ARIZONA DEPARTMENT OF TRANSPORTATION * MATERIALS GROUP

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CHANGE LETTER

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MATERIALS TESTING MANUAL	CHANGE LETTER NO. 27
SUBJECT: Title Page; Table of Contents; Series 200 Cover Sheet; AASHTO T 87; AASHTO R 58; Series 400 Cover Sheet; Arizona Test Methods 410e and 424b.	EFFECTIVE DATE: March 29, 2012

SUMMARY:

NOTE: Unless otherwise specified, changes issued under this Change Letter are effective for projects with a bid opening date on or after March 29, 2012. 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 March 29, 2012.

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. Series 200 Cover Sheet, “SOILS AND AGGREGATES”

   AASHTO T 87 has been replaced by AASHTO R 58. Series 200 Cover Sheet has been revised to reflect this change. Please replace the existing Series 200 Cover Sheet with the attached.

4. Series 400 Cover Sheet, “BITUMINOUS MIXTURES”

   Series 400 Cover Sheet has been revised to reflect the changes made in this Change Letter. Please replace the existing Series 400 Cover Sheet with the attached.

5. Arizona Test Method 410e – "COMPACTION AND TESTING OF BITUMINOUS MIXTURES UTLIZING FOUR INCH MARSHALL APPARATUS"

   This test method has been revised to use the newly adopted format for Arizona Test Methods. Other revisions have been made in what are now Subsections 3.3, 3.4, 3.5, 3.6, and 4.5. Corrections have also been made in the "Stability Correlation Ratios" table given in Figure 2. Please replace the existing test method with the attached.

6. Arizona Test Method 424b – DETEMINATION OF AIR VOIDS IN COMPACTED BITUMINOUS MIXTURES"

   This test method has been revised in its entirety, including the use of the newly adopted format for Arizona Test Methods. Please replace the existing test method with the attached.

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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. 27
(March 29, 2012)

March 29, 2012
(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 (March 29, 2012).

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 (March 29, 2012).

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).

SERIES 800 DESIGN**

****** The above Arizona Test Methods are also shown on Series 800 Cover Sheet (November 14, 2008).

SERIES 900 MATERIALS QUALITY ASSURANCE PROGRAM
(January 7, 2011)

SERIES 1000 CERTIFICATES (July 15, 2005)

APPENDIX

March 29, 2012
(4 Pages)

SERIES 200

SOILS AND AGGREGATES

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

ARIZONA TEST METHODS:

TITLE	DESIGNATION
Sieving of Coarse and Fine Graded Soils and Aggregates	ARIZ 201c
Composite Grading	ARIZ 205c
Specific Gravity and Absorption of Coarse Aggregate	ARIZ 210b
Specific Gravity and Absorption of Fine Aggregate	ARIZ 211d
Percentage of Fractured Coarse Aggregate Particles	ARIZ 212e
Determination of Cement Content Required for Cement Treated Mixtures	ARIZ 220
Moisture-Density Relations of Cement Treated Mixtures	ARIZ 221
Rock Correction Procedure for Maximum Density Determination of Cement Treated Mixtures	ARIZ 222b
Field Density of Cement Treated Mixtures by Sand Cone Method or by Rubber Balloon Method	ARIZ 223
Maximum Dry Density and Optimum Moisture of Soils by Proctor Method A	ARIZ 225a
Maximum Density and Optimum Moisture of Soils – Methods C and D	ARIZ 226
Rock Correction Procedure for Maximum Dry Density and Optimum Moisture Content Determination	ARIZ 227c

ARIZONA TEST METHODS: (continued)

TITLE	DESIGNATION
Calibration of Standard Sand and Sand Cone …………..……	ARIZ 229a
Field Density by the Sand Cone Method ……………..………..	ARIZ 230a
Moisture-Density Relationship Using Typical Moisture-Density Curves (One Point Proctor) Method A …………………………………..……..……..	ARIZ 232b
Flakiness Index of Coarse Aggregate ………………..………...	ARIZ 233c
Density and Moisture Content of Soil and Soil-Aggregate Mixtures by the Nuclear Method ……..…….	ARIZ 235
Determining pH and Minimum Resistivity of Soils and Aggregates ………………………………….....................	ARIZ 236b
Determining pH and Soluble Salts of Soils ………..…..…….	ARIZ 237b
Percent Carbonates in Aggregate ……………………..……......	ARIZ 238a
Sieve Analysis and Separation of Salvaged AC Pavement Particles for Recycled Asphaltic Concrete ………………….	ARIZ 240a
Compressive Strength of Molded Cement Treated Base or Soil-Cement Specimens ……….....……..	ARIZ 241a
Sand Equivalent Test for Mineral Aggregate for Asphaltic Concrete Friction Course ………………………	ARIZ 242a
Artificial Grading of Mineral Aggregate ………………....………..	ARIZ 244
Maximum Dry Density and Optimum Moisture of Soils by Proctor Alternate Method D ………..……………	ARIZ 245
Moisture-Density Relationship using Typical Moisture-Density Curves (One Point Proctor) Alternate Method D …………………………………………….	ARIZ 246a
Particle Shape and Texture of Fine Aggregate Using Uncompacted Void Content …………..…………..………....	ARIZ 247a

ARIZONA TEST METHODS: (continued)

TITLE	DESIGNATION
Alternate Procedures for Sieving of Coarse and Fine Graded Soils and Aggregates …………………………..……………	ARIZ 248
Remolded Ring Samples for Direct Shear, Swell, and Consolidation ………………………………….………..……	ARIZ 249
Combined Coarse and Fine Aggregate Specific Gravity and Absorption ………………………………………………..….	ARIZ 251a

AASHTO STANDARDS:

TITLE	DESIGNATION
Dry Preparation of Disturbed Soil and Soil-Aggregate Samples for Test …………………………….	R 58
Bulk Density ("Unit Weight") and Voids in Aggregate ………….	T 19
Determining the Liquid Limit of Soils …………………………….	T 89
Determining the Plastic Limit and Plasticity Index of Soils …………………………………….…...	T 90
Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine ……………………………………..	T 96
Soundness of Aggregate by Use of Sodium Sulfate or Magnesium Sulfate ………………………	T 104
Wetting-and-Drying Test of Compacted Soil-Cement Mixtures ……………………………………….….	T 135
Freezing-and-Thawing Tests of Compacted Soil-Cement Mixtures ……………………………………….….	T 136
Plastic Fines in Graded Aggregates and Soils by Use of the Sand Equivalent Test ……….……………..……...	T 176

AASHTO STANDARDS: (continued)

TITLE	DESIGNATION
Resistance R-Value and Expansion Pressure of Compacted Soils ……………………………..…	T 190
Determination of Moisture in Soils by Means of a Calcium Carbide Gas Pressure Moisture Tester …………………………………….	T 217
Determination of Strength of Soil-Lime Mixtures ………………………………………..….	T 220
Reducing Field Samples of Aggregates to Testing Size ………………………………………..……	T 248
Total Evaporable Moisture Content of Aggregate by Drying ………………………………………....	T 255
Laboratory Determination of Moisture Content of Soils ……………………………………	T 265

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

March 29, 2012
(2 Pages)

SERIES 400

BITUMINOUS MIXTURES

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

<u>ARIZONA TEST METHODS:</u>

TITLE	DESIGNATION
Moisture Content of Bituminous Mixtures………………………	ARIZ 406c
Compaction and Testing of Bituminous Mixtures Utilizing Four Inch Marshall Apparatus……………………………….	ARIZ 410e
Determination of Transverse Distributor Spread Rate………..	ARIZ 411
Density of Compacted Bituminous Mixtures by the Nuclear Method………………………………………….	ARIZ 412b
Extraction of Asphalt from Bituminous Mixtures by Soxhlet Extraction……………………………………......…..	ARIZ 413
Bulk Specific Gravity and Bulk Density of Compacted Bituminous Mixtures………………………………………...	ARIZ 415c
Preparing and Splitting Field Samples of Bituminous Mixtures for Testing……………………..………………..…	ARIZ 416d
Maximum Theoretical Specific Gravity and Density of Field Produced Bituminous Mixtures (Rice Test)………………...	ARIZ 417c
Bituminous Material Content of Asphaltic Concrete Mixtures by the Nuclear Method………………….……….….	ARIZ 421
Compaction and Testing of Bituminous Mixtures Utilizing 152.4 mm (Six Inch) Marshall Apparatus……………………	ARIZ 422

ARIZONA TEST METHODS: (continued)

TITLE	DESIGNATION
Determination of Air Voids in Compacted Bituminous Mixtures………………………………………..……..……….	ARIZ 424b
Asphalt Binder Content of Asphaltic Concrete Mixtures by the Ignition Furnace Method……….……………..………….	ARIZ 427

AASHTO TEST METHODS:

TITLE	DESIGNATION
Quantitative Extraction of Bitumen from Bituminous Paving Mixtures……………………………………………...	T 164
Preparing and Determining the Density of Hot-Mix Asphalt (HMA) Specimens by Means of the Superpave Gyratory Compactor...……………………..……...	T 312

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

COMPACTION AND TESTING OF BITUMINOUS MIXTURES UTILIZING FOUR INCH MARSHALL APPARATUS

(A Modification of AASHTO T 245)

1. SCOPE

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

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

1.3 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.

1.4 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

2.1 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:

2.2 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.)

2.3 Specimen Extruding Device - Extrusion jack or press for extruding specimens from molds.

2.4 Compaction Hammer.

2.4.1 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).

2.4.2 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.

2.4.3 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.

2.4.4 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.

2.4.5 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.

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

2.5 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.

2.6 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.

2.7 Oven for heating bituminous mixtures and specimen mold assemblies at required temperature.

2.8 Hot plate for heating compaction hammer, spoon and spatula.

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

2.10 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.

2.11 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.

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

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

2.12.2 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.

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

3. PROCEDURE

3.1 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.)

$$\begin{bmatrix} \text{Weight of} \\ \text{each Sample} \end{bmatrix} = \frac{\begin{bmatrix} \text{Combined Aggregate} \\ \text{Bulk (O.D.) Specific Gravity} \end{bmatrix}}{2.520} \times 1150$$

3.2 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.

3.3 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 the perimeter and 10 times at random into the mixture. Smooth the surface of the mix to a slightly rounded shape.

3.4 The compaction temperature shall be the laboratory compaction temperature shown on the mix design.

3.5 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 laboratory compaction temperature ± 5 °F; however, in no case shall the mixture be reheated longer than 60 minutes.

3.6 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 Subsection 2.4] 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.

3.7 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.

3.8 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

4.1 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.

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

4.3 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.

4.4 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.

4.5 If the stability and flow are to be determined, the steps in Subsections 4.6 through 4.11 below are followed, utilizing the apparatus in accordance with the operating instructions for that apparatus.

4.6 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.

4.7 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.

4.8 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.

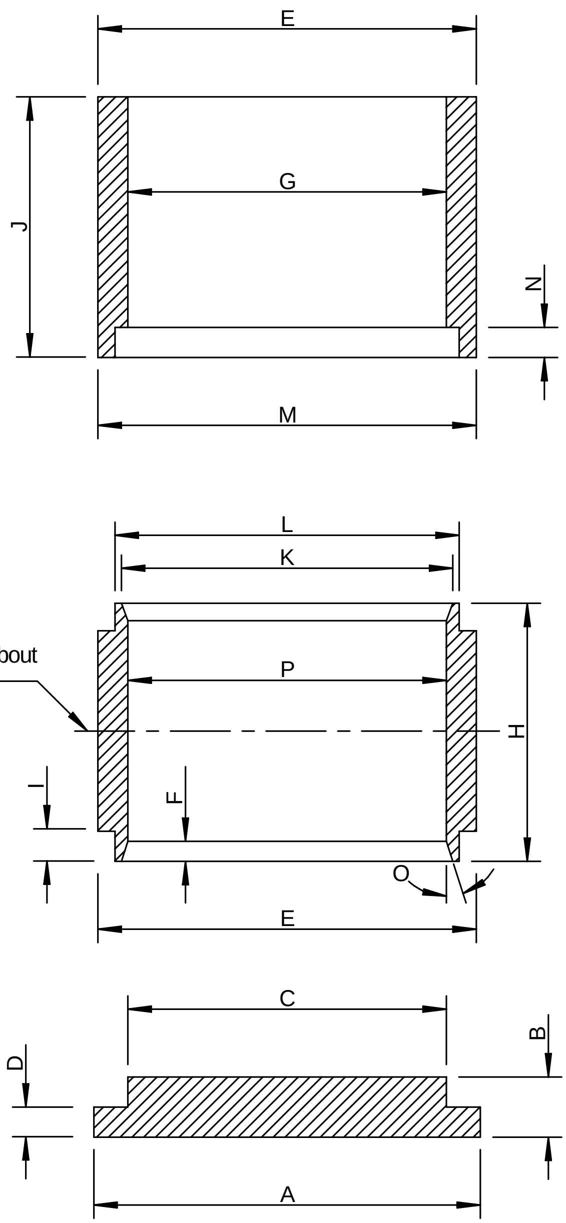
4.9 Record the stability of each specimen to the nearest 10 pounds force, and the flow to the nearest 0.01 inch.

4.10 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.

4.11 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	1.09
2.382 - 2.393	1.08
2.394 - 2.405	1.07
2.406 - 2.417	1.06
2.418 - 2.430	1.05
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

ARIZ 424b
March 29, 2012
(6 Pages)

DETERMINATION OF AIR VOIDS IN COMPACTED BITUMINOUS MIXTURES

(A Modification of AASHTO Designation T 269)

1. SCOPE

1.1 This procedure is used to determine the air voids in compacted bituminous mixtures. It is applicable for specimens which are either laboratory compacted or field compacted (for example, cores).

1.2 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. CALCULATION

2.1 For specimens which are either Marshall laboratory compacted or field compacted (e.g., cores), the percent air voids shall be calculated using the the bulk density of the compacted bituminous mixture (Arizona Test Method 415) and maximum density of the mixture from the Rice Test (Arizona Test Method 417).

2.1.1 The percent air voids are calculated by the following equation:

$$\text{Percent Air Voids} = \left[1 - \frac{\text{Bulk Density}}{\text{Maximum Density}}\right] \text{x } 100$$

2.1.1.1 An example of the calculations is given in Figure 1.

2.1.1.2 A blank form for perfoming the calculations is given in Figure 3.

2.2 For specimens which are gyratory laboratory compacted, the percent air voids shall be calculated using the average relative density of the compacted bituminous mixture at N_{design} (AASHTO T 312).

2.2.1 The percent air voids are calculated by the following equation:

Percent Air Voids = (100) – (Average Relative Density, % G_{mm}, at N_{design})

2.2.1.1 An example of the calculations is given in Figure 2.

2.2.1.2 A blank form for perfoming the calculations is given in Figure 4.

3. REPORT

3.1 The percent air voids shall be reported to the nearest 0.1%.

CALCULATION OF AIR VOIDS FOR MARSHALL LABORATORY COMPACTED SPECIMENS OR FIELD COMPACTED SPECIMENS				
Specimens Compacted by: Hand ☐ Mechanical ☒ 4 inch ☒ 6 inch ☐; Core ☐				
Specimen I.D.	1	2	3	Average
Specimen Height	2.516	2.515	2.519	
Bulk Specific Gravity, Bulk Density, and Absorption (Arizona Test Method 415: Method A ☒ or Method C ☐)				
A = Mass in grams of specimen in Air	1155.9	1155.4	1158.2	
B = Mass in grams of SSD specimen in Air	1156.9	1156.3	1159.2	
C = Mass in grams of specimen in Water	647.9	649.6	651.8	
G_{mb} = Bulk Specific Gravity = A/(B – C)	2.271	2.280	2.283	2.283
% Absorption = [(B – A)/(B – C)] x 100	0.20	0.18	0.20	
Bulk Density = (G_{mb} x 62.3 lbs./cu. ft.)	141.4	142.0	142.2	
Range of Bulk Density values (lbs./cu. ft.)	0.8			
Average Bulk Density = (Average G_{mb} x 62.3 lbs./cu. ft)				142.2
Maximum Density (lbs./cu. ft.) [from Rice Test]	149.4			

Notes:

The Individual specimen heights are reported to the nearest 0.001 inch.

The Individual specimen masses are reported to the nearest 0.1 gram.

The Indivdual bulk specific gravities are reported to the nearest 0.001.

The average bulk specific gravity is calculated, and reported to the nearest 0.001, using the individual bulk specific gravities which have been reported to the nearest 0.001.

The individual bulk densities are reported to the nearest 0.1 lb./cu. ft.

The average bulk density is reported to the nearest 0.1 lb./cu. ft.

The maximum density [from Rice Test] is reported to the nearest 0.1 lb./cu. ft.

$$\textbf{Percent Air Voids} = \left[1 - \frac{\textbf{Average Bulk Density}}{\textbf{Maximum Density from Rice Test}}\right] \times 100 = \left[1 - \frac{142.2}{149.4} \times 100\right] = 4.8\%$$

EXAMPLE AIR VOIDS CALCULATION FOR MARSHALL LABORATORY COMPACTED SPECIMENS

FIGURE 1

CALCULATION OF AIR VOIDS FOR GYRATORY LABORATORY COMPACTED SPECIMENS			
Specimen I.D.	1	2	Average
h_{ini} = Height, in mm, of specimen at N_{ini} (8 gyrations)	128.7	129.3	
h_{des} = Height, in mm, of specimen at N_{des} (100 gyrations)	117.0	117.4	
h_{max} = Height, in mm, of specimen at N_{max} (160 gyrations)	115.6	116.0	
Bulk Specific Gravity and Absorption (Arizona Test Method 415: Method A ☒ or Method C ☐)			
A = Mass, in grams, of specimen at N_{max} in Air	4747.4	4744.6	
B = Mass, in grams, of SSD specimen at N_{max} in Air	4759.4	4756.0	
C = Mass, in grams, of specimen at N_{max} in Water	2752.7	2751.2	
G_{mb} = Bulk Specific Gravity of specimen at N_{max} $= \frac{A}{B - C}$	2.366	2.367	
% Absorption = [(B – A)/(B – C)] x 100	0.60	0.57	
G_{mm} = Maximum Specific Gravity [from Rice Test]	2.449		
*Relative Density, %G_{mm}, of specimen at N_{ini}	86.8	86.7	86.8
*Relative Density, %G_{mm}, of specimen at N_{des}	95.5	95.5	95.5
*Relative Density, %G_{mm}, of specimen at N_{max}	96.6	96.7	96.7

$$* \text{Relative Density}, \%G_{mmx} = \frac{(G_{mb}) \times (h_{max})}{(G_{mm}) \times (h_x)} \times 100$$

Where: $\%G_{mmx}$ = Relative Density, %G_{mm}, of specimen at N_{ini}, N_{des}, or N_{max}
G_{mb} = Bulk Specific Gravity of specimen at N_{max}
h_{max} = Height, in mm, of specimen at N_{max}
G_{mm} = Maximum Specific Gravity [from Rice Test]
h_x = Height of specimen, in mm, at N_{ini}, N_{des}, or N_{max}

Notes:

The Individual specimen heights are reported to the nearest 0.1 mm.

The Individual specimen masses are reported to the nearest 0.1 gram.

The Indivdual bulk specific gravities are reported to the nearest 0.001.

The maximum specific gravity [from Rice Test] is reported to the nearest 0.001.

The individual relative densities are reported to the nearest 0.1 percent.

The average relative density for each set of specimens (at N_{ini}, N_{des}, and N_{max}) is calculated, and reported to the nearest 0.1 percent, using the corresponding individual relative densities which have been reported to the nearest 0.1 percent.

Three specimens are used when referee testing is performed.

Percent Air Voids = (100) – (Average Relative Density, % G_{mm}, at N_{des})

= 100 – 95.5 = 4.5%

EXAMPLE AIR VOIDS CALCULATION FOR GYRATORY LABORATORY COMPACTED SPECIMENS

FIGURE 2

CALCULATION OF AIR VOIDS FOR MARSHALL LABORATORY COMPACTED SPECIMENS OR FIELD COMPACTED SPECIMENS				
Specimens Compacted by: Hand ☐ Mechanical ☐ 4 inch ☐ 6 inch ☐; Core ☐				
Specimen I.D.				Average
Specimen Height				
Bulk Specific Gravity, Bulk Density, and Absorption (Arizona Test Method 415: Method A ☐ or Method C ☐)				
A = Mass in grams of specimen in Air				
B = Mass in grams of SSD specimen in Air				
C = Mass in grams of specimen in Water				
G_{mb} = Bulk Specific Gravity = A/(B – C)				
% Absorption = [(B – A)/(B – C)] x 100				
Bulk Density = (G_{mb} x 62.3 lbs./cu. ft.)				
Range of Bulk Density values (lbs./cu. ft.)				
Average Bulk Density = (Average G_{mb} x 62.3 lbs./cu. ft)				
Maximum Density (lbs./cu. ft.) [from Rice Test]				

Notes:

The Individual specimen heights are reported to the nearest 0.001 inch.

The Individual specimen masses are reported to the nearest 0.1 gram.

The Indivdual bulk specific gravities are reported to the nearest 0.001.

The average bulk specific gravity is calculated, and reported to the nearest 0.001, using the individual bulk specific gravities which have been reported to the nearest 0.001.

The individual bulk densities are reported to the nearest 0.1 lb./cu. ft.

The average bulk density is reported to the nearest 0.1 lb./cu. ft.

The maximum density [from Rice Test] is reported to the nearest 0.1 lb./cu. ft.

$$\textbf{Percent Air Voids} = \left[1 - \frac{\textbf{Average Bulk Density}}{\textbf{Maximum Density from Rice Test}}\right] \times 100 = \left[1 - \frac{(\quad)}{(\quad)} \times 100\right] = \_\_\_\%$$

FIGURE 3

CALCULATION OF AIR VOIDS FOR GYRATORY LABORATORY COMPACTED SPECIMENS			
Specimen I.D.			Average
h_{ini} = Height, in mm, of specimen at N_{ini} (8 gyrations)			
h_{des} = Height, in mm, of specimen at N_{des} (100 gyrations)			
h_{max} = Height, in mm, of specimen at N_{max} (160 gyrations)			
Bulk Specific Gravity and Absorption (Arizona Test Method 415: Method A ☐ or Method C ☐)			
A = Mass, in grams, of specimen at N_{max} in Air			
B = Mass, in grams, of SSD specimen at N_{max} in Air			
C = Mass, in grams, of specimen at N_{max} in Water			
G_{mb} = Bulk Specific Gravity of specimen at N_{max} $= \frac{A}{B - C}$			
% Absorption = [(B – A)/(B – C)] x 100			
G_{mm} = Maximum Specific Gravity [from Rice Test]			
*Relative Density, $\%G_{mm}$, of specimen at N_{ini}			
*Relative Density, $\%G_{mm}$, of specimen at N_{des}			
*Relative Density, $\%G_{mm}$, of specimen at N_{max}			

$$*\text{Relative Density}, \%G_{mmx} = \frac{(G_{mb}) \times (h_{max})}{(G_{mm}) \times (h_x)} \times 100$$

Where: $\%G_{mmx}$ = Relative Density, $\%G_{mm}$, of specimen at N_{ini}, N_{des}, or N_{max}
G_{mb} = Bulk Specific Gravity of specimen at N_{max}
h_{max} = Height, in mm, of specimen at N_{max}
G_{mm} = Maximum Specific Gravity [from Rice Test]
h_x = Height of specimen, in mm, at N_{ini}, N_{des}, or N_{max}

Notes:

The Individual specimen heights are reported to the nearest 0.1 mm.

The Individual specimen masses are reported to the nearest 0.1 gram.

The Indivdual bulk specific gravities are reported to the nearest 0.001.

The maximum specific gravity [from Rice Test] is reported to the nearest 0.001.

The individual relative densities are reported to the nearest 0.1 percent.

The average relative density for each set of specimens (at N_{ini}, N_{des}, and N_{max}) is calculated, and reported to the nearest 0.1 percent, using the corresponding individual relative densities which have been reported to the nearest 0.1 percent.

Three specimens are used when referee testing is performed.

Percent Air Voids = (100) – (Average Relative Density, % G_{mm}, at N_{des})

= (100) – (_______) = ______%

FIGURE 4