South Dakota

QC/QA

Asphalt Concrete

Training Manual

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QC/QA ASPHALT CONCRETE TRAINING MANUAL

prepared by

South Dakota Department of Transportation
Division of Planning/Engineering
Materials and Surfacing Program

prepared for

Bituminous Certification Program

presented by

South Dakota Department of Transportation
Division of Planning/Engineering
Materials and Surfacing Program

This training manual is based upon the South Dakota Department of Transportation Standard Specifications for Roads and Bridges, SD DOT Materials Manual, SD DOT Policies and Procedures, SD DOT Certification Program Manual and AASHTO / ASTM Methods of Sampling and Testing as of the date this manual was printed.

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FOREWORD

SDDOT, along with the Asphalt Industry, has always tried to maintain their level of expertise in an ever-changing environment. The Asphalt Industry, which includes Asphalt Cement Suppliers, Aggregate Producers, Asphalt Concrete Producers, Federal Highways Administration, and the SDDOT, has realized that a change in the way that we do business will improve the quality of our asphalt pavements.

In January of 1996, a meeting was held to bring the entire Asphalt community together to start a process of sharing information and training. This meeting, although not immediately realized, has led to a large effort in improving the quality of our asphalt pavements.

Since January of 1996, there have been numerous meetings, phone calls, and faxes working out the Quality Improvement Program that we all want. This Quality Improvement has led to the formation of a Specification Task Force for developing a QC/QA specification that not only deals with procedures for Quality Pavement but also has provided the necessary checks and balances we need. Unified goals are essential to implement a Quality Improvement Process.

The advent of QC/QA Specification Implementation requires an intensive training process. This process began with the Executive Hot Mix Asphalt Seminars held across SD in October 1996. This training continued with the first of many Bituminous Technician Training Classes that began in December of 1996 and will continue for many years in the future.

The QC/QA Asphalt Concrete Training Manual is current as of the printing date. It is anticipated that this manual will be a used as a training document and updated in the future as we see the need for changes.

It is the desire of the contributing authors of this manual that it will serve as a valuable reference for those involved with asphalt construction in South Dakota.

INTRODUCTION

For many years, Transportation engineers have been looking at asphalt pavements for solving the infrastructure pavement needs. These ever-growing needs caused by heavy truckloads and increased traffic volumes mandate that we build asphalt pavement right the first time. The SDDOT does not have the financial independence to fix or repair all our highways in the State Truck System to full design requirements when they need attention. SDDOT presently has a backlog of highway needs and prioritizes those highway segments according to need. To keep this backlog static, or at best reducing the total, the Asphalt Construction Industry is called upon to deliver pavements that meet or exceed their design life.

SDDOT has adopted Quality Control / Quality Assurance methods for monitoring the asphalt mix produced to give the citizens of South Dakota a long lasting high performance asphalt pavement. Across the nation, nearly every State is looking into Quality Improvements necessary to provide highways that meet the Traveling Public's Requirements.

With asphalt mix designs many variables exist. These variables include aggregate (crushed/rounded, gradation, particle shape, etc.) and asphalt binder (different sources). Many combinations of these variables exist within the boundaries of South Dakota. The proper asphalt content and air void levels are critical to the long-term performance of the asphalt pavement. In the Asphalt Concrete Mix Design Process, the proper configuration of all the ingredients is necessary for long-term pavement performance.

This Quality Control/Quality Assurance Asphalt Concrete Training Manual is provided to those in the industry as a ready reference. This training manual includes SDDOT's QC/QA Specification, Training Requirements, Asphalt Mix Design Procedures, along with applicable policies relating to asphalt construction current at the time of printing.

Our intent is to provide personnel involved in the design and construction of asphalt pavements with the information needed to perform their tasks with Quality in mind.

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Section Number 1

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QC/QA ASPHALT CONCRETE TRAINING MANUAL

1. PURPOSE AND PROCESS:

The purpose of the South Dakota Quality Control / Quality Assurance Asphalt Concrete Training Manual is to explain the inspection, sampling, and testing methods necessary to comply with the Standard Specification for Roads and Bridges Asphalt Concrete - Class Q Hot Mixed Asphalt Concrete Pavements. This manual will serve as a guide for the Contractor, the Aggregate Producer, and SDDOT personnel.

Quality Control is the responsibility of the contractor.
Quality Assurance is the responsibility of the state.

The Contractor shall provide a Quality Control System that assures all asphalt concrete materials and constructed pavement, including aggregate process control and handling conforms to the contract requirements.

2. SCOPE FOR ASPHALT CONCRETE - CLASS Q:

This training manual is applicable to the production and construction of hot mix pavement on all projects let using the Standard Specification for Roads and Bridges Asphalt Concrete - Class Q. Use the current Standard Specification for Roads and Bridges Asphalt Concrete - Class Q, current Materials Manual and the correct set of plans.

3. CERTIFICATION PROGRAM FOR TECHNICIANS ON QC/QA PROJECTS:

The purpose of this program is to develop and maintain a pool of well-trained technicians for the Department and its Contractors, and to test and manage highway construction materials. The intent of this program is to improve the quality and performance of pavements through knowledge and understanding of the products.

On gyratory Class Q projects the Contractor shall have a minimum of one certified Level AC Aggregate Testing and level Asphalt Concrete Hot Mix testing certified tester conducting the QC testing and one certified Level Roadway Inspection person on the project. The State shall have a minimum of one certified Level Asphalt Concrete Aggregate testing and QC/QA Asphalt Concrete Hot Mix testing tester conducting the QC testing and one Level III Roadway Inspection certified person on the Project. The certified technicians must be present at the plant and roadway whenever the plant is supplying asphalt concrete to the roadway.

The requirements for certification are shown in the Materials Testing and Inspection Certification program manual in this section which is current as of the printing date.

4. SAMPLING AND TESTING MATERIALS:

Aggregate material shall be sampled from the cold feed belt in a manner that will assure a representative sample is obtained. The procedures in SD 201 and SD 213 shall be followed to obtain and reduce the material sampled to the testing size. Aggregate sample size shall be large enough to obtain four (4) splits of the minimum sample size needed (6 IA technicians have obtained their tests results for the individual lot and have found their results to be within the allowable tolerances in Materials Manual for Class Q and SD 317. The QA splits are to be retained until the Bituminous Engineer has completed F and t testing on the materials and has notified the Project Engineer or QA technicians that samples can be discarded.

Hot mix asphalt samples shall be obtained from the windrow in front of the pickup machine in a manner that will assure a representative sample is obtained. The procedures in SD 312 and SD 313 shall be followed to obtain and reduce the material sampled to the testing size. The sample shall be large enough to obtain 4 splits and make reheat samples if necessary (6 splits if IA is obtained). The QC splits are to be retained until the QC, QA, and IA technicians have obtained their tests results for the individual lot and have found their results to be within the allowable tolerances in the Materials Manual for Class Q, SD 317, and the Project Engineer has told the QC technician he can dispose of the samples. The QC gyratory samples made shall be labeled the same as the sample number with an A and a B and be retained until the end of the Project. The QA splits are to be retained until the end of the Project and the Bituminous Engineer has completed the F and t tests on the sets of test results.

If the difference between the QC and QA/IA test results is greater than allowed in the Materials Manual for Class Q or in SD 317, the Engineer will investigate the reason for the difference. This investigation will include review and observation of sampling, splitting, test equipment condition, and testing procedures on a sample. If upon test result review, equipment or procedural problems are found, the problems will be corrected and documented.

Asphalt binder and liquid asphalt are to be sampled according to SD 301. Asphalt binders require a sample of two 1 quart metal cans per 200 tons of material. The sample shall be obtained from an in-line sampling valve located between the storage unit and the mix plant. Emulsions require a sample of two 1/2 gallon plastic jugs per 100 tons of material. Other liquid asphalt requires a sample of two 1 quart metal cans per 100 tons of material. The oil content will be determined daily by using SD 314. Hydrated lime shall be sampled according to Materials Manual using SD 502 if not furnished from a certified lime plant.

These procedures shall be used by certified technicians on all projects let with the Standard Specification for Roads and Bridges Asphalt Concrete - Class Q. Test data and forms shall be submitted on SDDOT forms unless the Engineer approves other forms for use. The forms shall be submitted in a timely manner to the Area and Region personnel.

Test procedures in this manual are the current procedures at the time of printing of this Training Manual. The current edition of sampling and testing procedures used by the South Dakota Department of Transportation will be in the SDDOT Materials Manual and at the SDDOT website sddot.com

5. TEST REPORTS AND CONTROL CHARTS:

Test results shall be reported on SDDOT forms unless approved by the Engineer. QC/QA Numbering shall begin with a prefix of QC or QA or IA followed by 01 or 001 and run consecutively throughout the Project. IA or QA tests shall be referenced to their corresponding QC or QA tests (QC01/QA01). Non payfactor material shall be labeled with an N prefix before the test number (NQC01). The core samples shall be numbered consecutively with an A and a B following the test number for each sublot. A computer program called Material Sampling and Testing (MS&T) in the Construction Management System will be used on Projects and the numbering system and recording will be according to the requirements of the system. Computations and rounding numbers shall be as required by the Materials Manual and the new (MS&T) system.

Roadway diaries are to include; hours paved, equipment in use, stations paved, course, depth, width, crown, spread checks, tonnage, weather, temperature of mix delivered to the road and other pertinent data. Plant diaries are to include; plant start and shutdown times, mix temperature of material produced, oil spot checks, aggregate bin splits being used, actual calculated oil percentage for the day, tons plant produced, mix and binder content changes, and weather conditions. This list is not complete and may be expanded to cover as much pertinent data as you wish. There are no restrictions on such notes and they serve as important documentation. The Project Engineer will be responsible for collecting the information from the inspectors and recording it in the project diary.

Control charts shall be maintained for gradation of the control sieves in the Job Mix Formula, asphalt binder content, hydrated lime content, maximum specific gravity (rice), bulk specific gravity (Marshall or Gyratory), air voids, VMA, VFA, dust to binder ratio and in-place density for the Project. The QC technician shall maintain the control charts and the QA technician shall give their test results to be added to the charts in a different pen color and also give the IA samples to be added as they become available in a different color as well.

The current forms are in the SDDOT Materials Manual. An electronic version is available in the M S & T system.

6. COMPARISON OF QUALITY CONTROL AND ACCEPTANCE TESTS OR INDEPENDENT ASSURANCE TESTS ON ENTIRE PROJECT:

The purpose of this procedure is to provide a method of comparing two different sets of multiple test results. This procedure can be used to compare the contractor QC tests to

the SDDOT QA tests and the SDDOT IA test results to determine if the material tested came from the same population. The procedure for this is from the AASHTO Implementation Manual for Quality Assurance (February 1996) Appendix F. This is the F-test and t-test statistical procedures which will be conducted by the Bituminous Engineer.

7. SDDOT PROFICIENCY SAMPLE PROGRAM:

Contractors or consultants doing mix designs for the South Dakota Department of Transportation must participate in the SDDOT round robin Proficiency Sample Program.

8. QC/QA PROJECT INSPECTION REPORT:

This section is a checklist of items for QC/QA Projects. This list is not all inclusive and does not include every necessary item.

Section Number 2

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322.1 DESCRIPTION

The work consists of constructing one or more courses of gyratory controlled QC/QA hot mixed asphalt concrete pavement on a prepared foundation.

322.2 MATERIALS

Mineral aggregate shall conform to the requirements of Section 322.3. All other materials and their use shall conform to Section 320.2.

322.3 CONSTRUCTION REQUIREMENTS

The construction requirements shall be as prescribed in Section 320.3 with the following additional requirements:

A. Laboratories:

1. **Quality Control Laboratory:** The Contractor shall furnish and maintain a Quality Control (QC) laboratory at the plant site. The laboratory shall be furnished with the necessary space, equipment, and supplies to properly perform all specified testing. The laboratory shall be equipped with a gyratory compactor meeting the requirements of AASHTO T 312. The laboratory equipment shall meet the requirements of the test methods contained in the Department's Materials Manual and Materials Testing & Inspection Certification Program Manual. A copy of the equipment calibration records shall be kept in the QC laboratory.

   The Contractor's QC laboratory shall be equipped with a mechanical convection oven meeting the requirements of Section 600.

   The Contractor shall furnish a cut off saw equipped with a diamond tipped blade. The saw is to separate the core samples to the actual lift thickness. The cores shall be sawed by the Contractor to the correct lift line prior to testing the cores for density.

2. **Quality Assurance Laboratory:** The Contractor shall also provide a separate Quality Assurance (QA) laboratory for QA testing performed by the Engineer. The QA laboratory shall meet the requirements of Section 600.

B. Quality Control:

1. **Contractor Furnished Quality Control Program:** QC for the asphalt concrete pavement is the responsibility of the Contractor. The Contractor shall provide and maintain a QC program. The program shall assure that all asphalt concrete materials and constructed pavement submitted for acceptance conforms to the contract requirements. The Contractor shall be responsible for all asphalt concrete materials and constructed pavement, including aggregate process control and handling.

The Contractor shall provide at least one technician certified in Asphalt Concrete Aggregate Testing and Asphalt Concrete Hot Mix Testing for conducting the QC testing and at least one technician certified in Asphalt Concrete Roadway Inspection for roadway inspection. All of the Contractors QC testing and inspection technicians shall meet the Department's certification requirements or be under the direct supervision of a certified technician for the type of work they are actually performing. The certified testing and inspection technicians must be present at the plant and roadway whenever the plant is supplying asphalt concrete to the roadway.

At or prior to the preconstruction meeting the Contractor shall submit a QC plan to the Engineer for approval. The plan shall contain the following minimum requirements:

a. The names and phone numbers of the individual(s) responsible for the Contractor's QC program.

b. A listing of the certified technician(s) responsible for the QC inspection, material sampling, and testing.

c. A copy of the completed performance checklist and training and evaluation records for all temporary or seasonal personnel who will be performing QC inspection or sampling and testing.

d. An organizational chart indicating lines of authority.

e. The Contractor shall notify the Engineer if a control test strip will be used. The Contractor may produce approximately 500 tons of material to establish a roller pattern and verify the field produced mix properties match those of the lab mix design. After test strip placement, further mixing and laydown operations will be suspended until the laboratory test results of the asphalt mixture and core densities are available. The material used in the test strip will not be included in the mix pay factor analysis. The material used in the test strip shall be tested for all the properties listed in the Department's Materials Manual. The Engineer shall approve the location of the test strip.

If a control test strip is not constructed, the QC plan shall specify how the Contractor will establish a roller pattern to achieve the specified density and volumetric requirements.

The Engineer will provide the following to the Contractor at the preconstruction meeting:

- Names of the certified individuals in charge of Quality Assurance (QA) testing and roadway inspection.

- An organizational chart including the names and phone numbers of those in the direct line of authority.

2. **Mineral Aggregate Testing Prior to Production:** The aggregate producer shall provide test results to the Contractor and Engineer for each stockpile of virgin mineral aggregate that will be incorporated into the asphalt concrete mixture a minimum of 3 weeks prior to asphalt concrete production. The aggregate producer shall use an individual certified in Asphalt Concrete Aggregate Testing. The required tests shall include gradation, crushed particles, fine aggregate angularity, flat and elongated particles, sand equivalent, and lightweight particles at the following minimum frequencies:

   One test per 1500 tons for each virgin mineral aggregate ingredient produced.

   A minimum of three tests for each virgin mineral aggregate stockpile.

   The Contractor may vary the frequency of the crushed particles, fine aggregate angularity, flat and elongated particles, sand equivalent, and lightweight particles tests on ledge rock sources depending on the quality and uniformity of the materials.

3. **Contractor Furnished Mix Designs:** Asphalt concrete mix designs shall be performed by the Contractor and verified by the Department's Bituminous Mix Design Lab. A certified Asphalt Concrete Mix Design and Production Control technician shall perform the asphalt concrete mix design. All Contractors submitting mix designs to the Department are required to participate in the Proficiency Sample Program.

   Prior to submitting samples to the Department's Bituminous Mix Design Lab, 50% of the plans quantity or 15,000 tons, whichever is less, of the virgin mineral aggregate shall be produced.

   When RAP is required, the Contractor shall sample the RAP from the roadway by an approved method. The sampling method shall ensure a representative sample of material is obtained from approximately the same depth as the plans shown milling depth. The RAP sample shall be obtained from a minimum of three locations throughout the project length. The Contractor shall daylight all edges of the sampling area leaving no vertical faces or shall fill the sample area with an approved product leaving no vertical faces. The equipment used shall generate a representative sample of RAP similar to what will be produced from the cold milling operation. The Contractor shall notify the Area office a minimum of 5 calendar days prior to sampling the RAP from the roadway. A representative from the Area office shall witness all sampling of RAP to be submitted for mix design. This material shall be used to perform the mix design. A portion of this sample shall be submitted to the Department's Bituminous Mix Design Lab.

   The Contractor shall notify the Area office a minimum of 5 calendar days prior to sampling and submitting the mix design aggregates. A representative from the Area office shall witness all sampling of aggregates to be submitted for mix design.

   A representative from the Area office shall complete the Form DOT-1 for the composite aggregate sample and RAP sample required for submittal to the

Department's Bituminous Mix Design Lab. The Area office representative shall take possession of the aggregate and RAP samples for mix design and aggregate quality testing. Samples shall be obtained a minimum of 21 calendar days prior to hot mix production. The Area office will deliver the samples to the Department's Bituminous Mix Design Lab in Pierre, SD.

The Area office may allow the Contractor to transport and deliver the RAP and aggregate samples for mix design and aggregate quality testing only when the Area office representative has sealed the samples with a tamper evident tag, with the DOT-1 attached.

Mix designs will only be performed on samples when accompanied by the following information:

a. A completed data sheet (form DOT-1), including the legal description of virgin mineral aggregate source(s).

b. Representative virgin mineral aggregate samples and RAP samples shall be proportionate to the bin splits proposed for use during construction.

c. A summary sheet showing all test results from the gradations completed and the average gradation of each mineral aggregate stockpile produced along with the proposed bin splits to be used in the production of asphalt concrete pavement.

d. A 2 gallon sample of asphalt binder intended for use shall be obtained from the designated supplier for the project.

e. A mix design report and moisture sensitivity test results, if required, that includes the lab data and test results required in SD 318, SD 319, and Section 322.3 B.4. The Contractor's mix design shall meet all of the mix design specifications.

When the mix design verification is completed by the Department's Bituminous Mix Design Lab, an approved mix design report (DOT 64) will be provided to the Area Engineer and the Contractor prior to production. The mix design report will include the single percentage of aggregate passing each required sieve size, a single percentage of asphalt binder to be added to the mixture, a single percentage of hydrated lime to be added to the mixture, a single asphalt binder application temperature, a single temperature at which the mix is to be discharged from the mixer, and a single temperature at which the mix is to be delivered on the road.

4. Gyratory Controlled QC/QA Mix Design Requirements and Specifications: Unless otherwise specified in the plans, the mix design criteria shall conform to the following requirements.

a. Consensus Virgin Mineral Aggregate Requirements:

1.) Crushed Particles (SD 211)
The crushed particles shall be tested on the composite virgin mineral aggregate sample.

Table A Crushed Particles	
	Minimum two or more crushed faces (%)
Class Q1	50
Class Q2	65
Class Q3	75
Class Q4	90
Class Q5	100

2.) Fine Aggregate Angularity (SD 217)

Table B - Fine Aggregate Angularity	
	Minimum Uncompacted Void Content (%)
Class Q1	40.0
Class Q2	41.5
Class Q3	43.0
Class Q4	44.0
Class Q5	45.0

3.) Flat and Elongated Particles (SD 212)
The maximum amount of flat and elongated particles for the coarse aggregate shall not exceed the limits shown in Table C. Flat and elongated particles are defined where the ratio of maximum to minimum dimension is greater than 5:1. The aggregate tested shall be the composite virgin aggregate material that is retained on a #4 sieve

Table C – Flat and Elongated Particles	
	Maximum Flat and Elongated Particles (%)*[1]
Class Q1	No Limit
Class Q2	10
Class Q3	10
Class Q4	10
Class Q5	10

*[1] evaluated for specification at mix design only

4.) Sand Equivalent (SD 221)

Table D - Sand Equivalent	
	Sand Equivalent Minimum (%)
Class Q1	40
Class Q2	42
Class Q3	45
Class Q4	50
Class Q5	60

b. Source Virgin Mineral Aggregate Requirements:

1.) Source Virgin Mineral Aggregate Requirements

Table E - Source Mineral Aggregate Requirements					
	Light Weight Particles (SD 208 & SD 214)		Sodium Sulfate Soundness (SD 220; 5 cycles)		Los Angeles Abrasion Loss (SD 204)
	+#4	-#4	+#4	-#4	
Class Q1	4.5% maximum	4.5% maximum	15% maximum	15% maximum	45% maximum
Class Q2	3.0% maximum	3.0% maximum	15% maximum	15% maximum	45% maximum
Class Q3	3.0% maximum	3.0% maximum	15% maximum	15% maximum	40% maximum
Class Q4	1.0% maximum	1.0% maximum	12% maximum	12% maximum	35% maximum
Class Q5	0.5% maximum	0.5% maximum	12% maximum	12% maximum	35% maximum

2.) Gyratory Controlled QC/QA Gradation (Sieve Analysis; SD 202)
Virgin mineral aggregate gradations, at mix design, must be within the control points for the designated aggregate size of the table below.

Table F - Gyratory Controlled QC/QA Gradation*[1]		
	Control Points (percent passing)	
Sieve Size	Min.	Max.
3/4 inch	100	
1/2 inch	90	100
3/8 inch		85
#8	30	55
#200	2.0	7.0

*[1] the gradation sample shall not include hydrated lime.

c. Mixture Requirements:

1.) Gyratory Compactive Effort

The mixture shall be compacted in accordance with SD 318. The number of gyrations and densification criteria are in listed in Tables G and H.

Table G - Gyratory Compactive Effort			
	$N_{initial}$	N_{design}	$N_{maximum}$
Class Q1	6	40	65
Class Q2	6	50	75
Class Q3	6	60	85
Class Q4	7	70	95
Class Q5	7	80	110

2.) Mixture Densification Criteria

Table H – Target Mixture Densification Criteria		
	Percent of Mixture Maximum Specific Gravity (G_{mm})	
	N_{design}	$N_{maximum}$*[1]
Class Q1	96.0	≤98.0
Class Q2	96.0	≤98.0
Class Q3	96.0	≤98.0
Class Q4	96.0	≤98.0
Class Q5	96.0	≤98.0

*[1] $N_{maximum}$ evaluated for specification at mix design only

3.) Voids in Mineral Aggregate Criteria (VMA)

VMA is calculated from the mixture bulk specific gravity at N_{design} gyrations.

Table I - Voids in Mineral Aggregate Criteria	
Nominal Maximum Aggregate Size	Minimum VMA, %*[1]
Class Q1	14.5
Class Q2	14.5
Class Q3	14.5
Class Q4	14.5
Class Q5	14.5

*[1] the minimum VMA% required for hot mix during production shall be 13.5%

4.) Voids Filled with Asphalt (VFA)

VFA is calculated from the mixture bulk specific gravity at N_{design} gyrations.

Table J - Voids Filled with Asphalt Criteria	
	VFA*[1], %
Class Q1	70-80
Class Q2	65-80
Class Q3	65-78
Class Q4	65-78
Class Q5	65-75

*[1] evaluated for specification at mix design only

5.) Dust to Binder Ratio
The dust to binder ratio shall be 0.6 to 1.4 The dust to binder ratio is calculated as the percent by mass of the total material passing the #200 sieve (including hydrated lime) divided by the effective asphalt binder content (expressed as percent by mass of mix). If the aggregate gradation percent passing the #8 sieve is less than 39% at mix design, the dust to binder ratio shall be increased to 0.8 to 1.6.

6.) Moisture Sensitivity (SD 309)
The minimum retained tensile strength ratio for the mixture is 80%. The moisture sensitivity requirement will be waived if 1.00% hydrated lime is added to the mix. Hydrated lime will not be required, or can be added at a rate lower than 1.00% if the moisture sensitivity requirement is met. If lime is used, a minimum of 0.50% hydrated lime shall be added to the mix. Liquid anti-stripping additives will not be allowed in lieu of hydrated lime. An item will be included in the contract for hydrated lime. Payment for hydrated lime will only be made when hydrated lime is actually used. Moisture sensitivity will only be evaluated during the mix design process.

7.) Asphalt Pavement Analyzer: (AASHTO T 340)
Samples shall be compacted at the N_{design} gyratory level at the Contractor selected binder content and tested at the PG binder high temperature. Field samples will be tested at the binder and air void content of the selected field gyratory samples or as made at the N_{design} gyratory level from a sample of field produced mix.

Table K - Asphalt Pavement Analyzer Criteria

	APA, Maximum Rutting (mm)
Class Q1	8
Class Q2	7
Class Q3	6
Class Q4	5
Class Q5	5

8.) Moisture Content of Mix
The maximum moisture in the field produced mix shall be 0.3%. The mix shall be sampled from the windrow in front of the laydown machine and placed in an airtight tared container. The mix shall be dried to a constant mass as described in SD 305.

5. Quality Control Testing:

a. Calibration Testing:

1.) Cold Feed: Prior to production of asphalt concrete, the QC and QA certified technicians shall conduct comparison tests at the plant with a split companion cold feed calibration sample of virgin aggregate to assure that all associated

equipment and procedures provide comparable results. Comparison test results shall meet the requirements of the mix design report and shall conform to the tolerances shown in the Department's Materials Manual. The split companion calibration testing shall continue until the results meet the requirements of the mix design report and are within the listed tolerances. The split companion calibration testing shall be performed on each mix type produced prior to production of that mix type.

2.) **Mixture Testing:** The QC and the QA technicians shall perform correlation testing on a reheated prebuilt split companion sample (from the mix design process) supplied by the Contractor. The correlation testing will be for the theoretical maximum specific gravity (Rice Method) and gyratory bulk specific gravities.

Two gyratory compaction samples shall be made using a compactive effort of N_{design}. The bulk specific gravity shall than be measured on specimens compacted to N_{design} gyrations. Air voids shall be calculated using the theoretical maximum specific gravity and bulk specific gravity at N_{design} gyrations. The percent of theoretical maximum specific gravity densification shall be determined at N_{design}. The results shall be within the tolerances shown in the Department's Materials Manual.

3.) **Bulk Specific Gravity Reheat Correlation:** The QC and the QA technicians shall perform a reheat correlation test for the bulk specific gravity. The reheat correlation test shall be performed on a split sample of a sublot from within the first lot of production for the mix design. An additional reheat correlation test shall be performed on a split sample of a sublot from within the first lot of production for any new mix designs.

Cool a split portion of the sample down to room temperature. After the split sample has cooled, reheat and compact according to SD 318. Calculate the difference in the bulk specific gravities of the non-reheated and reheated tests. The average difference using the QC and QA technician's test results will be the correction factor for a reheated bulk specific gravity. This test may be repeated at the discretion of the Contractor or the Engineer.

b. **Asphalt Concrete Quality Control (Production) Testing:** After the calibration cold feed and mixture testing is completed and the results are within the specified tolerances, the Contractor will be allowed to begin production of asphalt concrete.

The Engineer shall randomly determine all sample locations. Sampling and splitting not performed by the Engineer shall be witnessed by the Engineer. To ensure that a representative random sample is obtained, the QC sample locations shall only be given to the Contractor immediately prior to sampling. The hot mix sample shall be obtained before the cold feed gradation sample. If hydrated lime is used in the mix, the hydrated lime shall be momentarily shut off while obtaining the cold feed gradation sample. If hydrated lime is to be included

in the mix, care shall be taken to ensure that the hot mix sample is obtained with hydrated lime included in the sample. There will be a 200 ton buffer between the random sample locations. The intent of the buffer is to prevent back-to-back sampling and to more evenly distribute the sampling and testing workload.

A lot shall consist of five sublots. Sublots shall not represent more than 1000 tons of asphalt concrete unless the current sublot is terminated.

The Contractor shall obtain QC samples at the specified locations for four of the five sublots. The Engineer will sample and split a minimum of one of the five sublots, and witness all QC sampling. The Contractor shall test all five sublot samples (a split of the one sublot sampled by the Engineer and four sublot samples taken by the Contractor). The material shall be sampled, split, and tested by the methods and procedures described in the Department's Materials Manual.

The aggregate and hot mix samples shall be large enough to obtain 4 splits of the minimum sample size needed for testing. If the sample is to be used for IA testing, the samples shall be large enough to obtain 6 splits of the minimum size needed for testing. Immediately after splitting, the QA technician shall take possession of half of the sample for all of the QC samples. The QA technician shall ensure the Department's portion of the backup samples for all QC and QA tests are properly labeled, stored, and retained until the Department's Bituminous Engineer has completed the F-test and t-test statistical evaluation. The QC technician shall retain their backup split until the QC, QA, and IA technicians have obtained their test results for the individual lot and have found the results to be within the allowable tolerances in the Department's Materials Manual, SD 317, and the Engineer has approved the disposal of the backup samples.

The Engineer will determine and mark the core locations after the mix is placed and compacted. The cores will be taken the next working day after the asphalt pavement is placed. The Contractor shall perform the coring under observation by the Engineer. The Engineer will take immediate possession of the core samples for density testing. The Contractor shall fill all core holes before the end of the next working day with hot asphalt concrete and compact the mix to a density close to that of the surrounding pavement.

Core samples for density will be tested by the Engineer.

The QC technician shall complete all of the required tests on the samples selected for QA or IA testing.

c. **Specification Control Limits:** The control limits of materials being produced will be evaluated under two different categories, pay factor attributes and non-pay factor attributes.

1.) **Pay Factor Attributes:** Air voids and in place density (compaction) are the two pay factor attributes. These attributes will be statistically analyzed for contract unit price adjustment.

The percent air voids shall meet the requirement in Table L and the in place density of the asphalt concrete when expressed as a percent of the lot average maximum specific gravity (Rice Method) shall meet the requirements in Table L.

TABLE L - PAY FACTOR ATTRIBUTES			
a.	% Air Voids	4.0% ± 1.0%	
b.	In Place Density (% Compaction)	Class Q1	92.0% to 96.0%
		Class Q2	92.0% to 96.0%
		Class Q3	92.0% to 96.0%
		Class Q4	92.0% to 96.0%
		Class Q5	92.0% to 96.0%

When field test results for air voids or in place density deviate from the job mix formula values, the Contractor may adjust the gradation, asphalt binder content, or both within the allowable tolerances shown for items a, b, c, and d shown in Table N. Bin splits may be adjusted up to ± 5% from the job mix formula bin splits. Adjustments shall be made as a result of an interactive process between the Contractor and the Engineer. The Contractor's recommendations shall prevail, provided all specifications and established mix design criteria are being met.

If new materials are to be incorporated into the asphalt concrete or bin split percentages are adjusted by more than 5% from the job mix formula, a new mix design will be required by the Contractor (unless otherwise approved by the Bituminous Engineer) with verification by the Department’s Bituminous Mix Design Lab. The Contractor shall be responsible to verify that all mix design criteria are being met prior to written job mix formula approval.

When a new mix design and job mix formula is required, the current sublot shall be terminated and incorporated into the previous sublot for pay factor analysis. A new lot will be started when production is changed to the new job mix formula. At the end of production, the current sublot shall be terminated and incorporated into the previous sublot unless the hot mix sample and both core sample locations have been obtained and tested for the current sublot.

2.) **Non-Pay Factor Attributes:** There are several requirements not used in the determination of the pay factor that are very important to the performance of the asphalt concrete. The below listed attributes are tested at the frequency listed in the Department’s Materials Manual. The attributes shall be maintained within the requirements in Section 322.3 B.4 or as otherwise specified.

Table M – Non-Pay Factor Attributes
Virgin Mineral Aggregate Gradation
Asphalt Binder Content
Hydrated Lime Content
Moisture Content of Mix
Sand Equivalent
Lightweight Particles
Crushed Particles
Fine Aggregate Angularity
Voids in Mineral Aggregate (VMA)
Dust to Binder Ratio
RAP Content (if used)

The asphalt binder and hydrated lime content are not statistically evaluated as pay factor attributes, but may be price adjusted (DOT-18) for failure to conform to specification requirements.

The VMA and dust to binder ratio are calculated using the asphalt binder percentage determined from the daily cutoff from that day's production. The bulk specific gravity of the mineral aggregate will be determined by the Department's Materials & Surfacing Central Laboratory during the mix design verification.

When RAP is required, the VMA will be calculated using the bulk specific gravity of the mixture, the percent stone of the mixture, and the bulk specific gravity of the aggregate as determined by the Department's Materials & Surfacing Central Laboratory during the mix design verification, all including RAP. When RAP is required, the Dust to Binder Ratio will be calculated using the percent -#200 material from the virgin aggregate, the percent hydrated lime, and the effective binder content of the total mixture including RAP.

The bulk specific gravity of the mineral aggregate may be tested during production at the discretion of the Contractor or the Engineer. A split portion of material shall be given to the other entity for verification.

If the VMA or dust to binder ratio value does not meet the requirements in Section 322.3 B.4, the Contractor shall make corrective actions before production continues and document the corrective actions taken. If three out of any five consecutive tests for VMA or dust to binder ratio exceed the criteria in Section 322.3 B.4, the Contractor shall immediately cease operations. A new mix design will be required by the Contractor (unless otherwise approved by the Department's Bituminous Engineer) with verification by the Department's Bituminous Mix Design Lab prior to resuming production. The Contractor shall be responsible to verify that all mix design criteria are being met.

TABLE N – JOB MIX FORMULA TOLERANCES		
Attribute		**Tolerance from Target Value**
a.	Sieve 5/8" thru 3/8"	± 7
b.	Sieve #4 thru #50	± 5
c.	Sieve #100 thru #200	± 2.0
d.	Percent Asphalt Binder	± 0.3
e.	Sand Equivalent*[1]	Minimum or more
f.	Percent Lightweight Particles*[1]	Maximum or less
g.	Fine Aggregate Angularity*[1]	Minimum or more
h.	Crushed Particles*[1]	Minimum or more
j.	Percent Hydrated Lime	± 0.10
k.	Asphalt Application Temperature	± 20°F
l.	Temp. of Mixture when emptied from the mixer	± 20°F
m.	Temp. of Mixture on delivery to the road	-20°F & + 30 °F
n.	Percent RAP Content (if used)	± 5

*[1] These properties are not listed on the job mix formula but will be tested for compliance with the mix design specifications listed in Tables A-E.

If two out of any five consecutive tests for the gradation requirements (Items a, b, or c) fail to meet the tolerances contained in Table N, the Contractor shall immediately cease operations. The Contractor shall investigate the cause of the variation in production. Production will not be allowed to resume until a passing cold feed sample is obtained and the Engineer has approved the corrective action.

If the asphalt binder content, hydrated lime content, or RAP content falls outside the tolerance in Table N; the Contractor shall make corrective actions before production continues and document the corrective actions taken. If two out of any five consecutive tests for the asphalt binder content, hydrated lime content, or RAP content fail to meet the tolerances contained in Table N; the corrective action shall include recalibration of the binder meter, the lime weigh and feed system, or the RAP feed system, respectively.

The maximum moisture content in the field-produced mix shall be 0.3%. If the moisture content in the mix exceeds the maximum allowed the Contractor shall make corrective actions before production continues and document the corrective actions taken. Burner adjustments, increase mix temperature, slower plant production rates, use of drier aggregates, and adjustment to the amount of time material is in drum for mixing and heating are possible corrective actions. Additional moisture content in the field-produced mix tests shall be conducted to verify that the corrective action has worked to produce specification mix.

If the sand equivalent, percent lightweight particles, fine aggregate angularity, or crushed particles (Items e, f, g, or h) for a single test fall outside the tolerances shown in Table N, the Contractor shall immediately cease operations. The Contractor shall investigate the cause of the variation in production. The Contractor will not be allowed to continue operations until a

passing cold feed sample is obtained and the Engineer has approved the corrective action.

3.) **Test Identification:** Number the production control sublot tests consecutively in accordance with the Department's Materials Manual starting with number "QC01" or "QC001" based on the total number of samples needed. The two density cores in a sublot shall have the same number along with an "A" or "B" designation and shall match the sublot number. The two gyratory specimens shall be numbered with the sublot number and an "A" and a "B" for the two specimens. Use "N" before the sublot number for non-pay factor material. Use "Info" before the number for information samples. Use "TS" before the sublot number for test strip samples. Use "R" after the number for remedial samples. Use "Cal" before the number for calibration samples.

4.) **Control Charts:** The Contractor shall provide QC charts that include the control limits and each individual test result for the following parameters:

a) Gradation of the control sieves in the Job Mix Formula
b) Asphalt Binder Content
c) Hydrated Lime Content
d) Maximum Specific Gravity (Rice)
e) Bulk Specific Gravity (Gyratory)
f) Air voids
g) In place density
h) VMA
i) Dust to Binder Ratio

QC test results shall be recorded on the control charts immediately after completion of the test. The control charts shall also include the QA and Independent Assurance test results. The control charts shall be prominently displayed and accessible to the Engineer. The control charts shall be given to the Engineer upon completion of the project.

5.) **Documentation:** The Contractor is responsible for documenting all observations, inspection records, mixture adjustments, test results, and corrective actions on a daily basis. The Contractor shall also record and maintain a plant record of plant starts and stops, mix temperatures leaving the plant, bin split of aggregates, and the temperature of the asphalt binder going into the mix.

Field observations and inspections shall be noted as they occur in a permanent duplicating field book or diary, provided by the Engineer. The roadway diaries shall include hours paved, equipment in use, stations paved, course depth, width, crown, spread checks, tonnage, weather, and temperature of mixture delivered to the road. Plant diaries shall include plant start and shutdown times, mix temperature of material produced, binder spot checks, aggregate bin splits being used, actual calculated asphalt binder

percentage for the day, tons of mix produced, mixture or aggregate adjustments, weather conditions, and any other pertinent information.

The Engineer will collect copies of documentation records and recorded mix temperature charts daily. All records shall be made available at all times upon request by the Engineer. The test results and original work sheets, including all gyratory specimen compaction sheets, for the production control testing listed in Table M shall be given to the Engineer upon completion of the test.

C. Quality Assurance: The Engineer will randomly sample and test a minimum of one sublot for each lot. The Engineer may test any or all of the splits of the QC sublot samples as part of the QA program. The Engineer will provide at least one individual certified in Asphalt Concrete Aggregate Testing and Asphalt Concrete Hot Mix Testing for conducting the QA testing and at least one individual certified in Asphalt Concrete Roadway Inspection for roadway inspection.

The QA technician will complete all of the required tests on the samples that are selected for QA testing.

The services of contractor's personnel to assist in obtaining the QA samples should be limited only to instances when hazardous conditions or liability issues exists that dictate their involvement and the following requirements are met:

1. The QA sample location or time is only given to the contractor immediately prior to sampling.
2. The contractor's personnel are used only to provide labor to assist in physically obtaining the QA sample.
3. The Engineer is present to witness the taking of the QA sample.
4. The Engineer witnessing the sampling and the contractor labor performing the sampling are certified in accordance with the Department's Certification program.
5. The Engineer immediately takes possession of the QA sample.

QA test results will be made available to the Contractor within 24 hours, or the next working day.

The split sample test results (QA) of the sample taken by the Engineer will be compared to the Contractor test results (QC) for conformance with the Department's Materials Manual. Populations of the QC sample test results will be compared to the QA sample test results utilizing the procedures shown in SD 317. If the test results are within the allowable tolerances, found to be similar, and found to represent the same population, as determined by F-test and t-test statistical evaluation procedures conducted by the Bituminous Engineer, the Contract unit price adjustments will be based on the Contractor QC test results.

Sampling and splitting not required to be performed by the Engineer will be witnessed by the Engineer.

The Engineer will test the core samples for density.

The Engineer will perform or witness the measurement of the depth of the asphalt binder in the storage tanks as described in SD 314. The Engineer will determine the temperature of the asphalt binder in the tank and will perform the daily calculation of the asphalt binder content.

The Engineer will perform the daily calculation of the hydrated lime content.

The Engineer will test the moisture content of the hot mix. The mix for the moisture test shall be sampled from the windrow in front of the laydown machine and placed in an airtight, tared container. The mix shall be dried to a constant mass as described in SD 305.

D. Independent Assurance Procedures: The Department will perform Independent Assurance (IA) testing on project produced materials. Random samples of mineral aggregate and hot mix asphalt concrete used for QC testing will be selected by the Region Materials Engineer for IA testing.

The Region Materials Engineer will perform IA testing for the attributes listed in the Department's Materials Manual. The tolerances from the Department's Materials Manual will be used to independently evaluate the QC and QA testing procedures and equipment. The Region Materials Engineer shall witness the sampling and splitting of the designated IA sample (an actual sublot sample). The Region Materials Engineer may select either Engineer or Contractor sampled sublot for the IA testing.

The Region Materials Engineer will also perform IA testing for the bulk specific gravity on in place density cores. A separate IA core shall be obtained by the Contractor while obtaining the in place density core used to determine the pay factor. The IA core shall be taken at the same offset and within one foot of the core used in determining the pay factor.

E. Dispute Resolution System: Process verification procedures using F-test and t-test statistical evaluation procedures to determine if both QC and QA test results represent the same sample population may result in the need for testing backup sublot samples and substituting the new test result for pay factor calculations. If the QC and QA test results do represent the same population, as determined by F-test and t-test statistical evaluation procedures, the Contractor's test results may be used for quality acceptance.

322.4 METHOD OF MEASUREMENT AND ACCEPTANCE

The method of measurement shall be as prescribed in Section 320.4 except the method of measurement for QA and QC field laboratories and the method of measurement and acceptance for asphalt concrete will be made according to the following:

A. Asphalt Concrete: The asphalt concrete shall be statistically accepted by lots. A lot shall consist of five sublots. Sublots shall not represent more than 1000 tons unless the current sublot is terminated. The first lot shall start at the beginning of production or following the Control Test Strip.

A lot will be terminated when a new mix design is completed and a new job mix formula is issued. If less than five sublots have been completed when a lot is terminated, the sublots will be included in the previous lot, and the pay factor computed for the revised lot. If there is no previous lot, the lot will not be terminated until five sublots are obtained.

1. **Determination of Contract Unit Price Adjustment:** Asphalt concrete that is not compacted according to the Specified Density Method will not be included in the pay factor calculations but may be price adjusted (DOT-18) for failure to conform to specification requirements. The material specified to be sampled and tested on a QC/QA basis will be evaluated for payment under this subsection. All QC test results for a lot will be analyzed collectively and statistically by the Quality Level Analysis-Standard Deviation Method using the procedures herein defined. The lots will be analyzed to determine the total estimated percent of the lot that is within the specification limits.

   Quality Level Analysis (specification conformance analysis) is a statistical procedure for estimating the percent of material that is within the specification limits (PWL). The PWL is determined by using the lot mean, ($\overline{X}$) and the lot standard deviation(s). Two measures of quality are required to establish the contract unit price adjustment. The first measure is the Acceptable Quality Level (AQL) which is the PWL at which the lot will receive 100% pay or a composite pay factor of 1.00. The second measure of quality is the Rejectable Quality Level (RQL) at which the Engineer has determined the material may not perform as desired and may be rejected.

   The AQL has been selected at 90 PWL and the RQL at 60 PWL. The RQL using the pay factor equation will result in 85% pay or a pay factor of 0.85.

   An individual pay factor for any attribute resulting in less than 85% pay may result in the lot being rejected.

   When the Acceptable Quality Level of any individual pay factor attribute has a QL of 90 or less the composite pay factor shall not exceed 1.00.

   A lot may be accepted provided the composite pay factor is at least 0.85 and there are no isolated defects identified by the Engineer.

   A lot containing material with less than a 0.85 composite pay factor may be rejected. All of the rejected material shall be removed from the work. The Engineer will determine if the material may remain in place at a reduced price. A lot containing material with less than a 0.85 composite pay factor may not be overlaid prior to the Engineer determining the acceptability of the lot.

   The Engineer may reject any quantity of material that appears to be defective based on visual inspection or test results. The visual rejection may include segregation, low temperature material, very high or low asphalt content, etc. Such rejected material

shall not be used in the work or included with the lot acceptance tests. Rejected material will not be measured for payment.

The Contractor may elect to remove any defective material and replace it with new material to avoid a pay factor less than 1.00. Any such new material will be sampled, tested, and evaluated for acceptance according to this specification.

2. **Quality Level Analysis:** The standard deviation method procedures are as follows:

   a. Only test results on material incorporated in the work will be included in the quality level analysis.

   b. Calculate the arithmetic mean ($\overline{X}$) of the test values:

$$\overline{X} = \frac{\Sigma x}{n}$$

   Where:
   Σ = summation of
   x = individual test value to x_n
   n = total number of test values

   c. Calculate the sample standard deviation(s):

$$S = \sqrt{\frac{n\Sigma(x^2)-(\Sigma x)^2}{n(n-1)}}$$

   Where:
   $\Sigma(x^2)$ = summation of the squares of individual test values.
   $(\Sigma x)^2$ = summation of the individual test values squared.

   d. Calculate the upper quality index (Q_U):

$$Q_U = \frac{USL - \overline{X}}{s}$$

   Where: USL = upper specification limit or target value (TV) plus allowable deviation.
   Target Value = the single specification value which would result in an ideal product.

   e. Calculate the lower quality index (Q_L):

$$Q_L = \frac{\overline{X} - LSL}{s}$$

Where: LSL = lower specification limit or target value minus allowable deviation.

f. Determine P_U (percent within the upper specification limit which corresponds to a given Q_U) from Table P.

Note: If a USL is not specified, P_U will be 100.

g. Determine P_L (percent within the lower specification limit which corresponds to a given Q_L) from Table P.

Note: If an LSL is not specified, P_L will be 100.

h. Determine the Quality Level (the total percent within specification limits).

Quality Level (QL) = $(P_U + P_L) - 100$

i. To determine the pay factor for each individual attribute (PF) = 55 + 0.5(QL).

j. Determine the Composite Pay Factor (CPF) for each lot. The third decimal place of the CPF shall be rounded to the nearest hundredth by the computer program.

$$CPF = \frac{[f_1(PF_1) + f_2(PF_2)]}{(100)\ \Sigma f}$$

f = 1 to 2

Where: $f_{1 \text{ or } 2}$ = price adjustment factor listed in Table O for each measured attribute.

$PF_{1 \text{ or } 2}$ = Pay Factor for each measured attribute.

Σf = Sum of the "f" (price adjustment) factors.

The asphalt concrete pavement contract unit price will be adjusted according to Section 322.4. Payment for the asphalt concrete will be made at a price determined by multiplying the contract unit price by the composite pay factor. The following table will be used to calculate the composite pay factor:

Table O - Pay Attributes & Price Adjustment Factors	
Measured Attribute	**Factor "f"**
Design Air Voids	50
In Place Density (% Compaction)	50

All mineral aggregate testing prior to production and QC/QA testing shall be incidental to the contract unit price per ton for asphalt concrete.

Asphalt concrete will be measured to the nearest 0.1 ton. The mixture of mineral aggregate and asphalt will be weighed after mixing. No deduction will be made for the weight of the asphalt included in the mixture.

Deduction will not be made for material removed from temporary approaches. Deductions will be made for all rejected and wasted asphalt concrete pavement.

B. QA and QC Field Laboratories: There will be no measurement or payment for the QC laboratory furnished and used by the Contractor to perform the QC testing. The Contractor furnished QA laboratory will be measured in accordance with Section 600.4.

322.5 BASIS OF PAYMENT

The basis of payment shall be as prescribed in Section 320.5 except the basis of payment for asphalt binder, asphalt concrete, and QA and QC field laboratories will be made according to the following:

A. Asphalt Binder: The accepted quantities of asphalt binder will be paid for at the contract unit price per ton. The amount bid for this item shall be at least the cost of the asphalt binder furnished and delivered to the project site.

Payment for the asphalt binder is not subject to the statistical pay factor adjustment.

B. Asphalt Concrete: The accepted quantities of asphalt concrete, will be paid for at the contract unit price as adjusted by the pay factor calculations in Section 322.4 of this specification per ton complete and accepted in place.

Asphalt concrete that is not compacted according to the Specified Density Method will not be included in the pay factor calculations. Asphalt concrete that is not included in the pay factor calculations shall be paid for at the contract unit price per ton.

The contract unit price of asphalt concrete shall include all cost for labor, equipment, materials, testing, and all incidentals required to furnish and place the asphalt concrete mix according to these specifications.

C. Laboratories:

1. **QC Laboratory:** The laboratory used by the Contractor for QC testing shall be incidental to the asphalt concrete pavement item(s).

2. **QA Laboratory:** Payment for the QA laboratory will be according to Section 600.5 of the Standard Specifications.

TABLE P - QUALITY LEVELS
QUALITY LEVEL ANALYSIS BY STANDARD DEVIATION METHOD

P_u or P_l Percent Within Limits for Positive Values Of Q_u or Q_l	UPPER QUALITY INDEX Q_U OR LOWER QUALITY INDEX Q_L														
	n=3	n=4	n=5	n=6	n=7	n=8	n=9	n=10 to n=11	n=12 to n=14	n=15 to n=18	n=19 to n=25	n=26 to n=37	n=38 to n=69	n=70 to n=200	n=201 to n=∞
100	1.16	1.50	1.79	2.03	2.23	2.39	2.53	2.65	2.83	3.03	3.20	3.38	3.54	3.70	3.83
99		1.47	1.67	1.80	1.89	1.95	2.00	2.04	2.09	2.14	2.18	2.22	2.26	2.29	2.31
98	1.15	1.44	1.60	1.70	1.76	1.81	1.84	1.86	1.91	1.93	1.96	1.99	2.01	2.03	2.05
97		1.41	1.54	1.62	1.67	1.70	1.72	1.74	1.77	1.79	1.81	1.83	1.85	1.86	1.87
96	1.14	1.38	1.49	1.55	1.59	1.61	1.63	1.65	1.67	1.68	1.70	1.71	1.73	1.74	1.75
95		1.35	1.44	1.49	1.52	1.54	1.55	1.56	1.58	1.59	1.61	1.62	1.63	1.63	1.64
94	1.13	1.32	1.39	1.43	1.46	1.47	1.48	1.49	1.50	1.51	1.52	1.53	1.54	1.55	1.55
93		1.29	1.35	1.38	1.40	1.41	1.42	1.43	1.44	1.44	1.45	1.46	1.46	1.47	1.47
92	1.12	1.26	1.31	1.33	1.35	1.36	1.36	1.37	1.37	1.38	1.39	1.39	1.40	1.40	1.40
91	1.11	1.23	1.27	1.29	1.30	1.30	1.31	1.31	1.32	1.32	1.33	1.33	1.33	1.34	1.34
90	1.10	1.20	1.23	1.24	1.25	1.25	1.26	1.26	1.26	1.27	1.27	1.27	1.28	1.28	1.28
89	1.09	1.17	1.19	1.20	1.20	1.21	1.21	1.21	1.21	1.22	1.22	1.22	1.22	1.22	1.23
88	1.07	1.14	1.15	1.16	1.16	1.16	1.16	1.17	1.17	1.17	1.17	1.17	1.17	1.17	1.17
87	1.06	1.11	1.12	1.12	1.12	1.12	1.12	1.12	1.12	1.12	1.12	1.12	1.12	1.13	1.13
86	1.04	1.08	1.08	1.08	1.08	1.08	1.08	1.08	1.08	1.08	1.08	1.08	1.08	1.08	1.08
85	1.03	1.05	1.05	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04
84	1.01	1.02	1.01	1.01	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.99	0.99	0.99
83	1.00	0.99	0.98	0.97	0.97	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.95	0.95	0.95
82	0.97	0.96	0.95	0.94	0.93	0.93	0.93	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
81	0.96	0.93	0.91	0.90	0.90	0.89	0.89	0.89	0.89	0.88	0.88	0.88	0.88	0.88	0.88
80	0.93	0.90	0.88	0.87	0.86	0.86	0.86	0.85	0.85	0.85	0.85	0.84	0.84	0.84	0.84
79	0.91	0.87	0.85	0.84	0.83	0.82	0.82	0.82	0.82	0.81	0.81	0.81	0.81	0.81	0.81
78	0.89	0.84	0.82	0.80	0.80	0.79	0.79	0.79	0.78	0.78	0.78	0.78	0.77	0.77	0.77
77	0.87	0.81	0.78	0.77	0.76	0.76	0.76	0.75	0.75	0.75	0.75	0.74	0.74	0.74	0.74
76	0.84	0.78	0.75	0.74	0.73	0.73	0.72	0.72	0.72	0.71	0.71	0.71	0.71	0.71	0.71
75	0.82	0.75	0.72	0.71	0.70	0.70	0.69	0.69	0.69	0.68	0.68	0.68	0.68	0.68	0.67
74	0.79	0.72	0.69	0.68	0.67	0.66	0.66	0.66	0.66	0.65	0.65	0.65	0.65	0.64	0.64
73	0.76	0.69	0.66	0.65	0.64	0.63	0.63	0.63	0.62	0.62	0.62	0.62	0.62	0.61	0.61
72	0.74	0.66	0.63	0.62	0.61	0.60	0.60	0.60	0.59	0.59	0.59	0.59	0.59	0.58	0.58
71	0.71	0.63	0.60	0.59	0.58	0.57	0.57	0.57	0.57	0.56	0.56	0.56	0.56	0.55	0.55
70	0.68	0.60	0.57	0.56	0.55	0.55	0.54	0.54	0.54	0.53	0.53	0.53	0.53	0.53	0.52
69	0.65	0.57	0.54	0.53	0.52	0.52	0.51	0.51	0.51	0.50	0.50	0.50	0.50	0.50	0.50
68	0.62	0.54	0.51	0.50	0.49	0.49	0.48	0.48	0.48	0.48	0.47	0.47	0.47	0.47	0.47
67	0.59	0.51	0.47	0.47	0.46	0.46	0.46	0.45	0.45	0.45	0.45	0.44	0.44	0.44	0.44
66	0.56	0.48	0.45	0.44	0.44	0.43	0.43	0.43	0.42	0.42	0.42	0.42	0.41	0.41	0.41
65	0.52	0.45	0.43	0.41	0.41	0.40	0.40	0.40	0.40	0.39	0.39	0.39	0.39	0.39	0.39
64	0.49	0.42	0.40	0.39	0.38	0.38	0.37	0.37	0.37	0.37	0.36	0.36	0.36	0.36	0.36
63	0.46	0.39	0.37	0.36	0.35	0.35	0.35	0.34	0.34	0.34	0.34	0.34	0.33	0.33	0.33
62	0.43	0.36	0.34	0.33	0.32	0.32	0.32	0.32	0.31	0.31	0.31	0.31	0.31	0.31	0.31
61	0.39	0.33	0.31	0.30	0.30	0.29	0.29	0.29	0.29	0.29	0.28	0.28	0.28	0.28	0.28
60	0.36	0.30	0.28	0.27	0.27	0.27	0.26	0.26	0.26	0.26	0.26	0.26	0.26	0.25	0.25
59	0.32	0.27	0.25	0.25	0.24	0.24	0.24	0.24	0.23	0.23	0.23	0.23	0.23	0.23	0.23
58	0.29	0.24	0.23	0.22	0.21	0.21	0.21	0.21	0.21	0.21	0.20	0.20	0.20	0.20	0.20
57	0.25	0.21	0.20	0.19	0.19	0.19	0.18	0.18	0.18	0.18	0.18	0.18	0.18	0.18	0.18
56	0.22	0.18	0.17	0.16	0.16	0.16	0.16	0.16	0.16	0.15	0.15	0.15	0.15	0.15	0.15
55	0.18	0.15	0.14	0.14	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13
54	0.14	0.12	0.11	0.11	0.11	0.11	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10
53	0.11	0.09	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08
52	0.07	0.06	0.06	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
51	0.04	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.02
50	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

NOTE: For negative values of Q_U or Q_L, P_U or P_L is equal to 100 minus the table P_U or P_L. If the value of Q_U or Q_L does not correspond exactly to a figure in the table, use the next higher value.

14. QC/QA Asphalt Construction:

General Notes:

The total aggregate submitted for mix design verification shall be from 400 to 500 pounds (180 to 230 kilograms).

14.1 Tolerance between QC, QA and IA Test Results

A. Comparison test results shall conform to the tolerances shown in the following table:

Table 1. TOLERANCE BETWEEN QC, QA, AND IA TEST RESULTS

	Attribute	Tolerance
a.	Sieve 3/8 inch (9.5 mm) & larger	± 5
b.	Sieve #4 (4.75 mm) thru #50 (300 µm)	± 3
c.	Sieve #100 (150 µm) thru #200 (75 µm)	± 1.5
d.	Lightweight Particles	± 1.0
e.	Sand Equivalent	± 7
f.	Crushed Particles	±10
g.	Fine Aggregate Angularity	± 1.0
h.	Air Voids	± 1.2
i.	Bulk Specific Gravity of Asphalt Concrete (gyratory) @ N_{design}	± 0.020
j.	Mixture Densification @ N_{design}	± 1.2
k.	Maximum Specific Gravity (Rice)	± 0.020
l.	Bulk Specific Gravity of In Place Density Cores	± 0.020

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14.2 Minimum Frequency for Production Sampling/Testing

Table 2. MINIMUM FREQUENCE FOR PRODUCTION SAMPLING/TESTING

		Minimum Frequency			
Test		**QC**	**QA**	**IA**	**Test Method**
Virgin Mineral Aggregate Gradation*		1/1000 ton (M ton)	1/5000 ton (M ton)	1/15000 ton (M ton)	SD 202
Lightweight Particles*		1/1000 ton (M ton)	1/5000 ton (M ton)	1/15000 ton (M ton)	SD 208 & SD 214
Sand Equivalent*		1/1000 ton (M ton)	1/5000 ton (M ton)	1/15000 ton (M ton)	SD 221
Crushed Particles*		1/1000 ton (M ton)	1/5000 ton (M ton)	1/15000 ton (M ton)	SD 211
Fine Aggregate Angularity*		1/1000 ton (M ton)	1/5000 ton (M ton)	1/15000 ton (M ton)	SD 217
Max. Specific Gravity of Asphalt Concrete (Rice Method)**		1/1000 ton (M ton)	1/5000 ton (M ton)	1/15000 ton (M ton)	SD 312
Bulk Specific Gravity of Asphalt Concrete (gyratory)**	N_{design}	1/1000 ton (M ton)	1/5000 ton (M ton)	1/15000 ton (M ton)	SD 318 (average of 2 specimens)
Mixture Densification	N_{design}	1/1000 ton (M ton)	1/5000 ton (M ton)	1/15000 ton (M ton)	Calculation (SD 318)

Voids in Mineral Aggregate (VMA) @ N_{design}	1/1000 ton (M ton)	1/5000 ton (M ton)	1/15000 ton (M ton)	Calculation (SD 318)
Dust to Binder Ratio	1/1000 ton (M ton)	1/5000 ton (M ton)	1/15000 ton (M ton)	Calculation (SD 318)
Asphalt Binder Content (sticking the tank)**	1 per day	1 per day	1 per project	SD 314
Hydrated Lime Content**	1 per day	1 per day	None	Form DOT-33Q
RAP Content (if used)**	1 per day	1 per day	None	Form DOT-93
Moisture Content of Mix***	1/10000 ton (M ton)	1/10000 ton (M ton)	None	SD 305
Density, In Place****	2/1000 ton (M ton)	2/1000 ton (M ton)	1/15000 ton (M ton)	SD 315

* Samples shall be taken according to SD 201 Section 3.2.
** As necessary to control process.
*** Samples shall be taken from the windrow in front of the laydown machine.
**** Two density cores per 1000 ton (M ton) sublot shall be taken for determination of in place density. The average of the two core density results will be the 1000 ton (M ton) sublot value used for density in the pay factor calculations. An IA core must be taken during the first 5,000 (M ton) tons of hot mix tested for in place density and then at a minimum frequency of one core per 15,000 tons (M ton) thereafter.

The Contractor may request to reduce the QC testing frequency when the QC samples and the QA samples indicate acceptable results within the specifications located in Section 322 of the Standard Specifications for Roads and Bridges and the tolerances from Table 1 for sand equivalent, lightweight particles, crushed particles, and fine aggregate angularity and the Engineer and the Contractor are both confident that future production will meet specifications. The reduction in test frequency shall be authorized in writing by the Area Engineer. 15

The Area Engineer shall notify the Contractor in writing of the reduction in testing frequency and a copy of this letter shall be forwarded to the Region Materials Engineer and Certification Engineer. A reduction in testing frequency may be revoked by the Area Engineer at any time.

The frequency of tests performed may be reduced using the following procedure. The QC technician shall complete all tests on the first lot of material produced. A reduction in the frequency of testing shall be allowed based upon the average test results obtained from the first lot of material tested by the QC technician. This reduction in test frequency for any of the test shown in the QC Test Frequency Reduction Guidelines shall remain in effect as long as the test results remain within the range of the testing frequency currently being used.

The frequency of the QC testing for sand equivalent, lightweight particles, and crushed particles may be further reduced beyond what is shown in the QC Test Frequency Reduction Guidelines by the Area Engineer. The Area Engineer may reduce the frequency beyond what is shown in the QC Test Frequency

Reduction Guidelines based on an evaluation of test results from the material source.

A. **QC TEST FREQUENCY REDUCTION GUIDELINES**

Sand Equivalent

10 or more above minimum	Reduce test frequency to 1 test per lot
7 to 9 above minimum	Reduce test frequency to 2 tests per lot
4 to 6 above minimum	Reduce test frequency to 3 tests per lot
Within 3 of minimum	No reduction in test frequency

+#4 and -#4 Lightweight Particles (less than 1.95 Specific Gravity)

Results of 0.0% lightweight particles	Reduce test frequency to 1 test per lot
1.5% or more below maximum	Reduce test frequency to 1 test per lot
1.1 to 1.4% below maximum	Reduce test frequency to 2 tests per lot
0.6 to 1.0% below maximum	Reduce test frequency to 3 tests per lot
Within 0.5% of maximum	No reduction in test frequency

Crushed Particles

Results of 100% crushed faces	Reduce test frequency to 1 test per lot
25% or more above minimum	Reduce test frequency to 1 test per lot
16 to 24% above minimum	Reduce test frequency to 2 tests per lot
6 to 15% above minimum	Reduce test frequency to 3 tests per lot
Within 5% of minimum	No reduction in test frequency

Fine Aggregate Angularity

2.5% or more above minimum	Reduce test frequency to 1 test per lot
2.0 to 2.4% above minimum	Reduce test frequency to 2 tests per lot
1.5 to 1.9% above minimum	Reduce test frequency to 3 tests per lot
Within 1.4% of minimum	No reduction in test frequency

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14.3 Dispute Resolution System

A. If the differences between the QC and QA results are greater than allowed in Table 1 or SD 317, the Engineer will investigate the reason for the difference. The investigation may include review and observation of test procedures and equipment. The QA technician shall test the next QC sample as soon as a difference between any QC and QA test result is found. The Engineer may require that a sample be tested jointly by the Contractor's QC technician, the Engineer's QA technician, and the Region Materials Engineer. The Region Materials Engineer test results or, if necessary, the Department’s Materials & Surfacing Central Laboratory test results will be the referee used for acceptance and will determine which sample test results will be incorporated into the pay factor calculations only when a dispute between the QA and QC sample cannot be resolved.

C. Asphalt Binder.

(1) Tier 2.

(2) Certification.
A Certificate of Compliance is required for each conveyance or load of asphalt delivered to a project. The original and one copy should be received with each load delivered to the project.

NOTE: The Department is a member of a Combined State Binder Group. The group includes surrounding state Department of Transportation and a variety of suppliers of asphalt binder materials who have become certified through the process outlined by the group's publication. The certification and testing requirements shall be the same for materials received from these suppliers as with other suppliers.

(3) Acceptance.
One randomly selected sample per 200 ton (180 mton), per type, grade, and source. Sample size: two 1 qt. (1 L) samples. A certificate of compliance for each conveyance or load the sample represents must be submitted with each sample.

The sample shall be obtained from an in-line-sampling valve located between the storage unit and the mix plant. (SD 301)

Detailed analysis shall be made on the 1st sample of each type or grade, from each source, then on a random basis for each 200 ton (180 mton) per type, grade, and source.

Identification tests may be made on all samples for which the detailed analysis is not made.

(4) Independent Assurance.
One sample per project. Observation of acceptance sampling is permissible for this sample. None required for contract quantities less than 100 ton (90 mton).

D. Asphalt Binder Content.

(1) Tier not applicable.

(2) Certification.
None required.

(3) Acceptance.
Calculated daily using measured quantity of asphalt and tonnage of mix produced for each mix design. (DOT-89)

NOTE: The asphalt binder content shall be carried over and calculated with the next day of production if less than 500 ton (450 mton) of material is produced for the day. In case that there is no next day of production, an asphalt binder content shall be measured and reported for the smaller than 500 ton (450 mton) day.

NOTE: If asphalt concrete is being produced by a commercial source that is supplying two or more different types of mixes with different binder contents throughout the day, the binder content may be determined by using one of the following methods:

(1) Stick the tank before each change of making different types of mixes as shown above for determining the quantity of binder used and the daily binder content.

(2) Determine the binder content by using the ignition oven test method (AASHTO T 308) with at least one test per day for determining the quantity of binder used and the daily binder content.

(3) The quantity of asphalt binder may be determined by the use of a certified binder pump/flow meter. The Contractor will be responsible for pump/flow meter certification. Certification shall be performed by a State scale inspector, a licensed private testing company, or a qualified representative of the pump/flow meter manufacturer. Certification shall be evidenced by a letter of certification or seal. Pump/flow meters must be certified within the past 12 months. Use the print out sheet from the plant pump/flow meter showing the amount of binder added into the asphalt mix furnished to the project to determine the quantity of binder used and the daily binder content.

(4) Independent Assurance.
None required.

E. RAP Content

(1) Tier not applicable.

(2) Certification.
None required.

(3) Acceptance.
Calculated daily. (DOT-93)

(4) Independent Assurance.
None required.

F. Lime Content

(1) Tier not applicable.

(2) Certification.
None required.

(3) Acceptance.
Calculated daily using weighed quantity of lime and tonnage of mix produced. (DOT-33)

NOTE: Lime supplied by non-certified lime plants will require 1 acceptance sample per 750 tons.

(4) Independent Assurance.
None required.

Section Number 3

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SOUTH DAKOTA
DEPARTMENT OF TRANSPORTATION

MATERIALS TESTING & INSPECTION CERTIFICATION PROGRAM MANUAL

Revised November 2015

SOUTH DAKOTA DEPARTMENT OF TRANSPORTATION

MATERIAL TESTING & INSPECTION CERTIFICATION PROGRAM MANUAL

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Appendix 1 - Equipment Calibration Frequencies
Appendix 2 - Equipment Calibration List, Procedures, and Records
Appendix 3 - SDDOT Asphalt Concrete QC/QA Certification Program

LIST OF ABBREVIATIONS

AASHTO	American Association of State Highway and Transportation Officials
ACI	American Concrete Institute
AMRL	AASHTO Materials Reference Laboratory
ASTM	American Society for Testing and Materials
CCRL	Cement and Concrete Reference Laboratory
CFR	Code of Federal Regulations
FHWA	Federal Highway Administration
IA	Independent Assurance
NHS	National Highway System
NIST	National Institute of Standards and Technology
QC	Quality Control
QA	Quality Assurance
QC/QA	Quality Control and Quality Assurance
SDDOT	South Dakota Department of Transportation
SDBOP	South Dakota Bureau of Personnel

REFERENCES

SDDOT Standard Specifications for Roads and Bridges, current edition

SDDOT Materials Manual, current edition

GLOSSARY OF TERMS

AASHTO Accredited Laboratories - Laboratories that satisfy the quality system requirements specified in AASHTO Practice R 18 and received an on site assessment from AMRL and/or CCRL for which test method accreditation is being sought.

Abuse - An intentional deviation from approved procedures.

Acceptance Testing – Acceptance samples and tests include the samples and tests used for determining the acceptability of the materials and workmanship which have been or are being incorporated in the project. They are the principal basis for determining the acceptability of the projects' materials and construction.

Certified Individual - An individual, who has successfully demonstrated through passing the required written and/or performance exams, with the knowledge and skills required to properly sample and test material or provide inspection of construction activities.

Certification Program - The process in-place that provides the requirements for those seeking certification and administration of the program.

Course Exam - An exam taken at the end of an approved course to gain certification.

Ethical Work - All work shall be accomplished honestly in a professional manner in accordance with the plans, specifications, contract, materials manual, or any other pertinent requirements. It shall be considered unprofessional and inconsistent with proper conduct and contrary to the public interest:

a) To act for his/her client or for his/her employer other than as a faithful agent or trustee.
b) To accept remuneration for services rendered other than from his/her client or his/her employer.
c) To attempt to injure (falsely or maliciously) the professional reputation of another individual or business.
d) To exert undue influence or to offer, solicit, or accept compensation for the purpose of affecting negotiations of a contract or contract item.
e) To act in any manner derogatory to honor, integrity, and dignity.

Independent Assurance (IA) Testing – Independent Assurance samples and tests are the samples taken, tests made, and other procedures performed for the expressed purpose of making independent checks on the reliability of the results of Acceptance sampling and testing. They do not provide test results for acceptance.

Inspection - The process of observing, measuring, examining, testing, gauging, or otherwise evaluating materials, products, services, testing activities, and equipment to determine their acceptability in meeting specification requirements.

Misconduct - An intentional wrongdoing or deliberate violation of the requirements of the certification program.

Negligence - A repeated unintentional deviation from approved procedures, which may or may not cause erroneous results.

Permanent Employee - A full time individual employed by a company or organization, who normally works 40 hours per week 52 weeks per year for the same company or organization.

Performance Exam - An exam taken by an individual to show that he/she has the knowledge and ability to perform the specified test.

Proficiency Sample - A standardized sample given to multiple laboratories to evaluate the performance of the laboratories and those performing the tests.

Quality - Consistently conforming to mutually agreed upon requirements.

Quality Assurance - All those planned and systematic activities necessary to provide adequate confidence that a product or service will satisfy given requirements for quality. In the laboratory, quality assurance should provide adequate confidence in each test result reported by the laboratory.

Quality Control - The sum of total activities performed by the seller (producer, manufacturer, and/or contractor) to make sure that a product meets contract specification requirements. Within the context of highway construction this includes materials handling and construction procedures, calibration and maintenance of equipment, production process control, and any sampling, testing, and inspection that is done for these purposes.

Recertification Exam - An exam taken by an individual to obtain certification in those areas for another specified time frame.

Reciprocity - When the Certification is granted to an individual based on other certifications, licenses, etc.

Re-test Exam - A different exam, other than the one that was previously failed, given to an individual to obtain certification.

SOUTH DAKOTA DEPARTMENT OF TRANSPORTATION

MATERIALS TESTING & INSPECTION CERTIFICATION PROGRAM MANUAL

I. Objective:

The Federal Highway Administration (per 23 CFR 637 Subpart B) requires that all individuals performing acceptance testing or independent assurance testing shall be certified and all testing equipment be calibrated at a specified frequency for all work on the National Highway System. The intent is to continually improve the quality of our highway system. With the adoption of quality control/quality assurance specifications, many more individuals are testing and inspecting, which requires training and good testing equipment to provide consistency and repeatability of results. The intent of the program is to assure that the quality of the inspection, testing, and testing equipment is uniform and consistent in providing quality results.

This Certification Program does not apply to the SDDOT Central laboratory. The Central Laboratory shall meet the requirements of CFR 637.209(a)(2).

All activities must be conducted in accordance with this manual.

A. There are three major parts to the program:

1. Calibration of Testing Equipment includes calibrations, standardizations and checks of equipment.
2. Material Testing Certification of Individuals.
3. Inspection Certification of Individuals.

B. The Program applies to highway construction on all highway systems plus all informal/maintenance projects which require testing and inspection as determined by the Region Engineer or Region Materials Engineer. 15

C. Any individual, who is performing acceptance or independent assurance testing of material, shall be certified.

D. Any individual, who is performing acceptance inspection of contract work in the areas designated by this program, shall be certified.

E. Overall Program Responsibility: The SDDOT Materials & Surfacing Program has the overall responsibility to administer this program. The duties and responsibilities of those individuals in the Materials & Surfacing Program to meet the administrative requirements shall be as outlined in this document.

F. The current edition of the SDDOT Materials Manual, Standard Specifications and Special Provisions shall be used as the source for the following:

1. Minimum Acceptance, Quality Control and Quality Assurance Testing Frequencies.

2. Minimum Independent Assurance Testing Frequencies.
3. Sampling and Testing Procedures.
4. Procedures for handling failing test results.
5. Procedures for the identification, conditioning, storage, retention, and disposal of test samples.

II. Testing Equipment: All testing equipment shall be calibrated to assure uniformity in the testing equipment and to provide more uniform test results. The Independent Assurance testing will be used to monitor uniformity of the testing equipment and procedures. Each entity is responsible for the maintenance and repairs of their own testing equipment.

A. Requirements: All testing equipment identified by the Materials & Surfacing Program shall:

1. Be calibrated at the required Frequency (Appendix 1).
2. Be calibrated according to the Equipment Calibration Procedures (Appendix 2), (Example Figure 1).
3. The equipment calibration shall be recorded on the Equipment Calibration Records (Appendix 2), (Example Figure 2). Where large numbers of a particular type of equipment exist, it will be permissible to list as many items on one record document as it will accommodate provided all required documentation, measurements, and any other required information is shown for each equipment item.
4. Equipment Calibration Records shall be retained for a period of three years.
5. No equipment shall be used for testing if it does not meet the calibration requirements. This may require corrective work or disposing of the non-conforming equipment.

B. Responsibilities:

1. Materials & Surfacing Program:
   a) Develop and furnish Equipment Calibration Frequencies, Procedures, & Records.

2. Region Materials:
   a) Calibrate SDDOT Region & Area equipment.
   b) Maintain equipment inventory.
   c) Maintain equipment calibration records.

3. Area Office:
   a) Ensure Area, Contractor, Consultant, or other's equipment is calibrated prior to use. This will require submitting Area Office equipment to Region Materials for calibration.
   b) Review Contractor, Consultant, or other entities' records. The Area Office will need to ensure that the consultant, contractor, or other entity's equipment calibration records are available for review on the project site. The Area Office is not required to check the equipment calibration, unless there appears to be a need.

IA testing will be used to monitor accuracy of equipment calibration and uniformity of testing procedures. The Area has the authority to check equipment at any time for any reason.

4. Contractor, Consultant, or other entities:
   a) Calibrate their equipment prior to use on project.
   b) Maintain their equipment inventory.
   c) Maintain their equipment calibration records.
   d) Have a copy of current equipment calibration records available on project site.
   e) Cooperate in the inspection conducted by SDDOT of their facilities, equipment, and/or records.

5. Individual:
   a) Each individual shall be responsible for keeping well-maintained and clean equipment and workspace.
   b) Each individual shall assure that their equipment has been calibrated and is functioning as intended.

III. Individual Certification: Any individual, who is performing Acceptance, Quality Control, Quality Assurance or Independent Assurance testing of materials and/or acceptance inspection in the areas designated by this program, shall be certified.

A. Certification will be required for all personnel who will be performing Materials Testing or Project Inspection in the following areas:

1. Materials Testing:
   a) Soils - SD 103, 104, 105, 106, 108, 110 & 114.

   b) Aggregate - SD 201, 202, 203, 206, 207, 208, 211, 212, 213, 214, & 219.

   c) Asphalt Aggregate Testing - SD 108, 201, 202, 206, 207, 208, 211, 212, 213, 214, 217 & 221, Hot Mix Testing – SD 301, 305, 306, 307, 311, 312, 313, 314, 315, 317 & 502.

   d) Fresh Concrete - SD 402, 403, 404, 405, 408 & 411

2. Project Inspection:
   a) Earthwork, Pipe Installation, Erosion Control.
   b) Structures.
   c) Concrete Paving.
   d) Concrete Plants.
   e) Asphalt
   f) Erosion & Sediment Control/Storm Water Management.

B. Materials Testing Certification:

1. Requirements for Permanent Personnel:

a) Initial certification:

1) Soils or Aggregate: The individual must successfully complete each segment of the Department's Soils and Aggregate Testing Course.

Asphalt: Individual must follow the procedures for certification contained in Appendix 3 of this document. The individual must attend the course and pass the required exams prior to sampling and testing materials associated with asphalt concrete construction.

Fresh Concrete: Individual must be certified as an ACI Concrete Field Testing Technician – Grade I prior to sampling and testing concrete. SDDOT personnel are required to attend the SDDOT+ presentation on DOT procedures. Testing out of the ACI Certification Course will not be allowed.

2) Permanent SDDOT employees, who will be sampling and testing materials for acceptance, are expected to become certified in at least one material testing area within one year of their date of hire. Until an individual is certified, they shall function in accordance with the parameters established for temporary or seasonal personnel.

3) All of the Materials Testing certifications are valid for four (4) years (except the ACI Certification which is valid for five (5) years, after which time the individual must become recertified before the expiration date of the current certification.

b) Recertification:

1) Soils or Aggregate: Recertification must be accomplished by successfully completing the course with Performance Exams or successfully completing the Re-certification process with Performance Exams on an alternating basis every four (4) years and before the expiration date of the current certification. Re-certification process can be scheduled through the Region Materials Engineers Office.

Participation in conducting any of the Department sponsored Certification testing and inspection courses as an instructor, will fulfill the requirement for certification or 15

recertification for that course for a period not to exceed four years.

2) Asphalt: Individual must follow the procedures for recertification contained in Appendix 3 of this document.

3) Fresh Concrete: Individuals certified by ACI must follow the current ACI procedures to become recertified.

2. Requirements for Temporary & Seasonal Personnel:
   a) Temporary and seasonal personnel who are utilized to perform materials testing duties shall obtain a copy of the test procedure(s) and become familiar with them.
   b) Shall observe a certified technician perform the test procedure.
   c) Shall perform the test procedure until proficiency is achieved.
   d) Shall demonstrate the test procedure to a certified technician. The certified technician shall use the Performance Checklist for the test being demonstrated to ascertain all steps are performed correctly. This document shall be retained as verification of successful demonstration of the procedure.
   e) Shall have a copy of the applicable test procedure available during the demonstration testing and while testing material on the project.
   f) Shall work on the same project under direct supervision of an individual certified in that area of testing.
      Direct Supervision (Materials Testing): A non-certified individual may perform tests or portions of tests only under direct observation of a Certified Technician until such time the non-certified technician demonstrates they can consistently perform the test or portion thereof in accordance with the outlined procedures. From that point on, the non-certified individual can perform the test or portion thereof whether or not a Certified Technician is physically present at the test site. The Certified Technician is however required to spend time at the project/laboratory on a daily basis. The Certified Technician assumes all responsibility for the accuracy of the test data and signifies so by placing their initials on the worksheet as the checker.
   g) A copy of the Performance Checklist for the test(s) in which a Temporary or Seasonal individual has demonstrated proficiency and the Training & Evaluation Record document for all non-DOT personnel used on a project shall be available for review in the Project File at the Area Office and in the laboratory on the project. These records for Temporary or Seasonal DOT Personnel shall be available for review at the Area office.
   h) Individuals must be certified as an ACI Concrete Field Testing Technician – Grade I if testing Fresh Concrete.
   i) Asphalt: Individuals on QC/QA asphalt projects must follow the procedures contained in Appendix 3 of this document.

C. Inspection Certification:

1. Requirements for Permanent Personnel:

a) Initial Certification:

1) Asphalt Inspections: Individual must follow the procedures for certification contained in Appendix 3 of this document. The individual must attend the certification course and pass the required exams prior to inspection of asphalt concrete.

2) Erosion and Sediment Control/Storm Water Management: The individual must attend the training course and pass the required exam prior to inspections. This certification is good for 3 years.

3) All Other Inspection Areas: Permanent SDDOT employees, who will be performing acceptance inspection, are expected to become certified in at least one inspection area within one year of their date of hire. Until they become certified, they shall function in accordance with the parameters established for temporary or seasonal personnel. Certifications are valid for four years, after which the individual must become recertified before the expiration date of the current certification.

b) Recertification:

1) Asphalt Inspections: Individual must follow the procedures for recertification contained in Appendix 3 of this document.

2) Erosion and Sediment Control and Storm Water Management: Individuals wanting to maintain certifications must attend the course and successfully pass the exam every 3 years.

3) All Other Inspection Areas: Recertification must be accomplished by completing the re-certification process or successfully completing the course on an alternating basis every four (4) years and before the expiration date of the current certification. Contractors and Consultants need to contact the Region Materials Engineers office nearest their area to sign up for re-certification courses.

2. Requirements for Temporary & Seasonal Personnel:

a) An individual's qualifications (certifications, education, and experience) will be considered in determining their ability to provide proper inspection in a particular area.

b) The individual must work on the same project under direct supervision of an inspector certified in that inspection area.
Direct Supervision (Inspection): A non-certified individual may perform inspection of a phase of work only under the direct observation of a Certified Technician until such time the non-certified individual demonstrates a thorough understanding and knowledge of the requirements and procedures for that phase of work. From that point on, the non-certified individual may inspect that phase of work whether or not a Certified Technician is physically present on the project. The Certified Technician shall however spend time on the project on a daily basis. The Certified Technician assumes all responsibility for the accuracy of the documentation provided and shall place his/her initials on the document to verify review and approval.

c) The certified inspector will determine whether the temporary or seasonal person is qualified for a particular area of inspection.

d) The individual shall review the applicable Course Manual and have it available for use on the project.

e) Temporary or seasonal personnel will not be required to take any of the inspection certification courses.

f) A copy of the Training & Evaluation Record document showing the area(s) in which a Temporary or Seasonal individual has demonstrated proficiency for inspection for non-DOT personnel used on a project shall be available for review in the Project File at the Area Office and on the project. These records for Temporary or Seasonal DOT Personnel shall be available for review at the Area Office.

g) Individuals must be certified in Erosion and Sediment Control/Storm Water Management.

D. Responsibilities - Material Testing:

1. Materials & Surfacing Program shall:

a) Maintain a list of Certified Individuals.

1) Retain records (exams) for five (5) years.

2) Create and maintain a current database of all certification records.

3) Provide a letter of notification to all individuals who fail to achieve a passing score. (A copy of this letter will be provided to the Area Engineer and the Region Materials Engineer for DOT employees or to the Employer and Region Materials Engineer if the individual is not a DOT Employee.)

4) Provide each individual a card at the beginning of the construction season indicating the areas in which they are certified and the expiration date of each certification.

5) At the beginning of each construction season, provide the Operations and Area Engineers with a tabulation of the personnel in their respective Regions/Areas that are

certified, along with the expiration dates for those certifications.

6) Distinguish between the types of exam given to the individual (re-test, re-certification, provisional, or course exam) for each certification area.

2. Region Materials
   a) Monitor certified individual's test procedures and comparison results through Independent Assurance testing.
   b) Verify temporary and seasonal personnel test procedures and comparison results through Independent Assurance testing.
   c) Administer and grade the written and performance re-certification and re-test exams for Soils & Aggregate Testing and applicable QC/QA levels to Area Office personnel, Contractors, Consultants, and other entities.
   d) Responsible for sending their individuals to the appropriate certification courses.
   e) Notify Area Office, Consultant, Contractor, or other entity of an individual's substandard test procedures or comparison results.
   f) Ensure all necessary equipment calibration records are complete and on file.

3. Area Office
   a) Ensure projects are staffed with properly certified Area personnel and verify Contractor, Consultant, or other Entity personnel are certified in the area in which they are working.
   b) Qualify SDDOT temporary and seasonal employees annually.
   c) Maintain documentation of seasonal qualifications on *Training and Evaluation Record* (Figure 3).
   d) Ensure that Certified Personnel are meeting the supervision requirements for temporary or seasonal personnel.
   e) Take appropriate action when notified of an individual's substandard test procedure or comparison results.

4. Contractors, Consultants & Other Entities
   a) Responsible for sending their individuals to the appropriate certification courses.
   b) Ensure properly certified individuals staff the project.
   c) Qualify their own temporary and seasonal employees annually.
   d) Maintain documentation on seasonal qualifications on *Training and Evaluation Record* (Figure 3).
   e) Take appropriate action when notified of an individual's substandard test procedures or comparison results.
   f) Have a copy of the Equipment Calibration Records for all Testing equipment used on the project available for review in the Project Files at the Area Office and also in the testing laboratory on the project.

5. Certified Individual
   a) Ensure he/she works only in the areas for which he/she has been certified.
   b) Ensure that certifications are kept current.
   c) Ensure the material tests are performed in accordance with the material test procedures and material test results are reported to the required precision.
   d) Ensure the equipment has been calibrated and properly maintained.
   e) Ensure that test samples are retained for the specified period of time. When a time period is not specified, passing samples shall be disposed of in a safe and expeditious manner after the testing is complete and the test results have been approved. Ensure that applicable State or Federal guidelines or regulations for the disposal of materials are strictly adhered to.
   f) Ensure work is accomplished in an ethical manner.
   g) Each Certified Individual will be allowed to supervise a maximum of 2 temporary or seasonal employees in an area in which they are certified.
   h) The Certified Individual will be responsible for overseeing the temporary or seasonal employee's work and initial any reports.
   i) Take corrective action when notified of substandard testing procedures or comparison results.

E. Responsibilities - Inspection

1. SDDOT Central Office personnel will:
   a) Assist in the development of the certification course material and/or provide instructors for the inspection and testing classes.
   b) Ensure exams are graded by the Lead Instructors.
   c) Materials and Surfacing Program will maintain a List of Certified Individuals in each of the inspection areas.
      1) Retain records (exams) for five (5) years.
      2) Create and maintain a current database of all certification records.
      3) Provide a letter of notification to all individuals who fail to achieve a passing score. (A copy of this letter will be provided to the Area Engineer and the Region Materials Engineer for DOT employees or to the Employer and Region Materials Engineer if the individual is not a DOT Employee.)
      4) Provide each individual a card at the beginning of the construction season indicating the areas in which they are certified and the expiration date of each certification.
      5) At the beginning of each construction season, provide the Operations and Area Engineers with a tabulation of the personnel in their respective Regions/Areas that are certified along with the expiration dates for those certifications.

2. Region Materials
   a) Administer and grade the re-certification and re-test exams for the various inspection areas to Area Office personnel, Contractors, Consultants, and other entities.

3. Area Office
   a) Ensure projects are staffed with properly certified Area personnel and verify Contractor, Contractor, Consultant & Other Entities' personnel are certified in the inspection area in which they are working.
   b) Responsible for sending their individuals to the appropriate certification course.
   c) Verify SDDOT temporary and seasonal employee inspection proficiency.
   d) Maintain documentation of seasonal qualifications on *Training and Evaluation Record* (Figure 3).
   e) Ensure that Certified Personnel are meeting the supervision requirements for temporary or seasonal personnel.
   f) Take appropriate action when notified of an individual's substandard work.

4. Contractors, Consultants & Other Entities
   a) Responsible for sending their individuals to the appropriate certification course.
   b) Ensure properly certified individuals staff the project.
   c) Verify temporary and seasonal employee inspection proficiency.
   d) Maintain documentation of seasonal qualifications on *Training and Evaluation Record* (Figure 3).
   e) Take appropriate action when notified of an individual's substandard work.

5. Certified Individual
   a) Ensure he/she works only in areas for which he/she has been certified.
   b) Ensure that certifications are kept current.
   c) Ensure inspections are conducted to verify compliance with plans and specifications and that proper documentation is made.
   d) Ensure work is accomplished in an ethical manner and non-specification work is properly documented and reported to the Area Engineer.
   e) Qualify temporary & seasonal employees based on education, experience, and/or successful completion of exam.
   f) Each Certified Inspector will be allowed to directly supervise a maximum of two (2) temporary or seasonal employees in an area in which they are certified.
   g) The Certified Inspector will be responsible for overseeing the temporary or seasonal employee's work and shall initial any reports.
   h) Take corrective action when notified of substandard work.

F. Conflict of Interest:

In order to avoid a conflict of interest, no individual or laboratory shall perform more than one of the following types of testing on the same project:

- Acceptance Testing
- Quality Control Testing
- Quality Assurance Testing
- Independent Assurance Testing
- Dispute Resolution Testing

Note: The Region Materials Laboratory may perform Dispute Resolution Testing on QC/QA projects.

G. Dispute Resolution Testing: Dispute resolution testing of materials shall be accomplished by the SDDOT Central Testing Laboratory, AASHTO Accredited Laboratories, Region Materials Laboratory or other SDDOT Approved Accredited Laboratories. The dispute resolution system shall be administered by the SDDOT.

H. Suspension/Revocation of Certification: Any suspension or revocation of an individual's certification shall be administered by the Oversight Committee. A meeting of the Oversight Committee may be called at any time by the Chair of the committee or by a written request to the Chair by at least three committee members. A majority of the members shall be present for the transaction of official business.

1. Oversight Committee members are:
   a) Chief Materials & Surfacing Engineer - Chair.
   b) Director of Operations. 15
   c) Certification/Accreditation Engineer.
   d) Pavement and Materials Engineer, FHWA.
   e) One Region Operations Engineer rotated on a five (5) year basis.
   f) One Area Engineer rotated on a five (5) year basis.
   g) Consultant Engineering Firm representative - appointed by the Chair serving a five (5) year term.
   i) Region Materials Engineers

2. Oversight Committee responsibilities:
   a) The purpose of the Oversight Committee is to review the certification program on an annual basis or as often as deemed necessary by the Chair of the Committee.

b) Investigate and resolve (majority vote) written allegations of misconduct. Allegations of misconduct shall be made to the Chair of the Oversight Committee in writing. The allegation shall contain the name, phone number, address, and signature of the individual(s) making the allegation. The allegations will be investigated by the Oversight Committee. If warranted, the accused and the individual(s) making the allegation will be given the opportunity to appear before the Oversight Committee to resolve the allegation. The Chair of the Oversight Committee will provide written notification to all of the involved parties of the decision of the Oversight Committee. Any warranted penalties may be imposed as determined by the Oversight Committee.

For just cause the Oversight Committee may impose suspension or revocation of an individual's certification at any time. The reasons that an individual will be subject to revocation or suspension of their certification are falsification of records/tests/reports, negligence, or abuse of their responsibilities. The Oversight Committee may also suspend or revoke an individual's certification for other reasons of just cause, which may or may not be specifically defined.

Negligence is defined as repeated unintentional deviations from approved procedures, which may or may not cause erroneous results. A reoccurring finding of negligence will result in a letter from the Oversight Committee to the Employer directing them to write a letter of reprimand to the individual. A continuing finding will result in a thirty (30) day suspension of the individual's certification. Any subsequent finding will be treated as abuse.

Abuse is defined as intentional deviations from approved procedures. (Examples of abuse include, but are not limited to: the falsification of test results or records, submittal of false information on certification applications, and/or unwillingness to follow prescribed test procedures.) The first instance of abuse shall result in a one (1) year suspension of an individual's certification. Any subsequent finding of abuse shall result in the permanent revocation of the individual's certification.

Any findings of abuse or negligence warranting the revocation or suspension of an individual's certification will result in the revocation or suspension of all certifications held by that individual in the various Material Testing or Inspection Areas. When the suspended individual is reinstated and prior to performing work, the individual will be required to pass the written and/or performance re-certification exams, as applicable, and the individual's recertification expiration date(s) will be that expiration date(s) held prior to the suspension.

Falsification of records/tests/reports: Any person who knowingly makes any false statements of records/tests/reports as to the quantity, quality, or cost of the material used on, or the work performed on any federal-aid project is also subject to be fined or imprisoned in accordance with Title 18, United States Code Section 1020.

c) Investigation and resolution (majority vote) of any appeals of exam scores due to ambiguous question(s) or problem(s) with the course exam(s). For just cause the Oversight Committee may adjust an exam score of an individual, if investigation and resolution of the written request warrants such action. The individual must provide a written appeal with the justification(s) why the question(s) or problem(s) was/were ambiguous within 60 calendar days from the date of the exam.

d) The Oversight Committee will notify the employer of all actions taken.

e) Other duties as required to successfully implement and continue the Certification Program.

I. Reciprocity:

1. Reciprocity may be allowed for soil and aggregate material testing. The individual's qualifications will be reviewed by the Materials and Surfacing Program to see if they meet SDDOT standards of material testing. Reciprocity will not be granted for inspection certification or asphalt and concrete material testing certification.

2. Reciprocity may also be granted for erosion & sediment control/storm water management when the individual provides documentation he/she is certified in one or more of the following.
   a) Certified Professional in Erosion and Sediment Control (CPESC)
   b) Certified Professional in Storm Water Quality (CPSWQ)
   c) Certified Erosion, Sediment and Storm Water Inspector (CESSWI)
   d) Certified Storm Water Compliance Inspector (CSWCI)
   e) Certified Preparer of SWPPPs (CPSWPPP)
   f) Other States' certification in Erosion and Sediment Control/Storm Water Management will be considered contingent on the individual also passing the SDDOT exam.

Note: Individual certifications will be verified by a representative from SDDOT Office of Project Development, Environmental Program.

IV. Exams

A. Types of Exams:

1. Written Exams:
   a) Types of written exams:
      1) Course Exam.
      2) Re-test Exam.
      3) Re-certification Exam.
      4) Provisional Exam.

   Note: A Provisional Certification is an exam opportunity made available upon approval by the Chairman of the Certification Advisory Committee for QC/QA Asphalt Projects or by the Chairman of the Oversight Committee for the Materials Testing & Inspection Program to provisionally certify an individual so they may provide inspection or testing for only one construction season. A provisionally certified individual will need to attend the next available course for the applicable area of expertise to maintain that certification. This process is permitted only when there is a shortage of certified individuals as a result of a locally heavy workload in combination with unforeseen circumstances. This individual must pass the written examination for the area of work in which they are going to perform. Following successful completion of the written examination, the provisional status individual must work under direct supervision of a certified individual for a period of not less than two (2) days to ascertain the individual knows the applicable project requirements and/or testing procedures.

   b) Exams will be open book unless precluded by the approved testing entity.

   c) A minimum overall score of 70% on the written exam shall be obtained to successfully pass the written exam or as deemed passing by the approval testing entity.

   d) If the written exam is failed, the individual will be given one more opportunity to pass another written exam. The re-test exams will be scheduled at the convenience of the Region Materials Engineer and within 30 calendar days of the original written exam. *NOTE: The Region Materials Engineer cannot administer a re-test for the ACI course. This re-test must be rescheduled with a duly authorized ACI representative. The Region Materials Engineer cannot administer a re-test for the Erosion and Sediment Control/Storm Water Management certification. The course must be retaken to maintain certification.* If a re-test is failed, the individual will not be allowed to provide inspection, acceptance testing, or independent assurance testing for that certifiable area until the individual has taken the appropriate class and successfully completed the written exam(s).

      NOTE: Any individual failing the written exam in an attempt to become <u>re-certified</u> will not be allowed to re-test and will be required to attend the appropriate class and successfully complete

the written exam before being allowed to provide inspection, acceptance testing or independent assurance testing for that certifiable area. Individuals failing the written and/or performance exam(s) may be utilized to provide inspection and acceptance testing provided the rules under "Requirements for Temporary & Seasonal Personnel" are followed and only at the discretion and approval of the Region Materials Engineer.

2. Performance Exams:
   a) Types of Performance Exams:
      1) Course Performance Exam.
      2) Re-test Performance Exam.
      3) Re-certification Performance Exam.
      4) Provisional Performance Exam.

   Note: A Provisional Performance Exam is an exam opportunity made available upon approval by the Chairman of the Certification Advisory Committee for QC/QA Asphalt Projects or by the Chairman of the Oversight Committee for the Materials Testing & Inspection Program to provisionally certify an individual so they may provide inspection or testing for only one construction season. A provisionally certified individual will need to attend the next available course for the applicable area of expertise to maintain that certification. This process is permitted only when there is a shortage of certified individuals as a result of a locally heavy workload in combination with unforeseen circumstances. This individual must pass the performance examination for the area of work in which they are going to perform. Following successful completion of the performance examination, the provisional status individual must work under direct supervision of a certified individual for a period of not less than two (2) days to ascertain the individual knows the applicable project requirements and/or testing procedures.

   b) The individual will be required to demonstrate and/or explain the material test procedure as determined by the testing agency.
   c) Individuals shall successfully complete all of the items covered on the checklist for each test method within the test procedure time restraints. The omission of one or more of the prescribed procedures will constitute failure of the performance test method. The individual will be allowed two trials on the day of the performance examination for each test procedure. Failure of any one of the prescribed tests after two trials will constitute failure of the entire performance exam. Grading of the performance exam is on a Pass/Fail basis.
   d) Any individual failing the performance exam on the day of the examination has the opportunity to retake another exam at the scheduling convenience of the department.
   e) If the individual fails the performance exam a second time, they will not be allowed to provide testing in that certifiable area until the individual attends the appropriate class and successfully completes the exam(s).

NOTE: Any individual failing a performance exam in an attempt to become re-certified will not be allowed to re-test and will be required to attend the appropriate class and successfully complete the performance exam before being allowed to provide inspection, acceptance testing or independent assurance testing for that certifiable area. Individuals failing the written and/or performance exam(s) may be utilized to provide inspection and acceptance testing provided the rules under "Requirements for Temporary & Seasonal Personnel" are followed and only at the discretion and approval of the Region Materials Engineer.

B. Requirements:

1. Materials Testing Certification:
   a) Pass Written Exam.
   b) Pass Performance Exam.

2. Inspection Certification:
   a) Pass Written Exam.

V. Certification Courses:

Courses will be provided by SDDOT or other SDDOT approved entities. Each individual attending any of the certification courses or test outs shall furnish their social security, driver's license or employee number. The number will be used as the key identifier for tracking each individual's certification record.

A. Instructors: SDDOT will provide instructors or other authorized individuals to teach the courses.

B. Enrollments: The South Dakota Bureau of Personnel (BOP) Training Program will support the SDDOT in maintaining course enrollment information and provide printed rosters to be e-mailed to the instructors. The instructors shall provide an accurate roster of those attendees actually at the course to the SDDOT Materials & Surfacing Program at the completion of each course.

1. SDDOT Employees: DOT approving authority will send an e-mail requesting attendance at the certification course to the Department's Personnel Assistant at the Personnel Office who will forward the request to TRAINING REGISTRATION (an e-mail address). The enrollment information includes: Employee name, department, employee work address, employee's or supervisor's phone number, employee's social security number/employee's identification number/employee's drivers license number, organization MSA number, and course title, date, & location. Confirmation of enrollment and the AFE number is sent to the DOT approving authority.

2. Non-DOT Persons: The DOT/BOP will announce the course prerequisites, cost, date(s), and time to the Non-DOT target audience. The company can enroll their personnel in the certification course by e-mail to ctr@state.sd.us or letter through the mail. Enrollment information includes: employee name, company, company billing address, employee work address, employee's or supervisor's phone number, employee's social security number or drivers license number, and course title, date, & location. Confirmation of enrollment will be sent to the employee's supervisor or company.

3. Attendance Cancellation Policy: If the individual enrolled in the course cannot attend, the individual, supervisor, or company is required to cancel their registration at least 24 hours prior to the start of the certification course. To cancel an individual from the certification course call (605) 773-3461. Failure to cancel will result in a no show and deprive a person on the waiting list from being able to attend.

C. Costs of Certification Courses: The SDDOT will determine the cost of the certification course for those they are conducting. Other entities providing certification courses (ACI, Erosion & Sediment Control & Asphalt QC/QA) will determine the cost of the certifications that they provide. These costs will be provided in the course announcements. The cost of course manuals may be billed separately.

D. Contractor, Consultant, or Other Entities:

1. Shall pay for certification courses and manuals as outlined above.
2. Shall be charged for certification course enrollees who do not show at the class. A refund of the registration fee(s), if prepaid, will be granted if the class is canceled by the SDDOT. If notified on the day of the course that an individual is unable to attend due to inclement weather or good cause (605-773-3461), the registration fee may be refunded.

PROCEDURE FOR CALIBRATING, STANDARDIZING OR CHECKING EQUIPMENT

Original 12/96, Revised 8/21/08, 5/11

PROCEDURE #6

Equipment Checked:

SIEVES M 92

Purpose:

To provide instructions for checking the physical condition of laboratory test sieves ranging in size from 3" to the #4, and visually from the #8 to the #200.

Inspection Equipment Required:

1. Caliper readable to 0.0005" (0.01 mm).

Tolerance:

Sieves shall meet the physical requirements in the test methods listed above.

Procedure for 3" to #4

1. Measure and record three openings along a 45 ^{o} angle.
2. Verify that the openings are within tolerance.

Visual inspection for sieves finer than #4

1. Inspect the general condition for waviness, dents, scratches or looseness. Record findings.

Figure 1 - Example of a Procedure for Calibrating Equipment

EQUIPMENT CALIBRATION, STANDARDIZATION OR CHECK RECORD

Revised 11/2010, 5/11

PROCEDURE #6

Date: _____ Checked by: _____

Equipment: COARSE SIEVES M 92

Previous check date: _____ Next due: _____ Frequency: 12 Months Max

Inspection Equipment and Serial Number:

Caliper readable to 0.0005" (0.01 mm) #: _____

							Action Recommended	
Sieves	**Specification (mm)**	**Serial No. or I.D. No.**	**Reading 1**	**Reading 2**	**Reading 3**	**Average**	**Accept**	**Replace**
3" (75 mm)	72.8 - 77.2							
2 - 1/2" (63 mm)	61.1 - 64.9							
2" (50 mm)	48.5 - 51.5							
1 - 1/2" (37.5 mm)	36.4 - 38.6							
1 - 1/4" (31.5 mm)	30.5 - 32.5							
1" (25.0 mm)	24.2 - 25.8							
3/4" (19.0 mm)	18.4 - 19.6							
5/8" (16.0 mm)	15.5 - 16.5							
1/2" (12.5 mm)	12.11 - 12.89							
3/8" (9.5 mm)	9.2 - 9.8							
5/16" (8.0 mm)	7.75 - 8.25							
1/4" (6.3 mm)	6.1 - 6.5							
#4 (4.75 mm)	4.6 - 4.9							
#5 (4.00 mm)	3.87 - 4.13							

Figure 2 - Example of a Record for Calibrating Equipment

SDDOT Material Testing & Inspection Certification Program

Training and Evaluation Record

Temporary or Seasonal Name: _____ Project: _____

Employee Number: _____ PCN: _____

Test Method and Inspection	Check One		Evaluated By	Title	Date	Comments
	Pass	Fail				

CC: Region Materials Engineer

Figure 3

APPENDIX 1

SOUTH DAKOTA DEPARTMENT OF TRANSPORTATION
REGION AND FIELD/LAB AREA
Revised March 28, 2014
BITUMINOUS MATERIALS AREA

APPARATUS	REQUIREMENT	**IA** REGION CALIBRATION & VERIFICATION FREQUENCY	**ACCEPTANCE** FIELD LAB/AREA CALIBRATION & VERIFICATION FREQUENCY	TEST METHOD	PROCEDURE NUMBER
Ovens	Standardize thermometric device.	12 mo.	Prior to use on project		02
Sieves					
Coarse	Check physical condition and opening dimensions.	12 mo.	12 mo.	M 92	06
Fine	Check physical condition.	12 mo.	12 mo.	M 92	06
Vacuum System	Standardize.	12 mo.	12 mo.	T 100, T 209	09
Marshall Hammer	Check critical dimensions and weight of hammer.	12 mo.	12 mo.	T 245, SD 313	16
Mechanical Marshall Hammer Correlation	Standardize.	36 mo.	36 mo.	T 245, SD 313	17
Rice Pycnometers	Standardize.	36 mo.	12 mo.	T 209, SD 312	21
Marshall Molds & Breaking Head	Check critical dimensions.	12 mo.	12 mo.	T 245, SD 313	30
Mechanical Shaker (Thoroughness)	Check sieving thoroughness.	12 mo. Permanent Locations	24 mo. Permanent Locations	T 27	40
Thermometers	Standardize.	12 mo.	12 mo.		44
Balances and Scales	Standardize.	12 mo. Perm. Loc.	Prior to use on project	M 231	45
Gyratory Molds, Ram Heads & Base Plates	Check critical dimensions.	12 mo.	12 mo.	T 312, SD 318	49
Uncompacted Void Content Apparatus	Check dimensional tolerances.	12 mo.	12 mo.	T 304, SD 217	76
Gyratory Compactor	Standardize.	12 mo.	12 mo.	T 312, SD 318	78
Caliper	Standardize	12 mo.	12 mo.		81
10' Straightedge	Standardize.	12 mo.	12 mo.	ASTM E 1703	82

SOUTH DAKOTA DEPARTMENT OF TRANSPORTATION
REGION AND FIELD/LAB AREA
Revised July 2014
SOIL AND AGGREGATE AREA

APPARATUS	REQUIREMENT	**IA** REGION CALIBRATION & VERIFICATION FREQUENCY	**ACCEPTANCE** FIELD LAB/AREA CALIBRATION & VERIFICATION FREQUENCY	TEST METHOD	PROCEDURE NUMBER
Ovens	Standardize thermometric device.	12 mo.	Prior to use on project.		02
Handheld Rammer (Proctor)	Check weight & critical dimensions.	12 mo.	12 mo.	T 99, T 180, SD 104	04
Molds (Proctor)	Check critical dimensions.	12 mo.	12 mo.	T 99, T 180, SD 104	05
Sieves					
Coarse	Check physical condition and opening dimensions.	12 mo.	12 mo.	M 92	06
Fine	Check physical condition.	12 mo.	12 mo.	M 92	06
Liquid Limit Device & Grooving Tool	Check wear & critical dimensions.	12 mo.	12 mo.	T 89, SD 207	15
Specific Gravity Apparatus (Coarse Agg)	Check critical dimensions.	12 mo.	12 mo. *	T 85, SD 210	23
Flakiness Index Slotted Plate	Checking Flakiness Index	12 mo.	12 mo.	SD 203, SD 202	25
Conical Mold & Tamper	Check critical dimensions.	24 mo.	24 mo. *	T 84, SD 209	33
Mechanical Shakers (Thoroughness)	Check sieving thoroughness.	12 mo.	Prior to use on project	T 27	40
Thermometers	Standardize	12 mo.	Prior to use on project	T 88, T 100	44
Balances and Scales	Standardize	12 mo.	Prior to use on project	M 231	45
Mechanical Rammer (Proctor)	Standardize	12 mo.	12 mo.	T-99, T-180, D 2168 SD 104	67
Rubber Balloon Density Apparatus	Calibrate.	12 mo.	12 mo.	T 205, SD 106	68
Specific Gravity Flasks	Calibrate.	12 mo.	12 mo. *	T 84, SD 209	69
Straightedge	Check critical dimensions & planeness of edge.	12 mo.	12 mo.	T 99, T 180, SD 104	70
Sand Equivalent Apparatus	Check critical dimensions.	12 mo.	12 mo.	T 176, SD 221	75
Caliper	Standardize	12 mo.	12 mo.		81
10' Straightedge	Standardize	12 mo.	12 mo.	ASTM E 1703	82

***Additional Calibration required for QC/QA Asphalt Mix Designs**

SOUTH DAKOTA DEPARTMENT OF TRANSPORTATION
REGION AND FIELD/LAB AREA
Revised July 2014
CONCRETE AREA

APPARATUS	REQUIREMENT	**IA** REGION CALIBRATION & VERIFICATION FREQUENCY	**ACCEPTANCE** FIELD LAB/AREA CALIBRATION & VERIFICATION FREQUENCY	TEST METHOD	PROCEDURE NUMBER
Unit Weight Measures	Standardize.	12 mo.	12 mo.	T 19, T 121, SD 205, SD 403, SD 411	07
Compression Machine Bearing Blocks	Check planeness.	12 mo.	12 mo.	T 22	11
Slump Cones	Check critical dimensions.	12 mo.	12 mo.	T 119, SD 404	38
Concrete Cylinder Molds (Single Use)	Check dimensions.	Each Shipment	Each Shipment	M 205, SD 405	43
Balances and Scales	Standardize	12 mo.	Prior to use on project	M 231	45
Compression Testing Machine	Standardize.	12 mo.	12 mo.	T 22	45
Air Meter Pressure (Type A)	Standardize	12 mo.	Prior to use on project	T 152, SD 403	59
Concrete Cylinder Molds (Reusable)	Check critical dimensions.	12 mo.	12 mo.	T 22, M 205, SD 405	71
Air Meter Pressure (Type B)	Standardize	3 month max when in use or 600’ change in elevation	Prior to use on project	T 152, SD 403	72
Caliper	Standardize.	12 mo.	12 mo.		81
10' Straightedge	Standardize	12 mo.	12 mo.	ASTM E 1703	82

Appendix 2

LISTING OF REGION & FIELD LAB CALIBRATION PROCEDURES May 2011

EQUIPMENT	PROCEDURE #	RECORD #
OVENS	02	02
HANDHELD RAMMER (PROCTOR)	04	04
MOLDS (4" AND 6" PROCTOR)	05	05
SIEVES (COARSE)	06	06-C
SIEVES (FINE)	06	06-F
UNIT WEIGHT MEASURE	07	07
VACUUM SYSTEM	09	09
COMPRESSION MACHINE BEARING BLOCKS	11	11
LIQUID LIMIT DEVICE & GROOVING TOOL	15	15
MARSHALL HAMMER	16	16
MECHANICAL MARSHALL HAMMER CORRELATION	17	17
RICE PYCNOMETERS	21	21
SPECIFIC GRAVITY APPARATUS (COARSE AGG)	23	23
FLAKINESS INDEX SLOTTED PLATE	25	25
MARSHALL MOLD	30	30
CONICAL MOLD & TAMPER	33	33
SLUMP CONE	38	38
MECHANICAL SHAKER (THOROUGHNESS)	40	40
CONC. CYL. MOLDS (SINGLE USE)	43	43
THERMOMETERS	44	44
SCALES, BALANCES, ANALYTICAL BALANCES, LOAD CELLS & COMPRESSION MACHINES	45	45
GYRATORY MOLDS, RAM HEADS & BASE PLATES	49	49
AIR METER PRESSURE (TYPE A)	59	59
MECHANICAL RAMMER (PROCTOR)	67	67
RUBBER BALLOON DENSITY APPARATUS	68	68
SPECIFIC GRAVITY FLASKS	69	69
STRAIGHTEDGE	70	70
CONC. CYL. MOLDS (REUSABLE)	71	71
AIR METER PRESSURE (TYPE B)	72	72
SAND EQUIVALENT APPARATUS	75	75
UNCOMPACTED VOID CONTENT APPARATUS	76	76
GYRATORY COMPACTOR	78	78
Caliper	81	81
10' Straightedge	82	82

Appendix 3

SOUTH DAKOTA DEPARTMENT OF TRANSPORTATION ASPHALT CONCRETE QUALITY CONTROL / QUALITY ASSURANCE CERTIFICATION PROGRAM

1. SCOPE:

The purpose of this program is to develop and maintain a pool of well-trained technicians for the Department and its contractors, and to test and manage highway construction materials. The intent of this program is to improve the quality and performance of hot mixed asphalt pavements through knowledge and understanding of the products.

2. CERTIFICATION LEVELS:

Introduction to Asphalt Concrete (strongly recommended but not mandatory.)

Asphalt Concrete Aggregate Testing. Tests covered: SD 108, SD 201, SD 202, SD 206, SD 207, SD 208, SD 211, SD 212, SD 213, SD 214, SD 217 and SD 221.

Asphalt Concrete Hot Mix Testing. Test covered: SD 301, SD 305, SD 306, SD 307, SD 311, SD 312, SD 313, SD 314, SD 315, SD 317 and SD 318.

Asphalt Concrete Roadway Inspection. Test covered: Parts of SD 312 and SD 315.

Asphalt Concrete Mix Design & Production Control. Test covered: SD 209, SD 210, SD 309, SD 316, SD 317 and SD 319.

Aggregate Testing, Asphalt Concrete Hot Mix Testing and Asphalt Concrete Roadway Inspection are prerequisites to Asphalt Concrete Mix Design and Production Control.

3. CERTIFICATION STANDARDS:

When the South Dakota Department of Transportation specifications require Quality Control / Quality Assurance testing, those technicians performing the sampling and testing must be certified in South Dakota. Certification may be attained in one of the following ways:

A. Technicians currently certified in a surrounding state have the opportunity to test out of Asphalt Concrete Roadway Inspection. The candidate may request to test out of this specific certification level by requesting in writing to the Chief South Dakota Department of Transportation Materials and Surfacing Engineer their desire to test out. The candidate must furnish documented work history showing that the candidate has been involved in the specific work area the past four years that relates to the certification level and have a current applicable certification level from one of the surrounding states.

B. Candidates not eligible to test out must attend the certification course.

1. As a prerequisite to attending the certification course, the candidate must exhibit basic mathematics and comprehensive reading skills.

2. The candidate shall successfully complete the classroom and laboratory evaluations if the course requires a laboratory evaluation.

    a. Laboratory Evaluation – Candidates must successfully perform in the presence of a qualified evaluator, all necessary tests required to control hot mixed asphalt mixtures as outlined in the course manual.

    b. Classroom Evaluation – Each candidate shall successfully pass an open book written examination administrated by a qualified evaluator.

        i. Successfully passing the written examination shall be defined as scoring a minimum of 70 percent.

        ii. A candidate failing the written examination shall be given the opportunity to retest within a period of thirty (30) days. There will be no charge for the retest.

        iii. Failure to pass the retest shall be considered as failing the entire course. Students still desirable of becoming certified must retake the entire course.

3. No refund of course fees will be made for failure to successfully complete the course.

C. Provisional Certification may be allowed under special circumstances.

1. The applicant's employer, whether SDDOT or contractor, must include the circumstances for the needed provisional status. These circumstances must outline the reasons for application and should be detailed enough for the Certification Advisory Committee to understand the organizational need for provisional certification.

2. A prior work history of the applicant must accompany the request for provisional status.

3. Whoever is applying for provisional certification in Asphalt Concrete Aggregate Testing, Asphalt Concrete Hot Mix Testing or Asphalt Concrete Roadway Inspection must pass the test for the area of work they are going to perform. This test would be administered by the SDDOT at a SDDOT site.

4. If the applicant successfully passes the test, they must work under the direction of an Asphalt Concrete Aggregate Testing, Asphalt Concrete Hot Mix Testing or Asphalt Concrete Roadway Inspection certified individual for a period of not less than two (2) days to ascertain familiarity with the project requirements and appropriate tests and procedures.

5. Provisional Certification is only valid for one (1) calendar year.

D. Non-certified temporary and seasonal individuals:

1. Non-certified individuals who test materials on a Project must demonstrate that they can correctly perform the test procedure by performing the procedure in front of a certified technician who completes a Performance Checklist. The certified technician shall use the Performance Checklist for the test being demonstrated to ascertain that all steps are performed correctly. The performance Checklist shall be retained in the laboratory and a copy shall be given to the Project Engineer to be kept in the Project file.

2. The non-certified individual must work under the supervision of a certified individual. The non-certified individual shall not assist with or conduct any test unless a passing Performance Checklist has been completed for that test procedure and is on file.

3. The Certified technician assumes all responsibility for the accuracy of the test data and signifies by placing their initials as the checker on the worksheet with the test data and signature of the non certified individual.

4. The non-certified individual shall not conduct the hot mix testing on QC/QA Asphalt Concrete Projects.

4. CERTIFICATION:

Final certification shall be contingent upon the applicant passing all course requirements. The SDDOT Materials and Surfacing Certification/Accreditation Engineer in Pierre shall maintain records of certification. Candidates are responsible for assuring that they work only in areas in which they are certified, that their certification does not expire, and that they are able to provide proof of certification when requested.

Asphalt Concrete Aggregate Testing and Asphalt Concrete Hot Mix Testing will cover the same tests and be equivalent certification to Bituminous Technology II “Bituminous Laboratory Testing” and Bituminous Technology SP “Superpave Laboratory Testing”.

5. RECERTIFICATION:

A technician’s certification is valid for not more than four (4) years, after which the individual must become recertified before the expiration date of the current certification. Recertification can be accomplished in one of the following ways which are determined by the Certification Advisory Committee.

A. The candidate for recertification must furnish documentation to the Certification Advisory Committee that he or she has consistently performed the required tests for the previously certified period. A refresher course will be held which will consist of ½ to 1 day of classroom/lab instruction and a test for recertification. Recertification can be

accomplished by successfully completing the recertification exam with a score of 70 percent or higher. If the candidate fails to pass the recertification exam, the candidate shall attend a certification course and pass the course to become certified. After successfully passing the recertification course, the technician will be fully certified for an additional four (4) year period.

B. The candidate for recertification who has taken and passed the Asphalt Concrete Mix Design and Production Control certification course will have their other current Asphalt Concrete certification expiration dates revised to reflect the Asphalt Concrete Mix Design and Production Control expiration date.

The candidate must attend the certification course every four (4) years or attend the certification course and the recertification course on an alternating basis every four (4) years and before the expiration of the current certification. After the end of a four (4) year recertification period the candidate must attend the certification class.

6. DECERTIFICATION:

For just cause, the Certification Advisory Committee may impose suspension or revocation of an individual's certification at any time. An individual may be subject to revocation or suspension of their certification based on falsification of records/tests/reports, negligence, or abuse of their responsibilities. The Certification Advisory Committee may also suspend or revoke an individual's certification for other reasons of just cause, which may or may not be specifically defined. Two levels of misconduct which may result in decertification, along with the associated penalties, are defined as follows:

1. Negligence: Negligence is defined as repeated unintentional deviations from approved procedures, which may or may not cause erroneous results. A reoccurring finding of negligence will result in a letter from the Certification Advisory Committee to the Employer directing them to write a letter of reprimand to the individual. A continuing finding will result in a thirty (30) day suspension of the individual's certification. Any subsequent finding will be treated as abuse.

2. Abuse: Abuse is defined as intentional deviations from approved procedures. (Examples of abuse include, but are not limited to: the falsification of test results or records, submittal of false information on certification applications, and/or unwillingness to follow prescribed test procedures). The first instance of abuse shall result in a one (1) year suspension of an individual's certification. Any subsequent finding of abuse shall result in the permanent revocation of the individual's certification.

Allegations of misconduct shall be made to the Certification Advisory Committee in writing. The allegation shall contain the name, phone number, address and signature of the individual(s) making the allegation. Upon receipt of the written allegation, the Oversight Committee will investigate the matter. If warranted, the accused and the individual(s) making the allegation will be given the opportunity to appear before the Certification Advisory Committee to resolve the allegation. The Chair of the Certification Advisory Committee will provide written notification

to all of the involved parties of the decision of the Certification Advisory Committee. Any warranted penalties may be imposed as determined by the Certification Advisory Committee.

Any findings of abuse or negligence warranting the revocation or suspension of an individual's certification will result in the revocation or suspension of all certifications held by that individual in the various Materials Testing or Inspection Areas. When the suspended individual is reinstated and prior to performing work, the individual will be required to pass the written and/or performance certification exams as applicable, and the individual's certification expiration date(s) will be that expiration date(s) held prior to suspension.

7. CERTIFICATION ADVISORY COMMITTEE:

The purpose of the Certification Advisory Committee is to review the certification program on an annual basis or as often as deemed necessary by the Chair of the Committee. They shall provide suggestions for modifications and improvements to the program curriculum and operations; review accusations concerning decertification and make recommendations to the Chief Materials and Surfacing Engineer and determine when refresher courses are needed. The Certification Advisory Committee shall perform other duties as required to successfully implement and continue the certification program. A meeting of the committee may be called at anytime by the Chair of the Committee or by written request of at least three (3) members of the Committee. A majority of the members of the Committee shall be present for the transaction of official business.

Membership: The membership of the Certification Advisory Committee shall be composed of the following individuals:

Chair: Construction Engineer
Chief Materials & Surfacing Engineer
Region Representative (appointed by the Chair)
Current Chairman of the AGC Bit/Gravel Committee
Industry Representative (appointed by the AGC Chair)
Industry Representative (appointed by the AGC Chair)
Supplier

8. REGISTRATION:

Registration information for any of the certification levels can be obtained from the Dakota Asphalt Pavement Association (DAPA) office in Pierre. Contact the DAPA at (605) 224-8500 or their website at dakota-asphalt.org for more information.

Section Number 4

Section Number 4

Section Number 4

QC/QA SAMPLING AND TESTING
TABLE OF CONTENTS

TEST NUMBER	ABBREVIATED TITLE
SD 108	Moisture Content Determinations
SD 201	Sampling Aggregate Materials
SD 202	Sieve Analysis
SD 204	Abrasion of Coarse Aggregate by use of the Los Angeles Machine
SD 206	Material Finer than a #200 Sieve
SD 207	Liquid Limit, Plastic Limit, and Plasticity Index
SD 208	Particles less than 1.95 Specific Gravity in Fine Aggregates
SD 209	Specific Gravity and Absorption in Fine Aggregate
SD 210	Specific Gravity and Absorption in Coarse Aggregate
SD 211	Crushed Particles (Fractured Faces)
SD 212	Flat and Elongated Particles
SD 213	Reducing Samples to Testing Size
SD 214	Particles less than 1.95 Specific Gravity in Coarse Aggregate
SD 217	Fine Aggregate Angularity
SD 220	Sodium Sulfate Soundness of Aggregates
SD 221	Sand Equivalent of Fine Aggregate
SD 301	Sampling Asphalt Materials
SD 305	Determining the Moisture Content in Uncompacted Bituminous Paving Mixtures
SD 306	Determining the Draindown Percent in Uncompacted Bituminous Paving Mixtures
SD 307	Field density Determinations of Asphalt Concrete by the Cutout Method
SD 309	Moisture Sensitivity of Compacted Asphalt Concrete Paving Mixtures
SD 311	Field Density Determination of Asphalt Concrete by Nuclear Gauge
SD 312	Theoretical Maximum Specific Gravity of Uncompacted Asphalt Concrete Paving Mixtures

SD 313	Density of Compacted Asphalt Concrete Mixtures by the Marshall Method
SD 314	Daily Asphalt Concrete Binder Content
SD 315	Field Density Determination by the Coring Method
SD 316	South Dakota Asphalt Concrete Marshall Mix Design Procedure
SD 317	Procedure for Evaluating Quality Control Tests (Sim/Dissim)
SD 318	Density and Air Voids of Asphalt Concrete by the Gyratory Compaction Method
SD 319	South Dakota Asphalt Concrete Gyratory Mix Design Procedure
SD 502	Lime Mill Certification and Sampling Hydrated Lime

Procedure for Moisture Content Determination for Soils and Aggregate

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1. Scope:

This test is for determining the moisture content of soils and aggregates by gas pressure, drying on a stove or hot plate, drying in a convection or microwave oven, and the nuclear method of in-place moisture tests.

2. Apparatus:

2.1 Calcium carbide gas pressure moisture tester method.

A. A calcium carbide gas pressure moisture (Speedy) tester.

B. Tared scale.

C. Two 1 1/4 " (31.5 mm) steel balls.

D. Cleaning brush and cloth.

E. Calcium carbide reagent.

F. Two 13 gram weights.

G. Reagent scoop.

2.2 Stove top or hot plate method.

A. Stove or hot plate.

B. Steel plate(s), approximately ¼" (6.3 mm) thick to place between the burner(s) and the sample pan.

C. Pan of sufficient size to contain the material and allow room for stirring without loss of material.

D. Spoon or trowel for stirring the material during the drying process.

E. Scale or balance having the capacity to weigh any sample which may be tested utilizing this procedure and readable to the nearest 0.1 gram.

F. Gloves.

2.3 Oven drying method.

A. Drying oven – Thermostatically controlled, preferably of the convection forced-draft type, capable of being heated continuously at a uniform temperature of 230º ± 9ºF (110º ± 5ºC) throughout the drying chamber.

B. Scale or balance having the capacity to weigh any sample which may be tested utilizing this procedure and readable to the nearest 0.1 gram.

C. Pan of sufficient size to contain the material and allow room for stirring without loss of material.

D. Stirring spoon or trowel.

E. Gloves.

2.4 Nuclear method – In-place moisture test.

A. A nuclear moisture/density gauge capable of determining moisture/densities by the direct transmission method and conforming to the requirements of AASHTO T 310.

B. A reference standard block for taking standard counts.

C. A drill rod, extraction tool and combination guide-scraper plate for preparing the test site and punching the hole for the source rod.

D. A manufacture's instruction manual for the nuclear gauge.

E. A nuclear gauge Information book, transportation documents book, nuclear badge, and metal storage box.

F. A hammer to drive the drill rod, and a shovel and other tools for site preparation.

2.5 Microwave oven method.

A. Microwave oven with vented chamber, variable power controls and output power rating of 700 watts is adequate.

B. Scale or balance having the capacity to weigh any sample which may be tested utilizing this procedure and readable to the nearest 0.1 gram.

C. Containers (Must be suitable for microwave ovens-i.e., nonmetallic and resistant to sudden and extreme temperature change; porcelain, or glass).

D. Glove or holder for handling hot containers.

E. Spatulas, putty knives and glass rods.

3. Procedure:

3.1 Calcium carbide gas pressure method.

A. Place 3 scoops of calcium carbide and two 1 1/4" (31.5 mm) steel balls in the chamber of the moisture tester.

The shelf life of calcium carbide reagent is limited, thus it should be used according to the manufacturer's recommendations.

B. Using the tared scale, weigh 26 g sample. If the moisture content of the 26 g sample exceeds the limit of the pressure gauge (20%), a one half sized sample must be used. The percentage indicated on the dial is then doubled. Larger samples can be used for low moisture contents (5% or less).

Two or more 26 g samples can be placed in the "CCGP" moisture tester and the resulting dial reading is divided by the number of 26 g samples used.

NOTE: This method shall not be used on granular materials having particles large enough to affect the accuracy of the test. In general, any appreciable amount retained on a #4 (4.75 mm) sieve.

C. Place the soil sample in the cap. With the pressure vessel in a horizontal position, insert the cap in the pressure vessel and tighten the clamp to seal the unit, taking care that no carbide comes in contact with the soil until a complete seal is achieved.

D. Raise the moisture tester to a vertical position and tap the side of the vessel with the hand so the soil in the cap falls into the pressure vessel.

E. Hold the vessel in a horizontal position and shake, ensuring that the steel balls rotate around the sides of the vessel to break up the soil lumps. (Never shake end to end or the steel balls may damage the dial orifice.) One minute of shaking should be sufficient for granular soils, while 5 minutes or more may be required for highly plastic soils or shale.

F. Cool the gas. When the needle has stopped moving shake the "SPEEDY" for at least a half minute, in order to cool the gas produced. Read the dial while holding the instrument in a horizontal position at eye level.

G. Record the sample weight and the dial reading on a DOT-35 or a DOT-41.

H. Point the instrument away from the operator and slowly release the gas pressure, then empty the contents. When the sample is dumped, it should be examined for lumps. If the sample is not completely broken down, the test is not valid. Repeat the test, with a new test sample increasing the shaking time by one minute.

I. The pressure vessel should be brushed out and the cap wiped clean after each test.

J. The tester shall be checked by comparison with oven dry samples, at the start of use and at least once per week thereafter, if in constant use.

K. The material for oven drying shall weigh at least 100 g and be weighed to the nearest 0.1 gram.

L. The results of the oven dry moisture test must be within one percentage point for soils and 0.6 of a percentage point for sand.

M. If a discrepancy exists, contact the Region Materials Engineer.

3.2 Stove top or hot plate method.

A. Obtain a sample of wet material weighing a minimum of 100 grams for soils and a minimum of 500 grams for granular materials.

B. Weigh the material to the nearest 0.1 gram and dry it to a constant weight. Constant weight is achieved when two successive periods of drying indicate no change in the weight of the material. Check the first two samples tested on a project and an occasional sample thereafter for constant weight, to insure that sufficient drying time is being allowed.

NOTE: The sample usually has been dried to constant weight, when, using a cool metal spoon or spatula, the sample is briefly stirred and there is no evidence of moisture or material sticking to the metal of the stirring instrument.

C. Place the steel plate on the burner of the stove or gas hot plate. Steel plates are not required on electric hot plates. Place the pan holding the material on the steel plate.

D. Stir the material during drying to prevent the temperature of the sample from exceeding 230° ± 9°F (110° ± 5°C).

E. If it is found that samples dried in an oven and those dried on top of the stove do not give test results that compare satisfactorily, use the oven dried method.

3.3 Oven drying method.

A. Obtain a sample of wet material weighing a minimum of 100 g for soils and a minimum of 500 g for granular material. Weigh wet material and record to the nearest 0.1 g.

B. Place in dry, clean pan and place in the oven. Stirring the sample periodically during drying accelerates the process.

C. Dry the material to a constant weight and weigh to the nearest 0.1 gram. Constant weight is achieved when two successive periods of drying indicate no change in the weight of the material. Check the first two samples tested on a project and occasional sample thereafter for constant weight, to insure that sufficient drying time is established for material being tested and apparatus being used.

NOTE: Cool until the container can be handled comfortably with bare hands and the operation of balance or sieves on which sample is placed are not affected by heat convection from material/pan.

3.4 Nuclear method – In-place moisture test.

A. Calibration and performing the standard count of the nuclear gauge shall be in accordance with SD 114, paragraph 3.1 and 3.2.

B. Select a location for the test where the gauge will be at least 2’ (600 mm) away from any vertical projection, at least 10’ (3 m) away from any vehicle and at least 30’ (10 m) away from another nuclear gauge.

C. Remove material, as necessary, to reach the top of the compacted lift to be tested. Prepare a horizontal area, sufficient in size to accommodate the gauge, using the scraper plate supplied with the gauge, by planing to a smooth condition to obtain maximum contact between the gauge and the material being tested. Make sure the gauge sits solidly on the site without rocking.

D. The maximum depressions beneath the gauge shall not exceed 1/8” (3 mm). Use native fines or fine sand to fill voids and level the excess with the scraper plate. The total areas thus filled with fines or sand should not exceed 10% of the bottom area of the gauge.

E. Place the guide scraper plate on the prepared test site and drive the drill rod with the extraction tool attached through the guide to a depth at least 2” (50 mm) below the depth of material to be measured. Remove the drill rod by pulling straight up and twisting the extraction tool, in order to avoid disturbing the hole.

F. Place the nuclear gauge over the test site and extend the source rod into the hole to the desired depth. Release the trigger at the desired depth and listen for the “Click” indicating that the source rod is properly locked into position on the index rod. Verify the depth shown on the display of the gauge agrees with the actual depth of the source rod. Slide the gauge so the surface of the source rod nearest the keypad is in contact with the edge of the hole.

G. Take a one-minute reading to determine the % moisture and record this number. It is allowable to take more than one measurement at each site and average the results. At the completion of the % moisture measurements, dig up the area beneath the gauge to collect the moisture specimen if a comparison is to be performed and visually check for large voids or inconsistent material which may give inaccurate results. If a large void or inconsistent material is encountered, disregard the test and move to a nearby location.

H. Correction determination: At least five tests must be performed using the nuclear gauge on mechanically compacted material and compared against oven dry moisture tests to compute a moisture correction. Take the moisture sample from the top of the lift to the depth of the source rod directly below the nuclear gauge and immediately place in an airtight container for moisture testing using the oven dry method. Use the DOT-39 to calculate the moisture correction. If an individual comparison is determined which is not within 2.0 % of the correction (Running average) calculated from the previous five individual comparisons, the results shall be considered suspect and additional checks should be run to determine if the material has changed.

I. After the moisture correction is determined, it is applied to future tests performed with the nuclear gauge. Each type of material shall have a different correction. Embankment material shall have a correction determination separate from surfacing material. Corrections are not interchangeable between nuclear gauges, and must be individually determined. If a change in project, change in material source, unusually high or low % moisture readings, considerable changes in sieve analysis, or visual change in material, additional checks should be completed and documented on a DOT-39.

NOTE: THE nuclear gauge moisture reading shall never be used for determination of in-place dry density.

J. Additional comparison checks against the oven dry method shall be performed at a minimum of at least once per 20 moisture tests. Results shall be documented on the DOT-39 worksheet and the correction (Running average) reevaluated for the five most recent in place moisture comparison tests performed.

K. If a discrepancy exists, contact the Region Materials Engineer.

3.5 Microwave oven moisture test method.

A. Determine the weight of a clean, dry container or dish, and record it on the applicable worksheet as "Wt. of container".

B. Cut or break up the soil into small size aggregations to aid in obtaining quicker and more uniform drying of the specimen. Obtain a sample of wet material weighing a minimum of 100 grams for soils and a minimum of 500 grams for aggregates. Place the sample in the container, and immediately determine and record the weight to the nearest 0.1 gram.

C. Place the sample and container in a microwave oven and turn the oven on for 3 minutes. If experience with a particular soil type and specimen size indicates shorter or longer initial drying times can be used without overheating, the initial and subsequent drying times may be adjusted.

NOTE: The 3-minute initial setting is for a minimum sample size of 100 grams. Smaller samples are not recommended when using the microwave oven because drying may be too rapid for proper control. Large samples may need to be split into segments and dried separately.

Most ovens have a variable power setting. For the majority of soils tested, a setting of "High" should be satisfactory; however, for some soils such a setting may be too severe. The proper setting can be determined only through the use of and experience with a particular oven for various soil types and sample sizes. The energy output of microwave ovens may decrease with age and usage; therefore, power settings and drying times should be established for each oven.

D. After the set time has elapsed, remove the container and soil from the oven, weigh the specimen as soon as the container may be handled safely to the nearest 0.1 gram and record the weight.

E. With a small spatula, knife, or short length of glass rod, carefully mix the soil, taking special precaution not to lose any soil.

F. Return the container and soil to the oven and reheat for 1 minute.

G. Repeat (D) through (F), until a constant weight has been achieved as per SD 108.

H. Use the final weight to calculate the moisture content. Obtain this value immediately after the heating cycle, as soon as the container may be handled safely.

NOTE: Incremental heating, together with stirring, will minimize overheating and localized drying of the soil. The recommended time increments have been suitable for most specimens having particles smaller than a #4 sieve and with a sample of approximately 200 g; however, they may not be appropriate for all soils and ovens, and adjustment may be necessary.

Moisture content specimens should be discarded after testing and not used in any other tests due to particle breakdown, chemical changes or losses, melting, or losses of organic constituents.

4. Report:

4.1 Calculations for speedy moisture testers.

The dial on the moisture tester reads directly in percent moisture by wet weight. The reading must be converted to percent moisture by dry weight. The computation is made by using the conversion table which equates moisture contents by wet weight and dry weight in the normal range that will be encountered on grading projects, or by using the following formula:

$$\text{\% Moisture by dry weight} = \frac{\text{\% moisture by wet weight}}{1 - (\text{\% moisture by wet weight divided by 100})}$$

Example: % moisture by wet weight is 14.8

$$\frac{14.8}{1 - (14.8 \text{ divided by } 100)} =$$

$$\frac{14.8}{1 - .148} = \frac{14.8}{.852} = 17.4\%$$

See “Speedy Conversion Chart”. (Figure 1)

4.2 Calculations for stove top or hot plate, oven drying, and microwave oven methods.

Calculate the percent of moisture for the drying on a stove or hot plate, oven drying and microwave oven methods as follows:

$$\text{Moisture content} = \frac{\text{Weight wet soil} - \text{weight dry soil}}{\text{Weight dry soil}} \times 100$$

4.3 Calculations for the nuclear method – In-place moisture test on DOT-39).

A = Oven dry moisture in %

B = % moisture determined by the nuclear gauge.

C = A - B

D = Correction (Running average) of 5 most recent valid values of C in %

moisture content = nuclear moisture + correction (Running average).

5. References:

AASHTO T 310
AASHTO T 265
SD 114
SD 311
DOT-35
DOT-39
DOT-41
DOT-208

Sample ID 2205174
File No.

Moisture - Density Worksheet

DOT - 35
9-15

County Aurora, Ziebach — PCN/PROJECT B015 PH 0066(00)15

Tested By: Tester, One — Checked By: Tester, Two — Test Date: 04/27/2015

Material Type Unclassified Excavation

Test No.	E021	E022	023E	E024	E025	E026	
Sampled at Station	44+25	36+57	34+75	37+30	41+30	36+25	
Distance from CL	22' L	10' L	15 L	17 R	22 R	13' R	
Represents Sta. - Sta.	27+00	27+00	27+00	27+00	27+00	27+00	
	53+40	53+40	53+40	53+40	53+40	53+40	
Depth Below Grade or Top of Pipe	4.5'	6'	5.5'	5'	2'	4.5'	
	Below Grade	Below Grade	Below Grade	Below Grade	Below Grade	Below Grade	
1-Point not made - Refer to Moisture or Density No.			E022			E024	
Correction							
Field Comparison							

Field Moisture

Nuclear Test...		☐	☐	☐	☑	☑	☑	☐
Time		7:35 am	9:30 am	11:30 am	1:30 pm	3:30 pm	5:30 pm	
Wt. of Can and Material	Meter No.	155.7	120.8	142.5	MQ 778	MQ 778	MQ 778	
Wt. of Can and Dry Material		133.7	99.6	119.6				
Wt. Loss (Moisture) Speedy Reading	Standard Moisture Count	22.0	21.2	22.9	656	656	656	
Wt. of Can/ Wt. of Speedy Sample	Pct. Moisture from Meter				21.6	20.8	20.6	
Wt. of Dry Material	Moisture Correction (±)	133.7	99.6	119.6				
Percent Moisture		16.5	21.3	19.1	21.6	20.8	20.6	

1-Point Determinations

A-2-4 or A-3 Soil or QC/QA Asphalt Concrete	☐	☐	☐	☐	☐	☐	☐
Wt. of Can and Wet Material	157.8	134.8	134.8	112.7	126.2	112.7	
Wt. of Can and Dry Material	135.8	115.0	115.0	93.6	105.7	93.6	
Wt. Loss Speedy Reading	22.0	19.8	19.8	19.1	20.5	19.1	
Wt. of Can							
Wt. of Dry Material	135.8	115.0	115.0	93.6	105.7	93.6	
Percent Moisture	16.2	17.2	17.2	20.4	19.4	20.4	
Wt. of Mold and Wet Specimen	13.32	13.37	13.37	13.40	13.37	13.40	
Wt. of Mold	9.23	9.23	9.23	9.23	9.23	9.23	9.23
Wt. of Wet Specimen	4.09	4.14	4.14	4.17	4.14	4.17	
Mold No. Factor of Mold	P-1885 30.01	P-1885 30.01	P-1885 30.01	P-1885 30.01	P-1885 30.01	P-1885 30.01	P-1885 30.01
Wet Density Lbs/cuft	122.7	124.2	124.2	125.1	124.2	125.1	
Dry Density Lbs/cuft	105.6	106.0	106.0	103.9	104.0	103.9	
Curve Used / Curve Family	O O	o O	o O	P O	p O	P O	O
Max Dry Dens. from Ohio Curve Lbs/cuft	107.1	105.9	105.9	104.7	103.5	104.7	
Optimum Moisture from Ohio Curve	18.1	18.6	18.6	19.2	19.7	19.2	
Pass/Fail	✓	✓	✓	✓	✓	✓	

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Figure 1

Speedy Reading	Percent Moisture Dry Weight	Speedy Reading	Percent Moisture Dry Weight	Speedy Reading	Percent Moisture Dry Weight	Speedy Reading	Percent Moisture Dry Weight	Speedy Reading	Percent Moisture Dry Weight	Speedy Reading	Percent Moisture Dry Weight
5.0	5.3	9.1	10.0	13.1	15.1	17.1	20.6	21.1	26.7	25.1	33.5
5.1	5.4	9.2	10.1	13.2	15.2	17.2	20.8	21.2	26.9	25.2	33.7
5.2	5.5	9.3	10.2	13.3	15.3	17.3	20.9	21.3	27.1	25.3	33.9
5.3	5.6	9.4	10.4	13.4	15.5	17.4	21.1	21.4	27.2	25.4	34.0
5.4	5.7	9.5	10.5	13.5	15.6	17.5	21.2	21.5	27.4	25.5	34.2
5.5	5.8	9.6	10.6	13.6	15.7	17.6	21.4	21.6	27.6	25.6	34.4
5.6	5.9	9.7	10.7	13.7	15.9	17.7	21.5	21.7	27.7	25.7	34.6
5.7	6.0	9.8	10.9	13.8	16.0	17.8	21.7	21.8	27.9	25.8	34.8
5.8	6.2	9.9	11.0	13.9	16.2	17.9	21.8	21.9	28.0	25.9	35.0
5.9	6.3	10.0	11.1	14.0	16.3	18.0	22.0	22.0	28.2	26.0	35.1
6.0	6.4	10.1	11.2	14.1	16.4	18.1	22.1	22.1	28.4	26.1	35.3
6.1	6.5	10.2	11.4	14.2	16.6	18.2	22.2	22.2	28.5	26.2	35.5
6.2	6.6	10.3	11.5	14.3	16.7	18.3	22.4	22.3	28.7	26.3	35.7
6.3	6.7	10.4	11.6	14.4	16.8	18.4	22.5	22.4	28.9	26.4	35.9
6.4	6.8	10.5	11.7	14.5	17.0	18.5	22.7	22.5	29.0	26.5	36.0
6.5	7.0	10.6	11.9	14.6	17.1	18.6	22.8	22.6	29.2	26.6	36.2
6.6	7.1	10.7	12.0	14.7	17.2	18.7	23.0	22.7	29.4	26.7	36.4
6.7	7.2	10.8	12.1	14.8	17.4	18.8	23.2	22.8	29.5	26.8	36.6
6.8	7.3	10.9	12.2	14.9	17.5	18.9	23.3	22.9	29.7	26.9	36.8
6.9	7.4	11.0	12.4	15.0	17.6	19.0	23.5	23.0	29.9	27.0	37.0
7.0	7.5	11.1	12.5	15.1	17.8	19.1	23.6	23.1	30.0	27.1	37.2
7.1	7.6	11.2	12.6	15.2	17.9	19.2	23.8	23.2	30.2	27.2	37.4
7.2	7.8	11.3	12.7	15.3	18.1	19.3	23.9	23.3	30.4	27.3	37.6
7.3	7.9	11.4	12.9	15.4	18.2	19.4	24.1	23.4	30.5	27.4	37.7
7.4	8.0	11.5	13.0	15.5	18.3	19.5	24.2	23.5	30.7	27.5	37.9
7.5	8.1	11.6	13.1	15.6	18.5	19.6	24.4	23.6	30.9	27.6	38.1
7.6	8.2	11.7	13.2	15.7	18.6	19.7	24.5	23.7	31.1	27.7	38.3
7.7	8.3	11.8	13.4	15.8	18.8	19.8	24.7	23.8	31.2	27.8	38.5
7.8	8.4	11.9	13.5	15.9	18.9	19.9	24.8	23.9	31.4	27.9	38.7
7.9	8.6	12.0	13.6	16.0	19.0	20.0	25.0	24.0	31.6	28.0	38.9
8.0	8.7	12.1	13.8	16.1	19.2	20.1	25.2	24.1	31.8	28.1	39.1
8.1	8.8	12.2	13.9	16.2	19.3	20.2	25.3	24.2	31.9	28.2	39.3
8.2	8.9	12.3	14.0	16.3	19.5	20.3	25.5	24.3	32.1	28.3	39.5
8.3	9.0	12.4	14.2	16.4	19.6	20.4	25.6	24.4	32.3	28.4	39.7
8.4	9.2	12.5	14.3	16.5	19.8	20.5	25.8	24.5	32.4	28.5	39.9
8.5	9.3	12.6	14.4	16.6	19.9	20.6	25.9	24.6	32.6	28.6	40.1
8.6	9.4	12.7	14.5	16.7	20.0	20.7	26.1	24.7	32.8	28.7	40.3
8.7	9.5	12.8	14.7	16.8	20.2	20.8	26.3	24.8	33.0	28.8	40.4
8.8	9.6	12.9	14.8	16.9	20.3	20.9	26.4	24.9	33.2	28.9	40.6
8.9	9.8	13.0	14.9	17.0	20.5	21.0	26.6	25.0	33.3	29.0	40.8
9.0	9.9										

Speedy Conversion Chart

Figure 2

Method of Sampling Gravel, Stone, Sand, Filler, and Clay

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1. Scope:

These methods are for obtaining samples from pits, quarries, stockpiles, rail cars, conveyor belts, windrows, and trucks. Procedures for reducing samples to testing size are described in SD 213.

Other methods giving representative samples may be used, if approved by the Chief Materials and Surfacing Engineer.

Sampling from aggregate stockpiles or rail cars or trucks should be avoided whenever possible.

2. Apparatus:

2.1 Not specified.

3. Procedure:

3.1 Pits.

A. Hole dug with auger.
Take material from the bottom of the auger representing each foot (300 mm) of depth as the hole is drilled. Sample approximately the same amount of material from each foot (300 mm) of depth. Take material from the auger only when it is going deeper and not just cleaning out the caved in material. Individual samples may be selected to represent material from each well-defined stratum.

B Exposed faces.
Take the sample by channeling the exposed face vertically from bottom to top. Overburden and disturbed material shall not be included in the sample. Individual samples may be selected to represent material from each well-defined stratum.

3.2 Conveyor belt.

A. Stop the conveyor belt while obtaining the sample. Insert 2 templates conforming to the width and shape of the belt into the aggregate stream on the belt. Scoop all material between the templates into a suitable container using a brush to collect the fines on the belt.

If templates are not available, care must be taken to prevent material from the upper side of the belt from sliding or rolling onto the section being sampled. Sample the full width of the belt.

B. A special device capable of obtaining an entire cross section of the material as it is being discharged from the belt may be used. This device must consist of a pan of sufficient size to intercept the entire cross section of the discharge stream and hold the required quantity of material without overflowing. A set of rails or another suitable device must be included so that a representative sample of the entire stream can be obtained. Obtain at least three approximately equal increments and combine to form the field sample.

3.3 Windrows.

Sample the material in windrows by shoveling through small windrows or removing material to the midpoint of the cross section of large windrows. Waste the material removed in both procedures. Shave material from one face of the cross sectional area for the sample.

3.4 Stockpile (Preliminary and quality samples).

A. Cone shaped stockpile.

Take care to avoid sampling segregated areas of the pile. Take approximately equal portions from the base, midpoint, and top of the pile. Before obtaining the sample at each sampling point, remove the aggregate to an approximate depth of 1 foot, and then obtain sample from the bottom of the hole. A board may be shoved into the pile just above the point of sampling to prevent segregation.

B. Flat topped stockpile.

Dig three or more shallow trenches on top of the stockpile approximately 10 feet (3 m) long and 1 foot (300 mm) wide. The bottom of the trenches shall be nearly level. Take equal portions from 3 equally spaced points along the bottom of each trench by pushing a shovel downward into the material and taking a shovel full from each point.

C. Stockpile (Loader method).

Sample the material from at least three different areas around the perimeter of the stockpile. Using a front-end loader dig into pile and set aside a small pile of approximately 10 to 15 tons. Material shall be removed from stockpile in same manner in which it will be removed for incorporation into project. The operator shall roll the material from the loader bucket to reduce the amount of free fall. The additional buckets shall be obtained and dumped in the same manner and placed uniformly over the preceding pile.

The small stockpile will then be struck off to approximately half of its original height by back dragging with the loader bucket. Take the

required amount of material for the sample from the exposed surface of the stockpile with a shovel taking care not to let material fall off the shovel.

3.5 Stockpile (Coarse and fine aggregate for concrete).

NOTE: Samples shall be taken from a belt whenever physically possible.

Sample the material from the area of the stockpile that is being incorporated into project. Using a front-end loader dig into pile and set aside a small pile of approximately 5 to 15 tons. Material shall be removed from stockpile in same manner in which it is being removed for incorporation into project. The operator shall roll the material from the loader bucket to reduce the amount of free fall. Any additional buckets shall be obtained and dumped in the same manner and placed uniformly over preceding pile.

The small stockpile will then be struck off to approximately half of its original height by back dragging with the loader bucket. Take the required amount of material for the sample from the top surface of the stockpile with a shovel taking care not to let material fall off the shovel.

3.6 Rail cars and trucks.

Dig 3 or more shallow trenches the full width of the rail car or truck with the bottom of the trench nearly level and approximately one foot (300 mm) wide. Take equal portions from 3 equally spaced points along the bottom of each trench by pushing a shovel downward into the material and taking a shovel full from each point.

3.7 Quarries.

See AASHTO T 2.

4. Report:

None required.

5. References:

AASHTO T 2
SD 213

Method of Test for Sieve Analysis

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1. Scope:

This test is for determining sieve analysis of sub-base, base course, mineral aggregate (Surface course materials), concrete aggregates, fillers, and similar materials.

2. Apparatus:

2.1 Scale or balance having the capacity to weigh any sample which may be tested utilizing this procedure and readable to the nearest 0.1 gram.

2.2 Sieves. Standard square opening, conforming to AASHTO M 92.

2.3 Drying oven capable of maintaining a temperature of 230° ± 9°F (110° ± 5°C).

2.4 Pans, scoops, brushes, etc., for handling materials.

2.5 Unit weight bucket.

2.6 Mechanical sieve shaker.

3. Procedure:

Surface Course Materials:

3.1 Obtain a sample in accordance with SD 201. The sample shall be large enough to provide specimens for all required testing.

3.2 Reduce the sample to the size of the specimen needed for testing by splitting or quartering in accordance with SD 213.

3.3 Minimum sample size.

NOTE: Nominal maximum size of particle is denoted by the smallest sieve opening listed below, through which 90% or more of the sample being tested will pass.

Nominal maximum size of particle	Minimum wt. of sample (Grams)
#4 (4.75 mm)	500
3/8" (9.5 mm)	1000
1/2" (12.5 mm)	2500
3/4" (19.0 mm)	5000
1" (25.0 mm)	10000
1 1/2" (37.5 mm)	15000
2" (50.0 mm)	20000
2 1/2" (63.0 mm)	35000
3" (75.0 mm)	60000
3 1/2" (90.0 mm)	100000
4" (100 mm)	150000

3.4 The sample shall be oven dried to a constant weight at a temperature of 230° ± 9°F (110° ± 5°C) or in accordance with SD 108. Frequent stirring will expedite the drying procedure.

3.5 Determine loose weight, if required, in accordance with SD 205.

3.6 Weigh the sample and record the weight in the "Original dry sample weight" box of the DOT-3 worksheet to the nearest 0.1 gram.

3.7 Assemble a series of sieves that will furnish the information required by the specifications covering the material to be tested. Nest the sieves in order of decreasing size of opening from top to bottom and include a pan below the last sieve.

3.8 Pour the sample into the top sieve of the nest. Agitate the sieves by hand or on a mechanical shaker for a sufficient period of time, established by trial or checked by measurement on the actual test sample, to meet the criterion for adequacy of sieving.

NOTE: The adequacy of sieving can be checked by the hand method. The end point for hand sieving requires that not more than 0.5% by weight of the material on a sieve shall pass that sieve in one minute of sieving.

3.9 Remove any dirt adhering to the + #4 (4.75 mm) material. This can be accomplished by dumping the material from each individual sieve into a flat pan and rubbing it with a soft pine or rubber covered block. After the dirt has been removed, pour the contents of the pan back onto the sieves and complete the shaking.

An alternate method is to place the material retained on an individual sieve in a cement sample can. With the lid in place, agitate the aggregate using a circular motion. The material is then reintroduced to the sieve and sieved by hand.

3.10 Weigh the material retained on each sieve and the material in the pan to the nearest 0.1 gram and record the weights on the worksheet. Tabulate the total for these weights. The tabulated total should check within 0.3% of the "Original dry sample weight." If it does not, a backup sample shall be tested.

3.11 In the coarse sieve series, the weight retained on a sieve in kg at the completion of sieving shall not exceed the product of 2.5 times the sieve size opening in millimeters times the effective sieving area in m^2. In the fine sieve series (Openings smaller than #4) the weight retained on any sieve shall not be greater than 7 kg/m^2 (4 $g/in.^2$) (See Chart 1 below). If any sieve is overloaded, make a notation on the gradation sheet and sieve the material retained on that sieve by hand in split portions until the adequacy of sieving requirement is met. Prevent the occurrence of any further overloading of sieves by using one of the following: insert an additional sieve with an opening size in between the overloaded sieve size and the next larger size in the sieve set, start with a smaller sample size to prevent the sieve from being overloaded, split the sample into two or more portions to sieve separately, or use a set of sieves having a larger frame size and providing greater sieving area. Sieve a sufficient amount of time so that the adequacy of sieving is met for all sieve sizes. Try approximately 10 minutes if using a mechanical sieve shaker, and increase the time if the adequacy of sieving is not met for all sieve sizes. 15

Sieve opening size (Inches/mm)	Maximum amount of material that may be retained in grams			
	8" dia. sieve	12" dia. sieve	13.8" x 13.8" sieve (14"x14" nominal)	14.6" x 22.8" sieve (16"x24" nominal)
4" (100.0 mm)	N/A	N/A	30,600	53,900
3 1/2" (90.0 mm)	N/A	15,100	27,600	48,500
3" (75.0 mm)	N/A	12,600	23,000	40,500
2 1/2" (63.0 mm)	N/A	10,600	19,300	34,000
2" (50.0 mm)	3,600	8,400	15,300	27,000
1 1/2" (37.5 mm)	2,700	6,300	11,500	20,200
1" (25.0 mm)	1,800	4,200	7,700	13,500
3/4" (19.0 mm)	1,400	3,200	5,800	10,200
5/8" (16.0 mm)	1,100	2,700	4,900	8,600
1/2" (12.5 mm)	890	2,100	3,800	6,700
3/8" (9.5 mm)	670	1,600	2,900	5,100
1/4" (6.3 mm)	450	1,100	1,900	3,400
#4 (4.75 mm)	330	800	1,500	2,600
#6 thru #200 (3.35 mm thru 75 µm)	200	470	900	1,500

Chart 1

3.12 Calculate the percentage of material retained on each sieve to the nearest 0.1% by dividing the weight of the retained material by the "Original dry sample weight" determined in 3.6.

3.13 Determine the accumulative percent passing each sieve by subtracting the retained percentage for the top sieve from 100.0 and continue subtracting the retained percentage for each sieve from the previous sieves accumulative passing percentage.

3.14 If the sample being tested requires a result for percentage of crushed particles, perform the test in accordance with SD 211 using a portion of the aggregate retained on the #4 (4.75 mm) sieve and above.

NOTE: If the material being tested requires a result for total - #200, the material from that test can be used to perform the percentage of crushed particles test.

3.15 If the sample being tested requires a result for percentage of particles less than 1.95 specific gravity for the + #4 (4.75 mm) sieve material, perform the test in accordance with SD 214 using a portion of the aggregate retained on the #4 (4.75 mm) sieve and above.

3.16 Using the material from the pan below the #4 (4.75 mm) sieve, split out samples in accordance with SD 213 to conduct the balance of the required testing. The number and size of samples to be split out will depend on the type of material being tested. Most (Surface course materials) will require a sample to complete the fine portion of the sieve analysis and one for liquid limit / plastic limit / P.I. If you are testing uncoated mineral aggregate for asphalt concrete, a third sample will have to be split out for a particles less than 1.95 specific gravity test.

The samples split out for the fine portion of the sieve analysis and liquid limit/plastic limit / P.I. must contain enough - #40 material to yield 100 grams. The less than 1.95 specific gravity test must obtain between 250 and 350 grams.

3.17 Weigh the sample to be used for the fine portion of the sieve analysis to the nearest 0.1 gram and record the weight on the "Weight before washing" line on the worksheet.

3.18 Place the sample in a pan and add enough water to cover it. Agitate the sample with sufficient vigor to result in complete separation of all particles finer than the #200 (0.075 mm) sieve from the coarser particles and bring the fine material into suspension. Pour the wash water containing the suspended and dissolved solids over a nest of 2 sieves. The lower sieve of the nest shall be a #200 (0.075 mm) and the upper shall be in a range of #8 (2.36 mm) to #16 (1.18 mm). Both of the sieves shall conform to the requirements of AASHTO M 92.

Repeat the process of adding water, agitating the sample, and pouring the water over the nest of sieves until the wash water is clear.

3.19 Dry the washed aggregate to a constant weight in an oven at 230° ± 9°F (110° ± 5°C), as per SD 108 and weigh to the nearest 0.1 gram. Record this weight on the "Weight after washing" line of the worksheet.

Subtract the weight of the sample after washing, from the weight of the sample before washing and record the result on the "Loss from washing (- #200)" line and on the "Pan wash" line below the #200 (0.075 mm) sieve on the sieve analysis.

3.20 Assemble a series of sieves that will furnish the information required by the specifications covering the material being tested. Nest the sieves in order of decreasing size of opening from top to bottom and include a pan below the last sieve.

3.21 Pour the aggregate into the top sieve of the nest, place the nest of sieves on a mechanical shaker and shake for a sufficient period of time (A minimum of 10 minutes). Adequacy of sieving can be checked as outlined in 3.8 above. The quantity of material retained on any sieve at the completion of the sieving operation shall not exceed 4 grams per in^2 (7 kg/m^2) of sieve surface area. This amounts to 200 grams for an 8" (200 mm) diameter sieve. 15

3.22 Weigh the material retained on each sieve and in the pan and record the weights on the worksheet to the nearest 0.1 gram. Add the retained weights including the "Pan dry" and "Pan wash" quantities below the #200 (0.075 mm) sieve. Record this weight on the "Total" line at the bottom of the worksheet. This weight must be within 0.3% of the weight of the sample before washing. If it is not, a new sample shall be tested.

NOTE: Correct brush to use when cleaning sieves.

3/8" to #16 - steel **#20 to #50 - brass** **#80 to > - paint**

3.23 Complete the calculations for the fine sieves, beginning by dividing the initial sample weight derived in 3.17 above into the retained weights for each sieve and record the results on the worksheet to the nearest 0.1%. Next, multiply these retained percentages times the accumulative percentage passing the #4 (4.75 mm) sieve determined in 3.13 above and record the results on the worksheet again to the nearest 0.1%. Finally, determine the accumulative percentage passing each of these sieves by subtracting the retained percentage from the previous sieves accumulative passing percentage.

3.24 The percentage of material passing each sieve in the coarse and fines portion of the analysis may now be rounded and reported on the worksheet to the nearest whole number except the #200 (0.075 mm) sieve shall be reported to the nearest 0.1%.

3.25 Prepare the sample of material split out earlier as outlined in SD 207 for liquid limit / plastic limit / P.I. testing.

3.26 Perform the liquid limit and plastic limit in accordance with SD 207, calculate the plasticity index, and report the results on the sieve analysis worksheet.

3.27 If the sample being tested requires a result for percentage of particles less Than 1.95 specific gravity for the - #4 (4.75 mm) sieve material, perform the test on the 250 to 350 gram sample split out in 3.16 above in accordance with SD 208.

Process for determining total - #200 materials in asphalt concrete:

3.28 Following completion of the coarse sieve analysis, combine all materials which were retained on #4 sieve and above and split out a sample for total - #200 (0.075 mm) testing in accordance with SD 213 which meets the requirements shown in the following table.

Nominal maximum size of particles		Minimum weight of sample, grams
#4	(4.75 mm)	500
3/8"	(9.50 mm)	500
1/2"	(12.5 mm)	700
3/4"	(19.0 mm)	1000
1"	(25.0 mm)	1500

3.29 Weigh the sample to the nearest 0.1 g and record the weight as "Weight before washing" in the box labeled “(A)” below the coarse sieve area as shown on the enclosed example DOT-3 worksheet.

3.30 Place the sample in a pan and add enough water to cover it. Agitate the sample with sufficient vigor to result in complete separation of all particles finer than the #200 (0.075 mm) sieve from the coarser particles and bring the fine material into suspension. Pour the wash water containing the suspended and dissolved solids over a nest of 2 sieves. The lower sieve of the nest shall be a #200 (0.075 mm) and the upper shall be in a range of #8 (2.36 mm) to #16 (1.18 mm). Both of the sieves shall conform to the requirements of AASHTO M 92. Repeat the process of adding water, agitating the sample, and pouring the water over the nest of sieves until the wash water is clear.

3.31 Following drying to a constant weight, weigh sample to nearest 0.1 g and record the weight as "Weight after wash" in the box labeled “(B)” below the coarse sieve area as shown on the enclosed example DOT-3 worksheet.

3.32 Calculate the percent passing the #200 Sieve (D) for the coarse aggregate by subtracting the "Weight after wash" (B) from the "weight before wash" (A) and dividing that result (C) by the "Weight before wash" (A). Multiply this result times 100. This is the percent - #200 for the coarse aggregate which must be recorded in the two boxes labeled “(D)” on the DOT-3 worksheet.

6.3	1/4		354.6	7.0		67.9	68		
4.75	#4	*	345.4	6.8	(F)	61.1	61		**57-67**
Pan			3090.1	61.1		wt. before washing (0.1		(A)	1069.3
TOTAL			5055.1	100.0		wt. after washing (0.1%		(B)	1058.5
+ #4 Gradation Check:						loss from washing		(C)	10.8
within 0.3% of original dry wt.			0.1%			% - #200		(D)	1.01

3.33 To complete the calculations for the total - #200 material, four pieces of information are needed in the - #200 box at the lower left corner of the DOT-3 worksheet. You have already provided one of these in step 3.32 above, ((D) which is the percent passing the #200 sieve on the coarse aggregate sample wash). The other three are: (E) The percent passing the #200 sieve on the fine sieve analysis (This includes the washed and sieved portion), (F) The percentage of material that passed the #4 sieve during the sieve analysis and (G) The percentage of material that was retained on the #4 Sieve. The amount of material retained on the #4 sieve (G) can be determined by subtracting the percent passing the #4 sieve (F) from 100.

3.34 Complete the calculations by multiplying the percent - #200 on the coarse sieve aggregate (D) times the percent of material retained on the #4 sieve (G) and multiply the percent - #200 on the fine sieves (E) times the percent of material that passed the #4 sieve (F) and divide each by 100. The result obtained when adding these 2 values is the "Total - #200 material" for this sample.

Example:

The coarse sieve analysis had 61.1% passing the #4 sieve. 100.0 minus 61.1% passing = 38.9% retained on the #4 sieve.

1.01% passed the #200 sieve in the coarse aggregate sample that was washed (D) and 10.06% passed the #200 sieve on the fine sieve analysis (E).

PAN	dry		2.5	52.5	6.1	wt. before washing (0.1g)	521.8
PAN	wash		50.0	(E) 10.06		wt. after washing (0.1g)	471.8
TOTAL			521.5			**loss from washing (- # 200)**	50.0

Coarse	(D) 1.01	x % Retain/Design	(G)	38.9	=	0.39	**- #4 Gradation check:**	
Chip		x % Retain/Design			=		within 0.3% of the	0.1
Fine	(E) 10.06	x %Pass/Design	(F)	61.1	=	6.15	wt. before washing	
				Total/Combined - #200		6.5		

Calculations:

Retained #4 sieve $\frac{\text{(G) 38.9\% x (D) 1.01\% pass on coarse aggregate}}{100}$ = 0.39%

Passing #4 sieve $\frac{\text{(F) 61.1\% x (E) 10.06\% pass on fine sieve analysis}}{100}$ = 6.15%

0.39 + 6.15 = 6.54 or 6.5% total minus #200 for the sample.

Coarse Aggregate for Concrete:

3.35 Obtain a sample in accordance with SD 201. The sample shall be large enough to provide specimens for all required testing.

3.36 Reduce the sample to the size of the various specimens needed for testing by splitting or quartering in accordance with SD 213. The number of specimens needed will depend on the testing required for the sample.

Most samples will require, as a minimum, a sieve analysis, material finer than #200 (0.075 mm) sieve and particles less than 1.95 specific gravity in coarse aggregate.

3.37 For the minimum size of samples for the various tests required, see 3.3 above for the sieve analysis, SD 206 for material finer than #200 (0.075 mm) sieve, SD 214 for particles less than 1.95 specific gravity in coarse aggregate and SD 218 for scratch hardness.

Coarse aggregate for lightweight concrete specimens shall consist of 0.1 ft^3 (0.003 m^3) or more of the material.

3.38 Perform the sieve analysis following the procedure outlined in 3.4, 3.6, 3.7, 3.8, 3.10, 3.11, 3.12, and 3.13 above. Coarse aggregate for concrete has a specification on the #8 (2.36 mm) sieve, so it will be necessary to add that sieve to the nest of sieves.

3.39 Using the samples split out in 3.36 above, perform the test for material finer than #200 (0.075 mm) sieve in accordance with SD 206, particles less than 1.95 specific gravity in coarse aggregate in accordance with SD 214 and scratch hardness of natural coarse aggregate in accordance with SD 218. Report the results of these tests on the worksheet in accordance with the guidelines provided by the applicable test procedure.

Fine Aggregate for Concrete:

3.40 Obtain a sample in accordance with SD 201. The sample shall be large enough to provide specimens for all required testing.

3.41 If the sample has free moisture on the particle surface, the entire sample may be dried or it may be split using a mechanical splitter with chute openings of 1 1/2" (38 mm) or more, to not less than 11 lbs. (5000 grams) and then dried.

3.42 Reduce the dried sample to the size of the various specimens needed for testing by splitting or quartering in accordance with SD 213. The number of specimens needed will depend on the testing required for the sample.

NOTE: If the sample received from the field does not have free moisture on the particle surface, it may be reduced to the various testing specimens by splitting or quartering in accordance with SD 213. It will, however, require drying before testing.

Most samples will require, as a minimum, a sieve analysis, inclusive of material finer than #200 (0.075 mm) sieve, and particles less than 1.95 specific gravity in fine aggregate.

The sample split out for the sieve analysis, inclusive of material finer than #200 (0.075 mm) sieve, must contain a minimum of 500 grams while the sample for the less than 1.95 specific gravity in fine aggregate test must contain between 250 and 350 grams.

The minimum sample specimen weight for the sieve analysis, inclusive of material finer than #200 (0.075 mm) sieve, for lightweight fine aggregate shall be as shown below:

Wt. of aggregate (lbs./ft$^{3)}$	Wt. of aggregate (kg/m^3)	Min. weight of test specimen (grams)
5 to 15	80 to 240	50
15 to 25	240 to 400	100
25 to 35	400 to 560	150
35 to 45	560 to 720	200
45 to 55	720 to 880	250
55 to 65	880 to 1040	300
65 to 75	1040 to 1200	350

3.43 Perform the sieve analysis, inclusive of material finer than #200 (0.075 mm) sieve, in accordance with procedure outlined in 3.17, 3.18, 3.19, 3.20, 3.21, and 3.22 above.

Fine aggregate for concrete has a specification on the 3/8” (9.5 mm) and #4 (4.75 mm) sieve, so it will be necessary to add these sieves to the nest of sieves.

3.44 Calculate the percentage of material retained on each sieve to the nearest 0.1% by dividing the weight of the retained material by the weight of the sample before washing. Material passing #200 should be calculated to 0.01% and rounded to 0.1%.

3.45 Determine the accumulative percent passing each sieve by subtracting the retained percentage for the top sieve from 100.0 and continue subtracting the retained percentage for each sieve from the previous sieves accumulative passing percentage.

3.46 The percentage of material passing each sieve may now be rounded and reported on the worksheet to the nearest whole number except the #200 (0.075 mm) sieve shall be reported to the nearest 0.1%.

3.47 Samples of fine aggregate for concrete require a result for fineness modulus (F.M.). The sieves used for determination of F.M. are identified on the DOT-3 worksheet by an (*). Calculate the F.M. as follows:

A. Subtract the percentage passing (before rounding) the sieves designated by the (*) from 100.0 and record the result in the column titled F.M. After this has been accomplished on each sieve designated, total the results and divide by 100.

B. Report the result to the nearest 0.01%.

Example:

Sieve Size	Percent Passing	100.0 Minus Percent Passing
#4 (4.75 mm)	98.1	1.9
#8 (2.36 mm)	89.8	10.2
#16 (1.18 mm)	70.4	29.6
#30 (0.600 mm)	38.9	61.1
#50 (0.300 mm)	22.6	77.4
#100 (0.150 mm)	9.3	90.7
		Total 270.9

$$\text{Fineness modulus (F.M.)} = \frac{270.9}{100} = 2.709 \text{ or } 2.71$$

3.48 The specifications for aggregates used in concrete require the combined mixture of fine and coarse aggregate be such that not more than a certain percent of the combined materials pass the #200 (0.075 mm) sieve.

To calculate this combined percentage of material passing the #200 (0.075 mm) sieve, multiply the percent passing the #200 (0.075 mm) sieve on the fine and coarse aggregate times the percentage of the sand and rock used in the mix according to the design mix, divide each of the results by 100 and then add them together.

Example:

A. .88% passing #200 (0.075 mm) sieve on fine aggregate.
B. 1.65% passing #200 (0.075 mm) sieve on coarse aggregate.
C. Fine aggregate is 35.6% of total aggregate used in the mix.
D. Coarse aggregate is 64.4% of total aggregate used in the mix.

Fine aggregate	.88%	x	35.6%	/	100	=	0.31%
Coarse aggregate	1.65%	x	64.4%	/	100	=	1.06%
Combined - #200 (0.075 mm) sieve						=	1.37 or 1.4%.

The final percentage shall be recorded to the nearest 0.1%.

3.49 Perform the test for particles less than 1.95 specific gravity in fine aggregates in accordance with SD 208 and report the results on the worksheet.

Asphalt Surface Treatments and Miscellaneous Fine Aggregate:

3.50 Obtain a sample in accordance with SD 201. The sample shall be large enough to provide specimens for all required testing.

3.51 Reduce the dried sample to the size of the various specimens needed for testing by splitting or quartering in accordance with SD 213. The

number of specimens needed will depend on the testing required for the sample.

3.52 The minimum sample size shall be as outlined in 3.3 above.

3.53 If the sample being tested requires a result for flakiness index, perform the test in accordance with SD 203 using a portion of the aggregate retained on the #4 (4.75 mm) sieve and above.

3.54 If the sample being tested requires a result for percentage of crushed particles, perform the test in accordance with SD 211 using a portion of the aggregate retained on the #4 (4.75 mm) sieve and above.

3.55 If liquid limit / plastic limit / P.I. is required by specifications, a sample of - #4 shall be obtained from a separate split. The sample split out for the liquid limit / plastic limit / P.I. must be of adequate size to produce at least 100 grams of - #40 (0.425 mm) sieve material.

3.56 The sample shall be oven dried to a constant weight at a temperature of 230° ± 9°F (110° ± 5°C) or in accordance with SD 108.

3.57 Weigh the sample and record the weight in the “Weight before washing” line in the fine aggregate portion of the worksheet to the nearest 0.1 gram.

3.58 Perform wash as outlined in 3.18 above.

3.59 Dry the washed aggregate to a constant weight in an oven at 230° ± 9°F (110° ± 5°C) as per SD 108 and weight to the nearest 0.1 gram. Record this weight on the “Weight after washing” line in the fine aggregate portion of the worksheet to the nearest 0.1 gram.

3.60 Subtract the weight of the sample after washing, from the weight of the sample before washing and record the result on the “Loss from washing (- #200)” line and on the “Pan wash” line below the #200 (0.075 mm) sieve on the sieve analysis.

3.61 Assemble a series of sieves that will furnish the information required be the specifications covering the material being tested. The use of 12” diameter sieves is recommended to prevent sieve overloading.

3.62 Pour the aggregate into the top sieve of the nest, place the nest of sieves on a mechanical shaker and shake for a sufficient period of time (A minimum of 10 minutes). Adequacy of sieving can be checked as outlined in 3.8 above. The quantity of material retained on any sieve at the completion of the sieving operation shall not exceed the amount listed in “Chart 1” of 3.11 above.

3.63 Weigh the material retained on each sieve and in the pan and record the weights on the worksheet to the nearest 0.1 gram. Add the

retained weights including the “Pan dry” and “Pan wash” quantities below the #200 (0.075 mm) sieve. Record this weight on the “Total” line at the bottom of the worksheet. This weight must be within 0.3% of the weight of the sample before washing. If it is not, a new sample shall be tested.

3.64 Calculate the percentage of material retained on each sieve to the nearest 0.1% by dividing the weight of the retained material by the weight of the sample before washing. Material passing #200 should be calculated to 0.01% and rounded to 0.1%.

3.65 Determine the accumulative percent passing each sieve by subtracting the retained percentage for the top sieve from 100.0 and continue subtracting the retained percentage for each sieve from the previous sieves accumulative passing percentage.

3.66 The percentage of material passing each sieve may now be rounded and reported on the worksheet to the nearest whole number except the #200 (0.075 mm) sieve shall be reported to the nearest 0.1%.

4. Report:

4.1 Test results will be reported on form DOT-3 or DOT-68 (These forms do not apply to the Central Lab). Use of the DOT-68 is limited to mineral aggregate samples on projects utilizing a batch type mixing plant.

5. References:

AASHTO T 27
AASHTO M 92
SD 108
SD 201
SD 204
SD 206
SD 207
SD 208
SD 211
SD 213
SD 214
DOT-3
DOT-68
DOT-69

Sample ID 2203565 **Sieve Analysis and P.I. Worksheet** **DOT-3 (Combined)**
File No. **9-15**

PROJECT PH 0066(00)15 COUNTY Aurora, Ziebach PCN B015
Charged To (if not above project)
Field No. 01 Date Sampled 03/10/2015 Date Tested 03/10/2015
Sampled By Tester, One Tested By Tester, One Checked By Tester, Two
Material Type Base Course Source Richland Pit
Taken @ 180.5 tons. Lot No. Sublot No.
Weight Ticket Number or Station Ticket #76427, Sta. 26+25 Lift 1 of 3

% moist. = (wet wt. - dry wt.) / dry wt. x 100 =
Original Dry Sample Wt. (0.1g) 7318.0

Sieve Size mm	Sieve Size in	F.M. *	Retained (0.1g)	% total ret.(0.1%)	% pass. 0.1%	% pass. (rounded)	Spec Req.
100	4						
75	3						
62.5	2 1/2						
50.0	2						
37.5	1 1/2						
31.5	1 1/4						
25.0	1		0.0	0.0	100.0	**100**	**100**
19.0	3/4		167.6	2.3	97.7	**98**	**80-100**
16.0	5/8		240.6	3.3	94.4	**94**	
12.5	1/2		351.7	4.8	89.6	**90**	**68-91**
9.5	3/8	*	338.8	4.6	85.0	**85**	
6.3	1/4		625.2	8.5	76.5	**77**	
4.75	#4	*	586.2	8.0	68.5	**69**	**46-70**
Pan			5008.1	68.4			
TOTAL			7318.2				

+ #4 Gradation Check:
within 0.3% of original dry wt. 0.0

Dust Chk: wt. before washing (0.1g); wt. after washing (0.1g); loss from washing; % - #200

Liquid Limit		**L.L.**	**P.L.**
a. can number		45	19
b. wt. can + wet soil	(.01g)	29.87	28.34
c. wt. can + dry soil	(.01g)	28.14	27.11
d. wt. of water (b - c)	(.01g)	1.73	1.23
e. wt. of can	(.01g)	19.92	20.17
f. wt. of dry soil (c - e)	(.01g)	8.22	6.94
g. Liquid Limit (d/f x j x 100)	(0.1)	21.2	N.P. ☐
h. Plastic Limit (d/f x 100)	(0.1)	N.A.	17.7
I. P. I. (g - h)	(0.1)	3.5	
Liquid Limit N.C. ☐	(**g**. rounded)	21	N.A.
Plasticity Index	(**i**. rounded)	4	

j. corr # blows 26 22 = 0.9846 23 = 0.9899 24 = 0.9952
25 = 1.0000 26 = 1.0050 27 = 1.0100 28 = 1.0138

wt. - #40 181.4 / wt. - #4 611.2 x % pass. #4 = 20.3
(± 3.0% VARIABLE of % pass. (0.1%) on the #40)

SPECIFICATION L.L. 0-25
SPECIFICATION P.I. 0-6

Sieve Size mm	Sieve Size #		retained (0.1g)	% total ret.(0.1%)	% total x % pa#4(0.1%)	% pass. (0.1%)	% pass (rounded)	Spec Req.
3.35	6							
2.36	8	*	136.5	21.6	14.8	53.7	**54**	**34-58**
2.00	10		28.2	4.5	3.1	50.6	**51**	
1.70	12							
1.18	16	*	67.1	10.6	7.3	43.3	**43**	
0.850	20		62.7	9.9	6.8	36.5	**37**	
0.600	30	*	75.8	12.0	8.2	28.3	**28**	
0.425	40		61.4	9.7	6.6	21.7	**22**	**13-35**
0.300	50	*	55.6	8.8	6.0	15.7	**16**	
0.180	80		34.4	5.4	3.7	12.0	**12**	
0.150	100	*	4.8	0.8	0.5	11.5	**12**	
0.075	200		10.6	1.7	1.2	10.3	10.3	**3.0-12.0**
PAN	dry		1.7	95.1	10.3	wt. before washing (0.1g)	631.9	
PAN	wash		93.4	15.1		wt. after washing (0.1g	538.5	
TOTAL			632.2			**loss from washing (- # 200)**	93.4	

+ #4 % Particles less than 1.95 SP. Gr.		
Specific gravity of solution (1.95 ± 0.01)		.
wt. of lightweight particles	(0.1g)	
wt of + #4 material	(0.1g)	
% lightweight particles		
SPECIFICATION		-
- #4 % Particles less than 1.95 SP. Gr.		
Specific gravity of solution (1.95 ± 0.01)		.
wt. of lightweight particles	(0.1g)	
wt of - #4 material	(0.1g)	
% lightweight particles		
SPECIFICATION		-

Coarse	x % Retain/Design	=	
Chip	x % Retain/Design	=	
Fine	x % Pass/Design	=	
	Total/Combined - #200		

- #4 Gradation check:
within 0.3% of the wt. before washing 0.1

Crushed Particles Test	
weight of crushed particles	447.0
weight of total + #4 sample	1015.9
percent of crushed particles	44
SPECIFICATION 1 or more FF	30-100

Natural Sand		Natural Fines		Na. Rock	
Ma. Sand		Filler		Cr. Rock	
Cr. Fines		Add Rock			

Figure 1

Sample ID 2203587 **Sieve Analysis and P.I. Worksheet** **DOT-3 (Combined)**
File No. **9-15**

PROJECT PH 0066(00)15 COUNTY Aurora, Ziebach PCN B015
Charged To (if not above project)
Field No. 06 Date Sampled 03/11/2015 Date Tested 03/11/2015
Sampled By Tester, One Tested By Tester, One Checked By Tester, Two
Material Type AGGREGATE COMPOSITE Source Jones Pit
Class E, Type 1 Lot No. 2 Sublot No. 1
Weight Ticket Number or Station Ticket #76421, Sta. 165+55 Lt. Lift 1 of 1

% moist. = (wet wt. 5235.1 - dry wt.) / dry wt. x 100 = 3.5
Original Dry Sample Wt. (0.1g) 5058.2

Sieve Size mm	Sieve Size in	F.M. *	Retained (0.1g)	% total ret.(0.1%)	% pass. 0.1%	% pass. (rounded)	Spec Req.
100	4						
75	3						
62.5	2 1/2						
50.0	2						
37.5	1 1/2						
31.5	1 1/4						
25.0	1		0.0	0.0	100.0	**100**	**100**
19.0	3/4		30.3	0.6	99.4	**99**	**97-100**
16.0	5/8		159.7	3.2	96.2	**96**	
12.5	1/2		620.1	12.3	83.9	**84**	**76-90**
9.5	3/8	*	454.9	9.0	74.9	**75**	
6.3	1/4		345.6	7.0	67.9	**68**	
4.75	#4	*	345.4	6.8	61.1	**61**	**57-67**
Pan			3090.1	61.1			
TOTAL			5055.1				

Dust Chk		
	wt. before washing (0.1g)	1069.3
	wt. after washing (0.1g)	1058.5
	loss from washing	10.8
	% - #200	1.01

+ #4 Gradation Check:
within 0.3% of original dry wt. 0.1

Liquid Limit		**L.L.**	**P.L.**
a. can number			
b. wt. can + wet soil	(.01g)		
c. wt. can + dry soil	(.01g)		
d. wt. of water (b - c)	(.01g)		
e. wt. of can	(.01g)		
f. wt. of dry soil (c - e)	(.01g)		
g. Liquid Limit (d/f x j x 100)	(0.1)		N.P. ☑
h. Plastic Limit (d/f x 100)	(0.1)	N.A.	
I. P. I. (g - h)	(0.1)		
Liquid Limit N.C. ☑	(**g**. rounded)		N.A.
Plasticity Index	(**i**. rounded)		

j. corr # blows 22 = 0.9846 23 = 0.9899 24 = 0.9952
25 = 1.0000 26 = 1.0050 27 = 1.0100 28 = 1.0138

wt. - #40 111.5 / wt. - #4 321.6 x % pass. #4 = 20.3
(± 3.0% VARIABLE of % pass. (0.1%) on the #40)

SPECIFICATION L.L.	0-25
SPECIFICATION P.I.	0-0

Sieve Size mm	Sieve Size #		retained (0.1g)	% total ret.(0.1%)	% total x % pa#4(0.1%)	% pass. (0.1%)	% pass (rounded)	Spec Req.
3.35	6							
2.36	8	*	104.1	20.0	12.2	48.9	**49**	**42-52**
2.00	10							
1.70	12							
1.18	16	*	83.4	16.0	9.8	39.1	**39**	**32-42**
0.850	20							
0.600	30	*	113.3	21.7	13.3	25.8	**26**	
0.425	40		33.2	6.4	3.9	21.9	**22**	**14-24**
0.300	50	*						
0.180	80		44.6	8.5	5.2	16.7	**17**	
0.150	100	*						
0.075	200		90.4	17.3	10.6	6.1	**6.1**	**4.0-8.0**
PAN	dry		2.5	52.5	6.2	wt. before washing (0.1g)		521.8
PAN	wash		50	10.1		wt. after washing (0.1g		471.8
TOTAL			521.5			**loss from washing (- # 200)**		50.0

Coarse	1.01%	x % Retain/Design	38.9	=	0.39	**- #4 Gradation check:**
Chip		x % Retain/Design		=		within 0.3% of the 0.1
Fine	10.06%	x % Pass/Design	61.1	=	6.15	wt. before washing
		Total/Combined - #200			6.5	

Natural Fines	45.00	Cr. Fines	23.00	Na. Rock	17.00
Add Rock	15.00	Natural Sand	.00	Ma. Sand	.00
Filler	.00	Cr. Rock	.00		.00

+ #4 % Particles less than 1.95 SP. Gr.		
Specific gravity of solution (1.95 ± 0.01)		1.96
wt. of lightweight particles	(0.1g)	30.3
wt of + #4 material	(0.1g)	1921.4
% lightweight particles		1.6
SPECIFICATION		0.0 - 3.0
- #4 % Particles less than 1.95 SP. Gr.		
Specific gravity of solution (1.95 ± 0.01)		1.96
wt. of lightweight particles	(0.1g)	5.2
wt of - #4 material	(0.1g)	304.1
% lightweight particles		1.7
SPECIFICATION		0.0 - 3.0

Crushed Particles Test	
weight of crushed particles	786.4
weight of total + #4 sample	1008.9
percent of crushed particles	78
SPECIFICATION 2 or more FF	70-100%

Figure 2

Sample ID 2203609 **Gyratory Aggregate Worksheet** **DOT-69**
File No. **9-14**

PROJECT PH 0066(00)15 COUNTY Aurora, Ziebach PCN B015
Charged To (if ɔt above project)
Field No. QC04 Date Sampled 03/12/2015 Date Tested 03/12/2015
Sampled By Tester, One Tested By Tester, One Checked By Tester, Two
Material Type AGGREGATE COMPOSITE Source Jones Pit
Class Q2 Lot No. 1 Sublot No. 4
Weight Ticket Number or Station Ticket #50855, Sta. 625+15 Lt. Lift 1 of 1

% moist. = (wet wt. 8616.4 - dry wt.) / dry wt. x 100 = 3.9
Original Dry Sample Wt. (0.1g) 8289.9

Sieve Size mm	in	Retained (0.1g)	% total ret.(0.1%)	% pass. 0.1%	% pass. (rounded)	Spec Req.
50	2					
37.5	1 1/2					
31.5	1 1/4					
25.0	1					
19.0	3/4	0.0	0.0	100.0	**100**	**100-100**
16.0	5/8	7.3				
12.5	1/2	501.4	0.0	100.0	**100**	**100**
9.5	3/8	890.3	0.6	99.4	**99**	**97-100**
6.25	1/4					
4.75	#4	1777.7	12.3	83.9	**84**	**76-90**
Pan		3090.1	61.1			
TOTAL		5055.1				

Sand Equiv. Test	Sand Rdg.	Clay Rdg.	S.E.
Reading #1	3.1	6.6	47
Reading #2	3.1	6.5	48

Sand Equivalent Test Results	48	42-100
Fine aggregate Angularity	41.8	41.0-100.0
Flat and Elongated Particles Test Results		

Dust Chk	
wt. before washing (0.1g)	709.3
wt. after washing (0.1g)	707.1
loss from washing	2.2
% - #200	0.31

+ #4 Gradation Check:
within 0.3% of original dry wt. 0.0

Sieve Size mm	#	retained (0.1g)	% total ret.(0.1%)	% total x % pa#4(0.1%)	% pass. (0.1%)	% pass (rounded)	Spec Req.
3.35	6						
2.36	8	187.7	29.8	18.4	43.4	**43**	**41-51**
2.00	10						
1.70	12						
1.18	16	137.2	21.8	13.5	29.9	**30**	
0.850	20						
0.600	30	112.0	17.8	11.0	18.9	**19**	
0.425	40	54.3	8.6	5.3	13.6	**14**	
0.300	50	42.7	6.8	4.2	9.4	**9**	
0.180	80						
0.150	100	35.0	5.6	3.5	5.9	**6**	
0.075	200	10.5	1.7	1.1	4.8	**4.8**	**2.9-6.9**
PAN	dry	4.8	49.2	4.8			
PAN	wash	44.4	7.8				
TOTAL		521.5					

wt. before washing (0.1g)	629.8
wt. after washing (0.1g	585.4
loss from washing (- # 200)	44.4

Coarse	0.31%	x % Retain/Design	38.2	=	0.12
Chip		x % Retain/Design		=	
Fine	7.81%	x % Pass/Design	61.8	=	4.83
		Total/Combined - #200			5.0

- #4 Gradation check:
within 0.3% of the wt. before washing 0.2

+ #4 % Particles less than 1.95 SP. Gr.	
Specific gravity of solution (1.95 ± 0.01)	1.95
wt. of lightweight particles (0.1g)	19.1
wt of + #4 material (0.1g)	1824.9
% lightweight particles	1.0
SPECIFICATION	0.0 - 3.0
- #4 % Particles less than 1.95 SP. Gr.	
Specific gravity of solution (1.95 ± 0.01)	1.95
wt. of lightweight particles (0.1g)	3.2
wt of - #4 material (0.1g)	302.4
% lightweight particles	1.1
SPECIFICATION	0.0 - 3.0

Crushed Particles Test	
weight of crushed particles	651.7
weight of total + #4 sample	729.7
percent of crushed particles	89
SPECIFICATION 2 or more FF	65-100

Na. Rock	31.00	Cr. Fines	28.00	Natural Fines	25.00
Osch Nat. Fines	16.00	Natural Sand	.00	Ma. Sand	.00
Filler	.00	Cr. Rock	.00	Add Rock	.00

Figure 3

Comments: 12" sieves used. #4 sieve was overloaded. Split in half and hand sieved in accordance with SD 202, 3.11.

Weight of measure and glass plate		327.1
Weight of measure, glass plate, & water		426.8
M = net mass of water		99.7
Water Temperature / Density	77 F (25.0C)	997.03
V = volume of cylinder, mL		100.0

Dry - #4 bulk specific gravity (Gsb)	2.563	2.563	
Volume of cylinder, mL (V)	100.0	100.0	
Weight of cylinder, g (A)	183.0	183.0	
Wt. of cylinder + aggregate, g (B)	332.5	332.2	
Wt, aggregate, g (F=B-A)	149.5	149.5	
Uncompacted voids, (nearest 0.1%) U=((V-(F/Gsb))/V) x 100	41.7	41.8	41.8

Sieve Size mm	Sieve Size in	Total Sample Weight on Sieve	Weight of Tested Portion	Weight of Flat/ Elongated Particles	Percent Flat/ Elongated Individual Sieve	Percent Flat/ Elongated Weighted Average
50.0	2					
37.5	1 1/2					
25.0	1					
19.0	3/4					
12.5	1/2					
9.5	3/8					
4.75	#4					

Total sample wt. [ ]

Percent flat and elongated particles		
in the total sample (weighted average)	rounded	

Figure 3A

Sample ID **2203613** **Sieve Analysis and P.I. Worksheet** **DOT-3 (Coarse)**
File No. **9-15**

PROJECT PH 0066(00)15 COUNTY Aurora, Ziebach PCN B015
Charged To (if not above project) _____
Field No. 03 Date Sampled 03/12/2015 Date Tested 03/12/2015
Sampled By Tester, One Tested By Tester, One Checked By Tester, Two
Material Type COARSE AGGREGATE Source Hills Materials, Rapid City Quarry
A-45, Bridge Lot No. _____ Sublot No. _____
Weight Ticket Number or Station _____ Lift _____ of _____

% moist. = (wet wt. _____ - dry wt.) / dry wt. x 100 = _____

Original Dry Sample Wt. (0.1g) 10414.8

Sieve Size mm	Sieve Size in	F.M. *	Retained (0.1g)	% total ret.(0.1%)	% pass. 0.1%	% pass. (rounded)	Spec Req.
100	4						
75	3						
62.5	2 1/2						
50.0	2						
37.5	1 1/2		0.0	0.0	100.0	**100**	**100-100**
31.5	1 1/4						
25.0	1		286.0	2.7	97.3	**97**	**95-100**
19.0	3/4		1720.7	16.5	80.8	**81**	**80-100**
16.0	5/8		1098.7	10.5	70.3	**70**	
12.5	1/2		1407.0	13.5	56.8	**57**	**25-60**
9.5	3/8	*	1620.8	15.6	41.2	**41**	
6.3	1/4		2492.5	23.9	17.3	**17**	
4.75	#4	*	908.0	8.7	8.6	**9**	**0-10**
Pan							
TOTAL							

Dust Chk	
wt. before washing (0.1g)	
wt. after washing (0.1g)	
loss from washing	
% - #200	

+ #4 Gradation Check:
within 0.3% of original dry wt. _____

Sieve Size mm	Sieve Size in	Total Sample Weight on Sieve	Weight of Tested Portion	Weight of Flat/ Elongated Particles	Percent Flat/ Elongated Individual Sieve	Percent Flat/ Elongated Weighted Average
50.0	2					
37.5	1 1/2					
25.0	1					
19.0	3/4					
12.5	1/2					
9.5	3/8					
4.75	#4					

Total sample wt. _____
Percent flat and elongated particles in the total sample (weighted average) _____

Sieve Size mm	Sieve Size #		retained (0.1g)	% total ret.(0.1%)	% total x % pa#4(0.1%)	% pass. (0.1%)	% pass (rounded)	Spec Req.
3.35	6							
2.36	8	*	644.7	6.2		2.4	**2**	**0-5**
2.00	10							
1.70	12							
1.18	16	*						
0.850	20							
0.600	30	*						
0.425	40							
0.300	50	*						
0.180	80							
0.150	100	*						
0.075	200							
PAN	dry		217.9	217.9		wt. before washing (0.1g)		5506.6
PAN	wash		0	2.1		wt. after washing (0.1g		5415.6
TOTAL			10396.3			**loss from washing (- # 200)**		91.0

+ #4 % Particles less than 1.95 SP. Gr.		
Specific gravity of solution (1.95 ± 0.01)		1.96
wt. of lightweight particles	(0.1g)	0.1
wt of + #4 material	(0.1g)	1857.0
% lightweight particles		0.0
SPECIFICATION		0.0-1.0

Coarse	1.65%	x % Retain/Design	64.4	=	1.06
Chip		x % Retain/Design		=	
Fine	0.88%	x % Pass/Design	35.6	=	0.31
03 Referenced		Total/Combined - #200			1.4

- #4 Gradation check:
within 0.3% of the wt. before washing 0.2

Crushed Particles Test		
weight of crushed particles		
weight of total + #4 sample		
percent of crushed particles		
SPECIFICATION	or more FF	

Comments: 16" x 24" sieves were used.

Figure 4

Sample ID **2203622** **Sieve Analysis and P.I. Worksheet** **DOT-3 (Fine)**
File No. **9-15**

PROJECT PH 0066(00)15 COUNTY Aurora, Ziebach PCN B015
Charged To (if not above project) _____
Field No. 03 Date Sampled 03/12/2015 Date Tested 03/12/2015
Sampled By Tester, One Tested By Tester, One Checked By Tester, Two
Material Type FINE AGGREGATE Source Birdsall S & G, Wasta
A-45, Bridge Lot No. _____ Sublot No. _____
Weight Ticket Number or Station _____ Lift _____ of _____

% moist. = (wet wt. _____ - dry wt.) / dry wt. x 100 = _____

Original Dry Sample Wt. (0.1g) 10414.8

Sieve Size mm	Sieve Size in	F.M. *	Retained (0.1g)	% total ret.(0.1%)	% pass. 0.1%	% pass. (rounded)	Spec Req.
100	4						
75	3						
62.5	2 1/2						
50.0	2						
37.5	1 1/2						
31.5	1 1/4						
25.0	1						
19.0	3/4						
16.0	5/8						
12.5	1/2						
9.5	3/8	* 0.00	0.0	0.0	100.0	**100**	**100-100**
6.3	1/4						
4.75	#4	* 0.20	1.2	0.2	99.8	**100**	**95-100**
Pan							
TOTAL							

Dust Chk	
wt. before washing (0.1g)	
wt. after washing (0.1g)	
loss from washing	
% - #200	

+ #4 Gradation Check:
within 0.3% of original dry wt.

Sieve Size mm	Sieve Size #		retained (0.1g)	% total ret.(0.1%)	% total x % pa#4(0.1%)	% pass. (0.1%)	% pass (rounded)	Spec Req.
3.35	6							
2.36	8	* 8.50	52.3	8.3		91.5	**92**	**0-5**
2.00	10							
1.70	12							
1.18	16	* 32.20	149.0	23.7		67.8	**68**	**45-85**
0.850	20							
0.600	30	* 50.10	112.8	17.9		49.9	**50**	
0.425	40		79.4	12.6		37.3	**37**	
0.300	50	* 78.50	99.3	15.8		21.5	**22**	**10-30**
0.180	80							
0.150	100	* 96.10	110.6	17.6		3.9	**4**	**2-10**
0.075	200		18.4	2.9		1.0	1.0	
PAN	dry		0.9	6.0		wt. before washing (0.1g)		629.4
PAN	wash		5.1	1.0		wt. after washing (0.1g		624.3
TOTAL		2.66	629.0			**loss from washing (- # 200)**		5.1

Coarse	1.65%	x % Retain/Design	64.4	=	1.06
Chip		x % Retain/Design		=	
Fine	0.88%	x % Pass/Design	35.6	=	0.31
03 Referenced		Total/Combined - #200			1.4

- #4 Gradation check:
within 0.3% of the wt. before washing 0.1

+ #4 % Particles less than 1.95 SP. Gr.		
Specific gravity of solution (1.95 ± 0.01)		1.95
wt. of lightweight particles	(0.1g)	1.6
wt of + #4 material	(0.1g)	274.3
% lightweight particles		0.6
SPECIFICATION		0.0-1.0

Figure 5

Sample Id 2203625 **Sieve Analysis** **DOT-68**

Mineral Aggregate **Stationary Plant Mix** **9-15**

Mix Batch Ticket, lbs./cu. Yd.; Total Agg		
1" Rock	1374.0	0.776
	396.0	0.224
		0
		0
Total	1770.0	1.0

Test # 04 File Number

PCN/Project B015 PH 0066(00)15 County Aurora, Ziebach

Charge to (if not above project

Sample Represents 1155.0 Cu. Yd Class and Type COARSE AGGREGATE

Date Sample 03/13/2015 Sampled By Tester, One

Date Tested 03/13/2015 Tested By Tester, One

Checked By Tester, Two

1" Rock				Chip											
Sample Wt. (0.1g)	10312.3			**Sample Wt.** (0.1g)	3098.8			**Sample Wt.** (0.1g)				**Sample Wt.** (0.1g)			
Sieve Size	Retained (0.1 g)	% total ret. (0.1%)	% pass. (0.1%)	Sieve Size	Retained (0.1 g)	% total ret. (0.1%)	% pass. (0.1%)	Sieve Size	Retained (0.1 g)	% total ret. (0.1%)	% pass. (0.1%)	Sieve Size	Retained (0.1 g)	% total ret. (0.1%)	% pass. (0.1%)
2				2				2				2			
1 1/2				1 1/2				1 1/2				1 1/2			
1 1/4				1 1/4				1 1/4				1 1/4			
1	0.0	0.0	100.0	1				1				1			
3/4	1431.6	13.9	86.1	3/4				3/4				3/4			
5/8	2964.8	28.8	57.3	5/8	0.0	0.0	100.0	5/8				5/8			
1/2	1853.9	18.0	39.3	1/2	0.0	0.0	100.0	1/2				1/2			
3/8	2095.4	20.3	19.0	3/8	104.8	3.4	96.6	3/8				3/8			
1/4			100.0	1/4	1347.5	43.5	53.1	1/4				1/4			
#4	1798.4	17.4	1.6	#4	935.3	30.2	22.9	#4				#4			
#8	60.7	0.6	1.0	#8	616.2	19.9	3.0	#8				#8			
Pan Dry	98.4			Pan Dry	90.5			Pan Dry				Pan Dry			
Pan Wash	0.0			Pan Wash	0.0			Pan Wash				Pan Wash			
TOTAL	10303.2			TOTAL	3094.3			TOTAL				TOTAL			
Gradation Check ==>	0.1			Gradation Check ==>	0.2			Gradation Check ==>				Gradation Check ==>			
wt. before wash	3771.0			wt. before wash	2752.8			wt. before wash				wt. before wash			
wt. after wash	3728.2			wt. after wash	2707.1			wt. after wash				wt. after wash			
loss from wash	42.8			loss from wash	45.7			loss from wash				loss from wash			
% - #200 ==>	1.14			% - #200 ==>	1.66			% - #200 ==>				% - #200 ==>			
Bin adj. - 200 ==>	0.88			Bin adj. - 200 ==>	0.37			Bin adj. - 200 ==>				Bin adj. - 200 ==>			

Page 1 of 3

Figure 6

Composite Coarse Aggregate

Sieve Size	1" Rock	Chip			Retained Total	Cumulative % Passing	Spec. Gradation	Job Mix Formula
2					0.0	100.0	100	
1 1/2					0.0	100.0	100	100-100
1 1/4					0.0	100.0	100	
1	0.0				0.0	100.0	100	95-100
3/4	10.8				10.8	89.2	89	
5/8	22.4	0.0			22.4	66.9	67	
1/2	14.0	0.0			14.0	52.9	53	25-60
3/8	15.8	0.8			16.5	36.4	36	
1/4		9.7			9.7	26.6	27	
#4	13.5	6.8			20.3	6.4	6	0-10
#8	0.5	4.5			4.9	1.4	1	0-5
Pan	0.7	0.7			1.4	0.1	0	
Total	77.6	22.4	0.0	0.0	99.9			

Combined - 200 ==> 1.25

+ #4 % Particles less than 1.95 Specific Gravity

Specific gravity of solution (1.95 ± 0.0	.	.	.	.
wt. of lightweight particle (0.1g)				
wt. of + #4 material (0.1g)				
% lightweight particles				
Bin Adj. % lightweight particles				
Composite % lightweight particles				
SPECIFICATION maximum			0.0-1.0	

Coarse	1.25%	x % Retain/Design	58.0	=	0.73
Chip		x % Retain/Design		=	
Fine	1.45%	x % Pass/Design	42.0	=	0.61
04 Referenced		Total/Combined - #200			1.3

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Figure 6A

Flat and Elongated Particles

Rock size	Sieve size mm	Sieve size inches	Total Sample Weight on Sieve	Weight of Tested Portion	Weight of Flat/ Elongated Particles	Percent Flat/ Elongated Individual Sieve	Percent Flat/ Elongated Weighted Average
1"	50.0	2					
% of Rock	37.5	1 1/2					
77.6	25.0	1					
	19.0	3/4	1431.6	1431.6	0.9	0.1	0.0
	12.5	1/2	4818.7	809.3	6.7	0.8	0.4
	9.5	3/8	2095.4	228.5	4.6	2.0	0.4
	4.75	#4	1798.4	96.7	0.9	0.9	0.2
	Total sample wt.		10144.1				

Percent flat and elongated particles in 1" 1.0

Percent flat and elongated particles in Total Rock: 0.8

Rock size							
Chip	50.0	2					
% of Rock	37.5	1 1/2					
22.4	25.0	1					
	19.0	3/4					
	12.5	1/2	0.0	0.0	0.0		
	9.5	3/8	104.8	75.0	0.0	0.0	0.0
	4.75	#4	2282.8	40.8	1.1	2.7	2.6
	Total sample wt.		2387.6				

Percent flat and elongated particles in 1" 2.6

Percent flat and elongated particles in Total Rock: 0.6

Rock size							
	50.0	2					
% of Rock	37.5	1 1/2					
	25.0	1					
	19.0	3/4					
	12.5	1/2					
	9.5	3/8					
	4.75	#4					
	Total sample wt.		0.0				

Percent flat and elongated particles in 1" 0.0

Percent flat and elongated particles in Total Rock:

Combined Percent Flat and Elongated Particles for Total Rock: **1.4**

Rounded: 1

Spec Max: 10

Page 3 of 3

Figure 6B

Sample ID **2203622** **Sieve Analysis and P.I. Worksheet** **DOT-3 (Fine)**
File No. **9-15**

PROJECT PH 0066(00)15 COUNTY Aurora, Ziebach PCN B015
Charged To (if not above project)
Field No. 04 Date Sampled 03/16/2015 Date Tested 03/16/2015
Sampled By Tester, One Tested By Tester, One Checked By Tester, Two
Material Type FINE AGGREGATE Source Pete Lein & sons, Wasta
1155.0 cu. Yds, Rt. 2805.0 Lot No. Sublot No.
Weight Ticket Number or Station Belt Lift of

% moist. = (wet wt. - dry wt.) / dry wt. x 100 =
Original Dry Sample Wt. (0.1g) 10414.8

Sieve Size mm	Sieve Size in	F.M. *	Retained (0.1g)	% total ret.(0.1%)	% pass. 0.1%	% pass. (rounded)	Spec Req.
100	4						
75	3						
62.5	2 1/2						
50.0	2						
37.5	1 1/2						
31.5	1 1/4						
25.0	1						
19.0	3/4						
16.0	5/8						
12.5	1/2						
9.5	3/8	* 0.00	0.0	0.0	100.0	**100**	**100-100**
6.3	1/4						
4.75	#4	* 0.10	0.8	0.1	99.9	**100**	**95-100**
Pan							
TOTAL							

Dust chk	
wt. before washing (0.1g)	
wt. after washing (0.1g)	
loss from washing	
% - #200	

+ #4 Gradation Check:	
within 0.3% of original dry wt.	

Sieve Size mm	Sieve Size #		retained (0.1g)	% total ret.(0.1%)	% total x % pa#4(0.1%)	% pass. (0.1%)	% pass (rounded)	Spec Req.
3.35	6							
2.36	8	* 5.40	31	5.3		94.6	**95**	**0-5**
2.00	10							
1.70	12							
1.18	16	* 27.30	128.2	21.9		72.7	**73**	**45-85**
0.850	20		96.5	16.5		56.2	**56**	
0.600	30	* 62.00	106.7	18.2		38	**38**	
0.425	40		89.1	15.2		22.8	**23**	
0.300	50	* 87.20	58.7	10		12.8	**13**	**10-30**
0.180	80		49	8.4		4.4	**4**	
0.150	100	* 96.80	6.9	1.2		3.2	**3**	**2-10**
0.075	200		10.6	1.8		1.4	**1.4**	
PAN	dry		0.8	8.5		wt. before washing (0.1g)		585.7
PAN	wash		7.7	1.5		wt. after washing (0.1g		578
TOTAL		2.79	586.0			**loss from washing (- # 200)**		7.7

+ #4 % Particles less than 1.95 SP. Gr.		
Specific gravity of solution (1.95 ± 0.01)		1.95
wt. of lightweight particles	(0.1g)	0
wt of + #4 material	(0.1g)	298.4
% lightweight particles		0.0
SPECIFICATION		0.0-1.0

Coarse	1.25%	x % Retain/Design	58.0	=	0.73
Chip		x % Retain/Design		=	
Fine	1.45%	x % Pass/Design	42.0	=	0.61
04 Referenced		Total/Combined - #200			1.3

- #4 Gradation check:	
within 0.3% of the	0.1
wt. before washing	

Figure 7

Sample ID 2203623 **Sieve Analysis and P.I. Worksheet** **DOT-3 (Combined)**
File No. **9-15**

PROJECT PH 0066(00)15 COUNTY Aurora, Ziebach PCN B015
Charged To (if not above project)
Field No. 01 Date Sampled 03/13/2015 Date Tested 03/13/2015
Sampled By Tester, One Tested By Tester, One Checked By Tester, Two
Material Type Type 2A Cover Aggregate Source Spencer Quarry
Taken @ 180.3 tons. Lot No. Sublot No.
Weight Ticket Number or Station Ticket # 194, Sta. 866+00 Rt. Lift of

% moist. = (wet wt. - dry wt.) / dry wt. x 100 =
Original Dry Sample Wt. (0.1g)

Sieve Size mm	Sieve Size in	F.M. *	Retained (0.1g)	% total ret.(0.1%)	% pass. 0.1%	% pass. (rounded)	Spec Req.
100	4						
75	3						
62.5	2 1/2						
50.0	2						
37.5	1 1/2						
31.5	1 1/4						
25.0	1						
19.0	3/4						
16.0	5/8						
12.5	1/2						
9.5	3/8	*	0.0	0.0	100.0	**100**	**100-100**
6.3	1/4		235.5	19.2	80.8	**81**	
4.75	#4	*	349.1	28.4	52.4	**52**	**0-70**
Pan							
TOTAL							

+ #4 Gradation Check:
within 0.3% of original dry wt.

Dust Chk
wt. before washing (0.1g)
wt. after washing (0.1g)
loss from washing
% - #200

Liquid Limit		**L.L.**	**P.L.**
a. can number			
b. wt. can + wet soil	(.01g)		
c. wt. can + dry soil	(.01g)		
d. wt. of water (b - c)	(.01g)		
e. wt. of can	(.01g)		
f. wt. of dry soil (c - e)	(.01g)		
g. Liquid Limit (d/f x j x 100)	(0.1)	N.A.	N.P. ☐
h. Plastic Limit (d/f x 100)	(0.1)	N.A.	N.A.
I. P. I. (g - h)	(0.1)		
Liquid Limit N.C. ☐	(**g**. rounded)		N.A.
Plasticity Index	(**i**. rounded)	N.A.	

j. corr # blows 26 22 = 0.9846 23 = 0.9899 24 = 0.9952
25 = 1.0000 26 = 1.0050 27 = 1.0100 28 = 1.0138

wt. - #40 / wt. - #4 x % pass. #4 =
(± 3.0% VARIABLE of % pass. (0.1%) on the #40)

SPECIFICATION L.L.
SPECIFICATION P.I. 0-3

Sieve Size mm	Sieve Size #		retained (0.1g)	% total ret.(0.1%)	% total x % pa#4(0.1%)	% pass. (0.1%)	% pass (rounded)	Spec Req.
3.35	6							
2.36	8	*	518.3	42.2	22.1	10.2	**10**	**0-28**
2.00	10		44.6	3.6	1.9	6.6	**7**	
1.70	12							
1.18	16	*						
0.850	20							
0.600	30	*						
0.425	40		66.0	5.4	2.8	1.2	**1**	**0-4**
0.300	50	*						
0.180	80							
0.150	100	*						
0.075	200		12.2	1.0	0.5	0.2	**0.2**	**0.0-3.0**
PAN	dry		1.1			wt. before washing (0.1g)		
PAN	wash		3.6			wt. after washing (0.1g		
TOTAL			1230.4			**loss from washing (- # 200)**		

+ #4 % Particles less than 1.95 SP. Gr.		
Specific gravity of solution (1.95 ± 0.01)		.
wt. of lightweight particles	(0.1g)	
wt of + #4 material	(0.1g)	
% lightweight particles		
SPECIFICATION		-
- #4 % Particles less than 1.95 SP. Gr.		
Specific gravity of solution (1.95 ± 0.01)		.
wt. of lightweight particles	(0.1g)	
wt of - #4 material	(0.1g)	
% lightweight particles		
SPECIFICATION		-

Coarse	x % Retain/Design	=	
Chip	x % Retain/Design	=	
Fine	0.38% x % Pass/Design	=	
	Total/Combined - #200		

- #4 Gradation check:
within 0.3% of the wt. before washing 0.2

Crushed Particles Test	
weight of crushed particles	582.6
weight of total + #4 sample	582.6
percent of crushed particles	100
SPECIFICATION 2 or more FF	50-100

Natural Sand		Natural Fines		Na. Rock	
Ma. Sand		Filler		Cr. Rock	
Cr. Fines		Add Rock			

Comments: 12" sieves were used. The #8 was split in two and hand shaken. As per foot note #2, plasticity index was waived as not more than 4.0% of the material passed the #40 sieve.

Figure 8

Method of Test for Abrasion of Small-Size Coarse Aggregate by use of the Los Angeles Machine

1. Scope:

This standard practice describes the procedure for determining the resistance of coarse aggregate to abrasion using the Los Angeles testing machine.

2. Apparatus:

2.1 Los Angeles testing machine meeting requirements of AASHTO T 96.

2.2 Sieves. All sieves conforming to the requirements of AASHTO M 92.

2.3 Scale or balance having the capacity to weigh any sample which may be tested utilizing this procedure and readable to the nearest 0.1 gram.

2.4 Abrasive charge, steel spheres meeting the requirements of AASHTO T 96.

Depending upon the grading of the test sample as described in table 1, the abrasive charge shall be as follows:

Grading	Number of Spheres	Mass of Charge (g)
A	12	5000 ± 25
B	11	4584 ± 25
C	8	3330 ± 25
D	6	2500 ± 15

3. Procedure:

3.1 Obtain field sample in accordance with SD 201 and reduce the sample to test size by using SD 213. Oven dry the sample at 230 ± 9°F (110 ± 5°C).

3.2 Assemble a series of sieves that will furnish the information required by the specifications covering the material to be tested. Nest the sieves in order of decreasing size of opening from top to bottom and include a pan below the last sieve.

3.3 Pour the sample into the top sieve of the nest. Agitate the sieves by hand or on a mechanical shaker for a sufficient period of time.

3.4 Remove any dirt adhering to the + #4 (4.75 mm) material. This can be accomplished by dumping the material from each individual sieve into a flat pan and rubbing it with a soft pine or rubber covered block. After the dirt has been removed, pour the contents of the pan back onto the sieves and complete the shaking.

An alternate method of removing dirt is to place the material retained on an individual sieve in an enclosed container. Agitate the aggregate in the container by hand using a circular motion. The material is then reintroduced to the sieve and sieved by hand.

3.5 Separate the test specimen into individual size fractions and recombine to the grading in table 1, most nearly corresponding to the gradation of the aggregate sample.

Table 1: Grading's for test specimens

Sieve size		Mass for each grading (g)			
Passing	Retained on	A	B	C	D
1 ½"	1"	1250 ± 25			
1"	3/4"	1250 ± 25			
3/4"	1/2"	1250 ± 10	2500 ± 10		
1/2"	3/8"	1250 ± 10	2500 ± 10		
3/8"	1/4"			2500 ± 10	
1/4"	#4			2500 ± 10	
#4	#8				5000 ± 10
Total		5000 ± 10	5000 ± 10	5000 ± 10	5000 ± 10

3.6 Record the mass of the sample before testing to the nearest 1 g.

3.7 Place the test specimen and abrasive charge in the Los Angeles testing machine and rotate the machine at a speed of 30 to 33 rpm for 500 revolutions.

3.8 After the testing machine has completed the required amount of revolutions, discharge the material from the machine and perform a preliminary separation of the test specimen on the #4 (4.75 mm) sieve. Sieve the finer portion on a #12 (1.70 mm) sieve.

3.9 Record the mass of the material retained above the #12 sieve to the nearest 1 g.

4. Report:

4.1 Calculate the “Percent wear” as follows:

$$\text{Percent wear} = \frac{(A - B)}{A} \times 100$$

Where:

A = Mass of original sample to the nearest 1 g.

B = Mass of final sample retained above the #12 sieve to the nearest 1 g.

4.2 Report the grading designation of the test specimen from table 1 and the percent wear to the nearest 1% by mass.

5. References:

AASHTO T 96
AASHTO M 92
ASTM C 131
SD 201
SD 202
SD 213

Method of Test for Amount of Material Finer than #200 Sieve

---

1. Scope:

This test covers the determination of the amount of material finer than a #200 (0.075 mm) sieve.

2. Apparatus:

2.1 Scale or balance having the capacity to weigh any sample which may be tested utilizing this procedure and readable to the nearest 0.1 gram.

2.2 Sieves. A nest of two sieves with the lower being a #200 (0.075 mm) sieve and the upper being a sieve with openings in the range of #8 (2.36 mm) to #16 (1.18 mm), both conforming to the requirements of AASHTO M 92.

2.3 Container. A pan or vessel of a size sufficient to contain the sample covered with water and to permit vigorous agitation without loss of material or water.

2.4 Drying oven capable of maintaining a temperature of 230° ± 9°F (110° ± 5°C).

3. Procedure:

3.1 Obtain samples in accordance with SD 201.

3.2 The size of the specimen shall conform to the following:

NOTE: Nominal maximum size of particle is denoted by the smallest sieve opening listed below, through which 90% or more of the sample being tested will pass.

Nominal maximum size of particles		Minimum weight of sample, grams
#4	(4.75 mm)	500
3/8”	(9.50 mm)	1000
1/2”	(12.5 mm)	2000
3/4”	(19.0 mm)	2500
1”	(25.0 mm)	3500
1 1/2”	(37.5 mm) & above	5000

3.3 Dry the sample to a constant weight in an oven at 230° ± 9°F (110° ± 5°C) or in accordance with SD 108. Weigh the material to the nearest 0.1 gram.

3.4 Place the sample in the container and add enough water to cover it. Agitate the sample with sufficient vigor to result in complete separation of all particles finer than the #200 (0.075 mm) sieve from the coarser particles, and to bring the fine material into suspension. Pour the wash water containing the

suspended and dissolved solids over the nest of sieves. Repeat the operation until the wash water is clear.

NOTE: Plain water should be used as noted above unless the finer material that is adhering to the larger particles can't be removed readily with plain water because of some clay coatings or when aggregates have been extracted from bituminous mixtures. In these cases the fine materials will be separated more readily when using a wetting agent such as Aerosol OT, Alconox, or liquid dishwashing detergents. Only use enough wetting agent so that a small amount of suds is obtained.

3.5 Dry the washed aggregate to a constant weight (As defined in section 3.3 above) in an oven at 230° ± 9°F (110° ± 5° C) or in accordance with SD 108.

NOTE: If the material being tested also requires testing in accordance with SD 216 and/or SD 218, material from this test may be used to eliminate the need for additional testing specimens.

4. Report:

4.1 Calculate the amount of material passing a #200 (0.075 mm) sieve by washing as follows:

$$\frac{\text{(Original dry weight - weight after washing)}}{\text{Original dry weight}} \times 100 = \text{\% of material finer than \#200 (0.075 mm) sieve}$$

4.2 Percentages shall be reported to the whole number or decimal required by the specification.

5. References:

AASHTO M 92
SD 108
SD 201
SD 216
SD 218
DOT-3

Method of Test for Liquid Limit, Plastic Limit, and Plasticity Index

1. Scope:

This test is for determining the liquid limit, plastic limit, and the plasticity index of soils and granular materials. Referee tests will be performed in accordance with AASHTO T 89 and AASHTO T 90.

The liquid limit is the water content at which a soil passes from a plastic to a liquid state.

The plastic limit is the lowest water content at which a soil remains plastic.

The plasticity index is the numerical difference between the liquid limit and the plastic limit.

The word “Soil” in these tests shall mean the - #40 (0.425 mm) sieve material.

2. Apparatus:

2.1 Balance having a capacity of at least 100 g sensitive and readable to .01 gram.

2.2 Containers. Containers, such as metal cans with lids, which will prevent loss of moisture prior to and during weighing.

2.3 Drying oven. Ovens, hot plates or other suitable devices for drying the samples at 230°F ± 9°F (110°C ± 5°C).

2.4 Evaporating dish. A porcelain dish used for mixing the soil and water.

2.5 Liquid limit device conforming to specifications as described in AASHTO T 89.

2.6 Grooving tool. A combined grooving tool and gauge as described in AASHTO T 89.

2.7 Gauge. 10mm x 25mm x 50mm (Optional). 15

2.8 Plastic wash bottle with jet opening for adding water to the soil.

2.9 Pulverizing apparatus shall be a mortar and rubber covered pestle or a mechanical device consisting of a mortar of suitable size and shape and a power-driven, rubber covered muller for breaking up soil particles without reducing individual grain size.

2.10 Splitter. Mechanical splitter capable of reducing the size of sample. (SD 213).

2.11 Sieves. Sieves shall conform to AASHTO M 92.

2.12 Spatula. A spatula having a flexible steel blade approximately 3” (75 mm) in length and 3/4” (19 mm) in width.

2.13 Spoon. An appropriate size spoon for mixing and transferring the dry soil.

2.14 Surface for rolling. A ground glass plate or a piece of smooth paper laying on a smooth, horizontal surface.

3. Procedure:

For Disturbed Soil Samples

3.1 Obtain a dry sample of - #4 (4.75 mm) sieve material that is of adequate size to produce at least 100 grams of - #40 (0.425 mm) sieve material.

3.2 Sieve the material on a #40 (0.425 mm) sieve.

3.3 Pulverize the material retained on the #40 (0.425 mm) sieve using the mortar and rubber covered pestle or the power driven muller. If the sample contains brittle particles, the pulverizing operation shall be done carefully and with just enough pressure to free the finer material that adheres to the coarser particles.

For Aggregate Samples

3.4 Begin by weighing the sample to the nearest 0.1 gram and record it as “Wt. - #4” on the worksheet. Place the material on a #40 (0.425 mm) sieve with a pan below the sieve and agitate them for a period of time. (The use of a relief sieve, #20 (0.850 mm) or #30 (0.600 mm), is encouraged above the #40 (0.425 mm) to prevent overloading.) Place the material retained on the sieves into a pulverizing mechanism (Which shall consist of a mortar and rubber covered pestle or a power driven muller) and carefully pulverize the material.

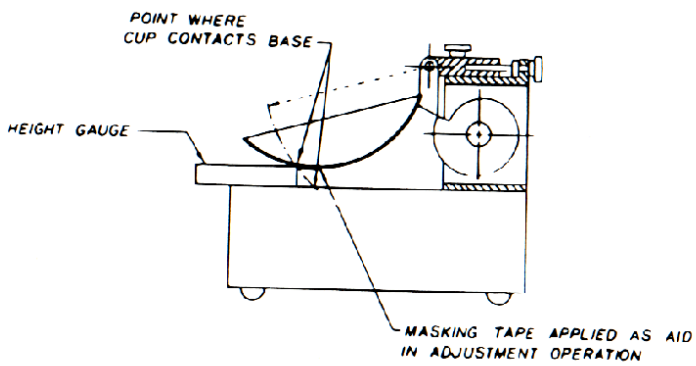
Alternately sieve and pulverize the material until not more than 1% will pass the #40 (0.425 mm) sieve during 1 minute of sieving.

Weigh the material in the pan to the nearest 0.1 gram and record it as “Wt. - #40” on the worksheet. Calculate the percentage of the sample which passed through the sieve by dividing the “Wt. - #40” by the “Wt. - #4” and then multiplying this percentage by the accumulative percent passing the #4 (4.75 mm) sieve in the sieve analysis. Compare this percentage to the accumulative percentage of material that passed the #40 (0.425 mm) sieve in the sieve analysis. These should compare within ±3.0%. If the difference is more than 3.0% above the sieve analysis percentage, a new sample should be prepared and sieved, if it is more than 3.0% below the percentage passing

in the sieve analysis, more pulverizing and sieving is required and the results recalculated.

NOTE: The variation should not be more than 3.0%.

3.5 Adjust the cup of the liquid limit device to a 10 mm drop. Place a piece of masking tape across the wear spot on the bottom of the cup parallel with the axis of the cup hanger pivot. The tape must bisect the center of the wear spot, leaving the front half of the wear spot (away from the cup hanger pivot) exposed. From the front of the liquid limit device, slide the gauge under the cup until it comes in contact with the tape. Check the adjustment by turning the crank at 2 revolutions per second while holding gauge in position against the tape and cup. The adjustment is correct if a ringing or clicking sound is heard without the cup rising from the gauge. 15



Calibration for Height of Drop

Figure 1

3.6 Mix the sample of - #40 (0.425 mm) material thoroughly and transfer 50 to 100 g to the evaporating dish. Add 15 to 20 mL of water by alternately and repeatedly stirring, kneading and chopping with a spatula, allowing time for moisture to soak into the soil. (Allow 5 to 10 minutes, with the longer time used for material slow to absorb water.) Make further additions of water in increments of 1 to 3 mL. Mix each increment of water thoroughly as previously described before adding another increment. Once testing has begun, no additional dry soil shall be added to the moistened soil. The cup of the liquid limit device shall not be used for mixing.

When sufficient water has been thoroughly mixed with the soil to form a uniform mass of stiff consistency, place an adequate quantity of this mixture in the cup above the spot where the cup rests on the base. Squeeze and spread this mixture with the spatula to level and at the same time trimmed to a depth of approximately 10 mm at the point of maximum thickness. Use as few strokes of the spatula as possible, taking care to prevent entrapment of air bubbles within the mass.

Divide the soil in the cup of the mechanical device with a firm stroke of the grooving tool, along the diameter through the centerline of the cam follower, forming a clean sharp groove of the proper dimensions (Figure 2). To avoid tearing the sides of the groove or slipping of the soil cake within the cup, up to 6 strokes (From front to back or back to front, counting as 1 stroke) shall be permitted.
NOTE: At this point, spilled portions of moistened soil shall be wiped from the edges of the cup and base of the machine to ensure a clean surface on which the cup will fall.

Lift and drop the cup containing the soil by turning the crank at a rate of two revolutions per second until the sides of the groove come in contact at the bottom of the groove for a distance of 1/2" (12.5 mm), (Figure 3). Do not hold the base of the machine with the hand while turning the crank.

NOTE: Some soils tend to slide on the surface of the cup instead of flowing. If this occurs, remove the material from the cup, add more water, remix and repeat the test. If the soil continues to slide on the cup at a lesser number of blows than 25, the test is not applicable and a note should be made that the liquid limit could not be determined.

Restrict the accepted number of blows for groove closure to between 22 and 28 blows. Record the number of blows for the accepted closure. Remove a slice of soil (8 grams minimum) approximately the width of the spatula, extending from edge to edge of the soil cake at right angles to and including that portion of the groove where the closure took place, and place it in a container. Promptly weigh and record to the nearest 0.01 g, the weight of the can and wet soil. Dry to a constant weight as per SD 108.

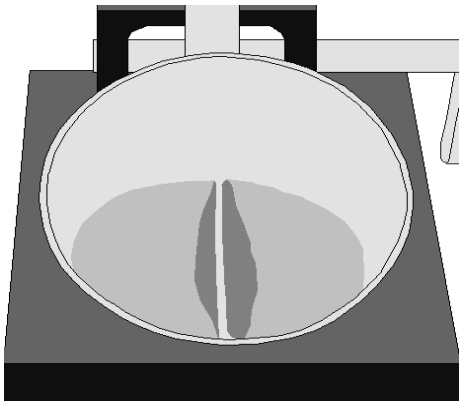


Figure 2
(Soil cake grooved for the test)

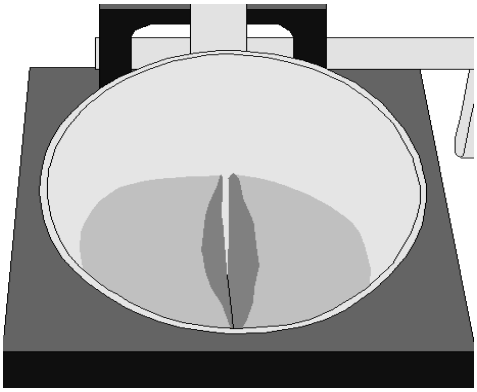


Figure 3
(Soil cake after normal test)

3.7 Plastic limit.

Take a sample weighing a minimum of 8 grams from the wet material in the evaporating dish used for the liquid limit test. Take the sample at any stage

of the mixing process when the material becomes plastic enough to be shaped without excessively sticking to the fingers when squeezed. Set this sample aside until the liquid limit test has been completed.

Select a 1.5 to 2.0 gram portion from the 8 gram sample and squeeze and form this into an ellipsoidal-shaped mass. Roll this mass between the fingers and the ground-glass plate or a piece of smooth paper (do not use paper towels) laying on a smooth horizontal surface with just sufficient pressure to roll the mass into a uniform thread approximately 1/8" (3 mm) in diameter throughout its length (Figure 4). When the diameter of the thread reaches 1/8" (3 mm), break it into 6 or 8 pieces, squeeze the pieces together into a uniform mass roughly ellipsoidal in shape and re-roll. The rate of rolling shall be between 80 and 90 strokes per minute, counting a stroke as one complete motion of the hand forward and back to the starting position.

NOTE: If 1/8" cannot be attained after repeated rolldown attempts, sample is considered non-plastic (NP).

Continue this alternate rolling to a thread, gathering together, kneading and re-rolling until the thread crumbles under the pressure required for rolling (Figure 5).

The crumbling may occur when the thread has a diameter greater than 1/8" (3 mm). This shall be a satisfactory end point, provided the soil has been previously rolled into a 1/8" (3 mm) diameter thread.

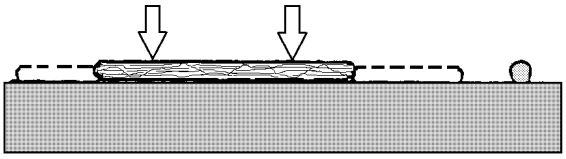


Figure 4

Figure 5

3.8 Gather all the crumbled soil together and place it in a tared container for weighing. This requires an additional sample to be taken and the steps in paragraph 3.7 followed again. Be sure the lid is on the container to prevent evaporation while the additional material is prepared.

Weigh and record the weight of the container and wet soil to the nearest 0.01 gram. Dry the sample to a constant weight as per SD 108.

4. Report:

4.1 Calculation of the liquid limit.

A. Calculate the moisture content to the nearest 0.1% of the oven-dried weight as follows:

$$\% \text{ moisture} = \frac{\text{Weight of water}}{\text{Weight of oven-dried material}} \times 100$$

B. Convert the percent of moisture to the Liquid Limit using the following conversion factors.

# of blows	x	factor	# of blows	x	factor
22	=	0.9846	26	=	1.0050
23	=	0.9899	27	=	1.0100
24	=	0.9952	28	=	1.0138
25	**=**	**1.0000**			

C. Record the liquid limit to the nearest 0.1% on the worksheet.

4.2 Calculation of the plastic limit.

A. Calculate the plastic limit as follows:

$$\text{Plastic limit} = \frac{\text{Weight of water}}{\text{Weight of oven-dried material}} \times 100$$

B. Record the plastic limit to the nearest 0.1% on the worksheet.

4.3 Calculation of the plasticity index.

A. Calculate the plasticity index as follows:

Plasticity index = liquid limit – plastic limit

B. Record the plasticity index to the nearest 0.1% on the worksheet.

4.4 Report the liquid limit and plasticity index to the whole number or decimal required by the specifications.

5. References:

AASHTO T 89
AASHTO T 90
AASHTO M 92
SD 108
SD 202
SD 213

Sample ID **Sieve Analysis and P.I. Worksheet** **DOT-3 (Combined)**
File No. **9-15**

PROJECT PH 0066(00)15 COUNTY Aurora, Ziebach PCN B015
Charged To (if not above project) _____
Field No. 01 Date Sampled 03/10/2015 Date Tested 03/10/2015
Sampled By. Tester, One Tested By Tester, One Checked By Tester, Two
Material Type Base Course Source Richland Pit
Lot No. 2 Sublot No. 1
Weight Ticket Number or Station Ticket #76427, Sta. 26+25 Lift 1 of 3

% moist. = (wet wt. _____ - dry wt.) / dry wt. x 100 = _____
Original Dry Sample Wt. (0.1g) 7318.0

Sieve Size mm	in	F.M. *	Retained (0.1g)	% total ret.(0.1%)	% pass. 0.1%	% pass. (rounded)	Spec Req.
100	4						
75	3						
62.5	2 1/2						
50.0	2						
37.5	1 1/2						
31.5	1 1/4						
25.0	1		0.0	0.0	100.0	**100**	**100**
19.0	3/4		167.6	2.3	97.7	**98**	**80-100**
16.0	5/8		240.6	3.3	94.4	**94**	
12.5	1/2		351.7	4.8	89.6	**90**	**68-91**
9.5	3/8	*	338.8	4.6	85.0	**85**	
6.3	1/4		625.2	8.5	76.5	**77**	
4.75	#4	*	586.2	8.0	68.5	**69**	**46-70**
Pan			5008.1	68.4			
TOTAL			7318.2				

+ #4 Gradation Check:
within 0.3% of original dry wt. 0.1

Dust Chk: wt. before washing (0.1g) _____; wt. after washing (0.1%) _____; loss from washing _____; % - #200 _____

Liquid Limit		**L.L.**	**P.L.**
a. can number		45	19
b. wt. can + wet soil	(.01g)	29.87	28.34
c. wt. can + dry soil	(.01g)	28.14	27.11
d. wt. of water (b - c)	(.01g)	1.73	1.23
e. wt. of can	(.01g)	19.92	20.17
f. wt. of dry soil (c - e)	(.01g)	8.22	6.94
g. Liquid Limit (d/f x j x 100)	(0.1)	21.2	N.P. ☐
h. Plastic Limit (d/f x 100)	(0.1)	N.A.	17.7
I. P. I. (g - h)	(0.1)	3.5	
Liquid Limit N.C. ☐	(**g**. rounded)	21	
Plasticity Index	(**i**. rounded)	4	

j. corr # blows 26 22 = 0.9846 23 = 0.9899 24 = 0.9952 25 = 1.0000 26 = 1.0050 27 = 1.0100 28 = 1.0138

wt. - #40 181.4 / wt. - #4 611.2 x % pass. #4 = 20.3
(± 3.0% VARIABLE of % pass. (0.1%) on the #40)

SPECIFICATION L.L.	0-25
SPECIFICATION P.I.	0-6

15

Sieve Size mm	#		retained (0.1g)	% total ret.(0.1%)	% total x % pa#4(0.1%)	% pass. (0.1%)	% pass (rounded)	Spec Req.
3.35	6							
2.36	8	*	136.5	21.6	14.8	53.7	**54**	**34-58**
2.00	10		28.2	4.5	3.1	50.6	**51**	
1.70	12							
1.18	16	*	67.1	10.6	7.3	43.3	**43**	
0.850	20		62.7	9.9	6.8	36.5	**37**	
0.600	30	*	75.8	12.0	8.2	28.3	**28**	
0.425	40		61.4	9.7	6.6	21.7	**22**	**13-35**
0.300	50	*	55.6	8.8	6.0	15.7	**16**	
0.180	80		34.4	5.4	3.7	12.0	**12**	
0.150	100	*	4.8	0.8	0.5	11.5	**12**	
0.075	200		10.6	1.7	1.2	10.3	**10.3**	**3.0-12.0**
PAN	dry		1.7	95.1	10.3	wt. before washing (0.1g)	521.8	
PAN	wash		93.4	15.1		wt. after washing (0.1g	471.8	
TOTAL			632.2			**loss from washing (- # 200)**	50.0	

+ #4 % Particles less than 1.95 SP. Gr.		
Specific gravity of solution (1.95 ± 0.01)		
wt. of lightweight particles	(0.1g)	
wt of + #4 material	(0.1g)	
% lightweight particles		
SPECIFICATION		

- #4 % Particles less than 1.95 SP. Gr.		
Specific gravity of solution (1.95 ± 0.01)		
wt. of lightweight particles	(0.1g)	
wt of - #4 material	(0.1g)	
% lightweight particles		
SPECIFICATION		

Crushed Particles Test	
weight of crushed particles	447.0
weight of total + #4 sample	1015.9
percent of crushed particles	44
SPECIFICATION 1 or more FF	30-100

Coarse	x % Retain/Design	=	
Chip	x % Retain/Design	=	
Fine	x %Pass/Design	=	
		Total/Combined - #200	

- #4 Gradation check: within 0.3% of the wt. before washing 0.1

Natural Sand	Natural Fines	Na. Rock
Ma. Sand	Filler	Cr. Rock
Cr. Fines	Add Rock	

Figure 6

Method of Test for Percentage of Particles of Less Than 1.95 Specific Gravity in Fine Aggregates

---

1. Scope:

This test is for determining the percentage of lightweight particles in fine aggregate.

2. Apparatus:

2.1 Scale or balance having the capacity to weigh any sample which may be tested utilizing this procedure and readable to the nearest 0.1 gram.

2.2 Sieves. A #30 (0.600 mm) sieve conforming to the requirements of AASHTO M 92.

2.3 Strainer. A piece of #30 sieve cloth, conforming to M 92, of suitable size and shape for separating the floating pieces from the heavy liquid.

2.4 Beakers and graduate. Two 1000 mL glass beakers and one glass graduate of at least 250 mL capacity.

2.5 Containers suitable for drying the aggregate sample.

2.6 Hydrometer for measuring the specific gravity of the liquid, readable to 0.01.

2.7 Zinc chloride solution having a specific gravity of 1.95 ± 0.01.

2.8 Drying oven capable of maintaining a temperature of 230° ± 9°F (110° ± 5°C).

3. Procedure:

3.1 Using the graduate and hydrometer, check the specific gravity of the zinc chloride solution and record on the worksheet to the nearest 0.01.

3.2 Obtain a 250 to 350 g sample in accordance with SD 201 and dry in an oven at 230° ± 9°F (110° ± 5°C) to a constant weight as per SD 108. Weigh the material to the nearest 0.1 gram.

NOTE: Previously washed material may not be used for this test.

3.3 Screen the material on a #30 (0.600 mm) sieve and save the retained portion for the test.

3.4 Place approximately 600 mL of the solution in a glass beaker. The material is poured into the solution and at the same time stir the solution with a spoon. Continue stirring to insure that all of the material is in suspension. Allow the material to settle until there is a defined cleavage plane between the rising and settling material.

3.5 Decant the solution over the strainer into a glass beaker. Continue decanting until the settled material appears near the lip of the beaker.

3.6 Pour the solution back into the settled material at the same time stirring with a spoon to bring all material into suspension. Decant the solution as described in paragraph 3.5.

3.7 Thoroughly wash the material retained on the strainer to remove all zinc chloride. Dry the material to a constant weight in an oven at 230° ± 9°F (110° ± 5°C). Weigh the material to the nearest 0.1 gram.

4. Report:

4.1 The approximate percentage of lightweight particles is calculated in the following manner:

$$\% \text{ lightweight particles} = \frac{\text{wt. of decanted particles}}{\text{wt. of original dry sample}} \times 100$$

4.2 Report the percentage of lightweight particles to the nearest 0.1%.

5. References:

AASHTO M 92
SD 108
SD 201

Method of Test for Specific Gravity and Absorption of Fine Aggregate

---

1. Scope:

This test is for determining the bulk specific gravity and absorption of fine aggregate.

2. Apparatus:

2.1 Scale or balance having the capacity to weigh any sample which may be tested utilizing this procedure and readable to the nearest 0.1 gram.

2.2 Flask. A volumetric flask having a capacity of 500 mL with a known tare weight.

2.3 Mold. A metal, cone shaped mold with the following dimensions: top, 1 ½" (38 mm); bottom, 3 ½" (90 mm); height, 2 7/8" (72 mm).

2.4 Tamper. A metal tamping rod weighing 12 oz. (340 g) and having a flat circular tamping face 1" (25 mm) in diameter.

2.5 Drying oven capable of maintaining a temperature of 230° ± 9°F (110° ± 5°C).

2.6 Funnel. A small funnel to introduce the fine aggregate into the flask.

3. Procedure:

3.1 Obtain a sample of at least 1000 g in accordance with SD 201.

3.2 Dry the sample in an oven at 230° ± 9°F (110° ± 5°C) to a constant weight as per SD 108. Weigh the material to the nearest 0.1 gram.

3.3 Allow the sample to cool to a comfortable handling temperature, cover with water, either by immersion or by the addition of at least 6% moisture to the fine aggregate, and permit to stand for 15 to 19 hours. When the absorption and specific gravity values are to be used in proportioning concrete mixtures with aggregates used in their naturally moist condition, the requirement for initial drying to constant weight may be eliminated. If the surface of the particles have been kept wet, the 15 hours of soaking may also be eliminated.

NOTE: Values for absorption and specific gravity in the saturated surface dry condition may be significantly higher for aggregate not oven-dried before soaking than for the same aggregate treated in accordance with paragraph 3.2 and 3.3.

3.4 Decant excess water with care to avoid loss of fines, spread on a flat non-absorbent surface exposed to a gently moving current of warm air, and stir frequently to secure homogenous drying. Continue until the test specimen approaches a free flowing condition.

3.5 Test the material to determine if surface moisture is present with the cone and tamper. Hold the mold firmly on a smooth non-absorbent surface with the large diameter down. Place a portion of the partially dried fine aggregate loosely in mold by filling it to overflowing and heaping additional material above the top of the mold by holding it with cupped fingers of the hand holding the mold.

Lightly tamp the fine aggregate into the mold with 25 light drops of the tamper. The height of each drop shall be about 1/4" (6 mm) above the surface elevation of the fine aggregate. Distribute the drops over the entire surface of the fine aggregate.

Remove the loose sand from the base of the mold and lift it vertically. If surface moisture is still present, the fine aggregate will retain the shape of the mold. When the fine aggregate slumps slightly, it indicates that it has reached a surface dry condition. (It is intended that the first trial of the cone test be made with some surface water in the specimen. If the first test indicates that moisture is not present on the surface, mix a few milliliters of water with the fine aggregate; allow to stand covered for approximately 30 minutes, then proceed with the cone test.)

3.6 Immediately weigh a 500.0 g sample of the surface dry material and place it in the flask. Add water at 73.4 ± 3°F (23.0 ±1.7°C) to the material and roll the flask to eliminate air bubbles. After all air bubbles have been removed, place the flask in a constant temperature bath at 73.4 ± 3°F (23.0 ± 1.7°C) for 1 hour.

Fill the flask with water to the 500 mL mark and weigh the flask, water and fine aggregate to the nearest gram.

Remove the fine aggregate from the flask and dry to a constant weight. Weigh the dry aggregate to the nearest 0.1 gram. In lieu of drying the material from the flask, a second 500.0 gram of surface dry sample may be used to determine the dry weight.

4. Report:

4.1 Bulk specific gravity:

Calculate the bulk specific gravity, 73.4/73.4°F (23/23°C), as defined in M132 as follows:

$$\text{Bulk Sp. Gr.} = A / (B + S - C)$$

Where:

A = Mass of oven-dry specimen in air, g;

B = Mass of pycnometer filled with water, g;

C = Mass of pycnometer with specimen and water to calibration mark, g; and

S = Mass of saturated surface-dry specimen, g;

A. Bulk specific gravity (Saturated surface-dry basis).

Calculate the bulk specific gravity, 73.4/73.4°F (23/23°C), on the basis of mass of saturated surface-dry aggregate as follows:

$$\text{Bulk Sp. Gr. (saturated surface-dry basis)} = S / (B + S - C)$$

B. Apparent specific gravity.

Calculate the apparent specific gravity, 73.4/73.4°F (23/23°C), as defined in M132 as follows:

$$\text{Apparent Sp. Gr.} = A / (B + A - C)$$

C. Absorption.

Calculate the percentage of absorption, as defined in ASTM C 125, as follows:

$$\text{Absorption, percent} = ((S - A) / A) \times 100$$

4.2 Report the concrete specific gravity to the nearest 0.01 and the absorption to the nearest 0.1%. Report the asphalt specific gravity to 0.001 and absorption to the nearest 0.1%.

5. References:

AASHTO T 84
AASHTO M 132
ASTM C 125
SD 108
SD 201

Method of Test for Specific Gravity and Absorption of Coarse Aggregate

---

1. Scope:

This test is for determining the bulk specific gravity and the absorption of coarse aggregate.

The bulk specific gravity, saturated surface dry test is the method used for the determination of the weight per ft^3 (m^3) of riprap.

2. Apparatus:

2.1 Scale or balance having the capacity to weigh any sample which may be tested utilizing this procedure and readable to the nearest 0.1 gram.

2.2 Wire basket. A wire basket, large enough to hold the coarse aggregate sample, with #6 (3.35 mm) mesh or smaller openings.

2.3 Water tank. A pail or tank into which the sample is suspended in water at 73.4° ± 3°F (23.0° ± 1.7°C) for weighing.

2.4 Sieves. A #4 (4.75 mm) sieve conforming to AASHTO M 92.

2.5 Drying oven capable of maintaining a temperature of 230° ± 9°F (110° ± 5°C).

3. Procedure:

3.1 Coarse aggregate.

A. Obtain a sample in accordance with SD 201. The minimum sample specimen weight shall be as shown in the following table.

Nominal maximum size, in (mm)		Minimum mass of test sample, lb. (kg)	
1/2	(12.5) or less	4.4	(2)
3/4	(19)	6.6	(3)
1	(25.0)	8.8	(4)
1 ½	(37.5)	11	(5)
2	(50)	18	(8)
2 ½	(63)	26	(12)
3	(75)	40	(18)
3 ½	(90)	55	(25)
4	(100)	88	(40)
4 ½	(112)	110	(50)
5	(125)	165	(75)
6	(150)	276	(125)

B. Screen and wash the sample on the #4 (4.75 mm) sieve.

C. Immerse the + #4 (4.75 mm) sieve material in water for 15 to 19 hours.

D. Remove the specimen from the water and roll in an absorbent cloth until all visible films of water are removed from the particles.

E. Weigh and record the weight of the material to the nearest 0.1 gram.

F. Place the specimen in the wire basket and weigh and record the weight to the nearest 0.1 g of the material suspended in water at 73.4°F ± 3°F (23.0°C ± 1.7°C).

G. Dry the material to a constant weight and weigh to the nearest 0.1 gram.

3.2 Riprap.

A. Select a representative sample in accordance with the table shown in 3.1 A. (If small pieces are not available, select a larger piece that can be broken down in the laboratory).

B. Wash the specimen to remove dust and then immerse it in water for 15 to 19 hours.

C. Continue with paragraph 3.1. D. thru 3.1 G.

4. Report:

4.1 Bulk specific gravity.

Calculate the bulk specific gravity, 73.4/73.4°F (23/23°C) as follows:

$$\text{Bulk Sp. Gr.} = A / (B - C)$$

Where:

A = Mass of oven-dry test sample in air, g,

B = Mass of saturated-surface-dry test sample in air, g, and

C = Mass of saturated test sample in water, g.

4.2 Bulk specific gravity (Saturated-surface-dry).

Calculate the bulk specific gravity, 73.4/73.4°F (23/23°C), on the basis of mass of saturated-surface-dry aggregate as follows:

Bulk sp. gr. (Saturated-surface-dry) = B / (B - C).

4.3 Apparent specific gravity.

Calculate the apparent specific gravity, 73.4/73.4°F (23/23°C), as follows:

Apparent sp. gr. = A / (A - C)

4.4 Average specific gravity values.

When the sample is tested in separate size fractions, the average value for bulk specific gravity, bulk specific gravity (SSD), or apparent specific gravity can be computed as the weighted average of the values as computed using the following equation:

$$G = \frac{1}{\dfrac{P_1}{100\,G_1} \quad \dfrac{P_2}{100\,G_2} \quad \dfrac{P_n}{100\,G_n}}$$

Where:

G	=	Average specific gravity. All forms of expression of specific gravity can be averaged in this manner.
G_1, G_2 … G_3	=	Appropriate specific gravity values for each size fraction depending on the type of specific gravity being averaged.
P_1, P_2 … P_n	=	Mass percentages of each size fraction present in the original sample.

4.5 Absorption.

Calculate the percentage of absorption, as follows:

Absorption, percent = ((B - A) / A) x 100

4.6 Average absorption value.

When the sample is tested in separate size fractions, the average absorption value is the average of the values as computed in section 9.3, weighted in proportion to the mass percentages of the size fractions in the original sample as follows:

$$A = (P_1A_1 / 100) + (P_2A_2 / 100) + \ldots (P_nA_n / 100)$$

Where:

A = Average absorption, percent,

A1, A2 … An = Absorption percentages for each size fraction, and

P1, P2 … Pn = Mass percentages of each size fraction present in the original sample.

4.7 Report the specific gravity of coarse aggregate to the nearest 0.01 for concrete, nearest 0.001 for asphalt, and the absorption to the nearest 0.1% for both.

4.8 Report the unit weight of riprap to the nearest whole lb./ft³ (kg/m³).

Unit weight of riprap = Use formula shown in paragraph 4.2 above.

5. References:

AASHTO T 85
AASHTO M 92
SD 201

Method of Test for Percentage of Crushed Particles

1. Scope:

This test is for determining the percentage of pieces having one or more crushed faces. A crushed face is an angular, rough, or broken surface of a particle created by crushing, by other artificial means, or by nature. 15

2. Apparatus:

2.1 Scale or balance having the capacity to weigh any sample which may be tested utilizing this procedure and readable to the nearest 0.1 gram.

2.2 Sieve. A #4 (4.75 mm) sieve conforming to AASHTO M 92.

2.3 Pans for washing and drying the samples.

2.4 Drying oven capable of maintaining a temperature of 230° ± 9°F (110° ± 5°C).

3. Procedure:

3.1 Obtain sample in accordance with SD 201.

3.2 The sample should be large enough to yield the minimum quantity of + #4 (4.75 mm) sieve material required by the table below. The sample includes all rock retained on the #4 (4.75 mm) sieve and above.

Nominal maximum size of aggregate	Minimum sample size of + #4 material
#4 (4.75mm)	200 grams
3/8" (9.5 mm)	400 grams
1/2" (12.5 mm)	700 grams
3/4" (19.0 mm)	1000 grams
1" (25.0 mm)	1500 grams
1 ½" (37.5 mm)	2500 grams

NOTE: Nominal maximum size of aggregate is denoted by the smallest sieve opening through which 90% or more of the sample being tested will pass.

3.3 The material used for this test may be the same material used for the total - #200 material tested in SD 202. This material will need to be screened over the #4 sieve prior to weighing.

If the material comes from the remaining portion of the original + #4 material, it shall be screened and washed over the #4 (4.75mm) sieve to remove fine material that may be adhering to. This will aid in the visual inspection of the crushed faces. Following screening and washing, dry the material in an oven

at 230 ± 9° F (110 ± 5°C) to a constant weight as per SD 108 and weigh it to the nearest 0.1 gram.

3.4 Spread the aggregate on a flat clean surface and separate the particles not having the required number of crushed faces from those that have.
Following are the definitions for a fractured face:

<u>One crushed face</u>

The particle face will be considered “Crushed" only if it has a projected area of at least 25% of the maximum cross-sectional area of the particle and the face has sharp and well-defined edges.

<u>Two crushed faces</u>

The particle will be considered to have two “Crushed faces” when the largest crushed face has a projected area of at least 50% of the maximum cross-sectional area of particle and the other crushed face has a projected area of at least 25% of the maximum cross sectional area of the particle. The crushed faces shall have sharp and well defined edges.

The maximum cross-sectional area of the particle would be the largest outline projected by the aggregate fragment when held under a light.

Weigh the crushed particles to the nearest 0.1 gram.

Figure 1
(Particles with one crushed face)

Figure 2
(Particles with two crushed faces)

4. Report:

4.1 Calculate the percent of crushed particles as follows:

$$\text{Percent crushed particles retained on \#4 (4.75 mm) sieve \& above} = \frac{\text{Wt. of crushed particles}}{\text{Wt. of sample retained on \#4 (4.75 mm) sieve \& above}} \times 100$$

4.2 Report the percent of crushed particles retained on the #4 (4.75 mm) sieve and above to the nearest whole number.

5. References:

AASHTO M 92
SD 108
SD 201
SD 202

Method of Test for Flat & Elongated Particles

---

1. Scope:

This test is for determining the percentage by weight of coarse aggregate that have a maximum to minimum dimension greater than the specified ratio of 5:1 or 3:1.

2. Apparatus:

2.1 Proportional caliper device that is equipped with a 5:1 (5 to 1) ratio setting and/or 3:1 (3 to 1) ratio setting consisting of a base plate with two fixed vertical posts and a swinging arm mounted between them so that the opening between the arms and the posts maintain a constant ratio. The apparatus must be calibrated as stated in the procedure.

2.2 Balance having the capacity to weigh any sample which may be tested utilizing this procedure, accurate and readable to the nearest 0.1 gram.

3. Procedure:

3.1 Verification of Ratio: Ratio settings on the proportional caliper device shall be verified by the use of a calibrated machined block, micrometer, or other appropriate device.

A. The caliper device must close and bars touch on both sides of the caliper. Set the caliper to a 5:1 or 3:1 ratio as required by the specification. Open the larger end of the caliper to 5 inches or 3 inches and verify that the other opening is 1 inch. If needed, adjust the bars with the set screws under the caliper device to meet calibration.

3.2 Use + #4 material from the SD 202 sieve test. Record the weight of the sieve samples being tested as indicated below. Weigh and record the total amount of material retained on each sieve to the nearest 0.1 gram (a) in column “Total sample weight on sieve”. Split out approximately 100 particles of material retained on each sieve group that is in the sample.

Passing the 2" sieve and retained on the 1 ½ " sieve
Passing the 1 ½ " sieve and retained on the 1" sieve
Passing the 1" sieve and retained on the 3/4" sieve
Passing the 3/4" sieve and retained on the 1/2" sieve
Passing the 1/2" sieve and retained on the 3/8" sieve
Passing the 3/8" sieve and retained on the #4 sieve

NOTE: If there are not 100 pieces retained on the sieves, test the entire amount retained on the sieve.

3.3 After counting out the first sample splits of approximately 100 particles per sieve size, obtain a weight to be able to use to split out the sample without counting particles in the future. Weigh the amount of particles split out to test for each sieve size to the nearest 0.1 gram (b) and record in column "Weight of tested portion".

3.4 Set the longest length of the particle to be tested end to end in the larger end of the caliper device.

3.5 With the caliper device fixed in that position, tighten the pivot screw. Observe if the particle will pass through the smaller end of the caliper device at its minimum width or thickness. If it does, the particle should be counted as flat and elongated (F&E).

3.6 Repeat 3.4 and 3.5 for each particle to be tested.

3.7 Weigh the F&E particles for each sieve sample to the nearest 0.1 gram and record in (c) (Weight of flat/elongated particles) on the form DOT-69.

3.8 Calculate the percent of F&E Individual Sieve and the percent F&E Weighted Average to the nearest 0.1 percent by using the following equations.

Equations: F&E – Flat and Elongated

Record the total sample weight on each sieve group (a)
Add up the total sample weight and write that in the (d) box
Record the total weight of tested portion (100 pieces) (b)
Record the total weight of the F&E particles (Determined by caliper) (c)
% F&E particles is the sum of the & F&E weighted average column (e)

$$\text{\% F\&E individual sieve} = \frac{\text{Weight of F\&E particles (c)} \times 100}{\text{Weight of tested portion (100 particles) (b)}}$$

$$\text{\% F\&E weight avg.} = \frac{\text{Weight of F\&E particles (c)} \times 100}{\text{Weight of tested portion (100 particles) (b)}} \times \frac{\text{Total sample weight on sieve (a)}}{\text{Total sample weight}}$$

3.9 Add up the values of the percent F&E weighted average column to get the total F&E particles in the total sample based on the sample weighted average.

3.10 Record all test results for asphalt on form DOT-69, otherwise use the following spreadsheet and document in MS&T.

	a	b	c	(c/b)*100	((c/b)*(a/d))*100
Sieve Size	Total Sample Weight on Sieve	Weight of Tested Portion (100 pieces)	Weight of Flat/Elong Particles	Percent Flat/ Elongated Individual Sieve	Percent Flat/ Elongated Weighted Average
2" to 1 1/2"	0.0				
1 1/2" to 1"	0.0				
1" to 3/4"	0.0				
3/4" to 1/2"	244.4	244.0	0.0	0.0	0.0
1/2" to 3/8"	522.7	238.2	3.0	1.3	0.3
3/8 to #4	1216.8	75.6	2.1	2.8	1.7
Total Sample wt.	1983.9	d			

Percent flat and elongated particles	e	2.0
in the total sample (weighted average)	rounded	2

Figure 1

4. Report:

4.1 Report the percent flat and elongated particles in the total sample (Weighted average) to the nearest 0.1 percent or whole number as required by the specification.

5. References

ASTM D4791
SD 202
DOT-69

Procedure for Reducing Samples to Testing Size

---

1. Scope:

These procedures are for the reduction of field samples of aggregates to the appropriate size for testing.

2. Apparatus:

2.1 Mechanical Method.

A. Mechanical sample splitter shall be equipped with 3 receptacles large enough to hold the sample following splitting. Only these receptacles shall be used when reducing the sample to the required testing size.

B. Sample splitters shall have an even number of equal width chutes. The number of chutes for coarse aggregate shall not be less than 8, and for fine aggregate, not less than 12. The chutes shall discharge alternately to each side of the splitter. The minimum width of the individual chutes shall be approximately 50% larger than the largest particles in the sample to be split. For fine aggregate a splitter having chutes 1/2” (13 mm) wide will be satisfactory when the entire sample passes the 3/8” (9.5 mm) sieve.

C. The splitter shall be equipped with a hopper or a straight edge pan, which has a width equal to or slightly less than the overall width of the assembly of chutes.

D. The splitter shall be leveled in a manner to ensure uniform material distribution throughout the chutes. 15

2.2 Quartering Method.

A. Canvas, heavy polyethylene or other suitable surface, or minimum of 24” x 24” x 4” pan.

B. Straightedge, scoop, shovel or trowel.

C. Broom or brush.

3. Procedure:

3.1 Fine aggregate to be split or quartered shall be dry or surface dry before reducing the sample to required size.

Fine aggregate is defined as an aggregate in which the entire sample will pass the 3/8” (9.5 mm) sieve.

Surface dry condition may be determined, as a quick approximation, if the fine aggregate will retain its shape when molded in the hand, it may be considered to be wetter than saturated-surface dry.

If the moist sample is large, a preliminary split may be made using a mechanical splitter having wide chute openings 1½" (38 mm) or more to reduce the sample to not less than 5000 grams. This portion is then dried and reduction to test sample size is completed.

Coarse aggregates and mixtures of coarse and fine aggregates may be reduced to test sample size using a mechanical splitter, in which the sample will flow smoothly without restriction or loss of material. The quartering method may be used without regard to moisture in the aggregates.

3.2 Mechanical Splitter.

Depending on the type of material, number of samples to be tested and the size of the sample needed for the required testing the appropriate method of splitting must be used.

Method 1 Used when only one container is needed to hold all the material for testing and backups.

A. Adjust splitter bars for required chute width.

B. Place sample in closed hopper, distributing as you pour, and level by hand until material is evenly distributed from side-to-side and from front to back in hopper.

C. Prior to splitting your sample, mix the sample by repetitive blending and mixing the entire sample (3 times) with the splitter.

D. Split the material by opening the gates of the hopper. The sample shall be fed at a controlled rate into the chutes.

E. To assure representative samples, split the original sample into (A) & (B) into (a) & (b), reverse (a) & (b) in splitter, combine (B) into (b) & (a). As shown in figure 2 .

F. Check for approximately equal splits by weighing.

NOTE: Rule of thumb - Coarse aggregate splits within 500 grams or fine aggregate within 30 grams.

G. Sample (b) can be tested or reduced further as needed.
Sample (a) can be saved as a backup. If four samples are required then split samples (a) and (b) to have four approximately equal samples.

Method 2 Used when two containers are needed to hold all the material for testing and backup

A. Adjust splitter bars for required chute width.

B. Place sample in closed hopper, distributing as you pour and level by hand until material is evenly distributed from side-to-side and from front to back in hopper.

C. Prior to splitting your sample, mix the sample by repetitive blending and mixing the entire sample (3 times) with the splitter.

D. Combine and blend (1) and (2) using the splitter as shown in figure 3.

E. To assure representative samples, split (1) and (2) to obtain the four samples (a), (b), (c), (d). These samples can be tested or reduced further as needed.

F. Check for approximately equal splits by weighing.

NOTE: Rule of Thumb - Coarse aggregate splits within 500 grams or fine aggregate within 30 grams.

G. If eight samples are required then split samples (a), (b), (c) and (d) to have eight approximately equal samples.

Figure 1

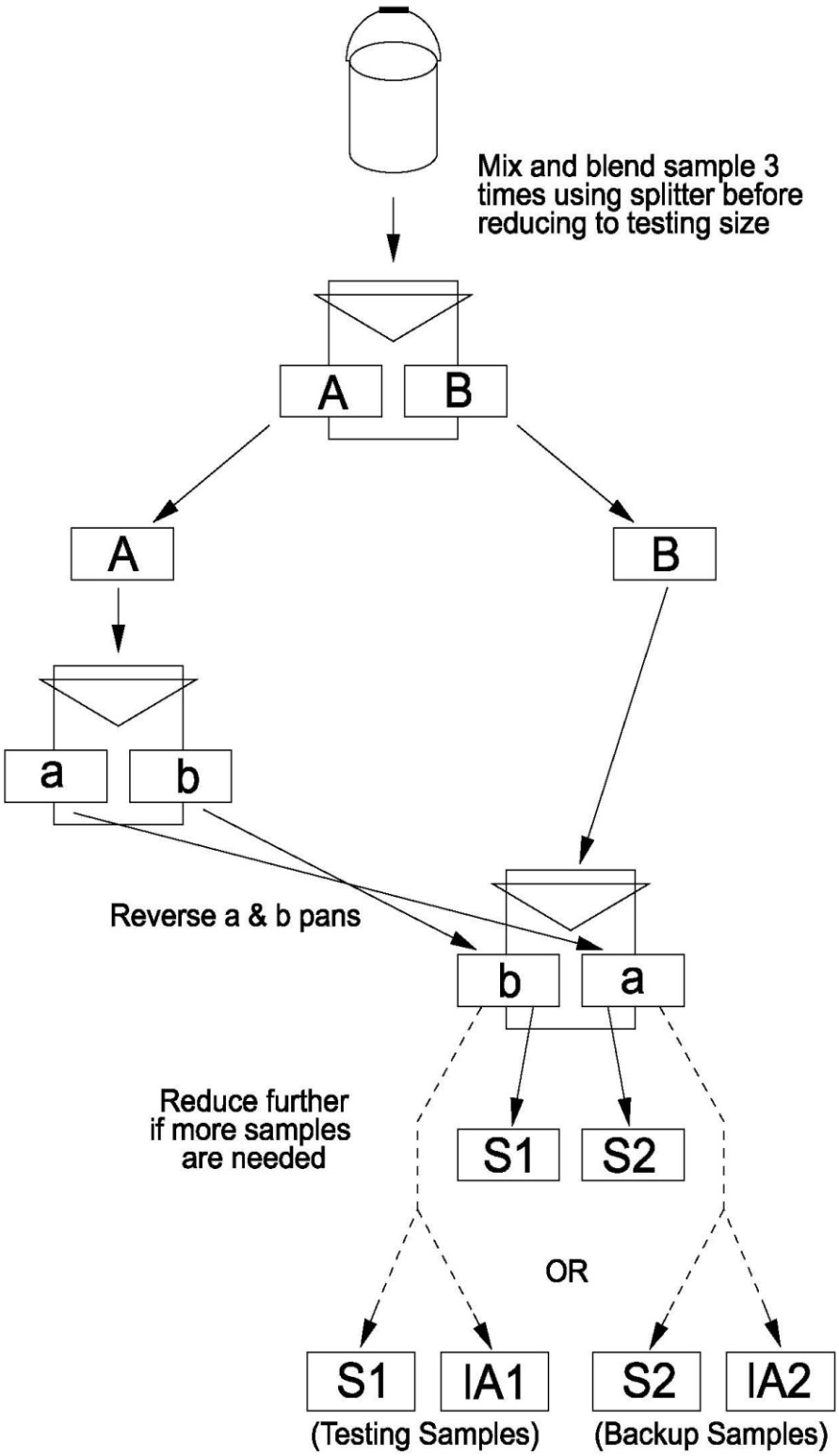

Mix and blend sample 3 times using splitter before reducing to testing size
A
B
A
B
a
b
Reverse a & b pans
b
a
Reduce further if more samples are needed
S1
S2
OR
S1
IA1
S2
IA2
(Testing Samples)
(Backup Samples)

Figure 2

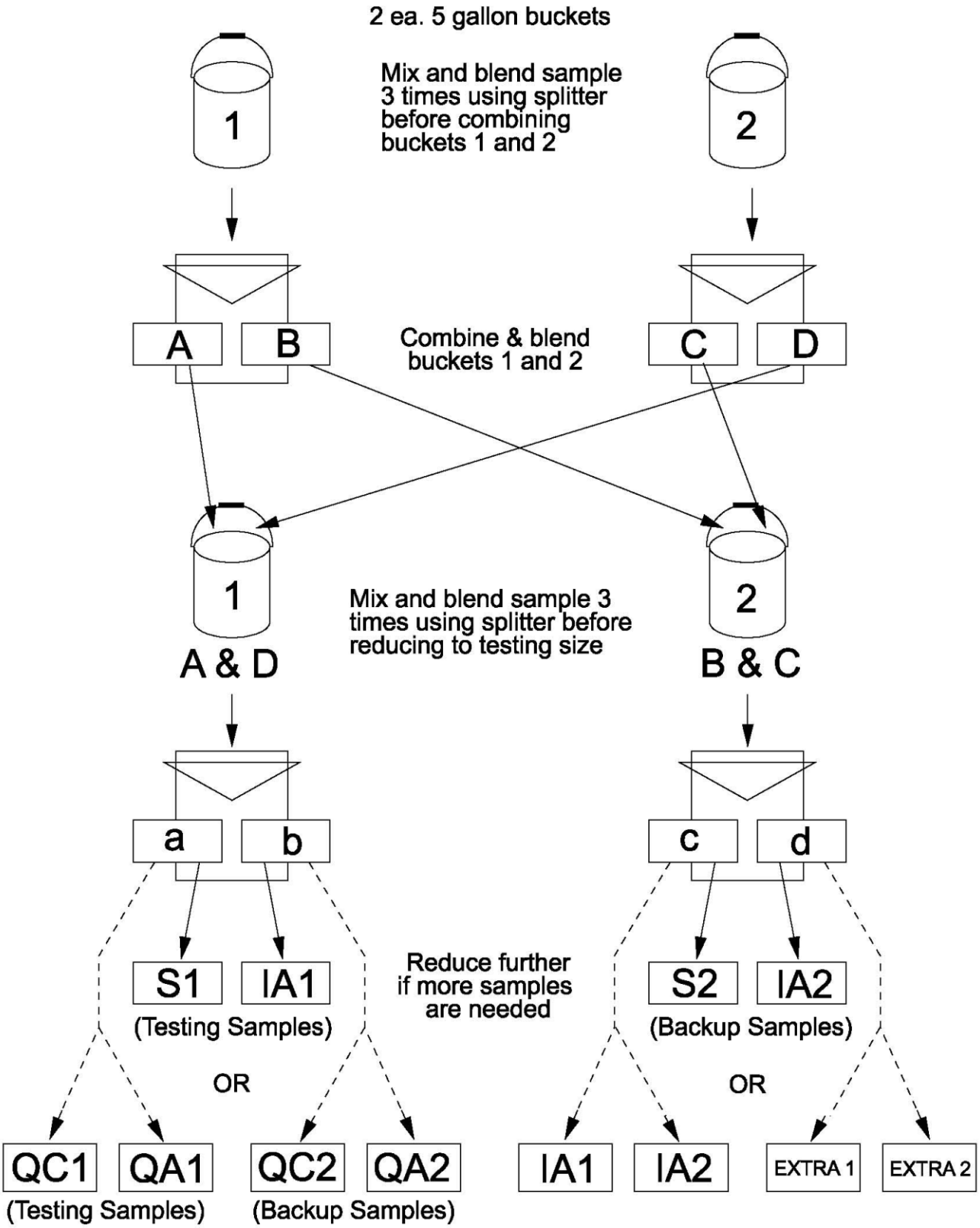
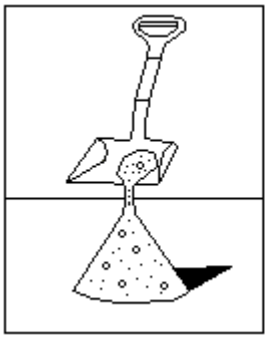

2 ea. 5 gallon buckets
1
2
Mix and blend sample 3 times using splitter before combining buckets 1 and 2
A
B
C
D
Combine & blend buckets 1 and 2
1
2
A & D
B & C
Mix and blend sample 3 times using splitter before reducing to testing size
a
b
c
d
S1
IA1
(Testing Samples)
Reduce further if more samples are needed
S2
IA2
(Backup Samples)
OR
OR
QC1
QA1
QC2
QA2
(Testing Samples)
(Backup Samples)
IA1
IA2
EXTRA 1
EXTRA 2

Figure 3

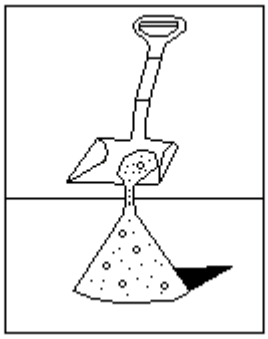
3.3 Quartering.

A. Place the sample on a hard, clean, level surface where there will be neither loss of material nor the addition of foreign material. Thoroughly mix the sample by turning the entire sample over at least three times. With the last turning, shovel the entire sample into a conical pile by depositing each shovelful on top of the preceding one. Carefully flatten the conical pile to a uniform thickness and diameter by pressing down the apex with a shovel so that each quarter sector of the resulting pile will contain the material originally in it. The diameter should be approximately 4 to 8 times the thickness. Divide the flattened mass into 4 equal quarters with a shovel or trowel and remove 2 diagonally opposite quarters, including all fine material, and brush the cleared spaces clean. Successively mix and quarter the remaining material until the sample is reduced to the desired size as shown in figure 4.

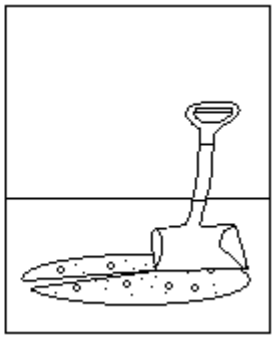
B. As an alternative when the floor surface is uneven, the field sample may be placed on a canvas blanket and mixed with a shovel as described in paragraph 3.3.A. or by alternately lifting each corner of the canvas and pulling it over the sample toward the diagonally opposite corner causing the material to be rolled. Flatter and divide the sample as described in paragraph 3.3.A. or if the surface beneath the blanket is uneven, insert a stick or pipe beneath the blanket and under the center of the pile, then lift both ends of the stick, dividing the sample into 2 equal parts. Remove the stick, leaving a fold of the blanket between the divided portions. Insert the stick under the center of the pile at right angles to the first division and again lift both ends of the stick, dividing the sample into 4 equal parts. Remove 2 diagonally opposite quarters, being careful to clean the fines from the blanket. Successively mix and quarter the remaining material until the sample is reduced to the desired size as shown in figure 5.



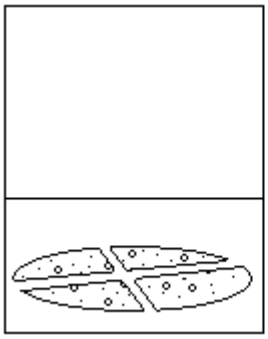
Cone sample on hard, clean level surface



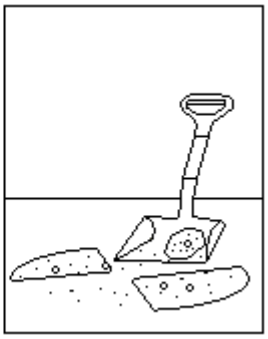
Mix by forming new cone



Quarter after flattening cone

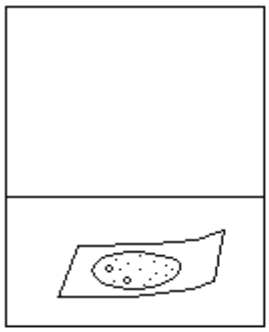


Sample into quarters

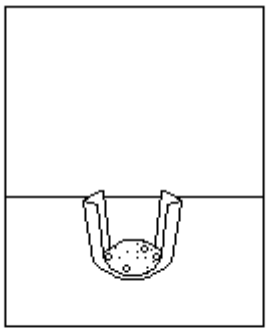


Retain opposite quarters
& reject other two quarters

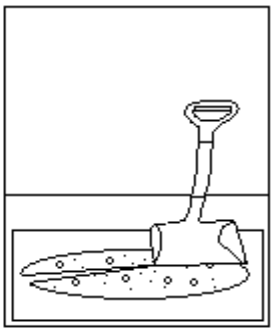
Figure 4



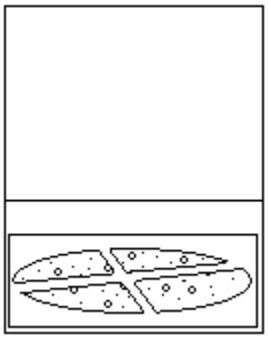
Mix by rolling on blanket



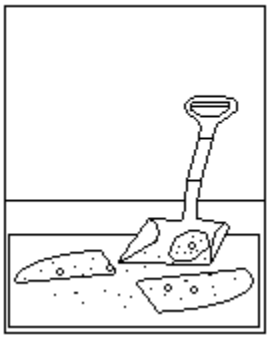
Form cone after mixing



Quarter after flattening cone



Sample into quarters



Retain opposite quarters
Reject other Two Quarters

Figure 5

4. Report:

None required.

5. References:

AASHTO T 248

Method of Test for Percentage of Particles of Less Than 1.95 Specific Gravity in Coarse Aggregate

---

1. Scope:

This test is for determining the percentage of lightweight particles in coarse aggregate.

2. Apparatus:

2.1 Scale or balance having the capacity to weigh any sample which may be tested utilizing this procedure and readable to the nearest 0.1 gram.

2.2 A suitable container and basket that will permit submerging the specimen to a minimum of 2” (50 mm) below the surface of the solution. The basket shall have openings not larger than a #8 (2.36 mm) mesh.

2.3 A #4 (4.75 mm) sieve conforming to AASHTO M 92.

2.4 A strainer with openings not larger than a #8 (2.36 mm) mesh.

2.5 A glass graduate of at least 250 mL capacity and a hydrometer for measuring the specific gravity of the liquid, readable to 0.01.

2.6 Zinc chloride solution having a specific gravity of 1.95 ± 0.01.

2.7 Drying oven capable of maintaining a temperature of 230° ± 9°F (110° ± 5°C).

3. Procedure:

3.1 Using a graduate and hydrometer, check the specific gravity of the zinc chloride solution and record on the worksheet to the nearest 0.01.

3.2 Obtain a 1500 to 2000 g sample in accordance with SD 201. Weigh the material to the nearest 0.1 gram and dry it to a constant weight as per SD 108. The sample includes all rock above the #4 (4.75 mm) sieve.

NOTE: Previously washed material may not be used for this test.

3.3 Sieve the dry sample on a #4 (4.75 mm) sieve and weigh the material retained to the nearest 0.1 gram.

3.4 Place the material in the basket and lower into the zinc chloride solution. Stir the aggregate with a large spoon. Skim off the floating particles using a strainer and save them. Repeat this process until no additional particles surface.

NOTE: The solution in the tank should be approximately 3 times the volume of the aggregate.

3.5 Thoroughly wash the particles that have been skimmed off, dry to a constant weight in an oven at 230° ± 9°F (110° ± 5°C).

4. Report:

4.1 Calculate the percentage of lightweight particles in the following manner.

$$\% \text{ lightweight particles} = \frac{\text{Weight of lightweight particles} \times 100}{\text{Weight of + \#4 (4.75 mm) material}}$$

4.2 Report the percentage to the nearest 0.1%.

5. References:

AASHTO M 92
SD 108
SD 201

Method of Test for Fine Aggregate Angularity

---

1. Scope:

The fine aggregate angularity test determines the loose uncompacted void content of a fine aggregate sample.

2. Apparatus:

2.1 Cylinder dimensions: Capacity of approximately 3.38 oz (100 mL), inside diameter 1.5 in. (39 mm), inside height 3.4 in. (86 mm), and base shall be 0.24 in. (6 mm) thick and securely sealed to the cylinder. The cylinder shall be made of drawn copper meeting ASTM B 88 Type M or C specifications. Calibration needs to be completed before starting procedure as to use the correct cylinder volume.

2.2 Funnel having a smooth inside with at least 1.5 in (38 mm) high sides. The funnel opening needs to be 0.5 ± 0.2 in. (12.7 ± 0.6 mm) diameter with the right frustum of a cone sloped at 60 ± 4° from the horizontal. The required volume is 200 mL. If the funnel does not support this capacity, use an additional container on the top of the funnel to reach the specified volume.

2.3 Funnel stand supported by three or four legs holding the funnel firmly in position. The axis of the funnel collinear needs to be inline with the cylindrical measure axis. The funnel opening shall be placed 4.5 ± 0.07 in. (115 ± 2 mm) above the cylinder top.

2.4 Glass plate with approximate dimensions of 2.4 in. x 2.4 in. (60 mm x 60 mm) and a thickness of 0.15 in. (4 mm) that will be used to calibrate the cylinder.

2.5 Spatula with a blade 0.8 in. wide and 4 in. long with straight edges and the end cut off at a 90° angle to the edges.

2.6 Metal or plastic pan large enough to contain the funnel stand and retain all material during and after completion of the procedure.

2.7 Balance accurate and readable to 0.1 grams capable of weighing the cylindrical measure and its contents.

Procedure:

3.1 Calibrate the cylinder to be used for the fine aggregate angularity tests.

A. Weigh the measuring cylinder and glass plate to the nearest 0.1g.

B. Fill the cylinder with distilled water at a temperature of 18 to 24 C^{o} (64.4 to 75.2 F^{o}).

C. Record the actual temperature of the water in the cylinder and place the glass plate on top of the filled cylinder while making sure that no air bubbles remain.

D. Completely dry the outside of the glass plate and cylinder filled with water, and record the weight to the nearest 0.1 gram.

E. Use the temperature conversion table and volume formula to calculate the volume of the cylinder using the density of water in kg/m^3:

Temperature		Density of Water	
^{0}F	^{0}C	lb/ft^3	kg/m^3
60	15.6	62.366	999.01
65	18.3	62.336	998.54
70	21.1	62.301	997.97
75	23.9	62.261	997.32
80	26.7	62.216	996.59
85	29.4	62.166	995.83

V = 1000 M/D

Weight of measure and glass plate	
weight of measure,glass plate& water	
M = net mass of water	
D = density of water at test temp.	
V = volume of cylinder, mL	

3.2 Obtain the sample from the fine (- #4) washed gradation in SD 202. After the - #4 gradation has been completed in SD 202 test procedure, keep individual sieves separate so that the following sieve amounts are obtained:

Passing the #8 and retained on the #16	=	44 grams
Passing the #16 and retained on the #30	=	57 grams
Passing the #30 and retained on the #50	=	72 grams
Passing the #50 and retained on the #100	=	17 grams
Total	=	190 grams

The tolerance for the sample is ± 0.2 grams per sieve.

3.3 Mix together thoroughly the 190 ± 0.8 gram sample.

3.4 Pour test sample into funnel while blocking the opening with your finger. Level the material in the funnel with a spatula.

3.5 Release the material into the cylinder, using something small like a pencil to unblock the opening should it become blocked. Once all the material has flowed from funnel and the cylinder is full, strike-off excess material with a single pass using the spatula with the width of the blade vertical, keeping the straight part of the blade horizontal and in light contact with the top of the measure. Make sure not to tap or move the cylinder. When strike-off is

completed, lightly tap the cylinder to settle material. Brush off any loose material clinging to the cylinder. Weigh the cylinder with the material to the nearest 0.1 gram.

3.6 Repeat steps 3.3 through 3.5 with same sample for 2nd trial.

4. Report:

4.1 Calculate the uncompacted voids (Us) for each trial as follows:

$$U = \frac{\text{Volume of cylinder} - (\text{Mass of aggr. / - \#4 Gsb of aggr.})}{\text{Volume of cylinder}} \times 100$$

To perform these calculations you will need the G_{sb} of the - #4 aggregate which can be obtained from the mix design report (Mix designers use SD 209) and the weight of the cylinder to obtain aggregate mass. Average the two test results to get the uncompacted voids (Us) for the sample.

Sample ID	1st trial	2nd trial	
Dry -#4 bulk specific gravity (Gsb)			
(from calibration) Volume of cylinder, mL (V)			
Weight of cylinder, g (A)			
Wt. of cylinder + aggregate, g (B)			
Wt. of aggregate, g (F=B-A)			Average
Uncompacted voids, (nearest 0.1%) U=((V-(F/Gsb))/V)*100			

4.2 Report the test results for uncompacted voids (Us) on form DOT-69. Report the average test result to the nearest 0.1 percent.

5. References

AASHTO T 304
SD 202
DOT-69

Procedure for Sodium Sulfate Soundness of Aggregates

---

1. Scope:

This test is for determining sodium sulfate soundness on coarse and fine aggregates.

Follow AASHTO T 104 in its entirety.

Method of Test for Sand Equivalent of Fine Aggregate

1. Scope:

This test is for determining the relative proportion of detrimental fine dust or clay-like particles in fine aggregates (Passing the #4 sieve).

2. Apparatus:

2.1 Balance having a sufficient capacity to weigh any sample which may be tested utilizing this procedure, accurate and readable to the nearest 0.1 gram.

2.2 Transparent plastic graduated cylinder having; a 1.25 in. (31.8 mm) inside diameter, approximately 17 in. (432 mm) in height and graduated up to 15 in. (381mm) in intervals of 0.1 in. (2.5 mm) starting at the base. The base dimensions must be ½ x 4 x 4 in. (12.5 x 102 x 102mm). Do not expose the plastic cylinders to direct sunlight any more than is necessary.

2.3 A rubber stopper that fits into the open end of the graduated cylinder.

2.4 Stock solution and set up must meet the requirements of AASHTO T-176. 3 oz. (85 ± 5 mL) of stock solution added to 1 gallon of distilled water. The solution needs to be maintained as close to 72 ± 5°F (22 ± 3°C) as possible to obtain representative results. Working solution more than 30 days old shall be discarded. If organic growth is present in the working solution, discard the solution, and then clean the container, tubing, irrigation tube and system with a 50:50 mixture of Clorox and water. Rinse the complete system with distilled water. Mix and use new solution.

2.5 An irrigator tube made of brass, stainless steel or copper with a 0.25 in. (6.4 mm) outside diameter, approximately 20 in. (508 mm) long, with one end closed to form a wedge-shaped tip with 2 small #60 holes through the flat side of the wedge.

2.6 A weighted foot assembly consisting of a metal rod connected to a foot with a flat, smooth surface at the lower end with the upper end weighted to give the total assembly a weight of 1000 ± 5 grams.

2.7 A 3.8 L (1 gal.) glass or plastic bottle equipped with a siphon assembly consisting of a 2 hole rubber stopper and pieces of copper tubing. The bottle sits 3 ft. ± 1 in. (915 ± 25 mm) above the work surface. A larger glass or plastic vat may be used provided that the liquid level of the working solution is maintained between 36 in. to 46 in. above the working surface.

2.8 A measuring can with a capacity of 3 oz. (85 ± 5 ml) approximately 2.25 in. in diameter at the mouth.

2.9 A timer reading in minutes and seconds.

2.10 A manually operated shaker capable of producing an oscillating motion at a rate of 100 complete cycles in 45 ± 5 seconds with a hand-assisted half stroke length of 5.0 ± 0.2 in. (127 ± 5 mm) or a mechanical shaker having a throw of 8.00 ± 0.04 in. (203.2 ± 1.0 mm) and operating at 175 ± 2 cycles per minute (2.92 ± 0.03 Hz). The shaker set up should be level and secure for either type system.

2.11 A splitting cloth made of plastic or canvas material approximately 2 ft. by 2 ft. (600 mm by 600 mm).

2.12 Drying oven capable of maintaining a temperature of approximately 230° ± 9° F (110° ± 5 C^o).

2.13 Funnel with a wide mouth about 4 in. (10 mm) in diameter.

2.14 Spatula or straightedge that is used to strike off the measuring can after obtaining the sample.

3. Procedure:

3.1 Obtain a split sample of - #4 material from SD 202 of approximately 750 to 1000 grams. Mix the sample in a pan using a spatula and add enough water so the material, when squeezed in the hand, forms a cast without free water present. The cast of material should break up slightly when rolled gently in the palm of the hand. If the material crumbles, add more water and mix the sample and recheck to see if a cast can be made which does not crumble. If the material forms a cast which does not break up, the material has free water and it must be allowed to dry before the sample is ready to be taken. After the required moisture content is obtained the sample shall sit a minimum of 15 minutes covered with a lid or damp cloth.

3.2 Place the sample on the splitting cloth and alternately lift each corner and pull toward the center to thoroughly mix the material. After thoroughly mixing the material, make a pile in the center of the cloth.

3.3 To take a sample, hold the 3 oz. sample can on its side on one side of the sample pile with the other hand palm facing the pile on the other side. Fill the container by pushing it through the pile while pushing the material into the container with the other hand. Press firmly so that the maximum amount of material will be placed in the tin. Strike off the top of the tin with a level spatula or straightedge.

3.4 Place the tin in an oven at 230 ± 9°F (110 ± 5°C) and dry to a constant weight. Material may also be removed from the tin and placed in a pan to dry. Remove the sample from the oven and cool to room temperature.

3.5 Repeat steps 3.2 to 3.4 to get a 2nd sample to test.

3.6 Siphon 4 ± 0.1 in. (101.6 ± 2.5 mm) of working calcium chloride solution into a plastic cylinder. Pour the sample into the cylinder using a funnel to assure material is not spilled. Tap the bottom of the cylinder with the heel of your hand several times to release air bubbles and make sure the sample is wetted thoroughly.

3.7 Put the cylinder on the counter and allow to stand undisturbed for 10 ± 1 minute.

3.8 Put the stopper in the cylinder and loosen the material in the cylinder by tipping (Partially inverting) the cylinder and shaking it at the same time.

3.9 A. Manual Shaker Method.

Make sure the stopper is securely in the cylinder. Place the cylinder in the manual shaker. Set the counter to zero. Apply enough force to the steel strap to make the cylinder move to the range markers on the shaking apparatus. The tip of the pointer should reverse direction within the marker limits. Continue the shaking action until 100 strokes (within 45 ± 5 seconds) are reached.

B. Mechanical Shaker Method.

Secure the cylinder in the mechanical shaker and operate for a complete cycle (usually 45 seconds.)

C. Hand Shake Method.

Hold cylinder in a horizontal position and shake it for 90 cycles in roughly 30 seconds. A cycle is back and forth with a throw of 9 in. ± 1 in.

3.10 Take the cylinder out of the apparatus and set upright on the working table. Remove the stopper, take irrigator tube and rinse material from the side of the cylinder while moving the tube down into the material to the bottom of the cylinder. Irrigate the material at the bottom, by stabbing and twisting to make sure that all the fine material is being agitated from the bottom and moves towards the top of the solution. When the solution in the cylinder is close to the 15 in. mark, slowly pull the irrigator out of the material and towards the top of the cylinder. Regulate the flow of solution so that the when the irrigator is completely removed from the cylinder the 15 in. mark is reached.

3.11 Set the cylinder on a flat surface that does not have any other vibrating equipment on it and let the material solution settle for 20 min. ± 15 sec. Time clock should be set right after the irrigator is completely withdrawn.

NOTE: Field laboratories shall be adequately anchored to the ground, leveled, and rigidly supported to eliminate floor and workbench vibrations. Vibrations may cause the suspended material to settle at a rate greater than normal.

3.12 When 20 min. is up, take the "Clay reading" which is at the top of the clay suspension. If there is no definite line, let the solution set till a clay line appears. If there is no definite line after 30 minutes, the test must be rerun with three separate samples of the same material. Read and record the sample with the shortest sedimentation period only.

NOTE: If clay or sand readings fall between 0.1 in. (2.5 mm) graduations, record the level of the higher graduation as the reading. A clay reading of 6.95 would be recorded as 7.0 and a sand reading of 2.63 would be recorded as 2.7.

3.13 After the clay reading is taken, the "Sand reading" will be taken by using a weighted foot as described. Slowly set the foot into the cylinder allowing it to rest on the sand, taking caution as to not jar the cylinder during this process. Take a reading at the top edge of the weighted foot indicator, and then subtract 10 in. (254 mm). Record the reading of the sand level.

4. Report:

4.1 Calculate the sand equivalent reading as follows:

$$\text{Sand equivalent (SE)} = \frac{\text{Sand reading X 100}}{\text{Clay reading}}$$

If the calculated sand equivalent is not a whole number, report the result to the next higher whole number.

$$\frac{4.2}{7.9} \text{ X } 100 = 53.16 = 54$$

4.2 Average the test results of the two samples as follows: if the average of the two test results in not a whole number, raise the test result to the next higher whole number.

$$54 + 53 = 53.5 = 54$$

4.3 Test results will be reported on form DOT-69.

5. References:

AASHTO T 176
SD 202
DOT-69

Method of Field Sampling Asphalt Materials

1. Scope:

This test covers the procedure for sampling performance graded asphalt binder, emulsified asphalt, cutback asphalt, etc.

2. Apparatus:

2.1 Containers.

1 quart (1 L) metal cans with screw tops used for PG 58-22, PG 58-28, PG 58-34, PG 64-22, PG 64-28, PG 64-34, PG 70-28, PG 70-34 and all other performance graded binders, SC 800, MC 70, MC 800, MC 3000, RC 70, RC 800, RC 3000 and all other grades of cutback asphalt.

1/2 gallon plastic bottles used for SS1H, CSS1H, AE-150, AE-200, CRS2 and all other liquid emulsions.

2.2 The contractor furnished bulkhead sampling valve (Submerged) shall conform to the requirements shown in figure 1. The size of the pipe may vary from the 3/4" (19 mm) shown.

2.3 The contractor furnished in-line asphalt sampling device shall conform approximately to the requirements shown in figure 2.

The device shown is a detachable design to be installed in the unloading line between the truck transport or railroad car and the contractor's equipment. This device shall also be installed between the contractor's storage tank and the asphalt concrete mix plant. In-line sampling valves may vary in configuration, pipe diameter and length.

In-line sampling valves may be permanently mounted in the discharge line of the supply vehicle or contractor's unloading equipment, provided the following conditions are met.

A. The size, location and configuration are such that samples can be readily obtained.

B. Adequate provisions are made to keep the sample valve clean and operable.

2.4 Gloves, tongs, or other devices for handling the containers and valves.

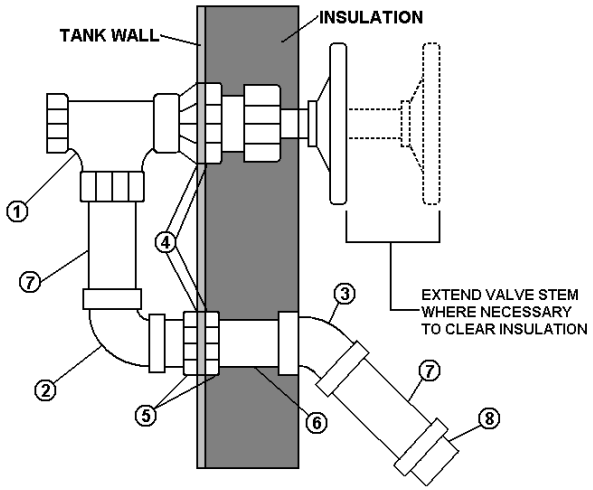
3. Procedure:

3.1 Bulkhead sampling valve.

A. Inspect the containers to insure that they are clean and dry.

B. Immediately after the beginning of the transfer of material, drain off approximately 1/2 gallon (2 L) of the asphalt and then completely fill the first container.

C. When approximately ½ of the load has been transferred, drain off approximately 1/2 gallon (2 L) of the asphalt and then completely fill the second container.



Mount in Lower Half of the Bulkhead at Least 1' (300 mm) from the Shell

Ref. #	Description	No Req.
1	3/4" (19 mm) "Vogt" P-9844 steel angle valve or similar, panel mounted	1
2	3/4" (19 mm) steel or mall iron 90° elbow	1
3	3/4" (19 mm) steel or mall iron 45° elbow	1
4	Asbestos gaskets snug on the thread or wound with yarn	4
5	3/4" (19 mm) 150# (70 kg) screwed M. I. lock nut	2
6	3/4" X 3 ½" (19 mm X 85 mm) = Parallel threaded steel pipe nipple (Cut from ¾" (19mm) std. tank nipple if otherwise unobtainable)	1
7	3/4" X 3" (19 mm X 75 mm) threaded steel pipe nipple	2
8	3/4" (19 mm) mall iron pipe cap	

Figure 1

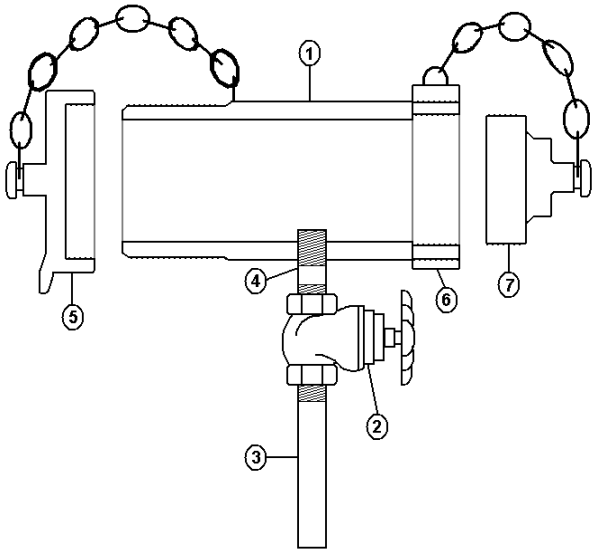
3.2 In-line sampling valve.

A. Inspect the containers to insure they are clean and dry.

B. Truck transport or railroad car – When approximately 1/3 of the load has been used or transferred, drain off 1/2 gallon (2 L) of asphalt and then completely fill the first container.

When approximately 2/3 of the load has been used or transferred, drain off 1/2 gallon (2 L) of asphalt and then completely fill the second container.

C. Between the storage tank and the mix plant – Drain off 1/2 gallon (2 L) of asphalt and then completely fill 2 one quart (1 L) sample containers.



Ref. #	Description	No Req.
1	3” X 10” (75 mm X 250 mm) steel pipe threaded outside at both ends and inside at one end	1
2	3/4" (19 mm) steel gate valve	1
3	3/4” X 3” (19 mm X 75 mm) steel nipple, threaded at one end	1
4	3/4” X 2” (19 mm X 50 mm) steel close nipple	1
5	3” (75 mm) brass cap with chain	1
6	3” (75 mm) brass pipe coupling	1
7	3” (75 mm) brass pipe plug with chain	

Figure 2

3.3 Distributor Sampling.

A. Inspect the containers to insure they are clean and dry.

B. Method 1: Drain off 1 gallon (4 L) of asphalt through a nozzle on the spray bar and completely fill 2 containers.

C. Method 2: Take the sample from a nozzle on the spray bar after a portion of a load has been applied. Completely fill 2 containers.

3.4 General.

A. If the asphalt is delivered in a truck transport and pup combination, take both of your samples from either one of the units. Do not take one can from one unit and the other from the other unit.

B. Tightly seal all sample containers, immediately after filling, using tape, if necessary.

C. The filled cans must not be submerged in, or cleaned with solvents, or solvent saturated rags. Spilled materials shall be wiped from the outside containers with clean dry cloths only.

D. Place the field sample number and project number on each container for the sample and tape the 2 containers together, i.e. 01A & 01B.

E. For other methods of sampling asphalt materials, use AASHTO T 40 or contact the Materials and Surfacing Office.

4. Report:

Certificate of Compliance and forms DOT-1 and DOT-2.

5. References:

AASHTO T 40
DOT-1
DOT-2

Method of Test for Determining the Moisture Content in Uncompacted Bituminous Paving Mixtures

1. Scope:

This test is for determining the amount of moisture in an uncompacted bituminous paving mixture.

2. Apparatus:

2.1 Container with cover suitable for a sample of hot uncompacted hot mix (cement can).

2.2 Convection oven capable of maintaining the temperature at 270° ± 10°F (132° ± 5°C).

2.3 Balance with a capacity of at least 5,000 grams, sensitive and readable to 0.1 gram. Use of a piece of wood or metal on the scale is recommended to protect the scale from the elevated temperatures.

2.4 Gloves.

3. Procedure:

3.1 Weigh and record the weight of a sample container and cover to the nearest 0.1 gram.

3.2 Obtain a representative 1,500 to 3,000 gram sample of uncompacted hot mix from the paver area in accordance with SD 312.

3.3 Place the sample in the container, put on the cover and transport back to the lab.

3.4 Weigh and record the weight of the container, cover and uncompacted hot mix to the nearest 0.1 gram. Subtract the weight obtained in 3.1 above from this weight to determine the original weight of the uncompacted hot mix (Which includes moisture).

3.5 Place the container and uncompacted hot mix without the cover in an oven set at 270° ± 10°F (132° ± 5°C) for 2 hours.

3.6 Weigh and record the weight of the container and uncompacted hot mix to the nearest 0.1 gram.

3.7 Place the container and hot mix back in the oven and weigh at 1 hour intervals until constant weight is obtained. Constant weight for this test procedure is defined as when the material does not lose more than 0.05% of

the original weight of the hot mix sample (Obtained in 3.4 above) in a one hour period.

3.8 Once constant weight has been obtained, record the weight of the container, cover, and hot mix to the nearest 0.1 gram.

3.9 Subtract the final weight of the uncompacted hot mix, container, and cover from the original weight of the uncompacted hot mix, container and cover determined in 3.4 to determine the amount of moisture in the mix.

4. Report:

4.1 Calculate the moisture content in the mix to the nearest 0.1 percent. Report on form DOT-35.

$$\frac{A - B}{B} \times 100$$

A = Initial weight of uncompacted hot mix
B = Final dry weight of uncompacted hot mix

5. References:

SD 312
DOT-35

Method of Test for Determining the Draindown Percent in Uncompacted Bituminous Paving Mixtures

---

1. Scope:

This test is for determining the amount of draindown in an uncompacted bituminous paving mixture such as Class S or SMA type mixes.

2. Apparatus:

2.1 Container with cover suitable for a sample of hot uncompacted hot mix (cement can).

2.2 Forced draft convection oven capable of maintaining the temperature at any temperature up to 350 ° ± 5 °F (177°± 5°C).

2.3 Balance with a capacity of at least 5,000 grams, sensitive and readable to 0.1 gram. Use of a piece of wood or metal on the scale is recommended to protect the scale from the elevated temperatures.

2.4 Gloves

2.5 Standard basket with a height of 6.5” ± 0.7” (165 ± 16.5 mm) by 4.3” ± 0.4” (108 ± 11 mm) with a bottom basket shelf at 1.0” ± 0.1” (25 ± 2.5 mm) measured from the base, made of standard 0.25” (6.3 mm) sieve cloth.

2.6 Plates such as pie tins, tops of cement cans or small metal pans.

3. Procedure:

3.1 Sample shall be obtained from a truck at the plant site at the plant production temperature.

3.2 Obtain a representative 1,000 to 3,000 gram sample of uncompacted hot mix from a truck box at the plant site.

3.3 Place the sample in the container, put on the cover and transport back to the lab.

3.4 Transfer 1200 ± 200 grams of hot plant produced mix sample to a tared wire basket. Determine the weight of the sample not including the basket to the nearest 0.1 gram.

3.5 Determine and record the weight of a metal plate. Place the basket with hot mix material on the plate and place in an oven that is at the temperature the hot mix is being discharged from the drum for 60 ± 5 minutes.

3.6 Weigh and record the weight of the plate with draindown material to the nearest 0.1 gram.

4. Report:

4.1 Calculate the percent of hot mix that drained by subtracting the initial plate weight from the final plate weight and dividing this value by the initial total sample weight. Multiply the result by 100 to get the percent and record to the nearest 0.1 percent. Report on form DOT- 91.

$$\frac{A - B}{C} \times 100$$

A = Final plate weight including draindown material
B = Initial plate weight
C = Total weight of the tested sample

5. References:

AASHTO T 305
DOT-91

Sample ID **Asphalt Draindown Worksheet** **DOT-91**
File No. **9-14**

PROJECT NH 0083(67)88 COUNTY Hughes, Lyman, Stanley PCN 02Q5

Field # 01 Date Sampled 09/07/2014 Date Tested 09/07/2014

Sampled By Riedl, Dan Tested By Riedl, Dan Checked By Peppel, Jay

Mix Type Class S Asphalt Cement PG 64-34 Hydrated Lime

Weight of test sample 1237.6 grams

Weight of container empty 127.2 grams Weight of container after test 130.0 grams

Draindow n 0.2 ≤ = 0.3% Temperature of test sample 300 F

Comments:

Figure 1

Method of Test for Determining the Cutout Calibration Check for In-place Nuclear Density Testing

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1. Scope:

This test is for determining cutout calibration for determination of in-place density of asphalt concrete.

2. Apparatus:

2.1 Scale or balance having the capacity to weigh any sample which may be tested utilizing this procedure and readable to the nearest 0.1 gram. The scale or balance shall be equipped with a suitable suspension apparatus and holder to permit weighing the sample while suspended from the center of the scale pan of the weighing device.

2.2 Miscellaneous pails, shovel, pans, hammer, roofing tacks, aluminum foil, 50' (15 m) tape, and 1" x 2" x 12" (25 mm x 50 mm x 300 mm) stakes.

2.3 Power driven masonry saw or core drill furnished by the Contractor.

2.4 The water bath for immersing the sample shall be equipped with an overflow outlet for maintaining a constant water level. An aquarium heater will suffice to control the temperature of the water bath at 77° ± 2° F (25° ± 1° C).The water bath must be large enough to allow the suspension apparatus holder to be covered with water at all times. The sample and suspension apparatus must be completely covered with water during weighing. The wire suspending the suspension apparatus shall be the smallest practical size to minimize any possible effects of a variable immersed length.

2.5 A thermometer with subdivisions and maximum scale error of 1˚F (0.5˚C) to cover the range of testing.

3. Procedure:

3.1 Randomly select test sites. Tack a double layer of aluminum foil, approximately 12" x 18" (300 mm x 450 mm) in size, to the base with roofing nails at each test site. Place foil at two locations for each test, so a backup site is available if the first sample is damaged.

When checking the nuclear gauge with in-place density cutouts, place 3 foils plus one extra for a backup.

Mark the location of the foils by measuring from the center of the foil to 2 offset stakes and recording the distance.

3.2 After the asphalt concrete has been placed and compacted, locate the foil by measuring the recorded distance from each stake and swinging arcs.

3.3 The Contractor will cool, saw and remove a 6” (150 mm) square sample or a 6” (150 mm) diameter core sample from the area designated. Check the sample closely for damage caused during removal.

3.4 Immediately upon removal from the pavement, place the sample with the finished side down in a clean pan and place in a level position away from exposure to heat or other damaging conditions. As soon as sampling has been finished, transport the sample to the laboratory for the density determination. When the sample arrives at the field laboratory, place on a clean surface.

NOTE: Perform the following and record on DOT-8.

3.5. Weigh the core and record the apparent dry weight in air to the nearest 0.1 gram on line (B).

3.6. Immerse each specimen in water at 77° ± 2° F (25° ± 1° C) for 3 to 3 1/2 minutes and record the submersed weight to the nearest 0.1 gram on line (C).

3.7. Remove each specimen from the water and surface dry by blotting with a damp terry cloth towel. Weigh and record the saturated surface dry (SSD) weight in air to the nearest 0.1 gram on line (D).

3.8. Calculate the volume of the core (D - C). Record on line (E).

3.9. Record the pan number on line (F).

3.10. Record the weight of the pan to the nearest 0.1 gram on line (G).

3.11. Place the core in the pan and place in an oven at 230° ± 9° F (110° ± 5° C) for 2 hours.

3.12. After the 2 hour period, record the weight of the core and the pan to the nearest 0.1 gram on line (J).

3.13. Place the core and pan back in the oven and weigh at 1 hour intervals until the core has reached a constant weight. Constant weight is attained when the weight loss is within 0.1 percent of the apparent dry weight. Calculate the amount of allowable loss (B x 0.001) to the nearest 0.1 gram. Record on line (M).

3.14. After a constant weight has been attained, cool the pan and core to room temperature. Record the weight to the nearest 0.1 gram on line (N).

3.15. Determine the actual dry weight of the core (N - G). Record on line (H).

3.16. Determine the core bulk specific gravity (H / E) to the nearest 0.001. Record on line (I).

3.17. Determine the moisture in the core (D - H). Record on line (K).

3.18. Calculate the percent water absorbed by volume (K / E x 100) to the nearest 0.1 percent. Record on line (L).

4. Report:

4.1 Calculate the density (PCF) in lbs./ft³ (kg/m³) of in-place specimens from numbers recorded on DOT-8 in the cutout calibration check on the DOT-42 in the following manner.

62.245 = Weight per ft^3 of water (77^0 F)
(997.1 = Weight per m^3 of water)

H = Actual dry weight.

D = Saturated surface dry weight (SSD) in air

C = Submersed weight in water

PCF = H / (D - C) x 62.245 (997.1 metric)

4.2 Calculate the calibration correction as follows:

Calibration correction = PCF average (Cutout) – PCF average (Nuclear gauge)

5. References:

DOT-8
DOT-42

Sample ID
File No.

Core Dry Back Worksheet

DOT-8
9-14

PROJECT P 6417(1) COUNTY Hand PCN 059H

Tested By Smith, Joe CHECKED BY Smith, Bob Test Date 09/30/2014

MATERIAL TYPE Class Q2 Hot Mixed Asphalt

Steps

1. Measure and record the thickness of the core and all lifts prior to sawing. (average of 4 locations around core)
2. Saw the lift to be tested from the core and record thickness (A).
3. Using SD 315, record the core apparent dry weight in air (B), the submersed weight under water (C), and the saturated surface dry weight in air(D) to the nearest 0.1 gram.
4. Calculate the volume of the core (E).
5. Record the pan number (F).
6. Weigh and record the weight of the pan to the nearest 0.1 gram (G).
7. Place the core and pan in an oven at 230° ± 9° F for 2 hours.
8. After the 2 hour period, record the weight of the core and the pan to the nearest 0.1gram. Record the time of weighing in column (J).
9. Place the core and pan back in the oven and weigh at 1 hour intervals until the core has reached a constant weight. Constant weight is attained when the weight loss is within 0.1 percent of the apparent dry weight. Calculate the amount of allowable loss (M).
10. After the above constant weight has been reached, cool the pan and core to room temperature, record the weight (N), and then determine the actual dry weight of the core (H).
11. Perform Calculations (I), (K), and (L).

Core measurement before sawing											
	Core Number	1A	1B	1C							
1	lift measured thickness	1.88	1.63	1.38							
	lift measured thickness										
	lift measured thickness										

A.	Sawed core thickness:	1.75	1.50	1.25							
B.	Apparent dry weight in air:	1477.3	1427.8	1305.7							
C.	Submersed weight in water:	800.1	771.2	705.3							
D.	SSD weight in air:	1478.3	1429.6	1308.5							
E.	Volume of core: (D - C)	678.2	658.4	603.2							
F.	Pan number:	1	2	3							
G.	Weight of pan:	162.4	165.2	164.5							
H.	Actual dry weight: (N - G)	1468.1	1421.5	1301.3							
I.	Core bulk specific gravity: (H / E)	2.165	2.159	2.157							
K.	Moisture in core: (D - H)	10.2	8.1	7.2							
L.	Percent water absorbed by volume: (K / E) * 100	1.5	1.2	1.2							
M.	Maximum allowable weight loss in 1 hour: (B x 0.001)	1.5	1.4	1.3							

	Time (J)	**Core Drying Weigh Back Area**									
After reaching constant weigh, allow the core & pan to cool to room temp. before weighing for the final time **(N)**	8:00 AM										
	10:00 AM	1635.7	1590.8	1470.9							
	11:00 AM	1633.1	1588.2	1467.9							
	NOON	1631.1	1586.6	1466.2							
	1:00 PM	1630.2	1586.2	1465.5							
N.	Weight of cooled core and pan	1630.5	1586.7	1465.8							

Comments:

Figure 1

Sample ID
File No.

Density Report - Bituminous Surfacing

DOT-42
9-14

PROJECT P 6417(1) COUNTY Hand PCN 059H

Test No. 1 Class and Type Class E Type 1 Lift 2 of 2 Thickness 2"

% Asphalt Binder 7 Actual Finished Width _____ Station _____

Date 9/17/14 Tested By Smith, Joe Checked By Doe, Linda

Specification Requirements - % of Standard Required _____ _____ Min. PCF (kg/m^3) _____

Daily Checks, Gauge No: _____ Standard Count: _____ Previous Standard: _____

Density Standard Data

Standard Density Test No: _____ Date: _____ Time: _____ Lift: _____ of _____

Sample Obtained From: _____ Tested By: _____

Theoretical Maximum Density

	1	2
A. Wt. of sample in Air		
B. Wt of Canister + Water		
C. Wt of Canister + Water + Sample		
Temperature of the Water		
D. Water Correction Factor		
E. Max. Specific Gravity [A/(A + B - C)] x D		
F. Max. Unit Wt. (E x 62.245) (E x 997.1)		
G. Avg. Unit Weight		
H. Moving Avg. (Last 5 Tests)		

Marshall Density Data

	1	2	3
A. Wt. of Sample in Air			
B. Wt. of Sample under water			
C. Saturated Surface Dry Wt.			
D. Volume Displaced (C - B)			
E. Bulk Specific Gravity (A/D)			
F. Unit Weight (E x 62.245) (E x 997.1)			
G. Compaction Sample Temp.			
H. Avg. Unit Weight			
I. Moving Avg. (Last 5 Tests)			

15

In-place Density Measurement

Lot Loc: Sta: _____ To Sta: _____ Dist. From Centerline: _____

Length: _____ Width: _____ Quantity Represented: _____

Site No.	Random No.	Distance Lot Beg.	Station	Random No.	Dist. From Out. Edge	Distance From C/L	PCF(kg/m^3)	Corrected PCF(kg/m^3)	% of Standard
1									
2									
3									
4									
5									
No more than 2 tests below spec. only 1 test may be 2% below spec. 1 Test @ 3% Below fails the Entire Lot.								Lot Average	

% AIR VOID CALCULATIONS

[(Maximum Specific Gravity - Bulk Specific Gravity) / Maximum Specific Gravity] x 100 = _____

CUTOUT CALIBRATION CHECK

CUTOUT No.	Station	Distance From C/L	Actual Dry Wt.	Submersed Wt. in Water	SSD Wt. in Air	PCF (kg/m^3)		Nuclear Gauge Readings			Avg.
1	301+03	7'	1468.1	800.1	1478.3	134.7	1	130.9	131.2	131.2	131.1
2	300+76	6'	1421.5	771.2	1429.6	134.4	2	131.8	132.0	132.2	132.0
3	300+58	7'	1301.3	705.3	1308.5	134.3	3	131.5	131.6	132.5	131.9
				PCF (kg/m^3) Average		134.5			PCF (kg/m^3) Average		131.7

CALIBRATION CORRECTION +2.8 PCF(kg/m^3)

Comments:

Figure 2

Moisture Sensitivity of Compacted Asphalt Concrete Paving Mixtures

---

1. Scope:

This test method covers the procedure for preparing and testing asphalt concrete specimens for the effect of water on the tensile strength of the paving mixture.

2. Apparatus:

2.1 Marshall slant foot rotating base compaction hammer.

2.2 Vacuum container, preferably a metal container and vacuum pump or water aspirator including a manometer or vacuum gauge.

2.3 Water bath at 140° ± 2°F (60° ± 1°C) and a water bath at 77° ± 2°F (25° ± 1°C).

2.4 Scale or balance having the capacity to weigh any sample which may be tested utilizing this procedure and readable to the nearest 0.1 gram.

2.5 Loading jack or mechanical testing machine with a vertical motion rate of 2” (50.8 mm) per minute.

2.6 Steel loading strips with a concave surface having a radius of curvature equal to the nominal radius of the test specimen. The strips shall be 0.5” (12.7 mm) wide for 4” (101.6 mm) specimens and have a length that exceeds the thickness of the specimens.

2.7 Calipers capable of measuring to the nearest 0.01" (0.25 mm).

3. Procedure:

3.1 Preparation of laboratory specimens.

A. At least 8 specimens are prepared as described in the South Dakota Mix Design Procedure. When adding a dry powder additive such as lime to the material, use the same procedure to add lime as will be used in the field. If adding a liquid anti-stripping to the asphalt binder, add the required quantity of liquid anti-strip to the asphalt binder, mix with a mechanical mixing device for at least 3 minutes.

Maintain the asphalt binder at the mixing temperature until it is used. Two samples of the minimum size specified in SD 312 are to be prepared to determine the theoretical maximum specific gravity of the uncompacted mix.

B. After mixing, the samples are put in a covered container in an oven at the compaction temperature for 2 hours prior to compaction.

C. The specimens shall be compacted to an air void level of 7% ± 1% by adjusting the number of Marshall blows.

D. Cool the specimens until the mold can be handled without gloves and extract from the molds. Allow the specimens to set overnight and then proceed with the test procedure.

3.2 Preparation of field samples.

A. Obtain a random sample of mix from behind the paver screed.

B. Stabilize the mix at the compaction temperature for 1 hour in the lab.

C. Compact at least 8 specimens to 7% ± 1% air void level using SD 313 test procedures.

D. Cool the specimens to room temperature and extract from the molds. Allow the specimens to set overnight and then proceed with the test procedure.

3.3 Preparation of core test specimens.

A. Select the core locations by using a random number table. Obtain at least 8 cores for testing. Separate the core lifts by use of a cutoff saw.

B. When determining the dry weight, make sure no moisture is remaining in the core.

3.4 Procedure for determining subsets.

A. Determine the theoretical maximum specific gravity of the mixture by using SD 312.

B. Determine specimen thickness to the nearest .01” (0.25 mm) by using calipers to measure the thickness at four quarter point locations on the specimen.

C. Determine the bulk specific gravity of the specimens by using SD 313. Record the dry weight, the submersed weight, and the saturated surface dry weight on a DOT-48. The SSD weight minus the submersed weight is the volume of the specimen in cubic centimeters.

D. Calculate the air voids as shown in SD 313. (The theoretical maximum specific gravity minus the specimen bulk specific gravity divided by the theoretical maximum specific gravity times 100 will be the percent of air voids.) Record the air voids to the nearest 0.01 percent.

E. Sort specimens into two subsets of at least three specimens each, so that the average air voids of the two subsets are approximately equal. The 2 extra samples can be used to determine the correct amount of vacuum needed in the saturation procedure.

F. One subset will be tested dry and the other subset will be preconditioned before testing. The dry subset will be stored at room temperature until tested.

3.5 Procedure for subset to be saturated. (Laboratory, field, or core specimens)

A. Partially saturate the subset to be moisture conditioned with room temperature distilled water using a vacuum container and a vacuum gauge or manometer to control the level of vacuum applied. Put one of the specimens in a vacuum container for 3 to 5 minutes with a specific level of vacuum applied such as 10” (254 mm) of Hg. After the vacuum saturation, place in 77° ± 2°F (25° ± 1°C) water for 3 to 3.5 minutes and then determine the submerged weight and the saturated surface dry weight of the partially saturated specimen. Determine the volume of water absorbed by subtracting the air dry mass of the specimen in 3.4 C. from the saturated surface dry mass obtained above. Continue to place in the vacuum container and reapply a higher level of vacuum until the specimen is saturated to the level required by this test procedure. If the level of saturation exceeds the upper limit allowed, the specimen is damaged and must be discarded.

B. If the average air voids of the subset to be saturated is 6.5% or less, saturate to a level of 70% to 80%. If the average air voids of the subset is between 6.6% and 7.4%, saturate to a level of 55% to 80%. If the average air voids of the subset is 7.5% or more, saturate to a level of 55% to 65%. One of the extra samples may be used to determine the correct amount of vacuum to apply to get the required level of saturation.

Remember, if the specimen is saturated to a level exceeding the upper limit, the specimen is damaged and must be discarded. The level of saturation is determined by dividing the volume of the absorbed water in 3.5 A. above by the volume of air voids in 3.4 D. and expressing as a percentage.

C. Moisture condition the partially saturated specimens by soaking in distilled water at 140° ± 2°F (60° ± 1°C) for 24 hours.

After the 24 hour period, remove the specimens and place them in a 77° ± 2°F (25° ± 1°C) water bath for one hour.

D. After one hour, measure the height of the moisture conditioned specimens to the nearest .01” (0.25 mm) and determine the saturated

surface dry weight, the submersed weight and the difference which is the volume of the saturated specimen. Return the specimens to the 77° ± 2°F (25° ± 1°C) water bath until ready to determine the tensile strength.

E. Determine the water absorption and the degree of saturation. A degree of saturation exceeding 80% is acceptable at this stage in the testing procedure.

F. Determine the swell of the partially saturated subset by dividing the change in specimen volumes from 3.5 A. and 3.4 C. by the specimen volume in 3.4 C. Determine the swell of the moisture conditioned specimens by dividing the change in specimen volumes from 3.5 E. and 3.4 C. by the specimen volume in 3.4 C.

3.6 Procedure for subset to be tested dry.

A. Adjust the temperature of the dry subset by soaking in a water bath for 20 minutes at 77° ± 2°F (25° ± 1°C).

3.7 Procedure for determining the tensile strength.

A. Determine the tensile strength at 77° ± 2°F (25° ± 1°C) of both subsets.

B. Place a specimen in the loading strip apparatus and position the loading strips so that they are parallel and centered on the vertical diametral plane. Apply a diametral load at 2” (50.8 mm) per minute until the maximum load is reached, and record the maximum load on a DOT-48.

C. Continue loading until the specimen fractures. Break open the specimen and visually estimate the degree of moisture damage, if any.

D. Record observations on the degree of broken or cracked aggregate.

4. Report:

4.1 Calculate the tensile strength (S) as follows:

S = Tensile strength, psi (kPa)

P = Maximum load, pounds (kilogram)

t = Specimen height immediately before tensile strength test, .01 inches (0.25 mm)

D = Specimen diameter, .01 inches (0.25 mm)

π = 3.1416

$$S = \frac{(2 \times P)}{(\pi \times t \times D)}$$

TSR = Tensile strength ratio, percent

Stm = Average tensile strength of the moisture conditioned subset, psi (kPa)

Std = Average tensile strength of the dry subset, psi (kPa)

$$TSR = \frac{Stm}{Std} \times 100$$

4.2 Record the test data on a DOT-48. Weights shall be recorded to the nearest 0.1 gram. Bulk specific gravity's and maximum specific gravity's shall be recorded to the nearest thousandth. Load shall be recorded to the nearest pound.

4.3 Volume and percentage calculations shall be reported to the nearest 0.01.

4.4 Tensile strength shall be calculated to the nearest 0.1 and the TSR reported to the nearest whole number.

5. References:

AASHTO T 245
ASTM D4867
SD 312
SD 313
SD 316
DOT-48
SD Mix Design Procedures

MOISTURE SENSITIVITY REPORT - BITUMINOUS SURFACING

DOT - 48
9-14

FILE NUMBER _____

PROJECT	P 3079(00)219	DESIGN LEVEL	Q LVT
PCN	5415	DESIGN AIR VOIDS	2.9
COUNTY	Harding	DESIGN AC CONTENT	6.0
DATE	09/27/2014		Spec.'s
ASPHALT BINDER	Cenex PG 58-28	AVERAGE AIR VOIDS	6.72 / 6-8
ADDITIVE & DOSAGE	0.75 percent hydrated lime	AVERAGE SATURATION LEVEL	65.0 / 55-80
METHOD OF ADDING	dry to aggregate with 3% H_2O	TENSILE STRENGTH RATIO	82 / > 60
COMPACTION BLOWS	13 blows per side		

SPECIMEN NUMBER		1	2	3	4	5	6	7	8	9	10
DIAMETER (.01 in.)	D	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00
THICKNESS (.01 in.)	t	2.53	2.57	2.61	2.57	2.57	2.59	2.56	2.58	2.59	2.66
DRY MASS IN AIR (0.1 g)	A	1169.4	1154.7	1177.4	1173.9	1163.5	1167.5	1181.4	1168.0	1175.8	1200.7
MASS IN WATER (0.1 g)	B	650.5	641.5	650.0	654.5	648.5	642.8	663.9	648.1	652.3	662.4
SSD MASS (0.1 g)	C	1170.6	1157.3	1179.1	1175.7	1164.9	1169.4	1182.6	1169.5	1177.7	1201.9
VOLUME (C - B)	E	520.1	515.8	529.1	521.2	516.4	526.6	518.7	521.4	525.4	539.5
BULK SP. GR. (A / E)	F	2.248	2.239	2.225	2.252	2.253	2.217	2.278	2.240	2.238	2.226
THEO. MAX. SP. GR.	G	2.403	2.403	2.403	2.403	2.403	2.403	2.403	2.403	2.403	2.403
% AIR VOIDS ((G-F)/G)x100	H	6.45	6.82	7.41	6.28	6.24	7.74	5.20	6.78	6.87	7.37
VOLUME AIR VOIDS (HE)/100	I	33.55	35.18	39.21	32.73	32.22	40.76	26.97	35.35	36.09	39.76
LOAD (LB.)	P	1105	1235				1235			1270	

AVERAGE AIR VOIDS OF DRY SUBSET: 6.97

SATURATED: 3 MIN. 19 "HG

AVERAGE AIR VOIDS OF SAT. SUBSET: 6.96

MASS IN WATER (0.1 g)	B'			674.0	672.7				670.2		687.1
SSD MASS (0.1 g)	C'			1203.6	1194.0				1191.6		1226.6
VOLUME (C' - B')	E'			529.6	521.3				521.4		539.5
VOL. ABS. WATER (C' - A)	J'			26.2	20.1				23.6		25.9
% SATURATION (J'/ I) x 100				66.8	61.4				66.8		65.1
% SWELL ((E' -E) / E) x 100				0.09	0.02				0.00		0.00

CONDITIONED 24 HOURS IN 140 DEGREE F WATER

THICKNESS (.01 in.)	t"			2.61	2.58				2.59		2.66
MASS IN WATER (0.1 g)	B"			681.9	680.1				678.2		695.5
SSD MASS (0.1 g)	C"			1217.4	1205.8				1206.3		1242.6
VOLUME (C" - B")	E"			535.5	525.7				528.1		547.1
VOL. ABS. WATER (C" - A)	J"			40.0	31.9				38.3		41.9
% SATURATION (J" / I) x 100				102.0	97.5				108.4		105.4
% SWELL((E" - E) / E) x 100				1.21	0.86				1.29		1.41
LOAD (LB.)	P"			1000	1030				940		1035
DRY STRENGTH ((2P) / tDπ)	Std	69.5	76.5				75.9			78.0	
WET STRENGTH((2P") / t"Dπ)	Stm			61.0	63.5				57.8		61.9
VISUAL MOISTURE DAMAGE											
CRACK / BREAK DAMAGE											

π = 3.1416

TENSILE STRENGTH RATIO $\frac{\text{Average Wet Strength (psi)}}{\text{Average Dry Strength (psi)}}$ $\frac{\text{Stm1+ Stm2 + ...+ Stmn}}{\text{Std1 + Std2 + ... + Stdn}} = \frac{61.1}{75.0} \times 100 = 81.5$

Figure 1

Method of Test for Field Density Determination of Asphalt Concrete by the Nuclear Gauge Method

---

1. Scope:

This test is for determining the in-place density of asphalt concrete by nuclear gauge.

Definitions:

Standard Density: Average of the 5 most recent theoretical maximum specific density determinations.

Lot: A quantity of material from a single source, representing a specific segment of construction, upon which decision is made for acceptance.

Random Measurement: A specific individual measurement of in-place density (One of 5 measurements made for a lot), the location is chosen such that each portion of the lot has an equal probability of being selected.

2. Apparatus:

2.1 Scale or balance having the capacity to weigh any sample which may be tested utilizing this procedure and readable to the nearest 0.1 gram.

2.2 Miscellaneous. Pails, pans, hammer, roofing tacks, aluminum foil, 50’ (15 m) tape measure, 1” x 2” x 12” (25 mm x 50 mm x 300 mm) stakes.

2.3 Power-driven masonry saw capable of cutting a 6” x 6” compaction sample or a coring device capable of cutting a 6” (150 mm) diameter core from the pavement.

2.4 Nuclear moisture-density gauge capable of determining densities by the backscatter method and conforming to the requirements of AASHTO T 310.

2.5 A reference standard block for taking standard counts.

2.6 A manufacturer’s instruction manual for the nuclear gauge.

2.7 A nuclear gauge information book, transportation documents book, and nuclear badge.

3. Procedure:

3.1 Calibration and standardization of nuclear gauge.

A. Calibration and performing the standard count of the nuclear gauge shall be in accordance with SD 114, paragraphs 3.1 and 3.2.

B. Compaction sample calibration checks to determine correction.

(1) Prior to use on a project, compare each nuclear gauge to a minimum of 3 compaction samples. The compaction samples shall be representative of the lift thickness. A minimum of 3 compaction samples shall be obtained per lift.

(2) Follow the procedure in SD 307 for obtaining and determining the density of the compaction samples. –It is allowable to not use aluminum foil and saw the 6" diameter core as described in paragraph 3.3 of SD 315.

(3) Just prior to obtaining the compaction samples from the road, take the nuclear wet density in backscatter mode. Place the gauge on the site and make sure that it doesn't "Rock" or shift due to an uneven surface. Lower the handle to the first notch, being careful not to pass the proper position and take a one minute reading to determine the wet density. Rotate the gauge approximately 120 degrees about the center of the gauge and take a second reading. Rotate the gauge approximately another 120 degrees and take the third reading.

(4) Record the 3 wet density readings to the nearest 0.1 lbs./ft^3 (kg/m^3) on form DOT-42 and determine the average of the 3 wet densities at each compaction sample location.

(5) Compare the average of the 3 wet densities determined by the nuclear gauge to the average density determined by the 3 compaction samples. When the nuclear gauge average is <u>greater</u> than the compaction sample average, the correction shall be <u>subtracted</u> and when the nuclear gauge average is <u>less</u>, the correction shall be <u>added</u> to the wet density determined by the nuclear gauge. (Figure 2)

3.2 Standard Density.

A. The standard unit weight shall be determined by the theoretical maximum specific gravity method in accordance with SD 312 (Figure 2).

(1) The average of the 5 most recent standard unit weight determinations shall be used as the standard density.

(2) Until 5 standard unit weight determinations have been made, base the standard density on the first determination; then, on the average of the first 2, 3, 4, and 5 determinations. Each standard density thereafter shall be the average of the 5 most recent valid standard unit weight determinations and shall be

used when the same source, mix and plant are being used on one or more projects.

3.3 Selecting Density Test Locations.

A. Record the location of the lot to be tested by indicating Sta. to Sta. and the distance right or left of the centerline. Show the length, width, and quantity represented by the lot.

B. Select 5 sites within the lot by use of the random number table. (Figure 1)

(1) Determine and record each site for the lot being tested to the nearest foot (Meter).

(2) The procedure for using the random number table is as follows:

Assume the lot to be tested is from Sta. 25+00 to Sta. 45+00 and extends from 12' left to centerline. The length of the lot is then 2000' and the width is 12'. Randomly select a number from the random number table.

(3) Stationing of each site is determined by multiplying each random number by 2000' then adding the resulting distances to the beginning station.

(4) Distance from centerline for each site is determined by multiplying each random number by 12'.

Measurement site	Longitudinal distance	Transverse distance
1	2000 x 0.43 = 860	12 x 0.75 = 9.0
2	2000 x 0.85 = 1700	12 x 0.02 = 1.0*
3	2000 x 0.50 = 1000	12 x 0.40 = 4.8
4	2000 x 0.80 = 1600	12 x 0.14 = 1.7
5	2000 x 0.90 = 1800	12 x 0.47 = 5.6

* The transverse distance for site 2 was actually 0.24; however, transverse measurements falling closer than 1.0' to the edge are moved to 1.0' from the edge.

C. Pacing longitudinal distances from station stakes or other known references and tape measurements of the transverse distances will be acceptable.

D. When compaction has been completed and the lot is ready for testing, locate the selected test sites. The selected sites shall not be marked or their location revealed before the material represented by the lot is compacted and ready for acceptance testing (Figure 2).

3.4 In-place density.

A. Base the density of the in-place material on the average of random measurements made at pre-selected sites within the lot.

B. Set the gauge on each test site with the gauge parallel to the direction of travel of the paver and rollers. Ensure that the gauge does not rock. The gauge base must be completely in contact with the asphalt material. Small shifts in the site locations necessary for proper seating of the gauge are permissible. Take a 1 minute wet density reading in the backscatter mode and record the results. Rotate the gauge 180 degrees and take a 2nd reading in the backscatter mode and record the results. Average the two results. 15

C. Record the wet density to the nearest 0.1 lb./ft³ (kg/m³).

4. Report:

4.1 Calculations.

A. Calculate the percent of standard density for each random measurement as follows:

$$\text{Percent of standard density} = \frac{\text{Wet density PCF (kg/m}^3\text{)} \pm \text{correction PCF (kg/m}^3\text{)}}{\text{Standard density}} \times 100$$

B. Record the percent of standard density for each random measurement to the nearest whole percent.

C. Calculate the percent of standard density for the lot by averaging the 5 random measurement percents of standard as recorded and report to the nearest whole percent.

4.2 Report the test as being satisfactory, provided all of the following conditions are met for each lot:

A. The percent of standard density obtained for the lot is equal to or greater than that specified for the project.

B. No more than 2 tests below specification.

C. No more than 1 test that is 2% below specification.

D. No tests that are 3% or more below specification.

5. References:

AASHTO T 310
SD 114
SD 307
SD 312
SD 315
DOT-42

SDDOT
TABLE OF RANDOM NUMBERS

.53 .74 .23 .99 .67	.61 .32 .28 .69 .84	.94 .62 .67 .86 .24	.98 .33 .74 .19 .95	.47 .53 .53 .38 .09
.63 .38 .06 .86 .54	.99 .00 .65 .26 .94	.02 .82 .90 .23 .07	.79 .62 .67 .80 .60	.75 .91 .12 .81 .19
.35 .30 .58 .21 .46	.06 .72 .17 .10 .94	.25 .21 .31 .75 .96	.49 .28 .24 .00 .49	.55 .65 .79 .78 .07
.63 .43 .36 .82 .69	.65 .51 .18 .37 .88	.61 .38 .44 .12 .45	.32 .92 .85 .88 .65	.54 .34 .81 .85 .35
.98 .25 .37 .55 .26	.01 .91 .82 .81 .46	.74 .71 .12 .94 .97	.24 .02 .71 .37 .07	.03 .92 .18 .66 .75
.02 .63 .21 .17 .69	.71 .50 .80 .89 .56	.38 .15 .70 .11 .48	.43 .40 .45 .86 .98	.00 .83 .26 .91 .03
.64 .55 .22 .21 .82	.48 .22 .28 .06 .00	.61 .54 .13 .43 .91	.82 .78 .12 .23 .29	.06 .66 .24 .12 .27
.85 .07 .26 .13 .89	.01 .10 .07 .82 .04	.59 .63 .69 .36 .03	.69 .11 .15 .83 .80	.13 .29 .54 .19 .28
.58 .54 .16 .24 .15	.51 .54 .44 .82 .00	.62 .61 .65 .04 .69	.38 .18 .65 .18 .97	.85 .72 .13 .49 .21
.34 .85 .27 .84 .87	.61 .48 .64 .56 .26	.90 .18 .48 .13 .26	.37 .70 .15 .42 .57	.65 .65 .80 .39 .07
.03 .92 .18 .27 .46	.57 .99 .16 .96 .56	.30 .33 .72 .85 .22	.84 .64 .38 .56 .98	.99 .01 .30 .98 .64
.62 .95 .30 .27 .59	.37 .75 .41 .66 .48	.86 .97 .80 .61 .45	.23 .53 .04 .01 .63	.45 .76 .08 .64 .27
.08 .45 .93 .15 .22	.60 .21 .75 .46 .91	.98 .77 .27 .85 .42	.28 .88 .61 .08 .84	.69 .62 .03 .42 .73
.07 .08 .55 .18 .40	.45 .44 .75 .13 .90	.24 .94 .96 .61 .02	.57 .55 .66 .83 .15	.73 .42 .37 .11 .16
.01 .85 .89 .95 .66	.51 .10 .19 .34 .88	.15 .84 .97 .19 .75	.12 .76 .39 .43 .78	.64 .63 .91 .08 .25
.72 .84 .71 .14 .35	.19 .11 .58 .49 .26	.50 .11 .17 .17 .76	.86 .31 .57 .20 .18	.95 .60 .78 .46 .75
.88 .78 .28 .16 .84	.13 .52 .53 .94 .53	.75 .45 .69 .30 .96	.73 .89 .65 .70 .31	.99 .17 .43 .48 .76
.45 .17 .75 .65 .57	.28 .40 .19 .72 .12	.25 .12 .74 .75 .67	.60 .40 .60 .81 .19	.24 .62 .01 .61 .16
.96 .76 .28 .12 .54	.22 .01 .11 .94 .25	.71 .96 .16 .16 .88	.68 .64 .36 .74 .45	.19 .59 .50 .88 .92
.43 .31 .67 .72 .30	.24 .02 .94 .08 .63	.38 .32 .36 .66 .02	.69 .36 .38 .25 .39	.48 .03 .45 .15 .22
.50 .44 .66 .44 .21	.66 .06 .58 .05 .62	.68 .15 .54 .35 .02	.42 .35 .48 .96 .32	.14 .52 .41 .52 .48
.22 .55 .22 .15 .86	.26 .63 .75 .41 .99	.58 .42 .36 .72 .24	.58 .37 .52 .18 .51	.03 .37 .18 .39 .11
.96 .24 .40 .14 .51	.23 .22 .30 .88 .57	.95 .67 .47 .29 .83	.94 .69 .40 .06 .07	.18 .16 .36 .78 .86
.31 .73 .91 .61 .19	.60 .20 .72 .93 .48	.98 .57 .07 .23 .69	.65 .95 .39 .69 .58	.56 .80 .30 .19 .44
.78 .60 .73 .99 .34	.43 .89 .94 .36 .45	.56 .69 .47 .07 .41	.90 .22 .91 .07 .12	.78 .35 .34 .08 .72
.84 .37 .90 .61 .56	.70 .10 .23 .98 .05	.85 .11 .34 .76 .60	.76 .48 .45 .34 .60	.01 .64 .18 .39 .96
.36 .67 .10 .08 .23	.98 .93 .35 .08 .86	.99 .29 .76 .29 .81	.33 .34 .91 .58 .93	.63 .14 .52 .32 .52
.07 .28 .59 .07 .48	.89 .64 .58 .89 .75	.83 .85 .62 .27 .89	.30 .14 .78 .56 .27	.86 .63 .59 .80 .02
.10 .15 .83 .87 .60	.79 .24 .31 .66 .56	.21 .48 .24 .06 .93	.91 .98 .94 .05 .49	.01 .47 .59 .38 .00
.55 .19 .68 .97 .65	.03 .73 .52 .16 .56	.00 .53 .55 .90 .27	.33 .42 .29 .38 .87	.22 .13 .88 .83 .34
.53 .81 .29 .13 .39	.35 .01 .20 .71 .34	.62 .33 .74 .82 .14	.53 .73 .19 .09 .03	.56 .54 .29 .56 .93
.51 .86 .32 .68 .92	.33 .98 .74 .66 .99	.40 .14 .71 .94 .58	.45 .94 .19 .38 .81	.14 .44 .99 .81 .07
.35 .91 .70 .29 .13	.80 .03 .54 .07 .27	.96 .94 .78 .32 .66	.50 .95 .52 .74 .33	.13 .80 .55 .62 .54
.37 .71 .67 .95 .13	.20 .02 .44 .95 .94	.64 .85 .04 .05 .72	.01 .32 .90 .76 .14	.53 .89 .74 .60 .41
.93 .66 .13 .83 .27	.92 .79 .64 .64 .72	.28 .54 .96 .53 .84	.48 .14 .52 .98 .94	.56 .07 .93 .89 .30
.02 .96 .08 .45 .65	.13 .05 .00 .41 .84	.93 .07 .54 .72 .59	.21 .45 .57 .09 .77	.19 .48 .56 .27 .44
.49 .83 .43 .48 .35	.82 .88 .33 .69 .96	.72 .36 .04 .19 .76	.47 .45 .15 .18 .60	.82 .11 .08 .95 .97
.84 .60 .71 .62 .46	.40 .80 .81 .30 .37	.34 .39 .23 .05 .38	.25 .15 .35 .71 .30	.88 .12 .57 .21 .77
.18 .17 .30 .88 .71	.44 .91 .14 .88 .47	.89 .23 .30 .63 .15	.56 .34 .20 .47 .89	.99 .82 .93 .24 .98
.79 .69 .10 .61 .78	.71 .32 .76 .95 .62	.87 .00 .22 .58 40	.92 .54 .01 .75 .25	.43 .11 .71 .99 .31
.75 .93 .36 .57 .83	.56 .20 .14 .82 .11	.74 .21 .97 .90 .65	.96 .42 .68 .63 .86	.74 .54 .13 .26 .94
.38 .30 .92 .29 .03	.06 .28 .81 .39 .38	.62 .25 .06 .84 .63	.61 .29 .08 .93 .67	.04 .32 .92 .08 .09
.51 .28 .50 .10 .34	.31 .57 .75 .95 .80	.51 .97 .02 .74 .77	.76 .15 .48 .49 .44	.18 .55 .63 .77 .09
.21 .31 .38 .86 .24	.37 .79 .81 .53 .74	.73 .24 .16 .10 .33	.52 .83 .90 .94 .76	.70 .47 .14 .54 .36
.29 .01 .23 .87 .88	.58 .02 .39 .37 .67	.42 .10 .14 .20 .92	.16 .55 .23 .42 .45	.54 .96 .09 .11 .06
.95 .33 .95 .22 .00	.18 .74 .72 .00 .18	.38 .79 .58 .69 .32	.81 .76 .80 .26 .92	.82 .80 .84 .25 .39
.90 .84 .60 .79 .80	.24 .36 .59 .87 .38	.82 .07 .53 .89 .35	.96 .35 .23 .79 .18	.05 .98 .90 .07 .35
.46 .40 .62 .98 .82	.54 .97 .20 .56 .95	.15 .74 .80 .08 .32	.16 .46 .70 .50 .80	.67 .72 .16 .42 .79
.20 .31 .89 .03 .43	.38 .46 .82 .68 .72	.32 .14 .82 .99 .70	.80 .60 .47 .18 .97	.63 .49 .30 .21 .30
.71 .59 .73 .05 .50	.08 .22 .23 .71 .77	.91 .01 .93 .20 .49	.82 .96 .59 .26 .94	.66 .39 .67 .98 .60

Figure 1

Sample ID
File No.

Density Report - Bituminous Surfacing

DOT-42
9-14

PROJECT P 6417(1) COUNTY Hand PCN 059H

Test No. 06 Class and Type Class HR Lift 1 of 1 Thickness 2"

% Asphalt Binder 6.0 Actual Finished Width 28 Station

Date 9/20/14 Tested By Smith, Joe Checked By Doe, Linda

Specification Requirements - % of Standard Required 92 Min. PCF (kg/m^3)

Daily Checks, Gauge No: MQ 772 Standard Count 2626 Previous Standard: 2600

Density Standard Data

Standard Density Test No: 06 Date: 9/30/2014 Time: 9:15 AM Lift: 1 of 1

Sample Obtained From: Windrow Tested By: Smith, Joe

Theoretical Maximum Density	1	2
A. Wt. of sample in Air	1503.6	1501.3
B. Wt of Canister + Water	1390.0	1390.0
C. Wt of Canister + Water + Sample	2272.3	2272.9
Temperature of the Water	77F (25.0C)	77F (25.0C)
D. Water Correction Factor	1.0000	1.0000
E. Max. Specific Gravity [A/(A + B - C)] x D	2.420	2.428
F. Max. Unit Wt. (E x 62.245) (E x 997.1)	150.6	151.1
G. Avg. Unit Weight	150.9	
H. Moving Avg. (Last 5 Tests)	150.7	

Marshall Density Data	1	2	3
A. Wt. of Sample in Air			
B. Wt. of Sample under water			
C. Saturated Surface Dry Wt.			
D. Volume Displaced (C - B)			
E. Bulk Specific Gravity (A/D)			
F. Unit Weight (E x 62.245) (E x 997.1)			
G. Compaction Sample Temp.			
H. Avg. Unit Weight			
I. Moving Avg. (Last 5 Tests)			

15

In-place Density Measurement

Lot Loc: Sta: 346+20 To Sta: 414+70 Dist. From Centerline: 12 Lt.

Length: 6850 Width: 12 Quantity Represented: 1200 tons

Site No.	Random No.	Distance Lot Beg.	Station	Random No.	Dist. From Out. Edge	Distance From C/L	PCF(kg/m^3)	Corrected PCF(kg/m^3)	% of Standard
1	0.68	4658	392+78	0.05		1.0	138.4	141.9	94
2	0.47	3220	378+40	0.91		10.9	136.6	140.1	93
3	0.57	3905	385+25	0.67		8.0	134.6	138.1	92
4	0.87	5960	405+80	0.23		2.8	135.2	138.7	92
5	0.91	6234	408+54	0.97		11.0	133.9	137.4	91
No more than 2 tests below spec. only 1 test may be 2% below spec. 1 Test @ 3% Below fails the Entire Lot.								Lot Average	92

% AIR VOID CALCULATIONS

[(Maximum Specific Gravity - Bulk Specific Gravity) / Maximum Specific Gravity] x 100 =

CUTOUT CALIBRATION CHECK

CUTOUT No.	Station	Distance From C/L	Actual Dry Wt.	Submersed Wt. in Water	SSD Wt. in Air	PCF (kg/m^3)		Nuclear Gauge Readings			Avg.
1	383+77	4.0	1592.9	901.2	1600.5	141.8	1	138.1	138.6	140.1	138.9
2	336+74	2.5	1401.7	804.8	1405.0	145.4	2	140.2	140.8	141.2	140.7
3	353+26	7.9	1141.0	644.4	1146.5	141.4	3	138.6	138.2	139.1	138.6
				PCF (kg/m^3) Average		142.9			PCF (kg/m^3) Average		139.4

CALIBRATION CORRECTION 3.5 PCF(kg/m^3)

Comments:

Figure 2

Method of Test for Theoretical Maximum Specific Gravity of Asphalt Concrete Paving Mixtures

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1. Scope:

This test is to determine the theoretical maximum specific gravity and/or density of uncompacted asphalt concrete paving mixtures. The theoretical maximum specific gravity or density is the standard used in the determination of in-place density of asphalt concrete pavements.

2. Apparatus:

2.1 Scale or balance having the capacity to weigh any sample which may be tested utilizing this procedure and readable to the nearest 0.1 gram. The scale or balance shall be equipped with a suitable suspension apparatus and holder to permit weighing the sample while suspended from the center of the scale pan of the weighing device.

2.2 Vacuum pycnometer capable of holding 3000 grams of loose asphalt mix.

2.3 Vacuum pump or water aspirator for evacuating air from the container. If a vacuum pump is used a suitable trap shall be installed between the pycnometer and the vacuum source.

2.4 Vibrating plate for continuously agitating the asphalt concrete mixture and container.

2.5 Water container that will provide a sufficient amount of potable water to maintain a uniform temperature throughout the testing procedure. An aquarium heater will work to control the temperature of water at 77° ± 2° F (25° ± 1° C).

2.6 A thermometer with subdivisions and maximum scale error of 1° F (0.5° C) to cover the range of testing.

2.7 A mercury or digital residual pressure manometer is required to measure the amount of vacuum.

2.8 A bleeder valve attached to the vacuum system to facilitate adjustment of the vacuum being applied to the vacuum container.

2.9 The water bath for immersing the sample if using the (Weighing in water method) shall be equipped with an overflow outlet for maintaining a constant water level. The water bath must be large enough to allow the suspension apparatus holder to be covered with water at all times. The sample and suspension apparatus must be completely covered with water during weighing. The wire suspending

the suspension apparatus shall be the smallest practical size to minimize any possible effects of a variable immersed length.

3. Procedure:

3.1 Sampling of uncompacted mix.

A. A random sample, approximately 160 to 180 lbs. (73 to 82 kg), of hot mix shall be taken from the paver area, - plus an additional 80 to 90 lbs. (36 to 41 kg), when IA testing is required. Samples may be obtained from behind the paver screed or from the windrow in front of the pickup machine. Material from the same sample shall be used for both SD 312 and SD 313 test procedures. On projects not requiring QC/QA testing a minimum sample size of 35 to 40 lbs. is required.

Sampling from behind the paver screed.

Example: Select a location in the random number table. Take that number (0.58) times the tonnage in the lot (1000). The sample will be taken at 580 tons into the lot on the road at the location the truck unloads where the weigh ticket is nearest to 580 tons. Record the weigh ticket number on the DOT 42Q. Use a 2nd random number (0.17) to select the distance from centerline where the sample will be taken. An example of this is 0.17 x 12' (3.7m) width = 2.0' (0.6m) from centerline.

Sample the mix by placing a template through the entire lift of hot mix or by using a square bottom shovel to create a sample area with vertical faces. Remove all material within the template or between the vertical lifts and place in the sample container or containers. On QC/QA projects obtain at least three approximately equal increments from this sample area for each sample container by placing the increments by alternating between sample container using a square bottom shovel or scoop. The QC/QA and IA sample splits can be obtained by using this procedure. The sample in each sample container must be large enough for two complete sets of all required tests.

Sampling from the windrow in front of the pickup machine.

The random sample for QC/QA projects shall be selected by using random numbers such as from the tables included in this test procedure. Use the random number selected to determine the tonnage location in the sublot where the sample will be obtained.

Do not sample the top surface of the windrow. Use a square bottom shovel to remove and discard the top foot of material from the windrow. Next, remove and discard the outside edge

of the remaining windrow to create a vertical face parallel to the windrow. Obtain the sample from the exposed vertical face. Split samples can be obtained by alternating equal shovels of hot mix into the sample containers. The QC, QA and IA sample splits can be obtained by using this procedure. The sample in each sample container must be large enough for two complete sets of all required tests.

B. There will be a 200 ton buffer between the random locations of the hot mix samples.

C. Transport the sample in a pail or box that is insulated or protected to help retain heat.

3.2 Calibration of the pycnometer for the weighing in air method.

A. Determine the weight of the container completely full of water with the calibration lid on, over the range of temperatures that will likely be encountered in service. Be sure the outside of the container is dry when weighed. Measure and record the temperature of the water and the weight of the container to the nearest 0.1 gram for at least one calibration point per 4° F (2° C) after allowing the water to be in the container for 15 minutes. Construct a calibration curve for the water and container that is being used so that the weight of the container filled with water can be determined for any temperature from the calibration curve. At least weekly check the weight of the container filled with water to verify the weight is very close to the same as obtained from the calibration curve. Record the checks in the field diary.

Correction factor for different water temperatures °F (°C)

°C	°F		°C	°F		°C	°F	
(15.6)	60	1.0020	(21.7)	71	1.0008	(27.2)	81	0.9994
(16.1)	61	1.0019	(22.2)	72	1.0007	(27.8)	82	0.9992
(16.7)	62	1.0018	(22.8)	73	1.0005	(28.3)	83	0.9991
(17.2)	63	1.0017	(23.3)	74	1.0004	(28.9)	84	0.9989
(17.8)	64	1.0016	(23.9)	75	1.0003	(29.4)	85	0.9988
(18.3)	65	1.0015	(24.4)	76	1.0001	(30.0)	86	0.9986
(18.9)	66	1.0014	(25.0)	77	1.0000	(30.6)	87	0.9984
(19.4)	67	1.0013	(25.6)	78	0.9999	(31.1)	88	0.9983
(20.0)	68	1.0012	(26.1)	79	0.9998	(31.7)	89	0.9981
(20.6)	69	1.0011	(26.7)	80	0.9996	(32.2)	90	0.9979
(21.1)	70	1.0009						

NOTE: Whenever possible, use water that is close to 77°F (25°C).

3.3 Sample size and preparation.

A. The size of the sample shall conform to the following requirements.

Nominal maximum size of aggregate	Minimum size of sample	
#4 (4.75 mm)	500 grams	(0.5 kg)
3/8" (9.5 mm)	1000 grams	(1 kg)
1/2" (12.5 mm)	1500 grams	(1.5 kg)
3/4" (19.0 mm)	2000 grams	(2 kg)
1" (25.0 mm)	2500 grams	(2.5 kg)
1¼" (31.5 mm)	3000 grams	(3 kg)

B. Obtain 2 representative samples for testing from the sample taken in accordance with paragraph 3.1. Use the quartering method in SD 213, an asphalt quartering device, or by using the method as follows. Place the original sample in a large clean pan where there will be neither loss of material nor the addition of foreign matter. Mix the sample thoroughly and flatten the material in the pan. Obtain a representative cross section of the pan area by using a heated flat bottom scoop to obtain material for testing. Scoop material from several selected locations in the pan to achieve a sample size that will conform to the requirements in the sample size table 3.3 A.

C. Separate the particles of the sample on a clean surface, to prevent contamination. The fines portion of the hot mix shall be separated such that no lumps are larger than ¼" (6 mm). If the mixture is not sufficiently soft to be separated manually, place it in a large flat pan and warm in an oven until it can be handled.

D. Cool the sample to room temperature before beginning the test.

3.4 Determine the theoretical maximum specific gravity by one of the following methods.

(Weighing in air method)

A. Weigh the cooled sample to the nearest 0.1 gram in a tared container and record the weight. Add sufficient water to cover the sample approximately 1" (6 mm). The release of entrapped air may be facilitated by the addition of a suitable wetting agent such as Aerosol OT in concentration of 0.001 percent or 0.2 grams in 20L of water. This solution is then diluted by about 20:1 to make a wetting agent of which 5 to 10 mL may be added to the container.

B. Remove entrapped air by subjecting the contents to a partial vacuum of 25 to 30 mm Hg. absolute pressure for 15 minutes

± 30 seconds. Agitate the container and contents continuously by a mechanical device. A manometer shall be installed inline to measure the amount of vacuum applied. A bleeder valve shall be installed in the vacuum system to maintain the vacuum at the required level.

C. Upon completion of the 15 minute vacuum period, slowly release the vacuum on the system. Fill the container with water. Place a thermometer in the container and record the water temperature 9 minutes after completing the vacuum period. Replace the calibration lid, dry the outside of the container, and record the weight of the container, sample and water to the nearest 0.1 gram.

D. Repeat A., B., and C. for a duplicate sample. The values of the two samples will be averaged for final results.

E. Duplicate specific gravity values not within 0.011 should be considered suspect and performed again.

(Weighing in water method)

F. Weigh the cooled sample to the nearest 0.1 gram in a tared container and record the weight. Add sufficient water to cover the sample approximately 1" (6 mm). The release of entrapped air may be facilitated by the addition of a suitable wetting agent such as Aerosol OT in concentration of 0.001 percent or 0.2 grams in 20L of water. This solution is then diluted by about 20:1 to make a wetting agent of which 5 to 10 mL may be added to the container.

G. Remove entrapped air by subjecting the contents to a partial vacuum of 25 to 30 mm Hg. absolute pressure for 15 minutes ± 30 seconds. Agitate the container and contents continuously by a mechanical device. A manometer shall be installed inline to measure the amount of vacuum applied. A bleeder valve shall be installed in the vacuum system to maintain the vacuum at the required level.

H. Upon completion of the 15 minute vacuum period, slowly release the vacuum on the system. Suspend the container and material in the water bath for 9 minutes. Record the water temperature. Record the weight of the container and sample suspended under water to the nearest 0.1 gram. Maintain a constant level of water in the water bath with the use of an overflow outlet.

I. Weigh the empty container suspended under water and record the weight to the nearest 0.1 gram.

J. Repeat F., G., H., and I. for a duplicate sample. The values of the two samples will be averaged for final results.

K. Duplicate specific gravity values not within 0.011 should be considered suspect and performed again.

4. Report:

4.1 Calculate the theoretical maximum specific gravity of the asphalt concrete mix in one of the following manners:

4.2

(Weighing in air method) (Figure 1 or figure 2)

Theoretical maximum specific gravity = (A / (A + B - C)) x D

A = Dry weight of the sample.

B = Calibration weight of the canister and water at the test temperature.

C = Final weight of the canister, water & sample.

D = Correction factor for water temperature.

(Weighing in water method) (Figure 1 or figure 3)

Theoretical maximum specific gravity = ((A / (A + B - C)) x D

A = Dry weight of the sample.

B = Weight of the canister suspended under water.

C = Weight of the canister and sample suspended under water.

D = Correction factor for water temperature.

Report the theoretical maximum specific gravity to the third decimal place.

4.3 Calculate the standard unit weight in the following manner if required by the specifications:

Standard Unit Weight (lb./ft^3) = Theo. maximum specific gravity x 62.245
Standard Unit Weight (kg/m^3) = Theo. maximum specific gravity x 997.1

4.4 Report the standard unit weight to one decimal place if required by the specifications.

5. References:

SD 213
SD 313
DOT-42QA
DOT-86

Sample ID
File No.

Gyratory Specific Gravity

DOT-86
9-14

PROJECT P 0000(00)0 COUNTY Hand PCN 01ST

Field # QC01 Date Sampled 09/01/2014 Date Tested 09/01/2014

Sampled by Jones, Jim Tested by Jones, Jim Checked By Doe, Jane

Material Type Class Q2 Hot Mix Asphalt Ticket # 125896

Source Pete Lien & Sons, Birdsall S & G Lift 2 of 2

Lot # 1 Sublot # 1

Mix Temp 270 Offset 6' Rt. ESAL's Q2

Daily Ton 496 Total Ton 496 Oil Type Cenex PG 58-28

			No. of Gyrations		
% binder Pb		N initial		Gse	
Gsb		N design		Pba	
binder Gb		N max		Pbe	
dust (-#200)					
lime					
dust (-#200) + lime					

	Spec. A (Ndes)		Spec. B (Ndes)		Spec. M (Nmax)		
	@ N ini	@ N des	@ N ini	@ N des	@ N ini	@ N des	@ N max
a) Height, mm							
b) Weight in air							
c) Weight in water							
d) SSD weight							
e) Bulk SpGr meas b /(d-c)							
f) Bulk SpGr calc (Gmb)							

	Gmm # 1	Gmm # 2
Weight of sample in air	2006.8	2009.1
Weight of canister + water	1283.6	1283.1
Weight of canister + water + sample	2485.0	2486.9
Temperature of the water	77F (25.0C)	77F (25.0C)
Water correction factor	1.0000	1.0000
Rice SpGr (Gmm)	2.492	2.495

Average Maximum SpGr (Gmm) 2.494

Average Gmb			
% of Rice SpGr (Gmm)			

% Air Voids (VA)		**% VMA**		**% VFA**		**Dust to binder ratio**	

Comments:

Figure 1

15

DOT-42QA
9-14

AIR VOIDS REPORT - ASPHALT CONCRETE SURFACING

FILE # _____

PROJECT P 0000(00)0 COUNTY Any PCN 1234
SUBLOT NUMBER QC-1 DATE 9/1/14 TIME 10:05 AM LIFT 2 of 2
SAMPLE OBTAINED FROM behind paver screed DISTANCE LT. OR RT. OF CENTERLINE 4' left
TICKET NO. 123456 TONS 496 QUANTITY REPRESENTED 1000 TONS
TESTED BY Jim Jones CHECKED BY RER
PERCENT BINDER DESIRED 6.4 DAILY BINDER CONTENT DETERMINATION (DOT-89) 6.3

THEORETICAL MAXIMUM SPECIFIC GRAVITY (RICE)

(Weight in Air Method)	1	2	(Weight in Water Method)
A. Weight of sample in air	2006.8	2009.1	A. Weight of sample in air
B. Weight of container + water	7442.7	7443.5	B. Weight of Container in water
C. Wt. of container + water + sample	8644.2	8647.4	C. Wt. of container + sample in water
Temperature of water ° F	77	74	Temperature of water ° F
D. Water correction factor	1.0000	1.0004	D. Water correction factor
E. Theo. Maximum Specifiec Gravity [A / (A + B - C)] x D	2.492	2.496	E. Theo. Maximum Specifiec Gravity [A / (A + B - C)] x D
F. Average Theo. Maximum Specific Gravity	2.494		F. Average Theo. Maximum Specific Gravity

MARSHALL BULK SPECIFIC GRAVITY DATA

	Specimen number		
A. Height of specimen			
B. Weight of specimen in air			
C. Weight of specimen in water			
D. Weight of SSD specimen in air			
E. Volume Displaced (D - C)			
F. Bulk Specific Gravity (B / E)			
G. Actual Compaction Temperature ° F			
JFM Compaction Temp. _____ ° F			
H. Average Bulk Specific Gravity			

PERCENT AIR VOIDS CALCULATION

[(Maximum Sp. Gr.-Marsh. Bulk Sp. Gr.) / Mazimum Sp. Gr.] x 100 = _____

Figure 2

DOT-42QA
9-14

AIR VOIDS REPORT - ASPHALT CONCRETE SURFACING

FILE # _____

PROJECT P 0000(00)0 COUNTY Any PCN 1234
SUBLOT NUMBER QC-1 DATE 9/1/14 TIME 10:05 AM LIFT 2 of 2
SAMPLE OBTAINED FROM behind paver screed DISTANCE LT. OR RT. OF CENTERLINE 4' left
TICKET NO. 123456 TONS 496 QUANTITY REPRESENTED 1000 TONS
TESTED BY Jim Jones CHECKED BY RER
PERCENT BINDER DESIRED 6.4 DAILY BINDER CONTENT DETERMINATION (DOT-89) 6.3

THEORETICAL MAXIMUM SPECIFIC GRAVITY (RICE)

(Weight in Air Method)	1	2	(Weight in Water Method)
A. Weight of sample in air	2006.8	2009.1	A. Weight of sample in air
B. Weight of container + water	1283.6	1283.1	B. Weight of Container in water
C. Wt. of container + water + sample	2485.0	2486.9	C. Wt. of container + sample in water
Temperature of water ° F	77	74	Temperature of water ° F
D. Water correction factor	1.0000	1.0004	D. Water correction factor
E. Theo. Maximum Specifiec Gravity [A / (A + B - C)] x D	2.492	2.496	E. Theo. Maximum Specifiec Gravity [A / (A + B - C)] x D
F. Average Theo. Maximum Specific Gravity	2.494		F. Average Theo. Maximum Specific Gravity

MARSHALL BULK SPECIFIC GRAVITY DATA

	Specimen number		
A. Height of specimen			
B. Weight of specimen in air			
C. Weight of specimen in water			
D. Weight of SSD specimen in air			
E. Volume Displaced (D - C)			
F. Bulk Specific Gravity (B / E)			
G. Actual Compaction Temperature ° F			
JFM Compaction Temp. _____ ° F			
H. Average Bulk Specific Gravity			

PERCENT AIR VOIDS CALCULATION

[(Maximum Sp. Gr.-Marsh. Bulk Sp. Gr.) / Mazimum Sp. Gr.] x 100 = _____

Figure 3

SDDOT
TABLE OF RANDOM NUMBERS

.53 .74 .23 .99 .67	.61 .32 .28 .69 .84	.94 .62 .67 .86 .24	.98 .33 .74 .19 .95	.47 .53 .53 .38 .09
.63 .38 .06 .86 .54	.99 .00 .65 .26 .94	.02 .82 .90 .23 .07	.79 .62 .67 .80 .60	.75 .91 .12 .81 .19
.35 .30 .58 .21 .46	.06 .72 .17 .10 .94	.25 .21 .31 .75 .96	.49 .28 .24 .00 .49	.55 .65 .79 .78 .07
.63 .43 .36 .82 .69	.65 .51 .18 .37 .88	.61 .38 .44 .12 .45	.32 .92 .85 .88 .65	.54 .34 .81 .85 .35
.98 .25 .37 .55 .26	.01 .91 .82 .81 .46	.74 .71 .12 .94 .97	.24 .02 .71 .37 .07	.03 .92 .18 .66 .75
.02 .63 .21 .17 .69	.71 .50 .80 .89 .56	.38 .15 .70 .11 .48	.43 .40 .45 .86 .98	.00 .83 .26 .91 .03
.64 .55 .22 .21 .82	.48 .22 .28 .06 .00	.61 .54 .13 .43 .91	.82 .78 .12 .23 .29	.06 .66 .24 .12 .27
.85 .07 .26 .13 .89	.01 .10 .07 .82 .04	.59 .63 .69 .36 .03	.69 .11 .15 .83 .80	.13 .29 .54 .19 .28
.58 .54 .16 .24 .15	.51 .54 .44 .82 .00	.62 .61 .65 .04 .69	.38 .18 .65 .18 .97	.85 .72 .13 .49 .21
.34 .85 .27 .84 .87	.61 .48 .64 .56 .26	.90 .18 .48 .13 .26	.37 .70 .15 .42 .57	.65 .65 .80 .39 .07
.03 .92 .18 .27 .46	.57 .99 .16 .96 .56	.30 .33 .72 .85 .22	.84 .64 .38 .56 .98	.99 .01 .30 .98 .64
.62 .95 .30 .27 .59	.37 .75 .41 .66 .48	.86 .97 .80 .61 .45	.23 .53 .04 .01 .63	.45 .76 .08 .64 .27
.08 .45 .93 .15 .22	.60 .21 .75 .46 .91	.98 .77 .27 .85 .42	.28 .88 .61 .08 .84	.69 .62 .03 .42 .73
.07 .08 .55 .18 .40	.45 .44 .75 .13 .90	.24 .94 .96 .61 .02	.57 .55 .66 .83 .15	.73 .42 .37 .11 .16
.01 .85 .89 .95 .66	.51 .10 .19 .34 .88	.15 .84 .97 .19 .75	.12 .76 .39 .43 .78	.64 .63 .91 .08 .25
.72 .84 .71 .14 .35	.19 .11 .58 .49 .26	.50 .11 .17 .17 .76	.86 .31 .57 .20 .18	.95 .60 .78 .46 .75
.88 .78 .28 .16 .84	.13 .52 .53 .94 .53	.75 .45 .69 .30 .96	.73 .89 .65 .70 .31	.99 .17 .43 .48 .76
.45 .17 .75 .65 .57	.28 .40 .19 .72 .12	.25 .12 .74 .75 .67	.60 .40 .60 .81 .19	.24 .62 .01 .61 .16
.96 .76 .28 .12 .54	.22 .01 .11 .94 .25	.71 .96 .16 .16 .88	.68 .64 .36 .74 .45	.19 .59 .50 .88 .92
.43 .31 .67 .72 .30	.24 .02 .94 .08 .63	.38 .32 .36 .66 .02	.69 .36 .38 .25 .39	.48 .03 .45 .15 .22
.50 .44 .66 .44 .21	.66 .06 .58 .05 .62	.68 .15 .54 .35 .02	.42 .35 .48 .96 .32	.14 .52 .41 .52 .48
.22 .55 .22 .15 .86	.26 .63 .75 .41 .99	.58 .42 .36 .72 .24	.58 .37 .52 .18 .51	.03 .37 .18 .39 .11
.96 .24 .40 .14 .51	.23 .22 .30 .88 .57	.95 .67 .47 .29 .83	.94 .69 .40 .06 .07	.18 .16 .36 .78 .86
.31 .73 .91 .61 .19	.60 .20 .72 .93 .48	.98 .57 .07 .23 .69	.65 .95 .39 .69 .58	.56 .80 .30 .19 .44
.78 .60 .73 .99 .34	.43 .89 .94 .36 .45	.56 .69 .47 .07 .41	.90 .22 .91 .07 .12	.78 .35 .34 .08 .72
.84 .37 .90 .61 .56	.70 .10 .23 .98 .05	.85 .11 .34 .76 .60	.76 .48 .45 .34 .60	.01 .64 .18 .39 .96
.36 .67 .10 .08 .23	.98 .93 .35 .08 .86	.99 .29 .76 .29 .81	.33 .34 .91 .58 .93	.63 .14 .52 .32 .52
.07 .28 .59 .07 .48	.89 .64 .58 .89 .75	.83 .85 .62 .27 .89	.30 .14 .78 .56 .27	.86 .63 .59 .80 .02
.10 .15 .83 .87 .60	.79 .24 .31 .66 .56	.21 .48 .24 .06 .93	.91 .98 .94 .05 .49	.01 .47 .59 .38 .00
.55 .19 .68 .97 .65	.03 .73 .52 .16 .56	.00 .53 .55 .90 .27	.33 .42 .29 .38 .87	.22 .13 .88 .83 .34
.53 .81 .29 .13 .39	.35 .01 .20 .71 .34	.62 .33 .74 .82 .14	.53 .73 .19 .09 .03	.56 .54 .29 .56 .93
.51 .86 .32 .68 .92	.33 .98 .74 .66 .99	.40 .14 .71 .94 .58	.45 .94 .19 .38 .81	.14 .44 .99 .81 .07
.35 .91 .70 .29 .13	.80 .03 .54 .07 .27	.96 .94 .78 .32 .66	.50 .95 .52 .74 .33	.13 .80 .55 .62 .54
.37 .71 .67 .95 .13	.20 .02 .44 .95 .94	.64 .85 .04 .05 .72	.01 .32 .90 .76 .14	.53 .89 .74 .60 .41
.93 .66 .13 .83 .27	.92 .79 .64 .64 .72	.28 .54 .96 .53 .84	.48 .14 .52 .98 .94	.56 .07 .93 .89 .30
.02 .96 .08 .45 .65	.13 .05 .00 .41 .84	.93 .07 .54 .72 .59	.21 .45 .57 .09 .77	.19 .48 .56 .27 .44
.49 .83 .43 .48 .35	.82 .88 .33 .69 .96	.72 .36 .04 .19 .76	.47 .45 .15 .18 .60	.82 .11 .08 .95 .97
.84 .60 .71 .62 .46	.40 .80 .81 .30 .37	.34 .39 .23 .05 .38	.25 .15 .35 .71 .30	.88 .12 .57 .21 .77
.18 .17 .30 .88 .71	.44 .91 .14 .88 .47	.89 .23 .30 .63 .15	.56 .34 .20 .47 .89	.99 .82 .93 .24 .98
.79 .69 .10 .61 .78	.71 .32 .76 .95 .62	.87 .00 .22 .58 40	.92 .54 .01 .75 .25	.43 .11 .71 .99 .31
.75 .93 .36 .57 .83	.56 .20 .14 .82 .11	.74 .21 .97 .90 .65	.96 .42 .68 .63 .86	.74 .54 .13 .26 .94
.38 .30 .92 .29 .03	.06 .28 .81 .39 .38	.62 .25 .06 .84 .63	.61 .29 .08 .93 .67	.04 .32 .92 .08 .09
.51 .28 .50 .10 .34	.31 .57 .75 .95 .80	.51 .97 .02 .74 .77	.76 .15 .48 .49 .44	.18 .55 .63 .77 .09
.21 .31 .38 .86 .24	.37 .79 .81 .53 .74	.73 .24 .16 .10 .33	.52 .83 .90 .94 .76	.70 .47 .14 .54 .36
.29 .01 .23 .87 .88	.58 .02 .39 .37 .67	.42 .10 .14 .20 .92	.16 .55 .23 .42 .45	.54 .96 .09 .11 .06
.95 .33 .95 .22 .00	.18 .74 .72 .00 .18	.38 .79 .58 .69 .32	.81 .76 .80 .26 .92	.82 .80 .84 .25 .39
.90 .84 .60 .79 .80	.24 .36 .59 .87 .38	.82 .07 .53 .89 .35	.96 .35 .23 .79 .18	.05 .98 .90 .07 .35
.46 .40 .62 .98 .82	.54 .97 .20 .56 .95	.15 .74 .80 .08 .32	.16 .46 .70 .50 .80	.67 .72 .16 .42 .79
.20 .31 .89 .03 .43	.38 .46 .82 .68 .72	.32 .14 .82 .99 .70	.80 .60 .47 .18 .97	.63 .49 .30 .21 .30
.71 .59 .73 .05 .50	.08 .22 .23 .71 .77	.91 .01 .93 .20 .49	.82 .96 .59 .26 .94	.66 .39 .67 .98 .60

Figure 4

Method of Test for Density and Air Voids of Asphalt Concrete by the Marshall Method

---

1. Scope:

This test is to determine the density and air void level of asphalt concrete mixtures.

2. Apparatus:

2.1 Slant foot (1° bevel) rotating base Marshall mechanical compaction machine mounted on a wooden pedestal secured to a concrete slab.

2.2 Compaction hammer conforming to AASHTO T 245.

2.3 Compaction molds conforming to AASHTO T 245.

2.4 Scale or balance having the capacity to weigh any sample which may be tested utilizing this procedure and readable to the nearest 0.1 gram. The scale or balance shall be equipped with a suitable suspension apparatus and holder to permit weighing the sample while suspended from the center of the scale pan of the weighing device.

2.5 Thermometers, dial type, armored glass, or digital with a range of 50° to 400°F (10° to 204°C) with a sensitivity of 5° F (2.8° C).

2.6 Thermometer sensitive to 0.5°F (0.2°C) and readable to 1°F (0.5°C).

2.7 Miscellaneous. Insulated gloves, small trowel, filter paper discs, pails, shovel, pans, scoop or spoon, fuel oil, and rags.

2.8 Electric hot plate or roaster oven.

2.9 Water bath with an overflow outlet for maintaining a constant water level. An aquarium heater will suffice to control the temperature of the water bath at 77° ± 2°F (25° ± 1°C). The water bath must be large enough to allow the suspension apparatus holder to be covered with water at all times. The sample and suspension apparatus must be completely covered with water during weighing. The wire suspending the suspension apparatus shall be the smallest practical size to minimize any possible effects of a variable immersed length.

2.10 A mechanical convection oven with a minimum chamber volume of 5.0 cubic feet (0.142 cubic meter) capable of heating to 350°F (177°C).

3. Procedure:

3.1 Sampling uncompacted mix.

A. Material for the Marshall determinations shall be obtained from the same sample as obtained in SD 312.

B. Take approximately 70 to 80 lbs. (32 to 36 kg) of hot mix for the laboratory density determination - 110 to 120 lbs. (50 to 55 kg) when IA testing is required.

C. Transport the sample in a pail or box that is insulated or protected to help retain heat.

D. Place the sample in a clean pan where there will be neither loss of material nor the addition of foreign matter. Place the pan and material in an oven maintained at or slightly above the required compaction temperature.

3.2 Laboratory density determination.

A. Preheat 3 molds, a flat bottom scoop, and a trowel or spatula in an oven or on a hot plate to the established mix compaction temperature recommended on the job mix formula. Preheat the tamping face of the hammer to 200° to 300° F (93° to 149° C) on a hot plate. On non QC/QA projects compact the mix at the delivery temperature to the road ± 10°F (± 6°C).

B. Obtain by quartering or by using a heated flat bottom scoop a representative sample, from the same pan of material used in SD 312 Section 3.3 B. The material placed in the mold shall make a Marshall specimen with a compacted height of 2 1/2" ± 1/8" (63.5 ± 3 mm). Once the amount of material needed to make a compacted specimen the required height is established, material can be weighed into the compaction molds that have a paper disc in the bottom of the mold and placed in an oven. Monitor the temperature of the hot mix so that compacting will take place when the mix is at the established mix design compaction temperature recommended on the job mix formula. Thermometers should be calibrated and checked often to insure accurate temperature measurements.

C. Once the hot mix in the mold has reached the correct temperature, remove from the oven, rod 25 times (15 around the perimeter and 10 in the center) with the small trowel or spatula. After rodding, round off the top surface of the mixture. Measure and record the temperature of the mix in the mold.

D. Place a paper disc on the top of the mix in the mold and place the mold on the base of the mechanical compactor under the mold holder.

Place the face of the hammer inside the mold and apply 50 blows, unless otherwise specified in the plans. Invert the mold and apply 50 blows or the number of blows specified in the plans to the opposite end of the specimen. After compaction, the base plate shall be removed and the paper discs discarded.

E. Repeat the procedure listed in paragraphs B., C., and D. above for the second and third specimens.

F. Cool the specimens in air. A fan may be used to aid in the cooling of the specimens. After a specimen has cooled enough to touch with the bare hand, remove it from the forming mold.

G. After removal, number each specimen and set aside. Avoid fracturing or deforming the specimens when handling. Rest specimens on a smooth, level surface until ready for testing. The height of each specimen shall be 2 1/2" ± 1/8" (63.5 ± 3 mm).

If the Marshall specimen doesn't compact to a height of 2 1/2" ± 1/8" (63.5 ± 3 mm), use the following equation to correct the amount of material to be used:

A = Actual weight of the specimen

B = Actual height of the specimen

$$\frac{(2.5 \times A)}{B}$$

H. After the specimen has cooled to room temperature, measure the height at four locations. Record the average height of the specimen to the nearest 1/16" (2 mm).

I. Weigh the specimen in air and record the weight to the nearest 0.1 gram.

J. Suspend the specimen in a water bath at 77° ± 2° F (25° ± 1° C) for 3 to 3.5 minutes. Record the immersed weight to the nearest 0.1 gram. Maintain a constant level of water in the water bath at the overflow outlet through the entire test procedure.

K. Immediately after weighing under water, blot the specimen dry with a damp terry cloth towel and record the saturated surface dry weight to the nearest 0.1 gram.

L. Repeat H., I., J., and K. for the other two specimens.

NOTE: Cores and pucks shall be weighed individually.

4. Report:

4.1 Calculate the Marshall bulk specific gravity of the laboratory specimens in the following manner.

$$\text{Marshall bulk specific gravity} = \frac{B}{D - C}$$

B = Weight of sample in air.

C = Weight of the sample suspended in water.

D = Weight of saturated surface dry sample in air.

4.2 Report the Marshall bulk specific gravity to the nearest 0.001 on a DOT-42QA or a DOT-42 (Figure 1 or figure2) .

NOTE: Use all three of the specimens provided the difference between the high and low specimen does not exceed 0.020. When any specimen varies by more than 0.020 from any of the other specimens, that specimen will not be used in the calculations and will be discarded. If the remaining two specimens are within 0.010 of each other, use their average for the Marshall density data. If they are not, discard the specimens and obtain a new set of Marshall specimens.

4.3 Calculate the percent of air voids in the following manner:

$$\text{\% air voids} = \frac{(E - F)}{E} \times 100$$

E = Theoretical maximum specific gravity from SD 312.

F = Marshall bulk specific gravity average.

4.4 Report the percent air voids to the nearest 0.1 on a DOT-42QA or the DOT-42.

5. References:

AASHTO T 245
SD 312
DOT-42
DOT-42QA

DOT-42QA
9-14

AIR VOIDS REPORT - ASPHALT CONCRETE SURFACING

FILE # _____

PROJECT P 0000(00)0 COUNTY Any PCN 1234
SUBLOT NUMBER QC-1 DATE 9/1/14 TIME 10:05 AM LIFT 2 of 2
SAMPLE OBTAINED FROM behind paver screed DISTANCE LT. OR RT. OF CENTERLINE 4' Left
TICKET NO. 123456 TONS 496 QUANTITY REPRESENTED 1000 TONS
TESTED BY Jim Jones CHECKED BY RER
PERCENT BINDER DESIRED 6.4 DAILY BINDER CONTENT DETERMINATION (DOT-89) 6.3

THEORETICAL MAXIMUM SPECIFIC GRAVITY (RICE)

(Weight in Air Method)	1	2	(Weight in Water Method)
A. Weight of sample in air	2006.8	2009.1	A. Weight of sample in air
B. Weight of container + water	7442.7	7443.5	B. Weight of Container in water
C. Wt. of container + water + sample	8644.2	8647.4	C. Wt. of container + sample in water
Temperature of water ° F	77	74	Temperature of water ° F
D. Water correction factor	1.0000	1.0004	D. Water correction factor
E. Theo. Maximum Specifiec Gravity [A / (A + B - C)] x D	2.492	2.496	E. Theo. Maximum Specifiec Gravity [A / (A + B - C)] x D
F. Average Theo. Maximum Specific Gravity	2.494		F. Average Theo. Maximum Specific Gravity

MARSHALL BULK SPECIFIC GRAVITY DATA

	Specimen number		
	1A	1B	1C
A. Height of specimen	2.62	2.61	2.56
B. Weight of specimen in air	1243.7	1245.1	1236.4
C. Weight of specimen in water	722.1	724.3	718.7
D. Weight of SSD specimen in air	1245.1	1247.1	1237.6
E. Volume Displaced (D - C)	523.0	522.8	518.9
F. Bulk Specific Gravity (B / E)	2.378	2.382	2.383
G. Actual Compaction Temperature ° F	272	275	270
JFM Compaction Temp. 270 ° F			
H. Average Bulk Specific Gravity		2.381	

PERCENT AIR VOIDS CALCULATION

[(Maximum Sp. Gr.-Marsh. Bulk Sp. Gr.) / Mazimum Sp. Gr.] x 100 = 4.5%

Figure 1

Sample ID
File No.

Density Report - Bituminous Surfacing

DOT-42
9-14

PROJECT P 0000(00) COUNTY Hand PCN 1234

Test No. 01 Class and Type Class E Type 1 Lift 1 of 2 Thickness 2"

% Asphalt Binder 5.5 Actual Finished Width 18' Station 105+15 EBL

Date 9/17/14 Tested By Smith, Joe Checked By Doe, Linda

Specification Requirements - % of Standard Required _____ _____ Min. PCF (kg/m^3) _____

Daily Checks, Gauge No: _____ Standard Count: _____ Previous Standard: _____

Density Standard Data

Standard Density Test No: _____ Date: _____ Time: _____ Lift: _____ of _____

Sample Obtained From: _____ Tested By: _____

Theoretical Maximum Density

	1	2
A. Wt. of sample in Air	2006.8	2009.1
B. Wt of Canister + Water	1283.6	1283.1
C. Wt of Canister + Water + Sample	2485.0	2486.9
Temperature of the Water	77F (25.0 C)	77F (25.0 C)
D. Water Correction Factor	1.0000	1.0000
E. Max. Specific Gravity [A/(A + B - C)] x D	2.492	2.495
F. Max. Unit Wt. (E x 62.245) (E x 997.1)	155.1	155.3
G. Avg. Unit Weight	155.2	
H. Moving Avg. (Last 5 Tests)		

Marshall Density Data

	1	2	3
A. Wt. of Sample in Air	1243.7	1245.1	1236.4
B. Wt. of Sample under water	722.1	724.3	718.7
C. Saturated Surface Dry Wt.	1245.1	1247.1	1237.6
D. Volume Displaced (C - B)	523.0	522.8	518.9
E. Bulk Specific Gravity (A/D)	2.378	2.382	2.383
F. Unit Weight (E x 62.245) (E x 997.1)	148.0	148.3	148.3
G. Compaction Sample Temp.	272	275	270
H. Avg. Unit Weight		148.2	
I. Moving Avg. (Last 5 Tests)			

In-place Density Measurement

Lot Loc: Sta: _____ To Sta: _____ Dist. From Centerline: _____

Length: _____ Width: _____ Quantity Represented: _____

Site No.	Random No.	Distance Lot Beg.	Station	Random No.	Dist. From Out. Edge	Distance From C/L	PCF(kg/m^3)	Corrected PCF(kg/m^3)	% of Standard
1									
2									
3									
4									
5									
No more than 2 tests below spec. only 1 test may be 2% below spec. 1 Test @ 3% Below fails the Entire Lot.								Lot Average	

% AIR VOID CALCULATIONS

[(Maximum Specific Gravity - Bulk Specific Gravity) / Maximum Specific Gravity] x 100 = 4.5

CUTOUT CALIBRATION CHECK

CUTOUT No.	Station	Distance From C/L	Actual Dry Wt.	Submersed Wt. in Water	SSD Wt. in Air	PCF (kg/m^3)	Nuclear Gauge Readings				Avg.
1											
2											
3											

PCF (kg/m^3) Average PCF (kg/m^3) Average

CALIBRATION CORRECTION _____ PCF(kg/m^3)

Comments:

Figure 2

Method for Field Determination of the Daily Asphalt Binder Content

---

1. Scope:

This test covers the procedure for calculating the daily asphalt binder content for an asphalt hot mix plant.

2. Apparatus:

2.1 Furnished charts showing the capacity per fractions of an inch (mm) for each oil storage tank.

2.2 A measuring device to measure the amount of asphalt in the storage tank. A calibrated stick or tape measure.

NOTE: The asphalt storage tanks must be level and remain level for measurements to be reliable.

3. Procedure:

3.1 Measure the depth and take the temperature of the asphalt binder in the storage tank or tanks before the plant starts to produce hot mix.

3.2 Determine the number of gallons (L) of asphalt binder at the storage temperature from the charts furnished for the storage tank capacity. Convert this gallon (L) quantity to a weight quantity in pounds (kg) by using one of the formulas on the back of form DOT-89. (Figure 1) These formulas are used to determine the weight per gallon (L) of asphalt binder at a particular temperature by using a multiplier for correcting oil volumes to the basis of 60° F (15.6° C). Multiply the weight per gallon (L) of asphalt binder at the storage temperature by the number of gallons (L) and divide by 2,000 lbs. (907.2 kg) to get the tons (mtons) of asphalt binder in the storage tank.

The weight per gallon of asphalt binder at 60° F (15.6° C) and/or the specific gravity of the asphalt binder can be found on the Certificate of Compliance or weight ticket furnished with each load of asphalt binder delivered to the project.

3.3 Add up the weight in tons (mtons) of the truckloads of asphalt binder added to the storage tanks during the day.

3.4 Measure the depth and take the temperature of the asphalt binder in the storage tank or tanks after the plant finishes producing hot mix.

3.5 Convert the gallons (L) of asphalt binder to tons (mtons) by using the same procedure as used in 3.2 above.

3.6 Record the weight of all hot mix produced by the plant in tons (mtons).

4. Report:

4.1 Calculate the daily asphalt binder content in the following manner to the nearest 0.01% on a DOT-89.

$$\text{Daily asphalt binder content} = \frac{(A + B - C) \times 100}{D}$$

A = Tons (mtons) of asphalt binder in the storage tanks at the start of the day.

B = Tons (mtons) of asphalt binder added to storage tanks during the day.

C = Tons (mtons) of asphalt binder in the storage tanks at the end of the day.

D = Tons (Mtons) of hot mix produced during the day.

4.2 Report the daily asphalt binder content to one decimal place.

5. References:

DOT-66
DOT-89

Sample ID
File No.

BITUMEN CONTENT DETERMINATION

DOT-89
9-14

Report No. 04

County Jones, Lyman PCN/PROJECT IM-BRF 090-5(71)187

Test Date 09/22/2014 Inspector Gardner, Bill Contractor Border States Paving

Percent Bitumen Desired 5.1 - 5.7 Percent Used by Test 5.4

Bitumen Type PG 64-34

TANK METHOD

	Tank #1	Tank #2
A. Beginning Specific Gravity of Bitumen @ 60°F	1.011	
B. Beginning Weight Per Gallon @ 60°F	8.420	
C. Temperature of Bitumen in Tank When Check Starts	313	
D. Weight Per Gallon of Bitumen at Temperature	7.7	
E. Gallons in Tank When Check Starts (calibrated stick)	31022	
Gallons at Start (at start of tank use)	☐	☐
F. Weight of Bitumen in Tank (start check) (D x E / 2000)	119.43	
G. Weight of Bitumen Added to Tank(s)	226.02	
H. Temperature of Bitumen in Tank When Check Ends	307	
I. Gallons in Tank When Check Ends (calibrated stick)	27982	
J. Ending Specific Gravity of Bitumen @ 60°F	1.011	
K. Ending Weight Per Gallon @ 60°F	8.420	
L. Weight Per Gallon at Temperature	7.716	
M. Weight of Bitumen in Tank (end check) (I x L / 2000)	107.95	
Left in Storage (at end of tank use)	☐	☐
N. Weight of Bitumen Used (F + G - M)	237.5	
O. Weight of Mix Produced (Tons)	4432.52	
P. Percent of Bitumen in Mix (N / O x 100)	5.36	

G.

Load #	Invoice #	Tons
14A	79111A	36.97
15A	79112A	38.19
16A	79113A	37.85
14B	79111B	36.97
15B	79112B	38.19
16B	79113B	37.85

Summary of Mix Produced **Bitumen**

To Road	4432.52	Tons	237.5	Tons
Plant Waste		Tons		Tons
Road Waste		Tons		Tons
To Others		Tons		Tons
Produced	4432.52	Tons		

REMARKS

Figure 1

DETERMINING POUNDS OF BITUMEN PER GALLON

1. _____ X _____ = X 8.328 (1) = _____ lbs. (kg) of Bitumen per
   Spec. Gravity of Bitumen Temp. Factor Gallon (L) @ temperature

2. _____8.4196_____ X _____0.9146_____ = ___7.70__ lbs. (kg) of Bitumen per
   Wt./Gal. (L) @ 60°F Temp. Factor
   Gallon (L) @ temperature

Temp. ºC	Temp. ºF	Factor
107	225	0.9436
110	230	0.9419
113	235	0.9402
116	240	0.9385
118	245	0.9369
121	250	0.9352
124	255	0.9336
127	260	0.9319
129	265	0.9302
132	270	0.9286
135	275	0.9269
138	280	0.9253
141	285	0.9236
143	290	0.9220
146	295	0.9204
149	300	0.9187
152	305	0.9171
154	310	0.9154
157	315	0.9138
160	320	0.9122
163	325	0.9105
166	330	0.9089
168	335	0.9073
171	340	0.9057
174	345	0.9040
177	350	0.9024

(Table for converting pounds of bitumen per gallon – Applicable for DOT-89 & DOT-66)

Sample ID **Asphalt Plant Mix - Spot Check** **DOT-66**

File No. **9-14**

PROJECT P 0044(21)291 COUNTY Gregory PCN 02BQ

Field # 5 Date Sampled 9/23/14 Date Tested 9/23/14

Inspector Travis Schnabel Contractor Border States Paving

TANK METHOD

	Tank #1	Tank #2
A. Beginning Specific Gravity of Bitumen @ 60° F	1.032	1.032
B. Beginning Weight Per Gallon @ 60° F	8.5945	8.5945
C. Temperature of Bitumen in Tank When Check Starts	300	300
D. Beginning Weight Per Gallon at Temperature	7.896	7.896
E. Gallons in Tank When Check Starts (calibrated stick)	3685	6304
Gallons at Start (at start of tank use)		
F. Weight of Bitumen in Tank (start check) (D x E / 2000)	14.55	24.89
G. Weight of Bitumen Added to Tank(s)	184.92	
H. Temperature of Bitumen in Tank When Check Ends	300	300
I. Gallons in Tank When Check Ends (calibrated stick)	3332	5771
J. Ending Specific Gravity of Bitumen @ 60° F	1.032	1.032
K. Ending Weight Per Gallon @ 60° F	8.5945	8.5945
L. Ending Weight Per Gallon at Temperature	7.896	7.896
M. Weight of Bitumen in Tank (end check) (I x L / 2000)	13.15	22.78
Left in Storage (at end of tank use)		
N. Weight of Bitumen Used (F + G - M)	188.43	
O. Weight of Mix Produced (Tons)	3101.8	
P. Percent of Bitumen in Mix (N / O x 100)	6.07	

(*) Computed on reverse side

METER METHOD

Q. Applied Temperature of Bitumen _____

R. Weight Per Gallon (L) of Bitumen at Applied Temperature _____

S. Weight of Mix Produced (tons) _____

☐ Meter Reads in Weight

T. Stop (tons) _____

U. Start (tons) _____

V. Net Weight _____

V / S x 100 = _____ % of Bitumen in Mix

☐ Meter reads in Gallons

T. Stop (Gallons) _____

U. Start (Gallons) _____

V. Net Gallons _____

R x V / S x 100 = _____ % of Bitumen in Mix

Figure 2

Sample ID **Asphalt Plant Mix - Spot Check** **DOT-66**

File No. **9-14**

PROJECT P 0044(21)291 COUNTY Gregory PCN 02BQ

Field # 5 Date Sampled 9/23/14 Date Tested 9/23/14

Inspector Travis Schnabel Contractor Border States Paving

TANK METHOD

	Tank #1	Tank #2
A. Beginning Specific Gravity of Bitumen @ 60° F		
B. Beginning Weight Per Gallon @ 60° F		
C. Temperature of Bitumen in Tank When Check Starts		
D. Beginning Weight Per Gallon at Temperature		
E. Gallons in Tank When Check Starts (calibrated stick)		
Gallons at Start (at start of tank use)	☐	☐
F. Weight of Bitumen in Tank (start check) (D x E / 2000)		
G. Weight of Bitumen Added to Tank(s)		
H. Temperature of Bitumen in Tank When Check Ends		
I. Gallons in Tank When Check Ends (calibrated stick)		
J. Ending Specific Gravity of Bitumen @ 60° F		
K. Ending Weight Per Gallon @ 60° F		
L. Ending Weight Per Gallon at Temperature		
M. Weight of Bitumen in Tank (end check) (I x L / 2000)		
Left in Storage (at end of tank use)	☐	☐
N. Weight of Bitumen Used (F + G - M)		
O. Weight of Mix Produced (Tons)		
P. Percent of Bitumen in Mix (N / O x 100)		

(*) Computed on reverse side

METER METHOD

Q. Applied Temperature of Bitumen

R. Weight Per Gallon (L) of Bitumen at Applied Temperature

S. Weight of Mix Produced (tons) 1256

☑ Meter Reads in Weight

T. Stop (tons) 73

U. Start (tons) 0

V. Net Weight 73

V / S x 100 = 5.81 % of Bitumen in Mix

☐ Meter reads in Gallons

T. Stop (Gallons)

U. Start (Gallons)

V. Net Gallons

R x V / S x 100 = % of Bitumen in Mix

Figure 3

Sample ID
File No.

Asphalt Plant Mix - Spot Check

DOT-66
9-14

PROJECT P 0044(21)291 COUNTY Gregory PCN 02BQ
Field # 5 Date Sampled 9/23/14 Date Tested 9/23/14
Inspector Travis Schnabel Contractor Border States Paving

TANK METHOD

	Tank #1	Tank #2
A. Beginning Specific Gravity of Bitumen @ 60° F		
B. Beginning Weight Per Gallon @ 60° F		
C. Temperature of Bitumen in Tank When Check Starts		
D. Beginning Weight Per Gallon at Temperature		
E. Gallons in Tank When Check Starts (calibrated stick)		
Gallons at Start (at start of tank use)	☐	☐
F. Weight of Bitumen in Tank (start check) (D x E / 2000)		
G. Weight of Bitumen Added to Tank(s)		
H. Temperature of Bitumen in Tank When Check Ends		
I. Gallons in Tank When Check Ends (calibrated stick)		
J. Ending Specific Gravity of Bitumen @ 60° F		
K. Ending Weight Per Gallon @ 60° F		
L. Ending Weight Per Gallon at Temperature		
M. Weight of Bitumen in Tank (end check) (I x L / 2000)		
Left in Storage (at end of tank use)	☐	☐
N. Weight of Bitumen Used (F + G - M)		
O. Weight of Mix Produced (Tons)		
P. Percent of Bitumen in Mix (N / O x 100)		

(*) Computed on reverse side

METER METHOD

Q. Applied Temperature of Bitumen 310
R. Weight Per Gallon (L) of Bitumen at Applied Temperature 7.867
S. Weight of Mix Produced (tons) 1256

☐ Meter Reads in Weight

T. Stop (tons) _____
U. Start (tons) _____
V. Net Weight _____

V / S x 100 = _____ % of Bitumen in Mix

☑ Meter reads in Gallons

T. Stop (Gallons) 18898
U. Start (Gallons) 0
V. Net Gallons 18898

R x V / S x 100 = 5.92 % of Bitumen in Mix

Figure 4

Field Density Determination of Asphalt Concrete by the Coring Method

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1. Scope:

This procedure is for determining the density of in place asphalt concrete pavement.

2. Apparatus:

2.1 Scale or balance having the capacity to weigh any sample which may be tested utilizing this procedure and readable to the nearest 0.1 gram. The scale or balance shall be equipped with a suitable suspension apparatus and holder to permit weighing the sample while suspended from the center of the scale pan of the weighing device.

2.2 Coring device capable of getting a minimum 4” (100 mm) diameter core from the pavement.

2.3 Diamond tipped blade cut off saw capable of sawing the 4" (100 mm) or larger core on the correct lift line without distortion and damage to the core.

2.4 The water bath for immersing the sample shall be equipped with an overflow outlet for maintaining a constant water level. An aquarium heater will suffice to control the temperature of the water bath at 77° ± 2° F (25° ± 1° C). The water bath must be large enough to allow the suspension apparatus holder to be covered with water at all times. The sample and suspension apparatus must be completely covered with water during weighing. The wire suspending the suspension apparatus shall be the smallest practical size to minimize any possible effects of a variable immersed length.

3. Procedure:

3.1 Randomly select 2 core sites per 1000 ton sublot and mark for the Contractor to core. Random core locations will be located within the pay factor asphalt mix being placed in the sublot. Core locations that fall within one foot (0.3 m) from the edge of the paving sublot shall be adjusted so that the core is taken one-foot (0.3 m) from the paving sublot edge line. Exercise care when removing the core from the pavement to prevent distortion or cracking. Label the core sample. 15

3.2 After removing the core, fill the hole in the pavement before the end of the next working day with mix and tamp to a density, which will be close to that of the surrounding pavement.

3.3 Transport the cores to the field laboratory site. Measure the core lift or lifts to the nearest .05 inch or 1/16" (1 mm) and record the measurements on a core dry back worksheet (DOT-8). Remove the pavement lift of interest from the core by using a cut off or masonry saw with a diamond tipped blade. Inspect

the core for damage. Record the sawed core thickness on line (A) of the core dry back worksheet (DOT-8).

3.4 Weigh the core and record the “Apparent dry weight” to the nearest 0.1 gram on line (B).

NOTE: Cores and pucks shall be weighed individually.

3.5 Immerse each core in water at 77° ± 2° F (25° ± 1° C) for 3 to 3.5 minutes and record the submersed weight to the nearest 0.1 gram on line (C). Maintain a constant level of water in the water bath at the overflow outlet through the entire test procedure.

3.6 Remove each core from the water and surface dry by blotting with a damp terry cloth towel and record the saturated surface-dry mass to the nearest 0.1 gram on line (D).

3.7 Calculate the volume of the core (D - C). Record on line (E).

NOTE: Cores have taken on water from the coring and sawing process. The following procedure must be used to get the water out of the cores.

3.8 Record the pan number on line (F).

3.9 Record the weight of the pan to the nearest 0.1 gram on line (G).

3.10 Place the core in the pan and place in an oven at 230 ± 9° F for 2 hours.

3.11 After the 2 hour period, record the weight of the core and the pan to the nearest 0.1 gram on the first time space on line (J).

3.12 Place the core and pan back in the oven and weigh at 1 hour intervals until the core has reached a constant weight. Constant weight is attained when the weight loss is within 0.1 percent of the apparent dry weight. Calculate the amount of allowable loss (B x .001) to the nearest 0.1 gram. Record on line (M).

3.13 After a constant weight has been attained, cool the pan and core to room temperature. Record the weight to the nearest 0.1 gram on line (N).

3.14 Determine the actual dry weight of the core (N - G). Record on line (H).

3.15 Determine the core bulk specific gravity (H / E) to the nearest 0.001. Record on line (I).

3.16 Determine the moisture in the core (D - H). Record on line (K).

3.17 Calculate the percent water absorbed by volume (K / E x 100) to the nearest 0.1 percent. Record on line (L).

Example for determining coring locations using QC/QA stratified random sampling procedure:

Each 1000 ton sublot is divided into two 500 ton sections of pavement (one core per 500 ton). Using a random number table generate two random numbers to determine the location for each core. The first random number determines the tonnage into the sublot where the core will be taken. The second random number determines the offset distance from centerline or paving edge line where the core will be taken. The station of the random tonnage can be taken from the asphalt checkers weigh tickets. Round the longitudinal distances to the nearest foot (0.3 m) and the offset distances to the nearest 0.5 foot (0.1 m).

The table shows a method using random numbers to determine the core stationing and offset distance from the beginning tonnage of the lot. The tonnage corresponds to the station, which is on the asphalt checkers weigh ticket. Note that the whole lot does not need to be completed prior to determining the coring locations for each individual core. 15

Core site	(Longitudinal location) Random #	Tonnage	Station	Distance from centerline
1A	0 + (500 x 0.57)	= 285 ton;	83+86	12 x 0.82 = 9.8' - 10' Lt.
1B	500 + (500 x 0.90)	= 950 ton;	97+21	12 x 0.34 = 4.1' - 4' Lt.
2A	1,000 + (500 x 0.47)	= 1235 ton;	102+90	12 x 0.68 = 8.2' - 8' Lt.
2B	1,500 + (500 x 0.07)	= 1535 ton;	108+88	12 x 0.24 = 2.9' - 3' Lt.
3A	2,000 + (500 x 0.87)	= 2435 ton;	126+94	12 x 0.42 = 5.0' - 5' Lt.
3B	2,500 + (500 x 0.90)	= 2950 ton;	137+17	12 x 0.88 = 10.6' - 10.5 Lt.
4A	3,000 + (500 x 0.88)	= 3440 ton;	146+95	12 x 0.97 = 11.6'* - 11' Lt.
4B	3,500 + (500 x 0.19)	= 3595 ton;	150+10	12 x 0.70 = 8.4' - 8.5' Lt.
5A	4,000 + (500 x 0.34)	= 4170 ton;	161+61	12 x 0.36 = 4.3' - 4.5' Lt.
5B	4,500 + (500 x 0.85)	= 4925 ton;	176+66	12 x 0.23 = 2.8' - 3' Lt.

* Any transverse distance closer than one (1) foot (0.3 m) from either paving edge line is moved to one (1) foot (0.3 m) from the edge of edge line.

The Contractor shall take cores with the quality assurance technician witnessing the sampling. The core shall be centered over the selected coring location and immediately transported to the QA Lab for testing. The cores shall be measured and then separated on the lift line by means of sawing with a diamond blade cut off or masonry saw being careful not to damage the core. The density of each core is determined and the average core density for each 1,000 ton sublot is then determined. The average of the lot's maximum specific gravity (Rice) tests is used to compute the lot average density.

4. Report:

4.1 Calculate the bulk specific gravity to the nearest 0.001.

$$\frac{A}{B - C}$$

A = Mass in grams of the dry core in air.

B = Mass in grams of the saturated surface dry core in air.

C = Mass in grams of the core submersed in water.

4.2 Calculate the core density percent of standard to the nearest 0.01 by dividing the core bulk specific gravity by the lot's average maximum theoretical specific gravity.

4.3 Calculate the average density percent of standard of the two cores to the nearest 0.1.

4.4 Report the results on a DOT-42Q.

5. References:

DOT-8
DOT-42Q

Sample ID 2188769
File No.

Core Dry Back Worksheet

DOT-8
9-14

PROJECT P 0020(107)394 COUNTY Hand PCN 027U

Tested By Tester, One CHECKED BY Tester , Two Test Date 04/21/2015

Material Type Class Q3R Hot Mixed Asphalt

Steps

1. Measure and record the thickness of the core and all lifts prior to sawing. (average of 4 locations around core)
2. Saw the lift to be tested from the core and record thickness (A).
3. Using SD 315, record the core apparent dry weight in air (B), the submersed weight under water (C), and the saturated surface dry weight in air(D) to the nearest 0.1 gram.
4. Calculate the volume of the core (E).
5. Record the pan number (F).
6. Weigh and record the weight of the pan to the nearest 0.1 gram (G).
7. Place the core and pan in an oven at 230° ± 9° F for 2 hours.
8. After the 2 hour period, record the weight of the core and the pan to the nearest 0.1gram. Record the time of weighing in column (J).
9. Place the core and pan back in the oven and weigh at 1 hour intervals until the core has reached a constant weight. Constant weight is attained when the weight loss is within 0.1 percent of the apparent dry weight. Calculate the amount of allowable loss (M).
10. After the above constant weight has been reached, cool the pan and core to room temperature, record the weight (N), and then determine the actual dry weight of the core (H).
11. Perform Calculations (I), (K), and (L).

Core measurement before sawing	5 13/16	5 1/2	5 3/4	4	4 1/4	3 1/2	5 1/4	2 3/4	3 5/8	3 1/2
Core Number	6A	6B	7A	7B	8A	8B	9A	9B	10A	10B
2 lift measured thickness	2 1/8	1 7/8	1 7/8	2 3/8	2 1/4	2 3/8	2 1/16	2 1/8	2 1/2	2
lift measured thickness										
lift measured thickness										

15

A.	Sawed core thickness:	2 1/8	1 7/8	1 7/8	2 3/8	2 1/4	2 1/2	2 1/16	2 1/8	2 3/8	2
B.	Apparent dry weight in air:	913.7	845.4	824.3	1102.3	1003.1	1167.6	1098.9	1024.2	1146.3	933.7
C.	Submersed weight in water:	506.0	464.8	456.6	610.2	556.6	659.7	620.1	573.6	649.3	527.3
D.	SSD weight in air:	914.7	846.3	824.7	1103.4	1007.7	1168.8	1099.7	1025.1	1147.6	934.8
E.	Volume of core: (D - C)	408.7	381.5	368.1	493.2	451.1	509.1	479.6	451.5	498.3	407.5
F.	Pan number:	4	5	6	1	2	3	4	5	6	1
G.	Weight of pan:	21.9	21.2	20.9	22.7	21.7	21.2	21.5	21.1	20.6	23.0
H.	Actual dry weight: (N - G)	909.6	844.5	820.3	1101.0	1004.9	1166.9	1098.7	1023.4	1145.8	933.0
I.	Core bulk specific gravity: (H / E)	2.226	2.214	2.228	2.232	2.228	2.292	2.291	2.267	2.299	2.290
K.	Moisture in core: (D - H)	5.1	1.8	4.4	2.4	2.8	1.9	1.0	1.7	1.8	1.8
L.	Percent water absorbed by volume: (K / E) * 100	1.2	.5	1.2	.5	.6	.4	.2	.4	.4	.4
M.	Maximum allowable weight loss in 1 hour: (B x 0.001)	0.9	0.8	0.8	1.1	1.0	1.2	1.1	1.0	1.1	0.9

	Time (J)	**Core Drying Weigh Back Area**									
After reaching constant weigh, allow the core & pan to cool to room temp. before weighing for the final time **(N)**	8:30 AM										
	10:30 AM	931.2	865.9	841.1							
	11:30 AM	931.5	865.4	840.8							
	9:15 AM										
	11:15 AM				1123.8	1026.5	1187.7	1119.8	1044.4	1166.4	
	12:15 PM				1123.6	1026.3	1187.6	1119.5	1044.1	1166.2	
	1:00 PM										
	3:00 PM										956.1
	4:00 PM										955.8
N. Weight of cooled core and pan		931.5	865.7	841.2	1123.7	1026.6	1188.1	1120.2	1044.5	1166.4	956.0

Figure 1

Sample ID | **Density Report - Bituminous Surfacing** | **DOT-42Q**

File No. | **9-14**

PROJECT P 0000(00)0 COUNTY Hand PCN 1234

Class and Type Class Q2 Hot Mixed Asphalt Lift 1 of 3 Thickness 2"

% Asphalt Binder 6.0 Actual Finished Width 16.2 Station 45+51

Tested By Jones, Jim Checked By Doe, Jane Date 09/20/2014

Specification Requirement - Percent of Standard Required 91 - 96

Lot No. 1 Lot Location Sta. Various patches

Core Site Length 24970 Lot Width 16 Quantity Represented 5000 tons

Theoretical Maximum Specific Gravity

Sublot No.	1	2	3	4	5				
Maximum Sp. Gr.	2.475	2.477	2.481	2.475	2.482				

Lot Average Maximum Specific Gravity (Standard) 2.478

In-Place Density Measurement

Percent of Standard = [(Core Bulk Specific Gravity / Lot Average Maximum Specific Gravity)] x 100

Core Sublot No.	Height	Rand Nbr	Cumulative Tonnage	Station for Core	Rand Nbr	Paving Width	Distance from C/L		Actual Dry Weight	Weight in Water	SSD Weight	Reheat Correction Factor	Core Bulk Specific Gravity	Percent of Standard	Average Percent Standard
1A	1.95	0.35	175	8+75	0.00	16.2	*1.0	LT	940.7	535.3	946.7		2.287	92.29	91.9
1B	2.05	0.33	665	33+90	0.53	16.2	8.5	LT	945.7	534.5	951.2		2.269	91.57	
2A	2.05	0.80	1400	69+20	0.55	16.2	9.0	LT	949.2	538.1	953.6		2.284	92.17	92.5
2B	2.10	0.20	1600	79+39	0.90	16.2	14.5	LT	959.1	545.3	962.5		2.299	92.78	
3A	2.05	0.92	2460	122+97	0.27	16.2	4.5	LT	952.6	538.1	958.4		2.266	91.44	91.6
3B	1.90	0.53	2765	139+26	0.42	16.2	6.5	LT	937.6	530.6	942.9		2.274	91.77	
4A	2.20	0.45	3225	161+85	0.29	16.2	4.5	LT	952.1	538.7	958.1		2.270	91.61	90.9
4B	1.95	0.50	3750	190+34	0.15	16.2	2.5	RT	942.7	526.2	947.8		2.236	90.23	
5A	2.00	0.01	4005	201+47	0.83	16.2	13.5	RT	943.7	535.6	948.1		2.288	92.33	92.1
5B	2.10	0.48	4740	238+41	0.55	16.2	9.0	LT	953.5	539.6	958.6		2.276	91.85	

Figure 2

South Dakota Asphalt Concrete Marshall Mix Design Procedure

1. Scope:

This standard practice for mix design evaluation uses aggregate and mixture properties to produce an asphalt concrete mix design formula that meets the specification requirements. This standard is for asphalt concrete hot mix that may or may not contain reclaimed asphalt pavement (RAP).

Contractors and consultants shall contact the Area Engineer when requesting to submit a mix design to the SDDOT Bituminous Mix Design Lab. Mix Designs will not be performed on samples that are not submitted through the Area Engineer and accompanied by the Area's properly filled out data sheet. The Engineer shall witness and/or take the sample. 50 percent of the plan quantity of material or 15,000 tons whichever is less shall be produced prior to material being submitted for a mix design. The Department may allow the Contractor to transport and deliver the RAP and aggregates samples for mix design and aggregate quality testing only when the Area office representative has sealed the samples with a tamper evident tag, with the DOT-1 attached. 15

2. Apparatus:

2.1 Humboldt slant foot (1 degree bevel) rotating base hammer is kept in the South Dakota Central Office Mix Design Lab. All other hammers will be compared/calibrated against this hammer. Slant foot rotating base hammers can be used if results can be obtained which are comparable to those obtained in the South Dakota Central Office Mix Design Lab. The South Dakota Mix Design Lab's hammer has been calibrated to a hand-operated hammer.

2.2 All related equipment and/or apparatus to perform parts or all of tests including: SD 108, SD 201, SD 202, SD 206, SD 208, SD 209, SD 210, SD 211, SD 212, SD 213, SD 214, SD 217, SD 220, SD 221, SD 301, SD 306, SD 309, SD 312, SD 313, SD 316, SD 318, AASHTO T 164, and AASHTO T 308.

3. Procedure:

3.1 Preparation of aggregates.

The average gradation of each individual aggregate fraction shall be used when combining to form an aggregate composite. This average shall come from testing done on the individual fraction/stockpile prior to the asphalt concrete mix design being performed.

NOTE: When recycled asphalt pavement (RAP) is allowed, it will not be included in meeting the total aggregate requirements set forth in the plans, Special Provisions, and/or Specification Book.

A. The following are the minimum number of size fractions to use when recombining the gradation of each individual stockpile. The 3/4" (19.0 mm), 1/2" (12.5 mm), 3/8" (9.5 mm), #4 (4.75 mm), #8 (2.36 mm), and all material passing the #8 (2.36) are the minimum number of sizes required to be used when recombining the stockpiles.

B. Bulk specific gravity of the aggregate (G_{sb}) is determined by SD 209, and SD 210 for each fraction and combining to form a composite total G_{sb} and a - #4 G_{sb}. SDDOT Bituminous Office will determine both the total G_{sb} and the + #4 G_{sb} and - #4 G_{sb} on the total composite and not on individual fractions.

NOTE: When RAP is included in the plans, determine the asphalt binder content by conducting at least two extractions or ignition oven tests (Only if a correction factor is known). Determine the RAP aggregate gradation from the extractions (AASHTO T 164) or ignition oven tests (AASHTO T 308) and show the average RAP virgin aggregate only gradation on the mix design sheet. When 20 percent or less RAP is used in the mix design, use the G_{sb} from the old RAP mix design for the RAP virgin mineral aggregate G_{sb} or by conducting G_{sb} **tests on the extracted or ignition oven aggregate samples using SD 209 and SD 210. If more than 20 percent RAP is used the G_{sb} shall be determined by conducting** G_{sb} **tests on the extracted or ignition oven aggregate samples using SD 209 and SD 210.** 15

C. Determine consensus virgin aggregate properties for the composite gradation including:

Crushed particles (SD 211), fine aggregate angularity (SD 217), flat & elongated particles (SD 212), and sand equivalent (SD 221). Also, determine source virgin aggregate properties for lightweight particles (SD 208, SD 214), sodium sulfate soundness (SD 220) (Optional), and Los Angeles abrasion loss (AASHTO T 96) (Optional), if have previous tests from pit history.

3.2 Determination of mixing and compacting temperatures.

A. Performance graded binder (PG); mixing temperature shall be 300° ± 10°F (147° ± 5° C).

B. Performance graded binder (PG 58-28, PG 64-22); compaction temperature shall be 270° ±5° F (132° ± 3° C); (PG 58-34, PG 64-28) compaction temperature shall be 275° ±5° F. (134° ± 3° C); (PG 64-34, PG 70-28) compaction temperature shall be 280° ±5° F. (136° ± 3° C)

3.3 Preparation of mixtures.

A. Adjust the laboratory sample gradations to meet the average stockpile gradations down to the #8 (2.36 mm) and recalculate the laboratory - #8 (2.36 mm) gradation to reflect the changes. Weigh into pans material from each fraction to form a composite. Heat aggregate composite samples in an oven overnight or for a minimum of four hours to a temperature not exceeding 50° F (10°C) above the mixing temperature.

NOTE: If recycled asphalt pavement is allowed, heat the RAP in an individual oven for a period of no more than two hours at 230° ± 5° F (110° ± 3° C) and add soon after heating to the mixture of aggregate and binder. Also, when RAP is added, care must be taken to thoroughly mix all components.

B. Following mixing immediately put the mixture in a covered container in an oven maintained at the compaction temperature for a period of two hours. At least three sets of specimens are to be made at 0.5% oil increments. This will include 3 Marshall samples made using SD 313. Two G_{mm} (SD 312) samples are to be made at the center oil increment. The oil content will be based on the total weight of the bituminous mixture.

NOTE: This total weight of mixture would include RAP if it is allowed in the mixture. An example of combining virgin aggregate, RAP, lime, and 4.5% virgin binder is as follows for a total sample of 4750 grams:

Virgin aggregate = 3591.0 g (80%) + RAP = 897.7 g (20%) + 47.5 g (1.00%) hydrated lime + 213.8 g (4.50%) virgin binder = 4750.0 g. The RAP contains 6.00% binder content from the average of two extractions. 53.9 g is from the RAP binder. The total asphalt binder content of the sample is (213.8 g + 53.9 g) / 4750 x 100 = 5.64%. 4.50% added from the new virgin binder is a contribution of 79.9% to the total binder content and 1.13% from the RAP binder is a contribution of 20.1% to the total binder content. 15

3.4 Compaction of specimens.

Combining elements of 3.1, 3.2 and 3.3 compact the specimens with a Marshall hammer using SD 313. The number of Marshall blows is included in the plans, plan notes, Standard Specification book and/or Special Provision for a specific project. Determine the bulk specific gravity (G_{mb}) of each of the compacted specimens in accordance with SD 313.

3.5 Determine the air voids (V_a), voids in the mineral aggregate (VMA), voids filled with asphalt (VFA), dust to effective binder ratio, Marshall stability, and

Marshall flow for each binder percent increment in accordance with the formulas and calculations in Asphalt Institute MS-2 or SD 318.

4. Report:

4.1 The Contractor's material and data submitted to the SD DOT Mix Design Lab in Pierre must meet all of the specifications and requirements as shown in the plans, plan notes, Standard Specifications book and the Special Provision Regarding quality control/quality assurance specifications that apply to the project.

4.2 The Contractor's mix design submittal will include the source of the binder, bin splits selected to use along with the legal pit descriptions of all the materials, average gradation of the stockpiles, and the recommended JMF gradation values to be used for the mix design.

4.3 The SD DOT Mix Design Lab will complete the mix design submitted by the Contractor/Area and conduct all necessary mix design quality tests required on the mineral aggregate, RAP, and asphalt concrete mixture. When the mix design is completed by the Department's Bituminous Mix Design Lab, an approved mix design report (DOT-64) will be provided to the Area Engineer and the Contractor prior to production. 15

5. References:

AASHTO T 245
Listed in 2.2 above

Procedure for Evaluating Quality Control Test Results of Aggregate Gradations, Theoretical Maximum Specific Gravity, and Bulk Specific Gravity of Asphalt Concrete Mixes

1. Scope:

To provide a procedure for comparing the Contractor's quality control (QC) test results with the Department of Transportation's quality assurance (QA) test results for the lot. This procedure is for aggregate gradation and specific gravities of hot mix asphalt concrete and should be used by Area personnel to determine if the QC and QA samples are similar or dissimilar. The similar/dissimilar test should be used to verify that sampling and testing methods are giving comparable test results for the lot tested.

2. Procedure:

2.1 Immediately after the completion of a lot, determine the average of the QC test results for that individual lot. Determine the average percent passing for each sieve size and the average of the theoretical maximum (Rice) and bulk (Marshall) specific gravities of the hot mix asphalt concrete.

2.2 Determine the range (R) of the QC samples from the lot by subtracting the smallest test value from the largest value. The range will be calculated for each sieve size, theoretical maximum (Rice) and bulk (Marshall) specific gravities.

2.3 Determine the upper and lower interval (I) of the QC test results by using the following equation:

$$I = \text{Average} \pm \text{Constant} \times \text{Range}$$

Number of QC samples used in calculating average	Constant
9	0.97
8	1.05
7	1.17
6	1.33
5	1.61

2.4 Compare the quality assurance sample tests with the calculated interval (I). A comparison will be made on each sieve size. The comparison will also be made for the theoretical maximum and bulk specific gravities.

2.5 Determine if the results are similar or dissimilar. If all the test results of the QA sample coincide with, or lie between, the upper and lower limits of their interval, the QC samples will be considered similar to the QA sample. If the QA sample has any sieve size or specific gravity in which a result does not coincide with or lie between the upper and lower limits of their interval, the QC samples will be considered dissimilar to the QA sample.

2.6 If the results are dissimilar, action must be taken to determine the reason for the dissimilar results. Review the QA and QC sampling procedures. Review the QA and QC testing procedures. Check scales and all other testing equipment. Review computations and the reporting procedure. Perform any additional investigation that may clarify the reason for the dissimilarity. The Region Materials Engineer should be involved in the review and investigation. Region Materials IA test results may be used to help identify the reason for the dissimilar test result.

2.7 Perform additional testing if any test result is found to be dissimilar until the reason for the dissimilar test result is found and documented. Document the results of the additional testing and findings in the field diary and the similar/dissimilar worksheet.

3. Report:

Report the results on the similar/dissimilar worksheet. Report the similarity as (Yes) similar or (No) dissimilar on the DOT 3 or DOT 42QA and include the signature of the individual determining if the results are similar or dissimilar. The following computer spread sheet can be used for determining similar/dissimilar results. The spread sheet is available from the SDDOT Bituminous Engineer or from the DOT U drive (U:\ms\Qcqa). The spreadsheet will be available in the MS&T system to record the results.

4. References:

Similar/dissimilar worksheet

COMPARISON OF QUALITY CONTROL AND QUALITY ASSURANCE TESTING

LOT NUMBER _____

PROJECT P0014(126)303 COUNTY Haakon PCN 1234

DATE 09/06/2014 TESTED BY Thomas G. Grannes

	Percent passing the control sieves							Hot mix asphalt specific gravity	
QC test No.	3/4"	1/2"	#4	#8	#16	#40	#200	Max. Theoretical (Rice)	Bulk (Marshall)
11	100	89	70	57	41	22	4.8	2.410	2.333
12	100	91	71	57	42	23	5.5	2.413	2.333
13	100	91	72	58	43	23	5.6	2.409	2.331
14	100	92	72	55	39	21	5.0	2.409	2.339
15	100	91	70	54	39	21	5.5	2.413	2.335
Average	100.0	90.8	71.0	56.2	40.8	22.0	5.3	2.411	2.334
Range (R)	0.0	3.0	2.0	4.0	4.0	2.0	0.8	0.004	0.008
Constant	1.61	1.61	1.61	1.61	1.61	1.61	1.61	1.61	1.61
Interval (I)									
upper	100	96	74	63	47	25	6.6	2.417	2.347
lower	100	86	68	50	34	19	4.0	2.404	2.321
QA test result	100	93	72	59	45	25	5.8	2.405	2.339
Similar/ Dissimilar	similar	similar	similar	similar	similar	similar	similar	similar	similar

Comments: _____

Figure 1

Method of Test for Density and Air Voids of Asphalt Concrete by the Gyratory Method

1. Scope:

This test is to determine the density and air void level of asphalt concrete mix by using the gyratory compactor.

2. Apparatus:

2.1 Gyratory compactor conforming to the requirements of AASHTO T 312.

2.2 Gyratory molds & plates conforming to the requirements of AASHTO T 312.

2.3 Thermometers, dial type, armored glass, or digital with a range of 50° to 400^oF (10° to 204^oC) with a sensitivity of 5^oF (2.8^oC).

2.4 Thermometer sensitive to 0.5^oF (0.2^oC) and readable to 1^oF ($05.^oC$).

2.5 Scale or balance having the capacity to weigh any sample which may be tested utilizing this procedure, accurate and readable to the nearest 0.1 gram. The scale or balance shall be equipped with a suitable suspension apparatus and holder to permit weighing the sample while suspended from the center of the scale pan of the weighing device.

2.6 Mechanical convection oven with a minimum chamber volume of 5.0 cubic feet (0.142 cubic meter) capable of heating to 350^oF (177^oC).

2.7 Flat bottom metal pan, flat bottom scoop, containers, large mixing spoon or small trowel, large spatula, gloves, paper disks, WD 40 lubricant, and grease.

2.8 Water Bath with an overflow outlet for maintaining a constant water level. An aquarium heater will suffice to control the temperature of the water bath at $77^o \pm 2^oF$ ($25^o \pm 1^oC$). The water bath must be large enough to allow the suspension apparatus holder to be covered with water at all times. The sample and suspension apparatus must be completely covered with water during weighing. The wire suspension apparatus shall be the smallest practical size to minimize any possible effect of a variable immersed length.

3. Procedure:

3.1 Sampling uncompacted mix.

A. Material for the gyratory testing shall be obtained from the same sample as will be used for SD 312 but a larger sample must be obtained.

B. Take approximately 180 to 200 lbs. (82 to 91 kg) of hot mix for the laboratory density determination, 270-300 pounds (123-136 kg) when IA testing is required.

C. Transport the sample in a pail or box that is insulated or protected to help retain heat.

D. Place the hot mix in a clean pan where there will be neither loss of material nor the addition of foreign matter. Place the pan and material in an oven maintained at or slightly above the required compaction temperature.

3.2 Gyratory machine preparation.

NOTE: Before operating the gyratory, it's important to make sure that it's ready for operation. The steps below need to be completed prior to operating the Pine Brovold portable (AFGB1A) gyratory. Other gyratory compactors can be used and must be operated according to the manufacturer's recommendations.

A. Make sure the gyratory compactor has been calibrated to an internal angle of (1.16 ± 0.02°) or if using a Pine RAM calibration device, calibrated to a cold internal angle of (1.19 ± 0.03°) and the calibration records are available. SD DOT machines are calibrated by the SD DOT Central Lab.

B. Make sure that the gyratory is properly lubricated. There are a number of spots that require a regular application of grease, including:

a. The ring at the top of the cylinder which controls the angle of the gyration. This should be done prior to running a set of three gyratories.

b. The ram head on the top of the gyratory. Grease the outer portion of the ram head prior to running a set of three gyratories. This head causes the cylinder to gyrate.

c. The ram pressure head at the bottom of the cylinder. This is the head that pushes up the plate. This should get a coating of grease prior to running <u>every</u> gyratory, before the mold is put in place.

d. Once the material is loaded and leveled, put in the paper disk and top plate and grease the top of the plate. This is to be done on <u>every</u> gyratory.

e. The spherical bearing that contacts the bottom of the mold. The spherical bearing is located below the ram pressure plate. The best way to lubricate it is to use a brush with grease. This should be done once every three gyratories.

C. The gyratory mold needs to be cleaned inside and out with WD 40 at the end of each day to avoid HMA buildup. This is easiest when the molds are hot.

D. Turn the machine on and wait for it to run through the startup routine.

E. Make sure all the "Set Points" on the machine are correct. This is done by going into the "Setup" program on the machine. Most of these, like the dwell and the pressure, are constant and shouldn't require adjustment. However, the number of gyrations will need to be changed when switching from the design gyration number to the maximum gyration number. This is done in the "Set Gyrations" category at the top of the "Setup" page. <u>The gyrations are specified in the plans and shown on the mix design DOT-64 form</u>. To change any of the settings, using the arrow keys scroll the cursor down to the desired attribute. Type in the number you want and press ↵ "Enter".

F. Make sure that all pertinent points are lubricated (See gyratory machine preparation, step B)

3.3 Laboratory density determination.

A. Preheat molds, a flat bottom scoop and a trowel or spatula in an oven to the established mix compaction temperature recommended on the job mix formula (JMF) from the DOT 64 mix design form.

B. Obtain by quartering or by using a heated flat bottom scoop a representative sample from the pan of material used in SD 312 Section 3.3 B. The material placed in the mold shall make a specimen 4.5 ± 0.2 inches (115 ± 5 mm) high and 6 inches (150 mm) in diameter (Approximately 4500-4800 grams of material) and be compacted at established mix design compaction temperature on the JMF.

If the gyratory specimen doesn't compact to a height of 115 mm ± 5 mm use the following equation to correct the amount of material to put in the mold.

A = Actual weight of the specimen (grams)

$$(115 \times A) \div B$$

B = Actual height of the specimen (mm)

15

C. Heat the hot mix so that compaction takes place when the mix is at the established mix design compaction temperature recommended on the JMF. Thermometers shall be calibrated and checked often to insure accurate temperature measurements.

D. Once the hot mix, tools and mold has reached the correct temperature recommended on the JMF prepare to make a specimen.

E. Apply grease to bottom ram head. Place a cylinder plate in the bottom of the mold with the beveled end toward the bottom that is heated to compaction temp prior to being placed in the gyratory machine. Put a paper disk in on top of the plate.

F. Place the mold into the gyratory compactor using the tongs, lowering it into the compactor until it reaches bottom, and then rotate the mold clockwise until it stops. Put the funnel on the top of the mold, and load the mold with HMA mix in one lift (Usually about 4500-4700 grams of mix), which should only be loaded at the proper mix compaction temperature. Remove funnel, lightly level out the mix with spatula and put paper disk on top. Do not pack the mix. The temperature should be within ± 5° of the mix design compaction temperature shown on the DOT-64 JMF.

G. Place the plate on top of mix, with the beveled edge away from the mix, grease the top of the plate and swing the gyratory head on top of the cylinder and lower the head into place. Lock the gyratory head onto the machine using the three levers.

H. Press “Run” on the machine to get into the “Run Mode”, and then press “Start”, which will begin the process. As the gyratory is running, keep an eye on the gyrations, pressure, and angle. The gyrations are as specified in the Special Provision or plan notes. The pressure should be 600 ± 18 kPa. If the angle goes out (External angle range from calibration) make sure the molds are clean on the outside and the mold and material is at the correct compaction temperature. Call the Central Materials Lab on a SDDOT gyratory before making any adjustments to the machine angle.

I. Once the specified number of gyrations is complete and the ram head returned to its original position, then loosen the three levers on the side of the machine, lift the gyratory head and swing it out of the way.

J. Place the funnel on the top of the machine, press “Unload” twice, and as the gyratory breaks free of the mold, remove the funnel quickly to prevent injury to the gyratory specimen.

K. Once the specimen is completely extruded, remove the top paper disk and carefully remove the specimen from the machine, inverting it before you set it down to allow removal of the bottom paper disk. Set the specimen in front of a fan to cool on a smooth flat surface and cool to room temperature.

L. Press the “Main Menu” button, and then press “Result”. This will bring up a menu with “Select”, “Print”, and “Send”. Press “Print”, and the machine will ask you if you want to “Print Report” - “Yes”. Press “Enter” to print.

M. Once the gyratory is unloaded and results printed, grease the machine as needed and ready it for the next test.

N. Make sure to label the gyratory correctly and label the printout sheet the same way.

O. After the specimens have cooled to room temperature, begin bulk specific gravity procedure as outlined below in the report section.

P. Make sure the required number of gyratory specimens have been made. 15

* For more detailed instructions or to solve any problems that might arise, contact the Central Materials lab (605 773-6994) if problem is not resolved.

4. Report:

Calculations to be completed on the DOT-86:

- G_{mm} - The maximum specific gravity will be determined according to SD 312 to the nearest 0.001.

- ***Put in the plant settings values until the actual cutoff values are obtained.

- % binder P_b - Binder content calculation value determined on DOT-89 to the nearest 0.1 percent.

  If it is a RAP (Recycled asphalt pavement) mix, values off of the job mix formula (JMF) on DOT 64 are needed (Just below the gradation chart):

  Estimated total binder by weight of total mix - Virgin binder recommended by weight of total mix = RAP binder content

  The obtained RAP binder content needs to be added to the binder content that was determined on the DOT 89 form to take into account the oil that is being added to the mix by the RAP and recorded to the nearest 0.1 percent.

- G_{sb} – Aggregate Composite G_{sb}, found on the DOT-64 mix design JMF reported to the nearest 0.001.

- Binder G_b – Designated on the oil tickets from the supplier reported to the nearest 0.001.

- Dust (- #200) – On the gradation DOT-69 form total/ combined - #200 or from the (Acc % passing #200 sieve rounded) column if a + #4 sample was not washed reported to the nearest 0.1 percent.

- Lime – Lime content determination from the DOT 33Q reported to the nearest 0.01 percent.

- Add the dust and the lime together and report to the nearest 0.1 percent.

- Obtain the number of gyrations needed for the type of mix design from gyratory QC/QA Special Provision or project plan notes (Field gyration values will be shown on the DOT-64 mix design form).

<u>Complete the following calculations in order as follows:</u>

1. Effective specific gravity of the mineral aggregate (G_{se}).

$$Gse = \frac{100 - Pb}{\frac{100}{Gmm} - \frac{Pb}{Gb}}$$

(Report to nearest 0.001)

2. Percent asphalt absorption (P_{ba}).

$$Pba = 100 \times \left[\frac{Gse - Gsb}{Gse \times Gsb} \right] \times Gb$$

(Report to nearest 0.01 %)

3. Percent effecting asphalt content (P_{be}).

$$Pbe = Pb - \frac{Pba \times Ps}{100}$$

(Report to nearest 0.1 %)

4. Bulk specific gravity measured ($G_{mb\ meas.}$) – Gyratory specimen G_{mb} weights determined using SD 313 procedure:

   Weight in air, weight in water, SSD weight.

$$Gmb_{(measured)} = \frac{\text{Weight in Air}}{\text{SSD Weight - Weight in Water}}$$

(Report to nearest 0.001)

5. Bulk specific gravity calculated (G_{mb}).

$$Gmb\ x = \frac{Gmb\ (measured) \times height\ (measured)}{height\ x}$$

Gmb x = calculation for Gmb bulk specific gravity of compacted mix at any given gyration point in the compaction process when x is number of gyrations such as at Nini or Ndes

6. Make sure that the Rice specific gravity (G_{mm}) testing is completed using SD 312. Average the two Rice G_{mm} values together that were obtained and record to the nearest 0.001.

7. Calculate average G_{mb}.

Get the average of both N_{ini} G_{mb} (N_{des}) calculated values.
Get the average of both N_{des} G_{mb} measured values.
Get the one N_{max} G_{mb} measured value.
(Report all to nearest 0.001)

8. % of Rice specific gravity (G_{mm}).

$$\% \text{ of Gmm} = \frac{\text{Gmb}}{\text{Gmm}} \times 100$$

(Report to nearest 0.1 %)

9. % air voids.

$$\text{Va} = \left(\frac{\text{Gmm} - \text{Gmb}}{\text{Gmm}} \right) \times 100$$

(Report to the nearest 0.1 %)

10. % VMA – Voids in mineral aggregate.

$$\text{VMA} = 100 - \frac{\text{Gmb} \times \text{Ps}}{\text{Gsb}}$$

(Report to the nearest 0.1 %)

11. % VFA – Voids filled with asphalt.

$$\text{VFA} = \left(\frac{\text{VMA} - \text{Va}}{\text{VMA}} \right) \times 100$$

(Report to the nearest %)

12. Dust to binder ratio.

$$\text{Dust to binder ratio} = \frac{(\text{\% - \#200 material} + \text{\% hydrated lime})}{\text{Pbe}}$$

(Report to the nearest 0.1)

Do Not forget to compare calculated values with the QC/QA Special Provision specification requirements.

5. References

AASHTO R 35
AASHTO T 312
ANSI B46.1 (Note 2)
SD 312
SD 313
DOT-33Q
DOT-64
DOT-69
DOT-89

Sample ID
File No.

Gyratory Specific Gravity

DOT-86
9-14

PROJECT P 0000(00)0 COUNTY Hand PCN 01ST

Field # QC01/QA01 Date Sampled 09/01/2014 Date Tested 09/01/2014

Sampled by Jones, Jim Tested by Jones, Jim Checked By Doe, Jane

Material Type Class Q2 Hot Mix Asphalt Ticket # 125869

Source Pete Lien & Sons, Birdsall S & G Lift 1 of 1

Lot # 1 Sublot # 1

Mix Temp 270 Offset 6' Rt. ESAL's Q2

Daily Ton 542.27 Total Ton 496 Oil Type Cenex PG 58-28

			No. of Gyrations		
% binder Pb	4.5	N initial	6	Gse	2.703
Gsb	2.650	N design	50	Pba	0.76
binder Gb	1.030	N max	75	Pbe	3.8
dust (-#200)	4.6				
lime	0.60				
dust (-#200) + lime	5.2				

15

	Spec. A (Ndes)		Spec. B (Ndes)		Spec. M (Nmax)		
	@ N ini	@ N des	@ N ini	@ N des	@ N ini	@ N des	@ N max
a) Height, mm	126.9	116.0	126.9	116.0	127.0	115.9	114.3
b) Weight in air		4858.5		4864.3			4856.4
c) Weight in water		2836.4		2839.0			2860.4
d) SSD weight		4863.3		4867.5			4859.2
e) Bulk SpGr meas b /(d-c)		2.397		2.398			2.430
f) Bulk SpGr calc (Gmb)	2.191		2.192		2.187	2.396	

	Gmm # 1	Gmm # 2
Weight of sample in air	1510.5	1511.1
Weight of canister + water	1376.0	1376.0
Weight of canister + water + sample	2286.8	2287.2
Temperature of the water	77F (25.0C)	77F (25.0C)
Water correction factor	1.0000	1.0000
Rice SpGr (Gmm)	2.519	2.519

Average Maximum SpGr (Gmm) 2.519

Average Gmb	2.192	2.398	2.430
% of Rice SpGr (Gmm)	87.0	95.2	96.5

% Air Voids (VA)	4.8	**% VMA**	13.6	**% VFA**	65	**Dust to binder ratio**	1.4

Comments:

Figure 1

South Dakota Asphalt Concrete Gyratory Mix Design Procedure

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1. Scope:

This standard practice for mix design evaluation uses aggregate and mixture properties to produce an asphalt concrete mix design formula that meets the specification requirements. This standard is for asphalt concrete hot mix that may or may not contain reclaimed asphalt pavement (RAP).

2. Apparatus:

2.1 Gyratory compactor and support equipment (Including height recording device, specimen molds, ram heads, and mold bottoms) meeting requirements of AASHTO T 312.

2.2 All related equipment and/or apparatus to perform parts or all of tests including: SD 108, SD 201, SD 202, SD 206, SD 208, SD 209, SD 210, SD 211, SD 212, SD 213, SD 214, SD 217, SD 220, SD 221, SD 301, SD 306, SD 309, SD 312, SD 313, SD 316, SD 318, SD 319, AASHTO T 164, AASHTO T 308, & AASHTO T 312. | 15

3. Procedure:

3.1 Preparation of aggregates.

The average gradation of each individual aggregate fraction shall be used when combining to form an aggregate composite. This average shall come from testing done on the individual fraction/stockpile prior to the asphalt concrete mix design being performed.

NOTE: When recycled asphalt pavement (RAP) is allowed, it will not be included in meeting the total aggregate requirements set forth in the plans, Special Provisions, and/or Specification book.

A. The following are the minimum number of size fractions to use when recombining the gradation of each individual stockpile. The 3/4" (19.0 mm), 1/2" (12.5 mm), 3/8" (9.5 mm), #4 (4.75 mm), #8 (2.36 mm), and all material passing the #8 (2.36) are the minimum number of sizes required to be used when recombining the stockpiles.

B. Bulk specific gravity of the aggregate (G_{sb}) is determined by SD 209, and SD 210 for each fraction and combining to form a composite total G_{sb} and a - #4 Gsb. SDDOT Bituminous Office will determine both the total G_{sb} and the - #4 G_{sb} on the total composite and not on individual fractions.

NOTE: When RAP is included in the plans, determine the asphalt binder content by conducting at least two extractions or ignition oven tests (Only if a correction factor is known). Determine the RAP aggregate gradation from the extractions (AASHTO T 164) or ignition oven tests (AASHTO T 308) and show the average RAP virgin aggregate only gradation on the mix design sheet. When 20 percent or less RAP is used in the mix design, use the G_{sb} from the old RAP mix design for the RAP virgin mineral aggregate G_{sb} or by conducting G_{sb} tests on the extracted or ignition oven aggregate samples using SD 209 and SD 210. If more than 20 percent RAP is used to determine the RAP aggregate G_{sb} by conducting G_{sb} tests on the extracted or ignition aggregate samples using SD 209 and SD 210. 15

C. Determine consensus virgin aggregate properties for the composite gradation including:

Crushed particles (SD 211), fine aggregate Angularity (SD 217), flat and elongated particles (SD 212), and sand equivalent (SD 221). Also, determine source virgin aggregate properties for lightweight particles (SD 208, SD 214), sodium sulfate soundness (SD 220) (Optional), and Los Angeles abrasion loss (AASHTO T 96) (Optional), if have previous tests from pit history.

3.2 Determination of mixing and compacting temperatures.

A. Performance graded binder (PG); mixing temperature shall be 300° ± 10° F. (147° ± 5° C)

B. Performance graded binder (PG 58-28, PG 64-22); compaction temperature shall be 270° ± 5° F (132° ± 3° C); (PG 58-34, PG 64-28) compaction temperature shall be 275° ±5° F. (134° ± 3° C); (PG 64-34, PG 70-28) compaction temperature shall be 280° ± 5° F. (136° ± 3° C)

3.3 Preparation of mixtures.

A. Adjust the laboratory sample gradations to meet the average stockpile gradations down to the #8 (2.36 mm) and recalculate the laboratory - #8 (2.36 mm) gradation to reflect the changes. Weigh into pans material from each fraction to form a composite. Heat aggregate composite samples in an oven overnight or for a minimum of four hours to a temperature not exceeding 50° F (10°C) above the mixing temperature.

NOTE: If recycled asphalt pavement is allowed, heat the RAP in an individual oven for a period of no more than two hours at 230° ± 5° F (110° ± 3° C) and add soon after heating to the mixture of aggregate and binder. Also, when RAP is added, care must be taken to thoroughly mix all components.

B. Following mixing immediately put the mixture in a covered container in an oven maintained at the compaction temperature for a period of two hours. At least three sets of specimens are to be made at 0.5% oil increments. This will include (2) G_{mb} samples at N_{des} and (1) G_{mb} sample at N_{max} using SD 318. Two G_{mm} (SD 312) samples are to be made at the center oil increment. The oil content will be based on the total weight of the bituminous mixture.

NOTE: This total weight of mixture would include RAP if it is allowed in the mixture and should make a gyratory specimen to the required height of 115 ± 5 mm. An example of combining virgin aggregate, RAP, lime, and virgin binder is as follows:

If 4750 grams is the target weight; hydrated lime at 1.00% = 47.5 g, virgin aggregate = 3598.6 g (80%), RAP = 899.6 g (20%) and 4.3% new binder = 204.3 g for a total of 4750 grams. The RAP contains 6.00% binder content from the average of the two extraction tests. 54.0 g of binder is coming from the RAP. 54.0 g + 204.3 g = 258.3 g of total binder in the sample for a total asphalt content of 258.3 / 4750 x 100 = 5.44%. The old asphalt binder at 1.14% is contributing 20.9% to the total binder content with a 79.1% contribution to the total binder content from the new binder at 4.30% added. 15

3.4 Compaction of specimens.

Combining elements of 3.1, 3.2, and 3.3 referenced from above, compact the specimens with a gyratory compactor at the gyration levels for N_{des}, and N_{max} and calculate the N_{ini} using SD 318. The specified gyration levels are included in the plans, plan notes, Standard Specification book and/or Special Provision for a specific project. Determine the bulk specific gravity (G_{mb}) of each of the compacted specimens in accordance with SD 313.

3.5 Determine the air voids (V_a), voids in the mineral aggregate (VMA), voids filled with asphalt (VFA), and dust to effective binder for each binder percent increment in accordance with SD 318. Also include the percent of G_{mm} at N_{ini} and N_{max} for each binder increment.

4. Report:

4.1 Contractor and consultants can use and submit mix design data and calculations on their own forms and charts as long as all pertinent mix design data is included with the material sent to the SD DOT Mix Design Lab. Aggregate stockpile gradation averages including the legal pit descriptions for the materials, and the + #4 and - #4 bulk specific gravity of each individual stockpile are data which needs to be included with the mix design submittal. The asphalt binder supplier and grade of binder to be used shall be listed. A completed DOT 48 form for moisture sensitivity (SD 309) shall also be included with the mix design data submitted (If not adding 1.00% hydrated lime) The Contractor's material and data submitted to the SD DOT Mix Design Lab in Pierre must meet all of the specifications and requirements as shown in the plans, plan notes, Standard Specifications book and the Special Provision regarding quality control/quality assurance specifications that apply to the project.

4.2 The Contractor's mix design submittal will include a single percentage of binder recommended, the source of the binder, bin splits selected to use along with the legal pit descriptions of all the materials, average gradation of the stockpiles, and the recommended JMF to be used for the mix design along with a signed JMF mix design sheet including all the required mix design test results.

4.3 The SD DOT Mix Design Lab will verify the mix design submitted by the Contractor/Area and conduct all necessary mix design quality tests required on the mineral aggregate, RAP, and asphalt concrete mixture. When the mix design verification is completed by the Department's Bituminous Mix Design Lab, an approved mix design report (DOT-64) will be provided to the Area Engineer and the Contractor prior to production. | 15

5. References

Listed in 2.2 above

Lime Mill Certification

---

1. Scope:

Mills furnishing Lime to South Dakota Department of Transportation projects shall be classified by the Chief Materials and Surfacing Engineer as Certified mills or non-certified mills in accordance with this procedure.

2. Apparatus:

2.1 Dipper, hand scoop, sampling tube, shovel or any satisfactory sampling device.

2.2 Sample cans, 4 lb. (2 kg.)

2.3 Miscellaneous. Brooms, brushes and a funnel.

3. Procedure:

3.1 Certified mill.

A. Basis for qualification.

(1) A certified mill is any mill that furnishes lime on a relatively continuous basis or a volume sufficient to justify the sampling and testing necessary to qualify and maintain a "Certified" status. The mill shall:

(a) Have an acceptable quality history based upon the manufacturer's data or Department of Transportation test records, as required by the Chief Materials and Surfacing Engineer.

(b) Maintain mill laboratory facilities which are periodically inspected by an authorized representative of the Office of Materials and Surfacing.

(c) As production warrants, and/or as directed by the Chief Materials and Surfacing Engineer, at the beginning of each month, make available a minimum of one random composite sample of material produced during the previous month along with copies of results of tests made by the plant since the last sample. This sample will be collected from the mill and tested by the Department.

Additional samples may be requested as deemed necessary, to determine the quality of lime being produced.

(d) In addition to making a sample available as specified in (c) above, the certified mill shall also furnish the Central Testing Laboratory weekly certified analysis of its product, reporting the following:

(1) Percent calcium and magnesium oxide.

(2) Percent free water or mechanical moisture.

(3) Accumulative percentage, by weight of residue retained on the #6 (3.35 mm), #20 (0.850 mm) and #100 (0.150 mm) sieves.

(e) When tests confirm non-specification material or product, the certified plant shall be notified of the deviation and may be removed from the certified list until the deviation and cause have been corrected.

3.2 Non-certified mills.

A. Basis for qualification.

(1) Any mill not currently identified as a certified mill shall be a non-certified mill.

(a) The manufacturer and appropriate Department of Transportation personnel will be notified by the Office of Materials and Surfacing when a mill is certified and when there is a change in a mill's certification.

3.3 Lime delivery.

A. From a certified mill.

(1) Two copies of a Certificate of Compliance shall accompany each conveyance to the project.

(2) No sampling will be required on the project.

B. From a non-certified mill.

(1) Two copies of a properly executed Certificate of Compliance shall be submitted by the manufacturer for each conveyance, prior to or at the time of delivery to the project. Information required by the certificate may be included as part of the

standard bill of lading, loading or weight ticket, or shipping invoice.

The original shall be placed in the project file. The copy shall be forwarded to the Office of Materials and Surfacing.

(2) A sample consisting of two 4-lb. (2 kg) cans shall be obtained and submitted to the Central Testing Laboratory for testing for each conveyance of lime received on the project. The sample shall be obtained from the loading or unloading spout/hose.

Seal sample containers against contamination from air or moisture immediately after filling. Submit the samples and a Certificate of Compliance as required, to the Central Testing Laboratory.

(3) Shipments of lime received from a non-certified mill without the required certification shall not be used until the Engineer in charge of the project has obtained the documents or has received satisfactory test results on the samples.

3.4 Safety precautions.

A. Although lime (Calcium hydroxide) does not normally cause severe burns, care should be exercised to avoid excessive material contact with lungs, eyes and the exposed areas of the body.

4. Report:

Report the test results.

5. References:

None.

SOUTH DAKOTA DEPARTMENT OF TRANSPORTATION
CERTIFICATE OF COMPLIANCE
LIME
FILE # _____

DOT-60
9-14

PROJECT_____COUNTY_____
PCN_____

CAR OR TRUCK NO. _____NET WEIGHT:TON/MTON _____ SEAL NO._____

MANUFACTURER _____DESTINATION _____DATE_____

This sealed shipment of hydrated lime is in compliance with the Department of Transportation Specifications in effect on the project shown. AND, if submitted herewith, the two test specimens obtained by the manufacturer in accordance with SD 502, are truly representative of the transported material described above. They have been as indicated below.

1. _____ For Truck Shipment — Specimens and certificates sent with driver for delivery to the Project Engineer
2. _____ For Rail Shipment — Specimens mailed directly to: South Dakota Department of Transportation, Central Testing Laboratory, Pierre, SD 57501. The Certificate is mailed to: Project Engineer.
3. _____

Signed _____
Manufacturer's Authorized Agent

INSTRUCTIONS

The Certificate of Compliance and its duplicate copy must accompany each load of hydrated lime, if the material is to be used on the project prior to receipt of satisfactory test results from the Central Testing Laboratory.

Certified shipments of lime which have been sampled by the manufacturer shall have the 2 Certificates (original and one copy) and the 2 test specimens forwarded as follows:

1. SEALED SHIPMENTS BY TRUCK TRANSPORT - The driver shall deliver, to the Engineer in charge of lime blending operations, the 2 Certificates and the 2 test specimens at the time the load is delivered to the project.

2. SEALED SHIPMENTS BY RAILROAD CAR - The original and 1 copy of the Certificate of Compliance shall be affixed to the lower side of 1 of the upper hopper car doors. The inside of the boxcar door, or to the car's placard board. The 2 test specimens (when taken by the manufacturer) should be sent directly to the South Dakota Department of Transportation, Testing Laboratory, Pierre, SD 57501. NOTE: The Project Engineer must be informed by the manufacturer, if the test specimens are sent directly to the Central Testing Laboratory.

CERTIFICATE DISTRIBUTION BY PROJECT ENGINEER:
Original - To project file
Duplicate - To Central Testing Laboratory with test specimens (except in 2., above)

Figure 1

Section Number 5

Section Number 5

Section Number 5

FORMS TABLE OF CONTENTS

FORM	FORM DESCRIPTION
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DOT 3	Screen Analysis and P.I. Worksheet (combined)
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DOT 78Q	Temperature / Viscosity Chart
DOT 79Q	Gradation Control Chart
DOT 86	Gyratory Specific Gravity
DOT 89	Asphalt Binder Content Determination
DOT 93	Percent RAP in the Mix as a Percent of the Total Aggregate
DOT 97	Certificate of Compliance for Asphalt Concrete Composite

Sample ID

File No.

Sample Data Sheet

DOT-1
9-14

Laboratory Test No. _____

County _____ PCN/PROJECT _____

SUBMITTED BY _____ PROJECT ENGINEER _____

SEND RESULTS TO _____

CONTRACTOR _____ SUB-CONTRACTOR _____

CHARGE TO (If not above project) _____ SUPPLIER _____

This is a _____ sample. MATERIAL TYPE _____

FIELD SAMPLE NO. _____ DATE SAMPLED _____ TIME SAMPLED _____

THIS SAMPLE REPRESENTS _____ (quantity & unit of measurement)

Please identify as: Sta. _____ Dist. L/R _____ Lift _____ / _____

Certification ID: _____

FOR CONCRETE	Type	Lot No.	Crushed Rock	_____ %	MISCELLANEOUS	Type	Lot No.
◯ cement	_____	_____	Sand	_____ %	◯ beads	_____	_____
◯ admixture	_____	_____	Lime	_____ %	◯ paint	_____	_____
◯ latex modifier	_____	_____	Gravel	_____ %	◯ asphalt	_____	_____
◯ curing compound	_____	_____	Filler	_____ %	sampling method	_____	
◯ coarse agg., size	_____	_____	Coated Aggregate	_____ %	◯ fencing material (list under remarks)		
◯ fine agg.	_____	_____	Clay	_____ %	◯ _____	_____	_____
◯ cylinders	_____						

If material is to be used for CONCRETE, check its use as follows:

◯ On Grading ◯ On Bridge ◯ Paving ◯ Class ◯ Other

If material is to be used for SURFACE COURSES, check its use as follows:

◯ Base Coarse, Type	◯ Treated	◯ Subbase, Type
◯ Asph. Conc., Class/Type	◯ Asph. Surf. Treatment, Type	◯ Gravel Surfacing
◯ Maintenance Stockpile	◯ Miscellaneous	◯ Shoulders

Use Description: _____

FOR SHIPPED IN MATERIAL: Producer's Name & Address _____

Brand, Trade Name or Quarry _____

FOR LOCAL MATERIAL: Location of Pit or Quarrry _____ 1/4 Sec. _____

_____ Twp. _____ Range, _____ County Owner & Address _____

Shipping Ticket No. _____ Truck or Car No. _____ Unloaded at _____

Remarks:

Sample ID
File No.

Sieve Analysis and P.I. Worksheet

DOT-3 (Combined)
9-15

PROJECT _____ COUNTY _____ PCN _____
Charged To (if not above project) _____
Field No. _____ Date Sampled _____ Date Tested _____
Sampled By _____ Tested By _____ Checked By _____
Material Type _____ Source _____
_____ Lot No. _____ Sublot No. _____
Weight Ticket Number or Station _____ Lift _____ of _____

% moist. = (wet wt. _____ - dry wt.) / dry wt. x 100 = _____

Original Dry Sample Wt. (0.1g) _____

Sieve Size mm	Sieve Size in	F.M. *	Retained (0.1g)	% total ret.(0.1%)	% pass. 0.1%	% pass. (rounded)	Spec Req.
100	4						
75	3						
62.5	2 1/2						
50.0	2						
37.5	1 1/2						
31.5	1 1/4						
25.0	1						
19.0	3/4						
16.0	5/8						
12.5	1/2						
9.5	3/8	*					
6.3	1/4						
4.75	#4	*					
Pan							
TOTAL							

Dust Chk	
wt. before washing (0.1g)	
wt. after washing (0.1g)	
loss from washing	
% - #200	

+ #4 Gradation Check:
within 0.3% of original dry wt. _____

Liquid Limit		**L.L.**	**P.L.**
a. can number			
b. wt. can + wet soil	(.01g)		
c. wt. can + dry soil	(.01g)		
d. wt. of water (b - c)	(.01g)		
e. wt. of can	(.01g)		
f. wt. of dry soil (c - e)	(.01g)		
g. Liquid Limit (d/f x j x 100)	(0.1)		
h. Plastic Limit (d/f x 100)	(0.1)		
I. P. I. (g - h)	(0.1)		
Liquid Limit N.C. ☐	(**g**. rounded)		
Plasticity Index	(**i**. rounded)		

j. corr # blows _____ 22 = 0.9846 23 = 0.9899 24 = 0.9952
25 = 1.0000 26 = 1.0050 27 = 1.0100 28 = 1.0138

wt. - #40 _____ / wt. - #4 _____ x % pass. #4 = _____
(± 3.0% VARIABLE of % pass. (0.1%) on the #40)

SPECIFICATION L.L. _____
SPECIFICATION P.I. _____

Sieve Size mm	Sieve Size #		retained (0.1g)	% total ret.(0.1%)	% total x % pa#4(0.1%)	% pass. (0.1%)	% pass (rounded)	Spec Req.
3.35	6							
2.36	8	*						
2.00	10							
1.70	12							
1.18	16	*						
0.850	20							
0.600	30	*						
0.425	40							
0.300	50	*						
0.180	80							
0.150	100	*						
0.075	200							
PAN	dry					wt. before washing (0.1g)		
PAN	wash					wt. after washing (0.1g)		
TOTAL						**loss from washing (- # 200)**		

+ #4 % Particles less than 1.95 SP. Gr.		
Specific gravity of solution (1.95 ± 0.01)		.
wt. of lightweight particles	(0.1g)	
wt of + #4 material	(0.1g)	
% lightweight particles		
SPECIFICATION		-

- #4 % Particles less than 1.95 SP. Gr.		
Specific gravity of solution (1.95 ± 0.01)		.
wt. of lightweight particles	(0.1g)	
wt of - #4 material	(0.1g)	
% lightweight particles		
SPECIFICATION		-

Coarse	_____ x % Retain/Design	=	
Chip	_____ x % Retain/Design	=	
Fine	_____ x % Pass/Design	=	
	Total/Combined - #200		

- #4 Gradation check:
within 0.3% of the _____
wt. before washing

Crushed Particles Test		
weight of crushed particles		
weight of total + #4 sample		
percent of crushed particles		
SPECIFICATION	or more FF	

Natural Sand	_____	Natural Fines	_____	Na. Rock	_____
Ma. Sand	_____	Filler	_____	Cr. Rock	_____
Cr. Fines		Add Rock			

SOUTH DAKOTA DEPARTMENT OF TRANSPORTATION
_____MATERIALS LABORATORY
_____, SOUTH DAKOTA
FILE NO. _____

DOT-4
(09/2004)

Lab Test No. _____

PROJECT NO.: _____ COUNTY: _____ PCN: _____
SUBMITTED BY _____
REPORT TO _____
CONT. PROD. _____
SAMPLE OF _____
TO BE USED _____
SOURCE _____
QUAN. REPRSNTD. _____
DATE SAMPLED _____
DATE RECEIVED _____
DATE REPORTED _____
FIELD TEST NO. _____
COMMENTS _____

Oversize Ret:													
Sieve Sizes													
Inches	mm	Ret.	Ac.p	Ret.	Ac.p	Ret.	Ac.p	Ret.	Ac.p	Ret.	Ac.p	Ret.	Ac.p
3"	75												
2-1/2"	63												
2"	50												
1-1/2"	37.5												
1-1/4"	31.5												
1"	25.0												
3/4"	19.0												
5/8"	16.0												
1/2"	12.5												
3/8"	9.5												
1/4"	6.3												
#4	4.75												
#8	2.36												
#10	2.00												
#16	1.18												
#20	0.850												
#30	0.600												
#40	0.425												
#50	0.300												
#80	0.180												
#100	0.150												
#200	0.075												
Liquid Limit													
Plastic Index													
-4 Lt. Wt. Particle													
+4 Lt. Wt. Particle													
% Crushed PC's.													
F.M.													
Combined -#200													

Deviations/Comparison Results: _____

cc: Area Engineer
Cert. Engineer
Reg. Matl's Engineer

Respectfully submitted: _____

PROJECT NUMBER _____
PCN _____
COUNTY _____
DATE _____
ASPHALT GRADE _____
ASPHALT SP.GR. _____

SAND EQUIVALENT

Sand	Clay	SE
	Average SE	

FINE AGGREGATE ANGULARITY

	Method A	Method C
Average FAA		

Spec. No.	Ht. (in.)	Dry Wt. (0.1 g)	Sub. Wt. (0.1 g)	SSD Wt. (0.1 g)	Difference (0.1 g)	Bulk Sp. Gr. (0.001 g)	Ave. BSG (0.001 g)	Stability (lbs.)	Corr. Stab. (lbs.)	Flow (0.01 in.)	Av. Flow (0.01 in.)

Sample ID

File No.

Core Dry Back Worksheet

DOT - 8
9-14

PROJECT _____ COUNTY _____ PCN _____

Tested By _____ Checked By _____ Test Date _____

Material Type _____

Steps

1. Measure and record the thickness of the core and all lifts prior to sawing. (average of 4 locations around core)
2. Saw the lift to be tested from the core and record thickness (A).
3. Using SD 315, record the core apparent dry weight in air (B), the submersed weight under water (C), and the saturated surface dry weight in air (D) to the nearest 0.1 gram.
4. Calculate the volume of the core (E).
5. Record the pan number (F).
6. Weigh and record the weight of the pan to the nearest 0.1 gram (G).
7. Place the core and pan in an oven at 230° ± 9° F for 2 hours.
8. After the 2 hour period, record the weight of the core and the pan to the nearest 0.1gram. Record the time of weighing in column (J).
9. Place the core and pan back in the oven and weigh at 1 hour intervals until the core has reached a constant weight. Constant weight is attained when the weight loss is within 0.1 percent of the apparent dry weight. Calculate the amount of allowable loss (M).
10. After the above constant weight has been reached, cool the pan and core to room temperature, record the weight (N), and then determine the actual dry weight of the core (H).
11. Perform Calculations (I), (K), and (L).

Core measurement before sawing										
Core Number										
_____ lift measured thickness										
_____ lift measured thickness										
_____ lift measured thickness										

A.	Sawed core thickness:										
B.	Apparent dry weight in air:										
C.	Submersed weight in water:										
D.	SSD weight in air:										
E.	Volume of core: (D - C)										
F.	Pan number:										
G.	Weight of pan:										
H.	Actual dry weight: (N - G)										
I.	Core bulk specific gravity: (H / E)										
K.	Moisture in core: (D - H)										
L.	Percent water absorbed by volume: (K / E) * 100										
M.	Maximum allowable weight loss in 1 hour: (B x 0.001)										

	Time (J)	**Core Drying Weigh Back Area**									
After reaching constant weigh, allow the core & pan to cool to room temp. before weighing for the final time **(N)**											
N.	Weight of cooled core and pan										

Comments:

SHEET _____ OF _____

DOT-16
(09/2004)

SUMMARY OF AGGREGATE TEST RESULTS
File Number _____

ACCEPTANCE _____
INDEPENDENT ASSURANCE_____

PROJECT _____ COUNTY _____ PCN _____

MATERIAL TYPE _____ SPECIFICATION REFERENCE _____ AREA ENGINEER _____

TEST IDENTITY								SPECIFICATION											
Sequence	Number	Date 20__	Entry By					SIEVE SIZE									FAILING TEST / Date of DOT-18	STATION TO STATION AND/OR LOCATION	REMARKS

FILE NO. _____

SUMMARY OF MEASUREMENTS

PROJECT _____ COUNTY _____ PCN _____

BASE COURSE GRADING MAT SHOULDER SUBBASE _____ DATE: _____
(Circle designated use) (Other)

TEST IDENTITY		DATE 20 __	ENTRY BY	LOT NO.	STATION TO STATION	AT STA.	DIST-ANCE FROM ℄	DENSITY					THICKNESS		WIDTH		REMARKS
								(lbs/ft^3) (kg/m^3)			% OF STANDARD		(in) (mm)		(ft) (m)		
SEQ.	NO.							AVE.LAB UNIT WT	AVE.FLD UNIT WT	MOVING AVERAGE	REQ'D	OBT'D	SPEC.	FIELD	SPEC.	FIELD	

COPIES TO: Region Materials
Area Engineer

SUBMITTED BY:

_____

REPORT OF REMEDIAL ACTION

File No. _____

Project No. _____ **PCN** _____

County _____ **Date** _____

TEST NO.	**UNACCEPTABLE COMPARISON TEST RESULTS**

TEST NO.	**REMEDIAL ACTION TEST RESULTS**

REMEDIAL ACTION TAKEN: (Attach additional sheets as necessary)

_____

Region Materials Engineer **Date**

cc: Area Engineer
Certification Engineer

Sample ID

File No.

Test Strip Worksheet

DOT-28
9-14

PROJECT _____ COUNTY _____ PCN _____

Test No. _____ Test Date _____ Lift _____ of _____ Thickness _____

Tested By _____ Checked By _____

Nuclear Gauge No. _____ Test Mode _____

NUCLEAR GAUGE WET DENSITY lbs/ft^3 (kg/m^3)

	STATION _____	STATION _____	STATION _____	STATION _____	AVERAGE
1st Reading Total Passes _____					
2nd Reading Total Passes _____					
3rd Reading Total Passes _____					
4th Reading Total Passes _____					
5th Reading Total Passes _____					
6th Reading Total Passes _____					
7th Reading Total Passes _____					

MOISTURE AND DRY DENSITY DETERMINATION

A. Final Wet Density				
B. Weight of Can and Wet Material				
C. Weight of Can and Dry Material				
D. Weight of Moisture (B - C)				
E. Weight of Can				
F. Weight of Dry Material (C - E)				
G. % Moisture (D x 100) / F				
H. Dry Density A x 100 / (100 + G)				

Average Dry Density _____

Sample ID

File No.

LIME CONTENT DETERMINATION - ASPHALT CONCRETE

DOT - 33Q
9-14

Report No. _____

County _____ PCN/PROJECT _____

Test Date _____ Inspector _____ Contractor _____

Percent Lime Desired _____

Hydrated Lime Type _____

TANK METHOD

A. Weight of Lime in Tank at Start (Tons) _____
☐ Tons at Start (at start of project only)

B. Weight of Lime Added to Tank (Tons) _____

C. Weight of Lime in Tank at End (Tons) _____
☐ Left in Storage (at end of project only)

D. Weight of Lime Used (A + B - C) (Tons) _____

E. Weight of Mix Produced (Tons) _____

F. Percent of Lime in Mix (D / E x 100) _____

B.

Load #	Invoice #	Tons

Summary of Mix Produced			Lime
To Road		Tons	
Plant Waste		Tons	
Road Waste		Tons	
To Others		Tons	
Produced		Tons	

REMARKS

Sample ID

File No.

Density Report - Bituminous Surfacing

DOT-42Q
9-14

PROJECT _____ COUNTY _____ PCN _____

Class and Type _____ Lift _____ of _____ Thickness _____

% Asphalt Binder _____ Actual Finished Width _____ Station _____

Tested By _____ Checked By _____ Date _____

Specification Requirement - Percent of Standard Required _____

Lot No. _____ Lot Location Sta. _____

Core Site Length _____ Lot Width _____ Quantity Represented _____ tons

Theoretical Maximum Specific Gravity

Sublot No.									
Max. Sp. Gr.									

Lot Average Maximum Specific Gravity (Standard) _____

In-Place Density Measurement

Percent of Standard = [(Core Bulk Specific Gravity / Lot Average Maximum Specific Gravity)] x 100

Core Sublot No.	Height	Rand Nbr.	Cumulative Tonnage	Station for Core	Rand Nbr	Paving Width	Distance from C/L		Actual Dry Weight	Weight in Water	SSD Weight	Reheat Correction Factor	Core Bulk Specific Gravity	Percent of Standard	Average Percent Standard

Percent Density: _____

Comments:

Sample ID

File No.

Air Voids Report - Bituminous Surfacing

DOT - 42QA
9-14

County _____ PCN/PROJECT _____

Field # _____ Sublot Number _____ Date _____ Time _____ Lift _____ of _____

Lot No. _____ Sample Obtained From _____ Distance _____ of Centerline

Ticket No. _____ Quantity Represented _____ tons

Tested By _____ Checked By _____

Theoretical Maximum Density (Rice)

	1	2	Rerun
A. Weight of sample in air			
B. Weight of canister + water			
C. Weight of canister + water + sample			
Temperature of the water			
D. Water correction factor			
E. Maximum Specific Gravity			
[A / (A + B - C)] * D			
F. Average Maximum Specific Gravity			

Marshall Density Data

	1	2	3
A. Height of Sample			
B. Weight of sample in air			
C. Weight of sample in water			
D. Weight of SSD sample in air			
E. Volume Displaced (D - C)			
F. Bulk Specific Gravity (B/E)			
G. Compaction temperature			
Columns Used for Average			
H. Average Bulk Specific Gravity			

Percent Air Voids Calculation

[(Maximum Sp. Gr. - Marsh. Bulk Sp. Gr.) / Maximum Sp. Gr.] x 100 = _____

MOISTURE SENSITIVITY REPORT - BITUMINOUS SURFACING

DOT-48
9-14

FILE NUMBER _____

PROJECT		DESIGN LEVEL	
PCN		DESIGN AIR VOIDS	
COUNTY		DESIGN AC CONTENT	
DATE			Spec.'s
ASPHALT BINDER		AVERAGE AIR VOIDS	
ADDITIVE & DOSAGE		AVERAGE SATURATION LEVEL	
METHOD OF ADDING		TENSILE STRENGTH RATION	
COMPACTION BLOWS			

SPECIMEN NUMBER		1	2	3	4	5	6	7	8	9	10
DIAMETER (0.01 in.)	D										
THICKNESS (0.01 in.)	t										
DRY MASS IN AIR(0.1 g)	A										
MASS IN WATER (0.1g)	B										
SSD MASS (0.1g)	C										
VOLUME (C - B)	E										
BULK SP. GR. (A / E)	F										
THEO. MAX. SP. GR.	G										
% AIR VOIDS ((G - F) / G) × 100	H										
VOLUME AIR VOIDS (HE)/100	I										
LOAD (LB.)	P										
							AVERAGE AIR VOIDS OF DRY SUBSET				
SATURATED			MIN.		"HG		AVERAGE AIR VOIDS OF SAT. SUBSET				

MASS IN WATER (0.1.g)	B'										
SSD MASS (0.1 g)	C'										
VOLUME (C' - B')	E'										
VOL. ABS. WATER (C' - A')	J'										
% SATURATION (J' / I) × 100											
% SWELL ((E' - E) / E) × 100											

CONDITIONED 24 HOURS AT 140°F WATER

THICKNESS (0.1 in.)	t"										
MASS IN WATER (0.1 g)	B"										
SSD MASS (0.1 g)	C"										
VOLUME (C" - B")	E"										
VOL. ABS. WATER (C" - A)	J"										
% SATURATION (J" / I) × 100											
% SWELL ((E" - E) / E × 100											
LOAD (LB.)	P"										
DRY STRENGTH ((2P) / tDπ)	Std										
WET STRENGTH ((2P") / t"Dπ)	Stm										
VISUAL MOISTURE DAMAGE											
CRACK / BREAK DAMAGE											

π = 3.1416

TENSILE STRENGTH RATIO $\dfrac{\text{Average Wet Strength (psi)}}{\text{Average Dry Strength (psi)}}$ $\dfrac{\text{Stm1 + Stm2 + … + Stmn}}{\text{Std1 + Std2 + … + Stdn}}$ = _____ × 100 = [ ]

EQUIPMENT INSPECTION REPORT
INVENTORY OF CALIBRATED FIELD LAB EQUIPMENT

DOT-49
(09/2004)

PROJECT_____ COUNTY_____ PCN _____

TYPE OF CONSTRUCTION _____ CONTRACTOR _____

AREA ENGINEER _____ PROJECT ENGINEER _____

LAB PERSONNEL _____ LAB TYPE _____

ORGANIZATION RESPONSIBLE FOR EQUIPMENT _____

==========

CALIBRATION RECORDS IN FIELD LABORATORY: YES NO

TEST EQUIPMENT

12" Sieves			**8" Sieves**		
63	2 1/2	_____	9.5	3/8	_____
50	2	_____	6.3	1/4	_____
37.5	1 1/2	_____	4.75	#4	_____
31.5	1 1/4	_____	2.36	8	_____
25.0	1	_____	2.00	10	_____
19.0	3/4	_____	1.18	16	_____
16.0	5/8	_____	0.850	20	_____
12.5	1/2	_____	0.600	30	_____
9.5	3/8	_____	0.425	40	_____
6.3	1/4	_____	0.300	50	_____
4.75	#4	_____	0.180	80	_____
PAN		_____	0.150	100	_____
		_____	0.075	200	_____
		_____	PAN		_____
		_____			_____
					_____
					_____

Scales	**Thermometers & Hydrometers**	**Measure**
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____		

Molds	**Pycnometers & Viscometers**	**Misc. Equip.**
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____		_____

Meters	**Liquid Limit Devices**	**Sieve Shakers**	**Hammers**
Air _____	_____	_____	_____
Volume _____	_____	_____	_____
Density _____	_____	_____	_____
_____	_____	_____	_____
_____	_____		_____
_____			_____

CALIBRATION & COMPARISONS _____

SAMPLING &/OR TESTING PROCEDURES OBSERVED _____

REMARKS _____

cc: Area Engineer

INSPECTED BY _____
Region Materials Engineer Date

DOT-49A
(09/2004)

EQUIPMENT CHECKOUT LIST

PROJECT _____ PCN _____

COUNTY _____ ASSIGNED TO _____

SCALES ELECTRIC BALANCE _____ 5KG* _____ SET OF WEIGHTS _____
100G(PI) _____ 20KG**
35LB/16KG _____ PLATFORM *** _____
2KG _____ SET OF WEIGHTS _____ _____
SPLITTERS LARGE 4> _____ MEDIUM 3/4"> _____ SMALL 1"> _____ MINI 1/4" _____

**********G R A D A T I O N **********

SHAKER _____ TIMER _____

	3"/75mm	_____	1/14"/31.5mm	_____	1/2"/12.5mm	_____	#8	_____
SIEVE 12"	21/2"/63mm	_____	1"/25mm	_____	3/8"/9.5mm	_____	PAN	_____
	2"/50mm	_____	3/4"/19mm	_____	1/4"/6.3mm	_____	PAN	_____
	11/2"/37.5mm	_____	5/8"/16mm	_____	#4/4.75mm	_____	LID	_____
	3/8"/9.5mm	_____	#10	_____	#40	_____	#200	_____
SIEVE 8"	1/4"/6.3mm	_____	#16	_____	#50	_____	PAN	_____
	#4/4.75mm	_____	#20	_____	#80	_____	LID	_____
	#8	_____	#30	_____	#100	_____		

WASH #200 SIEVE_____ LIGHTWEIGHT #30 SIEVE_____ LL & PI #40 SIEVE_____

WASH PANS	_____	HOG PANS	_____	INSULATED GLOVES	_____
BRASS BRUSH	_____	STEEL BRISTLE BRUSH	_____	SPOON	_____
NAIL	_____	PAINT BRUSHES	_____	STEEL BURN PLATES	_____

LIGHTWEIGHT PARTICLES

ZINC CHLORIDE _____ HYDROMETER ____ 250 ML GRAD. CYLINDER _____ RUBBER GLOVES ____
RETAINED #4(COARSE AGGREGATE)>>> BUCKET/BASKET ____ STRAINER ____ SPOON _____
PASSING #4(FINE AGGREGATE)>>> 1000 ML BEAKERS ____ STRAINER ____ SPOON _____
L.L. & P.I. LL MACHINE _____ GROOVING TOOL _____
HOT PLATE _____ PI CANS _____ APPARATUS (MOTOR BOWL & RUBBER PESTLE) _____

**********D E N S I T Y**********

SAND CONE _____ JARS _____ MODIFIED 10" CONE/BASE PLATE _____ SAND _____
VOLUME METER _____ BALLOONS _____ 1/10 FT3 BUCKET _____
4"(101.6 mm) MOLD _____ 6"(152.4mm) MOLD_____ 5.5lb(2.5 kg) RAMMER _____
KNIFE _____ STRAIGHT EDGE _____ #4 ROUGH SCREEN _____ PINE BOARD _____
SPOON _____ DRYING PANS _____ LARGE PAN _____ CEMENT CANS _____
INSULATED GLOVES _____ SPATULA _____ EXTRUDER(JACK) _____
200LB/90KG CONCRETE BLOCK FOR SETTING MOLD ON TO POUND OUT _____
PLASTIC BAGS _____ (SAMPLING & 100 FT/300 m - LL SAMPLES)
SPEEDY _____ (2 - 1 1/4" STEEL BALLS, 2 - 13 gm WEIGHTS, SCOOP, BRUSH, CLOTH) REAGENT _____

**********A S P H A L T D E N S I T Y**********

MARSHALL> MECHANICAL COMPACTION HAMMER/WOODEN BLOCK _____
SET MOLDS _____ PAPER DISC _____ COMPACTION HAMMERS _____
ROASTER OR HOT PLATE _____ BASKET _____ SCALE _____
RICE> VACUUM PUMP/OIL _____ VIBRATOR POT/C-CLAMP & HOLDER _____
PYCNOMETER (CANISTER _____ PRESSURE GAUGE LID _____ CALIB. LID _____
THERMOMETER _____ PRESSURE MANOMETER/DRIERITE UNIT _____
SCALE ___**___RELEASE AGENT _____THERMOMETER 50^0 - 400^0F _____
MISC.> INSULATED GLOVES _____ TROWEL _____ SCOOP _____ PANS _____
CUT OUT CALIB.> 6" MARK OUT BLOCK _____ TIN FOIL 4-12"x18" _____ NAILS _____

**********F R E S H C O N C R E T E T E S T**********

AIR METER_____ TAMPING ROD_____ MALLET_____ STRAIGHT EDGE_____
SLUMP CONE_____ SCOOP _____ POCKET THERMOMETER _____ TROWEL _____
SET CONC. CYLINDERS MOLDS _____
DENSITY/UNIT WEIGHTS> 1/2" PLASTIC COVER _____ SCALE _____***_____

_____ _____
Signature Date

File No. _____

FIELD LABORATORY INSPECTION RECORD

TYPE OF LAB _____

Project _____ County _____ Contractor _____

This record is provided to determine compliance with specifications, to document acceptable deviations, and to record the initial and final condition of the contract Field Laboratory used on this project.

NOTE: Representatives of the South Dakota Department of Transportation and the Contractor should make the initial inspection and record when the Field Laboratory is placed, ready for use, and the final report when the project is completed or the Laboratory released. Minor deviations which do not impair its usefulness, or are compensated for by related features exceeding minimum specification requirements, will be permitted when explained and documented herein. Changes made in locations of, malfunctions, damages, and/or repairs made to the Field Laboratory shall be recorded. Briefly describe, in column 9, or the summary, all notations made in columns 4, 6, and 8.

ITEM	Quantity or Dimensions	SPECIFICATION COMPLIANCE		CONDITION OF LABORATORY				INSTRUCTIONS: Use numerical values, Col. 2. Indicate by "yes" or "no", Col. 3 & 4. Check ( ) proper column, Col. 5, 6, 7, 8.
				Begin Proj.		End Proj.		
		Satisfactory	Accepted as Noted	Satisfactory	Needs Repair	Satisfactory	Needs Repair	REMARKS
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
1. HEATING and/or COOLING SYSTEM								
2. CABINET (enclosed)								
3. CHAIRS/STOOLS								
4. DESK								
5. DIMENSIONS Length _____ Width _____ Height								
6. DOORS								
7. EQUIPMENT (for concrete test specimens, if required)								
8. EXHAUST FANS								
9. LIGHTS (electric)								
10. OUTLETS (electric)								
11. POWER								
12. RANGE/OVEN Size _____ Burners _____								
13. ROOMS OR SECTIONS								
14. SINK								
15. TABLES								

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
16. WATER SYSTEM Capacity _____ Pressure _____ Gravity								
17. WINDOWS								
18. FIRE EXTINGUISHERS								
19. MICROWAVE OVEN								
20. FIRST AID KIT								
21. EYEWASH								
22. BROOM/DUSTPAN/GARBAGE								
23. SANITARY FACILITY								
24. PHONE/ANSWERING MACHINE/FAX/COPIER								
25. CONVECTION OVENS (if applicable)								
26. CONCRETE BASE (if applicable)								
27. STEPS AND HAND RAILINGS								
28. LAB ANCHORING SYSTEM								
29. NO SMOKING FACILITY SIGNS POSTED								

SUMMARY AND ADDITIONAL COMMENTS:

_____

_____

_____

_____

_____

_____

_____

DEPARTMENT OF TRANSPORTATION CONTRACTOR

Initial Inspection _____ _____ _____ _____

Name Title Date Name Title Date

Final Inspection _____ _____ _____ _____

Name Title Date Name Title Date

ACCEPTED FOR FINAL PAYMENT _____ _____

Name Date

_____

Title

BULK SPECIFIC GRAVITY OF MINERAL AGGREGATE

PROJECT:
PCN:
COUNTY:

AGGREGATE TYPE:
PIT LOCATION:
% RETAINED #4:
% PASSING #4:

- #4 Bulk Specific Gravity

	#1	#2
(A) weight of oven dry sample in air:		
(B) weight of pycnometer filled with water:		
(C) weight of pycn. + water + sample:		
(S) weight of saturated surface dry sample:		
temperature of the water:		

BULK SP. GR. $\frac{A}{(B + S - C)}$ _____ _____

AVERAGE =

APPARENT SP. GR. $\frac{A}{(B + A - C)}$ _____ _____

AVERAGE =

WATER ABSORPTION (percent) (S-A / A) * 100 _____ _____

AVERAGE =

+ #4 Bulk Specific Gravity

(A) weight of oven dry sample in air:
(B) weight of sat. surf. dry sample in air:
(C) weight of saturated sample in water:
Temperature of the water:

BULK SP. GR. $\frac{A}{(B - C)}$ _____

APPARENT SP. GR. $\frac{A}{(A - C)}$ _____

WATER ABSORPTION (percent) $\frac{(B - A) * 100}{A}$ _____

SAMPLE BULK SPECIFIC GRAVITY
Gsb = bulk specific gravity for the total sample
P1, P2, Pn = individual percentages by weight of aggregate
G1, G2, Gn = individual bulk specific gravities of aggregate

$$Gsb = \frac{P1 + P2 + \ldots\ldots + Pn}{P1/G1 + P2/G2 + \ldots\ldots + Pn/Gn}$$

Bulk Sp. Gr. (Gsb) =

SAMPLE APPARENT SPECIFIC GRAVITY
Gsa = apparent specific gravity for the total sample
P1, P2, Pn = individual percentages by weight of aggregate
G1, G2, Gn = individual apparent specific gravities of aggregate

$$Gsa = \frac{P1 + P2 + \ldots\ldots + Pn}{P1/G1 + P2/G2 + \ldots\ldots + Pn/Gn}$$

Apparent Sp. Gr. (Gsa) =

WATER ABSORPTION (percent)
Aw = water absorption for the total sample
P1, P2, Pn = individual percentages by weight of aggregate
A1, A2, An = absorption percentages for each size fractions

$$Aw = (P1*A1/100) + (P2*A2/100) + \ldots\ldots + (Pn*An/100)$$

Water Absorption (Aw) =

SOUTH DAKOTA DEPARTMENT OF TRANSPORTATION
CERTIFICATE OF COMPLIANCE FOR ASPHALT
File # _____

*PROJECT_____ COUNTY_____ PCN _____

SUPPLIER _____ CONSIGNEE _____

Bill of Lading or Invoice No. _____ Tank Car or Truck No. _____

**Type & Grade of Material _____ Specific Gravity @ 60^0F. _____ Net Weight _____

DESTINATION _____ DATE SHIPPED _____

TEMPERATURE FOR KINEMATIC VISCOSITY

FOR MIXING APPLICATION	FOR SPRAY APPLICATION
300 Centistokes = _____ ^{0}F	200 Centistokes = _____ ^{0}F.
150 Centistokes = _____ ^{0}F	50 Centistokes = _____ ^{0}F.

This shipment of asphalt material complies with specification requirements of the South Dakota Department of Transportation. The transporting conveyance has been inspected and found free of contaminating material.

SIGNED _____
Supplier's Authorized Representative

* Information may be supplied at destination, if not known when loading.

** If material contains anti-stripping additive, the grade shall be indicated with the notation "with anti-stripping additive".

NOTE: The specimen shown here details the information required.
Such data may be forwarded on the supplier's own invoice, Bill of Lading, or on his own reproductions of the specimen format.

Two (2) copies with each conveyance.

Original - To project file
Duplicate - To Central Testing Laboratory

REPORT ON AGGREGATE-BITUMINOUS MATERIAL PROPORTIONS
SOUTH DAKOTA DOT BITUMINOUS MIX DESIGN LAB
700 EAST BROADWAY AVE., PIERRE, SD

DOT-64
(9-10)

Project: 0 County: 0 Reported:
PCN 0
Job Location: 0
Date Submitted: ?
Sample Submitted By:

Aggregate Source: ?

Type of Work: 0

Prime Contractor: 0

Subcontractor:

GRADATION OF MINERAL AGGREGATE USED FOR TRIAL MIXTURES
(Accumulative Percentages Passing)

% AGGR =	0	0	0	0	0		Recommended Job Mix
Sieve	?	?	?	?	?	Comp	Gradation
1 IN.	0.0	0.0	0.0	0.0	0.0	0.0	0
3/4 IN.	0.0	0.0	0.0	0.0	0.0	0.0	0
5/8 IN.	0.0	0.0	0.0	0.0	0.0	0.0	0
1/2 IN.	0.0	0.0	0.0	0.0	0.0	0.0	0
3/8 IN.	0.0	0.0	0.0	0.0	0.0	0.0	0
# 4	0.0	0.0	0.0	0.0	0.0	0.0	0
# 8	0.0	0.0	0.0	0.0	0.0	0.0	0
# 16	0.0	0.0	0.0	0.0	0.0	0.0	0
# 40	0.0	0.0	0.0	0.0	0.0	0.0	0
# 200	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Asphalt Binder by weight of total mix = 0.0 per cent PG

The above optimum asphalt percentage is determined by Marshall Mix Design tests on submitted aggregate samples. If variation in aggregate quality or gradation occurs, or if the plant produced mix volumetric properties are different from the lab mix volumetric properties, bitumen requirements may be altered. In case of necessary deviation from the recommended percentages, please notify the Bituminous Office.

50 blow AASHTO T-245 Mix Design criteria are as follows:

Marshall equals ? lbs./cu.ft. at ? % asphalt cement. Air Voids = ? % with ? % VMA. Rice equals ? lbs./cu.ft

Temperature of mixture when emptied from the drum	**285 ± 20^0 F**
Temperature of mixture on delivery to the road	**275 ± 30 or -20^0 F**
Asphalt application temperature at the mixer	**290 ± 15^0 F**
Marshall poundout temperature	**275 ± 10^0 F**

Copies to:
?
?
?
G. Hedman
File

Sincerely,
James J. Costello
Bit. Mix Design Engineer

Sincerely
Richard E. Rowen
Bituminous Engineer

File No. _____

DOT-65
(09/2004)

ASPHALT CONCRETE
JOB MIX FORMULA - BITUMINOUS SURFACING

Project _____ County _____ PCN _____

Contractor _____ Asphalt Concrete Type _____

Area Engineer _____ Time _____ Date _____, 20 _____

The following job mix formula with permissible tolerances as set forth in the specifications shall apply to the Bituminous Plant Mix on the above project effective this date until otherwise notified.

1 1/4" sieve -	% Passing	_____
1.0" sieve -	% Passing	_____
3/4" sieve -	% Passing	_____
1/2" sieve -	% Passing	_____
3/8" sieve -	% Passing	_____
No. 4 sieve -	% Passing	_____
No. 8 sieve -	% Passing	_____
No. 16 sieve -	% Passing	_____
No. 40 sieve -	% Passing	_____
No. 80 sieve -	% Passing	_____
No. 200 Sieve -	% Passing	_____
) - - - - Hot Mix-Main Line	% Total Mix	_____
Asphalt Content)		
) - - - - Hot Mix-Shoulders	% Total Mix	_____

Temperature of mixture when emptied from mixer _____

Temperature of mixture on delivery to the road _____

Asphalt application temperature (at mixer) _____

_____
AREA ENGINEER

cc: Bituminous Engineer
Region
Region Materials
Contractor

Sample ID
File No.

Asphalt Plant Mix - Spot Check

DOT-66
9-14

PROJECT _____ COUNTY _____ PCN _____
Field # _____ Date Sampled _____ Date Tested _____
Inspector _____ Contractor _____

TANK METHOD

	Tank #1	Tank #2
A. Beginning Specific Gravity of Bitumen @ 60° F	_____	_____
B. Beginning Weight Per Gallon @ 60° F	_____	_____
C. Temperature of Bitumen in Tank When Check Starts	_____	_____
D. Beginning Weight Per Gallon at Temperature (*)	_____	_____
E. Gallons in Tank When Check Starts (calibrated stick)	_____	_____
Gallons at Start (at start of tank use)	☐	☐
F. Weight of Bitumen in Tank (start check) (D × E / 2000)	_____	_____
G. Weight of Bitumen Added to Tank(s)	_____	
H. Temperature of Bitumen in Tank When Check Ends	_____	_____
I. Gallons in Tank When Check Ends (calibrated stick)	_____	_____
J. Ending Specific Gravity of Bitumen @ 60° F	_____	_____
K. Ending Weight Per Gallon @ 60° F	_____	_____
L. Ending Weight Per Gallon at Temperature (*)	_____	_____
M. Weight of Butumen in Tank (end check) (I × L / 2000)	_____	_____
Left in Storage (at end of tank use)	☐	☐
N. Weight of Bitumen Used (F + G - M)	_____	
O. Weight of Mix Produced (Tons)	_____	
P. Percent of Bitumen in Mix (N / O × 100)	_____	

(*) Computed on reverse side

METER METHOD

Q. Applied Temperature of Bitumen _____
R. Weight Per Gallon (L) of Bitumen at Applied Temperature _____
S. Weight of Mix Produced (Tons) _____

☐ Meter Reads in Weight

T. Stop (tons) _____
U. Start (tons) _____
V. Net Weight _____
V / S × 100 = _____ % of Bitumen in Mix

☐ Meter Reads in Gallons

T. Stop (Gallons) _____
U. Start (Gallons) _____
V. Net Gallons _____
R × V / S × 100 = _____ % of Bitumen in Mix

DETERMINING WEIGHT OF BITUMEN PER GALLON (L) @ TEMPERATURE

1 _____ × _____ × 8.328 = _____ lbs (kg) of Bitumen per Gallon (L) @ temperature

Spec. Grav. of Bitumen — Temp. Factor

2 _____ × _____ = _____ lbs (kg) of Bitumen per Gallon (L) @ temperature

Wt./Gal/ (L) @ 60° F — Temp. Factor

Temp. °C	Temp. °F	Temp. Factor
107	225	0.9436
110	230	0.9419
113	235	0.9402
116	240	0.9385
118	245	0.9369
121	250	0.9352
124	255	0.9336
127	260	0.9319
129	265	0.9302
132	270	0.9286
135	275	0.9269
138	280	0.9253
141	285	0.9236
143	290	0.9220
146	295	0.9204
149	300	0.9187
152	305	0.9171
154	310	0.9154
157	315	0.9138
160	320	0.9122

DISTRIBUTOR "SHOT" RECORD SHEET

DOT-67
(11/2005)

File No. _____

PROJECT _____ COUNTY _____ PCN _____

AREA ENGINEER _____ INSPECTOR _____

MATERIAL _____ SPECIFIC GRAVITY _____ PLAN RATE _____ LBS., GALS OR SQ. YDS.

Sta to Sta	Car or Transp Number	Wt or Gal Start	Wt or Gal Stop	Wt or Gal Used	Oil Temp ^{0}F	Convers. Factor	Comp Gal 60^{0}F	Width	Lin. Ft. Actual	Lin. Ft. Comp	Sq Yds	Actual Lbs, Gals or Sq Yd	Sec	Date	* Code

REMARKS _____

_____

* Weather Code 1. CLEAR 2. PARTLY CLOUDY 3. CLOUDY 4. MIST 5. RAIN 6. SNOW

Sample ID **Sieve Analysis** **DOT-68**

Mineral Aggregate **Stationary Plant Mix** **9-14**

Mix Batch Ticket	lbs./cu.yd.	Total Agg %
Total		

Test # _____ File Number _____

PCN/Project _____ County _____

Charge to (if not above project) _____

Sample Represents _____ Cu. Yd. Class and Type _____

Date Sampled _____ Sampled By _____

Date Tested _____ Tested By _____

Checked By _____

Sample Wt. (0.1g) [ ]

Sieve Size	Retained (0.1g)	% total ret.(0.1g)	% pass (0.1g)
2			
1 1/2			
1 1/4			
1			
3/4			
5/8			
1/2			
3/8			
1/4			
#4			
#8			
Pan Dry			
Pan Wash			

TOTAL _____

Gradation Check ==> [ ]

wt. before wash

wt. after wash _____

loss from wash

% - #200==>

Bin adj. - 200==>

Sample Wt. (0.1g) [ ]

Sieve Size	Retained (0.1g)	% total ret.(0.1g)	% pass (0.1g)
2			
1 1/2			
1 1/4			
1			
3/4			
5/8			
1/2			
3/8			
1/4			
#4			
#8			
Pan Dry			
Pan Wash			

TOTAL _____

Gradation Check ==> [ ]

wt. before wash

wt. after wash _____

loss from wash

% - #200==>

Bin adj. - 200==>

Sample Wt. (0.1g) [ ]

Sieve Size	Retained (0.1g)	% total ret.(0.1g)	% pass (0.1g)
2			
1 1/2			
1 1/4			
1			
3/4			
5/8			
1/2			
3/8			
1/4			
#4			
#8			
Pan Dry			
Pan Wash			

TOTAL _____

Gradation Check ==> [ ]

wt. before wash

wt. after wash _____

loss from wash

% - #200==>

Bin adj. - 200==>

Sample Wt. (0.1g) [ ]

Sieve Size	Retained (0.1g)	% total ret.(0.1g)	% pass (0.1g)
2			
1 1/2			
1 1/4			
1			
3/4			
5/8			
1/2			
3/8			
1/4			
#4			
#8			
Pan Dry			
Pan Wash			

TOTAL _____

Gradation Check ==> [ ]

wt. before wash

wt. after wash _____

loss from wash

% - #200==>

Bin adj. - 200==>

Composite Coarse Aggregate

Sieve Size					Retained Total	Cumulative % Passing	Spec. Gradation	Job Mix Formula
2								
1 1/2								
1 1/4								
1								
3/4								
5/8								
1/2								
3/8								
1/4								
#4								
#8								
Pan								
Total								

Total Combined - 200 ==> _____

+ #4 % Particles less than 1.95 Specific Gravity

Specific gravity of solution	(1.95 ± 0.01)				
wt of light weight particles	(0.1g)				
wt of + #4 material	(0.1g)				
% lightweight particles					
Bin Adj. % lightweight particles					
Composite % lightweight particles					
SPECIFICATION maximum					

Coarse	_____	x % Retain/Design	_____	=
Chip	_____	x % Retain/Design	_____	=
Fine	_____	x % Pass/Design	_____	=
		Total/Combined - #200		

Flat and Elongated Particles

	Sieve Sizes mm	Sieve Sizes Inches	Total Sample Weight on Sieve	Weight of Tested Portion	Weight of Flat/ Elongated Particles	Percent Flat/ Elongated Individual Sieve	Percent Flat/ Elongated Weighted Average
Rock Size	50.0	2					
	37.5	1 1/2					
% of Rock	25.0	1					
	19.0	3/4					
	12.5	1/2					
	9.5	3/8					
	4.75	#4					
	Total Sample Wt.						

Percent flat and elongated particles in:

Percent flat and elongated particles in Total Rock:

	Sieve Sizes mm	Sieve Sizes Inches	Total Sample Weight on Sieve	Weight of Tested Portion	Weight of Flat/ Elongated Particles	Percent Flat/ Elongated Individual Sieve	Percent Flat/ Elongated Weighted Average
Rock Size	50.0	2					
	37.5	1 1/2					
% of Rock	25.0	1					
	19.0	3/4					
	12.5	1/2					
	9.5	3/8					
	4.75	#4					
	Total Sample Wt.						

Percent flat and elongated particles in:

Percent flat and elongated particles in Total Rock:

	Sieve Sizes mm	Sieve Sizes Inches	Total Sample Weight on Sieve	Weight of Tested Portion	Weight of Flat/ Elongated Particles	Percent Flat/ Elongated Individual Sieve	Percent Flat/ Elongated Weighted Average
Rock Size	50.0	2					
	37.5	1 1/2					
% of Rock	25.0	1					
	19.0	3/4					
	12.5	1/2					
	9.5	3/8					
	4.75	#4					
	Total Sample Wt.						

Percent flat and elongated particles in:

Percent flat and elongated particles in Total Rock:

Combined Percent Flat and Elongated Particles for Total Rock:

Rounded:

Spec Max:

Comments:

Sample ID
File No.

Gyratory Aggregate Worksheet

DOT-69
9-14

PROJECT _____ COUNTY _____ PCN _____

Field # _____ Date Sampled _____ Date Tested _____

Sampled By _____ Tested By _____ Checked By _____

Material Type _____ Source _____

_____ Lot No. _____ Sublot No. _____

Weight Ticket Number or Station _____ Lift ____ of ____

% moist. = (wet wt. _____ - dry wt.) / dry wt. x 100 = [ ]

Original Dry Sample Wt. (0.1g) [ ]

Sieve Size mm	Sieve Size in	Retained (0.1g)	% total ret. (0.1%)	% pass. (0.1%)	% pass. (rounded)	**Spec Req.**
50.0	2					
37.5	1 1/2					
31.5	1 1/4					
25.0	1					
19.0	3/4					
16.0	5/8					
12.5	1/2					
9.5	3/8					
6.3	1/4					
4.75	#4					
PAN						
TOTAL						

Sand Equiv Test	Sand Rdg.	Clay Rdg.	S. E.
Reading # 1			
Reading #2			

Sand Equivalent Test Results [ ] _____

Fine Aggregate Angularity Test Results [ ] _____

Flat and Elongated Particles Test Results [ ] _____

Dustchk	
wt. before washing(0.1 g)	
wt. after washing (0.1 g)	
loss for washing	
% - #200	

+ #4 Gradation Check:
within 0.3% of the original dry wt

Sieve Size mm	Sieve Size #	Retained (.1g)	% total ret. (0.1%)	% total x % pa #4 (0.1%)	% pass. (0.1%)	% pass. (rounded)	**Spec Req.**
3.35	6						
2.36	8						
2.00	10						
1.70	12						
1.18	16						
0.850	20						
0.600	30						
0.425	40						
0.300	50						
0.180	80						
0.150	100						
0.075	200						
PAN	dry				wt. before washing (0.1 g)		
PAN	wash				wt. after washing (0.1 g)		
TOTAL					**loss for washing (- #200)**		

+ #4 % PARTICLES LESS THAN 1.95 SP. GR.		
Specific Gravity of solution (1.95 ± 0.1)		
wt. of lightweight particles	(0.1g)	
weight of + #4 material	(0.1g)	
% lightweight particles	(0.1g)	
SPECIFICATION maximum		

- #4 % PARTICLES LESS THAN 1.95 SP. GR.		
Specific Gravity of solution (1.95 ± 0.1)		
wt. of lightweight particles	(0.1g)	
weight of - #4 material	(0.1g)	
% lightweight particles	(0.1g)	
SPECIFICATION maximum		

Coarse	_____	× % Retained/Design	=
Chip	_____	× % Pass/Design	=
Fine	_____	× % Pass/Design	=
		Total/Combined - #200	

- #4 Gradation Check	
within 0.3% of the	
wt. before washing	

CRUSHED PARTICLES TEST		
weight of crushed particles	(0.1g)	
weight of total + #4 sample	(0.1g)	
percent of crushed pieces	(%Whole)	
SPECIFICATION _____	or more FF, min	

Natural Sand		Natural Fines		Na.Rock	
Ma.Sand		Filler		Cr.Rock	
Cr.Fines					

Weight of measure and glass plate		
Weight of measure, glass plate & water		
M = net mass of water		
Water Temperature / Density		
V = volume of cylinder, mL		

Dry - #4 bulk specific gravity (Gsb)			
Volume of cylinder, mL (V)			
Weight of cylinder, g (A)			
Wt. of cylinder + aggregate, g (B)			
Wt. of aggregate, g (F = B-A)			Average
Uncompacted voids, (nearest 0.1%) U = ((V-(F/Gsb))/V x 100			

Sieve Size mm	Sieve Size in	Total Sample Weight on Sieve	Weight of Tested Portion	Weight of Flat/Elong Particles	Percent Flat/ Elongated Individual Sieve	Percent Flat/ Elongated Weighted Average
50.0	2					
37.5	1 1/2					
25.0	1					
19.0	3/4					
12.5	1/2					
9.5	3/8					
4.75	#4					

Total Sample wt.

Percent flat and elongated particles in the total sample (weighted average)

rounded

Comments:

LETTER OF TRANSFER FOR MATERIALS

DOT-70
(09/2004)

File # _____

FROM _____ TO _____ DATE _____
Area Area

RE: Material Transfer From Project (A) _____ PCN _____

To Project (B) _____ PCN _____

As requested by _____, this letter of transfer will provide the data
Contractor

required for permission to transfer the material represented and previously accepted for use.

Material description, producer and remarks _____

_____

_____

_____

Date(s) used on previous Project (A) _____

Identity (Type, size, grade, model, catalogue No., etc.) _____

Batch, Lot No., Tag No., Stamp No. _____

Original Quantity _____

Transfer Quantity _____

Date of Transfer _____

Basis for Acceptance, Project (A): Test No. _____ Date _____

Other _____

For Asphalt Materials Include the following:

*A. Specific Gravity @ 60^0 F. _____

*B. Temperature for Kinematic Viscosities:
300 Centistokes =
150 Centistokes =
200 Centistokes =
50 Centistokes =

C. Transfer Vehicle No. _____

*A copy of the test may be attached to this sheet.

_____ENGINEER

cc: Contractor
Project File
Region Materials
Certification Engineer

DOT-71
(09/2004)

SOUTH DAKOTA
DEPARTMENT OF TRANSPORTATION

FILE NO. _____

RECORD OF ORAL COMMUNICATION

PROJECT _____ COUNTY _____ PCN _____

_____ DATE _____

WITH _____

TEL. _____, VISIT _____, RADIO _____, CONFERENCE _____

PLACE _____

1) PURPOSE _____

2) PERTINENT FACTS _____

3) CONCLUSIONS OR RECOMMENDATIONS _____

cc:

By _____
Title _____

DOT-74
(09/2004)

SOUTH DAKOTA
DEPARTMENT OF TRANSPORTATION

FILE NO. _____

PROJECT SUMMARY OF BITUMEN APPLIED

PROJECT _____ COUNTY _____ PCN _____

SUPPLIER(S) _____ CONTRACTOR _____ AREA ENGINEER _____

Weigh Ticket No.*		NET POUNDS BY GRADE							
Contractor Carrier	Commercial Carrier								Remarks
On Hand	In Storage								Start of Project
Sub-Total – Pounds									
DEDUCTIONS:									
Rejected									
Wasted									
Used off Project									
Left in Storage									
Net Total Pounds									
Net Total Tons									

_____
Inspector Date

DETERMINING POUNDS OF BITUMEN PER GALLON

1. _____ x _____ = _____ x 8.328 = _____ Lbs. Of Bitumen per gallon at temperature
   Sp. Gravity of Bitumen Temp. Factor

2. _____ x _____ = _____ Lbs. of Bitumen per gallon at temperature
   Wt/Gal. @ 60^0 F. of Bitumen Temp. Factor

T = Temperature at which bitumen will be pumped

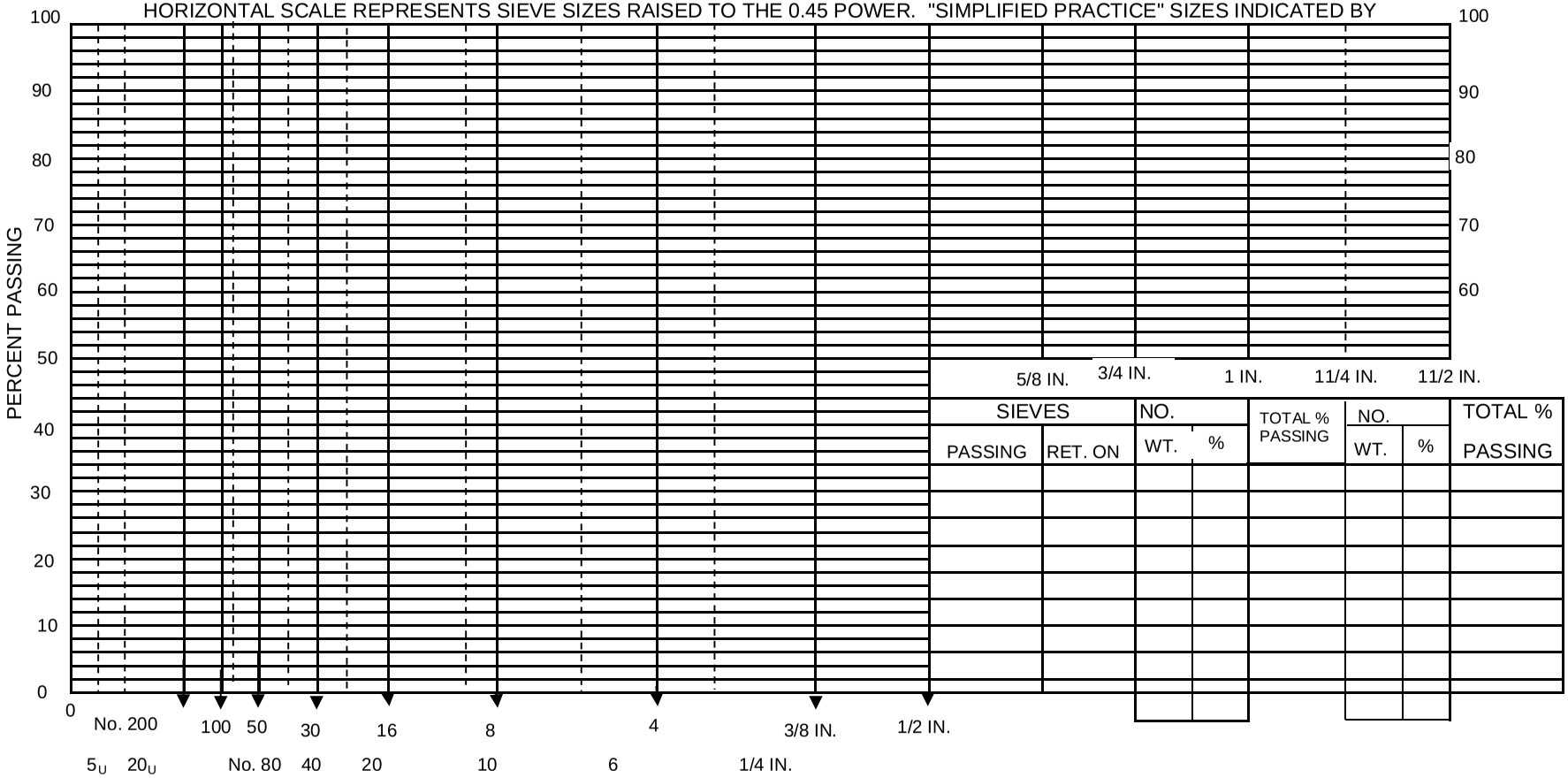
F = Temperature factor

T	F
225	0.9436
230	0.9419
235	0.9402
240	0.9385
245	0.9369
250	0.9352
255	0.9336
260	0.9319
265	0.9302
270	0.9286

T	F
275	0.9269
280	0.9253
285	0.9236
290	0.9220
295	0.9204
300	0.9187
305	0.9171
310	0.9154
315	0.9138
320	0.9122

GRADATION CHART

HORIZONTAL SCALE REPRESENTS SIEVE SIZES RAISED TO THE 0.45 POWER. "SIMPLIFIED PRACTICE" SIZES INDICATED BY

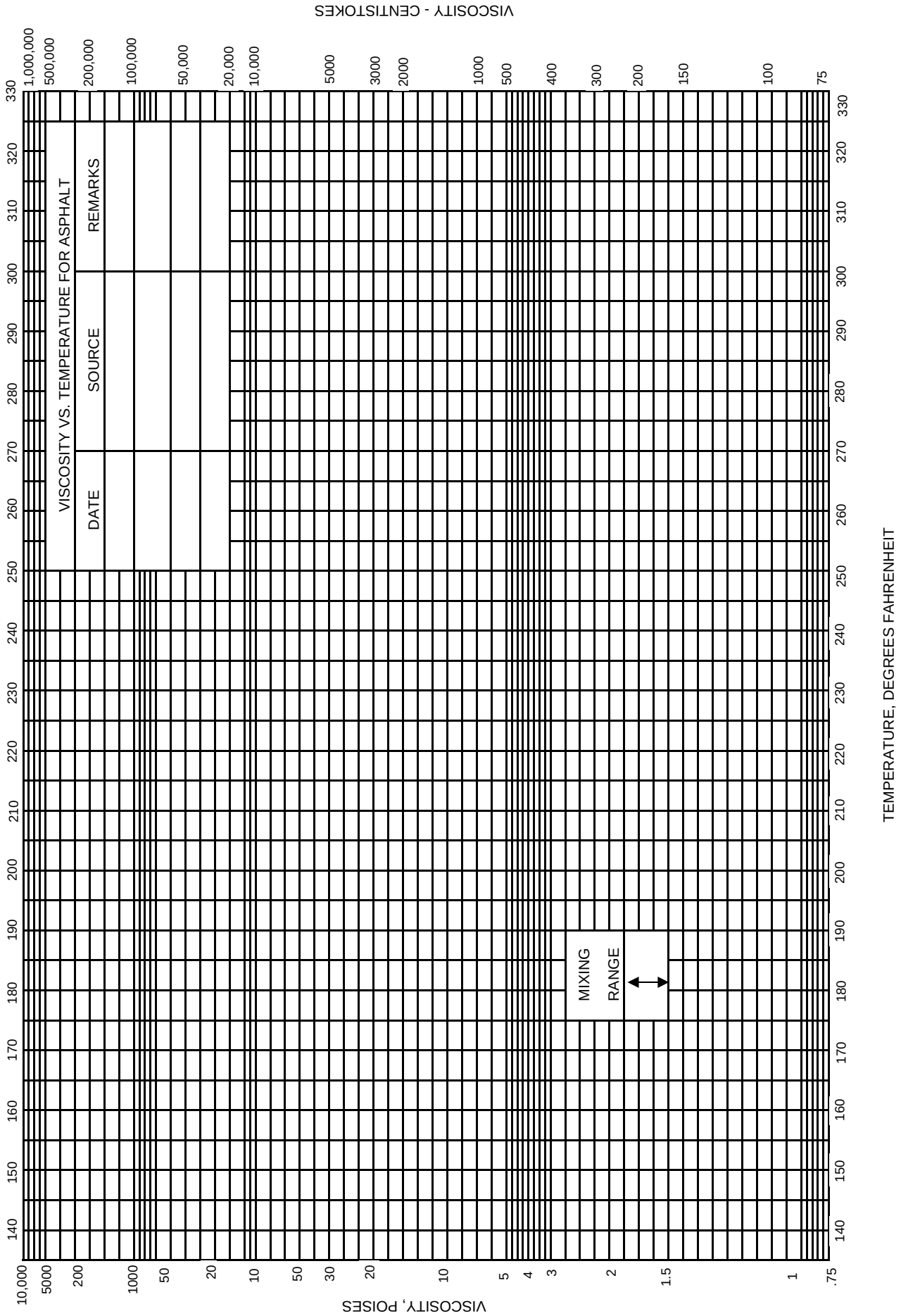


SIEVES		NO.		TOTAL % PASSING	NO.		TOTAL %
PASSING	RET. ON	WT.	%		WT.	%	PASSING

SIEVE SIZES

STATE	PROJECT NO.					TYPE CONST; LOCATION ON PROJECT	
TYPE, SOURCE, PRODUCER OF AGG.							
SAMPLED FROM	SAMPLED BY	DATE	QUANT. REPRESENTED	SIEVED BY	DATE	SIEVE METHOD ☐ WET ☐ DRY	REMARKS

ATTACHMENT 2



PROJECT:
PCN:
COUNTY

ASPHALT GRADATION
*ADD SHEETS AS NECESSARY

DOT-79Q
(09/2004)

1/2" SIEVE SIZE ____ + -7

#4 SIEVE SIZE ____ + -5

#8 SIEVE SIZE ____ + -5

#16 SIEVE SIZE ____ + -5

#40 SIEVE SIZE ____ + -5

#200 SIEVE SIZE ____ + -2.0

% A.C. ____ + -0.3

DENSITY > 9_ ____ < 96

* PLEASE POST IN PLANT LABORATORY

Sample ID
File No.

Gyratory Specific Gravity

DOT-86
9-14

PROJECT _____ COUNTY _____ PCN _____

Field # _____ Date Sampled _____ Date Tested _____

Sampled by _____ Tested by _____ Checked by _____

Material Type _____ Ticket # _____

Source _____ Lift _____ of _____

Lot No. _____ Sublot No. _____

Mix Temp _____ Offset _____ ESAL's _____

Daily Ton _____ Total Ton _____ Oil Type _____

		No of gyrations			
% binder Pb		N initial		Gse	
Gsb		N design		Pba	
binder Gb		N max		Pbe	
Dust (-#200)					
lime					
Dust (-#200) + lime					

	Spec. A)Ndes)		**Spec. B (Ndes)**		**Spec. M (Nmax)**		
	@ N ini	@ N des	@ N ini	@ N des	@ N ini	@ N des	@ N max
a) Height, mm							
b) Weight in air							
c) Weight in water							
d)SSD weight							
e) Bulk SpGr meas b /(d-c)							
f) Bulk SpGr calc (Gmb)							

	Gmm # 1	Gmm # 2
Weight of sample in air		
Weight of canister + water		
Weight of canister + water + sample		
Temperature of the water		
Water correction factor		
Rice SpGr (Gmm)		

Average Maximum SpGr (Gmm) _____

	N initial	N design	N maximum
Average Gmb			
% of Rice SpGr (Gmm)			

% Air Voids (VA)		**% VMA**		**% VFA**		**Dust to binder ratio**	

Comments:

Sample ID

File No.

BITUMEN CONTENT DETERMINATION

DOT - 89
9-14

Report No.

County _____ PCN/PROJECT _____

Test Date _____ Inspector _____ Contractor _____

Percent Bitumen Desired _____ Percent Used by Test _____

Bitumen Type _____

TANK METHOD

A. Beginning Specific Gravity of Bitumen @ 60°F	_____	_____
B. Beginning Weight Per Gallong @ 60°F	_____	_____
C. Temperature of Bitumen in Tank When Check Starts	_____	_____
D. Weight Per Gallon of Bitumen at Temperature	_____	_____
E. Gallons in Tank When Check Starts (calibrated stick)	_____	_____
Gallons at Start (at start of tank use)	☐	☐
f. Weight of Bitumen in Tank (start check) (D x E / 2000)	_____	_____
G. Weight of Bitumen Added to Tank(s)	_____	_____
H. Temperature of Bitumen in Tank When Check Ends	_____	_____
I. Gallons in Tank When Check Ends (calibrated stick)	_____	_____
J. Ending Specific Gravity of Bitumen @ 60°F	_____	_____
K. Ending Weight Per Gallon @ 60°F	_____	_____
L. Weight Per Gallon at Temperature	_____	_____
M. Weight of Bitumen in Tank (end check) (I x L / 2000)	_____	_____
Left in Storage (at end of tank use)	☐	☐
N. Weight of Bitumen Used (F + G - M)	_____	_____
O. Weight of Mix Produced (Tons)	_____	_____
P. Percent Bitumen in Mix (N / 0 x 100)	_____	_____

G. Load #	Invoice #	Tons
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____

Summary of Mix Produced			Bitumen	
To Road	_____	Tons	_____	Tons
Plant Waste	_____	Tons	_____	Tons
Road Waste	_____	Tons	_____	Tons
To Others	_____	Tons	_____	Tons
Produced	_____	Tons		

REMARKS

DETERMINING WEIGHT OF BITUMEN PER GALLON (L) @ TEMPERATURE

1 _____ × _____ × 8.328 = _____ lbs (kg) of Bitumen per Gallon (L) @ temperature

Spec. Grav. of Bitumen — Temp. Factor

2 _____ × _____ = _____ lbs (kg) of Bitumen per Gallon (L) @ temperature

Wt./Gal/ (L) @ 60° F — Temp. Factor

Temp. °C	Temp. °F	Temp. Factor
107	225	0.9436
110	230	0.9419
113	235	0.9402
116	240	0.9385
118	245	0.9369
121	250	0.9352
124	255	0.9336
127	260	0.9319
129	265	0.9302
132	270	0.9286
135	275	0.9269
138	280	0.9253
141	285	0.9236
143	290	0.9220
146	295	0.9204
149	300	0.9187
152	305	0.9171
154	310	0.9154
157	315	0.9138
160	320	0.9122

PERCENT RECLAIMED ASPHALT PAVEMENT (RAP) IN THE MIX AS PERCENT OF TOTAL AGGREGATE

File # _____ REPORT # _____

PROJECT _____ COUNTY _____ PCN _____

DATE _____ INSPECTOR _____ CONTRACTOR _____

Per Cent RAP Desired _____ Per Cent RAP by Test _____ MATERIAL TYPE _____

WEIGH TICKET ENTRIES

A.	Total of hot mix produced by tickets (tons)	
B.	Moisture in the mix percentage (most recent one tested)	
C.	Moisture in the mix (tons)	
D.	Total dry amount of hot mix produce for the day (tons)	
E.	Added binder percentage by cutoff (DOT-89)	
F	Total amount of added binder (tons)	
G.	Added lime percentage by cutoff (DOT-33Q)	
H.	Total amount of added lime (tons)	
I.	Total dry Virgin MA and RAP from tickets & cutoffs (tons)	

WEIGH BRIDGE ENTRIES

J.	Weight of Virgin MA from weight bridge totalizer (tons)	
K.	Percentage moisture in Virgin MA	
L.	Weight of water in in Virgin MA (tons)	
M.	Weight of dry Virgin MA (tons)	
N.	Weight of RAP from weigh bridge totalizer (tons)	
O.	Percent moisture in RAP	
P.	Weight of water in the RAP mixture (tons)	
Q.	Weight of dry RAP from weigh bridge totalizer (tons)	
R.	Total dry Virgin MA and RAP from weigh bridges (tons)	

RAP PERCENTAGES

S.	Percentage of RAP based on weigh bridges	
T.	Percentage of RAP based on weigh tickets	
U.	% difference between scale tickets and weigh bridges	

DOT-97
(7-10)

SOUTH DAKOTA
DEPARTMENT OF TRANSPORTATION
FILE NO. _____

CERTIFICATE OF COMPLIANCE FOR ASPHALT CONCRETE COMPOSITE

PROJECT _____ COUNTY _____ PCN _____

CONTRACTOR _____ AREA ENGINEER _____ DATE _____

Asphalt Concrete Class _____ Type _____

Supplier of Asphalt Concrete _____

Supplier of Asphalt Binder _____

Grade of Asphalt Binder _____

Source of Mineral Aggregate _____

JOB MIX FORMULA

3/4"	Sieve	.....	% Passing	_____
1/2"	Sieve	.....	% Passing	_____
#4	Sieve	.....	% Passing	_____
#8	Sieve	.....	% Passing	_____
#16	Sieve	.....	% Passing	_____
#40	Sieve	.....	% Passing	_____
#200	Sieve	.....	% Passing	_____

Percent of Asphalt Binder (% By Weight of Total Mix) ..... _____

Asphalt Binder Application Temperature ..... _____

Temperature of Mixture When Emptied from Mixer (Drum) ..... _____

Temperature of Mixture on Delivery to the Road ..... _____

This Certificate of Compliance certifies that the materials for Asphalt Concrete complies with specifications requirements of the South Dakota Department of Transportation.

Signed: _____

Supplier's Authorized Representative

Section Number 7

Section Number 7

Section Number 7

SDDOT PROFICIENCY SAMPLE PROGRAM

In an effort to improve the Quality Control/Quality Assurance mix design verification process, the SDDOT Bituminous Mix Design Laboratory has started a Proficiency Sample Program and developed a standard mix design submittal spreadsheet for Contractors to use. All Contractors/Consultants submitting mix designs to the SDDOT are required to participate in the Proficiency Sample Program.

SDDOT's new Proficiency Sample Program allows the Bituminous Mix Design lab, Contractors labs, and Consultants labs to compare equipment and technician proficiency under actual testing conditions using samples sent out from the Bituminous Mix Design lab in Pierre. In the late fall or winter, samples will be sent to all Contractors and Consultants who have submitted mix designs to the SDDOT. Others wishing to participate in the Proficiency Sample Program can request to be included by contacting Jim Costello at 605 773-3700 or Rick Rowen at 605 773-3427.

South Dakota's round robin Proficiency Sample Program is set up in a manner similar to the AMRL Proficiency Sample Program. SDDOT has been a member the AMRL Proficiency Sample Program for many years. Participants in SDDOT's Proficiency Sample Program will receive a summary showing their results, SDDOT results, and the average results from all participants.

Current South Dakota Test Procedures are in the South Dakota Materials Manual and are at the SDDOT web site under Materials and Surfacing. These SDDOT test procedures and if required by specification the current AASHTO/ASTM test procedures should be followed when conducting all of the required tests.

Section Number 8

Section Number 8

Section Number 8

QC/QA Project Inspection Report

Project Number _____ PCN _____ Date _____

County_____Project Engineer _____ Lab Site telephone number _____

Quality Assurance Lab	Comments
Types of mix being produced?	
Source and types of binders being used?	
Are the mix design(s) posted in the lab?	
Any changes to the original mix design(s)?	
Are current test proceds.&spec _____in lab?	
type_, size and number of rooms in lab provided	
lab meets requirements? (DOT 50) exceptions?	
Can technicians see plant operations from lab?	
Type/condition/ SD ID # of gyratory compactor	
condition of molds and plates	
Thermometers ((type, number, calibrated(labs))	
thermometers of correct type for applications	
Scales leveled and checked after set up?	
Calibration records for testing equipment in lab?	
all testing equipment provided? Region checked?	
all equipment meets SDDOT testing requirements	
weighing in water apparatus with overflow setup	
correlation testing (mix from Project, Yes or No)	
Fall within tolerances? Gmb, Gmm,Va,gradation	
Is correct MS&T numbering & procedures used?	
What process used to notify QC to get sample?	
Is random number procedure used for samples?	
Is random QA sampling being done by QA? Note	
Does QA watch QC sampling and splitting?	
QC and QA test results entered into M S &T	
QA test results given to QC upon completion	
any bin split changes?(amount)shown onDOT 3?	
Was bulk specific gravity reheat done? Results	
Is moisture in the mix test done? Frequency?	
Cores cored by QC and taken back to lab by QA	
Is core dryback procedure used correctly?DOT 8	
oil content and inpl. density results given to QC?	
IA witness sampling and splitting procedures?	
IA test results available in lab? Added QC charts	
Oil samples & cert entered MS&T? Look at cert.	
PG binder & emulsion samples.Witness or take?	
Receiving daily chart or print out of mix temps.?	
How daily PG binder cutoff done?Witness or do?	
Any out of spec. (0.3) tolerance? Action taken?	
How is daily lime cutoff done? Aggr.1.0% > SSD?	
Any out of spec.(0.10) tolerance? Action taken?	
RAP cutoff DOT-93 within + or - 5 % of target ?	
Any other failing tests on the Project?	
What action was taken?	
Any QC split samples out of tolerance?	
What corrective action was taken?	
Any IA split samples out of tolerance?	
What corrective action was taken?	
Is similiar/dissimiliar test procedure being used?	
Any dissimilar? Action taken?	
Are all backup samples being retained? For job?	
certified tester name and cert expiration date	
certified tester name and cert expiration date	
non certified helpers names	
non certified work checked?,has perf checklists?	
diary contains?oil%,tons, changes,problems,etc.	
QA comments?	