APPENDIX C
Sampling and Testing Procedures

SOUTH CAROLINA
DEPARTMENT
OF TRANSPORTATION

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Appendix C
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C.1 MATERIAL SAMPLING AND TESTING

C.1.1 Purpose

The importance of accurate and representative sampling of SCDOT highway construction materials cannot be overemphasized. If a material is not properly sampled, the sample taken may not be truly representative of the material that will eventually be incorporated into the work. If testing is performed on such a non-representative sample, the test results will be meaningless with respect to assessing material quality and adherence to specified requirements. Such practice wastes time and taxpayer dollars and eventually causes construction and maintenance problems.

C.1.2 Personnel Certification

It is essential that SCDOT and Contractor personnel in responsible charge of material sampling and testing be properly certified by the Department. SCDOT does not permit non-certified personnel to sample project materials. The Resident Construction Engineer is ultimately responsible for ensuring that each Inspector assigned to the project is properly certified by SCDOT for the type of sampling and testing to be performed. Certified Inspectors assigned to the project must adhere to the sampling and testing procedures and reporting requirements that are documented in Appendix C and the administrative policies and procedures for materials control that are documented in Section 106 of this *Manual*. Contact the Research and Materials Laboratory for any needed assistance.

C.1.3 Sampling and Testing Procedures

Appendix C documents the sampling and testing procedures that are typically used on SCDOT projects. Some of the referenced procedures are national AASHTO or ASTM procedures. SCDOT employees may obtain a copy of AASHTO and ASTM procedures from the Research and Materials Laboratory. SCDOT practices are designated “SC-T-##” (e.g., SC-T-100).

C.2 SAFETY CONSIDERATIONS

The sampling and testing procedures documented in Appendix C may involve hazardous materials, operations and equipment. Appendix C does not purport to address all of the safety hazards associated with using these sampling and testing procedures. It is the responsibility of the user of each documented procedure to consult and establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.

SCDOT Sampling and Testing Procedures

C.3 AGGREGATES

Standard Method of Test for

Methods of Sampling Coarse Aggregates

SCDOT Designation: SC-T-1

1. SCOPE

1.1. These methods are intended to apply to coarse aggregates of gravel and crushed stone that have been sized and processed for use in construction items of work.

1.2. This standard may involve hazardous materials, operations and equipment. This standard does not purport to address all of the safety problems associated with its use. It is the responsibility of the user of this standard to consult and establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.

2. SUMMARY OF TEST METHOD

2.1. A sample of coarse aggregate is obtained by combining portions taken from a conveyor belt, storage bin, truck, rail car or stockpile.

3. SIGNIFICANCE AND USE

3.1. Sampling is equally as important as the testing, and the sampler must use every precaution to obtain samples that will show the true nature and condition of the materials that they represent.

4. APPARATUS

4.1. Round point shovel, large sample bags, board (optional).

5. TEST SPECIMENS

5.1. The sample size shall be governed by the maximum size of the particles to be sampled. The minimum size of sample shall conform to the requirements shown in Figure SC-T-1A.

6. PROCEDURE

6.1. *Sampling from Conveyor Belts* — Conveyor belts furnish a good point for sampling. It is necessary to stop the belt before taking a portion of the sample. At least 2 feet of the belt should be scraped clean for the entire width and depth. A sample should consist of at least three (3) portions taken from the belt. The conveyor belt should make at least two (2) revolutions between the taking of each sample portion.

6.2. *Sampling from Storage Bins* — If samples are taken from a bin, they shall be taken from the entire cross-section of the flow of material as it is being discharged. At the beginning of the discharge from the bins, sufficient material should be permitted to flow to insure normal uniformity before the sample is selected.

MAXIMUM SIZE OF PARTICLES PASSING SIEVE (inches)	MINIMUM WEIGHT OF FIELD SAMPLES (pounds)
⅜	10
½	20
¾	30
1	50
1½	70
2	90
2½	100
3	125
3½	150

TABLE OF MINIMUM SAMPLES SIZES
Figure SC-T-1A

6.3. *Sampling from Railroad Cars or Trucks* — Material from railroad cars should be taken from three (3) or more trenches dug across the car at points that appear on the surface to be representative of the material. The bottom of the trench should be at least 1 foot below the surface of the aggregate at the sides of the car and approximately 1 foot wide at the bottom. The bottom of the trench should be practically level. Equal portions should be taken at seven (7) equally spaced points along the bottom of the trench by pushing a shovel downward into the material and not scraping horizontally. Two (2) of the seven (7) points should be directly against the sides of the car. All of the material from the three (3) or more trenches is combined to form a composite sample.

6.4. *Sampling from Stockpiles* — It is extremely difficult to obtain a representative sample of coarse aggregate from a stockpile and this method of sampling should be avoided whenever possible. When it is necessary to obtain samples from a stockpile, a sample should be taken by combining approximately equal portions of materials taken from ten (10) or more different locations care being taken to avoid sampling a segregated area of coarse-grained material that is likely to exist at the base of the pile. Before obtaining the material at each sampling point, remove the aggregate to a depth of 1 foot and then, with a round pointed shovel, obtain one shovel full from the bottom of the hole. Do not let pieces of aggregate fall off the shovel when transferring the material to the sample bag. To help in preventing further segregation during sampling, a board may be shoved into the pile just above the point of sampling. The separate portions of material taken from ten (10) or more different holes must be combined to form a composite sample.

Standard Method of Test for

Methods of Sampling Fine Aggregates

SCDOT Designation: SC-T-2

1. SCOPE

1.1. These methods are intended to apply to fine aggregates which have been produced for use in concrete or other construction items.

1.2. This standard may involve hazardous materials, operations and equipment. This standard does not purport to address all of the safety problems associated with its use. It is the responsibility of the user of this standard to consult and establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.

2. SUMMARY OF TEST METHOD

2.1. A sample of fine aggregate is obtained by combining portions taken from a conveyor belt, truck, rail car or stockpile.

3. SIGNIFICANCE AND USE

3.1. Sampling is equally as important as the testing, and the sampler must use every precaution to obtain samples that will show the true nature and condition of the materials that they represent.

4. APPARATUS

4.1. Depending on the location the sample is being taken: round pointed shovel, trowel, scoop, sampling tube, earth auger or other suitable device, sample bags.

5. TEST SPECIMENS

5.1. The portions obtained as described below should be large enough to make a field sample of 10 pounds when combined or mixed and reduced as outlined in SC-T-3.

6. PROCEDURE

6.1. *Sampling from Conveyor Belts* — When sampling from a conveyor belt, it is very important that the inspector communicate with the plant personnel to be assured that the conveyor will not be activated while a portion of the sample is being obtained, thus causing possible injury to the Inspector. Some conveyors may require a platform at the side to provide access for sampling. In the event a conveyor will not start again while it is loaded, some other method for obtaining a sample must be used.

6.1.1. Obtain at least three (3) approximately equal portions, selected at random, from the material being sampled. Stop the conveyor belt while each of the sample portions is being obtained. With scoop, trowel or other suitable tool, cut through the material at two (2) locations, thus separating the portion of material to be taken from the remaining

material on the belt. Carefully scoop all material within the limits of the selected increment into a suitable container, making special effort to clean the belt of all the fines. After obtaining the three (3) or more portions, combine them to create a field sample as described in Section 5 of this procedure.

6.2. *Sampling from Railroad Cars or Trucks* — Fine aggregates in railroad cars or trucks are to be sampled by shoveling away the surface material and digging into the fine aggregate in at least six (6) randomly selected locations over the car or truck. Obtain approximately equal portions from each location. Combine the material from the six (6) or more locations to form a composite sample, which can be used to create a field sample as described in Section 5 of this procedure.

6.3. *Sampling from Stockpiles* — When sampling fine aggregate from a stockpile, select six (6) or more places around the stockpile to obtain the portions that will be combined to form the sample. At each sampling location, use care to shovel away the surface material to a point that moist material is exposed. With a shovel, scoop, sampling tube, earth auger or other suitable device, obtain approximately equal portions from the six (6) or more locations. Combine the portions to form a composite sample that can be used to create a field sample as described in Section 5 of this procedure.

Standard Method of Test for

Methods of Reducing Size of Aggregate Sample

SCDOT Designation: SC-T-3

1. SCOPE

1.1. These methods are intended to apply to aggregate samples that have been obtained by the procedures outlined in SC-T-1 or SC-T-2.

1.2. This standard may involve hazardous materials, operations and equipment. This standard does not purport to address all of the safety problems associated with its use. It is the responsibility of the user of this standard to consult and establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.

2. REFERENCED DOCUMENT

2.1. SC-T-1, SC-T-2.

3. SUMMARY OF TEST METHOD

3.1. A bulk sample of aggregate is reduced to the size necessary for testing by either the quartering method or the riffle splitter method.

4. SIGNIFICANCE AND USE

4.1. Sampling is equally as important as the testing, and the sampler must use every precaution to obtain samples that will show the true nature and condition of the materials that they represent. The sample size obtained during sampling is often larger than desirable for test procedures. Samples must be reduced in a manner that retains the properties of the original sample.

5. APPARATUS

5.1. For quartering method: clean and smooth surface free from cracks, shovel, trowel or other acceptable device for mixing aggregate and dividing the material. For riffle splitter method: riffle splitter pans to distribute material over splitter and catch material coming through splitter.

6. TEST SPECIMENS

6.1. The size of the test specimen required after reduction will be given in the procedure for that particular test.

7. PROCEDURE

7.1. Quartering Method:

7.1.1. Empty sample on a hard, clean and smooth surface that is free from cracks. Mix thoroughly and pile in a cone. Materials which tend to segregate should be dampened.

7.1.2. Flatten cone with a shovel, spreading the material to a circular layer of uniform thickness. Divide into quarters by two (2) lines intersecting at right angles at the center of the pile.

7.1.3. Discard the two (2) diagonally opposite quarters. Sweep clean the space occupied by the discarded quarters.

7.1.4. The remaining quarters should be thoroughly mixed and further reduced by quartering if desired. “Quartering” may be performed any number of times to obtain the required sample size.

7.2. Riffle Splitter Method:

7.2.1. The openings in the splitter device must be wide enough to let the largest particle easily pass through yet not so wide that a non-representative separation is obtained. (In general, the opening size should be approximately 50 percent greater than the largest particle size.)

7.2.2. Thoroughly mix the aggregate sample. Spread the material evenly across a rectangular pan having the proper width to allow equal portions of the material to be fed to each individual chute.

7.2.3. Dump the aggregate into the splitter device so that the sample is uniformly and simultaneously fed over the entire length of the splitter. Discard the material caught on one side of the splitter. This method of reducing a sample size may be repeated as many times as necessary to obtain the appropriate sample size.

Standard Method of Test for

Sieve Analysis of Fine and Coarse Aggregates

SCDOT Designation: SC-T-4

1. SCOPE

1.1. This method of test covers a field procedure for the determination of particle size distribution of fine and coarse aggregates, using sieves with square openings.

1.2. This standard may involve hazardous materials, operations and equipment. This standard does not purport to address all of the safety problems associated with its use. It is the responsibility of the user of this standard to consult and establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.

2. REFERENCED DOCUMENT

2.1. SC-T-3.

3. SUMMARY OF TEST METHOD

3.1. A sample of aggregate is sieved to determine the gradation.

4. SIGNIFICANCE AND USE

4.1. The gradation of fine and coarse aggregate samples must be tested to determine compliance with the specifications for these materials.

5. APPARATUS

5.1. Sieves in a series of sizes to determine compliance with the specifications for the material in question, balance or electronic scales.

6. TEST SPECIMENS

6.1. Samples that are too large for testing should be reduced to the proper size by SC-T-3.

6.2. Samples for sieve analysis shall be dried to a saturated, surface dry condition prior to testing. Drying may be in air or by use of a method such that the temperature of the sample does not exceed 140°F.

6.2.1. Samples of fine aggregate for sieve analysis shall weigh, after drying, approximately the amount indicated in the following:

Material with at least 95% finer than a No. 8 sieve	= 100 grams
Fine Aggregate No. 10	= 200 grams
Material with at least 90% finer than a No 4 sieve and more than 5% coarser than a No. 8 sieve	= 500 grams

6.2.2. In no case, however, shall the fraction retained on any sieve at the completion of the sieving operation weigh more than 4 grams per square inch of sieving surface. This amounts to 200 grams for the usual 8-inch diameter sieve.

6.2.3. Samples of coarse aggregate for sieve analysis shall weigh, after drying, not less than the amount shown in Figure SC-T-4A.

NOMINAL MAXIMUM SIZE OF SAMPLE OPENINGS (inches)	MINIMUM DRY WEIGHT OF TEST SAMPLE	
	(pounds)	(kilograms)
3/8	2	1
½	4	2
¾	11	5
1	22	10
1½	33	15
2	44	20
2½	77	35

TABLE OF MINIMUM DRY SAMPLE WEIGHTS
Figure SC-T-4A

7. PROCEDURE

7.1. Separate into a series of sizes using such sieves as necessary to determine compliance with the specifications for the material under test.

7.2. Conduct sieving operations by means of lateral and vertical motion of the sieve, accompanied by jarring action so as to keep the sample moving continuously over the surface of the sieve. The motion of the sieve may be accomplished by mechanical shaker or by hand. Do not turn or manipulate fragments through the sieve by hand.

7.3. Continue the sieving operation until not more than 0.5 percent by weight of the total sample passes any sieve during one (1) minute of hand sieving.

7.4. Weigh the sieved material and record the weights. The total weight after sieving must check within 0.3 percent of the original dry sample weight.

8. CALCULATIONS

8.1. A sample calculation to determine the results of the sieving operations follows with the results reported in Figure SC-T-4B:

8.2. Total Weight of Sample = 17,327 grams

Passing 1½-inch Sieve = $\left(\frac{17{,}327}{17{,}327}\right)$ x 100 = 100%

Passing 1-inch Sieve = $\left(\frac{15{,}876}{17{,}327}\right)$ x 100 = 92%

Passing ½-inch Sieve = $\left(\frac{8{,}210}{17{,}327}\right)$ x 100 = 47%

Passing No. 4 Sieve = $\left(\frac{1{,}678}{17{,}327}\right)$ x 100 = 10%

Passing No. 8 Sieve = $\left(\frac{454}{17{,}327}\right)$ x 100 = 3%

SIEVE DESIGNATION	WEIGHT PASSING (grams)	PERCENT PASSING (%)
1½-inch	17,327	100
1-inch	15,876	92
½-inch	8210	47
No. 4	1678	10
No. 8	454	3

SIEVING OPERATIONS RESULTS
Figure SC-T-4B

9. REPORT

9.1. Report the percentage of material passing each sieve to the nearest whole percent, except the No. 200 sieve shall be reported to the nearest 0.1 percent.

Standard Method of Test for

Determination of Silt and Clay

SCDOT Designation: SC-T-5

1. SCOPE

1.1. This method covers a procedure for determining the combined silt and clay (total material passing the No. 200 sieve) in a local sand passing the No. 4 sieve.

1.2. This standard may involve hazardous materials, operations and equipment. This standard does not purport to address all of the safety problems associated with its use. It is the responsibility of the user of this standard to consult and establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.

2. REFERENCED DOCUMENT

2.1. SC-T-3.

3. SUMMARY OF TEST METHOD

3.1. The total percentage of silt and clay of a sample of fine aggregate is determined by washing the sample over a No. 200 sieve.

4. SIGNIFICANCE AND USE

4.1. The total percentage of silt and clay of a sample of natural fine aggregate can be tested quickly to determine the material's suitability for use in asphalt mixes. Excess fines can be detrimental to the performance of certain asphalt mixes.

5. APPARATUS

5.1. No. 4 sieve, No. 200 sieve, pan (approximately 11 inches in diameter and 3 inches in depth), balance or electronic scales, wetting agent.

6. TEST SPECIMENS

6.1. The sample shall consist of approximately 1000 grams of material. Larger samples shall be reduced to this size by the procedures in SC-T-3.

7. PROCEDURE

7.1. The material should be screened through a No. 4 sieve and the material retained on this sieve shall be discarded.

7.2. Approximately 300 grams of the material passing the No. 4 sieve shall be weighed and placed in a pan approximately 11 inches in diameter and 3 inches deep. The sample shall be covered with water containing a sufficient amount of wetting agent to assure a

thorough separation of the material finer than the No. 200 sieve from the coarser particles and allowed to stand for approximately 15 minutes.

7.3. The contents of the pan should be stirred vigorously with a trowel or spoon and allowed to settle for about a minute. The wash water shall then be poured down a No. 200 sieve. Care should be taken to avoid spilling any of the contents. The operations shall be repeated until the wash water is clear. Do not leave the material on the spoon used for stirring. Any material that is retained on the No. 200 sieve shall then be washed back into the pan and the material in the pan dried to a constant weight. This material shall then be weighed.

8. CALCULATIONS

8.1. To determine the percentage of material passing the No. 200 sieve, divide the weight of the sample lost during washing by the original dry weight of the sample as follows:

Original Dry Weight of Sample = 427.4 grams
Dry Weight of Sample After Washing = 401.5 grams
Total Material Lost through Washing = 427.4 - 401.5 = 25.9 grams

$$\text{Percentage Passing the No. 200 Sieve} = \left(\frac{25.9 \text{ grams}}{427.4 \text{ grams}} \right) \times 100 = 6.1\%$$

9. REPORT

9.1. Report the percentage of the sample passing the No. 200 sieve to the nearest 0.1 percent.

SCDOT Sampling and Testing Procedures

C.4 SOILS

Standard Method of Test for

Methods of Sampling Soil Pits and Fields

SCDOT Designation: SC-T-21

1. SCOPE

1.1. These methods outline the procedure to be followed when sampling sand-clay pits and borrow pits to be used for base or sub-base, and for sampling pits to be used for sand asphalt construction. Test holes should be identified by assigning them a number with a guard stake being driven by the hole with the number of the hole written on the stake as well as the depth of the test hole.

1.2. This standard may involve hazardous materials, operations and equipment. This standard does not purport to address all of the safety problems associated with its use. It is the responsibility of the user of this standard to consult and establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.

2. SUMMARY OF TEST METHOD

2.1. Samples of soil are obtained from soil pits and fields to test for specification compliance by use of continuous flight augers.

3. SIGNIFICANCE AND USE

3.1. Proper sampling techniques are necessary to obtain samples that are representative of the material in the pit in order to determine the suitability of the material for use in the work.

4. APPARATUS

4.1. Continuous flight auger, minimum 4 inch overall diameter, cutting head for the auger string suited for the type of soils expected to be encountered, motorized drill rig with sufficient torque and ram stroke to advance and rotate the auger at a sufficient rate to provide sample conveyance to the surface, hand trowel, 6 feet x 6 feet canvas, polyethylene sample bags (4 mil thickness, 10 inch x 18 inch).

5. TEST SPECIMENS

5.1. The objective of this test is to collect specimens of in-situ soils for laboratory analysis. Each sample will consist of not less than 10 pounds of material.

6. PROCEDURE

6.1. Sampling Sand-Clay Pits and Pits for Sand Asphalt:

6.1.1. Samples from proposed pits are obtained by boring test holes. A sufficient number of test holes must be dug so that the extent of the supply is fully established. Sand-clay

pits should also be referenced to a base line so that the outline of the pit may be later located.

6.1.2. A sample is to consist of a representative portion of the entire depth of the hole unless it is desirable to obtain samples to represent various depths of the hole. A representative portion should be obtained by placing the material taken from the hole on a canvas and mixing thoroughly prior to getting the required sample. The depth limits should be written on the sample identification card. A sample for each soil type should be sent to the Research and Materials Laboratory. When it is necessary that density tests should be run on sand-clay material, note this on the sample identification card. The sample should weigh at least 25 pounds.

6.1.3. Occasionally, materials from two different pits are blended to form a sand-clay base or sub-base. When samples representing such sources are submitted to the Research and Materials Laboratory for testing, note on the sample identification card if it desired that the Research and Materials Laboratory advise the Resident Construction Engineer of their recommended proportions.

6.1.4. A sample of at least 35 pounds is required when the material is to be used in sand asphalt work.

6.2. Sampling Borrow Material:

6.2.1. Samples (minimum weight 10 pounds) of ground surface material to be used as base are to be obtained by first cleaning off any vegetative matter at the sampling spot and then removing a portion of material for the full depth of the topsoil layer. A sample must be taken for each area of the field which represents a different soil type. If it is necessary that density tests be run on this material, this must be noted on the sample identification card. The sample should weigh at least 25 pounds.

6.2.2. A minimum of at least 1 sample shall be taken for each 1 acre of material.

Standard Method of Test for

Determining Moisture Content of Soils by Carbide Gas Method

SCDOT Designation: SC-T-22

1. SCOPE

1.1. This method covers a procedure for determining in the field the amount of moisture in a soil or fine aggregate. A carefully weighed soil sample and a powder reagent are introduced into a container with the pressure of the gas evolved from the chemical reaction being measured on a gauge that is specially calibrated to read moisture content.

1.2. This standard may involve hazardous materials, operations and equipment. This standard does not purport to address all of the safety problems associated with its use. It is the responsibility of the user of this standard to consult and establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.

2. SUMMARY OF TEST METHOD

2.1. The moisture content of a sample of soil is obtained by measuring the pressure created by chemical reaction between the moisture in the soil and calcium carbide reagent.

3. SIGNIFICANCE AND USE

3.1. The moisture content of a sample of soil or fine aggregate can be obtained quickly in the field.

4. APPARATUS

4.1. Speedy Moisture Tester, two 1¼-inch steel balls, calcium carbide reagent, and conversion chart for moisture content.

5. TEST SPECIMENS

5.1. A representative soil or fine aggregate sample weighing 20 grams or 26 grams, depending on the model of the Speedy Moisture Tester. Consult the manufacturer's instructions. For materials with higher moisture content than the gauge limit, use only half the standard weight of sample.

6. PROCEDURE

6.1. For the 26-gram Tester:

6.1.1. Place soil sample in the cap of the tester.

6.1.2. Place two 1¼-inch steel balls in the body of the tester.

6.1.3. With the body of the tester in the horizontal position, place the cap in place. Bring the stirrup in place and screw down to seal the instrument pressure tight. Raise the tester to the vertical position so as to empty the soil sample on top of the reagent.

6.1.4. With the instrument in the horizontal position, manually rotate the device so the steel balls are put into orbit around the inside circumference. During this shaking action, the steel balls break down the lumpy soil. Continue shaking for approximately 1 to 3 minutes until the gauge needle stops moving. With the device in the horizontal position, at eye level, read the dial and refer to the conversion chart for moisture content, which is supplied with the Speedy Moisture Tester.

6.1.5. When the sample is dumped, examine the cap to see if all the soil was removed and examine the soil for lumps. If any soil remained in the cap or remained lumpy, obtain another sample and re-run the test.

6.1.6. After each test, the instrument should be thoroughly cleaned, using the brush to clean the bomb and the cloth to clean the cap. The cap should not be beat on a hard surface. Do not use brush or air. Scales should be balanced frequently.

6.2. For 20-gram Tester:

6.2.1. Place amount of reagent required by the manufacturer's instructions in the cap of the tester.

6.2.2. Place the 20-gram soil sample in the body of the tester.

6.2.3. Run the test as described above for the 26-gram tester.

7. REPORT

7.1. Report the moisture content in the sample as read from the oven moisture conversion chart to the nearest 0.1 percent on SCDOT Form 200.02 – Percent Compaction by Nuclear Gauge or SCDOT Form 200.03 – Percent Compaction by Nuclear Gauge-Direct Read Gauge, as appropriate.

Standard Method of Test for

Determining Moisture Content of Soils by "Pan Drying" Method

SCDOT Designation: SC-T-23

1. SCOPE

1.1. This method covers a procedure for the determining in the field the amount of moisture in a soil or fine aggregate by placing the material in a pan and drying the material over a low flame. The accuracy of the method depends upon the care exercised in making the test. Too little drying will reflect a too small moisture content, while excessive drying drives out the water combined in the clay molecules and the result will be higher than the true moisture content. Too fast a drying process with a high flame will sometimes cause sample particles to pop out of the pan and the result will also be higher than the true moisture content.

1.2. This standard may involve hazardous materials, operations and equipment. This standard does not purport to address all of the safety problems associated with its use. It is the responsibility of the user of this standard to consult and establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.

2. SUMMARY OF TEST METHOD

2.1. The moisture content of a sample of soil is obtained by measuring the change in the mass of a sample of the soil prior to and after drying to a saturated surface dry condition over a heat source in an open pan.

3. SIGNIFICANCE AND USE

3.1. The moisture content of a sample of soil or fine aggregate can be obtained in the field.

4. APPARATUS

4.1. Pan approximately 11 inches in diameter and 3 inches in depth, rod or spoon for stirring, heat source, balance or electronic scales.

5. TEST SPECIMENS

5.1. A representative soil or fine aggregate sample weighing approximately 200 to 300 grams.

6. PROCEDURE

6.1. Determine the weight of the sample.

6.2. Place sample in pan and place over low heat.

6.3. Stir the material with a clean spoon or clean rod occasionally as it dries. Gradually, break down lumps so that they will dry throughout. When soil particles do not stick to the spoon or rod, remove the sample from the flame and weigh the dried sample. Be very careful not to overheat.

7. CALCULATIONS

7.1. The percent moisture in the fine aggregate or soil is computed as the difference in the wet and dry weights divided by the dry weight as follows:

Weight of Sample Before Drying = 237.5 grams

Dry Weight of Sample = 222.8 grams

%Moisture in Sample $= \left(\frac{237.5 \text{ grams} - 222.8 \text{ grams}}{222.8 \text{ grams}} \right) \text{x } 100 = 6.6\%$

8. REPORT

8.1. Report the moisture content in the sample to the nearest 0.1 percent on SCDOT Form 200.02 – Percent Compaction by Nuclear Gauge or SCDOT Form 200.03 – Percent Compaction by Nuclear Gauge-Direct Read Gauge, as appropriate.

Standard Method of Test for

Field Method of Determining Moisture-Density Relations of Soils

SCDOT Designation: SC-T-25

1. SCOPE

1.1. This method of test outlines the field procedure for determining the relation between the moisture content and density of soils.

1.2. This standard may involve hazardous materials, operations and equipment. This standard does not purport to address all of the safety problems associated with its use. It is the responsibility of the user of this standard to consult and establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.

2. REFERENCED DOCUMENT

2.1. SC-T-22, SC-T-23.

3. SUMMARY OF TEST METHOD

3.1. A soil sample is compacted in a mold having a capacity of 1/30 of a cubic foot and having an internal diameter of 4 inches. The soil in the mold is compacted in three layers with 25 blows per layer from a 5.5-pound rammer dropped from a height of 12 inches. The moisture content of the sample is raised and the procedure is repeated until the maximum density and optimum moisture content are determined.

4. SIGNIFICANCE AND USE

4.1. The maximum dry density and optimum moisture content of a sample of soil can be obtained quickly in the field.

5. APPARATUS

5.1. 4-inch diameter proctor mold and 5.5-pound hammer, No. 4 sieve for Method A or ¾-inch sieve for Method C, balance or electronic scales, metal straightedge.

6. TEST SPECIMENS

6.1. If the soil is damp when received, dry it until it becomes friable under a trowel. Drying may be in air or by use of a method such that the temperature does not exceed 60°C. Then, break up any lumps in such a manner as to avoid reducing the natural size of individual particles.

6.2. For Method A, screen an adequate quantity of representative pulverized soil over the No. 4 sieve. Discard the coarse material, if any, retained on the No. 4 sieve. Select a representative sample, weighing approximately 7 pounds or more.

6.3. For Method C, prepare the sample as for Method A except that the soil shall be screened over a ¾-inch sieve and the material larger than ¾ inch discarded. A 12-pound representative sample shall be selected.

7. PROCEDURE

7.1. Method A:

7.1.1. Thoroughly mix the selected representative sample with sufficient water to dampen it to approximately 4 percentage points below optimum moisture content.

7.1.2. Form a specimen by compacting the prepared soil in the 4-inch mold (with collar attached) in 3 equal layers to give a total compacted depth of about 5 inches. Compact each layer by 25 uniformly distributed blows from the hammer dropping free from a height of 12 inches above the elevation of the soil. During compaction, the mold shall rest on a uniform, rigid foundation such as provided by a cube of concrete. Following compaction, remove the extension collar, carefully trim the compacted soil even with the top of the mold by means of a straightedge and weigh. Multiply the weight of the compacted specimen and mold, minus the weight of the mold, by a constant which will be furnished by the Research and Materials Laboratory; and record the result as the wet unit weight per cubic foot of the compacted soil.

7.1.3. Remove the material from the mold and slice vertically through the center. Take a representative sample of the material from one of the cut faces, weight immediately, and then determine the moisture content of the soil by SC-T-22 or SC-T-23.

7.1.4. Thoroughly break up the remainder of the material until it will pass a No. 4 sieve as judged by eye. Add water in sufficient quantity to increase the moisture content of the sample by 1 or 2 percentage points, and repeat the above procedure for each increment of moisture added. Continue this series of determinations until the wet unit weight per cubic foot either decreases or there is no change in wet unit weight per cubic foot.

7.2. Method C:

7.2.1. The procedure is the same as that for Method A with the following exceptions:

7.2.2. Determine the moisture content by SC-T-23.

7.2.3. Thoroughly break up the soil until it will pass a ¾-inch sieve and 90% of the soil aggregations will pass the No. 4 sieve as judged by eye.

8. CALCULATIONS

8.1. Calculate the moisture content and the dry unit weight of the soil as compacted for each trial. The dry unit weight, in pounds per cubic foot of compacted soil, is computed by using the following equation:

$$\gamma_{DRY} = \left(\frac{\gamma_{WET}}{W + 100} \right) \text{x } 100$$

where: γ_{DRY} = dry unit weight, in pcf of compacted soil
γ_{WET} = wet unit weight, in pcf of compacted soil
W = percentage of moisture in the specimen

8.2. After calculating the moisture content and corresponding dry unit weight (density) for each of the soil samples, plot the dry unit weights per cubic foot as ordinates and corresponding moisture contents as abscissas. Connect the plotted points so as to produce a smooth curve.

8.3. The moisture content corresponding to the peak of the curve is termed the “optimum moisture content” of the soil. The dry unit weight per cubic foot of the soil at optimum moisture content is termed the “maximum dry density” under the above compaction.

9. REPORT

9.1. Report the optimum moisture content of the soil to the nearest 0.1 percent and the maximum dry density to the nearest 0.1 pound per cubic foot. Use SCDOT Form 200.01 – Field Density Test Report (Nuclear Gauge), SCDOT Form 200.02 – Percent Compaction by Nuclear Gauge, and SCDOT Form 200.03 – Percent Compaction by Nuclear Gauge-Direct Read Gauge.

Standard Method of Test for

Field Determination of Maximum Dry Density and Optimum Moisture Content of Soils by the One-Point Method

SCDOT Designation: SC-T-29

1. SCOPE

1.1. In this method, the maximum dry density and optimum moisture content of soils is obtained by using the results of one point on a standard proctor curve to enter a family of curves from which the maximum dry density and optimum moisture content can be determined. In most instances, it will be possible and advantageous to use the one-point proctor method, but since this method is not applicable to all soils found in South Carolina, there will be times when it will be necessary to conduct the more detailed test according to SC-T-25. The decision to run either the one-point proctor test or the more detailed test will be left to the Resident Construction Engineer. In general, if the one-point proctor test is conducted with the material at or near optimum moisture content and the point does not fall in the main portion of the family of curves, this is a good indication that SC-T-25 should be used.

1.2. This standard may involve hazardous materials, operations and equipment. This standard does not purport to address all of the safety problems associated with its use. It is the responsibility of the user of this standard to consult and establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.

2. REFERENCED DOCUMENT

2.1. SC-T-22, SC-T-25.

3. SUMMARY OF TEST METHOD

3.1. A soil sample is compacted in a mold having a capacity of 1/30 of a cubic foot and having an internal diameter of 4 inches. The soil in the mold is compacted in three layers with 25 blows per layer from a 5.5 pound rammer dropped from a height of 12 inches. The wet density and moisture content of the compacted specimen is plotted on a family of curves and a maximum dry density and optimum moisture content is selected from the family of curves for use in compaction calculations.

4. SIGNIFICANCE AND USE

4.1. The maximum dry density and optimum moisture content of a sample of soil can be obtained quickly in the field.

5. APPARATUS

5.1. Proctor mold and 5.5-pound hammer, No. 4 sieve, balance or electronic scales, metal straightedge.

6. TEST SPECIMENS

6.1. Obtain approximately 2500 grams of material representative of that tested for in-place density and moisture content. Break up this material and sieve through a No. 4 sieve. Discard the material retained on the No. 4 sieve. If more than 5 percent by weight of the total sample, as judged by eye, is retained as aggregate on the No. 4 sieve, note this in the comments on the field work sheet and on Research and Materials Laboratory Form 932. In the judgment of the operator, the moisture content of the material to be tested should be on the dry side of optimum and within 2 percent of the optimum moisture content. If the moisture content is not within this range, the material should be dried if it is too wet, or water added if it is too dry. If the soil is damp when received, dry it until it becomes friable under a trowel.

7. PROCEDURE

7.1. Determine the weight of a standard proctor mold.

7.2. Place the standard proctor mold (with base plate and collar attached) on a block of concrete of sufficient size to afford a uniform, rigid foundation.

7.3. Mix the 2500-gram sample so that the moisture content is as uniform as possible.

7.4. Place approximately one-third of the sample in the proctor mold.

7.5. Compact the layer using 25 uniformly distributed blows from the 5.5-pound hammer dropping free from a height of 12 inches.

7.6. Repeat Step 7.4 and Step 7.5 for the second and third layers of the specimen.

7.7. Following compaction of the third layer, remove the extension collar and carefully trim the compacted soil even with the top of the mold by means of a straightedge.

7.8. Remove the base plate from the mold and weigh the mold and specimen to the nearest gram.

7.9. Remove the material from the mold and slice vertically through the center. Take a representative sample of the material from one of the cut faces and determine the moisture content using SC-T-22.

7.10. Determine the weight of the specimen by subtracting the weight of the mold, as determined in Step 7.1, from the weight of the mold plus specimen, as determined in Step 7.8.

7.11. Determine the wet density of the soil specimen by multiplying the mold constant, which is stamped on the base plate, by the weight of the soil specimen, as determined in Step 7.10.

7.12. Using the moisture content determined in Step 7.9 and the wet density determined in Step 7.11, plot the one point on the family of curves as shown on Figure SC-T-29A.

7.13. If the point falls on one of the curves, the maximum dry density and optimum moisture content may be read directly from the table shown in the top right-hand corner of Figure SC-T-29A. If the point does not fall on one of the curves, it is necessary to interpolate between the curves and again use the table to determine the maximum dry density and optimum moisture content.

8. CALCULATIONS

8.1. Weight of Mold and Soil = 4006 grams

8.2. Weight of Mold = 2074 grams

8.3. Weight of Soil (Step 8.1 – Step 8.2) = 4006 grams – 2074 grams = 1932 grams

8.4. Wet Density of Soil = (Mold k) x (Step 8.3) = (0.06638) x (1932 grams) = 128.2 pcf

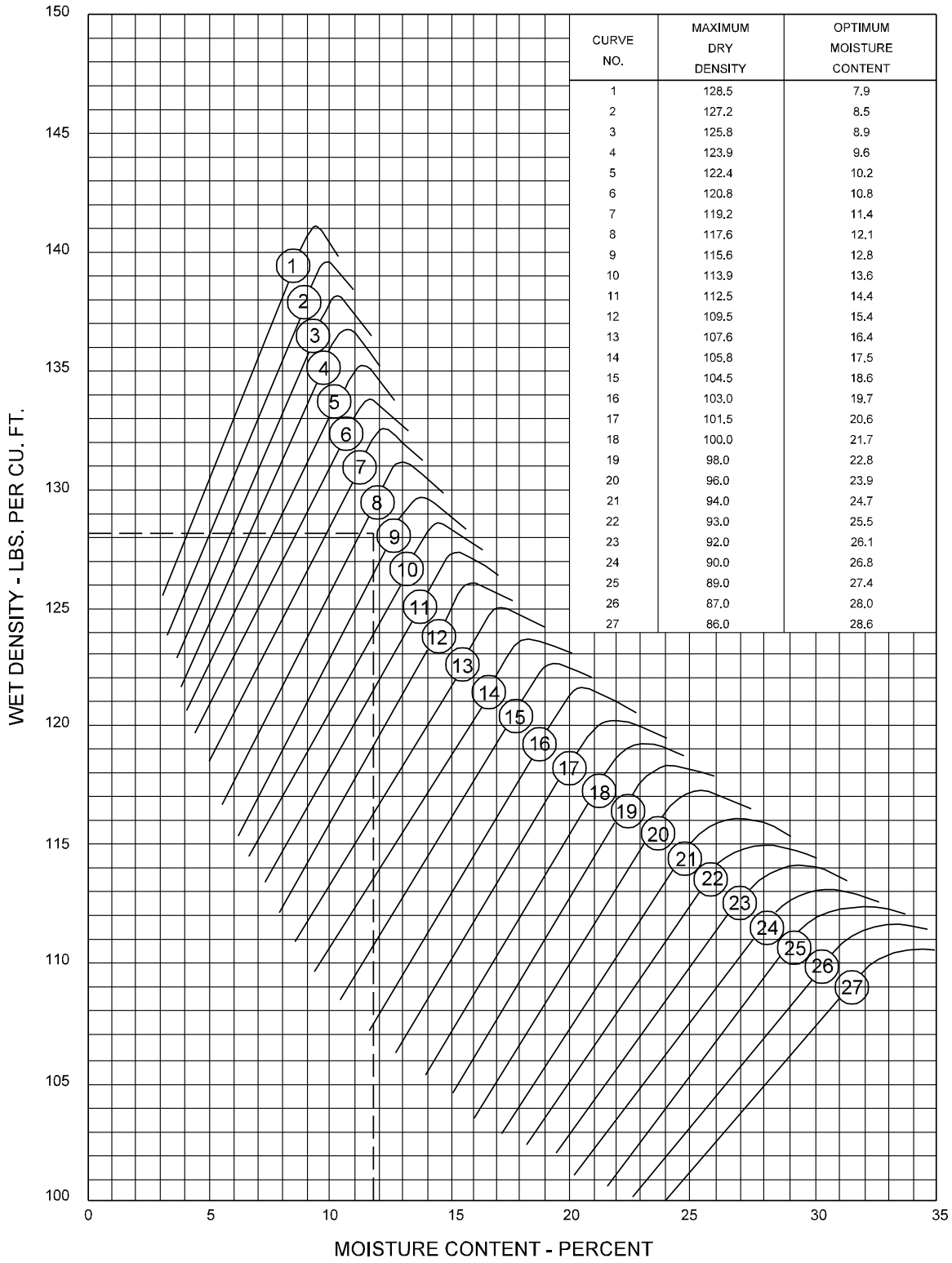
8.5. Percent Moisture (Speedy Moisture Tester) = 11.7%

8.6. Maximum Dry Density (taken from Figure SC-T-29A) = 116.6 pcf

8.7. Optimum Moisture Content (taken from Figure SC-T-29A) = 12.4%

9. REPORT

9.1. Report the optimum moisture content of the soil to the nearest 0.1 percent and the maximum dry density to the nearest 0.1 pound per cubic foot. Use SCDOT Form 200.01 – Field Density Test Report (Nuclear Gauge), SCDOT Form 200.02 – Percent Compaction by Nuclear Gauge, and SCDOT Form 200.03 – Percent Compaction by Nuclear Gauge-Direct Read Gauge.



CURVE NO.	MAXIMUM DRY DENSITY	OPTIMUM MOISTURE CONTENT
1	128.5	7.9
2	127.2	8.5
3	125.8	8.9
4	123.9	9.6
5	122.4	10.2
6	120.8	10.8
7	119.2	11.4
8	117.6	12.1
9	115.6	12.8
10	113.9	13.6
11	112.5	14.4
12	109.5	15.4
13	107.6	16.4
14	105.8	17.5
15	104.5	18.6
16	103.0	19.7
17	101.5	20.6
18	100.0	21.7
19	98.0	22.8
20	96.0	23.9
21	94.0	24.7
22	93.0	25.5
23	92.0	26.1
24	90.0	26.8
25	89.0	27.4
26	87.0	28.0
27	86.0	28.6

FAMILY OF CURVES FOR TYPICAL SOILS IN SOUTH CAROLINA
Figure SC-T-29A

Standard Method of Test for

Field Determination of Density and Moisture Content of Soils and Aggregate Bases by Use of the Troxler Model 3430 Nuclear Gauge

SCDOT Designation: SC-T- 30

1. SCOPE

1.1. This method describes procedures for determining the density and moisture content of soils and aggregate bases through the use of the nuclear equipment.

1.2. This standard may involve hazardous materials, operations and equipment. This standard does not purport to address all of the safety problems associated with its use. It is the responsibility of the user of this standard to consult and establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.

2. REFERENCED DOCUMENT

2.1. SC-T-22.

3. SUMMARY OF TEST METHOD

3.1. The total or wet density of the material is determined by placing a gamma source into the material under test. The intensity of radiation detected is dependent upon the density of the material under test. The radiation intensity reading is related to measured wet density by suitable calibration curves or tables. The total water content is determined by placing a neutron source into the material under test. The quantity of fast neutrons is dependent upon the hydrogen content of the water in the material. The quantity of fast neutrons is related to the measured water content by suitable calibration curves or tables.

4. SIGNIFICANCE AND USE

4.1. The test method described is useful as a rapid, nondestructive method for the in-place determination of the wet density of soils and the wet density and moisture content of aggregate bases.

5. APPARATUS

5.1. Troxler Model 3430 Nuclear Gauge, reference standard, scraper plate, drill rod, drill rod extraction tool.

6. TEST SPECIMENS

6.1. This test is conducted on in-place soils or aggregate base material.

7. PROCEDURE

7.1. Turn the gauge on for a minimum of 10 minutes to allow the systems critical circuits to stabilize.

7.2. Take moisture and density standard counts (at least 10 feet from any large object and at least 30 feet from another gauge).

7.3. Place the standard on a dry, solid and flat surface containing not more than 15 percent moisture and at least 100 pounds per cubic foot of density.

7.4. Place the gauge on the standard, being sure scaler end of gauge is toward the raised end of the standard and seated properly on the recessed surface.

7.5. Remove the padlock that locks the source rod in the “SAFE” position.

7.6. Press the “STD” key, then the “YES” key.

7.7. Press “START” key.

7.8. After the count is complete the gauge will display DS (Density Standard) and MS (Moisture Standard).

7.9. Record both the DS (Density Standard) and MS (Moisture Standard).

7.10. Compare these standard counts to the average of the previous 4 counts. The DS should be within 1 percent and the MS within 2 percent.

7.11. Press the “ON/YES” key and the gauge will return to the “READY” screen. Return the standard to its case.

7.12. If the surface is not relatively smooth, use the scraper plate to smooth and level the test surface (all loose stone should be removed and small voids filled with native fines or sand).

7.13. Take moisture and density measurement counts.

7.14. Using the drill rod and scraper plate, put the drill rod through the extractor tool, then through the scraper plate guide. Secure the scraper plate with one foot; drive the test hole at least 2 inches deeper than the desired test depth.

7.15. Remove the drill rod by rotating and pulling straight up. Do not loosen the drill rod by tapping from side to side with a hammer.

7.16. Before moving the scrapper plate, with your foot still securing the plate, take the drill rod and mark around the corners of the scraper plate.

7.17. Place the gauge within the scrapper plate outline.

7.18. Press the “MA/PR” key and scroll up or down to select “PR” for “SOIL MODE”.

7.19. Press the “TIME” key and use up or down arrows to view count times. Press the “ENTER” key after selecting the recommended time (1 minute).

7.20. This step is only used for Aggregate Bases and Coquina Base Course. To enter Lab Proctor information, press the “MA/PR” key and follow the display instructions to select “PR”. Press the “YES” key to change proctor information and scroll up or down to select correct digits. Press the “ENTER” key to return to the ready screen.

7.21. Release the trigger and lower the source rod into the hole to the desired depth of measurement.

7.22. Gently slide the gauge to the right (scaler end), placing the source rod in firm contact with the sidewall of the hole.

7.23. Press the “DEPTH” key and use the up or down arrows until the correct test depth is displayed. Press the “START/ENTER” key to begin the test count. At this time, the gauge will begin the test count.

7.24. After the count time is complete, the gauge will display %PR, DD, WD, M and %M. Record the WD (Wet Density) and the actual Density Count only. To obtain the actual Density Count, use the up or down arrows.

7.25. Pull the source rod to the top notch or “SAFE” position, and return the gauge to a safe area.

8. CALCULATIONS

8.1. Determine the moisture content and calculate the dry density, pounds per cubic foot (pcf).

8.2. For Soils:

8.2.1. Determine the percent moisture using SC-T-22.

8.2.2. Calculate the dry density using the following equation:

$$\gamma_{DRY} = \left(\frac{\gamma_{WET}}{W + 100} \right) \text{x } 100$$

where:
γ_{DRY} = dry unit weight, in pcf of compacted soil
γ_{WET} = wet unit weight, in pcf of compacted soil
W = percentage of moisture in the specimen

8.3. For Aggregate Base Materials:

8.3.1. Calculate the dry density using the following equation:

Dry Density (pcf) = Wet Density (pcf) – Moisture Content (pcf).

9. REPORT

9.1. Report the moisture content of the soil to the nearest 0.1 percent and the moisture content of aggregate base materials to the nearest 0.1 pound per cubic foot. Report the maximum dry density to the nearest 0.1 pound per cubic foot. If running the test on a soil material, report the results on SCDOT Form 200.03 – Percent Compaction by Nuclear Gauge-Direct Read Gauge and SCDOT Form 200.01 – Field Density Test Report (Nuclear Gauge). If running the test on a graded aggregate base material or other material composed of large particles, use SCDOT Form 300.03 – Density Test Report (Nuclear Gauge) – Direct Read Gauge.

Standard Method of Test for

Field Determination of Density and Moisture Content of Soils and Aggregate Bases by Use of the Troxler Model 3440 Nuclear Gauge

SCDOT Designation: SC-T- 31

1. SCOPE

1.1. This method describes procedures for determining the density and moisture content of soils and aggregate bases through the use of the nuclear equipment.

1.2. This standard may involve hazardous materials, operations and equipment. This standard does not purport to address all of the safety problems associated with its use. It is the responsibility of the user of this standard to consult and establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.

2. REFERENCED DOCUMENT

2.1. SC-T-22.

3. SUMMARY OF TEST METHOD

3.1. The total or wet density of the material is determined by placing a gamma source into the material under test. The intensity of radiation detected is dependent upon the density of the material under test. The radiation intensity reading is related to measured wet density by suitable calibration curves or tables. The total water content is determined by placing a neutron source into the material under test. The quantity of fast neutrons is dependent upon the hydrogen content of the water in the material. The quantity of fast neutrons is related to the measured water content by suitable calibration curves or tables.

4. SIGNIFICANCE AND USE

4.1. The test method described is useful as a rapid, nondestructive method for the in-place determination of the wet density of soils and the wet density and moisture content of aggregate bases.

5. APPARATUS

5.1. Troxler Model 3440 Nuclear Gauge, reference standard, scraper plate, drill rod, drill rod extraction tool.

6. TEST SPECIMENS

6.1. This test is conducted on in-place soils or aggregate base material.

7. PROCEDURE

7.1. Turn the gauge on by pressing the “ON” key and the gauge will go through a short self-test. After the self-test, allow the gauge to warm-up for a minimum of 10 minutes. This will allow the systems critical circuits to stabilize.

7.2. Take moisture and density standard counts (at least 10 feet from any large object and at least 30 feet from another gauge).

7.3. Place the standard on a dry, solid and flat surface containing not more than 15 percent moisture and at least 100 pounds per cubic foot of density.

7.4. Place the gauge on the standard, being sure scaler end of gauge is toward the raised end of the standard and seated properly on the recessed surface.

7.5. Remove the padlock that locks the source rod in the “SAFE” position.

7.6. Press the “STANDARD” key and answer the prompted questions.

7.7. The gauge will prompt, “Take a new count?” Press the “YES” key.

7.8. The gauge will prompt, “Is the gauge on Standard Block & Source Rod in SAFE position?” Press the “YES” key. The gauge will display the count progress.

7.9. After the count completion, the gauge will display the Moisture Standard (MS) and the Density Standard (DS). The “P” or “F” display will indicate whether or not the counts fall within the acceptable limits. The DS should be within 1 percent and the MS within 2 percent of the average of the previous four counts.

7.10. Record both the DS (Density Standard) and MS (Moisture Standard) on the daily log.

7.11. The gauge will prompt, “Do you want to use new STD?” Press the “YES” key to accept the counts.

7.12. The gauge will return to the “READY” screen. Return the standard to its case.

7.13. If the surface is not relatively smooth, use the scraper plate to smooth and level the test surface (all loose stone should be removed and small voids filled with native fines or sand).

7.14. Take moisture and density measurement counts.

7.15. Using the drill rod and scraper plate, put the drill rod through the extractor tool, then through the scraper plate guide. Secure the scraper plate with one foot; drive the test hole at least 2 inches deeper than the desired test depth.

7.16. Remove the drill rod by rotating and pulling straight up. Do not loosen the drill rod by tapping from side to side with a hammer.

7.17. Before moving the scrapper plate, with your foot still securing the plate, take the drill rod and mark around the corners of the scraper plate.

7.18. Place the gauge within the scrapper plate outline.

7.19. Press the “SHIFT” key and “MODE” key and follow the display instructions to select the “SOIL” mode.

7.20. Press the “TIME” key and select “#2” for the recommended time (1 minute).

7.21. This step is only used for Aggregate Bases and Coquina Base Course. To enter Lab Proctor information press the “PROCTOR/MARSHALL” key and follow the display instructions to select “PROCTOR”, “STORED VALUE” or “NEW VALUE” and “LOCATION”.

7.22. Release the trigger and lower the source rod into the hole to the desired depth of measurement.

7.23. Gently slide the gauge to the right (scaler end), placing the source rod in firm contact with the sidewall of the hole.

7.24. Press the “START/ENTER” key to begin the test count. If the gauge is in the automatic depth mode, the correct depth will be displayed. If the gauge is in the manual depth mode, the gauge will prompt you to enter the depth manually. At this time, the gauge will begin the test count.

7.25. After the count time is complete, the gauge will display %PR, DD, WD, M and %M. Record the WD (Wet Density) and the actual Density Count only. To obtain the actual Density Count, press the “SHIFT” key and the “COUNTS” key.

7.26. Pull the source rod to the top notch, or “SAFE” position, and return the gauge to a safe area.

8. CALCULATIONS

8.1. Determine the moisture content and calculate the dry density pounds per cubic foot (pcf).

8.2. For Soils:

8.2.1. Determine the percent moisture using SC-T-22.

8.2.2. Calculate the dry density using the following equation:

$$\gamma_{DRY} = \left(\frac{\gamma_{WET}}{W + 100} \right) \text{x } 100$$

where:
γ_{DRY} = dry unit weight, in pcf of compacted soil
γ_{WET} = wet unit weight, in pcf of compacted soil
W = percentage of moisture in the specimen

8.3. For Aggregate Base Materials:

8.3.1. Record %PR (% Compaction), DD (Dry Density), WD (Wet Density), M (Moisture) and %M (%Moisture) from the gauge display.

9. REPORT

9.1. Report the moisture content of the soil to the nearest 0.1 percent and the moisture content of aggregate base materials to the nearest 0.1 pound per cubic foot. Report the maximum dry density to the nearest 0.1 pound per cubic foot. If running the test on a soil material, report the results on SCDOT Form 200.03 – Percent Compaction by Nuclear Gauge-Direct Read Gauge and SCDOT Form 200.01 – Field Density Test Report (Nuclear Gauge). If running the test on a graded aggregate base material or other material composed of large particles, use SCDOT Form 300.03 – Density Test Report (Nuclear Gauge) Direct Read Gauge.

Standard Method of Test for

Field Determination of Density and Moisture Content of Soils and Aggregate Bases by Use of the Troxler Model 3450 Nuclear Gauge

SCDOT Designation: SC-T-32

1. SCOPE

1.1. This method describes procedures for determining the density and moisture content of soils and aggregate bases through the use of the nuclear equipment.

1.2. This standard may involve hazardous materials, operations, and equipment. This standard does not purport to address all of the safety problems associated with its use. It is the responsibility of the user of this standard to consult and establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.

2. REFERENCED DOCUMENT

2.1. SC-T-22.

3. SUMMARY OF TEST METHOD

3.1. The total or wet density of the material is determined by placing a gamma source into the material under test. The intensity of radiation detected is dependent upon the density of the material under test. The radiation intensity reading is related to measured wet density by suitable calibration curves or tables. The total water content is determined by placing a neutron source into the material under test. The quantity of fast neutrons is dependent upon the hydrogen content of the water in the material. The quantity of fast neutrons is related to the measured water content by suitable calibration curves or tables.

4. SIGNIFICANCE AND USE

4.1. The test method described is useful as a rapid, nondestructive method for the in-place determination of the wet density of soils and the wet density and moisture content of aggregate bases.

5. APPARATUS

5.1. Troxler Model 3450 Nuclear Gauge, reference standard, scraper plate, drill rod, drill rod extraction tool.

6. TEST SPECIMENS

6.1. This test is conducted on in-place soils or aggregate base material.

7. PROCEDURE

7.1. Turn the gauge on by pressing the “ON” key and the gauge will go through a short self-test. After the self-test, allow the gauge to warm-up for a minimum of 10 minutes. This will allow the systems critical circuits to stabilize.

7.2. Take moisture and density standard counts (at least 10 feet from any large object and at least 30 feet from another gauge).

7.3. Place the standard on a dry, solid and flat surface containing not more than 15 percent moisture and at least 100 pounds per cubic foot of density.

7.4. Place the gauge on the standard, being sure the scaler end of the gauge is toward the raised end of the standard and seated properly on the recessed surface.

7.5. Remove the padlock that locks the source rod in the “SAFE” position.

7.6. Press the “STANDARD” key and answer the prompted questions.

7.7. The gauge display will show the last standard count and two selections (“1”-take a new count and “2”-view counts). Select “1” (take new count).

7.8. The gauge will prompt, “Put Rod In STD Pos. Place Gauge on Standard Block.” Press the “ENTER” key. The gauge will display the count progress.

7.9. After the count completion, the gauge will display the Density Standard for Systems 1 (DS1), the Density Standard for Systems 2 (DS2) and the Moisture Standard (MS). The “#.#%” and “PASS” or “FAIL” display will indicate whether or not the counts fall within the acceptable limits. The DS1 and DS2 should be within 1 percent and the MS within 2 percent of the average of the previous four counts.

7.10. Record both the DS (Density Standard) and MS (Moisture Standard) on the daily log.

7.11. The gauge will prompt, “Use New Standard?” If the standard counts pass, press the “YES” key to accept the counts.

7.12. After accepting the new standard count, the gauge will prompt, “Calibrate the Depth Strip by Placing the Rod in Backscatter and Pressing Enter.”

7.13. The gauge will return to the “READY” screen. Return the standard to its case.

7.14. If the surface is not relatively smooth, use the scraper plate to smooth and level the test surface (all loose stone should be removed and small voids filled with native fines or sand).

7.15. Take moisture and density measurement counts.

7.16. Using the drill rod and the scraper plate, put the drill rod through the extractor tool, then through the scraper plate guide. Secure the scraper plate with one foot; drive the test hole at least 2 inches deeper than the desired test depth.

7.17. Remove the drill rod by rotating and pulling straight up. Do not loosen the drill rod by tapping from side to side with a hammer.

7.18. Before moving the scrapper plate, with your foot still securing the plate, take the drill rod and mark around the corners of the scraper plate.

7.19. Place the gauge within the scrapper plate outline.

7.20. Press the “MODE” key and select “1” for the “SOIL” mode.

7.21. Press the “TIME” key and select “#2” for the recommended time (1 minute).

7.22. This step is only used for Aggregate Bases and Coquina Base Course. To enter Lab Proctor information, press the “TARGET” key and select “1” for “PROCTOR”. Enter either “5” for a new “TARGET VALUE” or choose an existing “STORED VALUE” and “LOCATION” from the menu. Press the “ENTER” key to return to the ready screen.

7.23. Release the trigger and lower the source rod into the hole to the desired depth of measurement.

7.24. Gently slide the gauge to the right (scaler end), placing the source rod in firm contact with the sidewall of the hole.

7.25. Press the “START” key to begin the test count. If the gauge is in the automatic depth mode, the correct depth will be displayed. If the gauge is in the manual depth mode, the gauge will prompt you to enter the depth manually. At this time, the gauge will begin the test count.

7.26. After the count time is complete, the gauge will display %PR, DD, WD, M and %M. Record the WD (Wet Density) and the actual Density Count only. To obtain the actual Density Count, press the “ARROW UP” key.

7.27. Pull the source rod to the top notch, or “SAFE” position, and return the gauge to a safe area.

8. CALCULATIONS

8.1. Determine the moisture content and calculate the dry density pounds per cubic foot (pcf).

8.2. For Soils:

8.2.1. Determine the percent moisture using SC-T-22.

8.2.2. Calculate the dry density using the following equation:

$$\gamma_{DRY} = \left(\frac{\gamma_{WET}}{W + 100} \right) \text{x } 100$$

where: γ_{DRY} = dry unit weight, in pcf of compacted soil
γ_{WET} = wet unit weight, in pcf of compacted soil
W = percentage of moisture in the specimen

8.3. For Aggregate Base Materials:

8.3.1. Record %PR (% Compaction), DD (Dry Density), WD (Wet Density), M (Moisture) and %M (% Moisture) from the gauge display.

9. REPORT

9.1. Report the moisture content of the soil to the nearest 0.1 percent and the moisture content of aggregate base materials to the nearest 0.1 pound per cubic foot. Report the maximum dry density to the nearest 0.1 pound per cubic foot. If running the test on a soil material, report the results on SCDOT Form 200.03 – Percent Compaction by Nuclear Gauge-Direct Read Gauge and SCDOT Form 200.01 – Field Density Test Report (Nuclear Gauge). If running the test on a graded aggregate base material or other material composed of large particles, use SCDOT Form 300.03 – Density Test Report (Nuclear Gauge) Direct Read Gauge.

Standard Method of Test for

Field Determination of Density and Moisture Content of Soils and Aggregate Bases by Use of the Troxler Model 3401 Nuclear Gauge

SCDOT Designation: SC-T-33

1. SCOPE

1.1. This method describes procedures for determining the density and moisture content of soils and aggregate bases through the use of the nuclear equipment.

1.2. This standard may involve hazardous materials, operations and equipment. This standard does not purport to address all of the safety problems associated with its use. It is the responsibility of the user of this standard to consult and establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.

2. REFERENCED DOCUMENT

2.1. SC-T-22.

3. SUMMARY OF TEST METHOD

3.1. The total or wet density of the material is determined by placing a gamma source into the material under test. The intensity of radiation detected is dependent upon the density of the material under test. The radiation intensity reading is related to measured wet density by suitable calibration curves or tables. The total water content is determined by placing a neutron source into the material under test. The quantity of fast neutrons is dependent upon the hydrogen content of the water in the material. The quantity of fast neutrons is related to the measured water content by suitable calibration curves or tables.

4. SIGNIFICANCE AND USE

4.1. The test method described is useful as a rapid, nondestructive method for the in-place determination of the wet density of soils and the wet density and moisture content of aggregate bases.

5. APPARATUS

5.1. Troxler Model 3401 Nuclear Gauge, reference standard, scraper plate, drill rod, drill rod extraction tool.

6. TEST SPECIMENS

6.1. This test is conducted on in-place soils or aggregate base material.

7. PROCEDURE

7.1. Turn the “PWR/TIME” switch to the “SLOW” position for 10 minutes to allow critical circuits to stabilize.

7.2. Take moisture and density standard counts (at least 10 feet from any large object and at least 30 feet from another gauge).

7.3. Place the standard on a dry, solid and flat surface containing not more than 15 percent moisture and at least 100 pounds per cubic foot of density.

7.4. Place the gauge on the standard, being sure scaler end of gauge is toward the raised end of the standard and seated properly on the recessed surface.

7.5. Remove the padlock that locks the source rod in the “SAFE” position.

7.6. Place the “PWR/TIME” switch in the “SLOW” position.

7.7. Press the “START” button.

7.8. Wait 4 minutes after which time the “ERR” symbol will disappear.

7.9. Turn the display switch to “MOISTURE” and record the Moisture Standard Count.

7.10. Turn the display switch to “DENSITY” and record the Density Standard Count.

7.11. Return the standard to its case.

7.12. If the surface is not relatively smooth, use the scraper plate to smooth and level the test surface (all loose stone should be removed and small voids filled with native fines or sand).

7.13. Take moisture and density measurement counts.

7.14. Using the drill rod and the scraper plate, put the drill rod through the extractor tool, then through the scraper plate guide. Secure the scraper plate with one foot; drive the test hole at least 2 inches deeper than the desired test depth.

7.15. Remove the drill rod by rotating and pulling straight up. Do not loosen the drill rod by tapping from side to side with a hammer.

7.16. Before moving the scrapper plate, with your foot still securing the plate, take the drill rod and mark around the corners of the scraper plate.

7.17. Place the gauge within the scrapper plate outline.

7.18. Release the trigger and lower the source rod into the hole to the desired depth of measurement.

7.19. Gently slide the gauge to the right (scaler end), placing the source rod in firm contact with the sidewall of the hole.

7.20. Turn the “PWR/TIME” switch to “NORM.”

7.21. Press the “START” button.

7.22. Wait one minute, after which time the “ERR” symbol will disappear.

7.23. Turn the display switch to “MOISTURE” and record the Moisture Measurement Count.

7.24. Turn the display switch to “DENSITY” and record the Density Measurement Count.

7.25. Pull the source rod to the top notch, or “SAFE” position, and return the gauge to a safe area.

8. CALCULATIONS

8.1. Calculate wet density pounds per cubic foot (pcf).

8.1.1. Divide the density measurement count by the density standard count to obtain the count ratio.

8.1.2. Turn to the proper tables provided with the nuclear gauge and record the wet density, pcf.

8.2. Determine the moisture content and calculate the dry density pounds per cubic foot (pcf).

8.3. For Soils:

8.3.1. Determine the percent moisture using SC-T-22.

8.3.2. Calculate the dry density using the following equation:

$$\gamma_{DRY} = \left(\frac{\gamma_{WET}}{W + 100} \right) \text{x } 100$$

where: γ_{DRY} = dry unit weight, in pcf of compacted soil
γ_{WET} = wet unit weight, in pcf of compacted soil
W = percentage of moisture in the specimen

8.4. For Aggregate Base Materials:

8.4.1. Divide the moisture measurement count by the moisture standard count to obtain the count ratio.

8.4.2. Turn to the proper tables provided with the gauge and record the moisture content, pcf.

8.4.3. Calculate the dry density using the following equation:

Dry Density (pcf) = Wet Density (pcf) – Moisture Content (pcf).

9. REPORT

9.1. Report the moisture content of the soil to the nearest 0.1 percent and the moisture content of aggregate base materials to the nearest 0.1 pound per cubic foot. Report the maximum dry density to the nearest 0.1 pound per cubic foot. If running the test on a soil material, report the results on SCDOT Form 200.02 – Percent Compaction by Nuclear Gauge and SCDOT Form 200.01 – Field Density Test Report (Nuclear Gauge). If running the test on a graded aggregate base material or other material composed of large particles, use SCDOT Form 300.02 – Density Test Report (Nuclear Gauge).

SCDOT Sampling and Testing Procedures

C.5 CONCRETE AND CEMENT

Standard Practice for

Making and Curing Concrete Beam Specimens

SCDOT Designation: SC-T-46

1. SCOPE

1.1. This practice covers procedures for making beam specimens from representative samples of fresh concrete for a construction project. The nominal size of the beam specimen is 6 inches by 6 inches by 20 inches.

1.2. This practice is not satisfactory for making specimens from concrete not having measurable slump or requiring other shapes and sizes.

1.3. This standard may involve hazardous materials, operations, and equipment. This standard does not purport to address all of the safety problems associated with its use. It is the responsibility of the user of this standard to consult and establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.

2. REFERENCED DOCUMENTS

2.1. None.

3. SIGNIFICANCE AND USE

3.1. This practice provides standardized requirements for making concrete beam specimens.

3.2. If the specimens are made and standard cured, as stipulated herein, the resulting strength test data when the specimens are tested are able to be used for the following purposes:

3.2.1. Acceptance testing for specified strength,

3.2.2. Checking adequacy of mixture proportions for strength,

3.2.3. Quality control.

3.3. Sampling is equally as important as the testing, and the sampler must use every precaution to obtain samples that will show the true nature and condition of the materials that they represent.

4. APPARATUS

4.1. *Beam Molds* — Beam molds shall be of the shape and dimensions stipulated in step 5.1. The inside surfaces of the molds shall be smooth. The sides, bottom and ends shall be at right angles to each other and be straight and true and free of warpage. Maximum variation from the nominal cross section shall not exceed 1/8 inch. Molds shall produce

specimens at least as long but not more than 1/16 inch shorter than the required length in step 5.1.

4.2. *Tamping Rod* — A round, straight steel rod that is 5/8 inches in diameter and 20 inches in length, having the tamping end or both ends rounded to a hemispherical tip of the same diameter as the rod.

4.3. *Vibrators* — Internal vibrators shall be used. The vibrator frequency shall be at least 7000 vibrations per minute (150 Hz) while the vibrator is operating in the concrete. The diameter of a round vibrator shall be no more than 1.5 inches. Other shaped vibrators shall have a perimeter no greater than the equivalent round vibrator (1.77 inches). The combined length of the vibrator shaft and vibrating element shall be at least 9 inches. The vibrator frequency shall be checked periodically using the vibrating reed tachometer.

4.4. *Mallet* — A mallet with a rubber or rawhide head weighing 1.25 $\pm$ 0.50 pounds shall be used.

4.5. *Small Tools* — Shovels, hand-held floats, scoops, and vibrating reed tachometer shall be provided.

4.6. *Sampling Receptacle* — The receptacle shall be a suitable heavy gage metal pan, wheelbarrow, or flat, clean, nonabsorbent board of sufficient capacity to allow easy remixing of the entire sample with a shovel or trowel.

5. TESTING REQUIREMENTS

5.1. *Beam Specimens* — Flexural strength specimens shall be beams of concrete cast and hardened in the horizontal position. The standard beam shall be 6 by 6 inches in cross section and 20 inches in length.

6. SAMPLING CONCRETE

6.1. The samples used to fabricate test specimens under this standard shall be obtained in accordance with SCDOT procedure SC-T-41, “Sampling Fresh Concrete”.

7. MOLDING SPECIMENS

7.1. *Place of Molding* — Mold specimens promptly on a level, rigid surface, free of vibration and other disturbances, at a place as near as practicable to the location where they are to be stored.

7.2. *Consolidation* — The methods of consolidation for this practice are rodding or internal vibration.

7.2.1. *Rodding* — Place the concrete in the mold, in two layers of approximately equal depth. Rod each layer with the rounded end of the rod sixty (60) times, distributing the roddings uniformly over the cross section of the mold. For the upper layer, allow the rod to penetrate through the layer being rodded into the layer below approximately 1 inch.

After each layer is rodded, tap the outsides of the mold lightly 10 to 15 times with the mallet, to close any holes left by rodding and to release any large air bubbles that may have been trapped. *(Note: Do NOT use a steel hammer for this step.)* After tapping, spade each layer of the concrete along the sides and ends of beam molds with a trowel or other suitable tool. It is recommended that the mold be slightly overfilled for the second layer prior to rodding to account for the reduction of volume caused by consolidation. Underfilled molds shall be adjusted with representative concrete during consolidation of the top layer. Overfilled molds shall have excess concrete removed.

7.2.2. *Vibration* — Maintain a uniform duration of vibration for the particular kind of concrete and vibrator involved. Fill each mold so as to avoid overfilling (after vibration) by more than ¼ inch. Only one layer of concrete is required. Vibrate once in the center of the mold and once at each end, 6 inches from the center. Vibrate long enough only to achieve proper consolidation of the concrete. Usually sufficient vibration has been applied as soon as the surface of the concrete the surface of the specimen has become relatively smooth. While vibrating the specimen, the vibrator shall not be allowed to rest on or touch the sides or bottom of the mold. Carefully withdraw the vibrator in such a manner that no air pockets are left in the specimen. After vibration, tap the outsides of the mold at least 10 times with the mallet to close holes that remain and release entrapped air voids. *(Note: Do NOT use a steel hammer for this step.)*

7.3. *Finishing* — After consolidation, finish the specimen by striking off the top with a straightedge and finishing with a hand-held float. Overfinshing shall be avoided. Care should be taken to when cutting down the specimen to avoid removal of excess depth. *(Note: This can be accomplished with a straightedge that has a sharp side corner rather than a worn or rounded side corner.)* Smooth the surface with a flat trowel.

8. CURING

8.1. *Storage* — If specimens cannot be molded at the place where they will receive initial curing, immediately after finishing move the specimens to an initial curing place for storage. The supporting surface on which specimens are stored shall be level to within 0.25 inch per foot.

8.2. *Initial Curing* — Immediately after molding and finishing, the specimens shall be stored for a period between 18 and 48 hours in a temperature range of 60°F to 80°F and in an environment preventing moisture loss from the specimens. Various procedures are capable of being used during the initial curing period to maintain the specified moisture and temperature conditions. An appropriate procedure or combination of procedures shall be used (See Note 3). Shield all specimens from direct sunlight and, if used, radiant heating devices. The storage temperature shall be controlled by the use of heating and cooling devices, as necessary. Record the temperature using a maximum-minimum thermometer. *(Note 3: A satisfactory moisture environment can be created during the initial curing by one or more of the following procedures: (1) place inside plastic bags, (2) cover with plastic sheets or non-absorbent, non-reactive plates or a sheet of tough, durable plastic. A satisfactory temperature environment can be controlled during the initial curing of the specimens by one or more of the following*

procedures: (1) use of ventilation, (2) use of ice, (3) use of thermostatically controlled heating or curing devices, or (4) use of heating methods such as stoves or light bulbs. Other suitable methods may be used provide the requirements limiting specimen storage temperature and moisture loss are met.)

8.3. *Final Curing* — Upon completion of initial curing and within 30 minutes after removal the molds, cure specimens with free water maintained on their surfaces at all times at a temperature of $73^{o} \pm 3^{o}$F through the use of an approved moist curing room or in a continuously circulating, thermostatically temperature-controlled bath of water saturated with calcium hydroxide. Upon removal from the molds, the specimens shall be marked with a waterproof felt tip marker to minimally indicate month, day, and specimen number. Care shall be exercised in handling the beams to avoid bumping them together or dropping them. A recording thermometer shall be used to monitor air or water temperature, as appropriate, to create a permanent record of curing temperature. If a moist curing room is used, the specimens shall be stored in a calcium hydroxide-saturated water bath meeting the requirements given above for a minimum of 20 hours prior to testing. Drying of the surfaces of the beam shall be prevented between removal from water storage and completion of testing. *(Note 4: Relatively small amounts of surface drying of flexural specimens can induce tensile stresses in the extreme fibers that will markedly reduce the indicated flexural strength.)*

9. TRANSPORTATION OF SPECIMENS TO LABORATORY

9.1. If the specimens must be transported for final testing, cure and protect specimens as required in Step 8. Specimens shall not be transported until they are at least 7 days old. When transporting specimens, a truck bed covered with damp sand or several layers of dampened burlap shall be used in order to keep the surfaces damp while transporting. After placing beams in the prepared truck bed, a polyethylene cover should be used to hold moisture in the load while traveling. Under no circumstances shall the transportation time exceed 4 hours.

Standard Method of Test for

Method of Sampling Portland Cement, Slag, and Fly Ash

SCDOT Designation SC-T-47

1. SCOPE

1.1. These methods cover the procedures for sampling Portland cement, slag, and fly ash.

2. SUMMARY OF SAMPLING METHOD

2.1. A sample of Portland cement may be sampled from a bulk shipment of car or truck, or from the batch plant silo.

3. SIGNIFICANCE AND USE

3.1. Sampling is equally as important as the testing, and the sampler must use every precaution to obtain samples that will show the true nature and condition of the materials that they represent.

4. APPARATUS

4.1. Plastic airtight gallon container and a suitable, clean shoveling device.

5. TEST SPECIMENS

5.1. *Sample Size and Sample Protection* — The size of the sample of material shall be 1 gallon. As samples are taken, it shall be placed directly in moisture-proof, airtight 1-gallon container to avoid moisture absorption and aeration of the sample. Containers shall be completely filled and sealed immediately.

6. PROCEDURE

6.1. *Sampling* — The material may be sampled as circumstances and batch plant equipment permit. In all cases, care shall be taken to prevent contaminating the sample by foreign matter. In most cases, samples may be obtained as follows:

6.2. *From Bulk Shipment of Rail Car or Truck* — The sample may be obtained from the delivery vehicle or along the conveyer route of travel from the vehicle to the batch plant storage silo. When sampling from the delivery vehicle, the sample may be obtained from the top hatch openings of a full load. The sample shall be taken at different points and should not include the surface material. When sampling from the conveyor route, be it bucket, auger or air flow, the sample shall be obtained by stopping the conveyor as many times as necessary to obtain a complete sample.

6.3. *From Batch Plant Silo* — The sample may be obtained from the scale hopper or by discharge as equipment will permit. Sampling from batch plant silos should only be done as a last resort when the identity of the material sample by mill test report is questionable.

SCDOT Sampling and Testing Procedures

C.6 ASPHALT MATERIALS

Standard Method of Test for

Methods of Sampling Bituminous Materials

SCDOT Designation SC-T-61

1. SCOPE

1.1. These methods apply to the sampling of liquid or semi-solid bituminous materials from storage tanks and tanker trucks.

2. SIGNIFICANCE AND USE

2.1. The purpose of using this procedure is to ensure that the sample of bituminous material is representative of the entire storage tank and to reduce sampling bias.

3. APPARATUS

3.1. It is essential that thoroughly clean and dry containers are used. Samples of asphalt cement are to be placed in compression top cans; cutback asphalts are to be placed in screw top cans; and emulsions are to be placed in clean plastic containers.

4. TEST SPECIMEN

4.1. Care shall be taken that the samples are not contaminated with dirt, fuel-oil or other extraneous matter and that the sample containers are perfectly clean and dry before filling.

4.2. Immediately after filling, the sample containers shall be tightly closed and properly marked for identification. Samples of emulsions shall be protected from freezing.

5. PROCEDURE

5.1. Samples shall be taken in the manner hereinafter described. They shall in no case be dipped from the surface of the material.

5.2. *Sampling from Storage Tanks* — In sampling from storage tanks (such as those located at asphalt plants), the sample is to be taken from one of the three sampling outlets provided. Some asphalt should be permitted to flow through the sampling outlet before the sample portion is taken.

5.3. *Sampling from Delivering Tankers* — In sampling from delivery tankers, the sample is to be taken by using the sampling valve after a distributor load has been removed from the tanker. The sampling valve should be flushed with at least 4 liters (1 gallon) of the asphalt to remove foreign material prior to obtaining the sample.

Standard Method of Test for

Methods of Sampling Bituminous Materials

SCDOT Designation SC-T-62

1. SCOPE

1.1. This method covers the procedures for sampling mixtures of bituminous materials with mineral aggregate as prepared for use in paving.

2. SIGNIFICANCE AND USE

2.1. The purpose of using this procedure is to ensure that the sample of bituminous mixture is representative of the entire truck or paver and to reduce sampling bias.

3. APPARATUS

3.1. Round-point shovel and sample bag or 5-gallon pail.

4. TEST SPECIMEN

4.1. Minimum size sampled should be in accordance with Figure SC-T-62A.

MAXIMUM SIZE OF PARTICLE (Passing Sieve)	MINIMUM WEIGHT OF SAMPLES (kilograms (pounds))
2.00 mm (No. 10)	1.8 (4)
4.75 mm (No. 4)	1.8 (4)
9.5 mm ($^3/_8$ inch)	3.6 (8)
12.5 mm (½ inch)	5.4 (12)
19.0 mm (¾ inch)	7.2 (16)
25.0 mm (1 inch)	9.0 (20)
37.5 mm (1½ inch)	11.3 (25)
50.0 mm (2 inch)	15.9 (30)

TABLE OF MINIMUM SAMPLE SIZES
Figure SC-T-62A

5. PROCEDURE

5.1. *Selection of Samples* — Sampling is as equally important as testing, and the sampler shall use every precaution to obtain samples that are truly representative of the bituminous mixture. Care shall be taken in sampling to avoid segregation of coarse aggregate and bituminous binder. Care shall also be taken to prevent contamination by dust or other foreign matter.

5.2. *Size of Sample* — The size of the sample shall be governed by the maximum size of particle of mineral aggregate in the mixture. The minimum size of sample shall conform to the requirements shown in Figure SC-T-62A.

5.3. Sampling Plant-Mixed Bituminous Mixtures:

5.3.1. *Truck Bed Sampling* — Sampling from the truck beds shall be accomplished by shoveling away the top part of the section to be sampled to a depth of at least 300 millimeters (12 inches). This is done so as to eliminate the possibility of segregated material. Then, with a round-point shovel, dig straight down into the material from at least two places to obtain the sample. *In no case should the plant technician step into the bed of the truck. If necessary, the truck will need to be repositioned to reach a desired location.*

5.3.2. *Paver Hopper Sampling* — Sampling from the paver hopper shall be accomplished by having the truck unload half of its load into the hopper and then having the truck pull forward. The sample should be obtained by shoveling away the top material with a round-point shovel and removing the material from at least two places in the hopper, directly above the slat conveyors. Sampling from the paver screw conveyors shall not be permitted.

Standard Method of Test for

Field Determination Of Target Density For Asphalt Concrete Materials By Use Of The Control Strip Technique

SCDOT Designation: SC-T-65

1. SCOPE

1.1 This test method demonstrates how to properly construct a control strip during the placement of Hot Mix Asphalt Pavement (HMA). Control strips are necessary to determine an optimum roller pattern and to ensure proper target density.

2. REFERENCE DOCUMENTS

2.1 SC-T-101

3. SUMMARY OF TEST METHOD

3.1 This test method determines the number of passes for each phase of rolling to achieve contract density requirements. The average of 10 random nuclear gauge readings shall be used to determine the compaction effort to be used as a target density of the hot mix asphalt.

4. SIGNIFICANCE AND USE

4.1 The established target density shall be used to monitor the compaction effort throughout the construction of the hot mix asphalt.

5. APPARATUS

5.1 The Contractor may select the equipment for rolling the asphalt concrete mixture in the control strip so long as proper density and a smooth riding pavement are obtained. The density of the asphalt concrete material is determined with a nuclear gauge operating in the backscatter mode. The nuclear gauge shall be capable of measuring the density of asphalt concrete materials and shall be operated by a trained and certified operator.

6. TEST SPECIMEN

6.1 Minimum of 300 feet of freshly paved asphalt roadway.

7. PROCEDURE

7.1 General:

7.1.1 The control strip shall be constructed at the start of the paving operation, generally between 500 and 1000 feet from the point the paving operation begins. As work progresses, additional control strips will need to be constructed if there are changes in the underlying support, the materials in the asphalt mix, the thickness of the mat, the

paving or rolling equipment, any other elements that might affect the final density achieved, or when density requirements are not being met.

7.1.2 The control strip shall be a minimum of 300 feet in length, one paving width wide, and the same thickness as required in the construction documents.

7.1.3 Material used for construction of the control strip shall be representative of the asphalt concrete material in the subsequent paving operation. Delivery temperature of the material shall be within $\pm$ 20°F of the specified mixing temperature and shall be the same as the temperature expected on the remainder of the work.

7.1.4 The control strip shall be constructed using the same paving and rolling equipment that will be used for the subsequent paving operation.

7.2 Optimum Roller Pattern:

7.2.1 After the initial pass of the breakdown roller, 3 locations within the 300 ft. control strip shall be selected and marked with lumber crayon. These locations shall be at least 3 feet from the pavement edge. NOTE: A zero offset shall be used when obtaining control strip density readings.

7.2.2 Initial nuclear gauge readings shall be taken at each of the 3 selected locations. Density shall be determined from appropriate calibration curves for the nuclear gauge being used.

7.2.3 Successive nuclear gauge readings shall be taken at the exact same locations after each pass of the roller. Mix temperature will be taken and recorded at that time. Rolling shall continue until the maximum attainable density is achieved, as determined by successive readings showing not more than 1 pound of density increase, with a minimum of 2 passes of each rolling phase.

7.2.4 The procedure as outlined in 7.2.1, 7.2.2, and 7.2.3 shall be repeated for each phase of rolling. All rolling shall be completed while the mix temperature is above 175°F, unless otherwise approved in writing by Asphalt Materials Engineer.

7.2.5 The optimum roller pattern shall be established by eliminating subsequent passes of each roller that do not contribute to more than 1 pound of densification, except for the finishing rolling, which should yield the maximum compaction effort, without “breaking” the mixture. This roller pattern shall be recorded and used throughout the subsequent paving operation or until conditions require a new control strip to be constructed.

7.3 Target Density:

7.3.1 After all rolling of the control strip has been completed, twelve random nuclear gauge tests are made in the control strip area. The highest and lowest will be discarded. These readings are averaged and this average control strip density shall be the target density for subsequent paving operations.

CALCULATIONS

8.1 Example: .....

Roller & No. Passes	Site 1	Site 2	Site 3	Average	Remarks
Static 1	131.2	128.0	131.4	130.2	
Static 2	136.2	132.0	133.2	133.8	
Static 3	137.3	132.7	135.8	135.3	
~~Static 4~~	~~138.4~~	~~134.5~~	~~135.5~~	~~136.1~~	Omit
Pneumatic 1	135.4	135.1	135.9	135.5	
Pneumatic 2	135.3	136.8	138.7	136.9	
~~Pneumatic 3~~	~~137.7~~	~~136.6~~	~~135.9~~	~~136.7~~	Omit
Finish 1	138.5	136.9	137.7	137.7	
Finish 2	139.6	138.6	137.9	138.7	
Finish 3	139.5	137.8	138.4	138.6	Use

Notes: Omit these passes due to gaining less than 1 pound.

ROLLER PATTERN CALCULATIONS
Figure SC-T-65A

The above roller pattern shall be recorded as 3 Static – 2 Pneumatic – 3 Finish

8.2 The target density shall be used in the monitoring and acceptance of hot mix asphalt. Density readings taken throughout the monitored section of the roadway should compare reasonably with the target density. Compare the readings to the target density in the following manner:

Established Target Density = 135.6 psy

Average Daily Random Readings (SC-T-101) = 134.8 psy

Percentage of Target Density (% Compaction) = $\frac{134.8}{135.6} \times 100 = 99.4\%$

Results not comparing favorably should be investigated by the QC Manager and may require a new control strip and a new target value established.

8. REPORT

9.1 Record roller patterns and densities on SCDOT Form 400.02 – Determination of Target Density for Asphalt Concrete Materials.

Standard Method of Test for

Field Determination of Stability of Hot-Mix Asphalt Mixture by Marshall Method

SCDOT Designation: SC-T-66

1. SCOPE

1.1. This method covers the field procedure for determining Marshall stability of hot-mix asphalt surface, binder and sand asphalt mixes.

2. REFERENCED DOCUMENT

2.1. AASHTO T 245, AASHTO M 231.

2.2. SC-T-62, SC-T-100.

3. SIGNIFICANCE AND USE

3.1. The purpose of this procedure is to check or verify the compressive strength of an asphalt mixture to ensure that minimum stability values meet the required specifications.

4. APPARATUS

4.1. *Compaction Assembly* — specimen mold assembly, compaction hammer, compaction pedestal, specimen mold holder and breaking head meeting specifications of AASHTO T 245.

4.2. *Thermostatically Controlled Oven* — capable of maintaining 95°C to 150°C (200°F to 300°F).

4.3. *Hot Plate* — capable of maintaining 95°C to 150°C (200°F to 300°F).

4.4. *Balance* — of sufficient capability (2-kilogram capacity and sensitive to 0.1 gram) meeting the requirements of AASHTO M 231.

4.5. *Wire Basket* — or non-absorbent string (to hang under balance).

4.6. *Water Bath* — of sufficient capacity (typically 170 liters (45 gallons)) equipped with a mechanical stirrer and capable of maintaining 60°C ± 1.0°C (140°F ± 1.8°F). Bath shall contain potable water.

4.7. *Miscellaneous Items* — calibrated dial thermometer (range of 10°C to 204°C (50°C to 400°F) and sensitive to 2.8°C (5°F) is recommended, penetrating oil (e.g. WD-40), circular paper disks (100 millimeter diameter), spade or spatula.

5. TEST SPECIMENS

5.1. Thirty to sixty minutes prior to molding the specimens, heat the mold assembly (base plate, mold and collar) to a temperature between 95°C (200°F) and 150°C (300°F) in a thermostatically controlled oven. Heat the compaction hammer to a temperature between 100°C (200°F) and 150°C (300°F) on a hot plate. The mold assembly and hammer shall be perfectly clean.

5.2. Check the temperature of the mix in the truck. If the temperature is between 146°C (295°F) and 157°C (315°F), take a large enough sample for a solvent-extraction or ignition-oven test and two Marshall specimens.

5.3. Remove the mold from the oven and coat the inside of the mold with a light application of a penetrating oil. Place a circular 100-millimeter (4-inch) diameter disc of paper in the bottom before the mixture is introduced.

5.4. Weigh approximately 1000 grams of the sample for a sand asphalt specimen, and 1200 grams for binder and surface specimens.

5.5. Introduce the hot mix into the mold and spade with a heated spatula (or spade) 15 times around the perimeter and 10 times over the interior. Remove the collar and smooth the surface of the mix with a trowel to a slightly rounded shape. Insert a dial thermometer in the mix and move the thermometer around the mold to insure an accurate reading. The mix temperature before compacting should be 146°C ± 3°C (295°F ± 5°F). If the temperature is below 143°C (290°F), discard the batch and repeat the process quickly to reduce heat loss. The mixture shall not be reheated.

5.6. Replace the collar and place the mold assembly with the mixture in the mold holder, and insert another 100-millimeter (4-inch) diameter disc of paper. Apply a light coat of the penetrating oil to base of the hammer to prevent the sticking of the hammer to the surface of the core. Then, apply the number of blows specified in the Contract (either 50 blows or 75 blows) with the compaction hammer. The face of the compaction hammer shall be parallel to the base during the application of compaction blows.

5.7. Remove the base plate and collar, reverse and reassemble the mold. Repeat the same number of blows on the reverse side.

5.8. Remove the collar and base plate. After the specimen has air cooled, place the assembly (with the extension collar up) in the testing machine; apply pressure to the collar by means of the load transfer bar and force the specimen into the extension collar. After removal, number each specimen and place them on a flat surface. Care should be exercised in handling to avoid fracture.

5.9. The specimen shall then be air cooled to room temperature.

5.10. Make an additional specimen using the same material as obtained in Step 5.2 above. Dig deep down into the bucket of mixture to secure hot material.

6. PROCEDURE

6.1. To determine the volume of the test specimen, weigh the specimen in air and then, by attaching a non-absorbent string or wire basket to a balance, weigh the specimen under water at 25°C ± 1°C (77°F ± 1.8°F). The specimen should be gently moved around before obtaining a final reading to allow all air bubbles to escape. The specimen shall then be weighed saturated surface-dry (SSD). The SSD condition is obtained by gently blotting the wet specimen with a damp towel or cloth (do not use a dry paper towel to dry the specimen) until the surface of the specimen contains no free moisture. The weight in water subtracted from the SSD weight yields the volume (cubic millimeters) of the specimen. This volume will be used later to determine the correlation ratio.

6.2. Place the specimen and testing mold in a water bath, equipped with a mechanical stirrer, at a temperature of 60°C ± 1.0°C (140°F ± 1.8°F) for a period of 35 ± 5 minutes.

6.3. Check the guide rods to see that the upper test head slides freely. Remove the specimen from the water bath and place in the lower segment of the breaking head. Place the upper segment of the breaking head on the specimen. The testing head and specimen are then placed in the Marshall machine.

6.4. Apply load to the specimen until the maximum load is reached and the load decreases as indicated by the dial. Record the maximum deflection noted on the testing machine and refer to the chart for the stability value. The elapsed time for the test from removal of the test specimen from the water bath to the maximum load determination shall not exceed 30 seconds. The corrected stability is found by multiplying the measured stability by the correlation ratio. Using the volume of the core, calculated in Step 6.1., determine the correlation ratio using Figure SC-T-66A.

7. CALCULATIONS

7.1. Volume = Air Weight – SSD Weight

Corrected Stability = Measured Stability x Correlation Ratio
(see Note 2. Figure SC-T-66A)

8. REPORT

8.1. Record the corrected stability on SCDOT Form 400.01 – Ignition Oven Worksheet and report on SCDOT Form 400.03 – Daily Report of Asphalt Plant Inspection.

VOLUME OF SPECIMEN[1] (cm^3)	THICKNESS[1] OF SPECIMEN mm (inch)	CORRELATION RATIO
406 to 420	50.8 (2)	1.47
421 to 431	52.4 (2-1/16)	1.39
432 to 443	54.0 (2-1/8)	1.32
444 to 456	55.6 (2-3/16)	1.25
457 to 470	57.2 (2-1/4)	1.19
471 to 482	58.7 (2-5/16)	1.14
483 to 495	60.3 (2-3/8)	1.09
496 to 508	61.9 (2-7/16)	1.04
509 to 522	63.5 (2-1/2)	1.00
523 to 535	64.0 (2-9/16)	0.96
536 to 546	65.1 (2-5/8)	0.93
547 to 559	66.7 (2-11/16)	0.89
560 to 573	68.3 (2-3/4)	0.86
574 to 585	71.4 (2-13/16)	0.83
586 to 598	73.0 (2-7/8)	0.81
599 to 610	74.6 (2-15/16)	0.78
611 to 625	76.2 (3)	0.76

CORRELATION RATIOS FOR SPECIMENS
Figure SC-T-66A

Notes:

1. *Volume-thickness relationship is based on a specimen diameter of 100 millimeters (4 inches).*

2. *The measured stability of a specimen multiplied by the ratio for the thickness of the specimen equals the corrected stability for a 63.5-millimeter (2½-inch) specimen.*

Standard Method of Test for

Determination of Percent Air Voids and Percent Voids in Mineral Aggregate in Compacted Marshall / Gyratory Specimens

SCDOT Designation: SC-T-68

1. SCOPE

1.1. This test method outlines the procedure for determining the percent air voids and voids in mineral aggregate (VMA) in compacted Marshall / Gyratory specimens.

2. REFERENCED DOCUMENT

2.1. AASHTO M 231, AASHTO T 312.

2.2. SC-T-62, SC-T-66.

3. SIGNIFICANCE AND USE

3.1. The purpose of this procedure is to determine the percent of air voids in an asphalt mixture to assess whether the mixture meets specifications.

4. APPARATUS

4.1. *Balance* — meeting the requirements of AASHTO M 231, 3 kilograms or greater capacity, sensitive to 0.1 gram, equipped with suitable suspension apparatus and holder to permit weighing the specimen while suspended from the center of the scale pan of balance.

4.2. *Water Bath* — for immersing the specimen in water while suspended under the balance, capable of maintaining temperature of 25°C ± 1°C.

5. TEST SPECIMENS

5.1. Obtain the asphalt sample from the truck in accordance with SC-T-62 and prepare a minimum of two (2) Marshall/Gyratory specimens according to the method outlined in SC-T-66 or AASHTO T 312.

6. PROCEDURE

6.1. Cool the specimens to room temperature (25°C ± 1°C), weigh and record the dry mass in grams (designated as A).

6.2. Immerse each specimen in water for 3 to 5 minutes on the suspended scale pan, weigh and record the immersed mass in grams (designated as C).

6.3. Remove the specimens from the water, surface dry by blotting with a damp towel, and weigh and record the saturated surface-dry (SSD) mass in grams (designated as B).

7. CALCULATIONS

7.1. Calculate the Bulk Specific Gravity (BSG) of each specimen as follows:

$$\text{Bulk Specific Gravity} = D = \frac{A}{(B - C)}$$

where: A = mass (grams) of specimen in air
B = mass (grams) of specimen SSD in air
C = mass (grams) of specimen in water

7.2. Calculate the Maximum Rice Specific Gravity (MSG) for each specimen as follows:

$$E = MSG = \frac{100}{(F/G) + ((100 - F)/ESG)}$$

where: F = %AC in sample (from extraction)
G = specific gravity of AC in sample (from job mix information sheet)
ESG = Effective Specific Gravity (from job mix information sheet)

7.3. Calculate the Percent Air Voids as follows:

$$\%\text{Air Voids} = (1 - (D/E)) \times 100$$

where: D = Bulk Specific Gravity
E = Maximum Rice Specific Gravity

7.4. Calculate the %AC by volume as follows:

$$\%\text{AC by volume} = \frac{(F \times D)}{G}$$

where: D = Bulk Specific Gravity
F = %AC in sample (from extraction)
G = specific gravity of AC in sample (from job mix information sheet)

7.5. Calculate the Percent Voids in Mineral Aggregate as follows:

%VMA = %AC by volume + %Air Voids

7.6. Example Calculations:

7.6.1. Given: A = 1206 grams = mass of specimen in air
B = 1210 grams = mass of specimen SSD in air
C = 699 grams = mass of specimen in water
F = 5.7% = %AC in sample (from extraction)
G = 1.031 = specific gravity of AC in sample (from job mix info. sheet)
ESG = 2.738 = Effective Specific Gravity (from job mix info. sheet)

Find: %Air Voids and %VMA

7.6.2. Calculations:

$$\text{Bulk Specific Gravity} = \frac{1206}{(1210 - 699)} = 2.360$$

$$E = \text{MSG} = \frac{100}{(5.7/1.031) + ((100 - 5.7)/2.738)} = 2.502$$

$$\%\text{Air Voids} = (1 - (2.360/2.502)) \text{ x } 100 = 5.7\%$$

$$\%\text{AC by volume} = \frac{(5.7 \text{ x } 2.360)}{1.031} = 13.0\%$$

$$\%\text{VMA} = 13.0 + 5.7 = 18.7\%$$

8. REPORT

8.1. Record BSG, MSG, %Air Voids, %AC by volume and %VMA on SCDOT Form 400.01 – Ignition Oven Worksheet and report on SCDOT Form 400.03 – Daily Report of Asphalt Plant Inspection.

Standard Method of Test for

Field Determination of Percent Lime in Asphalt Mixtures

SCDOT Designation: SC-T-71

1. SCOPE

1.1. To determine the percent lime being entered into an asphalt mixture at the production site.

2. REFERENCED DOCUMENT

2.1. SC-T-2, SC-T-23.

3. SIGNIFICANCE AND USE

3.1. The purpose of this procedure is to check the lime rate to ensure that the lime rate meets SCDOT specifications to prevent asphalt mixtures from stripping.

4. APPARATUS

4.1. Heavy-duty large plastic garbage bag, scale, timing.

5. TEST SPECIMEN

5.1. Hydrated lime.

6. PROCEDURE

6.1. The plant's cold feed production rate at the time of sampling the lime shall be obtained from the computer display in the control room. The cold feed rate shall be the rate of aggregate and moisture in tons per hour (TPH).

6.2. Determining Moisture Content:

6.2.1. The moisture content of the aggregate is determined by stopping the cold feed belt and obtaining a representative sample of aggregate from the belt. The belt sample should be obtained by following the procedure outlined in SC-T-2, "Methods of Sampling Fine Aggregates." The aggregate moisture content shall be determined in accordance with SC-T-23, "Determining Moisture Content of Soils by Pan Drying Method." To account for the presence of coarse aggregate, use a sample of 2000 to 3000 grams stated in SC-T-23.

6.3. Sampling the Lime:

6.3.1. Using a pre-weighed bag, divert the lime to flow from the silo into the bag and immediately start a timer. After reaching a predetermined time (normally 10 or 15 seconds), allow the lime flow to return to the cold feed belt and remove the bag.

6.3.2. Fasten the bag containing the lime to a scale and record the weight. Subtract the weight of the bag to determine the actual weight of the lime sampled.

7. CALCULATIONS

7.1. The calculations may be performed using either Method A, a unit analysis procedure, or Method B, a direct formula procedure used on Research and Materials Laboratory Form 283, "Weekly Lime Anti-Stripping Additive Report." Both methods will yield the same result. Examples of each calculation are shown below:

7.1.1. Method A — Unit Analysis Procedure:

A = Cold Feed Rate (aggregate & moisture, TPH)
B = Moisture in Aggregate (%)
C = Time Length of Lime Sample (sec)
D = Weight of Sample (lbs)
E = Dry Aggregate (TPH)
F = Lime (TPH)

$$E = \frac{A}{(1 + (B/100))}$$

$$F = \frac{D}{C} \text{ x } \frac{1\,\text{ton}}{2000\,\text{lbs}} \text{ x } \frac{60\,\text{sec}}{1\,\text{min}} \text{ x } \frac{60\,\text{min}}{1\,\text{hr}}$$

Rate of Lime (%) = (F/E) x 100

7.1.2. Method B — Direct Formula Procedure:

A = Cold Feed Rate (aggregate & moisture, TPH)
B = Moisture in Aggregate (%)
C = Time Length of Lime Sample (sec)
D = Weight of Sample (lbs)

$$\text{Rate of Lime } (\%) = \frac{D(180 + 1.8B)}{(A)(C)}$$

8. REPORT

8.1. Record the percent lime on SCDOT Form 400.13 – Weekly Lime Anti-Stripping Additive Report.

Standard Method of Test for

Method of Quartering Bituminous Mixtures

SCDOT Designation: SC-T-72

1. SCOPE

1.1. This method is for use in obtaining the required size bituminous mixture sample for testing. In most instances, bituminous mixtures are too large in size and must be reduced to obtain the proper quantity for testing.

2. REFERENCED DOCUMENT

2.1. SC-T 62, SC-T-100.

3. SIGNIFICANCE AND USE

3.1. The purpose of this procedure is to properly reduce asphalt mixture samples to an appropriate testing size to ensure consistency and repetition of test results.

4. APPARATUS

4.1. Clean, smooth metal table; trowel; 5-gallon pail or sample bag.

5. TEST SPECIMEN

5.1. 5-gallon pail or sample bag of asphalt mixture.

6. PROCEDURE

6.1. Obtain a sample of the bituminous mixture for a random location, as determined using SC-T-100, by following the sampling method in SC-T-62.

6.2. Invert the sample bucket (or bag) containing the mixture on a clean, smooth metal table.

6.3. Using a trowel, gently slice into the mixture so the mixture spreads into a near circular layer with uniform thickness and with as little segregation as possible. Divide the mixture into quarters by two lines intersecting at right angles at the center.

6.4. Place the diagonally opposing quarters (i.e., 2 and 3 or 1 and 4) in a sample bag immediately, or discard as required. Clean and discard all fines from the trowel.

6.5. The remaining opposing quarters should be pulled together. DO NOT remix to avoid segregation. Quarter the mixture again until the required sample size is obtained.

6.6. Once the proper sample size is obtained, clean both sides of the trowel with the edge of the table or a straight edge, and place a quarter of the fines in the sample to be tested.

Standard Method of Test for

Determination of Asphalt Binder Content for Asphalt Paving Mixtures by the Ignition Oven

SCDOT Designation: SC-T-75

1. SCOPE

1.1. This method covers the determination of asphalt binder content of hot-mix paving mixtures by ignition of the asphalt binder in a furnace.

Safety Notice: This procedure involves extremely high temperatures (650°C (1200°F)) and will require the technician to wear appropriate safety protection during portions of the testing. Some steps in the procedure, which are known to involve high temperatures, are highlighted with a notice concerning the use of proper safety equipment. The absence of a warning does not necessarily mean that all material and equipment is safe to handle. The technician should use caution during each step of the procedure.

2. REFERENCED DOCUMENT

2.1. AASHTO M 231.

2.2. SC-T-62, SC-T-72, SC-T-76.

3. SIGNIFICANCE AND USE

3.1. The purpose of this procedure is to accurately determine the asphalt binder content from asphalt mixtures. The asphalt binder is burned in a furnace in accordance to this procedure. The asphalt binder content is calculated as the difference between the initial and ending weights, with a calibration factor for the mixture and temperature. The final asphalt content is expressed as a percentage of mass loss.

4. APPARATUS

4.1. *Furnace* — A forced air ignition furnace, capable of maintaining 650°C (1200°F), with an internal balance or load cell thermally isolated from the furnace chamber and accurate to 0.1 gram. The balance shall be capable of weighing a 3500-gram sample in addition to the sample baskets. If needed, the furnace shall calculate a temperature compensation factor for the change in weight of the sample baskets. Note that not all ovens may require the use of a temperature compensation factor. Check with the oven manufacturer to determine if this factor is necessary. The furnace shall provide a printed ticket with the initial specimen weight, specimen weight loss at one minute intervals, temperature compensation, if needed, aggregate correction factor, correct asphalt binder content (percent), test time and test temperature. The furnace chamber internal volume shall be at least 0.85 cubic feet. A method for reducing furnace emissions shall be provided. The furnace shall provide an audible alarm and indicator light when the sample weight loss does not exceed 0.2 grams for two (2) consecutive minutes. The furnace door shall be locked until the completion of the test procedure.

4.2. *Baskets* — Two (2) or three (3) tempered stainless steel 2.36-millimeter (No. 8) mesh or otherwise perforated baskets, dimensioned to properly fit in the oven. The baskets shall be nested and shall be provided with screening on the legs to confine the aggregate.

4.3. *Catch Pan* — One (1) stainless steel catch pan with dimensions slightly wider and longer than the stainless steel baskets and approximately 25 millimeter (1 inch) in height.

4.4. *Oven* — Oven capable of maintaining 125°C + 5°C (257°F + 9°F), inside volume of at least 70,800 cubic millimeters (2.5 cubic feet).

4.5. *Balance* — Balance, 8 kilogram or greater capacity, sensitive to 0.5 gram for weighing sample in baskets, meeting the requirements of AASHTO M 231.

4.6. *Miscellaneous Equipment* — Pan dimensions 380L x 380W x 50D millimeters (15L x 15W x 2D inches) minimum for transferring samples after ignition, spatulas, bowls and wire brushes.

4.7. *Safety Equipment* — Safety glasses, face shield, high temperature gloves, long sleeve jacket or apron. Additionally, a heat resistant surface capable of withstanding 650°C (1200°F) and a protective cage capable of surrounding the sample baskets shall be provided.

5. TEST SPECIMEN

5.1. The sample shall be the end result of quartering a larger sample taken in accordance with SC-T-62, except that the sample size will be determined using Figure SC-T-75A. The sample will be properly quartered to the required testing size using SC-T-72 or SC-T-93. When the mass of the test specimen exceeds the capacity of the equipment used, the test specimen may be divided into suitable increments, tested and the results appropriately combined for calculation of the asphalt binder content (weighted average). It is recommended the sample size should not be more than 400 grams greater than the minimum recommended sample mass. Large samples of fine mixes may result in incomplete ignition of the asphalt binder.

NOMINAL MAXIMUM AGGREGATE SIZE (sieve size)	MINIMUM MASS OF SAMPLE (grams)
4.75 (No. 4)	1200
9.5 ($^3/_8$ inch)	1200
12.5 (½ inch)	1500
19.0 (¾ inch)	2000
25.0 (1.0 inch)	3000
37.5 (1.5 inch)	4000

SIZE OF SAMPLE
Figure SC-T-75A

5.2. If the mixture is not sufficiently soft to separate with a spatula or trowel, place it in a large flat pan and warm it to 125°C ± 5°C (257°F ± 9°F) for 25 minutes. The sample shall not be heated for more than 1 hour.

5.3. A specimen for moisture determination may be made as deemed necessary. This specimen may not be used for asphalt binder content determination.

6. PROCEDURE

6.1. *Mixture Calibration – General*: Before testing can be performed on an asphalt mixture, the oven must be calibrated using the mixture. The mixture shall be calibrated following this procedure using the entire mixture. The use of aggregate-only calibration will not be permitted.

RAP Mixtures: For mix designs containing RAP, a sufficient quantity of RAP should be sampled such that the binder content of the RAP may be estimated and to provide for the RAP to be used in the mix calibration. The binder content of the RAP will be estimated from the average of four (4) samples (RAP only) burned in the furnace. The portions of RAP should be obtained using a sample splitter.

6.1.1. The ignition procedure may be affected by the type of aggregate in the mixture. Therefore, to optimize accuracy, a calibration factor will be established by testing a set of calibration samples for each mix. This procedure must be performed before any acceptance testing is completed.

6.1.2. A calibrated specimen conforming to the mass requirements of Figure SC-T-75A shall be prepared by a SCDOT Mix Design Technician at the design asphalt binder content and at +0.5% of the design asphalt binder content for a total of three (3) specimens. A butter mix shall be prepared at the design asphalt binder content, mixed and discarded prior to mixing any of the calibration specimens.

Aggregate, hydrated lime and asphalt binder used for the calibration specimens shall be representative of the material used in the mix. This may require the use of aggregate sampled from current stockpiles located at the plant for which the mix is, or will be, produced.

Any method may be used to combine the aggregates; however, an additional "blank" specimen with no asphalt binder shall be batched and tested according to SC-T-76. The washed gradation shall fall within the Job Mix allowable tolerances.

6.1.3. Reset the ignition furnace to 538°C + 10°C (1000°F + 18°F), and record the furnace temperature prior to the initiation of the test (set point). Although this temperature is to be used on most mixes, some mixes may have more aggregate breakdown at this high temperature than others. If it is determined during calibration that the mix is breaking down excessively, a lower ignition temperature may be used. If a lower temperature is used for calibration, this lower temperature shall be recorded and used on any future tests involving that mix. Using a lower temperature will cause the time for complete burning to increase.

6.1.4. Place the freshly mixed specimens directly into the sample baskets. If the specimens were allowed to cool, preheat them in an oven at 125°C ± 5°C (257°F ± 9°F) for 25 ± 5 minutes. Do not preheat the sample baskets.

6.1.5. Enter the correction factor of "0.0" in the ignition furnace. Weigh and record the weight of the sample baskets and batch pan (with guards in place) as W_b.

6.1.6. Place the sample basket into the catch pan. Evenly distribute the calibration specimen in the baskets taking care to keep the material away from the edges of the basket. Evenly distribute the specimen in the baskets using a spatula or trowel to level the specimen. Weigh and record the total weight of the sample, basket catch pan and basket guards (W_T). Calculate, using Equation 75-1, and record the initial weight of the sample specimen (W_i).

$$W_i = W_T - W_b \qquad \text{(Equation 75-1)}$$

6.1.7. Input the initial weight of the sample specimen (W_i) into the ignition furnace controller. Verify that the correct weight has been entered.

6.1.8. **For this next step, wear the appropriate safety gear**. Open the chamber door and place the sample baskets in the furnace. Be careful not to slide the basket on the floor of the furnace. Close the chamber door and verify that the total sample weight displayed on the furnace scale or load cell equals the total weight recorded as W_T (Equation 75-1), within ±5 grams. A difference greater than 5 grams or failure of the furnace scale to stabilize may indicate that the sample baskets are contacting the furnace wall.

Initiate the test by pressing the "START/STOP" button. At this point the chamber door will lock and will not open until the test is complete. The printer will begin recording the test results. Allow the test to continue until the stable light and audible stable indicator indicates the test is complete. The final weight of the sample will be denoted W_f.

6.1.9. **Wearing protective gear**, open the chamber door and remove the sample baskets using the proper tool and place them on a temperature resistant block. Cover the baskets with a protective cage and allow them to cool to room temperature (approximately 30 minutes).

6.1.10. Once all of the calibration specimens have been burned, use Equation 75-2 to determine the difference ($\%AC_{DIFF}$) between the actual ($\%AC_{ACT}$) and measured ($\%AC_{MEAS}$) asphalt binder contents for each sample. Use Equation 75-3 to calculate the mix correction factor (C_F), which is the average of the measured differences. The correction factor (C_F) is the number (either + or -) that will bring the tested asphalt binder content back to the original amount entered. If the oven consistently gives a higher $\%AC_{MEAS}$, the correction factor will be a negative number and will be subtracted from the final test result.

$$\%AC_{DIFF} = \%AC_{ACT} - \%AC_{MEAS} \qquad \text{(Equation 75-2)}$$

$$C_F = \frac{[\%AC_{DIFF}(1) + \%AC_{DIFF}(2) + \%AC_{DIFF}(3)]}{3} \qquad \text{(Equation 75-3)}$$

Refer to figure SC-T-75B see if the individual correction factors are within acceptable tolerances.

- 0.5 % BELOW OPTIMUM BINDER CONTENT	OPTIMUM BINDER CONTENT	+ 0.5 ABOVE OPTIMUM BINDER CONTENT	RERUN SAMPLE?
$\%AC_{DIFF} \leq C_F$			No
$\%AC_{DIFF} \geq C_F$			Yes*
$\%AC_{DIFF} \geq \pm 0.51$			Call R&M Lab

**Note: Rerun – if $\%AC_{DIFF}$ exceeds C_F (see Figure SC-T-75B) on any of the three burns, rerun two additional samples and recalculate the corrections factor using the average of correction factors by dropping the highest and lowest difference from the $\%AC_{ACT}$ and average the remaining (3) samples for the correction factor.*

CALIBRATION ALLOWABLE DIFFERENCE
Figure SC-T-75B

6.1.11. Verification and Updating of the Calibration Correction Factor:

6.1.12. The mix calibrations should be checked and updated on a routine basis, or as often as is required. The following steps indicate how to properly verify and update the mix calibration factor:

6.1.13. Prepare a specimen at the optimum asphalt binder content in the same manner in which specimens were prepared in the mixture calibration. Instead of three (3) calibration specimens, there will only be one (1).

6.1.14. Preset the ignition furnace to 538°C ± 10°C (1000°F ± 18°F). Record the furnace temperature prior to the ignition of the test (set point). If a lower oven temperature was used for calibration, record and use that temperature for verification testing as well.

6.1.15. Place the freshly mixed specimen directly into the sample baskets. If the specimen was allowed to cool, preheat it in an oven at 125°C ± 5°C (257°F ± 9°F) for 25 ± 5 minutes. Do not preheat the sample baskets.

6.1.16. Enter a correction factor of "0.0" in the ignition furnace. Weigh and record the weight of the sample baskets and catch pan (with guards in place) as W_b.

6.1.17. Follow the same steps as outlined in the mixture calibration procedure to completely burn the specimens. When the test is complete, use Equation 75-4 to calculate the %AC difference ($\%AC_{DIFF(Verify)}$).

$$\%AC_{DIFF(Verify)} = \%AC_{ACT} - \%AC_{MEAS} \quad \text{(Equation 75-4)}$$

6.1.18. The %AC difference ($\%AC_{DIFF(Verify)}$) from Equation 75-4 is to be factored as a weighted average into the current correction factor being used for the mix design using Equation 75-5.

$$C_{F(New)} = \frac{\%AC_{DIFF(Verify)} + 3\left(C_{F(CURRENT)}\right)}{4} \qquad \text{(Equation 75-5)}$$

$C_{F(New)}$, determined from Equation 75-5, becomes the new correction factor to be used for the mix design; and each time the correction factor is verified, the new correction factor should be averaged into the previous correction factor using Equation 75-5. If $C_{F(New)}$ is less than the allowable difference in Figure SC-T-75C, $C_{F\ (New)}$ can be utilized for 3 months. If the $C_{F(New)}$ is calculated and found to be outside of the allowable difference, monthly verification testing must continue monthly until is $C_{F(New)}$ is found to be within allowable tolerances.

CURRENT CORRECTION FACTOR C_F	ALLOWABLE DIFFERENCE FROM CORRECTION FACTOR (C_F - $C_{F\ (New)}$)	INDIVIDUAL DIFFERENCE FROM CORRECTION FACTOR (> 0.15)
≤ +/- 0.30	0.05	Must continue monthly verification
+/- 0.31 to 0.50	0.10	
≥ +/- 0.51	0.15	Must continue monthly verification & Contact R&M Lab

ALLOWABLE DIFFERENCE – VERIFICATION
Figure SC-T-75C

6.2. Asphalt Binder Content Determination Test Procedure:

6.2.1. Allow the ignition furnace to preheat to 538°C ± 10°C (1000°F ± 18°F). Record the furnace temperature (set point) prior to the initiation of the test. If needed, the temperature correction factor will be denoted T_{CF}. If a lower oven temperature was used for calibration, record and use that temperature for sample testing as well. At room temperature, weigh the sample baskets and catch pan (with guards in place). Record this weight as W_b.

6.2.2. Prepare the sample as described in Section 5 by heating for 25 ± 5 minutes in an oven at 125°C ± 5°C (257°F ± 9°F). Place the sample basket in the catch pan. Evenly distribute the sample in the basket taking care to keep the material away from the edges of the basket. Use a spatula or trowel to level the specimen.

6.2.3. Weigh the sample, basket, catch pan and basket guards and record the weight as W_T. Calculate and record the initial weight of the sample specimen (W_i) using Equation 75-1.

6.2.4. Input the initial weight of the sample specimen (W_i) into the ignition furnace controller. Verify that the correct weight has been entered.

6.2.5. **For this next step, wear the appropriate safety gear.** Open the chamber door and place the sample baskets in the furnace. Close the chamber door and verify that the total sample weight displayed on the furnace scale or load cell equals the total weight (W_T), as determined from Equation 75-1, within ±5 grams. A difference greater than 5

grams or failure of the furnace scale to stabilize may indicate that the sample baskets are contacting the furnace wall.

Initiate the test by pressing the "START/STOP" button. At this point, the chamber door will lock and will not open until the test is complete. The printer will begin recording the test results. Allow the test to continue until the stable light and audible stable indicator indicates that the test is complete. The final weight of the sample will be denoted W_f.

6.2.6. **Wearing protective gear**, open the chamber door and remove the sample baskets using the proper tool and place them on a temperature resistant block. Cover the baskets with a protective cage and allow them to cool to room temperature (approximately 30 minutes). If a gradation analysis is desired, empty the contents of the baskets into a flat pan (be sure all fines are removed), and perform the gradation analysis.

7. CALCULATION – ASPHALT BINDER CONTENT

7.1. The ignition oven will automatically calculate the corrected asphalt binder content of the sample based on Equation 75-6 and Equation 75-7. **Be sure to use the correct sign (+ or -) when using the correction factors.**

$$AC_{UNCORRECTED} = \frac{(W_i - W_f)}{W_i} \times 100 \qquad \text{(Equation 75-6)}$$

$$\%AC_{CORRECTED} = \%AC_{UNCORRECTED} + C_F + T_{CF} \text{ (if needed)} \qquad \text{(Equation 75-7)}$$

7.2. Example Calculation:

7.2.1. The results of an example mixture calibration for three (3) specimens is shown in Figure SC-T-75D.

DESCRIPTION	UNIT/EQUATION	SAMPLE NUMBER		
		1 (-0.5%)	2 (Opt.)	3 (+0.5%)
Test Temperature	T (°C)	1000	1000	1000
Known %AC	AC_{ACT}	5.7	6.2	6.7
Wt. Basket	W_b	3326.2	3326.1	3324.3
Wt. Basket + Sample	W_T	4718.7	4719.2	4718.4
Wt. Sample	$W_i = W_T - W_b$	1392.5	1393.1	1394.1
Measured %AC	AC_{MEAS}	5.45	6.15	6.67
Difference	$AC_{DIFF} = AC_{ACT} - AC_{MEAS}$	0.25 (Failed)	0.05	0.03
Correction Factor	C_F = [Avg. AC_{DIFF}] /3	0.11		

Note: All weights in grams.

EXAMPLE MIXTURE CALIBRATION
Figure SC-T-75B

Because the first sample was outside of allowable tolerances due to C_F (0.11), two additional samples were burned @ 5.7% AC, and the results were 5.61, and 5.60. The highest (i.e., 5.61), and the lowest (i.e., 5.45) were dropped, and the 5.60 was used to determine the C_F, as follows:

Corrected $C_F = [\%AC_{DIFF}(0.10) + \%AC_{DIFF}(0.05) + \%AC_{DIFF}(0.03)]/3 = 0.06$

7.3. Example Test Procedure (Unknown Specimen):

DESCRIPTION	UNIT/EQUATION	RESULT
Calibration Factor	C_F	0.06
Test Temperature	T (°C)	1000
Temperature Compensation Factor	$T_{CF}^{(1)}$	0.01
Wt. Basket	W_b	3325.8
Wt. Basket + Sample	W_T	4716.5
Wt. Sample (Initial)	$W_i = W_T - W_b$	1390.7
Wt. Sample (Final)	W_f	1305.7
Uncorrected %AC	$\%AC_{UNCORRECTED} = [(W_i - W_f)/W_i] \times 100$	6.11
Corrected %AC	$\%AC_{CORRECTED} = \%AC_{UNCORRECTED} + C_F + T_{CF}^{(1)}$	6.18

Notes:

1. *Use T_{CF} only if needed.*
2. *All weights in grams.*

EXAMPLE TEST PROCEDURE
Figure SC-T-75C

8. REPORT

8.1. Report the following information: Corrected asphalt binder content, mix correction factor, temperature compensation factor (if needed), total percent loss, sample mass and test temperature. Attach the original ignition oven ticket showing mass loss at one-minute intervals to the report. Test results are reported on SCDOT Form 400.03 – Daily Report of Asphalt Plant Inspection. Data and calculations are recorded on SCDOT Form 400.01 – Ignition Oven Worksheet. Calibration and verification data must be reported on SCDOT Form 400.06 – Asphalt Ignition Oven Mixture Calibration Worksheet and SCDOT Form 400.07 – Asphalt Ignition Oven Mixture Calibration Verification Worksheet.

Standard Method of Test for

Determination of Washed Aggregate Gradation of Hot-Mix Asphalt Extracted Aggregates

SCDOT Designation: SC-T-76

1. SCOPE

1.1. This method covers the determination of combined silt and clay material passing the 75-μm (No. 200) sieve and the mechanical analysis of hot-mix asphalt extracted aggregate.

2. REFERENCED DOCUMENT

2.1. AASHTO M 231.

3. SIGNIFICANCE AND USE

3.1. The purpose of this procedure is to accurately determine the amount of aggregate that passes the 75-μm (No. 200) sieve to ensure that the gradation of the mixture meets job mix specifications.

4. APPARATUS

4.1. *Sieves* — standard sieves with square openings. For the washing: a 600-μm (No. 30) sieve nested on a 75-μm (No. 200).

4.2. *Balance* — of sufficient capacity and accuracy meeting the requirements of AASHTO M 231.

4.3. *Wetting/Disbursing Agent* — (e.g., Calgon).

4.4. *Container* — bowl of sufficient capacity to hold the entire sample.

4.5. *Oven* — capable of maintaining 125°C ± 5°C (257°F ± 9°F).

4.6. *Shaker* — mechanical shaker (e.g., Rotap).

4.7. *Water* — potable water.

4.8. *Miscellaneous Items* — brush, trowel or spoon.

5. TEST SPECIMEN

5.1. The sample size used for conducting this test will be based on the amount of material remaining after a solvent extraction or ignition oven test has been performed. Unless otherwise indicated, this test will use the entire sample remaining after performing one of the aforementioned tests.

6. PROCEDURE

6.1. Place the entire sample at room temperature into a container. Use a brush to be sure that all of the fine material is transferred into the container. Material which has been allowed to sit for several hours, or has been obtained through solvent extraction, shall be heated in an oven at 125°C ± 5°C (257°F ± 9°F) until it is dried to constant weight. The sample and pan shall be weighed and the weight recorded to the nearest 0.1 gram as W_{Ti}. The weight of the empty container shall be recorded as W_C.

6.2. Cover the sample completely with water. Add a sufficient amount of wetting agent to assure a thorough separation of fine material from the coarser particles. Immediately stir the contents of the container vigorously with a trowel or spoon for approximately 10 to 15 seconds. Allow the material to sit and soak for a total of 5 minutes. Stir the sample once more in the middle of this time period and again at the end of the time period for a total of 3 stirrings.

6.3. At the end of the time period, after the material has been stirred for the final time, immediately pour the wash water through a nest of sieves consisting of a 600-μm (No. 30) sieve nested on a 75-μm (No. 200) sieve. Care should be taken to avoid spilling any of the larger particles onto the sieve nest.

6.4. An additional amount of water should be added to the container to again cover the sample completely. The sample should be immediately stirred and then decanted through the same nest of sieves. The sample should not be allowed to sit and soak. Repeat this rinsing and decanting until the wash water becomes clear.

6.5. Any material which is retained on the nest of sieves shall be carefully washed back into the container. The sample and container shall be placed in an oven at 125°C ± 5°C (257°F ± 9°F) and dried to constant weight. After drying, the material will be removed from the oven and immediately weighed before any moisture can be absorbed. The total weight of the sample and pan is designated as W_{TF}.

7. CALCULATIONS

7.1. Fine Aggregate Wash:

Figure SC-T-76A shows the calculations necessary to compute the total amount of material passing through the 75-μm (No. 200) sieve.

7.2. Mechanical Analysis of Extracted Aggregate:

7.2.1. The aggregate sample shall be introduced into a nested set of sieves corresponding to the required fraction sizes. Be sure to brush all fine material from the container. The sample shall be subjected to mechanical shaking for a period of 15 ± 1 minutes. If the sample size is greater than that allowed for the nest of sieves, the sample shall be split into smaller portions and subjected to shaking separately. When complete, the weight passing a given sieve size for each sample shall be added to each corresponding sieve size. The total amount of material from all sets of sieves shall be used in determining the percent passing each individual sieve.

DESCRIPTION	EQUATION	RESULT
ORIGINAL SAMPLE		
Initial Wt. Sample & Container	W_{Ti}	1645.0
Wt. of Container	W_C	500.0
Initial Sample Wt.	$W_i = W_{Ti} - W_C$	1145.0
MATERIAL DRIED		
Wt. Sample & Container After Drying	W_{Tf}	1635.0
Wt. of Container	W_C	500.0
Final Sample Wt.	$W_f = W_{Tf} - W_C$	1135.0
Total Loss thru 75-μm (No. 200) Sieve	$W_L = W_i - W_f$	10.0

Note: All weights in grams.

AGGREGATE WASH CALCULATIONS
Figure SC-T-76A

7.2.2. Invert the nest of sieves by removing the top size sieve and using it as the bottom. Remove the individual sieves and stack them on top of each until the pan is on top. Begin weighing and recording the amount of material contained in each sieve starting with the pan and proceeding cumulatively to the largest sieve containing material. Record the cumulative weight for the entire sample.

7.3. Mechanical Analysis Calculations:

7.3.1. Add the amount of material washed through the 75-μm (No. 200) sieve (W_L) back to each individual sieve fraction as shown in Figure SC-T-76B. Calculate the percentage of material passing each individual sieve as a portion of the entire sample with the washed material added back. Figure SC-T-76B shows an example of these calculations.

SIEVE SIZE	WT. PASSING	+ W_L	= TOTAL WT. PASSING	TOTAL PASSING %
19.0 mm	1135	10	1145	100.0
12.5 mm	1079	10	1089	95.1
9.5 mm	908	10	918	80.2
4.75 mm	646	10	656	57.3
2.36 mm	443	10	453	39.6
600 μm	261	10	271	23.7
150 μm	136	10	146	12.8
75 μm	85	10	95	8.30

Note: All weight in grams.

EXAMPLE MECHANICAL ANALYSIS CALCULATIONS
Figure SC-T-76B

8. REPORT

8.1. Report the total percent passing of the required sieves. Test results are reported on SCDOT Form 400.03 – Daily Report of Asphalt Plant Inspection. Data and calculations are recorded on SCDOT Form 400.01 – Ignition Oven Worksheet.

Standard Method of Test for

Method of Verification of Hydrated Lime Weighing Systems for Hot-Mix Asphalt

SCDOT Designation: SC-T-78

1. SCOPE

1.1. This method applies to the verification of hydrated lime weighing systems for hot-mix asphalt.

2. SIGNIFICANCE AND USE

2.1. The purpose of this procedure is to check the lime rate to ensure that the lime rate meets SCDOT specifications to prevent asphalt mixtures from stripping.

3. APPARATUS

3.1. Four 50-pound test weights that are certified once a year by an authorized public official or scale servicer. Documentation of weight certifications shall be maintained in the field laboratory.

4. PROCEDURE

4.1. With the weigh pod empty, record the scale indicator reading on Laboratory Form 979.

4.2. Apply all four test weights and record the scale indicator reading. The display reading on the scale indicator is to be within ±20 pounds of the actual weight when the four 50-pound weights (200 pounds) are attached to the empty weigh pod.

4.3. The weigh pod is to be loaded approximately half full with hydrated lime with four 50-pound weights attached. Record the scale indicator reading on Laboratory Form 979 for verification.

4.4. Remove the four 50-pound weights one at a time and record the scale indicator reading on Laboratory Form 979. The scale indicator reading in the control room shall reflect the weight changes to within ±5 pounds of the actual weight on the weigh pod.

5. CALCULATIONS

5.1. When performing the procedures in Section 4, the scale weight is subtracted from the actual calculated weight and its absolute value is compared to the allowable tolerance.

6. REPORT

6.1. The actual weight difference shall be within the allowable tolerance of ±5 pounds for each 50-pound test weight removed. All data must be reported on SCDOT Form 400.03 – Daily Report of Asphalt Plant Inspection and recorded on SCDOT Form 400.14 – Verification of Hydrated Lime Weighing Systems for Hot Mix Asphalt.

Standard Method of Test for

Sampling, Testing, and Approving Hot-Mix Asphalt Silos for Overnight Storage

SCDOT Designation: SC-T-79

1. SCOPE

1.1. This test method covers sampling, testing and acceptance of materials for overnight storage (up to 18 hours maximum) of hot-mix asphalt in identified silos.

2. REFERENCED DOCUMENT

2.1. AASHTO T 170, AASHTO T 202.

2.2. SC-T-62, SC-T-64, Laboratory Form 988.

3. SIGNIFICANCE AND USE

3.1. The purpose of this procedure is to determine whether an asphalt storage silo is letting too much air into the silo allowing the asphalt mixture to oxidize prematurely.

4. APPARATUS

4.1. Round pointed shovel; cloth sample bags; insulated cooler, metal or plastic, of sufficient size for transporting 3 bagged hot-mix asphalt samples; SCDOT security seals.

5. TEST SPECIMEN

5.1. Three bagged and sealed samples of asphalt mix obtained from silo. Minimum sized sample should be in accordance with SC-T-62.

6. PROCEDURE

6.1. With a Department Inspector observing operations, the asphalt storage silo shall be filled with a virgin binder or surface type mix at the end of the production period. No mix with recycled asphalt pavement will be allowed. The asphalt plant shall not add any additional material to the silo until all of the hot mix is discharged and sampled the next day. Asphalt mix stored for testing that meets all the Department's requirements may be used on Department projects upon the discretion of the Engineer.

6.2. The next day, three samples shall be obtained as follows:

6.3. Sample No.1 will be obtained in accordance with SC-T-62 from the first full truck-load discharged from the silo. The sample shall be placed into a cloth sample bag and sealed with a SCDOT security seal by the Department Inspector. The sample bag will be marked as Sample No. 1. Place the sample in the insulated cooler to prevent oxidation.

6.4. Sample No. 2 will be obtained in accordance with SC-T-62 from the truck when the silo is approximately half empty. The sample shall be placed into a cloth sample bag and sealed with a SCDOT security seal by the Department Inspector. The sample bag will be marked as Sample No. 2. Place the sample in the insulated cooler to prevent oxidation.

6.5. Sample No. 3 will be obtained in accordance with SC-T-62 from the truck when the last full load is discharged from the silo. The sample shall be placed into a cloth sample bag and sealed with a SCDOT security seal by the Department Inspector. The sample bag will be marked as Sample No. 3. Place the sample in the insulated cooler to prevent oxidation.

Note that this procedure must be coordinated with the Central Laboratory Liquid Asphalt Testing Supervisor (803-737-6704) to assure proper arrangements have been made for testing. Samples that are not submitted for testing within 1 day of sampling will be discarded and the entire procedure repeated. Mixture information is to be recorded on Laboratory Form 988 by the Inspector and submitted with the samples to the Central Laboratory.

6.6. The sample shall be immediately transferred to the Department's Central Laboratory and tested in accordance with SC-T-64, AASHTO T 170 and AASHTO T 202. The Contractor shall be responsible for transporting samples to the Department's Central Laboratory.

7. REPORT

7.1. The recovered viscosity of any individual sample shall not be greater than 13,000 p. Test results are to be recorded on SCDOT Form 400.08 – Silo Approval Overnight Storage.

Standard Method of Test for

Preparation, Verification and Approval of Asphalt Mix Designs

SCDOT Designation: SC-T-80

1. SCOPE

1.1. This method outlines the procedure for submitting asphalt mix designs to the Research and Materials Laboratory for preparation, verification and approval.

2. REFERENCED DOCUMENT

2.1. AASHTO T 245, AASHTO T 312.

2.2. SC-T-68, SC-T-83, SC-T-82, SC-T-82B, SC-T-88, R&M Laboratory Form 269.

3. APPARATUS

3.1. See SC-T-82 and SC-T-82B for a listing of equipment needed to complete a Marshall / Superpave gyratory mix design. If performing an Open-Graded Friction Course Design, use SC-T-88 in lieu of SC-T-80.

4. TEST SPECIMEN

4.1. A SCDOT-certified HMA Design Technician (Level 2S) must submit the following items for verification of each Mix Design along with the appropriate Form 269 and all Marshall / Gyratory, moisture susceptibility and maximum gravity data. These tests must be performed in an SCDOT-certified mix design laboratory in accordance with SC-T-82 / SC-T-82B.

4.2. Two Dry Marshall / Gyratory specimens, at each point, prepared just above and below optimum binder content. Specimens must be 2.50 inch ± 0.05 inch for Marshall specimens and 115 ± 5 millimeters for gyratory specimens. (e.g., Optimum is set at 4.8%, submit specimens at 4.5% and 5.0%). If optimum binder content is determined to be the same as one of the mix points, then a set of specimens at that point, along with a set 0.5 above or 0.5 below optimum must be submitted. (e.g. Optimum is set at 5.0%, submit specimens at 5.0% and either 4.5% or 5.5%). **Must be different specimens from the Contractor's specimens.**

4.3. One Maximum Theoretical Specific Gravity sample. Usually prepared at highest binder content and made at same batch weight of Marshall cores, not to exceed 2000 grams for gyratory specimens. **Must be different from Contractor's sample.**

4.4. Three blended aggregate samples at Marshall / Gyratory batch weight, for check samples. Samples must be submitted in plastic bags, not mixed with water, or if RAP is being used, RAP must be weighed into separate plastic bags according to the calculated batch weight.

4.5. Six Gyratory 75 ± 1 millimeter specimens meeting compaction criteria of 96 ± 1% air voids (Surface T-1C, Superpave 19.0 mm, and 12.5 mm only). If a gyratory compactor is not accessible, aggregate batches must be submitted so that the Research and Materials Laboratory can make gyratory specimens.

5. PROCEDURE

5.1. These steps will be performed by the Research and Materials Laboratory.

5.2. Determine the Bulk Specific Gravities (BSG) of the Marshall / Gyratory specimens using SC-T-68. The average BSG of each set of cores must compare within 0.020 of the contractor's BSG.

5.3. Perform SC-T-83 to calculate the Maximum Theoretical Specific Gravity (MSG). The Departments test results must compare to the Contractor's MSG within 0.018.

5.4. If either sets of Marshall / Gyratory cores, or the MSG, do not compare, then the Department will use the blended aggregate samples to check specimens. If the specimens still do not compare to the Contractor's tests the contractor will be required to redesign the mix. If the check specimen compares to the Contractor's original specimen, then the original data will be used.

5.5. Moisture susceptibility, stability and other test reports will be reviewed and may be required to be verified.

5.6. Perform rutting susceptibility testing, and make sure the mixtures meet rut depth criteria. (Surface T-1C, Superpave 19.0 mm, and 12.5 mm only).

6. CALCULATIONS

6.1. Calculations will be performed in accordance with AASHTO T-245, AASHTO T-312, SC-T-68 and SC-T-83.

7. REPORT

7.1. The Department will prepare an information sheet with the Contractor's name, plant location and Marshall / Gyratory data, along with approval and expiration dates and other information. The information sheet will be kept on file at the Department and a copy will be sent to the Contractor.

Standard Method of Test for

Inspection and Approval of Asphalt Field Laboratories

SCDOT Designation: SC-T-81

1. SCOPE

1.1. This method covers the inspection and approval process for asphalt plant field laboratories that are used in testing asphalt mixtures. This method is not a safety inspection. The Contractor shall be responsible for maintaining the safety requirements for the asphalt field laboratories.

2. REFERENCED DOCUMENT

2.1. AASHTO T 245.

2.2. SC-T-66, SC-T-68, SC-T-75, SC-T-83.

3. SIGNIFICANCE AND USE

3.1. The purpose of this procedure is to ensure Contractor field laboratories have all of the necessary equipment for testing asphalt mixtures, and the supplied equipment is properly calibrated to ensure the accuracy of testing materials.

4. APPARATUS

4.1. See Attachment SC-T-81.

5. PROCEDURE

5.1. Asphalt field laboratories must have all the required equipment listed on the asphalt field laboratory checklist (see Attachment SC-T-81) and meet all requirements as specified in the *Standard Specifications* and any Supplemental Specifications. It is the Contractor's responsibility to notify the Bituminous Engineer when their laboratory is ready for initial or annual inspection.

5.2. A representative of the Bituminous Materials Engineer will perform an inspection and verify that the laboratory complies with *Standard Specifications* and Attachment SC-T-81.

5.3. The required field laboratory equipment must be calibrated on an annual basis. All calibrations of equipment must be available upon request, and records must be kept at the field laboratory. The calibrations will require a calibrated manometer, micrometer and thermometers.

5.4. Upon meeting all requirements for approval, an annual approval decal will be placed at a suitable location inside the field laboratory. If at anytime all requirements are not met, the approval will be revoked.

6. REPORT

6.1. For reporting purposes, use Research and Materials Laboratory Form 981 (Checklist for Annual Field Lab Certification).

Attachment SC–T-81

I. CONTRACTOR INFORMATION:

Asphalt Contractor:_____ Plant Location:_____

Contractor's Representative:_____

Date Inspected: _____ Inspected By:_____

Next Inspection Due Date:_____ District:_____

NOTE: This checklist is used only as a guide for inspection. The requirements of the *Standard Specifications* and applicable Supplemental Specifications will govern any conflicts with the items listed.

II. LAB STRUCTURE

1. Size and Type of Structure:

   Floor Space: _____ Height: _____

   Type of Structure:_____

		Yes	No
2.	Is the plant in full view and close proximity from one of the windows of the laboratory?	☐	☐
3.	Is sufficient water available for all tests	☐	☐
4.	Is sufficient and satisfactory furniture for office work provided?	☐	☐
5.	Are satisfactory electric lighting and electric outlets provided?	☐	☐
6.	Are suitable worktables and/or benches provided?	☐	☐
7.	Are locks provided for the windows and doors?	☐	☐
8.	Is the field laboratory equipped so that the temperature inside the laboratory can be maintained between 65°F – 80°F?	☐	☐

III. EQUIPMENT

1.	Ignition oven meeting requirements of SC-T-75.	☐	☐
2	Complete Marshall Apparatus:	☐	☐
	a. automatic compaction hammer.	☐	☐
	b. four (4) compaction molds.	☐	☐
	c. compaction mold holder.	☐	☐

III. EQUIPMENT (continued)		Yes	No
d.	Marshall compression and testing machine.	☐	☐
e.	Marshall specimen protection paper disc No. 4.	☐	☐
f.	hot plate.	☐	☐
g.	sand bath for Marshall hammer.	☐	☐
h.	garden spade minimum 2″ wide.	☐	☐
i.	flat spade ¾″ wide and 6″ in length.	☐	☐
j.	extractor jack assembly – hydraulic type to extrude Marshall specimens.	☐	☐
3.	Marshall water bath capable of maintaining a constant temperature of 140°F ± 1.8°F (60°C ± 1°C) throughout the entire volume of the bath. Water bath should meet testing standards specified in SC-T-66.	☐	☐
4.	Marshall water bath equipped with a water circulator capable of maintaining a constant temperature of 77°F ± 1.8°F (25°C ± 1°C) throughout the entire volume of the bath. Water bath should meet the testing standards specified in SC-T-68.	☐	☐
5.	Maximum Gravity Equipment (see SC-T-83):	☐	☐
a.	Vacuum pump capable of pulling a vacuum of 27 mm Hg absolute pressure continuously throughout the test.	☐	☐
b.	Metal container or a volumetric metal flask having a capacity of at least 1000 mL. The container must have a cover fitted with a rubber gasket and a hose connection. The hose opening shall be covered with a small piece of No. 200 wire mesh to minimize the possibility of loss of fine material. Gauge or manometer installed in line to monitor vacuum. Kraft brown paper for preparation of sample approximately 3′ x 3′.	☐	☐
c.	Gauge or manometer installed in line to monitor vacuum.	☐	☐
d.	Kraft brown paper for preparation of sample approximately 3′ x 3′.	☐	☐
6.	Masonry saw equipped with a diamond tip blade and water cooling system. The masonry saw shall be capable of slicing a 6″ diameter core in one pass without disturbing the structure of the core.	☐	☐
7.	Double-walled convection laboratory oven with an inside volume of at least 2.5 ft^3. This oven should be capable of maintaining a temperature of 230°F ± 9°F (110°C ± 4.4°C).	☐	☐
8.	Fax machine and telephone for use by the Inspector.	☐	☐

III.	EQUIPMENT (continued)	Yes	No
9.	Double-walled thermostatic controlled forced air laboratory oven with a minimum inside volume of 5.0 ft^3. This oven should be capable of maintaining a temperature of 295°F ± 5°F (146°C ± 2.5°C).	☐	☐
10.	Sample quartering table of minimum size 3′ x 3′ and accessible from at least two sides.	☐	☐
11.	Two (2) buckets of adequate size (approximately 5 gallons) for sampling asphalt mix from the truck	☐	☐
12.	One (1) large mason trowel.	☐	☐
13.	Sample splitter with a minimum of eight chutes 2″ wide with a minimum of three (3) splitter pans.	☐	☐
14.	Motor driven large shaker complete with screens of suitable sizes.	☐	☐
15.	Sieves required for the large shaker: 2″, 1½″, 1″, ¾″, ½″, No. 4, No. 8 and bottom pan.	☐	☐
16.	One (1) milk scale having a maximum capacity of at least 30 pounds and graduated in 0.1-pound increments, for lime rate determination, or equivalent.	☐	☐
17.	8″ sieve shaker (e.g., Ro-Tap design or approval equivalent with a tapping device).	☐	☐
18.	Sieves required for the 8′ shaker: 1″, ¾″, ½″, 3/8″, No. 4, No. 8, No, 30, No. 100 bottom pan and two (2) No. 200 sieves.	☐	☐
19.	Two (2) 12K electronic balances accurate to 0.1 grams.	☐	☐
20.	Five (5) dial thermometers (50°F to 400°F) for Plant and Road Inspectors	☐	☐
21.	One (1) 140°F (60°C) mercury thermometer (graduated to nearest 0.1 degree).	☐	☐
22.	One (1) 77°F (25°C) mercury thermometer (graduated to nearest 0.1 degree).	☐	☐
23.	Two (2) weather thermometers.	☐	☐
24.	One (1) crucible tong.	☐	☐
25.	One (1) stencil brush.	☐	☐
26.	One (1) brass wire brush.	☐	☐

III.	EQUIPMENT (continued)	Yes	No
27.	One (1) wash No. 200 pan (e.g., enamel pan 3″ deep x 9″ diameter).	☐	☐
28.	Wetting/disbursing agent (e.g., Calgon, but not Calgon with oil beads).	☐	☐
29.	Penetrating oil.	☐	☐
30.	Adequate supply of rubber gloves.	☐	☐
31.	Two (2) pairs of work gloves (one pair regular and one pair insulated for high temperatures).	☐	☐
32.	Paper towels.	☐	☐
33.	Hand lotion with lanolin.	☐	☐
34.	Cloth towel (water absorbing for Marshall specimens).	☐	☐

IV.	CALIBRATION RECORDS		
1.	Ignition oven calibrations for individual job mixes posted or field in the field laboratory?	☐	☐
2.	Ignition oven calibration performed on a monthly basis?	☐	☐
3.	Mercury thermometers calibrated?	☐	☐
4.	Records on other type thermometers calibrated (digital or dial)?	☐	☐
5.	Marshall hammer calibrated to handheld hammer?	☐	☐
6.	Marshall hammer calibration records available in the field laboratory?	☐	☐
7.	Manometer for verifying vacuum gauge?	☐	☐

V. REMARKS:

Standard Method of Test for

Determination of Maximum Theoretical Specific Gravity

SCDOT Designation: SC-T-83

1. SCOPE

1.1. This method covers the determination of the maximum specific gravity of uncompacted bituminous paving mixtures.

2. REFERENCED DOCUMENT

2.1. AASHTO C 168, SC-T-80.

3. SIGNIFICANCE AND USE

3.1. The purpose of this procedure is to determine the maximum compacted state of a loose asphalt mixture. This value is used to determine the percent air voids in compacted asphalt mixtures.

4. APPARATUS

4.1. *Balance* — 12 K electronic balance with a suitable suspension apparatus. Suspension wire should be the smallest practical size to minimize any possible effects of a variable immersed length.

4.2. *Metal Container or Volumetric Metal Flask* — having a capacity of at least 1000 mL. The container must have a cover fitted with a rubber gasket and a hose connection. The hose opening shall be covered with a small piece of No. 200 wire mesh to minimize the possibility of loss of fine material.

4.3. *Thermometer* — calibrated liquid-in-glass, total immersion type, 77°F mercury thermometer with gradations at every 0.2°F minimum.

4.4. *Vacuum Pump* — capable of pulling a vacuum of 27 mm Hg absolute pressure continuously for at least 15 minutes. The assembly shall have a calibrated gauge or a manometer to show actual pressure.

4.5. *Water Bath* — capable of maintaining a constant temperature of 77°F ± 1.8°F (25°C ± 1°C) throughout the entire area of the bath. The bath shall have a method of continuously circulating the water and controlling water temperature.

5. TEST SPECIMEN

5.1. For field testing, the sample should be obtained in accordance with AASHTO T 168, “Sampling Bituminous Paving Mixtures.” The size will be governed by the nominal maximum aggregate size of the mixture and conform to Figure SC-T-83A.

NOMINAL MAXIMUM SIZE OF AGGREGATE * (sieve size)	MINIMUM MASS OF SAMPLE (kilograms)
25.0 mm (1 inch)	2.5
19.0 mm (¾ inch)	2.0
12.5 mm (½ inch)	1.5
9.5 mm (⅜ inch)	1.0
4.75 mm (No. 4)	0.5

** Note: The Nominal Maximum Aggregate Size is defined as one sieve size larger than the first sieve to retain more than 10%.*

NOMINAL AGGREGATE SIZE
Figure SC-T-83A

For laboratory testing, weigh and mix the maximum theoretical specific gravity samples as per SC-T-80.

6. PROCEDURE

6.1. Before obtaining the sample, determine which metal container will be used and obtain a dry weight (A) to the nearest 0.1 gram. Submerge the container in the 77°F water bath for 10 minutes and record the submerged weight (D) to the nearest 0.1 gram. Thoroughly dry the container when finished weighing.

6.2. Separate the particles of the sample, taking care not to fracture the mineral particles, so that the particles of fine aggregate portion are not larger than 6.5 mm (¼ inch). If needed, slightly heat the material in a flat pan to ensure separation.

6.3. Cool the samples to room temperature and place them in the metal container. Determine the mass of the sample and the metal container (B) to the nearest 0.1 gram.

6.4. Add sufficient 77°F ± 1.8°F (25°C ± 1°C) potable water to cover the sample. To aid in the release of entrapped air, add a suitable wetting agent such as Aerosol OT in a concentration of 0.01 percent.

6.5. Remove the entrapped air by subjecting the contents to a vacuum of at least 27 mm Hg absolute pressure continuously for 15 ± 2 minutes. Agitate the container and contents by using a mechanical device or vigorous shaking manually at minimum intervals of 2 minutes.

6.6. Suspend the container and sample in water at 77°F ± 1.8°F (25°C ± 1°C) and record its mass (E) to the nearest 0.1 gram after 10 ± 1 minutes.

7. CALCULATIONS

7.1. A = weight of container
B = weight of sample and container
C = weight of sample
D = weight of sample and container in water
E = weight of container in water
F = weight of submerged sample
$MSG_{Theoretical}$ = Maximum theoretical specific gravity

7.2. C = B – A

7.3. F = D – E

7.4. $$MSG_{Theoretical} = \frac{C}{(C - F)}$$

8. REPORT

8.1. Record $MSG_{Theoretical}$ to the nearest 0.001, which will be used in the calculation of the %Air Voids after the Bulk Specific Gravity is obtained. Data and calculations are recorded on Research and Materials Laboratory Form 409 and reported on Form 416, Form 910 or Form 969 (Plant Report).

Standard Method of Test for

Determination of Temperatures During Hot-Mix Asphalt Production

SCDOT Designation: SC-T-84

1. SCOPE

1.1. This method covers the determination of hot asphalt mixture temperature in the delivery trucks, the hot mat during compaction, the existing roadway surface and the ambient air.

2. SIGNIFICANCE AND USE

2.1. The purpose of this procedure is to ensure that asphalt mixtures meet temperature requirements in the SCDOT specifications and to eliminate any mix that is overheated or under-heated that may hinder the overall performance of the mixture.

3. APPARATUS

3.1. All thermometers must have records of calibration and shall be verified at a minimum of two (2) times a year. Calibration can be checked at the R&M Laboratory.

3.2. Calibrated dial thermometer with temperature ranges from 50°F to 400°F (10°C to 205°C).

3.3. Hand-held infrared non-contact thermometer with temperature ranges from 0°F to 1000°F (-18°C to 538°C).

3.4. Glass weather thermometers.

4. PROCEDURE

4.1. Asphalt Mixture in a Truck:

4.1.1. The temperature of asphalt mixtures in trucks shall be checked in a suitable location with a calibrated dial thermometer. The thermometer will be inserted into a hole located on each side of the truck bed. The hole should be located approximately 4 feet from the front of the truck bed and approximately 18 inches from the bottom of the truck bed. The thermometer shall be placed into the hole as deep as possible and remain there until the temperature reading stabilizes. Record this temperature reading as the mix temperature in the truck.

4.2. Existing Roadway:

4.2.1. The existing roadway temperature shall be checked with a handheld infrared non-contact thermometer in the shade (if available) at approximately 3 feet above the existing roadway in at least 5 random locations. These five random readings are to be averaged and recorded as the existing roadway temperature.

4.3. Asphalt Mat During Production:

4.3.1. The temperature of the hot mat shall be accomplished by either a handheld non-contact infrared thermometer held approximately 3 feet above the hot asphalt mat or by a calibrated dial thermometer inserted into the mat for a minimum of 5 random readings. These readings are to be averaged and recorded as the asphalt mat temperature.

4.4. Ambient Temperature:

4.4.1. The ambient temperature will be measured in the shade (if available) with a calibrated mercury thermometer. The reading will be measured until the reading stabilizes and recorded.

5. REPORT

5.1. Report the temperature of the mix inside the truck, on the roadway and the ambient temperature wherever required. Report data on SCDOT Form 400.04 – Daily Report of Asphalt Roadway Inspection.

Standard Method of Test for

Determination of Asphalt Mixture Roadway Placement Rate

SCDOT Designation: SC-T-85

1. SCOPE

1.1. This method covers the necessary calculations for calculating the rate of spread of hot-mix asphalt in pounds per square yard by using the asphalt truck delivery tickets. This method utilizes standard units of measure, however, the general procedure can be easily modified to calculate metric quantities.

2. SIGNIFICANCE AND USE

2.1. The purpose of this procedure is to ensure that the proper amount of asphalt mixture is applied to the roadway according to project requirements.

3. APPARATUS

3.1. Calibrated tape measure capable of measuring entire width of roadway being paved

4. PROCEDURE

4.1. Determine the length of roadway being surfaced using station numbers (i.e., feet or meters).

4.2. Measure the width of pavement placed (i.e., feet or meters).

4.3. Determine the area measured (i.e., square feet or square meters).

4.4. Calculate the weight of the mix placed in a section by totaling the amount of mix used from the asphalt truck delivery tickets (i.e., pounds or kilograms).

4.5. Divide the placement area into the weight of mix placed in the roadway section.

5. CALCULATIONS

5.1. Calculate the mix rate (i.e., pounds per square yard or kilograms per square meter).

5.2. Determine the length of roadway section by calculating the distance based on the established station numbers as follows:

Ending Station	14 + 75
– Beginning Station	–12 + 50
	2 + 25

Convert the station numbers to feet or meters: 2 + 25 times 100 = 225 linear feet.

5.3. Determine the area of the roadway section. Multiply the length of the section by the width of placement and convert this value to square yards or square meters, as needed.

Example: (225 feet x 10 feet) X [1 square yard/9 square feet] = 250 square yards

5.4. Based on the delivery tickets, determine the total weight of asphalt mix applied to the section (convert to tons, tonnes or kilograms as needed).

Example: 12.5 tons = 25,000 pounds of asphalt mix placed in this test section.

5.5. Calculate the placement rate by dividing the weight of asphalt mix placed by the area of the section.

Example: 25,000 pounds ÷ 250 square yards = 100 pounds per square yard.

6. REPORT

6.1. Actual rate in pounds per square yard or kilogram per square meter on SCDOT Form 400.04 – Daily Report of Asphalt Roadway Inspection.

Standard Method of Test for

Determination of Asphalt Tack Coat Roadway Placement Rate

SCDOT Designation: SC-T-86

1. SCOPE

1.1. This method describes how to determine liquid asphalt tack rate for emulsified asphalt products and is based on the use of a temperature-volume correction. Two methods are described. One method is based on the residual asphalt content, and the other is not. Note that these two methods are mutually exclusive. Ensure that the proper method is used as specified in the Standard Specifications for the particular Contract pay item under scrutiny.

2. REFERENCED DOCUMENT

2.1. Figure SC-T-86A, Temperature-Volume Corrections for Emulsified Asphalts.

3. SUMMARY OF TEST METHOD

3.1. The road surface to be covered is measured, the flow meter on the distribution tank is checked before and after application and the temperature of the tack in the distribution tank is recorded. The rate of application is determined for the quantity of tack used based on the temperature-volume correction for emulsified asphalt and the method specified for the Contract pay item (i.e., with or without consideration of residual asphalt content).

4. SIGNIFICANCE AND USE

4.1. The asphalt tack is used to bond layers of asphalt mixture together and to prevent slippage. The purpose of this procedure is to ensure that the tack application rate is in accordance with the Contract specifications.

5. APPARATUS

5.1. Calculator.

6. TEST SPECIMEN

6.1. None.

7. PROCEDURE

7.1. *Determine Area Covered* — Measure the longitudinal length and the transverse width of the roadway surface to be treated (i.e., feet or meters). Use pavement markings, surveys, a tape measure or other measuring device, as needed, to obtain these distances. Calculate the area (i.e., either square yards or square meters) of the roadway surface to be treated (i.e., length x width).

7.2. *Determine Quantity Used* — Determine the quantity (i.e., liters or gallons) of tack used. This is performed based on initial and final readings of the flow meter attached to the tack distributor. Take a reading before the tack is sprayed and a reading after the tack is sprayed. The absolute value of the difference in the readings will be the quantity of tack sprayed over the roadway surface.

7.3. *Measure Temperature for Volume Correction* — Measure the temperature of the tack in the distributor tank at the time it was sprayed on the roadway surface. This temperature will be used in conjunction with Figure SC-T-86A to obtain a temperature-volume multiplier, which will be used to adjust the volume of the quantity of used.

8. CALCULATIONS

8.1. *Adjust Volume of Tack Used* — Prior to calculating tack rate, it is important to understand that the quantity of tack used (i.e., its volume as determined in Step 7.2.) must be adjusted based on the temperature of the tack in the distribution tank, as determined in Step 7.3. Use Figure SC-T-86A to obtain the temperature-volume correction multiplier, and adjust the volume quantity used.

8.2. *Determine Tack Rate* — Tack rate (i.e., gallons per square yard or liters per square meter) is based on the adjusted volume of tack used (see Step 8.1) and the roadway area actually treated (see Step 7.1). The method used to calculate the tack rate may or may not require consideration of the residual asphalt content (see Section 1.1).

8.3. Example Calculations:

8.4. Method A – Without Residual Asphalt Content – Example for CSS-1 Tack:

8.4.1. Determine Area Covered (See Step 7.1):

Width of Coverage (W)	=	12 feet
Length of Coverage (L)	=	4765 feet
Area of Coverage ($A_{Coverage}$)	=	L x W
	=	12 x 4765 = 57,180 ft² = 6353.3 yd²

8.4.2. Determine Quantity Used (See Step 7.2):

Beginning Flow Meter Reading (Q_B)	=	123 gallons
Ending Flow Meter Reading (Q_E)	=	478 gallons
Total Quantity Tack Used (Q_{Total})	=	$Q_E - Q_B$ = 478 – 123 = 355 gallons

8.4.3. Adjust Volume of Tack Used (See Step 8.1):

Temperature of Tack in Distributor Tank	=	150°F (determined from Step 7.3)
Temperature-Volume Multiplier (M_{TV})	=	0.97750 (see Figure SC-T-86A)
Adjusted Tack Quantity (Q_{ADJ})	=	Q_{Total} x M_{TV}
	=	355 x 0.97750 = 347.0 gallons

8.4.4. Determine Tack Rate (See Step 8.2):

Tack Rate (R_{Tack}) = $Q_{ADJ} / A_{Coverage}$
= 347.0 / 6353.3 = 0.055 gal/yd²

8.5. Method B – With Residual Asphalt Content – Example using CRS-2 Tack:

8.5.1. Determine Area Covered (See Step 7.1):

Width of Coverage (W) = 10 feet
Length of Coverage (L) = 3000 feet
Area of Coverage ($A_{Coverage}$) = L x W
= 10 x 3000 = 30,000 ft² = 3333.3 yd²

8.5.2. Determine Quantity Used (See Step 7.2):

Beginning Flow Meter Reading (Q_B) = 120 gallons
Ending Flow Meter Reading (Q_E) = 500 gallons
Total Quantity Tack Used (Q_{Total}) = $Q_E – Q_B$
= 500 – 120 = 380 gallons

8.5.3. Adjust Volume of Tack Used (See Step 8.1):

Temperature of Tack in Distributor Tank = 122°F (determined from Step 7.3)
Temperature-Volume Multiplier (M_{TV}) = 0.98450 (see Figure SC-T-86A)
Adjusted Tack Quantity (Q_{ADJ}) = Q_{Total} x M_{TV}
= 380 x 0.98450 = 374.1 gallons

8.5.4. Determine Tack Rate (See Step 8.2):

Tack Rate (R_{Tack}) = $Q_{ADJ} / A_{Coverage}$
= 374.1 / 3333.3 = 0.1122 gal/yd²

8.5.5. Determine Residual Tack Rate:

Percent Residual Asphalt (P_{RA}) = 0.58 (submitted by supplier as 58%)
Residual Tack Rate ($R_{Residual}$) = R_{Tack} x P_{RA}
= 0.1122 x 0.58 = 0.065 gal/yd²

9. REPORT

9.1. Report the corrected rate of tack placed on the SCDOT Form 400.04 – Daily Report of Asphalt Roadway Inspection.

°C	°F	M	°C	°F	M	°C	°F	M
10.0	50	1.00250	35.0	95	0.99125	57.8	136	0.98100
10.6	51	1.00225	35.6	96	0.99100	58.3	137	0.98075
11.1	52	1.00200	36.1	97	0.99075	58.9	138	0.98050
11.7	53	1.00175	36.7	98	0.99050	59.4	139	0.98025
12.2	54	1.00150	37.2	99	0.99025	60.0	140	0.98000
12.8	55	1.00125	37.8	100	0.99000	60.6	141	0.97975
13.3	56	1.00100	38.3	101	0.98975	61.1	142	0.97950
13.9	57	1.00075	38.9	102	0.98950	61.7	143	0.97925
14.4	58	1.00050	39.4	103	0.98925	62.2	144	0.97900
15.0	59	1.00025	40.0	104	0.98900	62.8	145	0.97875
15.6	60	1.00000	40.6	105	0.98875	63.3	146	0.97850
16.1	61	0.99975	41.1	106	0.98850	63.9	147	0.97825
16.7	62	0.99950	41.7	107	0.98825	64.4	148	0.97800
17.2	63	0.99925	42.2	108	0.98800	65.0	149	0.97775
17.8	64	0.99900	42.8	109	0.98775	65.6	150	0.97750
18.3	65	0.99875	43.3	110	0.98750	66.1	151	0.97725
18.9	66	0.99850	43.9	111	0.98725	66.7	152	0.97700
19.4	67	0.99825	44.4	112	0.98700	67.2	153	0.97675
20.0	68	0.99800	45.0	113	0.98675	67.8	154	0.97650
20.6	69	0.99775	45.6	114	0.98650	68.3	155	0.97625
21.1	70	0.99750	46.1	115	0.98625	68.9	156	0.97600
21.7	71	0.99725	46.7	116	0.98600	69.4	157	0.97575
22.2	72	0.99700	47.2	117	0.98575	70.0	158	0.97550
22.8	73	0.99675	47.8	118	0.98550	70.6	159	0.97525
23.3	74	0.99650	48.3	119	0.98525	71.1	160	0.97500
23.9	75	0.99625	48.9	120	0.98500	71.7	161	0.97475
24.4	76	0.99600	49.4	121	0.98475	72.2	162	0.97450
25.0	77	0.99575	50.0	122	0.98450	72.8	163	0.97425
25.6	78	0.99550	50.6	123	0.98425	73.3	164	0.97400
26.1	79	0.99525	51.1	124	0.98400	73.9	165	0.97375
26.7	80	0.99500	51.7	125	0.98375	74.4	166	0.97350
27.2	81	0.99475	52.2	126	0.98350	75.0	167	0.97325
27.8	82	0.99450	52.8	127	0.98325	75.6	168	0.97300
28.3	83	0.99425	53.3	128	0.98300	76.1	169	9.97275
28.9	84	0.99400	53.9	129	0.98275	76.7	170	0.97250
29.4	85	0.99375	54.4	130	0.98250	77.2	171	0.97225
30.0	86	0.99350	55.0	131	0.98225	77.8	172	0.97200
30.6	87	0.99325	55.6	132	0.98200	78.3	173	0.97175
31.1	88	0.99300	56.1	133	0.98175	78.9	174	0.97150
31.7	89	0.99275	56.7	134	0.98150	79.4	175	0.97125
32.2	90	0.99250	57.2	135	0.98125			
32.8	91	0.99225						
33.3	92	0.99200						
33.9	93	0.99175						
34.4	94	0.99150						

Note: M = Multiplier for correcting volumes to the basis of 15.6°C (60°F).

TEMPERATURE-VOLUME CORRECTIONS FOR EMULSIFIED ASPHALTS
Figure SC-T-86A

Standard Method of Test for

Method of Determining Asphalt Pavement Compaction Using Maximum Specific Gravity

SCDOT Designation: SC-T-87

1. SCOPE

1.1. This method applies to situations where the asphalt roadway compaction is to be determined as a percentage of the asphalt mixture's daily maximum specific gravity. The Maximum Specific Gravity is often referred to as the Maximum Theoretical Specific Gravity, the Maximum Rice Specific Gravity or MSG.

2. REFERENCE DOCUMENT

2.1. SC-T-68, SC-T-100, SC-T-101.

3. SIGNIFICANCE AND USE

3.1. The purpose of this procedure is to ensure that the proper amount of field compaction is achieved according to SCDOT specifications.

4. APPARATUS

4.1. Diamond-bit 150-millimeter (6-inch) circular drill, water cooled; circular saw to cut roadway core into layers; see equipment list in SC-T-68 for density determination.

5. TEST SPECIMEN

5.1. 150-millimeter (6-inch) diameter roadway core obtained from the freshly paved layer of asphalt. Each core will be well marked to identify the location from which it was obtained.

6. PROCEDURE

6.1. Determine the average daily maximum specific gravity (MSG) of the asphalt mixture based on the job mix effective specific gravity (ESG), the asphalt binder specific gravity from the job mix and the average daily asphalt binder content. Compare this value with the bulk specific gravity of each core to determine the percent roadway compaction. Using SC-T-100, SC-T-101, determine the random location of the roadway cores based on the day's production and number of samples required.

6.2. Obtain an undamaged[(1)] roadway core from each of the locations identified using SC-T-100, SC-T-101. These locations should be clearly marked for future reference. The drill is to cut into the pavement to the full depth of asphalt, and the top layer removed with a circular saw. In no case should a screwdriver or other sharp device be used to pry the top layer from the existing roadway. The use of a screwdriver may damage the core and result in inaccurate density readings. If the roadway is too hot to obtain a core, a small amount of dry ice may be placed over the location to assist with the cooling. Bagged ice may be used in lieu of dry ice, provided the ice is not removed from the bag.

[1] *Note: Any cores that are damaged shall not be used in this procedure. If it is determined that a core is damaged while drilling, then another core will be taken within a 600-millimeter (2-foot) radius of the damaged core location. The original core will be marked and discarded.*

6.3. Carefully transport the core samples to the laboratory for testing. At all times the cores are to be kept at ambient temperature and shall remain dry. In no case will the cores be submerged in ice or in water.

6.4. At the laboratory, the cores are to remain at ambient temperature until they are dried to a constant weight. A fan may be used to provide some additional air-drying. In no case will the cores be placed in an oven at a temperature outside the range of 25°C ± 1°C (77°F ± 2°F).

6.5. When the cores have reached constant weight, they shall be individually weighed in air, weighed submerged in water and weighed in a saturated surface-dry (SSD) condition. This weighing procedure shall follow the procedure listed in SC-T-68 for weighing and recording the core sample weights.

7. CALCULATIONS

7.1. Calculate the Average Daily Maximum Specific Gravity (MSG) (see SC-T-68):

$$MSG = \frac{100}{(F/G) + ((100 - F)/ESG)}$$

where: F = Average Daily %Asphalt Binder (from ignition oven or solvent extractions)

G = Specific Gravity of Binder (from job mix information sheet)

ESG = Effective Specific Gravity (from job mix information sheet)

7.2. Calculate the Individual Core Bulk Specific Gravity (BSG) (see SC-T-68):

$$\text{Bulk Specific Gravity} = \frac{A}{(B - C)}$$

where: A = mass (grams) of specimen in air
B = mass (grams) of specimen SSD in air
C = mass (grams) of specimen in water

7.3. Determine the Individual Roadway Core Percent Compaction (%Compaction):

$$\%Compation = \left(\frac{BSG}{MSG}\right) \text{ x } 100$$

where: %Compaction = individual roadway core percent compaction
BSG = individual roadway core bulk specific gravity
MSG = average daily maximum specific gravity

7.4. Calculate the average daily roadway compaction. The average daily roadway compaction shall be the average of the individual core compactions.

7.5. Example Calculations:

7.5.1. Five cores were obtained from random locations (using SC-T-100, SC-T-101) on the roadway. The cores were taken to the field laboratory and weighed in air, under water and in SSD condition (see SC-T-68). The bulk specific gravity (BSG) was computed for each core as shown in Figure SC-T-87A.

CORE	WT. AIR	WT. WATER	WT. SSD	BSG
1	632.1	366.1	633.1	2.367
2	655.3	379.4	657.2	2.359
3	648.9	376.0	650.7	2.362
4	630.2	365.3	631.4	2.368
5	650.7	375.2	651.6	2.354

Note: All weights in grams.

BULK SPECIFIC GRAVITY OF CORES
Figure SC-T-87A

7.5.2. There were 4 extraction tests performed that day with the asphalt binder content results shown in Figure SC-T-87B. The average daily binder content was also calculated.

SAMPLE	BINDER CONTENT (%)
1	4.43
2	4.32
3	4.21
4	4.38
Average	4.34

AVERAGE DAILY BINDER CONTENT
Figure SC-T-87B

7.5.3. Using mix properties from the job mix information sheet (i.e., aggregate ESG = 2.647, asphalt binder specific gravity = 1.030), the daily average MSG was calculated as follows:

$$MSG = \frac{100}{(4.34/1.030) + ((100 - 4.34)/2.647)} = 2.480$$

7.5.4. The individual and average compaction were determined for the cores as shown in Figure SC-T-87C.

Core	BSG	%COMPACTION (BSG/MSG) x 100
1	2.367	95.5
2	2.359	95.2
3	2.362	95.3
4	2.368	95.6
5	2.354	95.0
Average		95.3

INDIVIDUAL AND AVERAGE COMPACTION FOR CORES
Figure SC-T-87C

8. REPORT

8.1. Report individual roadway core percent compaction and average roadway core percent compaction on SCDOT Form 400.16 – In-Place Density Contractor QA.

Standard Method of Test for

Wash Method for Determining Gradation of HMA Mixtures

SCDOT Designation: SC-T-92

1. SCOPE

1.1. This method is used to determine the gradation of the aggregate from a hot-mix asphalt (HMA) sample when the asphalt content of the mixture has been determined by SC-T-75.

2. REFERENCED DOCUMENT

2.1. AASHTO M 231, AASHTO T 27, AASHTO R 18.

2.2. SC-T-62, SC-T-72, SC-T-75, SC-T-100.

3. SIGNIFICANCE AND USE

3.1. The purpose of this procedure is to determine the aggregate gradation of an asphalt mixture in field applications. This procedure is often used to prevent aggregate breakdown of asphalt mixtures and to ensure that the gradations meet job mix specifications.

4. APPARATUS

4.1. *Balance* — sufficient capacity and sensitivity to 0.1 grams (see AASHTO M-231).

4.2. *Solvent* — shall be a biodegradable, nontoxic asphaltic extracting solvent.

4.3. *Oven* — capable of maintaining 135°C ± 5°C.

4.4. *Hot Plate or Oven* — capable of maintaining 110°C ± 5°C.

4.5. *Sieves and Shaker* — to conduct gradation analysis.

4.6. *Miscellaneous Equipment* — pans with dimensions 305L x 203W x 76D millimeters (12L x 8W x 3D inches) or bowls with the capacity of approximately 9.5 liters (10 quarts), spatula for stirring sample and sieve brushes.

5. TEST SPECIMEN

5.1. Obtain a representative sample of the bituminous mixture to yield a minimum sample size after quartering as shown in Figure SC-T-92A.

6. PROCEDURE

6.1. Obtain a representative sample of the mixture using SC-T-62, and reduce the HMA sample to testing size using SC-T-72. See Figure SC-T-92A for the minimum sample

size. The correct sample size is determined by the nominal maximum sieve size of the HMA mixture.

NOMINAL MAXIMUM AGGREGATE SIZE (sieve size)	MINIMUM MASS OF SAMPLE (grams)
4.75 mm (No. 4)	1000
9.5 mm ($^3/_8$ inch)	1100
12.5 mm (½ inch)	1250
19.0 mm (¾ inch)	1500
25.0 mm (1.0 inch)	3000
37.5 mm (1.5 inch)	4000

SAMPLE SIZE
Figure SC-T-92A

6.2. Dry the sample for 15 to 30 minutes in an oven at 125°C ± 5°C (257°F ± 9°F) and weigh to the nearest 0.1 gram. RAP stockpile samples shall be heated until dry, approximately 30 to 60 minutes.

6.3. Determine the percent asphalt binder being added to the mixture at the time that the sample was obtained from the results of the ignition oven using SC-T-75.

6.4. Place the mixture in the pan, pail or bowl and cover with solvent. Gently agitate the sample frequently with a spatula. Continue this process for 15 to 30 minutes for plant produced mixtures and 30 to 60 minutes for RAP stockpile samples.

6.5. Decant the solvent, pouring over a 2.36-mm (No. 8) sieve nested over a 75-μm (No. 200) sieve. Dispose of the solvent according to the products MSDS. Add water, agitate and decant over the same sieves. Continue washing with water until the wash water is clear. Material retained on either of the sieves shall be washed back into the sample. Decant off any excess water. Care should be taken to avoid the loss of particles.

6.6. Dry the sample to a constant weight in an oven or on a hot plate at 125°C ± 5°C (257°F ± 9°F). Stir occasionally to avoid excessive temperature in the drying process.

6.7. Conduct a gradation test on the aggregate in accordance with AASHTO T 27.

7. CALCULATIONS

7.1. Calculate the total dry weight of the aggregate (W_{agg}) as follows:

$$W_{agg} = (W_{mix}) \times \left[1 - \frac{\%Binder}{100}\right]$$

where: W_{agg} = total dry weight of the aggregate before wash (grams)
W_{mix} = total dry weight of the HMA mixture (grams)
%Binder = percent asphalt binder determined by SC-T-75

Calculations for the corrected %AC and aggregate wash are shown in Figure SC-T-92B and Figure SC-T-92C, respectively.

DESCRIPTION	UNIT/EQUATION	RESULT
Calibration Factor	C_F	0.11
Test Temperature	T (°C)	538
Temperature Compensation Factor	T_{CF} (1)	0.21
Wt. Basket	W_b	3611.5
Wt. Basket + Sample	W_T	5056.8
Wt. Sample (Initial)	$W_i = W_T - W_b$	1445.3
Wt. Sample (Final)	W_f	1370.4
Uncorrected %AC	$\%AC_{UNCORR} = [(W_i - W_f)/W_i] \times 100\%$	5.18
Corrected %AC	$\%AC_{CORR} = \%AC_{UNCORRECTED} + C_F + T_{CF}$ (1)	5.50

Notes:
1. *Use T_{CF} only if needed.*
2. *All weights in grams.*

EXAMPLE TEST PROCEDURE
Figure SC-T-92B

DESCRIPTION	EQUATION	RESULT
ORIGINAL SAMPLE		
Initial Wt. Sample & Container	W_{Ti}	1747.9
Wt. of Container	W_C	500.0
Initial Sample Wt.	$W_{mix} = W_{Ti} - W_C$	1247.9
MATERIAL DRIED		
Wt. of Binder	$W_B = W_{mix} \times (\%AC_{corr} / 100)$	68.6
Wt. Before Wash	$W_{agg} = W_{mix} - W_B$	1179.3
Wt. Sample & Container After Wash	W_{Tf}	1622.3
Final Sample Wt.	$W_f = W_{Tf} - W_C$	1122.3
Total Loss thru 75-μm (No. 200) Sieve	$W_L = W_{agg} - W_f$	57.0

Note: All weights in grams.

AGGREGATE WASH CALCULATIONS
Figure SC-T-92C

7.2. Calculate the gradation, as shown in Figure SC-T-92D, using the dry weight of aggregate determined in Step 7.1.

SIEVE SIZE	WT. PASSING	+ W_L	= TOTAL WT. PASSING	TOTAL PASSING (%)
19.0 mm	1122.3	57	1179.3	100.0
12.5 mm	1083.2	57	1140.2	96.7
9.5 mm	1012.0	57	1069.0	90.6
4.75 mm	766.3	57	823.3	69.8
2.36 mm	592.3	57	649.3	55.1
600 μm	353.2	57	410.2	34.8
150 μm	52.3	57	109.3	9.3
75 μm	12.1	57	69.1	5.86

Note: All weights in grams.

EXAMPLE MECHANICAL ANALYSIS CALCULATIONS
Figure SC-T-92D

8. REPORT

8.1. The results of the sieve analysis should be reported to the nearest 0.1 percent on all sieves other than the 75-μm sieve (0.01 percent). Data and calculations are recorded on SCDOT Form 400.01 – Ignition Oven Worksheet and reported on SCDOT Form 400.03 – Daily Report of Asphalt Plant Inspection.

Standard Method of Test for

Utilizing a Quartering Apparatus to Reduce Hot-Mix Asphalt Field Samples

SCDOT Designation: SC-T-93

1. SCOPE

1.1. This method is used for obtaining the required sample size for testing hot-mix asphalt.

2. REFERENCED DOCUMENT

2.1. SC-T-62, SC-T-100.

3. SIGNIFICANCE AND USE

3.1. The purpose of this procedure is to reduce asphalt mixtures in field applications to the proper testing size. This procedure is used to prevent segregation of mixtures and to ensure that all samples are divided equally, reducing technician variability in reducing samples.

4. APPARATUS

4.1. An approved quartering apparatus, similar to the Gilson's Quartermaster, with smaller pails capable of holding hot-mix asphalt.

5. TEST SPECIMEN

5.1. Bituminous material.

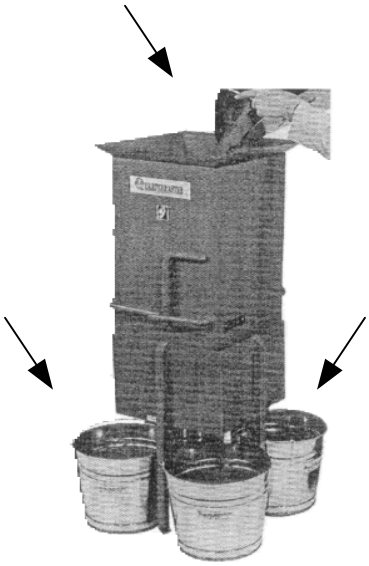
6. PROCEDURE

6.1. Obtain a representative sample of the bituminous mixture in accordance with SC-T-100, Random Method of Sampling Highway Construction Materials, and SC-T-62, Sampling of Bituminous Mixtures.

6.2. Invert the sample bucket or bag into the hopper of the quartering apparatus, as shown in Figure SC-T-93A, and level. Release the lever and allow the sample to flow into the four smaller buckets. Pour the opposing buckets into a sample bag and label accordingly. Place the other remaining buckets back into the original sample bucket or bag.

6.3. Repeat Step 6.2 using the opposite opposing buckets (see Figure SC-T-93B) until the required sample size is obtained.

INVERT SAMPLE BUCKET OR BAG INTO HOPPER AND LEVEL
Figure SC-T-93A



USE OF OPPOSITE OPPOSING BUCKETS
Figure SC-T-93B

SCDOT Sampling and Testing Procedures

C.7 GENERAL

Standard Method of Test for

Random Method of Sampling Highway Construction Materials

SCDOT Designation: SC-T-100

1. SCOPE

1.1. This test method outlines the procedure for randomly sampling highway construction materials at the production plant and on the roadway. A table of random numbers is used to pre-determine the sampling time and location. This method may be used in any situation requiring random selection procedures.

2. SIGNIFICANCE AND USE

2.1. The purpose of this procedure is to obtain random material samples that are representative of the material being produced. This procedure is used in determining sample times and sample locations that are necessary for obtaining random samples that are used for acceptability of materials according to SCDOT specifications.

3. PROCEDURE

3.1. Determine Sampling Times:

3.2. Sampling Frequency: Determine the number of samples of the material that are to be obtained from each day's production. A day's run will normally constitute a lot.

3.3. Randomization:

3.3.1. At the beginning of each day, divide the anticipated period of plant operation into the required number of equal intervals.

3.3.2. Select a series of consecutive random numbers from Figure SC-T-100A.

3.3.3. To determine the sampling time, multiply the first random number in the series by the number of minutes in the first time interval and add the product to the clock time at the beginning of the interval. Sample the first load of material which leaves the plant following the computed sampling time.

3.3.4. Repeat the operation, using the other random numbers in the same order as they appear in the Figure SC-T-100A, to determine the sampling times for the three remaining time intervals. In each interval, the product of the random number and the number of minutes in that interval is added to that interval's beginning clock time to determine the sampling time.

3.3.5. Example of Calculating the Random Sampling Times:

Assume the plant is expected to begin operations at 7:00 a.m. and operate for ten hours.

0.576	0.730	0.430	0.754	0.271	0.870	0.732	0.721	0.998	0.239
0.892	0.948	0.858	0.025	0.935	0.114	0.153	0.508	0.749	0.291
0.669	0.726	0.501	0.402	0.231	0.505	0.009	0.420	0.517	0.858
0.609	0.482	0.809	0.140	0.396	0.025	0.937	0.310	0.253	0.761
0.971	0.824	0.902	0.470	0.997	0.392	0.892	0.957	0.640	0.463
0.053	0.899	0.554	0.627	0.427	0.760	0.470	0.040	0.904	0.993
0.810	0.159	0.225	0.163	0.549	0.405	0.285	0.542	0.231	0.919
0.081	0.277	0.035	0.039	0.860	0.507	0.081	0.538	0.986	0.501
0.982	0.468	0.334	0.921	0.690	0.806	0.879	0.414	0.106	0.031
0.095	0.801	0.576	0.417	0.251	0.884	0.522	0.235	0.398	0.222
0.509	0.025	0.794	0.850	0.917	0.887	0.751	0.608	0.698	0.683
0.371	0.059	0.164	0.838	0.289	0.169	0.569	0.977	0.796	0.996
0.165	0.996	0.355	0.375	0.654	0.979	0.815	0.592	0.348	0.743
0.477	0.535	0.137	0.155	0.767	0.187	0.579	0.787	0.358	0.595
0.788	0.101	0.434	0.638	0.021	0.894	0.324	0.871	0.698	0.539
0.566	0.815	0.622	0.548	0.947	0.169	0.817	0.472	0.864	0.466
0.901	0.342	0.873	0.964	0.942	0.985	0.123	0.086	0.335	0.212
0.470	0.682	0.412	0.064	0.150	0.962	0.925	0.355	0.909	0.019
0.068	0.242	0.667	0.356	0.195	0.313	0.396	0.460	0.740	0.247
0.874	0.420	0.127	0.284	0.448	0.215	0.833	0.652	0.601	0.326
0.897	0.877	0.209	0.862	0.428	0.117	0.100	0.259	0.425	0.284
0.875	0.969	0.109	0.843	0.759	0.239	0.890	0.317	0.428	0.802
0.190	0.696	0.757	0.283	0.666	0.491	0.523	0.665	0.919	0.146
0.341	0.688	0.587	0.908	0.865	0.333	0.928	0.404	0.892	0.696
0.846	0.355	0.831	0.218	0.945	0.364	0.673	0.305	0.195	0.887
0.882	0.227	0.552	0.077	0.454	0.731	0.716	0.265	0.058	0.075
0.464	0.648	0.629	0.269	0.069	0.998	0.917	0.217	0.220	0.659
0.123	0.791	0.503	0.447	0.659	0.463	0.994	0.307	0.631	0.422
0.116	0.120	0.721	0.137	0.263	0.176	0.798	0.879	0.432	0.391
0.836	0.206	0.914	0.574	0.870	0.390	0.104	0.755	0.082	0.939
0.636	0.195	0.614	0.486	0.629	0.663	0.619	0.007	0.296	0.456
0.630	0.673	0.665	0.666	0.399	0.592	0.441	0.649	0.270	0.612
0.804	0.112	0.331	0.606	0.551	0.928	0.830	0.841	0.602	0.183
0.360	0.193	0.181	0.399	0.564	0.772	0.890	0.062	0.919	0.875
0.183	0.651	0.157	0.150	0.800	0.875	0.205	0.446	0.648	0.685

TABLE OF RANDOM NUMBERS
Figure SC-T-100A

3.3.5.1 Divide the operating period into four intervals as follows:

$$I = \frac{60H}{S} = \frac{(60)(10)}{4} = 150 \text{ minutes}$$

where: I = the interval (minutes)
H = number of hours the plant operates
S = number of samples to be obtained

3.3.5.2 Select a series of random numbers from the random number table.

0.354 0.949 0.24 0.826

3.3.5.3 Compute Sampling Times:

0.354 x 150 = 53 minutes
0.949 x 150 = 142 minutes
0.241 x 150 = 36 minutes
0.826 x 150 = 124 minutes

Interval 1 = 7:00 a.m.
Interval 2 = 7:00 a.m. + 150 minutes = 9:30 a.m.
Interval 3 = 9:30 a.m. + 150 minutes = 12:00 noon
Interval 4 = 12:00 noon + 150 minutes = 2:30 p.m.

Sampling Times:

Interval 1 = 7:00 a.m. + 53 minutes = 7:53 a.m.
Interval 2 = 9:30 a.m. + 142 minutes = 11:52 a.m.
Interval 3 = 12:00 noon + 36 minutes = 12:36 p.m.
Interval 4 = 2:30 p.m. + 124 minutes = 4:34 p.m.

3.3.6. Delay of production due to plant breakdown, weather or other cause:

When it is not possible to obtain a scheduled sample because of plant breakdown, weather or other cause, disregard the sample and proceed to obtain the next scheduled sample. If plant operations are resumed before the completion of a specific interval, then a sample is to be taken as soon as it is feasible to do so before completion of that interval.

3.3.7. Examples of a Delay in Production:

Example 1: Suppose a breakdown occurs at 10:30 a.m. and operations do not resume until 12:05 p.m. No sample would be obtained during Interval 2 because no load left the plant between 11:52 a.m., the sampling time and 12:00 noon, the end of Interval 2. Interval 3 would be sampled as scheduled.

Example 2: Suppose a breakdown occurs at 7:30 a.m. and operations do not resume until 8:30 a.m., then a sample would be required from Interval 1 as soon as it is feasible to obtain one.

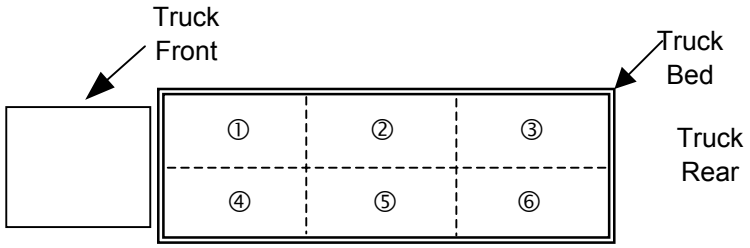
3.4. Sampling from a Truck Bed:

3.4.1. A suitable sampling platform shall be provided on which the Plant Inspector is able to stand and sample the material in the truck bed. The platform shall be constructed such that the truck is able to park on either side to prevent the Inspector from having to climb up onto the truck. If it is not possible for the platform to be constructed in this manner, then two appropriately constructed separate platforms shall be provided or the truck required to reverse direction so that the sample may be obtained.

3.4.2. Determining Sampling Locations on the Truck:

3.4.3. Divide the truck into 6 imaginary locations as shown in Figure SC-T-100B:

These locations are to remain constant and cannot be reversed.



TRUCK SAMPLING LOCATIONS
Figure SC-T-100B

3.4.4. Select a set of random numbers from Figure SC-T-100A. Because there are 6 imaginary locations on the truck, multiply each random number by 6. The sample locations are determined by the magnitude of the product (see Figure SC-T-100C):

PRODUCT	SAMPLE LOCATION
0.00-1.00	1
1.01-2.00	2
2.01-3.00	3
3.01-4.00	4
4.01-5.00	5
5.01-6.00	6

SAMPLE LOCATIONS
Figure SC-T-100C

3.4.5. Example of Computing Sampling Locations on Truck (see Figure SC-T-100D):

SAMPLE NO.	RANDOM NO.	PRODUCT (Random No. x 6)	TRUCK LOCATION
1	0.509	3.05	4
2	0.834	5.00	5
3	0.165	0.99	1

COMPUTING SAMPLING LOCATIONS
Figure SC-T-100D

3.5. Random Roadway Sampling of In-Place Highway Materials:

3.5.1. Divide the length of the day's run into the required number of equal subsections. Determine the beginning station number of each subsection.

3.5.2. Randomly select a column of random numbers from Figure SC-T-100A, which are the random number table to be used to determine the longitudinal distance from each beginning subsection station number.

3.5.3. Randomly select another column of random numbers from Figure SC-T-100A, which are to be used to determine the transverse distance from the right edge of the roadway to the sample location.

3.5.4. For the first sample, multiply the first random number of the first set by the number of feet in the subsection. Add this value to the beginning station number of that subsection. This will yield the station number of the sample location. To determine the transverse distance from the right edge of the roadway to the sample location, multiply the width of the lane available (available = width of lane - 2 ft.) by the random number from the second set and add one foot.

3.5.5. Continue this procedure for each sample location.

3.5.6. Example of Locating Samples of In-Place Highway Materials:

3.5.6.1 Suppose a day's run was 5000 feet. Determine the subsection lengths:

5000 feet = 1000 feet per subsection (5 subsections)

Recall the beginning station number for the day. Add 1000 feet to the station number to obtain the beginning station number of the next subsection. Do this for all 5 subsections.

3.5.6.2 Assume that the roadway is 12 feet wide; therefore, the available roadway width is:

12 feet - 2 feet = 10 feet

3.5.6.3 Randomly select 2 sets of random numbers from Figure SC-T-100A:

0.629	0.399	0.551	0.564	0.800
0.663	0.592	0.928	0.772	0.875

3.5.6.4 Using the first number in the first set of random numbers, calculate the longitudinal distance to the first sample in subsection 1:

(1000 feet subsection) (0.629) = 629 feet

Add this value to the beginning station number of the subsection to obtain the station number of the sample in subsection 1:

STA 0+00 + 629 feet = STA 6+29

Using the first number in the second set of random numbers, calculate the transverse distance from the right edge to the sample location:

(0.663) (10 feet) + 1 feet = 7.6 feet from right edge

Therefore, the first sample location is at STA 6+29 and is located 7.6 feet from the right edge.

3.5.6.5 Repeat Step 3.5.6.4. for each subsection, as shown in Figure SC-T-100E.

SUBSECTION	RANDOM NO.	FEET TO SAMPLE	SAMPLE LOCATION
1	0.629	(0.629)(1000 ft.) = 629 ft.	STA 0+00 + 629 = STA 6+29
	0.663	(0.663)(10 ft.) + 1 = 7.6 ft.	8 ft. from right edge
2	0.399	(0.399)(1000 ft.) = 399 ft.	STA 10+00 + 399 = STA 13+99
	0.592	(0.592)(10 ft.) + 1 = 6.9 ft.	7 ft. from right edge
3	0.511	(0.511)(1000 ft.) = 511 ft.	STA 20+00 + 511 = STA 25+11
	0.928	(0.928)(10 ft.) + 1 = 10.3 ft.	10 ft. from right edge
4	0.564	(0.564)(1000 ft.) = 546 ft.	STA 30+00 + 546 = STA 35+46
	0.772	(0.772)(10 ft.) + 1 = 8.8 ft.	9 ft. from right edge
5	0.800	(0.800)(1000 ft.) = 800 ft.	STA 40+00 + 800 = STA 48+00
	0.875	(0.875)(10 ft.) + 1 = 9.8 ft.	10 ft. from right edge

LOCATING SAMPLES OF IN-PLACE HIGHWAY MATERIALS
Figure SC-T-100E

4. CALCULATIONS

4.1. Calculations for this test are listed in the procedure section.

5. REPORT

5.1. Record what times the samples should be taken, where in the truck bed the samples are to be obtained and where the cores are to be taken from the roadway. For asphalt mixtures, report sampling times on SCDOT Form 400.03 – Daily Report of Asphalt Plant Inspection and roadway core locations on SCDOT Form 400.16 – In-Place Density Contractor QA or SCDOT Form 400.17 – In-Place Density Contractor QC / QA PWL, as appropriate.

Standard Method of Test for

Random Method of Sampling Hot-Mix Asphalt (HMA)

SCDOT Designation: SC-T-101

1. SCOPE

1.1. This test method outlines the procedure for randomly sampling highway construction materials at the production plants and on the roadway. A table of random numbers is used to pre-determine the sampling tonnage and location for in-place density. This method may be used in any situation requiring random selection procedures.

2. SIGNIFICANCE AND USE

2.1. The purpose of this procedure is to obtain random asphalt samples that are representative of the asphalt mixtures being produced. This procedure is used in determining sample tonnages and sample locations that are necessary for obtaining random samples used for acceptability of asphalt mixtures according to SCDOT specifications.

3. PROCEDURE

3.1. Determine Sampling Tonnages:

3.2. Sampling Frequency: Samples of the material are to be obtained from each sublot (500 tons) during a normal day's production. In-place density samples are taken depending on the type of asphalt mix.

3.3. Randomization:

3.3.1. At the beginning of each day, select from Figure SC-T-101A the set of the random numbers that corresponds to the calendar day of the month on which you are producing asphalt mix. This determines the sampling tonnages for your daily samples numbered from 1-10.

3.3.2. Each sublot sample should be taken from the truck that contains the total tonnage from the beginning of the lot or day’s production.

3.4. Sampling from a Truck Bed: A suitable sampling platform shall be provided on which the Plant Inspector is able to stand and sample the material in the truck bed. The platform shall be constructed such that the truck is able to park on either side to prevent the Inspector from having to climb up onto the truck. If it is not possible for the platform to be constructed in this manner, then two appropriately constructed separate platforms shall be provided or the truck required to reverse direction so that the sample may be obtained.

3.5. Random Roadway Sampling of In-Place Highway Materials:

3.5.1. Determine the sublot size for core locations depending on what type of asphalt mixture is being placed. Note the beginning station number for the day’s run.

1	2	3	4	5	6	7
0.117	0.391	0.764	0.414	0.710	0.086	0.748
0.724	0.105	0.943	0.653	0.910	0.344	0.807
0.013	0.440	0.252	0.515	0.955	0.776	0.752
0.717	0.066	0.389	0.368	0.113	0.816	0.600
0.723	0.182	0.853	0.141	0.582	0.896	0.206
0.875	0.970	0.497	0.080	0.442	0.998	0.718
0.493	0.552	0.592	0.680	0.449	0.676	0.013
0.866	0.488	0.931	0.997	0.394	0.481	0.157
0.768	0.261	0.994	0.324	0.383	0.542	0.590
0.093	0.123	0.827	0.936	0.458	0.312	0.413
8	9	10	11	12	13	14
0.966	0.750	0.689	0.586	0.140	0.535	0.600
0.595	0.188	0.371	0.051	0.985	0.911	0.692
0.114	0.948	0.906	0.966	0.756	0.631	0.599
0.024	0.971	0.435	0.986	0.534	0.676	0.543
0.933	0.172	0.186	0.895	0.918	0.827	0.757
0.381	0.167	0.618	0.362	0.519	0.963	0.963
0.739	0.340	0.553	0.131	0.359	0.004	0.054
0.833	0.112	0.360	0.667	0.080	0.594	0.968
0.481	0.915	0.617	0.165	0.348	0.874	0.502
0.138	0.724	0.478	0.092	0.872	0.193	0.708
15	16	17	18	19	20	21
0.479	0.890	0.883	0.406	0.359	0.090	0.853
0.802	0.787	0.093	0.327	0.101	0.078	0.489
0.506	0.352	0.689	0.649	0.940	0.899	0.800
0.094	0.656	0.693	0.644	0.751	0.406	0.643
0.282	0.418	0.158	0.598	0.092	0.994	0.498
0.108	0.580	0.785	0.859	0.656	0.245	0.853
0.878	0.751	0.837	0.971	0.939	0.533	0.804
0.908	0.575	0.470	0.957	0.920	0.692	0.863
0.516	0.130	0.725	0.705	0.059	0.628	0.556
0.965	0.188	0.881	0.691	0.770	0.092	0.239
22	23	24	25	26	27	28
0.143	0.278	0.858	0.672	0.785	0.407	0.708
0.243	0.503	0.714	0.280	0.523	0.918	0.139
0.530	0.102	0.293	0.557	0.944	0.621	0.707
0.697	0.818	0.520	0.860	0.639	0.229	0.563
0.372	0.015	0.185	0.173	0.673	0.767	0.528
0.749	0.489	0.923	0.227	0.452	0.587	0.630
0.524	0.277	0.664	0.759	0.945	0.040	0.602
0.106	0.924	0.649	0.149	0.560	0.225	0.773
0.274	0.481	0.424	0.692	0.834	0.208	0.889
0.608	0.557	0.612	0.412	0.077	0.203	0.734
29	30	31				
0.599	0.165	0.051				
0.573	0.951	0.432				
0.362	0.314	0.602				
0.784	0.138	0.331				
0.354	0.511	0.097				
0.664	0.942	0.510				
0.986	0.389	0.428				
0.099	0.932	0.596				
0.079	0.218	0.820				
0.440	0.354	0.544				

RANDOM TONNAGE SELECTION
Figure SC-T-101A

3.5.2. Select the set of random numbers from Figure SC-T-101B that corresponds to the calendar day that paving is beginning (day or night). The first column of the table is to be used to determine the longitudinal distance from each beginning sublot station number.

3.5.3. Select from the second column of random numbers in the same set to determine the transverse distance from the right edge of the roadway to the sample location.

3.5.4. For the first sample, multiply the first random number of the first column by the number of feet in the sublot (usually 1500 feet to 2000 feet). Add this value to the beginning station number of that sublot. This will yield the station number of the sample location. To determine the transverse distance from the right edge of the roadway to the sample location, multiply the width of the lane available (available = width of lane - 2 feet) by the random number from the second set and add one foot.

Assume that the roadway is 12 feet wide; therefore, the available roadway width is:

Width = 12 feet - 2 feet = 10 feet

3.5.5. Continue this procedure for each sample location.

3.6. Example of Locating Samples of In-Place Highway Materials:

3.6.1. Given:

Suppose a day's run was 5000 feet
Average width of 12 feet
(Surface Type 1C)
Date: August 15, 2002
Starting Station: STA 0+00

Refer to the Contract Specifications to determine the sublot lengths: Surface Course > 140 pounds per square yard requires a random core sample every 2000 feet.

5000 feet / 2000 feet per sublot = (2.5 => 3 sublots)

Recall the beginning station number for the day. Add 2000 feet to the station number to obtain the beginning station number for the next subsection. Do this for all 3 sublots.

3.6.2. Select from the first column of random numbers from Figure SC-T-101B: Date: August 15, so use the 15^{th} set (see Figure SC-T-101C).

1		2		3		4		5		6		7	
0.735	0.720	0.133	0.188	0.697	0.384	0.079	0.028	0.916	0.547	0.165	0.479	0.517	0.131
0.695	0.151	0.961	0.944	0.752	0.175	0.769	0.723	0.292	0.596	0.885	0.970	0.616	0.745
0.708	0.057	0.016	0.352	0.053	0.091	0.318	0.199	0.153	0.177	0.582	0.624	0.802	0.498
0.549	0.203	0.434	0.018	0.796	0.768	0.323	0.294	0.086	0.010	0.932	0.907	0.532	0.524
0.190	0.951	0.736	0.080	0.220	0.800	0.943	0.585	0.108	0.261	0.637	0.183	0.113	0.299
0.569	0.579	0.805	0.757	0.833	0.066	0.542	0.063	0.936	0.776	0.685	0.498	0.266	0.810
0.919	0.107	0.558	0.007	0.922	0.671	0.501	0.531	0.470	0.333	0.734	0.564	0.654	0.750
0.691	0.368	0.922	0.712	0.506	0.821	0.443	0.589	0.094	0.867	0.966	0.515	0.586	0.267
0.608	0.681	0.617	0.773	0.291	0.611	0.487	0.792	0.135	0.807	0.547	0.467	0.479	0.506
0.070	0.459	0.845	0.169	0.647	0.364	0.098	0.156	0.971	0.067	0.025	0.231	0.113	0.599
8		**9**		**10**		**11**		**12**		**13**		**14**	
0.611	0.622	0.540	0.406	0.792	0.338	0.493	0.338	0.351	0.462	0.260	0.714	0.358	0.909
0.840	0.966	0.873	0.468	0.096	0.962	0.457	0.864	0.469	0.266	0.985	0.173	0.547	0.505
0.918	0.879	0.733	0.767	0.056	0.607	0.113	0.715	0.293	0.729	0.410	0.984	0.217	0.547
0.366	0.007	0.147	0.243	0.004	0.745	0.047	0.235	0.288	0.408	0.900	0.137	0.103	0.799
0.576	0.884	0.109	0.252	0.835	0.968	0.643	0.060	0.463	0.325	0.661	0.179	0.917	0.044
0.472	0.517	0.955	0.357	0.622	0.740	0.796	0.768	0.586	0.196	0.884	0.951	0.975	0.588
0.306	0.437	0.703	0.376	0.212	0.610	0.649	0.055	0.369	0.661	0.086	0.536	0.003	0.883
0.900	0.559	0.645	0.665	0.027	0.601	0.776	0.178	0.487	0.124	0.635	0.020	0.808	0.924
0.920	0.960	0.306	0.796	0.640	0.550	0.604	0.609	0.374	0.714	0.351	0.729	0.273	0.405
0.091	0.049	0.624	0.144	0.790	0.379	0.206	0.720	0.462	0.468	0.966	0.535	0.239	0.678
15		**16**		**17**		**18**		**19**		**20**		**21**	
0.477	0.893	0.747	0.057	0.651	0.040	0.902	0.251	0.102	0.773	0.788	0.570	0.109	0.372
0.943	0.406	0.002	0.080	0.702	0.484	0.429	0.501	0.579	0.809	0.912	0.425	0.539	0.300
0.536	0.397	0.382	0.656	0.549	0.435	0.786	0.396	0.649	0.705	0.510	0.542	0.575	0.667
0.375	0.330	0.383	0.357	0.187	0.714	0.988	0.297	0.479	0.959	0.921	0.793	0.065	0.865
0.028	0.549	0.616	0.590	0.771	0.954	0.476	0.811	0.723	0.702	0.333	0.680	0.886	0.551
0.593	0.329	0.552	0.903	0.978	0.703	0.402	0.339	0.506	0.372	0.315	0.165	0.792	0.048
0.882	0.288	0.014	0.925	0.926	0.504	0.629	0.414	0.553	0.087	0.864	0.096	0.054	0.055
0.587	0.117	0.863	0.050	0.395	0.300	0.080	0.451	0.489	0.418	0.552	0.809	0.546	0.211
0.555	0.316	0.164	0.824	0.595	0.654	0.182	0.371	0.625	0.670	0.140	0.957	0.240	0.780
0.745	0.479	0.415	0.711	0.961	0.309	0.579	0.226	0.151	0.359	0.584	0.538	0.830	0.249
22		**23**		**24**		**25**		**26**		**27**		**28**	
0.708	0.978	0.805	0.011	0.269	0.710	0.741	0.065	0.553	0.732	0.796	0.401	0.039	0.841
0.034	0.110	0.917	0.392	0.195	0.052	0.079	0.063	0.537	0.099	0.634	0.876	0.451	0.034
0.684	0.299	0.090	0.908	0.938	0.556	0.928	0.262	0.983	0.413	0.699	0.110	0.320	0.295
0.800	0.198	0.551	0.087	0.056	0.183	0.771	0.836	0.396	0.337	0.456	0.678	0.628	0.229
0.560	0.330	0.270	0.320	0.343	0.957	0.283	0.256	0.402	0.835	0.221	0.406	0.829	0.064
0.119	0.631	0.474	0.741	0.536	0.778	0.580	0.108	0.806	0.580	0.935	0.282	0.674	0.138
0.078	0.441	0.515	0.899	0.919	0.888	0.920	0.059	0.114	0.908	0.074	0.255	0.164	0.664
0.479	0.187	0.270	0.585	0.924	0.510	0.032	0.033	0.803	0.199	0.766	0.870	0.061	0.799
0.244	0.660	0.871	0.437	0.032	0.050	0.530	0.992	0.672	0.407	0.898	0.249	0.615	0.950
0.065	0.253	0.957	0.036	0.110	0.441	0.415	0.893	0.489	0.933	0.596	0.446	0.848	0.244
29		**30**		**31**									
0.584	0.706	0.132	0.792	0.553	0.931								
0.178	0.820	0.017	0.712	0.996	0.658								
0.536	0.009	0.698	0.506	0.372	0.970								
0.898	0.981	0.439	0.046	0.832	0.660								
0.331	0.388	0.435	0.581	0.828	0.736								
0.107	0.893	0.828	0.156	0.597	0.580								
0.462	0.495	0.280	0.150	0.246	0.484								
0.033	0.344	0.475	0.238	0.742	0.163								
0.994	0.818	0.759	0.251	0.487	0.235								
0.599	0.512	0.710	0.027	0.351	0.186								

CORE LOCATIONS — LONGITUDINAL/TRANSVERSE
Figure SC-T-101B

15th	
0.477	0.893
0.943	0.406
0.536	0.397
0.375	0.330
0.028	0.549
0.593	0.329
0.882	0.288
0.587	0.177
0.555	0.316
0.745	0.479

Note: These random numbers were obtained from Figure SC-T-101B.

EXAMPLE RANDOM NUMBERS FOR AUGUST 15TH
Figure SC-T-101C

3.6.3. Using the first number in the first column of random numbers (see Figure SC-T-101C), calculate the longitudinal distance to the first sample in sublot number 1.

(2000 feet subsection) (0.477) = 954 feet

Add this value to the beginning station number of the subsection to get the station number of the sample in sublot number 1.

STA 0+00 + 954 feet = STA 9+54

3.6.4. Using the first number in the second column of random numbers (see Figure SC-T-101C), calculate the transverse distance from the right edge to the sample location.

(0.893) (10 feet) + 1 feet = 9.9 feet from right edge

Therefore, the first sample location is at STA 9+54 and is located 9.9 feet from the right edge.

3.6.5. Repeat this procedure for each sublot as shown in Figure SC-T-101D.

4. CALCULATIONS

4.1. Calculations for this test are listed in the procedure section.

SUBLOT	RANDOM NO.	FEET TO SAMPLE	SAMPLE LOCATION
1	0.477	(0.477)(2000 ft.) = 954 ft.	STA 0+00 + 954 = STA 9+54
	0.893	(0.893)(10 ft.) + 1 = 9.9 ft.	9.9 ft. from right edge
2	0.943	(0.943)(2000 ft.) = 1886 ft.	STA 20+00 + 1886 = STA 38+86
	0.406	(0.406)(10 ft.) + 1 = 5.1 ft.	5.1 ft. from right edge
3	0.536	(0.536)(2000 ft.) = 1072 ft.	STA 40+00 + 1072 = STA 50+72 STA 50+72 is beyond the ending STA 50+00 for the day; therefore, no core needs to be taken.
	0.397	(0.397)(10 ft.) + 1 = 5.0 ft.	

EXAMPLE LOCATIONS
Figure SC-T-101D

5. REPORT

5.1. Record what tonnage the samples should be taken and where the cores are to be taken from the roadway. Report sampling tonnages on SCDOT Form 400.03 – Daily Report of Asphalt Plant Inspection and roadway core locations on SCDOT Form 400.16 – In-Place Density Contractor QA or SCDOT Form 400.17 – In-Place Density Contractor QC / QA PWL, as appropriate.

Standard Method of Test for

Measuring the Field Application Rate of Portland Cement

SCDOT Designation: SC-T-141

1. SCOPE

1.1. This standard describes the procedure for determining the field spread rate of Portland cement for Cement Modified Subbase, Cement Stabilized Earth Base, Cement Stabilized Aggregate Base, or Reclaimed Asphalt Pavement.

1.2. This standard may involve hazardous materials, operations and equipment. This standard does not purport to address all of the safety problems associated with its use. It is the responsibility of the user of this standard to consult and establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.

2. REFERENCED DOCUMENTS

2.1. None.

3. SIGNIFICANCE AND USE

3.1. This practice provides standardized requirements for measuring the field spread rate of Portland cement used in road-mix applications of Cement Modified Subbase, Cement Stabilized Aggregate Base, Cement Stabilized Earth Base, and Reclaimed Asphalt Base.

3.2. Proper cement spread rate is essential to achieving a high quality base or subbase. The use of too little cement can result in weak layers and premature pavement failure. The use of excessive cement can result in shrinkage cracks that can reflect through overlying asphalt layers. Consequently, operations should strive to consistently place the specified quantity of cement.

4. APPARATUS

4.1. *Square Yard Pan* — A pan with an area equal to one square yard. These pans are available from the Research and Materials Laboratory.

4.2. *Balance* — A balance accurate to the nearest 0.1 pounds with a capacity sufficient to adequately measure the pan and contents.

5. DIRECT MEASUREMENT

5.1. Measure and record the weight of the empty pan to the nearest 0.1 pounds. Place the pan in front of the spreader. After the spreader has passed over the pan, reweigh the pan and its contents and subtract the weight of the empty pan. The weight of the contents should be within ±5% of the recommended spread rate.

5.2. If the cement spread rate is outside the tolerance, require the Contractor to adjust the spreader and repeat Step 5.1 until the desired spread rate is achieved.

6. INDIRECT MEASUREMENT

6.1. Once the proper spread rate is established using the Direct Method given in Section 5, make periodic checks of the spread rate by calculating the distance a load of cement should cover.

6.2. *Example* —The printout ticket for a cement tanker shows it is carrying 50,000 pounds of cement. The application rate established by the Research and Materials Laboratory is 48 pounds per square yard. The spreader is set to cover a width of 12 feet. Cement application will start at Station 100+00. Determine at what station the tanker should run out.

First, determine the area the tanker should cover at the established application rate:

(50,000 pounds / 48 pounds/yd^2) = 1041.7 yd^2

Next, calculate how many linear feet the tanker will cover at a width of 12 feet:

(1041.7 yd^2 x 9 ft^2/yd^2) / 12 feet = 781 feet

So, the tanker should run out of cement at approximately Station 107+80. If the tanker runs out more than ±5% (40 feet) of the estimated point, the spreader should be readjusted and recalibrated using the Direct Method given in Section 5.