ATT-7 / 22 - DENSITY, Immersion Method
Saturated Surface Dry Asphalt Concrete Specimens

1.0 SCOPE

This method describes the procedure for using the saturated surface dry (SSD) immersion volume method to determine the Dry Density (ρ) of asphalt concrete cores and formed marshall specimens.

The specimens can be suspended in water on top of the scale, or suspended in water under the scale, in order to determine the Volume (V_T) of the specimen.

2.0 EQUIPMENT

Masonry Saw: capable of wet or dry cutting of 6” asphalt cores. Using a Core Holder on the sliding table assists in cutting of the cores.

Suspension apparatus: Above scale: a non-absorptive, non-corrosive snare-wire suitable for suspending the core or marshall briquette into the center of the density bucket, which is sitting on top of the electronic balance.

Below scale: an under-hook is installed into the scale weighing port, on the bottom of the scale, to which a wire hanger assembly and platform is attached (not all balances have this capability).

Lab Drying Oven: a thermostatically controlled heating chamber capable of maintaining a uniform temperature of 130°C ± 5°C.

Electronic Balance: Above scale: capable of reading to 0.1 g and having an accuracy of at least 0.01% of the sample mass, e.g. for a 2000 g sample weight, the balance must be accurate to 0.2 g. The balance must be operated and calibrated as per the manufacturer's recommendations.

or, a Weigh-Below Capacity scale may also be used to weigh the samples suspended in a temperature controlled water bath (25 ± 1°C) beneath the scale. An aquarium water heater, or other type of immersion heater can be used to maintain the water bath temperature of 25°C. The water bath should be equipped with an overflow outlet for maintaining a constant water level. The use of an overflow outlet is mandatory.

Data Sheets: Mix Moisture Content and Marshall Density Data (such as MAT 6-80), Core Density, Extraction %AC and Sieve Analysis (such as MAT 6-79), Core Density, Ignition %AC and Sieve Analysis (such as MAT 6-98), ACP Density and Void Contents (such as MAT 6-40)


Core Saw

Core Holder

Classification: Public

3.0 PROCEDURE

This test method is used to determine the Density of asphalt concrete cores and field compacted marshall briquettes.

However, **this method SHOULD NOT BE USED with samples that contain open or interconnected voids**, or **if the sample absorbs more than 2.0 percent of water by volume** as determined in Section 3.9. For porous samples that absorb more than 2.0%, then use either ATT-6 DENSITY, Immersion Method, Waxed Asphalt Concrete Specimens, or refer to AASHTO T331 Automatic Vacuum Sealing Method.

If a pavement core obtained for quality assurance takes on more than 1% water while immersed, additional core(s) should be obtained at the same site, and also tested for density to ensure that the initial core was not damaged during the coring or shipping process.

Forms such as MAT 6-80 (Figure 1) are used for field formed Marshall specimens. Forms such as MAT 6-79 (Figure 2) or MAT 6-98 are used for field cores.

Forms such as MAT 6-40 (Figure 3) are used for cores taken for quality control testing. It may also be used to calculate the void contents of field Marshall specimens and cores, if void tables are not available.

3.1 EQUIPMENT PREPARATION

ABOVE SCALE WEIGHING:
(DIRECT MEASUREMENT OF VOLUME)

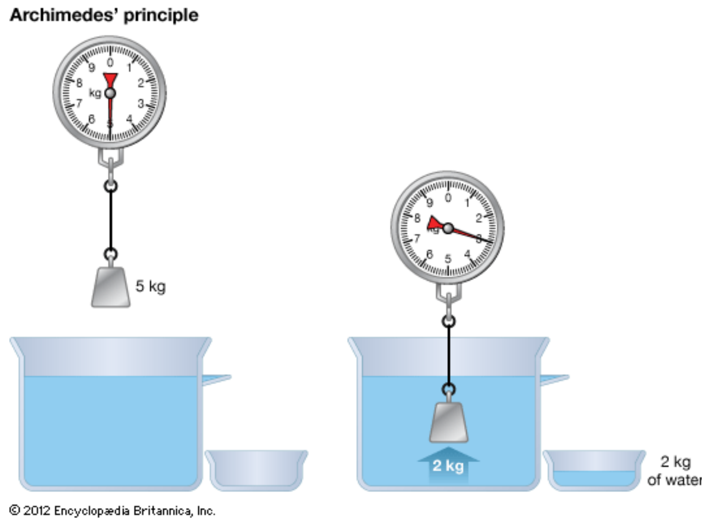
1. Attach a long piece of snare wire to the ceiling of the field laboratory trailer so it hangs down into a plastic density pail, which is centred on the scale pan of the balance.
2. Fashion a slip noose on the end of the wire.
3. Set the plastic density pail on the scale and suspend a specimen by the slip knot.
4. ***Adjust the location and height of the snare wire so that the specimen hangs freely within the pail, and is about 25 mm from the bottom without touching the sides.***
5. Once the snare wire is properly positioned, fill the plastic pail with potable water, about ¾ full.

BELOW SCALE WEIGHING:
(IN-DIRECT MEASUREMENT OF VOLUME)

1. Attach the wire and weighing platform to the under-hook in the bottom of the balance. The weighing platform will be suspended midway into the water bath. Press the Tare button on the scale, to zero out the scale.
2. An aquarium water heater, or other type of immersion heater can be used to maintain the water bath temperature of 25°C. The water bath should be equipped with an overflow outlet for maintaining a constant water level. The use of an overflow outlet is mandatory.

Classification: Public

Archimedes' principle states that any object immersed in a fluid is acted upon by an upward, or buoyant, force equal to the weight of the fluid displaced by the object.



Here a 5-kilogram object immersed in water is shown being acted upon by a buoyant force of 2 kilograms, which is equal to the weight of the water displaced by the object.

The buoyant force reduces the object's weight by 2 kilograms—that is, from 5 kilograms to 3 kilograms.

The Volume of the object is the amount of displaced water, or can be calculated by subtracting the "weight in air" from the "weight in water (under the scale)".

3.2 Sample Preparation

1. If testing cores, use a masonry saw to saw off the lift required for testing. Saw right on the tack line to eliminate any tack or seal coat chip contamination. After sawing, check that no tack remains. It will show up as a dark shadow. Use a fan to air dry the core after trimming the core on the core saw.

   If you need to test the top and bottom lifts, sawing may be required at the middle and bottom of the core(s).

2. **Measure and record the lift thickness of each core, before sawing**, and write it on the data sheet.

3. Perform a visual inspection on the cooled Marshall specimens, or on the core. Record the results in the "Sample Appearance" section on forms such as MAT 6-40, or the Remarks portion of MAT 6-79, 80 or 98.

4. Wearing leather gloves, rub the edges of the sample to remove any loose material, then **weigh the specimen**. Record as "Original Sample Weight" (MAT 6-80) or "Sawed Core Weight" (Mat 6-79) or "Wt. After Coring" (MAT 6-40).

5. Fill a large plastic, or metal pail, with **potable water at 25 ± 1 ºC**. The pail should be large enough to hold all the samples.

6. Submerge the specimen(s) in water for 5 minutes, or until bubbles stop forming. Place the specimens on their rounded sides, NOT on the flat side, so that more surface area is exposed to the water.

7. Tap the pail periodically and observe if air bubbles continue to come from the interior of the specimen. Continue periodically tapping the pail, till the air bubbles stop.

Classification: Public

3.3 Immersion Volume

ABOVE SCALE WEIGHING:

1. Place another pail containing water, at 25 ± 1 °C, on the electronic balance pan and press the tare button (for above scale weighing).

ABOVE SCALE WEIGHING and BELOW SCALE WEIGHING:

2. Remove one sample from the soaking pail. Quickly towel dry the sample with a damp towel to remove any excess moisture from the surface of the sample (removing any visible film of water). Immediately weigh this SSD sample, in air, on top of the scale, and record the SSD Weight.

3. Suspend the SSD specimen by the snare wire, or on the under scale platform suspended under the scale, and completely immerse it in the water of the density bucket or water bath. ***The specimen must not touch the sides, or the bottom, of the pail. The water level in the water bath must be at least 25 mm above the specimen.***

4. Weigh the immersed specimen and record as "Volume of Marshall", or "Volume of Core" (for above scale), or Mass of Specimen in Water (for below scale).

5. Remove the next sample from the soaking pail. Continue with #2 above.

EXAMPLE of calculations for weighing the sample under the scale

Mix Moisture Content see ATT-15 - Part V (Oven Method)				
	SAMPLE NO.		**1**	
A.	WT of Moist Sample + Pan		1111.1	g.
B.	WT of Dry Sample + Pan		1111.0	g.
C.	Wt of Water	A - B	0.1	g.
D.	Wt of Pan		12.2	g.
E.	WT of DRY SAMPLE	B - D	1098.80	g.
F.	***MOISTURE CONTENT***	100 (C/E)	**0.01**	**%**

Marshall Density see ATT-13 (Forming Marshall Specimens) see ATT-7 (Density, Immersion Method)						
	SAMPLE NO.			**1**		
G.	Mass of Specimen in Air	M_{AIR}		1206.5	1210.7	g.
H.	SSD Mass of Specimen	M_{SSD}		1207.1	1210.9	g.
I.	Mass of Specimen in Water	M_{water}	(weighed under the scale)	695.8	699.2	g.
J.	Volume of Specimen	V_T	$M_{SSD} - M_{water}$	511.3	511.7	cm^3
K.	Wet Density of Specimen	ρ	$M_{AIR} / V_T \times 1000$	2359.7	2366.0	kg/m^3
L.	% of Water Absorbed by Volume		$100 \times ((M_{SSD} - M_{AIR})/V_T)$	0.12	0.04	%
M.	***DRY DENSITY***	ρ	(K x 100) / (100 + F)	**2359.5**	**2365.8**	kg/m^3
N.	***AVERAGE DRY DENSITY***	ρ		**2363**		**kg/m^3**

Classification: Public

MIX MOISTURE CONTENT AND MARSHALL DENSITY DATA

Alberta Transportation

PROJECT :	HWY 99:08	CONTRACT NO.:	12345
LOT NO. :	8	DATE LAID :	17-Aug-2012
TECHNOLOGIST :	B. Good	DATE TESTED :	18-Aug-2012

MAT 6-80/13

MIX MOISTURE CONTENT

(see ATT-15, Part V, Moisture Content)

TIME SAMPLE PLACED IN OVEN		00:00	7:46	10:05	12:42	15:04	
TIME SAMPLE TAKEN OUT OF OVEN		00:00	12:03	14:10	16:55	19:16	
A. WEIGHT OF MOIST SAMPLE + PAN		g	1745.1	1737.5	1670.2	1704.4	
B. WEIGHT OF DRY SAMPLE + PAN		g	1743.0	1734.9	1667.3	1701.1	
C. WEIGHT OF WATER	**A - B**	g	2.1	2.6	2.9	3.3	
D. WEIGHT OF PAN		g	646.3	655.1	646.3	655.1	
E. WEIGHT OF DRY SAMPLE + PAN	**B - D**	g	1096.7	1079.8	1021.0	1046.0	
F. MOISTURE CONTENT	**(100 C) x E**	%	**0.19**	**0.24**	**0.28**	**0.32**	
LOT AVERAGE MIX MOISTURE CONTENT		%	**0.26**				

EXAMPLE

Calculations for weighing the sample on top of the scale

MARSHALL DENSITY

(see ATT-7, Density)

TEST NUMBER			1		2		3		4		5	
SAMPLE NUMBER			A	B	A	B	A	B	A	B	A	B
G. ORIGINAL SAMPLE WEIGHT		g	1200.3	1199.8	1201.0	1199.6	1201.5	1200.1	1198.9	1200.4		
H. DRY SAMPLE WEIGHT	**(100 x G) / (100 + F)**	g	1198.0	1197.5	1198.1	1196.7	1198.1	1196.7	1195.1	1196.6		
I. SATURATED SURFACE DRY WT.		g	1202.7	1201.9	1203.2	1201.6	1203.8	1202.6	1201.1	1202.4		
J. VOLUME OF SAMPLE		cm^3	509.4	508.3	510.0	510.5	507.5	508.2	508.8	509.0		
% OF WATER ABSORBED (by volume)	**100 x (I - G) / J**	%	0.5	0.4	0.4	0.4	0.5	0.5	0.4	0.4		
K. MARSHALL DRY DENSITY	**(1000 x H) / J**	kg/m^3	2352	2356	2349	2344	2361	2355	2349	2351		
L. AVERAGE MARSHALL DRY DENSITY		kg/m^3	**2354**		**2347**		**2358**		**2350**			
LOT AVERAGE MARSHALL DRY DENSITY			**2352**									
M. % AIR VOIDS		%	**3.8**		**3.9**		**3.6**		**3.9**			
LOT AVERAGE % AIR VOIDS			**3.8**									
N. % VMA		%	**14.8**		**15.2**		**14.8**		**15.0**			
LOT AVERAGE % VMA			**15.0**									

REMARKS :	Plant started up at 07:30 and shut down at 19:05
enter data into shaded areas	

NOTE: TRANSFER NECESSARY DATA TO THE DAILY LOT PAVING REPORT

FIGURE 1

Classification: Public

3.4 Saturated Surface Dry Weight (SSD)

1. Remove the specimen from the density pail and surface dry the specimen by gently rolling it in a damp towel until all visible films of water are removed from the surface.

2. Immediately weigh the specimen, in air, and record the weight in the Saturated Surface Dry Weight column. Note: Weigh the specimen right after surface drying to avoid loss of water from the voids in the specimen.

3.5 Volume of Specimen (V_T)

ABOVE SCALE WEIGHING

The weight shown on the scale, when the SSD sample is immersed into the density pail, is a *DIRECT READING of the Volume*.

BELOW SCALE WEIGHING

The weight shown on the scale, when the SSD sample is immersed in the water bath, is an *IN-DIRECT READING of the Volume*.
Volume = (Mass at SSD) – (Mass in Water)

3.6 Wet Density

1. Calculate the Wet Density of the specimen in kg/m^3 using the formula:
Density = Mass / Volume

$$\text{Wet Density } (kg/m^3) = \frac{\text{Original Wt. of Sample (g)}}{\text{Volume of Sample } (cm^3)} \times 1000$$

3.7 Moisture Content

The moisture content of cores, and field formed Marshall specimens, must be calculated to know the dry density, so that the correct percent compaction can be determined.

Each 0.1% of unaccounted moisture in the Marshall specimens results in a 0.1% lower compaction or a penalty to the contractor.

3.7.1 Moisture Content of Cores

Determine the moisture content of each core as follows:

1. Label and tare a drying pan. Record the pan weight and pan number in line "I" of a form such as MAT 6-79 or MAT-98.

2. Place the core in the tared drying pan.

3. Place the pan in the oven set at 130ºC ± 5ºC.

4. After the core has been in the oven for about half hour, remove the pan from the oven.

Classification: Public

Alberta Transportation

CORE DENSITY, EXTRACTION AND SIEVE ANALYSIS

	PROJECT :	HWY 40:40	DATE LAID :	4-Apr-2012
	STATION :	13+483	LOCATION :	3.8m Rt ℄
MAT 6-79/13	LOT NO. :	7	SEGMENT NO.	3

SEGMENT DENSITY

(see ATT-7, Density)

A. CORE THICKNESS		mm	43
B. SAWED CORE WEIGHT		g	1797.8
C. SATURATED SURFACE DRY WEIGHT		g	1801.7
D. VOLUME OF CORE		cm^3	784.4
E. **CORE WET DENSITY**	1000 (B / D)	kg/m^3	1013.4
F. DRY WT. OF CUT ROCK CORE MIX + PAN		g	1580.0
G. WT. OF TARE PAN	No. AA	g	830.9
H. DRY WT. OF UNCUT ROCK CORE MIX + PAN @ 130° C		g	1908.0
I. WT. OF TARE PAN @ 130° C	No. A	g	873.6
J. TOTAL DRY WT. OF CORE MIX	(F - G) + (H - I)	g	1783.5
K. WEIGHT OF WATER	(B - J)	g	14.3
L. **CORE MOISTURE CONTENT**	100 (K / J)	%	0.8
M. **CORE DRY DENSITY**	1000 (J / D)	kg/m^3	**2274**
N. AIR VOIDS CONTENT		%	**7.6**
O. **LOT AVERAGE MARSHALL DENSITY**		kg/m^3	**2333**
P. **PERCENT COMPACTION**	100 (M / O)	%	**97.5**
TIME CORE(S) PLACED IN OVEN		hh : min	9:15
TIME SAMPLES TAKEN OUT OF OVEN		hh : min	13:30
DRYING TIME		hh : min	4:15
TIME EXTRACTION STARTED		hh : min	13:50
TIME EXTRACTION COMPLETED		hh : min	16:40
EXTRACTION TIME		hh : min	2:50

ADDITIONAL UNCUT ROCK CORE MIX FOR EXTRACTION

(see ATT-12 Part II, Extraction)

Q. DRY WT. OF UNCUT ROCK CORE MIX + PAN @ 130° C		g	1849.7
R. WT. OF TARE PAN @ 130° C	No. AAA	g	798.5
S. DRY WT. OF UNCUT ROCK CORE MIX @ 130° C		g	1051.2

EXTRACTION DATA

(see ATT-12 Part II, Extraction)

T. TOTAL DRY WT. OF UNCUT ROCK MIX	S + H - I	(g)	2085.6
U. EXTRACTED DRY WT. OF AGGREGATE + PAN		(g)	2785.7
V. WEIGHT OF TARE PAN		(g)	834.9
W. EXTRACTED DRY WT. OF AGGREGATE	U - V	(g)	1950.8
X. WT. OF CENTRIFUGED DRY FINES + BEAKER		(g)	166.9
Y. WEIGHT OF BEAKER		%	141.6
Z. WT. OF CENTRIFUGED DRY FINES	X - Y	%	25.3
AA. TOTAL WT. OF DRY AGGREGATE	W + Z	%	1976.1
BB. WT. OF EXTRACTED ASPHALT	T - AA	(g)	109.5
CC. EXTRACTION ASPHALT CONTENT uncorrected	100 (BB / AA)	%	5.54
DD. EXTRACTION CORRECTION FACTOR		%	0.31
EE. **CORRECTED ASPHALT CONTENT**	CC + DD	%	**5.85**

*** If more than 50 g in the beaker, or the beaker has fines up to the rim, run a check beaker and check for holes in extraction & centrifuge screens**

WASHED SIEVE ANALYSIS

(see ATT-26, Sieve Analysis)

WT. OF DRY AGGREGATE (AA): 1976.1 g.

SIEVE SIZES (µm)	WEIGHT RETAINED (g)	WEIGHT PASSING (g)	PERCENT PASSING (%)	JOB MIX FORMULA	TOLERANCE
25 000	0.0	1976.1	**100**	100	
20 000	0.0	1976.1	**100**	100	±5
16 000	4.1	1972.0	**100**	100	±5
12 500	193.5	1778.5	**90**	87	±5
10 000	375.5	1403.0	**71**	74	±5
5 000	395.2	1007.8	**51**	53	±5
2 500					
1 250	217.4	790.4	**40**	42	±3
630	296.4	494.0	**25**	26	±2
315	177.8	316.2	**16**	17	±2
160	108.7	207.5	**10.5**	10.0	±1.5
80	94.9	112.6	**5.7**	6.1	±1.5
SIEVE PAN	4.3				

GG TOTAL WEIGHT	**1867.8**	% PASSING = (WT. PASSING / WT. OF DRY AGG) * 100
DRY WASH WT. + PAN	2705.1	
TARE OF PAN	834.9	% DIFFERENCE = (DIFFERENCE / DRY WASH WT) * 100
FF DRY WASH WT. (X-Y)	1870.2	
HH Difference (g)	2.4	MAXIMUM % DIFFERENCE IS 0.5 %
% Difference	**0.13**	

REMARKS

DATE TESTED :	5-Apr-2012
TECHNOLOGIST :	B. GOOD

enter data into shaded areas

NOTE: TRANSFER NECESSARY DATA TO THE DAILY LOT PAVING REPORT

FIGURE 2

Classification: Public

5. If only the dry density of the core is required, proceed to step 6.

   If the dry density, extraction asphalt content and gradation of the core are required, remove the core cut rock as follows:

   a) Label and tare a drying pan. Record the tare pan weight and number in line "G" of a form such as MAT 6-79 or 98.

   b) Turn on the stove burner and centre the base of the required core trimmer on the burner flame for a few minutes to heat the trimmer.

   c) Centre the heated trimmer on the heated core (allow equal clearance on all sides of the core).

   d) Hold the trimmer vertically by its handle, and then press it down through the core until it reaches the bottom of the pan. Apply a slight twist if the heated core is difficult to penetrate. Leave the trimmer in the core.

   e) Use a putty knife and mixing spoon to remove from the pan all the outside cut rock mix. Place this material in the tare pan recorded in line "G".

   f) Scrape off the mix adhering to the trimmer into the appropriate tare pan.

6. Use a putty knife to break up the specimen, taking care not to lose any material.

7. Clean the material adhering to the putty knife back onto the pan(s).

8. Place the pan(s) back in the oven and dry the core mix for 4 hours.

9. Remove the pan(s) from the oven and weigh the hot sample(s).

10. Oven dry the core mix for another hour, then reweigh the hot sample(s).

11. Repeat step 10 until a constant weight is obtained.

12. Weigh the hot mix in the tared pan(s) and record as Dry Wt. of Uncut Rock Core Mix + Pan (line "H"), and Dry Wt. of Cut Rock Core Mix + Pan (line "F"), if applicable.

13. Calculate the Dry Weight of Total Core Mix (line "J") as follows:

    = *Dry Wt. of Uncut Rock Core Mix + Pan (line "H") - Wt. of Tare Pan (line "I")*

    Plus, if applicable

    = *Dry Wt. of Cut Rock Core Mix + Pan (line "F") - Wt. of Tare Pan (line "G")*

14. Determine the Weight of Water removed from the specimen (line "K") using the formula:

    Wt. of Water (g) = Sawed Core Wt. - Dry Wt. of Total Core Mix

Classification: Public

15. Calculate the Moisture Content of the core in % (line "L") as follows:

$$\textbf{Moisture Content (\%)} = \frac{\textbf{Wt. of Water (g)}}{\textbf{Dry Wt. of Total Core Mix (g)}} \times 100$$

3.7.2 Moisture Content of Marshall Specimens

As directed in ATT-15, Part V, determine the moisture content of the fresh mix sample. The field formed Marshall specimen is assumed to have the same moisture content as the mix sample.

The moisture content of the fresh mix sample is determined on the top portion of a form such as MAT 6-80, as shown in Figure 1.

If testing for quality control, the moisture content test is usually performed with the extraction (or nuclear) asphalt content test. In this case, transfer the mix moisture content to a data sheet such as MAT 6-40, 6-80 or 6-98.

3.8 DRY DENSITY

1. Determine the Core Dry Density (kg/m^3) = Mass / Volume using the formula:

$$\textbf{Core Dry Density (kg/m}^3\textbf{)} = \frac{\textbf{Total Dry Wt. of Core Mix (g)}}{\textbf{Volume of Core (cm}^3\textbf{)}} \times 1000$$

2. Determine the Dry Density (kg/m^3) of the field formed Marshall specimens compacted from the test series mix sample as described in steps (a) to (c) below.

   a) Calculate the dry weight of the field Marshall specimen using the test series fresh mix moisture content as follows, on form MAT 6-80, on line H:

$$\textbf{Dry Sample Weight (g)} = \frac{\textbf{Original Sample Wet Weight (g)}}{\textbf{100 + Mix Moisture Content (g)}} \times 100$$

   b) Calculate the Dry Density of each Marshall specimen, using the formula:

$$\textbf{Marshall Dry Density (kg/m}^3\textbf{)} = \frac{\textbf{Dry Sample Weight (g)}}{\textbf{Volume of Sample (cm}^3\textbf{)}} \times 1000$$

   c) Calculate the "Average Marshall Dry Density" of the two Marshall specimens compacted for each test series.

Classification: Public

Alberta Transportation	ACP DENSITY AND VOID CONTENTS ATT-7, Density			
	PROJECT :	HWY 33:12	CONTRACT NO. :	12345
			DATE LAID :	1-May-2012
MAT 6-40/13	TECHNOLOGIST :	B. Good	PROJECT MANAGER :	M. SMART

DATE PROCESSED			1-May-1992				
DATE MIXED			30-Apr-1992				
LOT NO.			8				
SEGMENT NO. or TEST NO. or SAMPLE NO.			1	2	3	4	5
CORE IDENTIFICATION	STATION	0 + 000	7+750	9+131	9+375	10+728	11+706
	LOCATION	m	3.6m Rt ℄	2.0m Rt ℄	0.5m Rt ℄	4.6m Rt ℄	2.6m Rt ℄
	LANE / LIFT		NBL	NBL	NBL	NBL	NBL
	THICKNESS	mm	67	61	73	59	65
SAMPLE APPEARANCE	ASPHALT CONTENT: BLEEDING (B); RICH (R); NORMAL (N); LEAN (L)		N	N	N	N	N
	GRADATION: COARSE (R); NORMAL (N); LEAN (L)		N	N	N	N	N
IMMERSION DENSITY	A. WT. AFTER FORMING OR CORING	g	2534.0	2423.3	2748.9	2132.8	2513.1
	B. SATURATED SURFACE DRY WT.	g	2535.0	2424.6	2749.6	2134.0	2515.0
	C. IMMERSION VOLUME	cm^3	1086.7	1049.9	1182.3	943.6	1084.7
	% of Water Absorbed (by Volume) (B - A) / C * 100	%	0.1	0.1	0.1	0.1	0.2
	D. WET DENSITY 1000 A / C	kg/cm^3	2332	2308	2325	2260	2317
CORE MOISTURE CONTENT	E. WT. OF OVEN DRY CORE + PAN	g	4495.0	4381.5	4700.0	4095.0	4509.7
	F. WT. OF PAN	g	1964.3	1962.7	1953.5	1967.1	1999.6
	G. WT. OF DRY CORE E - F	g	2530.7	2418.8	2746.5	2127.9	2510.1
	H. WT. OF WATER A - G	g	3.3	4.5	2.4	4.9	3.0
	I. MOISTURE CONTENT 100 H / G	%	0.13	0.19	0.09	0.23	0.12
J. DRY DENSITY	100 D / (100 + I) or 1000 G / C		**2329**	**2304**	**2323**	**2255**	**2314**
AVERAGE DRY DENSITY			**2305**				

VOID CONTENTS CALCULATION

K. ASPHALT RELATIVE DENSITY			1.028				
L. ASPHALT ULTIMATE ABSORPTION		%	0.78				
M. BULK RELATIVE DENSITY OF AGGREGATE			2.598				
N. CORRECTED EXTRACTION ASPHALT CONTENT		%	5.66				
O. WT. OF DRY AGGREGATE	100 J / (100+N)	kg	2204.0	2180.4	2198.6	2134.3	2190.1
P. TOTAL WT. OF ASPHALT	J - O	kg	124.7	123.4	124.4	120.8	124.0
Q. WT. OF ASPHALT ABSORBED	O * L / 100	kg	17.2	17.0	17.1	16.6	17.1
R. WT. OF EFFECTIVE ASPHALT	P - Q	kg	107.6	106.4	107.3	104.2	106.9
S. VOLUME OF EFFECTIVE ASPHALT	R / 1000 * K	m^3	0.105	0.104	0.104	0.101	0.104
T. VOLUME OF AGGREGATE	O / 1000 * M	m^3	0.848	0.839	0.846	0.822	0.843
U. VOLUME OF VMA	1.000 - T	m^3	0.152	0.161	0.154	0.178	0.157
V. VOLUME OF AIRVOIDS	U - S	m^3	0.047	0.057	0.049	0.077	0.053
W. AIR VOIDS	100 * V	%	**4.7**	**5.7**	**4.9**	**7.7**	**5.3**
AVERAGE AIR VOIDS			**5.7**				
X. VOIDS FILLED WITH ASPHALT	100 * S / U	%	69.0	64.4	67.9	56.8	66.2
Y. VOIDS IN MINERAL AGGREGATE	100 * U	%	15.2	16.1	15.4	17.8	15.7

Z. DAILY AVERAGE MARSHALL DENSITY		kg/m^3	**2366**				
AA CORE PERCENT COMPACTION	100 * J / Z	%	98.4	97.4	98.2	95.3	97.8
AB AVERAGE CORE PERCENT COMPACTION		%	**97.4**				

REMARKS :

If the % of water absorbed by the specimen exceeds 2.0%, use either ATT-6 (Waxing) or AASHTO T 331 (vacuum sealing) to determine the density

enter data into shaded areas

FIGURE 3

Classification: Public

3.9 Percent of Water Absorbed (by Volume)

1. Calculate the percent of water absorbed by the specimen (on a volume basis) as follows:

$$\textit{\% of Water Absorbed by Volume} = \frac{\textit{SSD wt - mass of specimen in air}}{\textit{Volume of Sample}} \times 100$$

2. If the percent of water absorbed by the specimen exceeds 2.0%, use either ATT-6 DENSITY, Immersion Method, Waxed or AASHTO T 331 DENSITY, Vacuum Sealing Method.

4.0 HINTS AND PRECAUTIONS

1. Above Scale Weighing: Press the tare button prior to immersing each new specimen into the density bucket, as water adhering to the previous sample causes a continual decrease in the weight of water in the bucket on top of the scale.

2. Above Scale Weighing: Care should be taken when immersing the specimen held by the snare wire into the pail on the electronic balance. Ensure that your hands don't touch the water in the pail, as water sticking to your hands will change the tare weight of the water in the bucket, and produce an erroneous weight.

3. Water entering the specimen during immersion yields a lower volume than actual, which leads to an erroneous high density. The wax method as directed in ATT-6 can be used to determine if an excess of water is entering the specimen.

4. Any water that seeps from the specimen during the weighing operation for the Saturated Surface Dry Weight is considered part of the saturated specimen.

5. Care should be taken to avoid distortion, bending, or cracking of specimens during and after removal either from the roadway, or from the marshall molds. Store the specimens on a flat surface in a cool place.

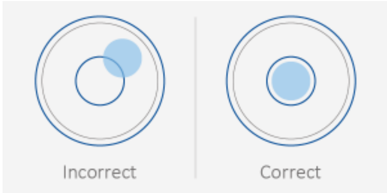
6. Care should be taken to ensure no trapped air bubbles exist under the specimen. To accomplish this, the **cores and briquettes should be resting on their rounded sides, not on the flat side, during the 5 minute soaking process**.

7. Installation of Balance:
   Location: When selecting a location to install your balance, always allow sufficient space around the balance for ease of operation, and keep away from radiating heat sources.

   Vibrations: Ensure that there is no rotating or reciprocating machinery located near the balance.

Classification: Public

Slope: Ensure the balance is on a stable and level table. Place a spirit level, or bubble level, on the balance platform, then using the adjustable legs on the balance, level the balance.



Air Drafts: Ensure that there are no air conditioning or heat vents above, or near the balance.

Temperature: Any windows or doors to the outside can cause airflow and/or rapid temperature changes.

Balance Heat Shield: Never weigh a sample directly on the weighing platform. It is recommended that a wood, metal, or ceramic tile be placed on the scale platform to protect the load cell. This will prevent damage to the load cell, especially when weighing heated pans from the lab oven at 135^{o}C, or when weighing very hot ignition oven baskets directly out of the ignition oven at 500^{o}C.

8. Yearly Balance Calibrations:
   Each balance should have a sticker on the side which normally shows the calibration date, calibration company, and calibration techs name.

9. Calibration Check Weight:
   Calibration weights are available in various masses and tolerances to maintain any lab balance. To ensure that your balance is both precise and accurate, a check weight (1-5 kg) should be used at the start of each day, before using the balance to weigh any actual samples, to confirm that the balance is in tolerance. This weight should be recorded daily, and stored for future reference, to show compliance.

   It is best to never touch the weights with your bare hands, as oils from your fingers can erode the coating on the weights, and will then affect the weight accuracy. The weights should always be handled with a pair of white cotton gloves (supplied with the weights).

   Once the weight is lifted, handle it carefully, taking care not to let it be scratched or dragged over the surface of the balance platform, when placing it on the scale, and when removing it.

   Always store the weights in their weight box, or other appropriate container so the weights aren't damaged.

   You should purchase your test weights in the same measurement units that you are normally weighing samples in. Since we normally weigh samples in metric units, so it is best to purchase a metric weight, to eliminate the potential error in weight conversions.

Classification: Public