multiplying by 100.

$$W_{\%} = \frac{(W_{\text{wet}} - W_{\text{dry}})}{(W_{\text{dry}} - W_{\text{con}})} \times 100$$

Where:

$W_{\%}$ = Percent Moisture

W_{wet} = Weight of Wet Aggregate and Container (g or lb)

W_{dry} = Weight of Dry Aggregate and Container (g or lb)

W_{con} = Weight of the Container (g or lb)

- 3) Calculate the dry density for each compacted sample based on the corresponding moisture sample for each compacted specimen.

$$D_{\text{dry}} = \frac{D_{\text{wet}}}{100 + W_{\%}} \times 100$$

Where:

D_{dry} = Dry Density (kg/m³ or lb/ft³)

D_{wet} = Wet Density (kg/m³ or lb/ft³)

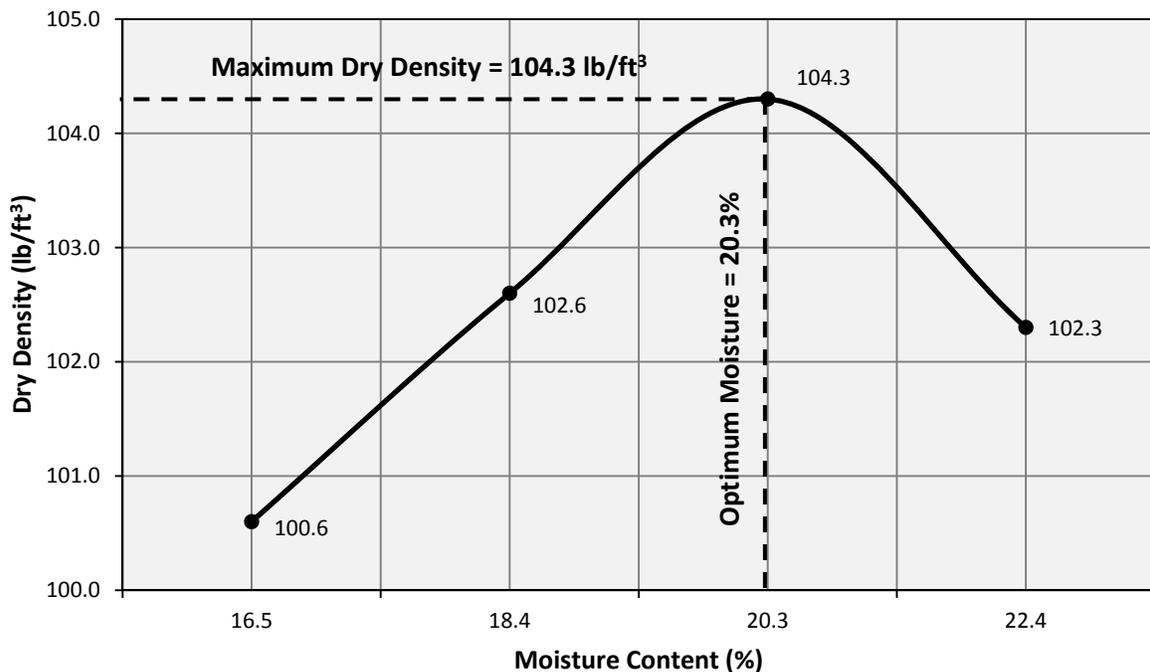
$W_{\%}$ = Moisture Content of Sample

- 4) Plot each compaction point for dry density on graph paper with density on the y-axis and moisture content on the x-axis as shown on Figure 6.7.
- 5) Form a smooth line using the engineer's curve by connecting the plotted points to form two curves. As close as possible to the intersection, round the peak to form a smooth, continuous line.
- 6) The moisture content corresponding to the peak of the curve will be termed the "optimum moisture content."
- 7) The dry density corresponding to the peak of the curve will be termed "maximum dry density."

Example Calculation

The following example moisture density relationship (Table 5.4) is calculated as a Modified (AASHTO T 180), Method A (Large Rammer, Small Mold). Remember that the mass of the wet soil needs to be expressed per the unit volume of the mold used. The mass of the wet soil in kilograms is multiplied by 66.22 to determine the wet density in lb/ft³.

TABLE 5.4				
Modified Method A Moisture-Density Relationship Computation				
Point No.	1	2	3	4
Mass of Mold and Soil (kg)	6.065	6.130	6.190	6.185
(-) Mass of Mold (kg)	4.295	4.295	4.295	4.295
(=) Mass of Wet Soil (kg)	1.770	1.835	1.895	1.890
Wet Density (lb/ft ³)	117.2	121.5	125.5	125.2
A = Mass of Container and Wet Soil (g)	373.5	397.5	385.2	387.3
B = Mass of Container and Dry Soil (g)	336.9	354.9	339.7	338.9
C = Mass of Container (g)	115.2	123.2	115.4	122.8
W = Moisture Content (%)	16.5	18.4	20.3	22.4
D _{dry} = Dry Density (lb/ft ³)	100.6	102.6	104.3	102.3



Common Testing Errors

- 1) The soil is not thoroughly mixed to achieve uniform moisture.
- 2) The wrong mold is used for the test.
- 3) The mold is out of calibration tolerances.
- 4) The compaction block is not of sufficient mass (200 lbs.).
- 5) The compaction block is unstable.
- 6) The wrong rammer is used for the test.
- 7) The drop of the rammer is incorrect.
- 8) The manual rammer is not lifted to the full stroke.
- 9) The manual rammer is not held vertically when the blows are delivered.
- 10) The rammer is not properly cleaned between uses.
- 11) The mechanical rammer is out of calibration.
- 12) The wrong number of blows is delivered with the rammer.
- 13) The mechanical rammer has the wrong compaction face.
- 14) The lifts vary in thickness.
- 15) The straightedge may become worn with use - replace as necessary.
- 16) The sample is not properly dried or the moisture content sample is improperly taken.
- 17) The points are not plotted correctly on the graph.

ONE POINT PROCTOR

A one point proctor is run after the material has been placed and bladed off to determine the optimum moisture and maximum dry density. This information will be compared to the field density test, which is run on the same soil, to determine the percentage of compaction achieved by the contractor's operations.

The information for the one point proctor goes on form TL-125A. The test is run as follows:

- 1) Obtain a representative sample.



- 2) Weigh the mold and base plate and record on line B of the worksheet. Attach the collar.
- 3) Pass the soil that was removed through a No.4 sieve.



- 4) Place the mold on a hard stable surface. Place the material passing the No. 4 sieve in three approximately equal layers, compacting each layer 25 times with the hand held hammer – 5.5 lbs. dropped 12 inches.

Note: A satisfactory base is defined by AASHTO as a concrete block weighing at least 200 lbs. supported by a relatively stable foundation or a concrete floor; a concrete box culvert or a bridge abutment will certainly meet these conditions.



- 5) After the soil is compacted, remove the collar, and use a straightedge with a beveled edge to strike off the surface evenly. Be careful to avoid removal of the soil within the mold. Should surface voids be created, take enough soil from the trimming to fill the void and apply pressure with a finger to compact the soil in the void. Once the sample has been trimmed, weigh the mold and wet soil, record the weight on line A.



Subtract line B from line A to determine the wet soil weight and record on line C. Multiply line C by 30 to determine the wet density of the soil and record on line D.

$$\text{Wet Density} = \text{Wt. of Wet Soil} \times 30$$

$$\text{Proctor mold volume} = 1/30 \text{ cubic foot}$$

- 6) The Moisture Content of the Soil is determined by the use of a field hot plate to dry the soil and then calculate the moisture content as in the laboratory or the Speedy Moisture Tester can be used.

- 7) Record the Speedy Dial reading from the test on line E and the moisture content from the chart that comes with the test unit on line F.
- 8) Now that the wet density and the moisture content have been determined, use the one point proctor typical moisture density curves set C worksheet to determine the maximum dry density of the soil.

Take the values from line D (wet density of soil) and line F (moisture content of soil) and locate this point on the Typical Moisture-Density curves set C. Find the curve where the wet density and moisture content lines intersect and go to the upper right hand corner of the graph and read the Maximum Dry Density and Optimum Moisture Content that correspond to that curve.

Form TL-125A (Rev. 07/15)

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

Route No. 726 County Pittsylvania
 Project No. 0726-071-274, C501 Inspector Your Name
 FHWA No. AS-414(101)

Field Test No.		1	2	3
Date of Test		3/5/2015		
Location of Test	Station Number – ft. (m)	27+50		
	Reference to Center Line – ft. (m)	3' Rt. C/L		
Reference Elevation	Original Ground – ft. (m)	+10 ft.		
	Finished Grade – ft. (m)	-26 ft.		
Type of Roller		Sheepsfoot		
A. Weight (mass) of mold and wet soil – lb. (kg)		13.57		
B. Weight (mass) of mold – lb. (kg)		9.34		
C. Weight (mass) of wet soil (A - B) – lb. (kg)		4.23		
D. Wet density of soil (Line C x 30 lb/ft ³) or (Line C x 1060 kg/m ³)		126.9		
E. "Speedy" Dial Reading				
F. Moisture Content (%) from Speedy Chart				
G. Maximum Dry Density – lb/ft ³ (kg/m ³)				
H. Optimum Moisture (%)				
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 (%)				

Line D = Line C x 30

Line D = 4.23 x 30

Line D = 126.9

Comments:

BY: _____

TITLE: _____

THE “SPEEDY” MOISTURE TESTER INSTRUCTIONS FOR USE

AMERICAN ASSOCIATION OF STATE HIGHWAY AND TRANSPORTATION OFFICIALS AASHTO DESIGNATION: T-217-96

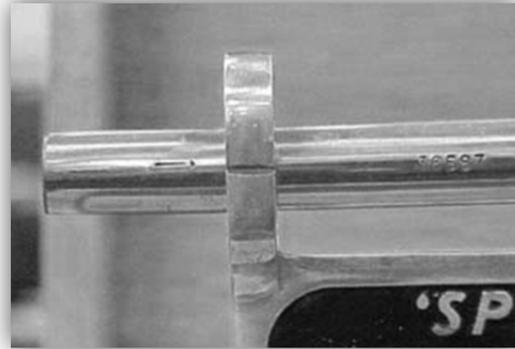


This method of test is intended to determine the moisture content of soils by means of a calcium carbide gas pressure moisture tester (speedy moisture tester).

- 1) Place three scoops (approximately 24g) of calcium carbide in the body of the moisture tester.



- 2) Weigh a sample of -4 material the exact weight specified by the manufacturer of the instrument in the balance provided (20 or 26g), and place the sample in the cap of the tester. If the moisture content of the sample exceeds the limit of the pressure gauge, a one-half size sample must be used and the dial reading must be multiplied by 2.



- 3) Place two 1¼" steel balls in the body of the tester with the calcium carbide (do not allow the steel balls to fall to the bottom of the tester, since this might cause damage to the dial).



- 4) With the pressure vessel in an approximately horizontal position, insert the cap in the pressure vessel and seal the unit by tightening the clamp, taking care that no carbide comes in contact with the soil until complete seal is achieved.



- 5) Raise the moisture tester to a vertical position so that the soil in the cap will fall into the pressure vessel (tap with hand to ensure all soil has fallen into pressure vessel).

- 6) Shake the instrument vigorously so that all lumps will be broken up to permit the calcium carbide to react with all available free moisture. The instrument should be shaken with a rotating motion so the steel balls will not damage the instrument or cause soil particles to become embedded in the orifice leading to the pressure diaphragm.
- 7) Shaking should continue for at least one minute with granular soils and for up to three minutes for other soils so as to permit complete reaction between the calcium carbide and the free moisture. Time should be permitted to allow dissipation of the heat generated by the chemical reaction. (Manufacturer suggests rotating the device for 10 seconds and resting for 20 seconds. Repeat the shake-rest cycle for a total of 3 minutes.)
- 8) When the needle stops moving, read the dial while holding the instrument in a horizontal position at eye level.



- 9) Record the dial reading and then determine the moisture content of the soil on a dry weight basis from the moisture chart.
- 10) With the cap of the instrument pointed away from the operator, slowly release the gas pressure, empty the pressure vessel and examine the material for lumps. If the sample is not completely pulverized, the test should be repeated using a new sample.

- NOTE:
- a) This method shall not be used on granular materials having particles large enough to affect the accuracy of the test - in general any appreciable amount retained on the No. 4 sieve.
 - b) Care must be exercised to prevent the calcium carbide from coming into direct contact with water.
 - c) When removing the cap, care should be taken to point the instrument away from the operator to avoid breathing the fumes, and away from any potential source of ignition for the acetylene gas.

SPEEDY MOISTURE CHART

SPEEDY MOIST.													
READ.	CONT.												
1.0	1.0	8.2	9.0	15.4	18.3	22.6	29.2	29.8	42.5	37.0	58.8	44.2	79.2
1.2	1.3	8.4	9.2	15.6	18.5	22.8	29.6	30.0	42.9	37.2	59.3	44.4	79.9
1.4	1.5	8.6	9.5	15.8	18.8	23.0	30.2	30.2	43.3	37.4	59.8	44.6	80.5
1.6	1.8	8.8	9.7	16.0	19.1	23.2	30.6	30.4	43.8	37.6	60.3	44.8	81.2
1.8	2.0	9.0	9.9	16.2	19.4	23.4	30.9	30.6	44.2	37.8	60.8	45.0	81.8
2.0	2.2	9.2	10.1	16.4	19.6	23.6	31.3	30.8	44.6	38.0	61.3	45.2	82.5
2.2	2.4	9.4	10.4	16.6	19.9	23.8	31.6	31.0	45.0	38.2	61.8	45.4	83.2
2.4	2.6	9.6	10.6	16.8	20.2	24.0	31.9	31.2	45.4	38.4	62.4	45.6	83.1
2.6	2.9	9.8	10.8	17.0	20.5	24.2	32.3	31.4	45.8	38.6	62.9	45.8	84.5
2.8	3.1	10.0	11.1	17.2	20.8	24.4	32.7	31.6	46.2	38.8	63.5	46.0	85.2
3.0	3.3	10.2	11.4	17.4	21.1	24.6	33.0	31.8	46.7	39.0	64.0	46.2	85.9
3.2	3.5	10.4	11.6	17.6	21.4	24.8	33.4	32.0	47.1	39.2	64.5	46.4	86.6
3.4	3.7	10.6	11.9	17.8	21.7	25.0	33.7	32.2	47.5	39.4	65.0	46.6	87.3
3.6	4.0	10.8	12.1	18.0	22.0	25.2	34.1	32.4	48.0	39.6	65.6	46.8	88.0
3.8	4.2	11.0	12.4	18.2	22.3	25.4	34.5	32.6	48.4	39.8	66.1	47.0	88.7
4.0	4.4	11.2	12.7	18.4	22.6	25.6	34.9	32.8	48.8	40.0	66.7	47.2	89.4
4.2	4.6	11.4	12.9	18.6	23.0	25.8	35.4	33.0	49.3	40.2	67.2	47.4	90.2
4.4	4.8	11.6	13.2	18.8	23.2	26.0	35.7	33.2	49.7	40.4	67.8	47.6	90.8
4.6	5.1	11.8	13.4	19.0	23.5	26.2	35.9	33.4	50.2	40.6	68.4	47.8	91.6
4.8	5.3	12.0	13.7	19.2	23.8	26.4	36.3	33.6	50.6	40.8	68.9	48.0	92.3
5.0	5.5	12.2	13.9	19.4				33.8	51.1	41.0	69.5	48.2	93.1
5.2	5.7	12.4	14.2	19.6				34.0	51.6	41.2	70.1	48.4	93.8
5.4	5.9	12.6	14.4	19.8				34.2	52.0	41.4	70.7	48.6	94.6
5.6	6.2	12.8	14.7	20.0	25.1	27.2	37.8	34.4	52.5	41.6	71.3	48.8	95.3
5.8	6.4	13.0	15.0	20.2	25.4	27.4	38.2	34.6	52.9	41.8	71.9	49.0	96.1
6.0	6.6	13.2	15.3	20.4	25.7	27.6	38.5	34.8	53.4	42.0	72.5	49.2	96.9
6.2	6.8	13.4	15.5	20.6	26.0	27.8	38.9	35.0	53.9	42.2	73.0	49.4	97.6
6.4	7.0	13.6	15.8	20.8	26.3	28.0	39.3	35.2	54.4	42.4	73.6	49.6	98.4
6.6	7.3	13.8	16.1	21.0	26.6	28.2	39.7	35.4	54.8	42.6	74.2	49.8	99.2
6.8	7.5	14.0	16.4	21.2	26.9	28.4	40.1	35.6	55.3	42.8	74.8	50.0	----
7.0	7.7	14.2	16.6	21.4	27.3	28.6	40.5	35.8	55.8	43.0	75.5		
7.2	7.9	14.4	16.9	21.6	27.6	28.8	40.9	36.0	56.3	43.2	76.1		
7.4	8.1	14.6	17.1	21.8	28.0	29.0	41.3	36.2	56.8	43.4	76.7		
7.6	8.4	14.8	17.4	22.0	28.3	29.2	41.5	36.4	57.2	43.6	77.3		
7.8	8.6	15.0	17.7	22.2	28.6	29.4	41.7	36.6	57.5	43.8	78.0		
8.0	8.8	15.2	18.0	22.4	28.9	29.6	42.1	36.8	58.3	44.0	78.6		

Speedy Reading for Proctor
 Dial Reading = 12.4
 Moisture Content = 14.2%

Form TL-125A (Rev. 07/15)

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

Route No. 726 County Pittsylvania
 Project No. 0726-071-274, C501 Inspector Your Name
 FHWA No. AS-414(101)

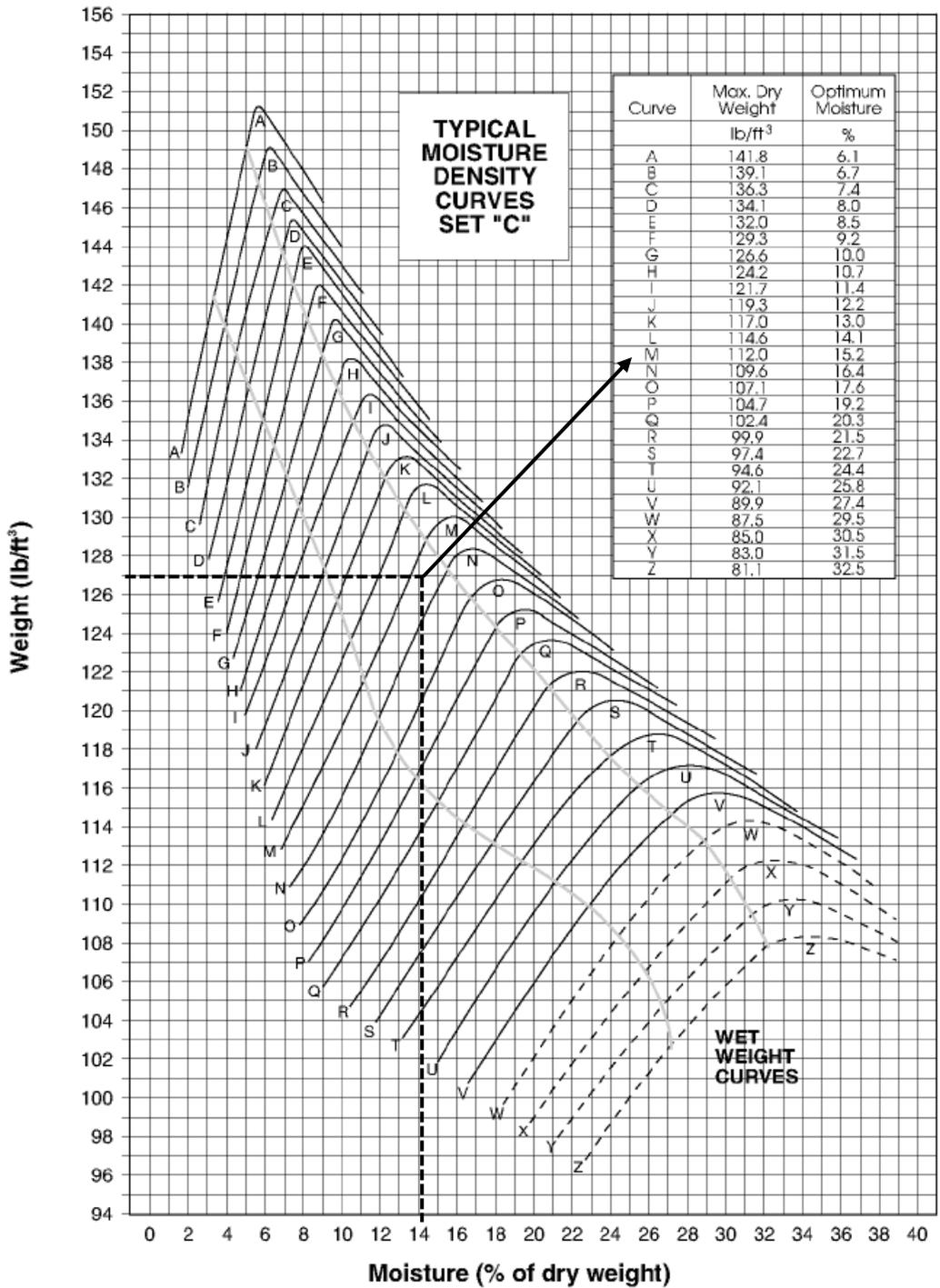
Field Test No.		1	2	3
Date of Test		3/5/2015		
Location of Test	Station Number – ft. (m)	27+50		
	Reference to Center Line – ft. (m)	3' Rt. C/L		
Reference Elevation	Original Ground – ft. (m)	+10 ft.		
	Finished Grade – ft. (m)	-26 ft.		
Type of Roller		Sheepsfoot		
A.	Weight (mass) of mold and wet soil – lb. (kg)	13.57		
B.	Weight (mass) of mold – lb. (kg)	9.34		
C.	Weight (mass) of wet soil (A - B) – lb. (kg)	4.23		
D.	Wet density of soil (Line C x 30 lb/ft ³) or (Line C x 1060 kg/m ³)	126.9		
E.	"Speedy" Dial Reading	12.4		
F.	Moisture Content (%) from Speedy Chart	14.2		
G.	Maximum Dry Density – lb/ft ³ (kg/m ³)			
H.	Optimum Moisture (%)			
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 (%)			

From Speedy Chart
 Dial Reading = 12.4
 Moisture Content = 14.2

Comments:

BY: _____
 TITLE: _____

The wet density of the soil is 126.9 lb/ft³. The moisture content is 14.2 percent. Find the wet density on the vertical axis, and the moisture content on the horizontal axis. Using a straightedge, extend the lines until they intersect. They intersect nearest to Line M. Go to the chart in the upper right hand corner and record the data from Line M. The Maximum Dry Density is 112.0 lb/ft³, and the optimum moisture is 15.2 percent. These values are recorded on Lines G and H of the one point proctor report (Form TL-125A).



Form TL-125A (Rev. 07/15)

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

Route No. 726 County Pittsylvania
 Project No. 0726-071-274, C501 Inspector Your Name
 FHWA No. AS-414(101)

Field Test No.		1	2	3
Date of Test		3/5/2015		
Location of Test	Station Number – ft. (m)	27+50		
	Reference to Center Line – ft. (m)	3' Rt. C/L		
Reference Elevation	Original Ground – ft. (m)	+10 ft.		
	Finished Grade – ft. (m)	-26 ft.		
Type of Roller		Sheepsfoot		
A. Weight (mass) of mold and wet soil – lb. (kg)		13.57		
B. Weight (mass) of mold – lb. (kg)		9.34		
C. Weight (mass) of wet soil (A - B) – lb. (kg)		4.23		
D. Wet density of soil (Line C x 30 lb/ft ³) or (Line C x 1060 kg/m ³)		126.9		
E. "Speedy" Dial Reading		12.4		
F. Moisture Content (%) from Speedy Chart		14.2		
G. Maximum Dry Density – lb/ft ³ (kg/m ³)		112.0		
H. Optimum Moisture (%)		15.2		
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 (%)				

From Moisture-Density Chart

Max. Dry Density = 112.0
Opt. Moisture = 15.2

Comments: Optimum Moisture Range = 12.2 – 18.2 %
 15.2 x 0.2 = 3.04 or 3.0
 15.2 – 3.0 = 12.2 (Lower Limit)
 15.2 + 3.0 = 18.2 (Upper Limit)

BY: _____
 TITLE: _____

FIELD MOISTURE CONTENT DETERMINATION OF FIELD MOISTURE CONTENT BY DRYING (MARTCP METHOD SA-1.3)

Scope

The moisture content of a material influences its ability or inability to be excavated, consolidated, moved, screened, weighed, dried out, or reabsorbed. Moisture content calculations used for soils and aggregates are by convention figured as the mass of water driven out of the material through drying over the dry mass of the material. The moisture content is used to calculate a variety of properties, including density, plasticity, permeability, and more.

Materials and Equipment

- 1) An electric hot plate or a gas burner
- 2) Scale or balance as required by state specifications.
- 3) Metal container, such as a large frying pan or equivalent.
- 4) Pointing trowel or large spoon.

Test procedure

- 1) Select a representative quantity of material based on the following table, or state specifications:

TABLE 5.5 Aggregate Moisture Content Test Sample Sizes	
Nominal Maximum Size, mm (in)	Minimum Sample Size, grams (lbs)
4.75 (No. 4)	500 (1.1)
9.5 (3/8)	1500 (3.3)
12.5 (1/2)	2000 (4.4)
19.0 (3/4)	3000 (6.6)
25.0 (1)	4000 (8.8)
37.5 (1 ½)	6000 (13.2)
50.0 (2)	8000 (17.6)
All soils moisture content sample sizes must be a minimum of 500 grams.	

- 2) Weigh a clean, dry container.
- 3) Place the sample in the container and weigh.
- 4) Place the container on the stove or hot plate and, while drying, mix the sample continuously to expedite drying and prevent burning of the aggregate. Always use a low flame or heat setting.

- 5) When the sample looks dry, remove it from the stove, cool, and weigh. Put sample back on the stove, continue drying for another two to three minutes, cool, and reweigh. When a constant weight has been achieved, the sample is dry. Record the weight of the sample and the container. Note: Care must be taken to avoid losing any of the sample.

Common Testing Errors

- Spillage or loss of sample – loss of sample voids test results.
- Insufficient sample quantity (size) to yield accurate results.
- Overheating sample during drying process causing a loss of organic material or partial oxidation of other sample constituents.

Calculations

- 1) Moisture content of aggregate:

$$W_{\%} = \frac{(W_{\text{wet}} - W_{\text{dry}})}{(W_{\text{dry}} - W_{\text{con}})} \times 100$$

Where:

$W_{\%}$ = Percent Moisture

W_{wet} = Weight of Wet Aggregate and Container (g or lb)

W_{dry} = Weight of Dry Aggregate and Container (g or lb)

W_{con} = Weight of the Container (g or lb)

- 2) Example Problem:

$$W_{\%} = \frac{(W_{\text{wet}} - W_{\text{dry}})}{(W_{\text{dry}} - W_{\text{con}})} \times 100$$

Where:

$W_{\%}$ = Percent Moisture

W_{wet} = 589.6 grams

W_{dry} = 536.2 grams

W_{con} = 149.8 grams

$$\begin{aligned}
 W_{\%} &= \frac{(589.6 - 536.2)}{(536.2 - 149.8)} \times 100 \\
 &\quad \downarrow \\
 &= \frac{53.4}{386.4} \times 100 \\
 &\quad \downarrow \\
 &= 0.1381 \times 100 \\
 &\quad \downarrow \\
 W_{\%} &= 13.8\%
 \end{aligned}$$

- 3) Report the moisture content according to required state specifications.

CHAPTER 5 – STUDY QUESTIONS

- 1) What are the three differences between AASHTO T-99 and AASHTO T-180?
- 2) _____ layers of soil are required to make a standard proctor mold and each layer must be compacted _____ blows with a _____ lb. hammer dropped _____ inches.
- 3) The moisture content corresponding to the peak of the curve will be termed the _____ and the density corresponding to the peak of the curve will be termed the _____.
- 4) _____ scoops of reagent are placed in the body of the “speedy” moisture tester.
- 5) According to AASHTO, the base on which the proctor test molds are made must weigh at least _____ lbs.
- 6) If the dial on the Speedy exceeds _____, a half-size sample must be used and the dial reading must be _____.
- 7) The proctor is run on soil which passes the _____ sieve.
- 8) Rotate the Speedy for _____, rest for _____ for a period of _____.
- 9) Calculate the moisture content using the following information:

$$W_{\text{wet}} = 10.85$$

$$W_{\text{dry}} = 10.05$$

$$W_{\text{con}} = 1.69$$

CHAPTER 5 – PRACTICE PROBLEMS

Practice Problem Number 1

Establishing Target Densities (One-Point Proctor)

- A. Complete the one-point proctor form (Form TL-125A) on soil using the information provided.

Date: Today's Date

Compacted Depth of Lift: 6"

Weight of Mold + Weight of Soil = 8.45 lbs.

Weight of Mold = 4.41 lbs.

Speedy Dial Reading = 13.2

- B. Answer the following questions.

- a) What is the maximum dry density?
- b) What is the optimum moisture and optimum moisture range?
- c) A nuclear density test determines the dry density to be 102 lb/ft^3 with a moisture content of 18.2%. Does this test pass?

Form TL-125A (Rev. 07/15)

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

Route No. 635 County Amherst
 Project No. 0635-005-187, C501 Inspector _____
 FHWA No. FH-151(102)

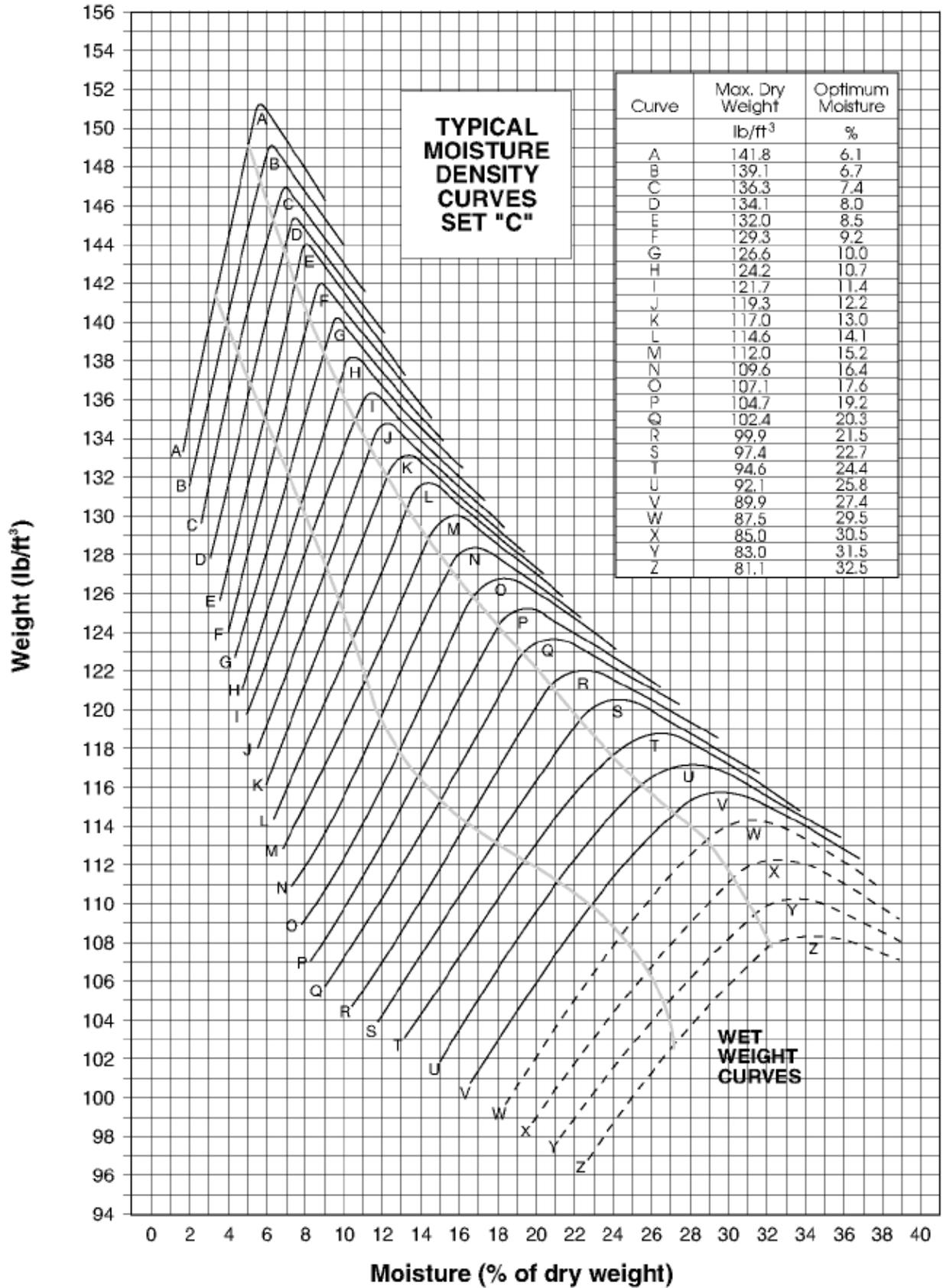
Field Test No.		1	2	3
Date of Test				
Location of Test	Station Number – ft. (m)	77+50		
	Reference to Center Line – ft. (m)	7' Lt. C/L		
Reference Elevation	Original Ground – ft. (m)	+10 ft.		
	Finished Grade – ft. (m)	-23 ft.		
Type of Roller		Sheepsfoot		
A. Weight (mass) of mold and wet soil – lb. (kg)				
B. Weight (mass) of mold – lb. (kg)				
C. Weight (mass) of wet soil (A - B) – lb. (kg)				
D. Wet density of soil (Line C x 30 lb/ft ³) or (Line C x 1060 kg/m ³)				
E. "Speedy" Dial Reading				
F. Moisture Content (%) from Speedy Chart				
G. Maximum Dry Density – lb/ft ³ (kg/m ³)				
H. Optimum Moisture (%)				
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 (%)				

Comments:

BY: _____
 TITLE: _____

SPEEDY MOISTURE CHART

SPEEDY MOIST.													
READ.	CONT.												
1.0	1.0	8.2	9.0	15.4	18.3	22.6	29.2	29.8	42.5	37.0	58.8	44.2	79.2
1.2	1.3	8.4	9.2	15.6	18.5	22.8	29.6	30.0	42.9	37.2	59.3	44.4	79.9
1.4	1.5	8.6	9.5	15.8	18.8	23.0	30.2	30.2	43.3	37.4	59.8	44.6	80.5
1.6	1.8	8.8	9.7	16.0	19.1	23.2	30.6	30.4	43.8	37.6	60.3	44.8	81.2
1.8	2.0	9.0	9.9	16.2	19.4	23.4	30.9	30.6	44.2	37.8	60.8	45.0	81.8
2.0	2.2	9.2	10.1	16.4	19.6	23.6	31.3	30.8	44.6	38.0	61.3	45.2	82.5
2.2	2.4	9.4	10.4	16.6	19.9	23.8	31.6	31.0	45.0	38.2	61.8	45.4	83.2
2.4	2.6	9.6	10.6	16.8	20.2	24.0	31.9	31.2	45.4	38.4	62.4	45.6	83.1
2.6	2.9	9.8	10.8	17.0	20.5	24.2	32.3	31.4	45.8	38.6	62.9	45.8	84.5
2.8	3.1	10.0	11.1	17.2	20.8	24.4	32.7	31.6	46.2	38.8	63.5	46.0	85.2
3.0	3.3	10.2	11.4	17.4	21.1	24.6	33.0	31.8	46.7	39.0	64.0	46.2	85.9
3.2	3.5	10.4	11.6	17.6	21.4	24.8	33.4	32.0	47.1	39.2	64.5	46.4	86.6
3.4	3.7	10.6	11.9	17.8	21.7	25.0	33.7	32.2	47.5	39.4	65.0	46.6	87.3
3.6	4.0	10.8	12.1	18.0	22.0	25.2	34.1	32.4	48.0	39.6	65.6	46.8	88.0
3.8	4.2	11.0	12.4	18.2	22.3	25.4	34.5	32.6	48.4	39.8	66.1	47.0	88.7
4.0	4.4	11.2	12.7	18.4	22.6	25.6	34.9	32.8	48.8	40.0	66.7	47.2	89.4
4.2	4.6	11.4	12.9	18.6	23.0	25.8	35.4	33.0	49.3	40.2	67.2	47.4	90.2
4.4	4.8	11.6	13.2	18.8	23.2	26.0	35.7	33.2	49.7	40.4	67.8	47.6	90.8
4.6	5.1	11.8	13.4	19.0	23.5	26.2	35.9	33.4	50.2	40.6	68.4	47.8	91.6
4.8	5.3	12.0	13.7	19.2	23.8	26.4	36.3	33.6	50.6	40.8	68.9	48.0	92.3
5.0	5.5	12.2	13.9	19.4	24.1	26.6	36.6	33.8	51.1	41.0	69.5	48.2	93.1
5.2	5.7	12.4	14.2	19.6	24.4	26.8	37.0	34.0	51.6	41.2	70.1	48.4	93.8
5.4	5.9	12.6	14.4	19.8	24.8	27.0	37.4	34.2	52.0	41.4	70.7	48.6	94.6
5.6	6.2	12.8	14.7	20.0	25.1	27.2	37.8	34.4	52.5	41.6	71.3	48.8	95.3
5.8	6.4	13.0	15.0	20.2	25.4	27.4	38.2	34.6	52.9	41.8	71.9	49.0	96.1
6.0	6.6	13.2	15.3	20.4	25.7	27.6	38.5	34.8	53.4	42.0	72.5	49.2	96.9
6.2	6.8	13.4	15.5	20.6	26.0	27.8	38.9	35.0	53.9	42.2	73.0	49.4	97.6
6.4	7.0	13.6	15.8	20.8	26.3	28.0	39.3	35.2	54.4	42.4	73.6	49.6	98.4
6.6	7.3	13.8	16.1	21.0	26.6	28.2	39.7	35.4	54.8	42.6	74.2	49.8	99.2
6.8	7.5	14.0	16.4	21.2	26.9	28.4	40.1	35.6	55.3	42.8	74.8	50.0	----
7.0	7.7	14.2	16.6	21.4	27.3	28.6	40.5	35.8	55.8	43.0	75.5		
7.2	7.9	14.4	16.9	21.6	27.6	28.8	40.9	36.0	56.3	43.2	76.1		
7.4	8.1	14.6	17.1	21.8	28.0	29.0	41.3	36.2	56.8	43.4	76.7		
7.6	8.4	14.8	17.4	22.0	28.3	29.2	41.5	36.4	57.2	43.6	77.3		
7.8	8.6	15.0	17.7	22.2	28.6	29.4	41.7	36.6	57.5	43.8	78.0		
8.0	8.8	15.2	18.0	22.4	28.9	29.6	42.1	36.8	58.3	44.0	78.6		



CHAPTER 5 – PRACTICE PROBLEMS

Practice Problem Number 2

Establishing Target Densities (One-Point Proctor)

- A. Complete the one-point proctor form (Form TL-125A) on soil using the information provided.

Date: Today's Date

Compacted Depth of Lift: 6"

Weight of Mold + Weight of Soil = 13.56 lbs.

Weight of Mold = 9.51 lbs.

Speedy Dial Reading = 16.0

- B. Answer the following questions.

- a) What is the maximum dry density?
- b) What is the optimum moisture and optimum moisture range?
- c) A nuclear density test determines the dry density to be 96.2 lb/ft^3 with a moisture content of 15.8%. Does this test pass?

Form TL-125A (Rev. 07/15)

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

Route No. 635 County Amherst
 Project No. 0635-005-187, C501 Inspector _____
 FHWA No. FH-151(102)

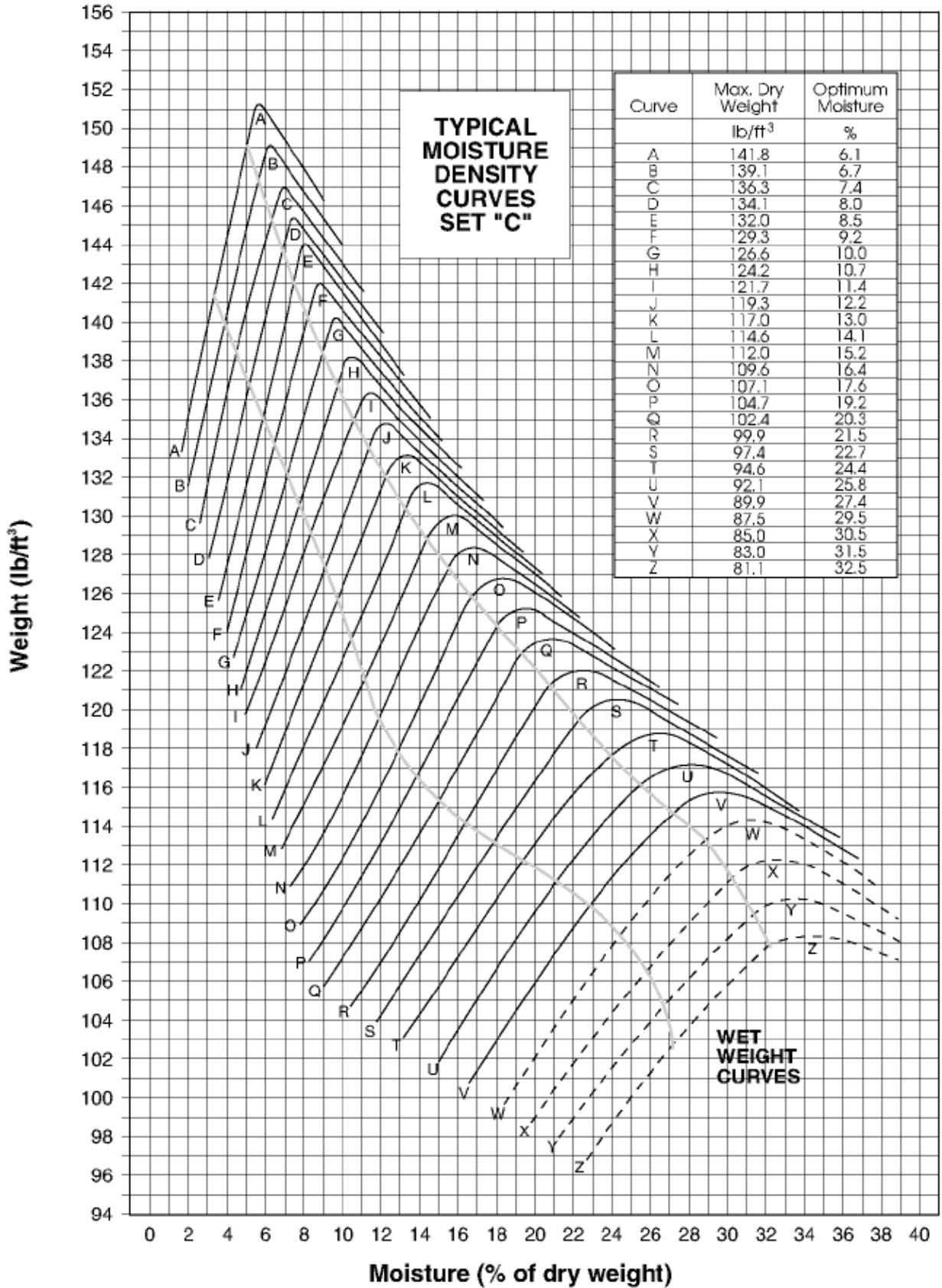
Field Test No.		1	2	3
Date of Test				
Location of Test	Station Number – ft. (m)	87+50		
	Reference to Center Line – ft. (m)	10' Rt. C/L		
Reference Elevation	Original Ground – ft. (m)	+20 ft.		
	Finished Grade – ft. (m)	-23 ft.		
Type of Roller		Sheepsfoot		
A. Weight (mass) of mold and wet soil – lb. (kg)				
B. Weight (mass) of mold – lb. (kg)				
C. Weight (mass) of wet soil (A - B) – lb. (kg)				
D. Wet density of soil (Line C x 30 lb/ft ³) or (Line C x 1060 kg/m ³)				
E. "Speedy" Dial Reading				
F. Moisture Content (%) from Speedy Chart				
G. Maximum Dry Density – lb/ft ³ (kg/m ³)				
H. Optimum Moisture (%)				
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 (%)				

Comments:

BY: _____
 TITLE: _____

SPEEDY MOISTURE CHART

SPEEDY MOIST.													
READ.	CONT.												
1.0	1.0	8.2	9.0	15.4	18.3	22.6	29.2	29.8	42.5	37.0	58.8	44.2	79.2
1.2	1.3	8.4	9.2	15.6	18.5	22.8	29.6	30.0	42.9	37.2	59.3	44.4	79.9
1.4	1.5	8.6	9.5	15.8	18.8	23.0	30.2	30.2	43.3	37.4	59.8	44.6	80.5
1.6	1.8	8.8	9.7	16.0	19.1	23.2	30.6	30.4	43.8	37.6	60.3	44.8	81.2
1.8	2.0	9.0	9.9	16.2	19.4	23.4	30.9	30.6	44.2	37.8	60.8	45.0	81.8
2.0	2.2	9.2	10.1	16.4	19.6	23.6	31.3	30.8	44.6	38.0	61.3	45.2	82.5
2.2	2.4	9.4	10.4	16.6	19.9	23.8	31.6	31.0	45.0	38.2	61.8	45.4	83.2
2.4	2.6	9.6	10.6	16.8	20.2	24.0	31.9	31.2	45.4	38.4	62.4	45.6	83.1
2.6	2.9	9.8	10.8	17.0	20.5	24.2	32.3	31.4	45.8	38.6	62.9	45.8	84.5
2.8	3.1	10.0	11.1	17.2	20.8	24.4	32.7	31.6	46.2	38.8	63.5	46.0	85.2
3.0	3.3	10.2	11.4	17.4	21.1	24.6	33.0	31.8	46.7	39.0	64.0	46.2	85.9
3.2	3.5	10.4	11.6	17.6	21.4	24.8	33.4	32.0	47.1	39.2	64.5	46.4	86.6
3.4	3.7	10.6	11.9	17.8	21.7	25.0	33.7	32.2	47.5	39.4	65.0	46.6	87.3
3.6	4.0	10.8	12.1	18.0	22.0	25.2	34.1	32.4	48.0	39.6	65.6	46.8	88.0
3.8	4.2	11.0	12.4	18.2	22.3	25.4	34.5	32.6	48.4	39.8	66.1	47.0	88.7
4.0	4.4	11.2	12.7	18.4	22.6	25.6	34.9	32.8	48.8	40.0	66.7	47.2	89.4
4.2	4.6	11.4	12.9	18.6	23.0	25.8	35.4	33.0	49.3	40.2	67.2	47.4	90.2
4.4	4.8	11.6	13.2	18.8	23.2	26.0	35.7	33.2	49.7	40.4	67.8	47.6	90.8
4.6	5.1	11.8	13.4	19.0	23.5	26.2	35.9	33.4	50.2	40.6	68.4	47.8	91.6
4.8	5.3	12.0	13.7	19.2	23.8	26.4	36.3	33.6	50.6	40.8	68.9	48.0	92.3
5.0	5.5	12.2	13.9	19.4	24.1	26.6	36.6	33.8	51.1	41.0	69.5	48.2	93.1
5.2	5.7	12.4	14.2	19.6	24.4	26.8	37.0	34.0	51.6	41.2	70.1	48.4	93.8
5.4	5.9	12.6	14.4	19.8	24.8	27.0	37.4	34.2	52.0	41.4	70.7	48.6	94.6
5.6	6.2	12.8	14.7	20.0	25.1	27.2	37.8	34.4	52.5	41.6	71.3	48.8	95.3
5.8	6.4	13.0	15.0	20.2	25.4	27.4	38.2	34.6	52.9	41.8	71.9	49.0	96.1
6.0	6.6	13.2	15.3	20.4	25.7	27.6	38.5	34.8	53.4	42.0	72.5	49.2	96.9
6.2	6.8	13.4	15.5	20.6	26.0	27.8	38.9	35.0	53.9	42.2	73.0	49.4	97.6
6.4	7.0	13.6	15.8	20.8	26.3	28.0	39.3	35.2	54.4	42.4	73.6	49.6	98.4
6.6	7.3	13.8	16.1	21.0	26.6	28.2	39.7	35.4	54.8	42.6	74.2	49.8	99.2
6.8	7.5	14.0	16.4	21.2	26.9	28.4	40.1	35.6	55.3	42.8	74.8	50.0	----
7.0	7.7	14.2	16.6	21.4	27.3	28.6	40.5	35.8	55.8	43.0	75.5		
7.2	7.9	14.4	16.9	21.6	27.6	28.8	40.9	36.0	56.3	43.2	76.1		
7.4	8.1	14.6	17.1	21.8	28.0	29.0	41.3	36.2	56.8	43.4	76.7		
7.6	8.4	14.8	17.4	22.0	28.3	29.2	41.5	36.4	57.2	43.6	77.3		
7.8	8.6	15.0	17.7	22.2	28.6	29.4	41.7	36.6	57.5	43.8	78.0		
8.0	8.8	15.2	18.0	22.4	28.9	29.6	42.1	36.8	58.3	44.0	78.6		



CHAPTER 5 – PRACTICE PROBLEMS

Practice Problem Number 3

Establishing Target Densities (One-Point Proctor)

- A. Complete the one-point proctor form (Form TL-125A) on soil using the information provided.

Date: Today's Date

Compacted Depth of Lift: 6"

Weight of Mold + Weight of Soil = 8.43 lbs.

Weight of Mold = 4.40 lbs.

Speedy Dial Reading = 14.0

- B. Answer the following questions.

- a) What is the maximum dry density?
- b) What is the optimum moisture and optimum moisture range?

Form TL-125A (Rev. 07/15)

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

Route No. 615 County Campbell
 Project No. 0615-015-186, C501 Inspector _____
 FHWA No. FH-132(104)

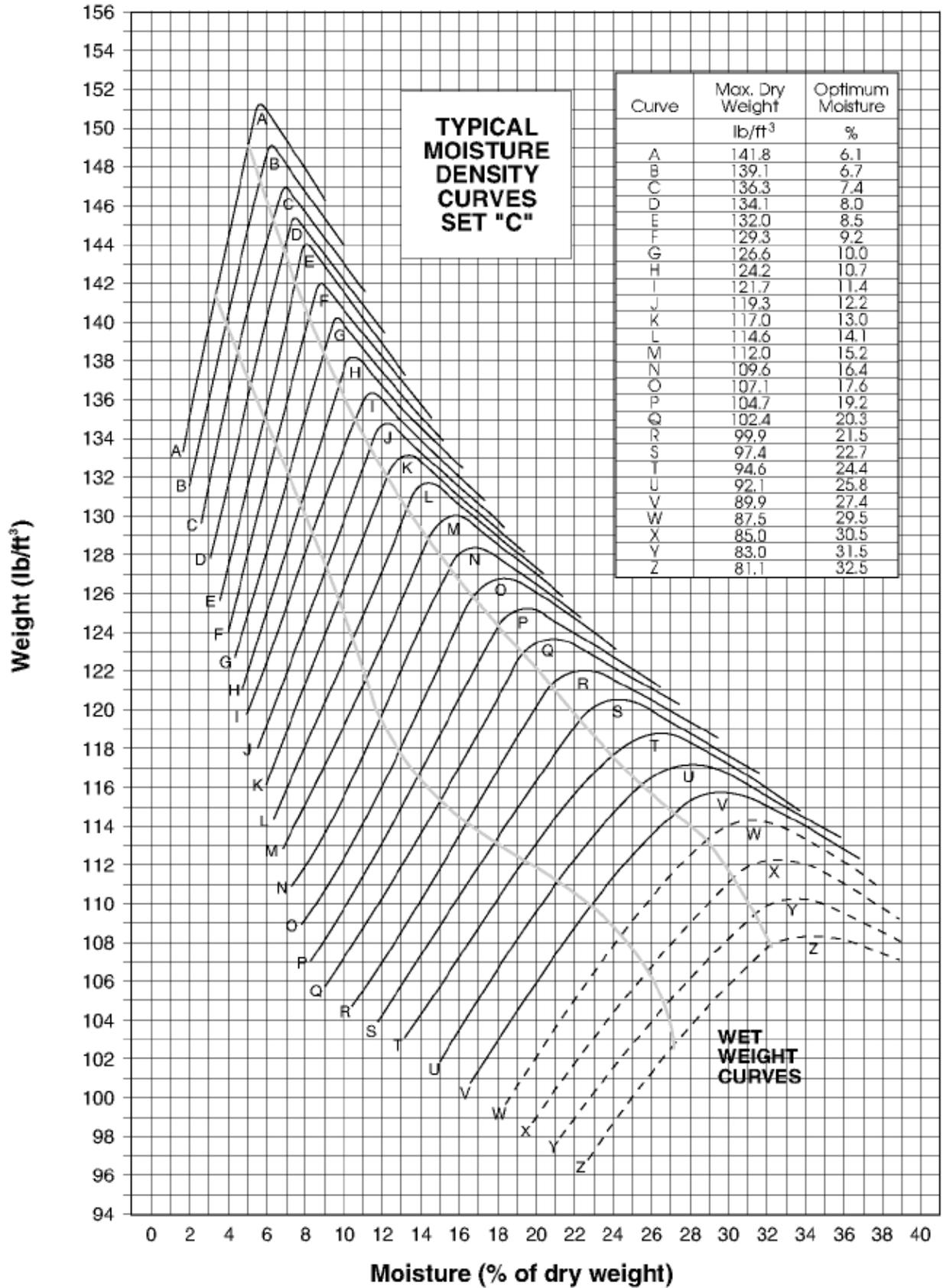
Field Test No.		1	2	3
Date of Test				
Location of Test	Station Number – ft. (m)	87+40		
	Reference to Center Line – ft. (m)	10' Rt. C/L		
Reference Elevation	Original Ground – ft. (m)	+13 ft.		
	Finished Grade – ft. (m)	-7 ft.		
Type of Roller		Sheepsfoot		
A. Weight (mass) of mold and wet soil – lb. (kg)				
B. Weight (mass) of mold – lb. (kg)				
C. Weight (mass) of wet soil (A - B) – lb. (kg)				
D. Wet density of soil (Line C x 30 lb/ft ³) or (Line C x 1060 kg/m ³)				
E. "Speedy" Dial Reading				
F. Moisture Content (%) from Speedy Chart				
G. Maximum Dry Density – lb/ft ³ (kg/m ³)				
H. Optimum Moisture (%)				
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 (%)				

Comments:

BY: _____
 TITLE: _____

SPEEDY MOISTURE CHART

SPEEDY MOIST.													
READ.	CONT.												
1.0	1.0	8.2	9.0	15.4	18.3	22.6	29.2	29.8	42.5	37.0	58.8	44.2	79.2
1.2	1.3	8.4	9.2	15.6	18.5	22.8	29.6	30.0	42.9	37.2	59.3	44.4	79.9
1.4	1.5	8.6	9.5	15.8	18.8	23.0	30.2	30.2	43.3	37.4	59.8	44.6	80.5
1.6	1.8	8.8	9.7	16.0	19.1	23.2	30.6	30.4	43.8	37.6	60.3	44.8	81.2
1.8	2.0	9.0	9.9	16.2	19.4	23.4	30.9	30.6	44.2	37.8	60.8	45.0	81.8
2.0	2.2	9.2	10.1	16.4	19.6	23.6	31.3	30.8	44.6	38.0	61.3	45.2	82.5
2.2	2.4	9.4	10.4	16.6	19.9	23.8	31.6	31.0	45.0	38.2	61.8	45.4	83.2
2.4	2.6	9.6	10.6	16.8	20.2	24.0	31.9	31.2	45.4	38.4	62.4	45.6	83.1
2.6	2.9	9.8	10.8	17.0	20.5	24.2	32.3	31.4	45.8	38.6	62.9	45.8	84.5
2.8	3.1	10.0	11.1	17.2	20.8	24.4	32.7	31.6	46.2	38.8	63.5	46.0	85.2
3.0	3.3	10.2	11.4	17.4	21.1	24.6	33.0	31.8	46.7	39.0	64.0	46.2	85.9
3.2	3.5	10.4	11.6	17.6	21.4	24.8	33.4	32.0	47.1	39.2	64.5	46.4	86.6
3.4	3.7	10.6	11.9	17.8	21.7	25.0	33.7	32.2	47.5	39.4	65.0	46.6	87.3
3.6	4.0	10.8	12.1	18.0	22.0	25.2	34.1	32.4	48.0	39.6	65.6	46.8	88.0
3.8	4.2	11.0	12.4	18.2	22.3	25.4	34.5	32.6	48.4	39.8	66.1	47.0	88.7
4.0	4.4	11.2	12.7	18.4	22.6	25.6	34.9	32.8	48.8	40.0	66.7	47.2	89.4
4.2	4.6	11.4	12.9	18.6	23.0	25.8	35.4	33.0	49.3	40.2	67.2	47.4	90.2
4.4	4.8	11.6	13.2	18.8	23.2	26.0	35.7	33.2	49.7	40.4	67.8	47.6	90.8
4.6	5.1	11.8	13.4	19.0	23.5	26.2	35.9	33.4	50.2	40.6	68.4	47.8	91.6
4.8	5.3	12.0	13.7	19.2	23.8	26.4	36.3	33.6	50.6	40.8	68.9	48.0	92.3
5.0	5.5	12.2	13.9	19.4	24.1	26.6	36.6	33.8	51.1	41.0	69.5	48.2	93.1
5.2	5.7	12.4	14.2	19.6	24.4	26.8	37.0	34.0	51.6	41.2	70.1	48.4	93.8
5.4	5.9	12.6	14.4	19.8	24.8	27.0	37.4	34.2	52.0	41.4	70.7	48.6	94.6
5.6	6.2	12.8	14.7	20.0	25.1	27.2	37.8	34.4	52.5	41.6	71.3	48.8	95.3
5.8	6.4	13.0	15.0	20.2	25.4	27.4	38.2	34.6	52.9	41.8	71.9	49.0	96.1
6.0	6.6	13.2	15.3	20.4	25.7	27.6	38.5	34.8	53.4	42.0	72.5	49.2	96.9
6.2	6.8	13.4	15.5	20.6	26.0	27.8	38.9	35.0	53.9	42.2	73.0	49.4	97.6
6.4	7.0	13.6	15.8	20.8	26.3	28.0	39.3	35.2	54.4	42.4	73.6	49.6	98.4
6.6	7.3	13.8	16.1	21.0	26.6	28.2	39.7	35.4	54.8	42.6	74.2	49.8	99.2
6.8	7.5	14.0	16.4	21.2	26.9	28.4	40.1	35.6	55.3	42.8	74.8	50.0	----
7.0	7.7	14.2	16.6	21.4	27.3	28.6	40.5	35.8	55.8	43.0	75.5		
7.2	7.9	14.4	16.9	21.6	27.6	28.8	40.9	36.0	56.3	43.2	76.1		
7.4	8.1	14.6	17.1	21.8	28.0	29.0	41.3	36.2	56.8	43.4	76.7		
7.6	8.4	14.8	17.4	22.0	28.3	29.2	41.5	36.4	57.2	43.6	77.3		
7.8	8.6	15.0	17.7	22.2	28.6	29.4	41.7	36.6	57.5	43.8	78.0		
8.0	8.8	15.2	18.0	22.4	28.9	29.6	42.1	36.8	58.3	44.0	78.6		



CHAPTER 5 – PRACTICE PROBLEMS

Practice Problem Number 4

Establishing Target Densities (One-Point Proctor)

- A. Complete the one-point proctor form (Form TL-125A) on soil using the information provided.

Date: Today's Date

Compacted Depth of Lift: 6"

Weight of Mold + Weight of Soil = 13.56 lbs.

Weight of Mold = 9.51 lbs.

Speedy Dial Reading = 16.2

- B. Answer the following questions.

- a) What is the maximum dry density?
- b) What is the optimum moisture and optimum moisture range?

Form TL-125A (Rev. 07/15)

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

Route No. 632 County Amherst
 Project No. 0632-005-184, C501 Inspector _____
 FHWA No. FH-130(101)

Field Test No.	7		
Date of Test			
Location of Test	Station Number – ft. (m)	120+40	
	Reference to Center Line – ft. (m)	13' Rt. C/L	
Reference Elevation	Original Ground – ft. (m)	+16 ft.	
	Finished Grade – ft. (m)	-7 ft.	
Type of Roller	Sheepsfoot		
A. Weight (mass) of mold and wet soil – lb. (kg)			
B. Weight (mass) of mold – lb. (kg)			
C. Weight (mass) of wet soil (A - B) – lb. (kg)			
D. Wet density of soil (Line C x 30 lb/ft ³) or (Line C x 1060 kg/m ³)			
E. "Speedy" Dial Reading			
F. Moisture Content (%) from Speedy Chart			
G. Maximum Dry Density – lb/ft ³ (kg/m ³)			
H. Optimum Moisture (%)			
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 (%)			

Comments:

BY: _____
 TITLE: _____

SPEEDY MOISTURE CHART

SPEEDY MOIST.													
READ.	CONT.												
1.0	1.0	8.2	9.0	15.4	18.3	22.6	29.2	29.8	42.5	37.0	58.8	44.2	79.2
1.2	1.3	8.4	9.2	15.6	18.5	22.8	29.6	30.0	42.9	37.2	59.3	44.4	79.9
1.4	1.5	8.6	9.5	15.8	18.8	23.0	30.2	30.2	43.3	37.4	59.8	44.6	80.5
1.6	1.8	8.8	9.7	16.0	19.1	23.2	30.6	30.4	43.8	37.6	60.3	44.8	81.2
1.8	2.0	9.0	9.9	16.2	19.4	23.4	30.9	30.6	44.2	37.8	60.8	45.0	81.8
2.0	2.2	9.2	10.1	16.4	19.6	23.6	31.3	30.8	44.6	38.0	61.3	45.2	82.5
2.2	2.4	9.4	10.4	16.6	19.9	23.8	31.6	31.0	45.0	38.2	61.8	45.4	83.2
2.4	2.6	9.6	10.6	16.8	20.2	24.0	31.9	31.2	45.4	38.4	62.4	45.6	83.1
2.6	2.9	9.8	10.8	17.0	20.5	24.2	32.3	31.4	45.8	38.6	62.9	45.8	84.5
2.8	3.1	10.0	11.1	17.2	20.8	24.4	32.7	31.6	46.2	38.8	63.5	46.0	85.2
3.0	3.3	10.2	11.4	17.4	21.1	24.6	33.0	31.8	46.7	39.0	64.0	46.2	85.9
3.2	3.5	10.4	11.6	17.6	21.4	24.8	33.4	32.0	47.1	39.2	64.5	46.4	86.6
3.4	3.7	10.6	11.9	17.8	21.7	25.0	33.7	32.2	47.5	39.4	65.0	46.6	87.3
3.6	4.0	10.8	12.1	18.0	22.0	25.2	34.1	32.4	48.0	39.6	65.6	46.8	88.0
3.8	4.2	11.0	12.4	18.2	22.3	25.4	34.5	32.6	48.4	39.8	66.1	47.0	88.7
4.0	4.4	11.2	12.7	18.4	22.6	25.6	34.9	32.8	48.8	40.0	66.7	47.2	89.4
4.2	4.6	11.4	12.9	18.6	23.0	25.8	35.4	33.0	49.3	40.2	67.2	47.4	90.2
4.4	4.8	11.6	13.2	18.8	23.2	26.0	35.7	33.2	49.7	40.4	67.8	47.6	90.8
4.6	5.1	11.8	13.4	19.0	23.5	26.2	35.9	33.4	50.2	40.6	68.4	47.8	91.6
4.8	5.3	12.0	13.7	19.2	23.8	26.4	36.3	33.6	50.6	40.8	68.9	48.0	92.3
5.0	5.5	12.2	13.9	19.4	24.1	26.6	36.6	33.8	51.1	41.0	69.5	48.2	93.1
5.2	5.7	12.4	14.2	19.6	24.4	26.8	37.0	34.0	51.6	41.2	70.1	48.4	93.8
5.4	5.9	12.6	14.4	19.8	24.8	27.0	37.4	34.2	52.0	41.4	70.7	48.6	94.6
5.6	6.2	12.8	14.7	20.0	25.1	27.2	37.8	34.4	52.5	41.6	71.3	48.8	95.3
5.8	6.4	13.0	15.0	20.2	25.4	27.4	38.2	34.6	52.9	41.8	71.9	49.0	96.1
6.0	6.6	13.2	15.3	20.4	25.7	27.6	38.5	34.8	53.4	42.0	72.5	49.2	96.9
6.2	6.8	13.4	15.5	20.6	26.0	27.8	38.9	35.0	53.9	42.2	73.0	49.4	97.6
6.4	7.0	13.6	15.8	20.8	26.3	28.0	39.3	35.2	54.4	42.4	73.6	49.6	98.4
6.6	7.3	13.8	16.1	21.0	26.6	28.2	39.7	35.4	54.8	42.6	74.2	49.8	99.2
6.8	7.5	14.0	16.4	21.2	26.9	28.4	40.1	35.6	55.3	42.8	74.8	50.0	----
7.0	7.7	14.2	16.6	21.4	27.3	28.6	40.5	35.8	55.8	43.0	75.5		
7.2	7.9	14.4	16.9	21.6	27.6	28.8	40.9	36.0	56.3	43.2	76.1		
7.4	8.1	14.6	17.1	21.8	28.0	29.0	41.3	36.2	56.8	43.4	76.7		
7.6	8.4	14.8	17.4	22.0	28.3	29.2	41.5	36.4	57.2	43.6	77.3		
7.8	8.6	15.0	17.7	22.2	28.6	29.4	41.7	36.6	57.5	43.8	78.0		
8.0	8.8	15.2	18.0	22.4	28.9	29.6	42.1	36.8	58.3	44.0	78.6		

