ARIZONA DEPARTMENT OF TRANSPORTATION * MATERIALS GROUP

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CHANGE LETTER

James P. Delton
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MATERIALS TESTING MANUAL	CHANGE LETTER NO. 25
SUBJECT: Title Page; Table of Contents; Cover Sheets for Series 100, Series 200, and Series 400; Arizona Test Methods 104d, 247a, 410d, and 417c.	EFFECTIVE DATE: December 15, 2010

SUMMARY:

NOTE: Unless otherwise specified, changes issued under this Change Letter are effective for projects with a bid opening date on or after December 15, 2010. Retain items removed from the Materials Testing Manual under this change letter for use as necessary on projects with a bid opening date prior to December 15, 2010.

1. TITLE PAGE - The Title Page has been revised to show the latest Change Letter number and revision date. Please replace the existing Title Page with the attached.

2. TABLE OF CONTENTS - The Table of Contents has been revised to reflect the changes made in this Change Letter. Please replace the existing Table of Contents with the attached.

3. The following items are revised by this Change Letter. Please replace the respective existing items with the attached.

   Series 100 Cover Sheet, "SAMPLING" (December 15, 2010).

   Series 200 Cover Sheet, "SOILS AND AGGREGATES" (December 15, 2010).

   Series 400 Cover Sheet, "BITUMINOUS MIXTURES" (December 15, 2010).

   Arizona Test Method 104d, "SAMPLING BITUMINOUS MIXTURES".

Arizona Test Method 247a, "PARTICLE SHAPE AND TEXTURE OF FINE AGGREGATE USING UNCOMPACTED VOID CONTENT".

Arizona Test Method 410d, "COMPACTION AND TESTING OF BITUMINOUS MIXTURES UTILIZING FOUR INCH MARSHALL APPARATUS".

Note: In addition to other revisions to the above test procedure, the title has also been revised.

Arizona Test Method 417c, "MAXIMUM THEORETICAL SPECIFIC GRAVITY AND DENSITY OF FIELD PRODUCED BITUMINOUS MIXTURES (RICE TEST)".

Note: In addition to other revisions to the above test procedure, the title has also been revised.

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Attachments

MATERIALS

TESTING MANUAL

SAMPLING AND TESTING PROCEDURES

PREPARED BY:
ARIZONA DEPARTMENT OF TRANSPORTATION
INTERMODAL TRANSPORTATION DIVISION
MATERIALS GROUP

REVISED TO CHANGE LETTER NO. 25
(December 15, 2010)

December 15, 2010
(5 Pages)

MATERIALS TESTING MANUAL

TABLE OF CONTENTS

****** The above Arizona Test Methods, and also commonly used AASHTO procedures in this category, are shown on Series 200 Cover Sheet (December 15, 2010).

SERIES 300 CONCRETE**

****** The above Arizona Test Methods, and also commonly used AASHTO and ASTM procedures in this category are show on Series 300 Cover Sheet (March 31, 2010).

SERIES 400 BITUMINOUS MIXTURES**

****** The above Arizona Test Methods, and also commonly used AASHTO procedures in this category, are show on Series 400 Cover Sheet (December 15, 2010).

SERIES 500 BITUMINOUS MATERIALS**

****** The above Arizona Test Methods, and also commonly used AASHTO and ASTM procedures and specifications are shown on Series 500 Cover Sheet (July 15, 2005).

SERIES 600 CEMENT AND RELATED MATERIALS**

****** Commonly used AASHTO and ASTM procedures in this category are show on Series 600 Cover Sheet (July 15, 2005).

SERIES 700 CHEMICAL AND SPECIALTY**

****** The above Arizona Test Methods, and also commonly used AASHTO and ASTM procedures in this category are show on Series 700 Cover Sheet (March 31, 2010).

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SERIES 100

SAMPLING

The following methods shall be performed in accordance with the respective designation:

ARIZONA TEST METHODS:

TITLE	DESIGNATION
Sampling Bituminous Materials…….	ARIZ 103a
Sampling Bituminous Mixtures……..	ARIZ 104d
Sampling Soils and Aggregates……..	ARIZ 105d
Sampling Hydrated Lime and Lime Products…….	ARIZ 108
Sampling Metallic Materials…….	ARIZ 109
Sampling Miscellaneous Materials…….	ARIZ 110

Note: Sampling of crumb rubber is performed in accordance with Arizona Test Method 714.

AASHTO TEST METHODS:

TITLE	DESIGNATION
Sampling and Testing Brick ……...	T 32
Sampling and Amount of Testing of Hydraulic Cement	T 127
Sampling Freshly Mixed Concrete .....….	T 141
Reducing Samples of Aggregate to Testing Size…….	T 248

NOTE: It shall be assured that the appropriate methods as given in the project requirements are being adhered to.

NOTE: Refer to Series 900, “Materials Quality Assurance Program”, of the Materials Testing Manual for current guidelines on sampling of materials for acceptance, independent assurance, and correlation testing.

December 15, 2010
(4 Pages)

SERIES 200

SOILS AND AGGREGATES

The following test methods shall be performed in accordance with the respective designation:

ARIZONA TEST METHODS:

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Flakiness Index of Coarse Aggregate……...	ARIZ 233c
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Determining pH and Minimum Resistivity of Soils and Aggregates……...	ARIZ 236b
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NOTE: It shall be assured that the appropriate test methods as given in the project requirements are being adhered to.

December 15, 2010
(2 Pages)

SERIES 400

BITUMINOUS MIXTURES

The following test methods shall be performed in accordance with the respective designation:

ARIZONA TEST METHODS:

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Maximum Theoretical Specific Gravity and Density of Field Produced Bituminous Mixtures (Rice Test)……..	ARIZ 417c
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NOTE: It shall be assured that the appropriate test methods as given in the project requirements are being adhered to.

SAMPLING BITUMINOUS MIXTURES

(An Arizona Method)

1. SCOPE

(a) This procedure describes the methods which are to be used when sampling bituminous mixtures.

(b) Sampling bituminous mixtures by this procedure may involve hazardous material, operations, or equipment. This procedure does not purport to address all of the safety concerns associated with its use. It is the responsibility of the user to consult and establish appropriate safety and health practices and determine the applicability of any regulatory limitations prior to use.

2. SAMPLING PLANT-MIXED BITUMINOUS MIXTURES

(a) Asphaltic Concrete and Asphaltic Concrete (Asphalt-Rubber) shall be sampled as described in paragraphs 2(d) through 2(f).

(b) Asphaltic Concrete Friction Course and Asphaltic Concrete Friction Course (Asphalt-Rubber) shall be sampled as described in paragraph 2(g).

(c) Minimum sample sizes shall be as follows:

1) For Asphaltic Concrete Friction Course mixtures or Asphaltic Concrete Friction Course (Asphalt-Rubber) mixtures, 50 pounds.

2) For Asphaltic Concrete mixtures or Asphaltic Concrete (Asphalt-Rubber) mixtures designed with Marshall design procedures, 75 pounds.

3) For Asphaltic Concrete mixtures designed with Gyratory design procedures, 130 pounds.

(d) A 4 foot x 1 foot x 1/16 inch steel plate, which has been prepared with a 1/8 inch hole at each corner of one end and a sufficient length of wire tied through each hole to form a loop approximately 4 feet in length, shall be placed on the roadway just ahead of the laydown machine. Except for wider mats when a sample is being taken from the middle of the mat, the steel plate is placed so that the end with the wire is approximately one foot in from the right or left edge of the mat being laid. The sampling

should be alternated between the right and left edges, and on wider mats also the middle when practical. The wire attached to the end of the plate shall be held to the ground to allow the laydown machine to pass over the plate and wire.

(e) After the laydown machine has passed, locate the plate by raising the wire.

(f) The sample shall be taken from the plate using a flat square point shovel. The sample shall consist of the full depth of material for one shovel width from the center portion of the plate over its entire length. Material covering the entire plate shall not be taken. A single pass of the shovel shall be made, moving along the surface of the plate until the shovel is full. Carefully deposit the bituminous mixture into a 5-gallon bucket, or other suitable container. Material which has sloughed into the resultant trench shall not be obtained. At the next undisturbed area of material on the plate, repeat shoveling and placing the material into the container. If necessary, additional material may be obtained by using an additional plate(s) in the immediate vicinity and combining all material. The use of an additional plate(s) cannot be used in lieu of splitting.

NOTE: As an alternate to obtaining the sample from the plate using a shovel as described above, a rectangular metal template ("cookie cutter") and metal plate of sufficient size may be used to sample the bituminous mixture. The metal template and plate shall be of sufficient size so that the desired amount of material is obtained by a single use of the template and plate at any one location. The metal plate shall be prepared with a wire(s) of sufficient length attached to each corner on one side of the metal plate (the short side when the plate is not square) so the metal plate may be located by raising the wire(s) after the laydown machine has passed. The metal plate shall be placed on the roadway at the location where the sample is to be taken, just ahead of the laydown machine. If the metal template is not square, it shall be placed on the roadway so that the longest side is in a transverse direction across the roadway. The wire(s) shall be held to the ground to allow the laydown machine to pass over the plate and wire(s). After the laydown machine has passed, locate the plate by raising the wire(s). The template is pressed through the bituminous mixture until it rests squarely upon the plate. The entire amount of bituminous mixture is removed from the interior of the template and carefully placed into a 5-gallon bucket, or other suitable container. Obtaining multiple samples cannot be used in lieu of splitting.

(g) When sampling Asphaltic Concrete Friction Course or Asphaltic Concrete Friction Course (Asphalt-Rubber), an adequate amount of material shall be taken from the truck at the mixing plant and placed into a 5-gallon bucket, or other suitable container. The sample shall be taken from at least 3 random locations, approximately 12" below the surface, within five minutes from the time the loading of the truck is completed.

(h) Material that is to be tested immediately after it has been sampled shall be protected to avoid heat loss while it is being transported to the laboratory.

3. SAMPLING FINISHED BITUMINOUS PAVEMENT

(a) Samples of bituminous mixture from finished pavement shall be taken through the complete thickness of the pavement or lift, in such a manner which causes minimum disturbance to the sample.

(b) If coring apparatus is used, the coring bit shall be subjected to enough vertical pressure to penetrate the pavement without causing damage to equipment or disturbance of the sample. Minimum core diameter shall be 4 inches.

(c) If coring equipment is not available, the sample may be taken with the use of a saw, pick, jackhammer, or other suitable means if a suitable specimen can be obtained for the intended testing.

(d) All samples shall be contained in their briquette form, transported on a relatively flat surface, and adequately protected to preserve shape and prevent fracture.

(e) The use of ice may be found helpful in obtaining and/or preserving the condition of the specimen.

4. SAMPLING MISCELLANEOUS PLACEMENT OF BITUMINOUS MIXTURES

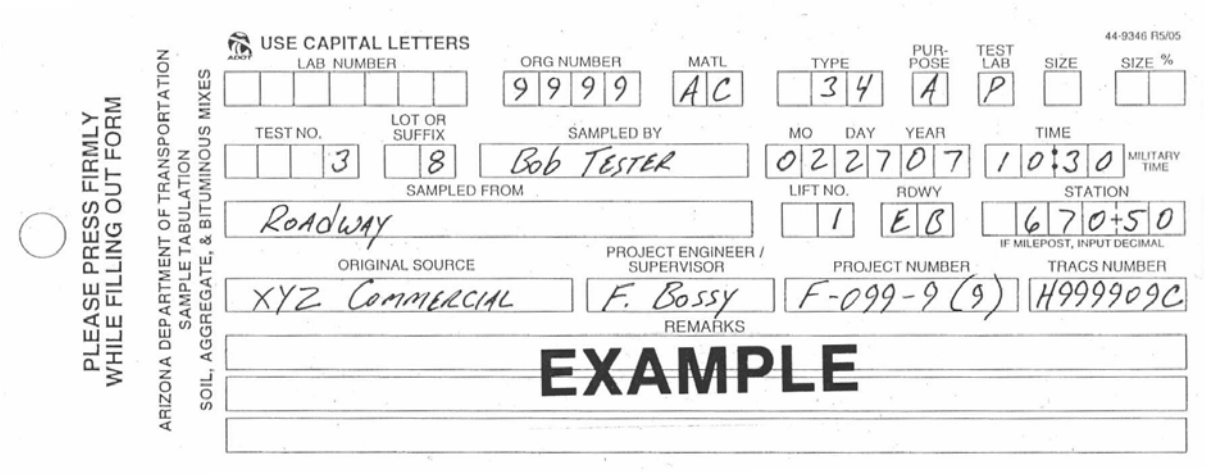
(a) The sampling of bituminous mixture used in paving slopes, median islands and other miscellaneous placement shall be accomplished by taking an adequate amount of material from the hauling vehicle by random shovelfuls.

5. SAMPLE IDENTIFICATION

(a) Each sample shall be identified by an accompanying sample ticket. Sample tickets shall be filled out as required to provide necessary information. The remarks area of the sample ticket should be used as necessary to provide additional information.

(b) The source of the sample shall be the "original source" of the material, as indicated on the sample ticket.

(c) An example of a completed sample ticket used by ADOT for construction projects is given below.



(d) The sample ticket consists of three copies. The center copy is kept by the person submitting the sample, the original copy is included inside the sample container, and the third copy is attached to the sample container. When filling out sample tickets, make certain information is clear and easily read on all three copies.

ARIZ 247a
December 15, 2010
(6 Pages)

PARTICLE SHAPE AND TEXTURE OF FINE AGGREGATE USING UNCOMPACTED VOID CONTENT

(A Modification of AASHTO T 304)

1. SCOPE

(a) This method covers the determination of the "Uncompacted Void Content" of a fine aggregate for use as a measure of its angularity and texture.

(b) This procedure provides a numerical result in terms of percent void content, determined under standardized conditions, which correlates with the particle shape and texture properties of a fine aggregate. An increase in void content indicates greater angularity and rougher texture. Lower void content results are associated with more rounded smooth particles.

(c) See Appendix A1 of the Materials Testing Manual for information regarding the procedure to be used for rounding numbers to the required degree of accuracy.

2. APPARATUS

NOTE: Requirements for the frequency of equipment calibration and verification are found in Appendix A3 of the Materials Testing Manual.

(a) A funnel having a volume of at least 200 cm^3, or being equipped with a supplemental container to provide the required volume, (See Figure 1).

(b) Funnel Stand - A support capable of holding the funnel firmly in position with its axis vertically in line with the axis of the measure, and the funnel opening 4.5 ± 0.1 inches above the top of the cylinder. A suitable arrangement is shown in Figure 1.

(c) Measure - A cylinder of approximately 100 cm^3 capacity, (See Figure 2).

(d) A flat metal or plastic pan of sufficient size for containing the funnel stand, and preventing loss of material that overflows the measure during filling and strike off. The pan shall not be warped so as to prevent rocking of the apparatus during testing.

(e) A straight metal spatula about 4 inches long and 1/2" wide. The end shall be cut at a right angle to the edges. The straight edge of the spatula is used to strike off the fine aggregate.

(f) A balance or scale capable of measuring the maximum weight to be determined and conforming to the requirements of AASHTO M 231, except the readability and sensitivity of any balance or scale utilized shall be at least 0.1 gram.

(g) Sieves of sizes No. 8, No. 16, No. 30, No. 50 and No. 100, conforming to the requirements of AASHTO M 92.

3. CALIBRATION OF MEASURE

(a) Determine and record the weight of the dry, empty measure and a flat, glass plate slightly larger than it's diameter. Fill the measure with water at a temperature of 77 $\pm$ 1° F. Place the glass plate on the measure, being sure that no air bubbles remain. It may be necessary to lightly coat the top edge of the measure with grease prior to determining the weight of the empty measure and glass plate. Dry the outer surfaces of the measure and determine and record the combined weight of measure, glass plate, and water.

(b) Determine and record the volume of the measure to the nearest 0.01 cm^3 by the following calculation:

$$V = \frac{w}{0.997}$$

Where: V = volume of cylinder in cm^3
w = net weight of water in grams

4. SAMPLE PREPARATION

(a) Obtain a representative minimum 500 gram sample of minus #8 material. The sample used for this test may either be virgin aggregate, or aggregate obtained from the extraction of a bituminous mixture.

(b) Utilizing either a No. 100 or a No. 200 sieve, wash the sample in accordance with either Section 6 or 7 of Arizona Test Method 201. Dry the material to constant weight and sieve into size fractions as indicated in paragraph 4(c) below. Maintain the material in a dry condition in separate containers for each of the sizes specified. The sieving is to be accomplished in accordance with Arizona Test

Method 201, using either the sieve sizes specified in paragraph 2(g) of this procedure; or, the entire nest of sieves for determining the fine sieve analysis and then combining the material into the designated size fractions. An additional sample(s) may be required to be washed and sieved to obtain the required amount of each size fraction.

(c) Weigh out and combine the following quantities of dry fine aggregate from each of the sizes below:

PASS	RETAINED	WEIGHT IN GRAMS	ACCUM. WEIGHT
# 8	# 16	44 ± 0.2	44 ± 0.2
# 16	# 30	57 ± 0.2	101 ± 0.4
# 30	# 50	72 ± 0.2	173 ± 0.6
# 50	# 100	17 ± 0.2	190 ± 0.8

5. PROCEDURE

(a) If the fine aggregate has become moist, dry to constant weight and cool to room temperature.

(b) Record the weight of the empty measure to the nearest 0.1 gram, place the funnel and measure in the funnel stand, and place the assembly in the pan described in paragraph 2(d).

(c) Mix the test sample until it appears homogeneous. Using a finger (if a slide trap is not attached) to block the opening, pour the test sample into the funnel. Make sure the funnel is centered over the measure, remove the finger (or slide trap), and allow the sample to fall freely into the measure.

(d) After the funnel empties, remove excess fine aggregate from the measure by a single pass of the spatula with the edge of the blade vertical and in light contact with the top of the measure. Until this operation is complete, exercise care to avoid vibration or disturbance that could cause compaction of the fine aggregate in the measure. After strike-off, tap the measure lightly to compact the sample to make it easier to transfer the measure to the balance without spilling any of the sample. Brush adhering material from the outside of the measure and determine and record the weight of the measure and contents to the nearest 0.1 gram.

(e) Collect all of the fine aggregate from the pan and measure, and repeat the procedure again.

(f) For each determination, record the net weight of the fine aggregate in the measure. If the two net weights differ by 0.5 gram or less, average the two weights and

record to the nearest 0.1 gram as the "average net weight of fine aggregate in measure", (W). If the two weights differ by more than 0.5 gram, the procedure shall be repeated until any two results are achieved which differ by 0.5 gram or less. The average of these two results is recorded to the nearest 0.1 gram as the "average net weight of fine aggregate in measure", (W).

6. CALCULATION

(a) Determine and record the "Uncompacted Void Content" (U), to the nearest 0.1% by the following calculation:

$$U = \frac{V - (W/G)}{V} \times 100$$

Where: U = Uncompacted Void Content, percent.

V = volume of measure in cm^3.

W = average net weight of fine aggregate in measure.

G = bulk oven dry specific gravity of fine aggregate, measured in accordance with Arizona Test Method 211, "Specific Gravity and Absorption of Fine Aggregate".

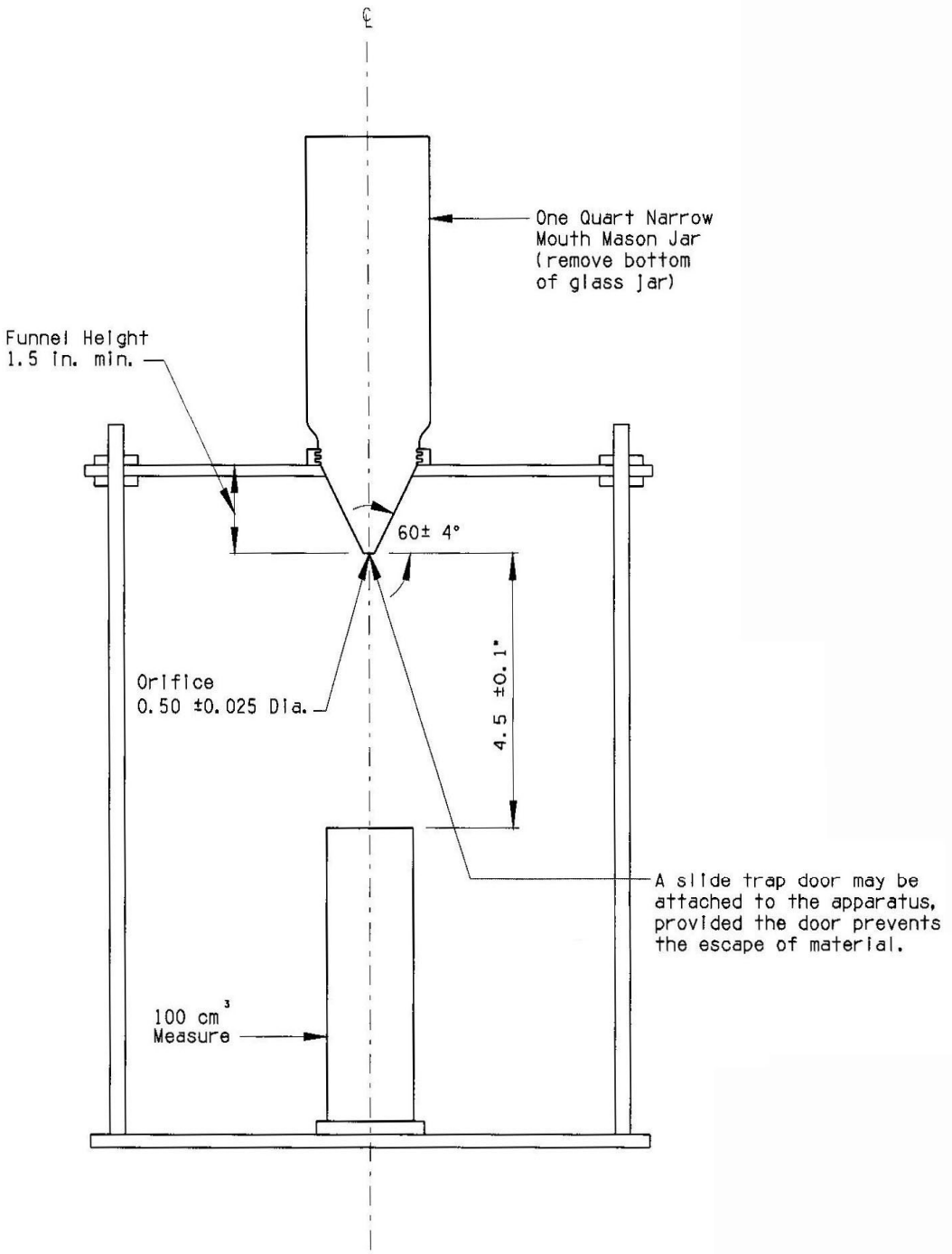
(b) For most aggregate sources the fine aggregate specific gravity does not vary much from sample to sample. It is intended that the value used in the above calculation be from a routine specific gravity test which is representative of the fine aggregate. A difference in specific gravity of 0.05 will change the calculated "Uncompacted Void Content" about one percent.

7. REPORT

(a) The "Uncompacted Void Content" (U), to the nearest 0.1%.

(b) The bulk oven dry specific gravity of the fine aggregate (G), to the nearest 0.001.

FUNNEL, FUNNEL STAND, AND MEASURE



Section Through Center of Apparatus

FIGURE 1

MEASURE

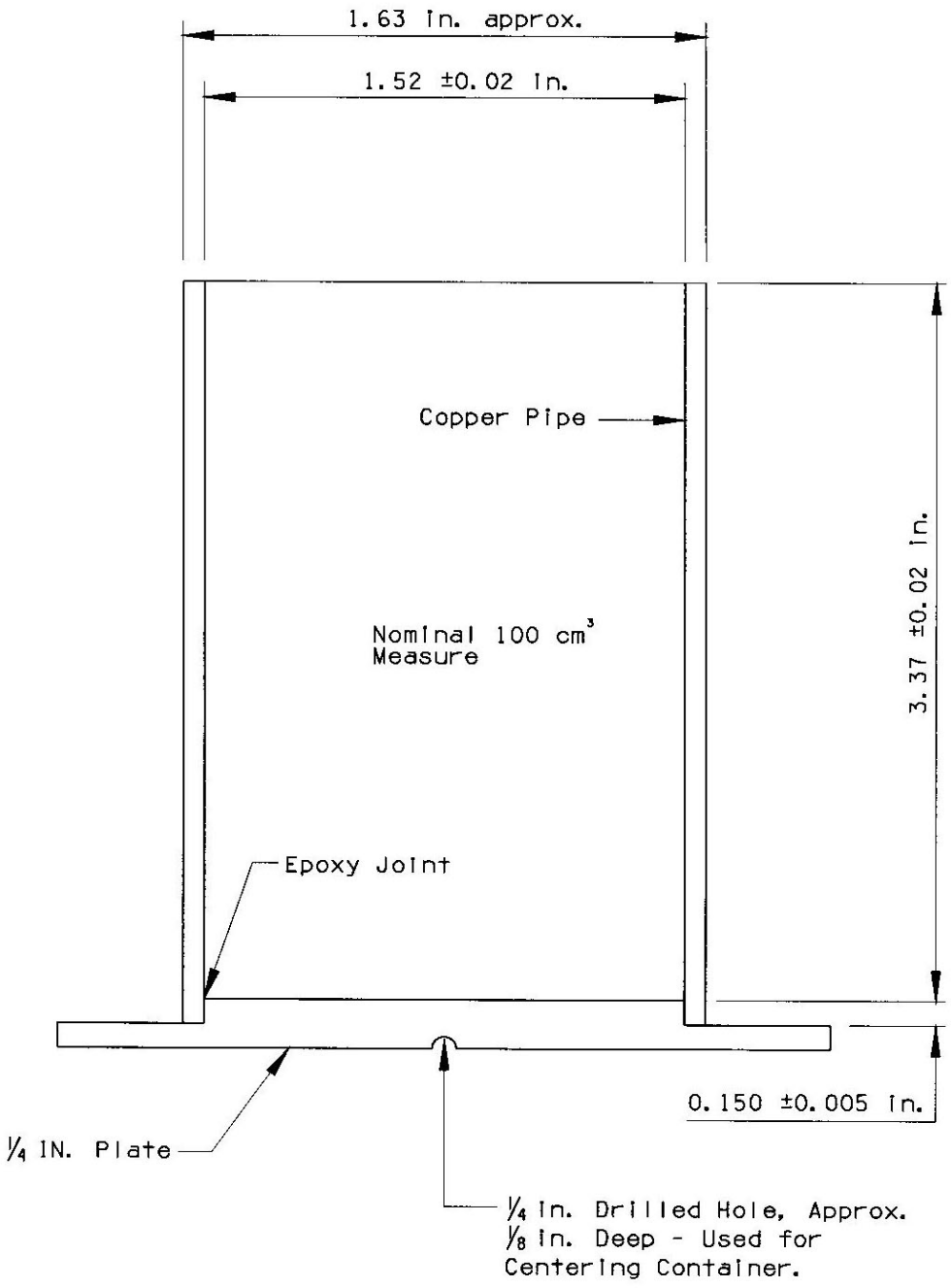


FIGURE 2

COMPACTION AND TESTING OF BITUMINOUS MIXTURES UTILIZING FOUR INCH MARSHALL APPARATUS

(A Modification of AASHTO T 245)

1. SCOPE

(a) This method covers the procedure for compacting and testing bituminous mixtures utilizing four inch Marshall apparatus.

(b) This procedure is used for bituminous mixtures with a mix design gradation target of at least 85% passing the 3/4 inch sieve sieve.

(c) This test method may involve hazardous material, operations, or equipment. This test method does not purport to address all of the safety concerns associated with its use. It is the responsibility of the user to consult and establish appropriate safety and health practices and determine the applicability of any regulatory limitations prior to use.

(d) See Appendix A1 of the Materials Testing Manual for information regarding the procedure to be used for rounding numbers to the required degree of accuracy.

2. APPARATUS

(a) Requirements for the frequency of equipment calibration and verification are found in Appendix A3 of the Materials Testing Manual. Apparatus for this test procedure shall consist of the following:

(b) Compaction Mold Assembly 4 inch diameter cylindrical mold, baseplate, and extension collar constructed of steel and conforming to the requirements of Figure 1. (Three compaction mold assemblies are normally utilized.)

(c) Specimen Extruding Device - Extrusion jack or press for extruding specimens from molds.

(d) Compaction Hammer.

1) The compaction hammer shall either be a mechanical or hand compaction hammer having a flat, circular tamping face with a nominal diameter of (3-7/8 inches), and a (10 ± 1/4 pound) sliding weight with a free fall of (18 ± 1/2 inches).

2) Compaction hammers must be monitored through the ADOT proficiency sample program. To be qualified, compaction hammers must produce specimens with an average density of no greater than ± 1.0 lb./cu. ft. from the average bulk density for the most recent set of proficiency samples. If two samples are required for the proficiency samples, both of the bulk density sets must meet the ± 1.0 lb./cu. ft. criteria, if not, the hammer is not qualified.

3) As an alternate to qualifying a compaction hammer through the proficiency sample program, a compaction hammer may be qualified by correlating with a hammer which has been approved through comparison with proficiency sample results. When qualified in this manner, results must be no greater than ± 0.5 lb./cu. ft.

4) Hammers which have had adjustments or repairs made to them after being qualified, must be requalified by correlating with another qualified hammer and yield results within ± 0.5 lb./cu. ft.

NOTE: In that Marshall compaction equipment can go out of calibration at any time, each laboratory is encouraged to establish a method of ensuring that their equipment remains in calibration. Alternate methods that can be used include regular comparisons with other approved hammers or compaction of samples which have a known density.

5) Hammers which do not meet the above requirements may be adjusted by modifying the weight, or the height of fall, within the given criteria; by adjusting the number of blows a maximum of ± 10 from the specified 75 blows; or by a combination of adjustments to weight, height of fall, or number of blows.

6) Should a compacton pedestal be moved or replaced, the compaction hammer(s) shall be requalified.

(e) Compaction pedestal - The compaction pedestal shall consist of a 8" x 8" x 18" wooden post capped with a 12" x 12" x 1" steel plate. The steel cap shall be firmly fastened to the post. The wooden post shall have a dry weight of 42 to 48 lbs./cu. ft. and shall rest squarely on, and be firmly secured to, a solid concrete slab. The pedestal assembly shall be installed so that the post is plumb and the cap is level.

(f) Specimen Mold Holder - Mounted on the compaction pedestal so as to center the compaction mold over the center of the post. It shall hold the compaction mold, collar, and base plate securely in position during compaction of specimen.

(g) Oven for heating bituminous mixtures and specimen mold assemblies at required temperature.

(h) Hot plate for heating compaction hammer, spoon and spatula.

(i) A flat spatula with blade approximately 1 inch wide and at least 6 inches long, stiff enough to penetrate the entire bituminous mixture.

(j) Calibrated/verified thermometers, for determining temperatures of bituminous mixtures, with a range of 50 to 400 °F and increments of not greater than 5 °F. For digital thermometers, increments shall not be greater than 1 °F.

(k) A balance or scale capable of measuring the maximum weight to be determined and conforming to the requirements of AASHTO M 231, except the readability and sensitivity of any balance or scale utilized shall be at least one gram.

(l) If Marshall stability and flow are to be determined, the following additional apparatus is required:

1) Breaking Head and Water Bath, conforming to the requirements specified in AASHTO T 245.

2) Marshall stability and flow testing apparatus, with operating instruction manual. The apparatus shall be capable of applying a load with a constant rate of travel of 2.0 ± 0.1 inches per minute.

3) Height gauge capable of measuring the height of specimens to the nearest 0.001 inch.

3. PROCEDURE

(a) Obtain three representative samples for Marshall specimens, as described in Arizona Test Method 416. If the Combined Aggregate Bulk (O.D.) Specific Gravity is known, the weight calculated by the following equation (± 50 grams) will normally give specimens which meet the height requirement of 2.300 to 2.700 inches. (1150 ± 50 grams is generally adequate.)

$$\left[\begin{array}{c}\text{Weight of}\\ \text{each Sample}\end{array}\right] = \frac{\left[\begin{array}{c}\text{Combined Aggregate}\\ \text{Bulk (O.D.) Specific Gravity}\end{array}\right]}{2.520} \times 1150$$

(b) Before placing the mixture in the mold, the mixture and a mold assembly (baseplate, mold, and collar) shall be at approximately 290 °F. The face of the compaction hammer shall be thoroughly cleaned and heated on a hot plate set at approximately 290 °F. The temperature of the laboratory during compaction of the specimens shall be between 68 and 86 °F.

(c) Place a 4 inch paper disc in the bottom of the mold before the mixture is introduced. Place the entire batch in the mold in one lift. Care should be taken to avoid segregation of material in the mold. Spade the mixture vigorously, penetrating the entire mix, with the heated spatula 15 times around perimeter and 10 times over the interior. Smooth the surface of the mix to a slightly rounded shape.

(d) The compaction temperature shall be as designated on the mix design.

(e) If necessary, the mixture and mold assembly shall be returned to an oven at the required temperature for the minimum time necessary to achieve the required compaction temperature. In no case shall the mixture be reheated longer than 60 minutes.

(f) Place a 4 inch paper disc on top of material, place the mold assembly on the compaction pedestal in the mold holder, and apply 75 blows [or adjusted number, as determined in paragraph 2(d)] with the compaction hammer. When a hand hammer is utilized, the operator shall hold the handle by one hand so that the axis of the compaction hammer is as nearly perpendicular to the base of the mold assembly as possible while compaction is accomplished. Care shall be taken not to add body weight to the hammer by leaning or pressing down on the hammer. When using a hand hammer, no mechanical device of any kind is to be used to restrict movement of the handle during compaction. Compaction shall be performed at a minimum rate of 40 blows per minute. The compaction hammer shall apply only one blow with each fall, that is, there shall not be a rebound impact. Remove the base plate and collar, and reverse and reassemble the mold. Apply 75 (or adjusted number) compaction blows to the face of the reversed specimen.

(g) Remove collar, baseplate, and paper discs, and allow specimen to cool. Cooling may be accomplished at room temperature, in a 77 °F air bath, or if more rapid cooling is desired the mold and specimen may be placed in front of a fan until cool.

(h) Extrude the specimen from the mold. Care shall be taken in extruding the specimen from the mold, so as not to develop tensile stresses in the specimen or tear the sides of the specimen.

4. SPECIMEN TESTING

(a) If Marshall stability and flow are to be determined, measure height of specimens to the nearest 0.001 inch. Prior to measurement of height, excess material shall be brushed from the edges of the specimens. Compacted specimens shall be 2.300 to 2.700 inches in height. If this criteria is not met, the entire set of specimens shall be discarded and a new set prepared after necessary adjustments in sample weight have been made.

(b) Determine the specific gravity of the specimens in accordance with Arizona Test Method 415, Method A. (Assume specimen is at constant weight after cooling.)

(c) Determine the bulk density of each of the specimens, by multiplying the respective specific gravity by 62.3 lbs./cu. ft. Record the individual bulk densities to the nearest 0.1 lb./cu. ft. The densities of the three specimens shall not differ by more than 2.5 lbs./cu. ft. for 1/2", 3/4", or recycle mixes; and 3.0 lbs./cu. ft. for Base mixes. If this density requirement is not met, the entire set of specimens shall be discarded and a new set of specimens prepared.

(d) Determine the average specific gravity of the specimens and record to the nearest 0.001. Calculate the average bulk density of the specimens, by multiplying the average specific gravity by 62.3 lbs./cu. ft. Record the average bulk density to the nearest 0.1 lb./cu. ft.

(e) If the stability and flow are to be determined, the steps in paragraphs (f) through (k) below are followed, utilizing apparatus in accordance with the operating instructions for that apparatus.

(f) Bring the specimens to 140° ± 2 °F by immersing in the water bath 30 to 40 minutes. Prior to testing, it shall be assured that the inside of the test heads are clean, and that the guide rods are clean and lubricated so that the upper test head slides freely over them.

(g) The breaking head temperature shall be maintained between 70 to 100 °F, using a water bath when required. Remove the specimen from the water bath, quickly towel dry specimen and place in the lower segment of the breaking head. Place the upper segment of the breaking head on the specimen, and place the complete assembly in position on the testing machine.

(h) Apply the load to the specimen with a constant rate of 2.0 ± 0.1 inches per minute until the maximum load is reached and the load decreases. The maximum load is defined as the last point in the load/time curve before the load decreases. The elapsed time for the test from removal of the test specimen from water bath to maximum load determination shall not exceed 30 seconds.

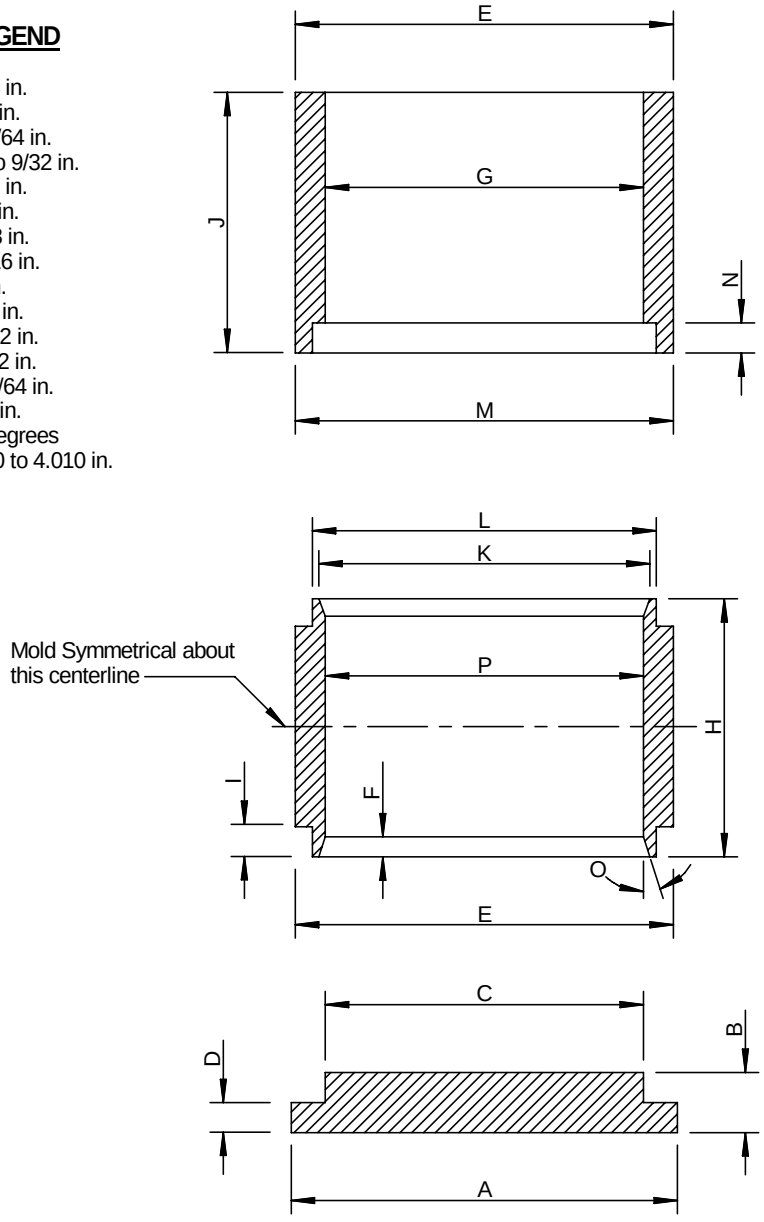
(i) Record the stability of each specimen to the nearest 10 pounds force, and the flow to the nearest 0.01 inch.

(j) Correct the stability obtained for each specimen, for the height of the specimen, by the table in Figure 2. Record the corrected stability to the nearest 10 pounds force.

(k) Determine and record the average corrected stability to the nearest 10 pounds force, and the average flow to the nearest 0.01 inch.

LEGEND

A: 4-3/4 in.
B: 9/16 in.
C: 3-63/64 in.
D: 1/8 to 9/32 in.
E: 4-1/2 in.
F: 3/16 in.
G: 4-1/8 in.
H: 3-7/16 in.
I: 1/4 in.
J: 2-3/4 in.
K: 4-5/32 in.
L: 4-9/32 in.
M: 4-19/64 in.
N: 9/32 in.
O: 20 degrees
P: 3.990 to 4.010 in.



All dimensions are nominal, except where tolerances are indicated.

Four Inch Compaction Mold, Extension Collar, and Baseplate

FIGURE 1

STABILITY CORRELATION RATIOS*

For 4 inch Diameter Specimens

Height of Specimen (Inches)	Correlation Ratio
2.300 - 2.306	1.15
2.307 - 2.319	1.14
2.320 - 2.332	1.13
2.333 - 2.344	1.12
2.345 - 2.357	1.11
2.358 - 2.369	1.10
2.370 - 2.381	1.19
2.382 - 2.393	1.18
2.394 - 2.405	1.07
2.406 - 2.417	1.06
2.418 - 2.430	1.15
2.431 - 2.445	1.04
2.446 - 2.461	1.03
2.462 - 2.477	1.02
2.478 - 2.492	1.01
2.493 - 2.507	1.00
2.508 - 2.522	0.99
2.523 - 2.537	0.98
2.538 - 2.553	0.97
2.554 - 2.573	0.96
2.574 - 2.594	0.95
2.595 - 2.615	0.94
2.616 - 2.634	0.93
2.635 - 2.649	0.92
2.650 - 2.663	0.91
2.664 - 2.679	0.90
2.680 - 2.697	0.89
2.698 - 2.700	0.88

* The measured stability of a specimen multiplied by the correlation ratio for the height of the specimen equals the corrected stability for a 2-1/2 inch specimen.

FIGURE 2

MAXIMUM THEORETICAL SPECIFIC GRAVITY AND DENSITY OF FIELD PRODUCED BITUMINOUS MIXTURES (RICE TEST)

(A Modification of AASHTO T 209)

1. SCOPE

(a) This method of test is intended for determining the maximum specific gravity and density of uncompacted bituminous mixtures that have been field produced.

NOTE: Two methods are provided for determining the maximum specific gravity. The method given in Section 6 is for determining results without fan drying the samples. Section 7 describes the procedure which is used when fan drying is necessary. For the first four samples taken at the beginning of production on a project the maximum specific gravity shall be determined in accordance with Section 6 and also shall be fan dried and maximum specific gravity determined in accordance with Section 7. If the difference in resultant air voids, when determined as described in Arizona Test Method 416, Section 9 is greater than 0.2% subsequent samples will be subjected to fan drying. During the course of the project comparisons should be made on approximate 10 sample intervals to determine need for fan drying. In case of dispute, fan drying shall be used.

(b) This test method may involve hazardous material, operations, or equipment. This test method does not purport to address all of the safety concerns associated with its use. It is the responsibility of the user to consult and establish appropriate safety and health practices and determine the applicability of any regulatory limitations prior to use.

(c) See Appendix A1 of the Materials Testing Manual for information regarding the procedure to be used for rounding numbers to the required degree of accuracy.

2. APPARATUS

NOTE: Requirements for the frequency of equipment calibration and verification are found in Appendix A3 of the Materials Testing Manual.

(a) Balance - A balance capable of measuring the maximum weight to be determined and conforming to the requirements of AASHTO M 231, except the readability and sensitivity of any balance utilized shall be at least 0.1 gram.

(b) Container - A heavy walled Erlenmeyer flask having a capacity of at least 1500 ml. strong enough to withstand a partial vacuum; the cover shall consist of a rubber stopper with a tight hose connection. A small piece of No. 200 wire mesh covering the hose opening shall be used to minimize the possibility of loss of fine material.

NOTE: If a procedure which subjects multiple flasks to a vacuum simultaneously is used, the vacuum gauge shall be placed beyond the last bottle to insure that all the bottles are being subjected to the same amount of vacuum.

(c) Flat glass plate large enough to cover mouth of the flask.

(d) Vacuum pump for evacuating air from the container.

(e) All water used in this procedure shall be distilled or de-mineralized water.

3. CALIBRATION OF FLASK

(a) Record the weight of the flask and flat glass plate separately to the nearest 0.1 gram on the work card. Using water at a temperature of 77 $\pm$ 1 °F, fill the flask to approximately 90% full. Using a long narrow rod, remove air bubbles adhering to the walls of the flask. Confirm that the temperature of the water is at 77 $\pm$ 1 °F. Fill to the top and slide the flat glass plate over the mouth of the flask. Verify that no air is trapped under the flat glass plate. Dry the outside of the flask and glass plate and weight to the nearest 0.1 gram. Subtract the weight of the glass plate and record the weight of the “flask and water” as "B".

4. PREPARATION OF SAMPLES

(a) Obtain 3 representative 1050 ± 50 gram samples of the material, as described in Arizona Test Method 416.

NOTE: If necessary, heat the sample for not more than one hour at a maximum temperature of 285 °F ONLY until it is pliable enough to allow separation of the coated aggregate.

(b) Spread each sample on a sheet of heavy paper or in a large flat bottom pan. Before the samples are completely cooled, separate the particles of the mixture, taking care not to fracture the coarse aggregate particles, so that the particles of the fine aggregate portion are not larger than 1/4 inch. Allow the samples to cool to room temperature.

5. PROCEDURE

(a) Place the sample in the flask and determine the weight to the nearest 0.1 gram. Subtract the weight of the flask and record the “weight of sample in air" as "Wmm".

(b) Add sufficient water to cover the sample. The water shall be at a temperature of approximately 77 °F and shall have been treated with a wetting agent.

NOTE: Aerosol OT in a concentration of 0.01%, or one mL of 10% solution per 1000 mL of water, has been found to be a suitable wetting agent and shall be used to facilitate the release of entrapped air.

(c) Remove entrapped air by subjecting the contents of the flask to a partial vacuum with a minimum of 20 inches of mercury (gauge) for 15 ± 2 minutes, agitating the contents of the flask four times at evenly spaced intervals throughout this period.

CAUTION: Do not agitate the sample too frequently or vigorously, as that can cause stripping of the asphalt film from some particles, resulting in erroneous specific gravities.

(d) After the evacuation period, fill the flask to approximately 90% full with water. Gently stir the sample with a long narrow rod in such a way to release any trapped air bubbles, avoiding breakage of the aggregates. Using the long narrow rod, carefully remove any air bubbles adhering to the walls of the flask. Fill completely to the

top and confirm that the temperature is at 77 ± 2 °F. Slide the pre-weighed flat glass plate over the mouth of the flask. Verify that no air is trapped under the flat glass plate. Dry the outside of the flask and glass plate and weigh immediately to the nearest 0.1 gram. Subtract the weight of the glass plate and record the weight of the "flask + water + sample" as "C".

6. CALCULATIONS

(a) The Volume of Voidless Mix, "Vvm", in mL, is determined for each sample by the following:

Where: $Vvm = Wmm + B - C$

Wmm = Wt. of Sample in Air

B = Wt. of Flask + Water

C = Wt. of Flask + Water + Sample

(b) The Maximum Specific Gravity, "Gmm", is determined for each sample by the following:

$$Gmm = \frac{Wmm}{Vvm}$$

(c) Compare the three individual values for maximum specific gravity. If the range of the three is within 0.024, all are used to determine the average maximum specific gravity as shown in paragraph (d) below. If the range is greater than 0.024, the average of two may be used if they are within a range of 0.012. If values are not achieved within the above criteria, the samples shall be discarded and a set of three new samples shall be tested. If material is not available, results should be used cautiously in the analysis of the bituminous mix. If results are used for specification compliance, additional material must be obtained for retesting.

(d) The average maximum specific gravity of the bituminous mix is determined for the samples with acceptable maximum specific gravity values, and recorded to the nearest 0.001.

(e) To determine the maximum density, the average maximum specific gravity is multiplied by 62.3 lbs./cu. ft.

7. PROCEDURE FOR FAN DRYING SAMPLES

(a) The entire contents of the flask shall be poured into a nest of sieves consisting of a No. 40 and a No. 200 screen.

NOTE: If stripping has occurred, as evidenced by discoloration of water in the flask, significant loss of Minus No. 200 material may be expected. Provisions for the recovery and addition of this material to the Plus No. 200 material shall be made.

(b) Allow the mix to drain through the sieves until excess moisture is removed from the mix. Spread the material retained on the No. 40 and No. 200 sieves in a pan and place before a fan to remove surface moisture. The air through the fan shall be at room temperature and no heat shall be used to dry the mix.

(c) After evaporation of excess moisture is observed, weigh the mix at 15 minute intervals and when the weight loss is 0.5 gram or less for this interval, the mix is considered to be surface dry. Record the surface dry weight as "Wsd". Intermittent stirring of the sample is required during the drying period. Conglomerations of the mix shall be broken by hand. Care must be taken to prevent loss of particles of the mixture.

NOTE: If the "Wsd" weight for any of the three samples is less than its corresponding "Wmm" weight, the samples shall be discarded and a set of three new samples shall be tested. If material is not available, the maximum specific gravity shall be determined utilizing the "Wmm" weight and results should be used cautiously in the analysis of the bituminous mix. If results are used for specification compliance, additional material must be obtained for retesting.

(d) To calculate the Vvm and maximum specific gravity, Gmm, of each sample, the surface dry weight, Wsd, is substituted for "Wmm" only in the equation given for Vvm in paragraph 6 (a).

8. EXAMPLE

(a) Examples of the calculations are shown in Figures 1 and 2.

(b) Figures 3 and 4 are illustrations of the front and back of a blank form.

Arizona Department of Transportation

ARIZONA TEST METHOD 417

Lab #: 08-3456 Date: 6-24-08 Project #: F-111-1(1) TRACS #: H999901C
Project Name: BIG GULCH - BUG MOUNTAIN Material Type: 3/4" A.C.
Lot #: 1 Sample #: 4 Maximum Specific Gravity Range: 0.004
Tested By: LISA TESTER Checked By: A.A.

If samples were fan dried, the maximum density is determined utilizing the "Wsd" weight as shown below:

Flask Number or I.D.	" Wf " Wt. of Flask	" Wmm " Wt. of Sample in Air Wfs - Wf	" B " Wt. of Flask + Water	" C " Wt. of Flask + Sample + Water Wa – Wp	" Vvm " Volume of Voidless Mix Wmm + B - C	" Gmm " Maximum Specific Gravity Wmm / Vvm	Maximum Density (lbs./cu. ft.) Gmm x 62.3	" Wsd " Surface Dry Weight (See Back)	" Vvm " Volume of Voidless Mix Wsd + B - C	" Gmm " Maximum Specific Gravity Wmm / Vvm	Maximum Density (lbs./cu. ft.) Gmm x 62.3
2	1029.8	1029.7	3301.2	3919.2	411.7	2.501		1030.3	412.3	2.497	
~~3~~	~~992.7~~	~~1062.6~~	~~3216.2~~	~~3876.0~~	~~402.8~~	~~2.638~~		~~1063.3~~	~~403.5~~	~~2.633~~	
4	1178.1	1064.0	3431.9	4071.1	424.8	2.505		1064.6	425.4	2.501	
Average						2.503	155.9			2.499	155.7

Remarks:

Flask Number or I.D.	2	3	4
Wt. of Flask + Sample, " Wfs "	2059.5	2055.3	2242.1
Wt. of Flask + Sample + Water + Glass Plate, " Wa "	4074.3	4084.2	4226.2
Wt. of Glass Plate, " Wp "	155.1	155.1	155.1

FLASK #3 ELIMINATED FROM THE AVERAGE DUE TO SPECIFIC GRAVITY BEING OUTSIDE SPECIFIED 0.024 ALLOWABLE RANGE

(See Back Also)

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Figure 1

Flask Number or I.D.	2	3	4
Tare Weight of Pan	950.1	897.2	955.6
Weight of Pan and Sample	1991.6	1971.9	2034.0
Weight of Pan and Sample	1984.2	1964.7	2026.1
Weight of Pan and Sample	1981.5	1961.9	2022.1
Weight of Pan and Sample	1980.6	1960.7	2021.2
Weight of Pan and Sample	1980.4	1960.5	2020.3
Weight of Pan and Sample			2020.2
Weight of Pan and Sample			
Weight of Pan and Sample			
Surface Dry Weight (Wsd)	1030.3	1063.3	1064.6

Air Voids (Sample not Fan Dried)

$$\left[1 - \frac{\text{A.C. Mix Bulk Density}}{\text{Maximum Density}}\right] \times 100$$

$$\left[1 - \frac{(143.5)}{(155.9)}\right] \times 100 = 8.0\ \%$$

Air Voids (Sample Fan Dried)

$$\left[1 - \frac{\text{A.C. Mix Bulk Density}}{\text{Maximum Density}}\right] \times 100$$

$$\left[1 - \frac{(143.5)}{(155.7)}\right] \times 100 = 7.8\ \%$$

Difference in Air Voids = [Air Voids (Sample not Fan Dried)] - [Air Voids (Sample Fan Dried)] = 0.2 %

Figure 2

Arizona Department of Transportation

ARIZONA TEST METHOD 417

Lab #: _____ Date: _____ Project #: _____ TRACS #: _____

Project Name: _____ Material Type: _____

Lot #: _____ Sample #: _____ Maximum Specific Gravity Range: _____

Tested By: _____ Checked By: _____

If samples were fan dried, the maximum density is determined utilizing the "Wsd" weight as shown below:

Flask Number or I.D.	" Wf " Wt. of Flask	" Wmm " Wt. of Sample in Air Wfs - Wf	" B " Wt. of Flask + Water	" C " Wt. of Flask + Sample + Water Wa – Wp	" Vvm " Volume of Voidless Mix Wmm + B - C	" Gmm " Maximum Specific Gravity $\frac{Wmm}{Vvm}$	Maximum Density (lbs./cu. ft.) Gmm x 62.3	" Wsd " Surface Dry Weight (See Back)	" Vvm " Volume of Voidless Mix Wsd + B - C	" Gmm " Maximum Specific Gravity $\frac{Wmm}{Vvm}$	Maximum Density (lbs./cu. ft.) Gmm x 62.3
Average											

Remarks:

Flask Number or I.D.			
Wt. of Flask + Sample, " Wfs "			
Wt. of Flask + Sample + Water + Glass Plate, " Wa "			
Wt. of Glass Plate, " Wp "			

(See Back Also)

Figure 3

44-3941 R11/02

Flask Number or I.D.				Air Voids (Sample not Fan Dried)	Air Voids (Sample Fan Dried)
Tare Weight of Pan					
Weight of Pan and Sample					
Weight of Pan and Sample					
Weight of Pan and Sample				$\left[1 - \frac{\text{A.C. Mix Bulk Density}}{\text{Maximum Density}}\right] \times 100$	$\left[1 - \frac{\text{A.C. Mix Bulk Density}}{\text{Maximum Density}}\right] \times 100$
Weight of Pan and Sample					
Weight of Pan and Sample					
Weight of Pan and Sample				$\left[1 - \frac{(\quad\quad)}{(\quad\quad)}\right] \times 100 = \_\_\_\_\_\%$	$\left[1 - \frac{(\quad\quad)}{(\quad\quad)}\right] \times 100 = \_\_\_\_\_\%$
Weight of Pan and Sample					
Weight of Pan and Sample					
Surface Dry Weight (Wsd)				Difference in Air Voids = [Air Voids (Sample not Fan Dried)] - [Air Voids (Sample Fan Dried)] = _____%	

Figure 4