MARYLAND DEPARTMENT OF TRANSPORTATION

STATE HIGHWAY ADMINISTRATION

Office of Materials Technology
Aggregate Technician Study Guide

Soils and Aggregate Technology Division
7450 Traffic Drive
Hanover, Maryland 21076

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1. Introduction

1.1 Purpose

Maryland Department of Transportation State Highway Administration (MDOT/SHA) has the responsibility to ensure that the aggregate quality control technicians are proficient in all test methods required. This document will provide the necessary information for becoming a certified aggregate technician for base course plants shipping material to MDOT/SHA projects. This document will prepare technicians for a written exam and a practical demonstration of the test methods outlined and described in this document.

1.2 Scope

The information provided in this document is specifically for technicians performing quality control testing in Certified Graded Aggregate Base Plants for MDOT/SHA projects. This course is self-taught using this document and the Mid-Atlantic Region Aggregate Technician Manual.

2. GAB Quality Control Procedures

2.1 Job Mix Formula

Certified Graded Aggregate Base Plants are required to submit the Job Mix Formula (JMF) every two years or when a change is needed to meet the current production. One aspect of the JMF is the selection of the gradation that will be produced. If any sieve limit is changed a new JMF will be determined by MDOT/SHA. The table below outlines the individual sieve ranges and production tolerances specified in the MDOT/SHA Standard Specifications for Construction and Materials, section 901, tables 901 A and 901 B.

Sieve Size	**2”**	**1 ½”**	**¾”**	**3/8”**	**#4**	**#30**	**#200**
Design High Range %	100	100	92	70	55	25	8
Design Low Range %	100	95	70	50	35	12	0
Production Tolerance %	-2	±5	±8	±8	±8	±5	±3*

*±2 for field grading (omitting T11)

This is important when comparing the quality control testing to the approved JMF of a certified Graded Aggregate Base plant. If any of the gradation values for one or more sieves are out of the production tolerance action must be taken to correct the material before shipment. Refer to the approved quality control plan for your plant and take the appropriate steps.

Moisture content testing is just as important as the gradation of the material. The stockpiles must be maintained to ±2% of optimum moisture as it was determined in the JMF testing performed by MDOT/SHA. If the moisture content is outside of the tolerance refer to the approved quality control plan and take the appropriate steps to correct the deviation.

2.2 Quality Control Test Frequency

The quality control technician will sample the material from the stockpile using a method from AASHTO R90 and perform a gradation check. This will occur at a minimum once per each 1000-ton lot (or a portion thereof) and at least once per 8 hours production shift. Moisture checks must be performed every four hours of production. This information will be reported on a Form-43. Submit the Form-43, daily, stating that the material was sampled and tested using the MDOT/SHA's sampling and testing guidelines and meets the applicable specifications.

T27 Gradation Test Frequency:

- 1 gradation test per 8-hour shift
- 1 gradation test per 1000-ton lot

T255 Moisture Test Frequency:

- 1 moisture test per 4 hours of production

2.3 Reporting

MDOT/SHA requires the Certified Graded Aggregate Base Plant to notify the Administration one day prior to producing materials for MDOT/SHA projects using a Form-43. All Certified Graded Aggregate Base Plants are notified when a contractor is approved to use their material for MDOT/SHA contract/project. The list of approved contract numbers should be checked before shipment of any material. If the plant receives an order of Graded Aggregate Base, for a contract that is not in the approved contract list, the plant should inform the contractor that the contract is not in the approved contract list and should not ship any material. The certified plant is to report the total tons shipped one business day after completion of daily shipments. The form includes the information that the material was sampled and tested using the

Administration's sampling and testing guidelines and meets the applicable specifications. Below is an example of a completed Form-43.

State Highway Administration

Office of Materials Technology

Graded Aggregate Base Plant Report

(EXAMPLE)

Shipment Date: 10/12/21

Next Day Shipment Date: 10/14/21

Contract # and Contractor	Total Tons /Cancellations ✓ ☐	Contract # and Contractor	Estimated Tons
BA1235175	80	HA3215176	50
TOTAL TONS FOR THE DAY:	80	TOTAL ESTIMATED TONS:	50

Date Tested: 10/12/21

G.A.B Job Mix Formula Approval Number GA-01 (Plant #) 1 (JMF No.) 22 (Year)

Plant Lab Test Data

	Sieve Size							Moisture & Additive			Sample	Tons	Result
	2"	1-1/2"	3/4"	3/8"	#4	#30	#200	% MC	Cement	CaCi2	Time	Shipped	(P or F)
JMF	100	100	82	68	47	15	6	4.5					
Tolerance	+/-2	+/-5	+/-8	+/-8	+/-8	+/-5	+/-2	+/-2					
Range	100	95-100	74-90	60-76	39-55	10-20	4-8						
%	100	100	85	65	44	19	7	4.4%			7:30	80	P
P													
A													
S													
S													
I													
N													
G													

First Truck Time 8:12am Last Truck Time 11:15am

Remark:

Date Submitted: 10/13/21

Sample Size: 50 (lbs.)

Reported by:(Name) A. Cert Tech

Reported by:(Signature)

Certified Technician No. MD-1234

3. Test Methods

3.1 Rounding Procedures

This Method addresses rounding of numbers from test results and calculations.

If the number following the last number to be retained is less than 5, the last number to be retained is left unchanged and the number(s) following the last number to be retained is/are discarded

- Example 1. 14.649 = 14.6
  14.749 = 14.7

If the number following the last number to be retained is greater than 5, increase the last number to be retained by 1 and discard the number(s) following the last number to be retained

- Example 2. 14.66 = 14.7
  14.76 = 14.8

If the number following the last number to be retained is 5, and there are no numbers beyond 5, only zeros, the last number to be retained is increased by 1 if odd or left unchanged if even. The number(s) following the last number to be retained is/are discarded.

- Example 3. 14.750 = 14.8
  14.650 = 14.6

If the number(s) following the last number to be retained is 5 and there is/are numbers following the 5, the last number to be retained is increased by 1 regardless of being odd or even. The number(s) following the last number to be retained is/are discarded

- Example 4. 14.751 = 14.8
  14.651 = 14.7

For questions involving significant figures, refer to AASHTO R 11.

3.2 AASHTO R 90: Sampling Aggregate Products

Scope:

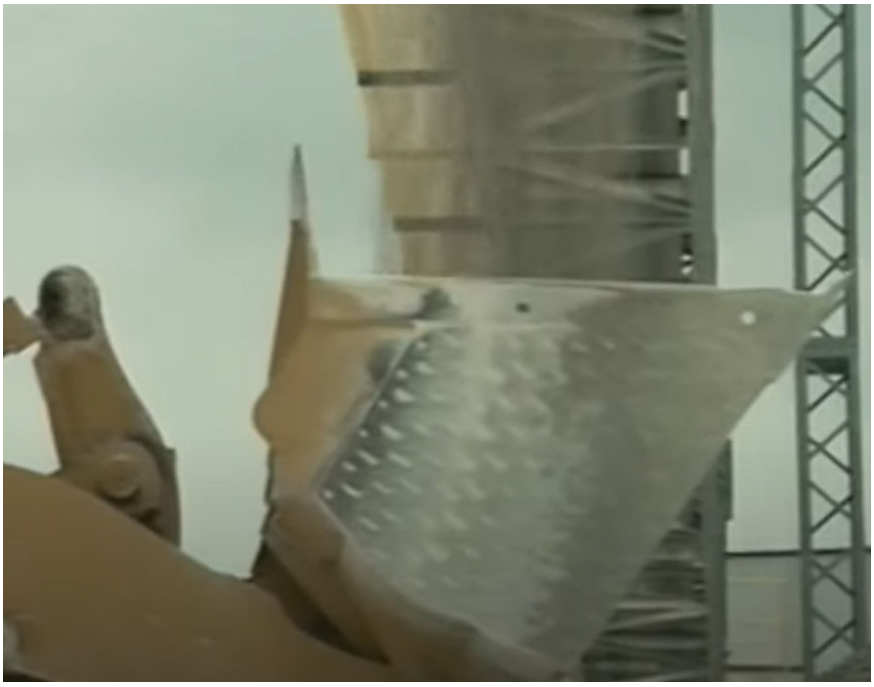
This practice covers the procedures for obtaining representative samples of coarse, fine, or combinations of coarse and fine aggregate products. Test samples should represent the total amount of the material being produced or used. This is normally accomplished by random sampling. All material should have an equal chance of being tested. During production at the source, care must be taken to assure that the virgin material being processed is normal to the overall consistency of the available material.

There are four methods approved by AASHTO for securing aggregate samples. The method the technician uses depends on the type of aggregate to be sampled, the location of the sample, and the sampling equipment available.

3.2.1 Method A: Sampling from Conveyor Belt Discharge (Aggregate Stream Overflow)

Apparatus: *A* manual, semiautomatic or automatic sampling device with a pan of sufficient size to intercept the entire cross section of the discharge stream.

- Do not sample from the beginning or end of an aggregate run to avoid potential for segregation.
- Pass the sampling device, perpendicular to the flow of material, through the full stream once in each direction.
- Obtain multiple equal increments when one increment isn't enough for the required testing.
- Empty all increments including material that may adhere to the sampling device into a single container to form a single sample.



3.2.2 Method B: Sampling from Conveyor Belt using a sampling template

Apparatus: *A* sampling template and broom or brush

- Do not sample from the beginning or end of an aggregate run to avoid potential for segregation.
- Stop the belt.
- Set the sampling template on the belt and avoid mixing of adjacent material.
- Remove the material inside the template; brushing all material adhering to the belt.
- Obtain multiple equal increments when one increment isn't enough for the required testing.
- Empty all increments into a single container to form a single sample.

3.2.3 Method C: Sampling from a flat surface created by a loader

Apparatus: *A* loader and a shovel

- Direct the loader operator to enter the stockpile with the bucket at least 1 ft (0.3 m) above ground without contaminating the stockpile.
- Discard the first bucketful of material.
- Have the loader e-enter the stockpile, obtain a full loader bucket of material, and tilt the bucket back and up.
- Form a small sampling pile at the base of the stockpile by gently rolling the material out of the bucket with the bucket high enough to permit the free flow of the material. Repeat as necessary.
- Create a flat surface by having the loader back-drag the small pile.
- Obtain increments from at least three randomly selected locations on the flat surface, at least 1 ft from the edge.
- Fully insert the shovel, excluding the underlying material, roll back the shovel, and lift the material slowly out of the pile.
- Combine the increments to form a single sample.

3.2.4 Method D: Sampling from a horizontal surface on the stockpile face

Apparatus: *A* shovel or a loader

- Create horizontal surfaces with vertical surfaces in the top, middle and bottom third of the stockpile with a shovel, or a loader.
- Shove a flat board against the vertical face behind sampling location to prevent sloughing.
- Discard any sloughed material to create a horizontal surface .
- Obtain sample from the horizontal surface as close as possible to the intersection of the horizontal and vertical faces.
- Obtain at least one increment of equal size from each of the top, middle , and bottom thirds of the pile.
- Combine the increments to form a single sample.

3.3 AASHTO R 76: Reducing Samples of Aggregate to Testing Size

Scope:

Aggregates compose a major portion of most highway construction. They are used in all phases including base construction, pavement mix, granular shoulders, granular surfacing, drainage and erosion control. In order to assure the aggregate performs as intended for the specified use, a variety of tests must be performed on the aggregate. These samples must be representative of the

aggregate selected for use and should be obtained by appropriate methods as described in AASHTO R 76.

These methods cover the reduction of large samples of aggregate to the appropriate size for testing, in such a way that the reduced sample remains representative of the larger sample.

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Selection of Method:

Aggregate Size	Moisture Presence	Appropriate Method
Fine Aggregate	Dry/ Drier than saturated surface-dry condition	Method A: Mechanical Splitter
Fine Aggregate	Wet / with free moisture on particle Surfaces	Method B: Quartering - or Method C: Miniature Stockpile
Coarse Aggregate	Dry or Wet	Method A: Mechanical Splitter - or Method B: Quartering
Combined Fine and Coarse Aggregate	Dry/ Drier than saturated surface-dry condition	Method A: Mechanical Splitter - or Method B: Quartering
Combined Fine and Coarse Aggregate	Wet / with free moisture on particle Surfaces	Method B: Quartering

3.3.1 Method A: Mechanical Splitter

Apparatus: Sample Splitter

- Place the sample in the hopper or pan of the sample splitter.
- Evenly distribute the sample from edge to edge so that equal amounts will flow through each receptacle.
- Reintroduce the portion of the sample in one of the receptacles into the splitter as many times as necessary to reduce the sample to testing size


3.3.2 Method B: Quartering

Apparatus: straightedge; straightedge scoop, shovel or trowel; a broom or brush; and a canvas blanket or tear-resistant tarp approximately 2 by 2.5 m (6 by 8 ft).

- Thoroughly mix the material on a hard, clean, level surface by turning the entire sample over three time.
- With last turning, form the entire sample into conical pile by depositing individual lifts on top of the preceding lift
- Flatten the conical pile to uniform thickness by pressing the apex with a shovel or trowel.
- Divide the flattened mass into four equal parts with a shovel or trowel.
- Remove two diagonally opposite quarters to obtain your testing sample or reduce them until again until you reach the desiring sample size.


3.3.3 Method C: Miniature Stockpile Sampling (Damp Fine Aggregate Only)

Apparatus: straightedge; straightedge scoop, shovel or trowel; and a small scoop, or spoon.

- Thoroughly mix the material on a hard, clean, level surface by turning the entire sample over three time.
- With last turning, form the entire sample into conical pile by depositing individual lifts on top of the preceding lift
- Flatten the conical pile to uniform thickness by pressing the apex with a shovel or trowel.
- Obtain the test sample for selecting at least five increments of material at random locations from the miniature stockpile, using a scoop or a spoon

3.4 AASHTO T 27: Sieve Analysis of Fine and Coarse Aggregates

Scope:

Sieve Analysis, commonly known as the gradation test determines the gradation (the distribution of particle size) with in each sample, in order to verify compliance with design, production control requirements and specifications.

Equipment:

- Balance - general purpose class (AASHTO M 231).
- Sieves - mounted on suitable frames, shall conform to AASHTO M 92.
- Mechanical sieve shaker - if used, must provide a vertical or lateral and vertical motion to the sieve. Sieve shaker must provide sieving thoroughness within a reasonable time.
- Oven - capable of maintaining 110 ± 5 °C (230 ± 9°F).

Sample Preparation:

- Samples should be obtained according to AASHTO R 90 and reduced to test size in according to AASHTO R 76.
- Samples should be dried to a constant mass in an oven regulated to 110 ± 5 °C (230 ± 9 °F).
- The mass of the test sample shall conform with the following.

Coarse Aggregate:

Nominal Maximum Size of Aggregate mm (in)	Minimum Mass of Test Sample kg (lbs.)
9.5 (3/8)	1 (2)

12.5 (1/2)	2 (4)
19.0 (3/4)	5 (11)
25.0 (1)	10 (22)
37.5 (1 1/2)	15 (33)
50.0 (2)	20 (44)
63.0 (2 1/2)	35 (77)

Fine Aggregate:

- The size of the test sample of aggregate after drying shall be 300g minimum.

Procedure:

- After obtaining the test sample, record the mass of the sample to the nearest 0.1% of the total mass of test sample.
- Limit the quantity of material on a given sieve so that all particles have opportunity to reach sieve openings several times during the sieving operation.
- Every effort should be made to avoid overloading the sieves. For fine aggregate sieves with openings smaller than 4.75-mm (No. 4), the quantity retained on any sieve at the completion of the sieving operation shall not exceed 7 kg/m^2 (4 g/$in.^2$) of sieving surface area. This amounts to 200 g on any small round 203.2 mm (8 in.) sieve below the 4.75 mm (No. 4) sieve.
- For sieves with openings 4.75 mm (No. 4) and larger, the quantity retained in kg shall not exceed the product of 2.5 × (sieve opening, mm × (effective sieving area, m2)). This quantity is shown in the following table for five sieve-frame dimensions in common use.

Maximum Allowable Quantity of Material Retained on a Sieve, (kg)					
Nominal Dimensions of Sieve					
Sieve Opening Size, mm (in)	**203.2-mm (8 in) Dia. Round Sieves**	**254-mm (10 in) Dia. Round Sieves**	**304.8-mm (12 in) Dia. Round Sieves**	**350 by 350 mm (14 x 14 in) Square Sieves**	**372 by 580 mm (16 x 24 in) Rectangular Sieves**
	Sieving Area, m^2				
	0.0285	0.0457	0.0670	0.1225	0.2158
50 (2)	3.6 kg	5.7 kg	8.4 kg	15.3 kg	27.0 kg
37.5 (1 1/2)	2.7 kg	4.3 kg	6.3 kg	11.5 kg	20.2 kg
25.0 (1)	1.8 kg	2.9 kg	4.2 kg	7.7 kg	13.5 kg
19.0 (3/4)	1.4 kg	2.2 kg	3.2 kg	5.8 kg	10.2 kg
12.5 (1/2)	0.89 kg	1.4 kg	2.1 kg	3.8 kg	6.7 kg
9.5 (3/8)	0.67 kg	1.1 kg	1.6 kg	2.9 kg	5.1 kg
4.75 (No. 4)	0.33 kg	0.54 kg	0.80 kg	1.5 kg	2.6 kg

- Nest the sieves in order of decreasing size from top to bottom and begin shaking the sample for a sufficient amount of time.
- For coarse aggregates, after the material has been sieved, remove each tray, weigh and record the mass to the nearest 0.1% of total mass. The final total of the masses retained on each sieve should be within 0.3% of the original mass of the sample prior to grading.
- For fine aggregates, weigh the material retained on each sieve size to the nearest 0.1% by total mass (e.g. 300 g ± sample recorded to nearest 0.1 g). Ensure that all material entrapped within the openings of the sieve is cleaned

out and included in the mass retained.

Calculation:

- Tare the pan on the scale. Weigh the material retained on each sieve (from top to bottom). After the material from each sieve is weighed, empty the tared pan and go to the next sieve. Once all the sieves have been weighed, total the mass (Figure 11).

Initial Dry Mass of Sample: 479.1 g

Sieve Size	Mass (g)	Percent Retained	Percent Passing
9.5 mm (3/8”)	0		
4.75 mm (No. 4)	178.2		
600 µm (No. 30)	131.6		
300 µm (No. 50)	93.5		
75 µm (No. 200)	62.5		
Pan	13.3		
Total	479.1		

Figure 11 - Record mass of material on each sieve individually, and record the total the mass.

- Calculate the mass passing each sieve by subtracting the mass retained on that sieve from the total mass passing the sieve above. The mass passing the top sieve shall be from the initial mass retained

  Example: (a) = 479.1 -0

  (b)=479.1-178.2

  (c) =300.9-131.6

Sieve Size	Mass Retained	Mass Passing	Percent Passing
9.5 mm (3/8”)	0	479.1 (a)	
4.75 mm (No. 4)	178.2	300.9 (b)	
600 µm (No. 30)	131.6	169.3 (c)	
300 µm (No. 50)	93.5	75.8	
75 µm (No. 200)	62.5	13.3	
Pan	13.3		
Total	479.1		

- Calculate the percentage passing each sieve by dividing the mass passing that sieve by the initial dry mass and multiply by 100 (Figure 12).

  Example: (a) = (479.1 ÷ 479.1) x 100 = 87

  (b) = (300.9 ÷ 479.1) x 100 =22

Sieve Size	Mass Retained	Mass Passing	Percent Passing
9.5 mm (3/8”)	0	479.1	87
4.75 mm (No. 4)	178.2	300.9	22
600 µm (No. 30)	131.6	169.3	50
300 µm (No. 50)	93.5	75.8	12
75 µm (No. 200)	62.5	13.3	2.8
Pan	13.3		
Total	479.1		

Note: Report the percentages to the nearest whole number, except if the percentage passing the 75 µm (No. 200) sieve is less than 10 percent, it shall be reported to the nearest 0.1 percent.

3.5 AASHTO T 255: Moisture Content of Aggregate by Drying

Scope:

The moisture content of a material influences its ability or inability to be excavated, consolidated, moved, screened, weighed, dried out or reabsorbed. Moisture content calculations used for soils and aggregates are by convention defined as the mass of water lost through drying divided by the dry mass of the material. The moisture content is used to calculate a variety of properties such as dry density, plasticity, permeability etc.

This test method determines the percentage of evaporable moisture in a sample of aggregates by drying both surface moisture and the moisture in the pores of the aggregate.

Equipment:

- Balance - readable to 0.1 percent of sample mass, class (AASHTO M 231).
- Source of Heat - Oven - capable of maintaining 110 ± 5 °C (230 ± 9°F) or (electric/ gas) hot plate
- Sample Container -metal container
- A Stirrer – a metal spoon or spatula

Sample Preparation:

- Samples should be obtained according to AASHTO R 90 and reduced to test size in according to AASHTO R 76.
- Obtain a representative sample of a mass not less than the amount listed below. Protect the sample against moisture loss prior to determining the mass.

Nominal Maximum Size of Aggregate mm (in)	Minimum Mass of Test Sample kg
4.75 (No. 4)	0.5
9.5 (3/8)	1.5
12.5 (1/2)	2
19.0 (3/4)	3
25.0 (1)	4
37.5 (1 1/2)	6

50.0 (2)	8
63.0 (2 1/2)	10

Procedure:

- Weight the mass of the wet sample to the nearest 0.1 percent
- Place the container into the selected source of heat. If the source of heat other than a controlled temperature oven is selected, stir the sample during drying.
- Dry the sample to constant mass, where further heating causes, or would cause less than 0.1 percent additional loss in mass.
- Determine the mass of the dried sample to the nearest 0.1 percent after it has cooled sufficiently not to damage the balance.

Calculation:

% Moisture = 100 (W – D)/D

Where: W = mass of wet aggregate
D = mass of dry aggregate

3.6 AASHTO T-85: Specific Gravity and Absorption of Coarse Aggregate

Scope:

Specific gravity is the ratio of mass of a given volume of aggregates to the mass of an equal volume of water. This test method determines the specific gravity and absorption of coarse aggregates that have been soaked for a period of 15–19 hours.

Equipment:

- Balance - general purpose class (AASHTO M 231).
- Sample Container – A wire basket of 3.35 mm (No. 6) of finer mesh with a capacity of 4 to 7 Liters.

- Water Tank: A watertight tank equipped with an outflow outlet into which the sample and sample container are placed for complete immersion while suspended below the balance.
- Suspension Apparatus: Wire suspending the container be of the smallest practical diameter.
- Sieves – A 4.75 mm (No. 4) sieve conforming to AASHTO M 92
- Oven - capable of maintaining 110 ± 5 °C (230 ± 9°F).

Sample Preparation:

- Samples should be obtained according to AASHTO R 90 and reduced to test size in according to AASHTO R 76.
- Dry sieve the sample through a 4.75 mm (No. 4) sieve and discard any material that passes the sieve. The minimum sample mass shall be as follows:

Nominal Maximum Size of Aggregate mm (in)	Minimum Mass of Test Sample kg (lbs.)
12.5 (1/2) or less	2 (4.4)
19.0 (3/4)	3 (6.6)
25.0 (1)	4 (8.8)
37.5 (1 1/2)	5 (11)
50.0 (2)	8 (18)
63.0 (2 1/2)	12 (26)

Procedure:

- Dry test sample to constant mass in an oven regulated at 110 ± 5°C (230 ±9°F). Cool the sample at room temperature for 1 to 3 hours. After the cooling period, immerse the aggregate in water at room temperature for a period of 15 to 19 hours.
- Remove the sample from soaking and drain any excess water from the aggregate. Place the aggregate on an absorbent towel and then shake and roll the aggregate from side to side, until all visible films of water are removed, and the aggregate has reached Saturated Surface Dry (SSD) condition.

- Weigh the SSD sample to the nearest 1.0 g of the sample mass.
- After weighing, place the entire sample in a container and immerse in water. Shake container to release any entrapped air, hook onto scale and weigh. Ensure that the overflow is working properly to compensate for the water displaced by the sample (Figure 10 & 10A). Record the mass of the submerged sample and container to the nearest gram.

- Remove the sample and container from the water. Place the sample from the container and dry in a pan to a constant mass in an oven at a temperature of 110 ± 5 °C (230 ± 9°F).
- Cool in air at room temperature for 1 to 3 hours (until the aggregate can be comfortably handled).
- Record mass to the nearest 1.0 g as oven dry mass.

Calculation:

There are four determinations that may be made from this procedure. They are as follows:

I. Bulk specific Gravity ($G_{s\,b}$) (also known as Bulk Dry Specific Gravity)

- The ratio of the mass (in air) of a unit volume of aggregate to the mass (in air) of an equal volume of gas-free distilled water at a stated temperature (Figure 11). This unit volume of aggregates is composed of the solid particle, permeable voids and impermeable voids.

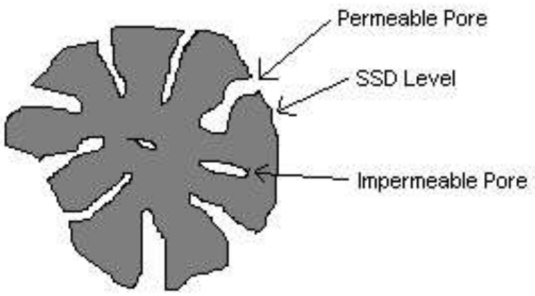

Figure 11 – Diagram of Bulk Specific Gravity

II. Bulk Specific Gravity – Saturated Surface Dry (Gs b SSD)

- The ratio of the mass (in air) of a unit volume of aggregate to the mass (in air) of an equal volume of gas-free distilled water at a stated temperature (Figure 12).

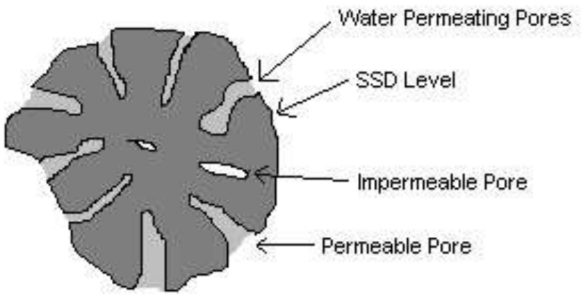

Figure 12 - Diagram of Bulk SSD. Specific Gravity SSD mass is the Saturated Surface Dry Condition and includes the mass of the water in the permeable pore space.

III. Apparent Specific Gravity (Gsa)

- This ratio of the mass (in air) of a unit volume of the "impermeable" portion of aggregate (does not include the permeable pores in aggregate) to the mass (in air) of an equal volume of gas-free distilled water at a stated temperature (Figure 13)

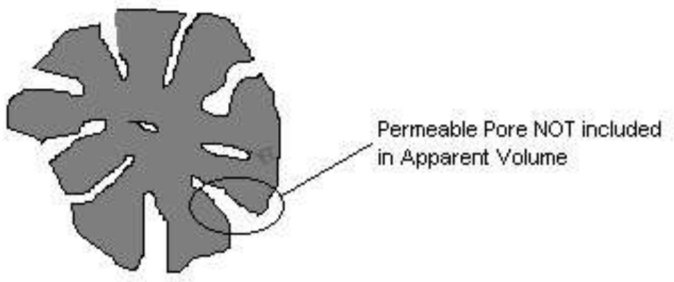

Figure 13 - Diagram of Apparent Specific Gravity Apparent Volume = volume of aggregate particle not including permeable voids.

IV. Percent Absorption (% Abs.)

The increase in mass of aggregate due to water in the pores of the material, but not including water adhering to the outside surface of the particles expressed as a percentage of the dry mass. (Figure 14.)

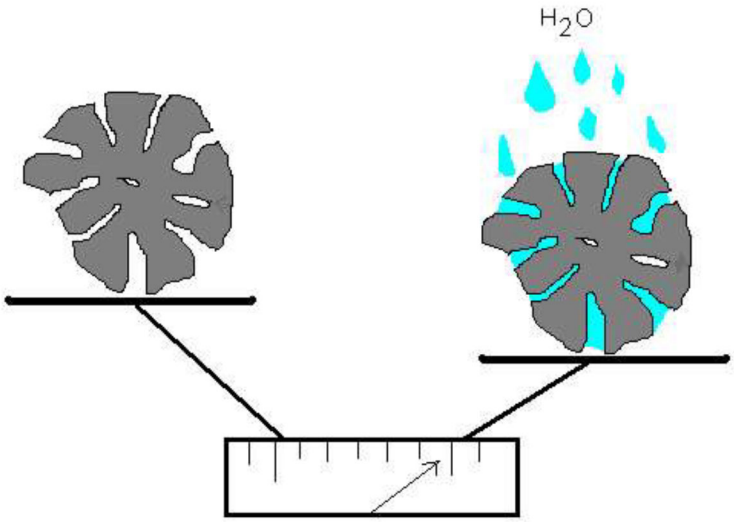

Figure 14. Increase in mass due to absorption of water

The formulas for the above-mentioned determinations are as follows:

1. Bulk Specific Gravity (Gs b)

   Gs b = A / (B-C)

2. Bulk SSD Specific Gravity (Gs b SSD)

   Gs b SSD = B / (B-C)

3. Apparent Specific Gravity (Gsa)

   Gsa = A / (A-C)

4. Absorption (%Abs.)

   %Abs. = [(B – A) / A] x 100

Where: A = Mass (grams) of Oven Dry Specimen in Air

B = Mass (grams) of SSD Specimen in Air

C = Mass (grams) of SSD Specimen in Water

B = Mass (grams) of SSD Specimen in Air

Appendix 1: RC-GAB

1. Introduction:

Maryland Department of Transportation State Highway Administration (MDOT/SHA) has the responsibility to ensure that the aggregate quality control technicians are proficient in all test methods required. This additional information will provide the necessary information for becoming a certified aggregate technician for recycled concrete base course plants shipping material to MDOT/SHA projects.

This document will prepare technicians for a written exam and a practical demonstration of the test method outlined and described in this section.

2. Quality Control Test Frequencies

The quality control technician will sample the material from the stockpile using a method from AASHTO R90 and perform a gradation check, moisture test, and pH check. The gradation and pH checks will occur at a minimum once per each 1000-ton lot (or a portion thereof) and at least once per 8 hours production shift. Moisture checks must be performed every four hours of production. This information will be reported on a Form-43. Submit the Form-43, daily, stating that the material was sampled and tested using the MDOT/SHA's sampling and testing guidelines and meets the applicable specifications.

T27 Gradation Test Frequency:

- 1 gradation test per 8-hour shift
- 1 gradation test per 1000-ton lot

T255 Moisture Test Frequency:

- 1 moisture test per 4 hours of production

T289 Determining pH

- 1 pH test per 8-hour shift
- 1 pH test per 1000-ton lot

3. T289 Determining pH of Soil for Use in Corrosion Testing

Scope:

This test method describes the procedure and test equipment for determining a pH (potential of hydrogen) value using a pH meter. The first part of the procedure details how you would obtain the test specimen. The second part is the test method for determining the Ph value.

Equipment:

- Sieves – Shall conform to ASTM E11in the following sizes: 6.3 mm (1/4 in), 4.75 mm (No. 4), 2.00 mm (No. 10), and a pan.
- Balance – Shall have enough capacity, be readable to 0.1 percent of the sample mass, or better, and conform to the requirements of M 231.
- Drying Apparatus – Any device that can dry samples at a temperature not exceeding 60° C (140° F).
- Pulverizing Apparatus – Either a mortar and rubber-covered pestle or any equipment suitable to break up any clumps or aggregations without reducing the size of the particles.
- Sample Splitter – A suitable riffle sampler or sample splitter for proportional splitting of the sample and capable of obtaining a representative test specimen without the appreciable loss of fines. Proportional splitting on a canvas cloth is also permitted.
- pH meter – A suitable device that can be used in the field or laboratory with either one or two electrodes. Have the capacity to be standardize at multiple pH values.
- 50-mL wide-mouth glass beaker.
- A watch glass of suitable size to cover the beaker
- Standard Buffer Solutions of Known pH values – Standards to be used 7.0, 10.0, 12.0
- Distilled water
- A teaspoon or small scoop
- Thermometer capable of reading 25 ± 10°C, to the nearest 0.1°C.
- Glass stirring rod.

Sample Size:

Approx. mass of 100g of minus 2.00 mm (No. 10) sieve.

Initial Preparation of Test Specimens:

1. The sample shall be in a moist condition for pH testing. If the sample has a high moisture content it can be air dried or in a drying apparatus not exceeding 60°C (140°F) before selection of the test specimen.
2. A representative test specimen shall be obtained with the use of a sampler, or by splitting or quartering as per R 76.
3. The portion of the sample selected as the test specimen for pH testing shall be separated into fractions by one of the following:

a. Using a 2.0 mm (No. 10) sieve – The test specimen shall be separated into two fractions using the 2.0 mm sieve. The portion retained on the sieve shall be ground down using a pulverizing equipment. Keep pulverizing until the aggregations of particles are broken into separate grains. The ground test specimen shall be separated into two fractions using the 2.0 mm sieve.
b. Using a 4.75 mm and 2.0 mm (No. 4 and No 10) sieve - The test specimen shall be separated into two fractions using the 4.75 mm sieve. The portion retained on the sieve shall be ground down using a pulverizing equipment. Keep pulverizing until the aggregations of particles are broken into separate grains and again are separated on the 4.75 mm sieve. The fraction passing the 4.75 mm sieve shall be mixed and , by use of a sampler or by splitting and quartering, a representative portion adequate for testing. The split-off portion shall then be separated on the 2.0 mm sieve and processed as in section "a" above.
c. Using a 6.3 mm and 2.0 mm (1/4 in and No. 10) sieve - The test specimen shall be separated into two fractions using the 6.3 mm sieve. The portion retained on the sieve shall be ground down using a pulverizing equipment. Keep pulverizing until the aggregations of particles are broken into separate grains and again are separated on the 6.3 mm sieve. The fraction passing the 6.3 mm sieve shall be mixed and , by use of a sampler or by splitting and quartering, a representative portion adequate for testing. The split-off portion shall then be separated on the 2.0 mm sieve and processed as in section "a" above.

Determination of pH:

1. Place a mass of 30.0 ± 0.1 g of the test specimen into the glass beaker.
2. Add 30.0 ± 0.1 g of distilled water to the test specimen. Stir to obtain a slurry and then cover with the watch glass.
3. The test specimen must stand for 1 h, stirring every 10 to 15 minutes. This will allow the solution to stabilize.
4. Measure the temperature of the slurry solution and adjust the temperature controller of the pH meter to that of the test specimen. This adjustment should be done just prior to testing. On meters with an automatic temperature control, follow the manufacturer's instructions.
5. Standardize the pH meter by using the standardized solutions. Temperature and adjustments must be performed as described in step 4. To standardize the pH meter, use the 7.0 pH buffer plus the other standard solution that is nearest to the estimated pH value of the material being tested. Example – If the meter is standardized at 7.0 and 10.0 and the pH meter reads over 10.0, the pH meter will need to be standardized at 12.0 by using that standard solution. Repeat the test after re-standardizing to pH meter. Failure to properly standardize the pH meter will provide an inaccurate reading/result.
6. Before immersing the electrode(s) into the test specimen, stir well with a glass rod. Place the electrode(s) into the slurry solution and gently turn the beaker to make good contact between the solution and electrode(s). DO NOT place the electrode(s) into the test

specimen; place them into the slurry solution. Take care not to damage the electrode(s) by hitting it on the sides or bottom.

7. Immerse the electrode(s) for 30 s or longer into the slurry solution before taking a reading. If your pH meter had an auto-read system, it will automatically signal when it is stabilized.
8. Read and record the value to the nearest tenth of a whole number.
9. Rinse off the electrode(s) with distilled water, then dab lightly with tissues to remove any film formed on the electrode(s). Use caution and do not wipe the electrode(s) as this may result in polarization of the electrode(s) and consequent a slow response. If polarization does occur, as indicated by a slow response, rinse the electrode(s) and lightly dab them again.

Precautions:

- Inspect the electrode(s) regularly for damage
- Keep the electrode(s) moist during storage and follow the manufacturer's instructions.
- Store the standard buffer solution in a cool dark environment when not in use. Pay attention to the expiration date.
- Never pour the used standard buffer solution back into the bottle/container. Dispose of used buffers properly.