

Transportation Technician  
Qualification Program

***SAMPLING  
AND  
REDUCTION  
Workbook***





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## **“1998”**

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## PREFACE

This module is one of a set developed for the Western Alliance for Quality Transportation Construction (WAQTC). WAQTC is an alliance supported by the western state Transportation Departments, along with the Federal Highway Administration (FHWA) and the Western Federal Lands Highway Division (WFLHD) of FHWA. WAQTC's charter includes the following mission.

### MISSION

Provide continuously improving quality in transportation construction.

Through our partnership, we will:

- Promote an atmosphere of trust, cooperation, and communication between government agencies and the private sector
- Respond in a unified and consistent manner to identify quality improvement needs and new technologies that impact the products that we provide,
- Provide a forum to promote uniform test standards,
- Provide highly skilled, knowledgeable materials sampling and testing technicians,
- Provide reciprocity opportunities for qualified testing technicians among Accredited Contributing Members.

### BACKGROUND

There are two significant driving forces behind the development of the WAQTC qualification program. One, there was a trend toward the use of quality control/quality assurance (QC/QA) specifications which included qualification requirements for contractor's QC personnel. Two, Federal regulation on materials sampling and testing (23 CFR 637, *Quality Assurance Procedures for Construction*, published in June 1995) mandated that by June 29, 2000, all testing technicians whose results are used as part of the acceptance decision shall be qualified. In addition, the regulation allows the use of contractor test results to be used as part of the acceptance decision.

### OBJECTIVES

WAQTC's objectives for its Transportation Technician Qualification Program include the following:

- To provide highly skilled, knowledgeable materials sampling and testing technicians.
- To promote uniformity and consistency in testing.
- To provide reciprocity for qualified testing technicians among participating agencies.
- To create a harmonious working atmosphere between public and private employees based upon trust, open communication, and equivalency of qualifications.

Training and qualification of transportation technicians is required for several reasons. It will increase the knowledge of laboratory, production, and field technicians – both industry and agency personnel – and increase the number of available, qualified testers. It will reduce problems associated with test result differences. Regional qualification eliminates the issue of reciprocity among participating agencies and allows qualified testing technicians to cross state lines without needing to be requalified by a different program.

The WAQTC Executive Board

## FOREWORD

This module is one of nine developed to satisfy the training requirements prescribed by Western Alliance for Quality Transportation Construction (WAQTC) for technicians involved in transportation projects. The nine modules cover:

- Aggregate
- Concrete
- Asphalt I
- Asphalt II
- Embankment and Base
- In-place Density
- Embankment and Base/In-place Density
- Self-Consolidating Concrete
- Sampling and Reduction

The modules are based upon AASHTO test methods along with procedures developed by WAQTC. They are narrative in style, illustrated, and include step-by-step instruction. There are review questions at the end of each test procedure, which are intended to reinforce the participants' understanding and help participants prepare for the final written and performance exams. Performance exam check lists are also included. The appendix includes WAQTC Field Operating Procedures (FOPs) in short form.

It is the technician's responsibility to stay current as changes are made to this living document.

The comments and suggestions of every participant are essential to the continued success and high standards of the Transportation Technician Qualification Program. Please take the time to fill out the Course Evaluation Form as the course progresses and hand it in on the last day of class. If you need additional room to fully convey your thoughts, please use the back of the form.

The WAQTC Executive Board



**GUIDANCE FOR COURSE EVALUATION FORM**

The Course Evaluation Form on the following page is very important to the continuing improvement and success of this course. The form is included in each Participant Workbook. During the course introduction, the Instructor will call the participants' attention to the form, its content, and the importance of its thoughtful completion at the end of the course. Participants will be encouraged to keep notes, or write down comments as the class progresses, in order to provide the best possible evaluation. The Instructor will direct participants to write down comments at the end of each day and to make use of the back of the form if more room is needed for comments.

On the last day of the course, just before the written examination, the Instructor will again refer to the form and instruct participants that completion of the form after their last examination is a requirement before leaving. Should the course have more than one Instructor, participants should be directed to list them as A, B, etc., with the Instructor's name beside the letter, and direct their answers in the Instructor Evaluation portion of the form accordingly.



**WESTERN ALLIANCE FOR QUALITY TRANSPORTATION CONSTRUCTION  
COURSE EVALUATION FORM**

The WAQTC Transportation Technician Qualification Program would appreciate your thoughtful completion of all items on this evaluation form. Your comments and constructive suggestions will be an asset in our continuing efforts to improve our course content and presentations.

Course Title: \_\_\_\_\_

Location: \_\_\_\_\_

Dates: \_\_\_\_\_

Your Name (Optional): \_\_\_\_\_

Employer: \_\_\_\_\_

Instructor(s) \_\_\_\_\_

**COURSE CONTENT**

Will the course help you perform your job better and with more understanding? Yes    Maybe    No

Explain: \_\_\_\_\_  
\_\_\_\_\_

Was there an adequate balance between theory, instruction, and hands-on application? Yes    Maybe    No

Explain: \_\_\_\_\_  
\_\_\_\_\_

Did the course prepare you to confidently complete both examinations? Yes    Maybe    No

Explain: \_\_\_\_\_  
\_\_\_\_\_

What was the most beneficial aspect of the course?  
\_\_\_\_\_

What was the least beneficial aspect of the course?  
\_\_\_\_\_

**GENERAL COMMENTS**

General comments on the course, content, materials, presentation method, facility, registration process, etc. Include suggestions for additional Tips!

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**INSTRUCTOR EVALUATION**

Were the objectives of the course, and the instructional and exam approach, clearly explained?	Yes	Maybe	No
--	-----	-------	----

Explain: \_\_\_\_\_

---

Was the information presented in a clear, understandable manner?	Yes	Maybe	No
--	-----	-------	----

Explain: \_\_\_\_\_

---

Did the instructors demonstrate a good knowledge of the subject?	Yes	Maybe	No
--	-----	-------	----

Explain: \_\_\_\_\_

---

Did the instructors create an atmosphere in which to ask questions and hold open discussion?	Yes	Maybe	No
--	-----	-------	----

Explain: \_\_\_\_\_

---

## COURSE OBJECTIVES AND SCHEDULE

### Learning Objectives

Understanding:

- Quality Assurance (QA) concepts
- Measurements and calculations
- Highway materials terminology
- Safety issues
- Random sampling techniques
- Basics of aggregate
- Demonstrating proficiency in the following test procedures:
  - FOP for AASHTO R 90  
Sampling Aggregate Products
  - FOP for AASHTO R 76  
Reducing Field Samples of Aggregate to Testing Size
  - FOP for AASHTO R 97  
Sampling Asphalt Mixtures
  - FOP for AASHTO R 47  
Reducing Samples of Asphalt Mixtures to Testing Size
  - FOP for AASHTO R 66  
Sampling Asphalt Materials

The overall goals of this aggregate course are to understand the basics of aggregate and to be competent with specific quality control test procedures identified for the Transportation Technician Qualification Program of the Western Alliance for Quality Transportation Construction (WAQTC). Additional studies beyond this course will be required for those desiring greater in-depth knowledge of the theory behind the test procedures included herein.

## Course Outline and Suggested Schedule

### Day One

Welcome  
Introduction of Instructors  
Introduction and Expectations of Participants

WAQTC Mission and TTQP Objectives  
Instructional Objectives for the Course  
Overview of the Course  
Course Evaluation Form

Review of Quality Assurance Concepts

Background in Measurements and Calculations

Random Sampling

Basics of Aggregate

Sampling Aggregate Products  
FOP for AASHTO R 90

Reducing Field Samples of Aggregate to Testing Size  
FOP for AASHTO R 76

Sampling Asphalt Mixtures  
FOP for AASHTO R 97  
Review with Questions and Answers Forum

Reducing Samples of Asphalt Mixtures to Testing Size  
FOP for AASHTO R 47

Sampling Asphalt Materials  
FOP for AASHTO R 66

Review with Questions and Answers Forum

Afternoon Laboratory Practice

### Day Two

Questions from previous day

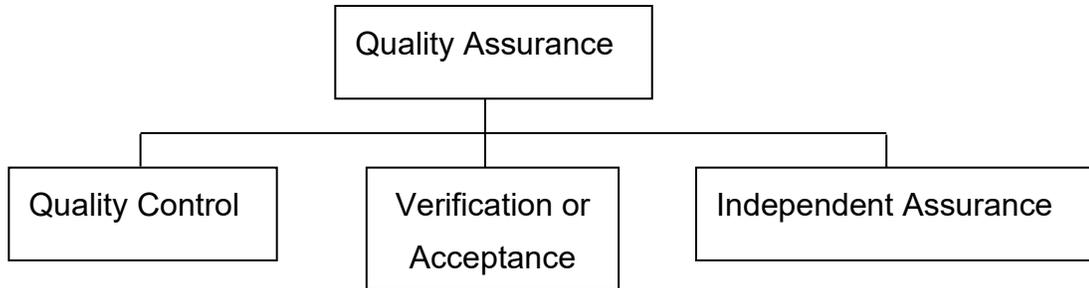
Exams

Evaluation

## QUALITY ASSURANCE CONCEPTS

The Federal Highway Administration (FHWA) has established requirements that each State Transportation Department must develop a Quality Assurance (QA) Program that is approved by the FHWA for projects on the National Highway System (NHS). In addition to complying with this requirement, implementing QA specifications in a construction program includes the benefit of improvement of overall quality of highway and bridge construction.

A QA Program may include three separate and distinct parts as illustrated below.



**Quality Assurance (QA)** are those planned and systematic actions necessary to provide confidence that a product or service will satisfy given requirements for quality.

**Quality Control (QC)** are those operational, process control techniques or activities that are performed or conducted to fulfill contract requirements for material and equipment quality. In some states, the constructor is responsible for providing QC sampling and testing, while in other states the STD handles QC. Where the constructor is responsible for QC tests, the results may be used for acceptance only if verified or accepted by additional tests performed by an independent group.

**Verification/Acceptance** consists of the sampling and testing performed to validate QC sampling and testing and, thus, the quality of the product. Verification/Acceptance samples are obtained and tests are performed independently from those involved with QC. Samples taken for QC tests may not be used for Verification/Acceptance testing.

**Independent Assurance (IA)** are those activities that are an unbiased and independent evaluation of all the sampling and testing procedures used in QC and Verification/Acceptance. IA may use a combination of laboratory certification, technician qualification or certification, proficiency samples, or split samples to assure that QC and Verification/Acceptance activities are valid. Agencies may qualify or certify laboratories and technicians, depending on the state in which the work is done.



## BACKGROUND ON MEASUREMENTS AND CALCULATIONS

01

### Introduction

This section provides a background in the mathematical rules and procedures used in making measurements and performing calculations. Topics include:

- Units: Metric vs. English
- Mass vs. Weight
- Balances and Scales
- Rounding
- Significant Figures
- Accuracy and Precision
- Tolerance

Also included is discussion of real-world applications in which the mathematical rules and procedures may not be followed.

02

### Units: Metric vs. English

The bulk of this document uses dual units. Metric units are followed by Imperial, more commonly known as English, units in parentheses. For example: 25 mm (1 in.). Exams are presented in metric or English.

Depending on the situation, some conversions are exact, and some are approximate. One inch is exactly 25.4 mm. If a procedure calls for measuring to the closest 1/4 in., however, 5 mm is close enough. We do not have to say 6.35 mm. That is because 1/4 in. is half way between 1/8 in. and 3/8 in. – or half way between 3.2 and 9.5 mm. Additionally, the tape measure or rule used may have 5 mm marks, but may not have 1 mm marks and certainly will not be graduated in 6 mm increments.

In SI (Le Systeme International d'Unites), the basic unit of mass is the kilogram (kg) and the basic unit of force, which includes weight, is the Newton (N).

03

- Basic units in SI include:
- Length: meter, m
- Mass: kilogram, kg
- Time: second, s
- 

#### SI units

04

<u>Metric</u>	<u>English</u>
25 mm	1 in.
1 kg	2.2 lb
1000 kg/m <sup>3</sup>	62.4 lb/ft <sup>3</sup>
25 MPa	3600 lb/in. <sup>2</sup>

#### Some approximate conversions

Mass in this document is given in grams (g) or kg. See the section below on “Mass vs. Weight” for further discussion of this topic.

### Mass vs. Weight

The terms mass, force, and weight are often confused. Mass,  $m$ , is a measure of an object’s material makeup, and has no direction. Force,  $F$ , is a measure of a push or pull, and has the direction of the push or pull. Force is equal to mass times acceleration,  $a$ .

$$F = ma$$

Weight,  $W$ , is a special kind of force, caused by gravitational acceleration. It is the force required to suspend or lift a mass against gravity. Weight is equal to mass times the acceleration due to gravity,  $g$ , and is directed toward the center of the earth.

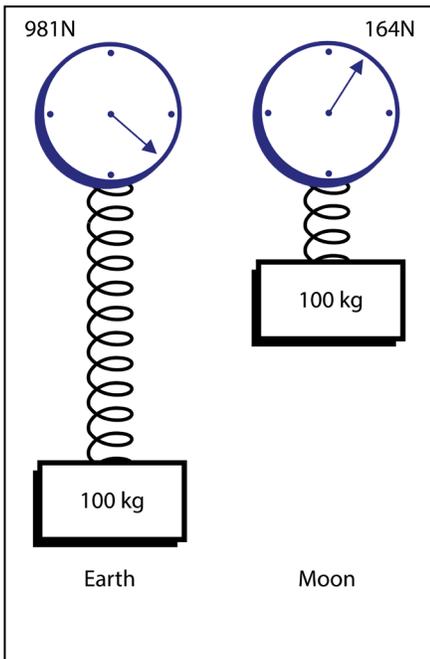
$$W = mg$$

In SI, the basic unit of mass is the kilogram (kg), the units of acceleration are meters per squared second ( $m/s^2$ ), and the unit of force is the Newton (N). Thus a person having a mass of 84 kg subject to the standard acceleration due to gravity, on earth, of  $9.81 m/s^2$  would have a weight of:

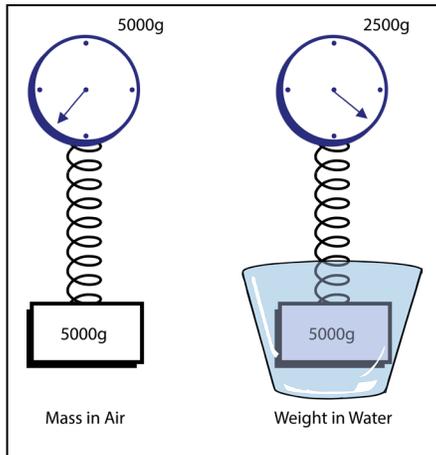
$$W = (84.0 \text{ kg})(9.81 \text{ m/s}^2) = 824 \text{ kg}\cdot\text{m/s}^2 = 824 \text{ N}$$

In the English system, mass can be measured in pounds-mass ( $lb_m$ ), while acceleration is in feet per square second ( $ft/s^2$ ), and force is in pounds-force ( $lb_f$ ). A person weighing 185  $lb_f$  on a scale has a mass of 185  $lb_m$  when subjected to the earth’s standard gravitational pull. If this person were to go to the moon, where the acceleration due to gravity is about one-sixth of what it is on earth, the person’s weight would be about 31  $lb_f$ , while his or her mass would remain 185  $lb_m$ . Mass does not depend on location, but weight does.

While the acceleration due to gravity does vary with position on the earth (latitude and elevation), the variation is not significant except for extremely precise work – the manufacture of electronic memory chips, for example.



Comparison of mass and weight



**Submerged weight**

09

As discussed above, there are two kinds of pounds,  $lb_m$  and  $lb_f$ . In laboratory measurements of mass, the gram or kilogram is the unit of choice. But, is this mass or force? Technically, it depends on the instrument used, but practically speaking, mass is the result of the measurement. When using a scale, force is being measured – either electronically by the stretching of strain gauges or mechanically by the stretching of a spring or other device. When using a balance, mass is being measured, because the mass of the object is being compared to a known mass built into the balance.

In this document, mass, not weight, is used in test procedures except when determining “weight” in water. When an object is submerged in water (as is done in specific gravity tests), the term weight is used. Technically, what is being measured is the force the object exerts on the balance or scale while the object is submerged in water (or the submerged weight). This force is actually the weight of the object less the weight of the volume of water displaced.

10

11

In summary, whenever the common terms “weight” and “weighing” are used, the more appropriate terms “mass” and “determining mass” are usually implied, except in the case of weighing an object submerged in water.

12

### **Balances and Scales**

Balances, technically used for mass determinations, and scales, used to weigh items, were discussed briefly above in the section on “Mass vs. Weight.” In field operating procedures, we usually do not differentiate between the two types of instruments. When using either one for a material or object in air, we are determining mass. For those procedures in which the material or object is suspended in water, we are determining weight in water.

13

AASHTO recognizes two general categories of instruments. Standard analytical balances are used in laboratories. For most field operations, general purpose balances and scales are specified. Specifications for both categories are shown in Tables 1 and 2.

14

**Table 1**  
**Standard Analytical Balances**

<b>Class</b>	<b>Capacity</b>	<b>Readability and Sensitivity</b>	<b>Accuracy</b>
A	200 g	0.0001 g	0.0002 g
B	200 g	0.001 g	0.002 g
C	1200 g	0.01 g	0.02 g

**Table 2**  
**General Purpose Balances and Scales**

<b>Class</b>	<b>Principal Sample Mass</b>	<b>Readability and Sensitivity</b>	<b>Accuracy</b>
G2	2 kg or less	0.1 g	0.1 g or 0.1 percent
G5	2 kg to 5 kg	1 g	1 g or 0.1 percent
G20	5 kg to 20 kg	5 g	5 g or 0.1 percent
G100	Over 20 kg	20 g	20 g or 0.1 percent

15

### **Rounding**

Numbers are commonly rounded up or down after measurement or calculation. For example, 53.67 would be rounded to 53.7 and 53.43 would be rounded to 53.4, if rounding were required. The first number was rounded up because 53.67 is closer to 53.7 than to 53.6. Likewise, the second number was rounded down because 53.43 is closer to 53.4 than to 53.5. The reasons for rounding are covered in the next section on “Significant Figures.”

If the number being rounded is followed by exactly 5, followed by only zeroes, two possibilities exist. In the more mathematically sound approach, numbers are rounded up or down depending on whether the number to the left of the 5 is odd or even. Thus, 102.25 would be rounded down to 102.2, while 102.35 would be rounded up to 102.4. This procedure avoids the bias that would exist if all numbers ending in 5 were rounded up or all numbers were rounded down. In some calculators, however, all rounding is up. This does result in some bias, or skewing of data, but the significance of the bias may or may not be significant to the calculations at hand.

When rounding numbers that are followed by exactly 5, follow agency guidelines. For the purpose of WAQTC training, if the number being rounded is followed by a 5, the number is increased by 1.

### Significant Figures

- General

16 A general-purpose balance or scale, classified as G20 in AASHTO M 231, has a capacity of 20,000 g and an accuracy requirement of  $\pm 5$  g. A mass of 18,285 g determined with such an instrument could actually range from 18,280 g to 18,290 g. Only four places in the measurement are significant. The fifth (last) place is not significant since it may change.

17 Mathematical rules exist for handling significant figures in different situations.

An example in Metric (**m**) or English(**ft**), when performing addition and subtraction, the number of significant figures in the sum or difference is determined by the least precise input. Consider the three situations shown below:

<u>Situation 1</u>	<u>Situation 2</u>	<u>Situation 3</u>
35.67	143.903	162
+ <u>423.938</u>	- <u>23.6</u>	+33.546
		- <u>.022</u>
= 459.61	= 120.3	= 196
not 459.608	not 120.303	not 195.524

Rules also exist for multiplication and division. These rules, and the rules for mixed operations involving addition, subtraction, multiplication, and/or division, are beyond the scope of these materials. AASHTO covers this topic to a certain extent in the section called “Precision” or “Precision and Bias” included in many test methods, and the reader is directed to those sections if more detail is desired.

18

- Real World Limitations

While the mathematical rules of significant digits have been established, they are not always followed. For example, AASHTO T 176, *Plastic Fines in Graded Aggregates and Soils by the Use of the Sand Equivalent Test*, prescribes a method for rounding and significant digits in conflict with the mathematical rules.

In this procedure, readings and calculated values are always rounded up. A clay reading of 7.94 would be rounded to 8.0 and a sand reading of 3.21 would be rounded to 3.3. The rounded numbers are then used to calculate the Sand Equivalent, which is the ratio of the two numbers multiplied by 100. In this case:

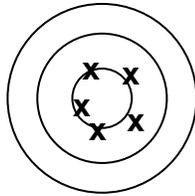
$$\frac{3.3}{8.0} \times 100 = 41.250 \dots$$

rounded to 41.3 and reported as 42

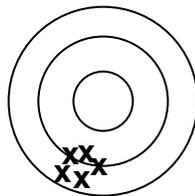
$$\text{Not: } \frac{3.21}{7.94} \times 100 = 40.428 \dots$$

rounded to 40.0 and reported as 40

It is extremely important that engineers and technicians understand the rules of rounding and significant digits just as well as they know procedures called for in standard test methods.



ACCURATE BUT NOT PRECISE,  
SCATTERED



PRECISE BUT NOT ACCURATE,  
BIASED

**Accuracy and Precision**

Although often used interchangeably, the terms accuracy and precision do not mean the same thing. In an engineering sense, accuracy denotes nearness to the truth or some value accepted as the truth, while precision relates to the degree of refinement or repeatability of a measurement.

Two bulls-eye targets are shown to the left. The upper one indicates hits that are scattered and, yet, are very close to the center. The lower one has a tight pattern, but all the shots are biased from the center. The upper one is more accurate, while the lower one is more precise. A biased, but precise, instrument can often be adjusted physically or mathematically to provide reliable single measurements. A scattered, but accurate, instrument can be used if enough measurements are made to provide a valid average.

Consider the measurement of the temperature of boiling water at standard atmospheric pressure by two thermometers. Five readings were taken with each, and the values were averaged.

Thermometer No. 1	Thermometer No. 2
101.2° 214.2°	100.6° 213.1°
101.1° 214.0°	99.2° 210.6°
101.2° 214.2°	98.9° 210.0°
101.1° 214.0°	101.0° 213.8°
101.2° 214.2°	100.3° 212.5°

AVG = 101.2° 214.2°      AVG = 100.0° 212.0°

No. 1 shows very little fluctuation, but is off the known boiling point (100°C or 212°F) by 1.2°C or 2.2°F. No. 2 has an average value equal to the known boiling point, but shows quite a bit of fluctuation. While it might be preferable to use neither thermometer, thermometer No. 1 could be employed if 1.2°C or 2.2°F were subtracted from each measurement. Thermometer No. 2 could be used if enough measurements were made to provide a valid average.

24 Engineering and scientific instruments should be  
calibrated and compared against reference standards  
periodically to assure that measurements are  
accurate. If such checks are not performed, the  
accuracy is uncertain, no matter what the precision.  
25 Calibration of an instrument removes fixed error,  
leaving only random error for concern.

### Tolerance

26 Dimensions of constructed or manufactured objects,  
including laboratory test equipment, cannot be  
specified exactly. Some tolerance must be allowed.  
Thus, procedures for including tolerance in  
addition/subtraction and multiplication/division  
operations must be understood.

- Addition and Subtraction

27 When adding or subtracting two numbers that  
individually have a tolerance, the tolerance of  
the sum or difference is equal to the sum of the  
individual tolerances.

An example in Metric (**m**) or English (**ft**), if the  
distance between two points is made up of two  
parts, one being  $113.361 \pm 0.006$  and the other  
being  $87.242 \pm 0.005$  then the tolerance of the  
sum (or the difference) is:

$$(0.006) + (0.005) = 0.011$$

and the sum would be  $200.603 \pm 0.011$ .

- Multiplication and Division

28 To demonstrate the determination of tolerance  
again in either Metric (**m**) or English (**ft**) for the  
product of two numbers, consider determining  
the area of a rectangle having sides of  $76.254 \pm 0.009$   
and  $34.972 \pm 0.007$ . The percentage  
variations of the two dimensions are:

$$\frac{0.009}{76.254} \times 100 = 0.01\% \quad \frac{0.007}{34.972} \times 100 = 0.02\%$$

The sum of the percentage variations is 0.03  
percent – the variation that is employed in the  
area of the rectangle:

Area =

$$266.8 (m^2 \text{ or } ft^2) = \pm 0.03\% \\ = 2666.8 \pm 0.8 (m^2 \text{ or } ft^2)$$

- Real World Applications

Tolerances are used whenever a product is manufactured. For example, the mold used for determining soil density in AASHTO T 99 has a diameter of  $101.60 \pm 0.41$  mm ( $4.000 \pm 0.016$  in) and a height of  $116.43 \pm 0.13$  mm ( $4.584 \pm 0.005$  in).

Using the smaller of each dimension results in a volume of:

$$\left(\frac{\pi}{4}\right) (101.19 \text{ mm})^2 (116.30 \text{ mm}) \\ = 935,287 \text{ mm}^3 \text{ or } 0.000935 \text{ m}^3$$

$$\left(\frac{\pi}{4}\right) (3.984 \text{ in})^2 (4.579 \text{ in}) \\ = 57.082 \text{ in}^3 \text{ or } 0.0330 \text{ ft}^3$$

Using the larger of each dimension results in a volume of:

$$\left(\frac{\pi}{4}\right) (102.01 \text{ mm})^2 (116.56 \text{ mm}) \\ = 952.631 \text{ mm}^3 \text{ or } 0.000953 \text{ m}^3$$

$$\left(\frac{\pi}{4}\right) (4.016 \text{ in})^2 (4.589 \text{ in}) \\ = 58.130 \text{ in}^3 \text{ or } 0.0336 \text{ ft}^3$$

The average value is  $0.000944 \text{ m}^3$  ( $0.0333$ ), and AASHTO T 99 specifies a volume of:

$$0.000943 \pm 0.000008 \text{ m}^3$$

or a range of

$$0.000935 \text{ to } 0.000951 \text{ m}^3$$

$$0.0333 \pm 0.0003 \text{ ft}^3$$

or a range of

$$0.0330 \text{ to } 0.0336 \text{ ft}^3$$

Because of the variation that can occur, some agencies periodically standardize molds, and make adjustments to calculated density based on those calculations.

### **Summary**

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Mathematics has certain rules and procedures for making measurements and performing calculations that are well established. So are standardized test procedures. Sometimes these agree, but occasionally, they do not. Engineers and technicians must be familiar with both but must follow test procedures in order to obtain valid, comparable results.

## TERMINOLOGY

Many of the terms listed below are defined differently by various agencies or organizations. The definitions of the American Association of State Highway and Transportation Officials (AASHTO) are the ones most commonly used in this document.

**Absorbed water** – Water drawn into a solid by absorption and having physical properties similar to ordinary water.

**Absorption** – The increase in the mass of aggregate due to water being absorbed into 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.

**Acceptance** – See verification.

**Acceptance program** – All factors that comprise the State Transportation Department's (STD) determination of the quality of the product as specified in the contract requirements. These factors include verification sampling, testing, and inspection and may include results of quality control sampling and testing.

**Admixture** – Material other than water, cement, and aggregates in Portland cement concrete (PCC).

**Adsorbed water** – Water attached to the surface of a solid by electrochemical forces and having physical properties substantially different from ordinary water.

**Aggregate** – Hard granular material of mineral composition, including sand, gravel, slag, or crushed stone, used in roadway base and in Portland cement concrete (PCC) and asphalt mixtures.

- **Coarse aggregate** – Aggregate retained on or above the No. 4 (4.75 mm) sieve.
- **Coarse-graded aggregate** – Aggregate having a predominance of coarse sizes.
- **Dense-graded aggregate** – Aggregate having a particle size distribution such that voids occupy a relatively small percentage of the total volume.
- **Fine aggregate** – Aggregate passing the No. 4 (4.75 mm) sieve.
- **Fine-graded aggregate** – Aggregate having a predominance of fine sizes.
- **Mineral filler** – A fine mineral product at least 70 percent of which passes a No. 200 (75  $\mu$ m) sieve.
- **Open-graded gap-graded aggregate** – Aggregate having a particle size distribution such that voids occupy a relatively large percentage of the total volume.
- **Well-Graded Aggregate** – Aggregate having an even distribution of particle sizes.

**Aggregate storage bins** – Bins that store aggregate for feeding material to the dryer in an asphalt mixture plant in substantially the same proportion as required in the finished mix.

**Agitation** – Provision of gentle motion in Portland cement concrete (PCC) sufficient to prevent segregation and loss of plasticity.

**Air voids ( $V_a$ )** – Total volume of the small air pockets between coated aggregate particles in asphalt mixtures; expressed as a percentage of the bulk volume of the compacted paving mixture.

**Ambient temperature** – Temperature of the surrounding air

**Angular aggregate** – Aggregate possessing well-defined edges at the intersection of roughly planar faces.

**Apparent specific gravity ( $G_{sa}$ )** – The ratio of the mass, in air, of a volume of the impermeable portion of aggregate to the mass of an equal volume of water at a stated temperature.

**Asphalt** – A dark brown to black cementitious material in which the predominate constituents are bitumens occurring in nature or obtained through petroleum processing. Asphalt is a constituent of most crude petroleum.

**Asphalt emulsion** – A mixture of asphalt binder and water.

**Asphalt binder** – An asphalt specially prepared in quality and consistency for use in the manufacture of asphalt mixtures.

**Asphalt mixtures** – High quality, thoroughly controlled mix of aggregate and asphalt binder.

- **Hot mix asphalt (HMA)** – Asphalt mixtures of well-graded aggregate and asphalt binder that are mixed and placed at high temperatures.
- **Stone matrix asphalt (SMA)** – A gap-graded hot asphalt mixture that is designed to maximize deformation (rutting) resistance and durability by using a structural basis of stone-on-stone contact.
- **Warm mix asphalt (WMA)** – Asphalt mixtures that, due to a variety of technologies, are mixed and placed at relatively lower temperatures than HMA.

**Automatic cycling control** – A control system in which the opening and closing of the weigh hopper discharge gate, the bituminous discharge valve, and the pugmill discharge gate are actuated by means of automatic mechanical or electronic devices without manual control. The system includes preset timing of dry and wet mixing cycles.

**Automatic dryer control** – A control system that automatically maintains the temperature of aggregates discharged from the dryer.

**Automatic proportioning control** – A control system in which proportions of the aggregate and asphalt binder fractions are controlled by means of gates or valves that are opened and closed by means of automatic mechanical or electronic devices without manual control.

**Bag (of cement)** – 94 lb of Portland cement (Approximately 1 ft<sup>3</sup> of bulk cement)

**Base** – A layer of selected material constructed on top of subgrade or subbase and below the paving on a roadway.

**Bias** – The offset or skewing of data or information away from its true or accurate position as the result of systematic error.

**Binder** – Asphalt binder or modified asphalt binder that binds the aggregate particles into a dense mass.

**Bleed** – Occurs in concrete when coarse aggregate tends to settle down and free water rises to the surface.

**Boulders** – Rock fragment, often rounded, with an average dimension larger than 300 mm (12 in.).

**Bulk specific gravity** – The ratio of the mass, in air, of a volume of aggregate ( $G_{sa}$ ) or compacted asphalt mixture ( $G_{mb}$ ) (including the permeable and impermeable voids in the particles, but not including the voids between particles) to the mass of an equal volume of water at a stated temperature.

**Bulk specific gravity (SSD)** – The ratio of the mass, in air, of a volume of aggregate ( $G_{sa SSD}$ ) or compacted asphalt mixtures ( $G_{mb SSD}$ ), including the mass of water within the voids (but not including the voids between particles), to the mass of an equal volume of water at a stated temperature. (See saturated surface dry.)

**Cementitious Materials** – cement and pozzolans used in concrete such as: Portland cement, fly ash, silica fume, and blast-furnace slag.

**Clay** – Fine-grained soil that exhibits plasticity over a range of water contents, and that exhibits considerable strength when dry, also, that portion of the soil finer than 2  $\mu$ m.

**Cobble** – Rock fragment, often rounded, with an average dimension between 75 and 300 mm (3 and 12 in.).

**Cohesionless soil** – Soil with little or no strength when dry and unconfined or when submerged, such as sand

**Cohesive soil** – Soil with considerable strength when dry and that has significant cohesion when unconfined or submerged.

**Compaction** – Densification of a soil or asphalt mixtures by mechanical means.

**Compaction curve (Proctor curve or moisture-density curve)** – The curve showing the relationship between the dry unit weight or density and the water content of a soil for a given compactive effort.

**Compaction test (moisture-density test)** – Laboratory compaction procedure in which a soil of known water content is placed in a specified manner into a mold of given dimensions, subjected to a compactive effort of controlled magnitude, and the resulting density determined.

**Compressibility** – Property of a soil or rock relating to susceptibility to decrease in volume when subject to load.

**Constant mass** – The state at which a mass does not change more than a given percent, after additional drying for a defined time interval, at a required temperature.

**Constructor** – The builder of a project. The individual or entity responsible for performing and completing the construction of a project required by the contract documents. Often called a contractor, since this individual or entity contracts with the owner.

**Cutback asphalt** – Asphalt binder that has been modified by blending with a chemical solvent.

**Crusher-run** – The total unscreened product of a stone crusher.

**Delivery tolerances** – Permissible variations from the desired proportions of aggregate and asphalt binder delivered to the pugmill.

**Density** – The ratio of mass to volume of a substance. Usually expressed in lb/ft<sup>3</sup> (kg/m<sup>3</sup>).

**Design professional** – The designer of a project. This individual or entity may provide services relating to the planning, design, and construction of a project, possibly including materials testing and construction inspection. Sometimes called a “contractor,” since this individual or entity contracts with the owner.

**Dryer** – An apparatus that dries aggregate and heats it to specified temperatures.

**Dry mix time** – The time interval between introduction of aggregate into the pugmill and the addition of asphalt binder.

**Durability** – The property of concrete that describes its ability to resist disintegration by weathering and traffic. Included under weathering are changes in the pavement and aggregate due to the action of water, including freezing and thawing.

**Dust Proportion – DP (Dust to Effective (asphalt) Binder Ratio)** – The percent passing the No. 200 sieve divided by the percent of effective asphalt binder.

**Effective specific gravity ( $G_{se}$ )** – The ratio of the mass in air of a unit volume of a permeable material (excluding voids permeable to asphalt binder) at a stated temperature to

the mass in air (of equal density) of an equal volume of gas-free distilled water at a stated temperature.

**Effective diameter (effective size)** –  $D_{10}$ , particle diameter corresponding to 10 percent finer or passing.

**Embankment** – Controlled, compacted material between the subgrade and subbase or base in a roadway.

**End-result specifications** – Specifications that require the Constructor to take the entire responsibility for supplying a product or an item of construction. The Owner's (the highway agency's) responsibility is to either accept or reject the final product or to apply a price adjustment that is commensurate with the degree of compliance with the specifications. Sometimes called performance specifications, although considered differently in highway work. (See performance specifications.)

**Family of curves** – a group of soil moisture-density relationships (curves) determined using AASHTO T 99 or T 180, which reveal certain similarities and trends characteristic of the soil type and source.

**Field operating procedure (FOP)** – Procedure used in field testing on a construction site or in a field laboratory. (Based on AASHTO or NAQTC test methods.)

**Fineness modulus** – A factor equal to the sum of the cumulative percentages of aggregate retained on certain sieves divided by 100; the sieves are 150, 75, 37.5, 19.0, 9.5, 4.75, 2.36, 1.18, 0.60, 0.30, and 0.15 mm. Used in the design of concrete mixes. The lower the fineness modulus, the more water/cement paste that is needed to coat the aggregate.

**Fines** – Portion of a soil or aggregate finer than a 75  $\mu\text{m}$  (No. 200) sieve. Also silts and clays.

**Fractured criteria** – The specified requirement for fractured particles determined by each agency.

**Fractured face** – An angular, rough, or broken surface of an aggregate particle created by crushing or by other means. A face is considered a "fractured face" whenever one-half or more of the projected area, when viewed normal to that face, is fractured with sharp and well-defined edges. This excludes small nicks.

**Fractured particle** – A particle of aggregate having at least the minimum number of fractured faces specified.

**Free water** – Water on aggregate available for reaction with hydraulic cement. Mathematically, the difference between total moisture content and absorbed moisture content.

**Glacial till** – Material deposited by glaciation, usually composed of a wide range of particle sizes, which has not been subjected to the sorting action of water.

**Gradation (grain-size distribution)** – The proportions by mass of a soil or fragmented rock distributed by particle size.

**Gradation analysis (grain size analysis or sieve analysis)** – The process of determining grain-size distribution by separation of sieves with different size openings.

**Halo** – A concentration of mortar that can form at the perimeter of the slump flow patty.

**High-range water-reducer (HRWR)** – A concrete admixture that can reduce the quantity of mixing water required to produce concrete by more than 12 percent, while maintaining a certain level of consistency in slump.

**Hot aggregate storage bins** – Bins that store heated and separated aggregate before final proportioning into the mixer.

**Hot Mix Asphalt (HMA) batch plant** – A manufacturing facility for producing asphalt mixture that proportions aggregate by weight and asphalt by weight or volume.

**HMA continuous mix plant** – A manufacturing facility for producing asphalt mixture that proportions aggregate and asphalt binder by a continuous volumetric proportioning system without specific batch intervals.

**Hydraulic cement** – Cement that sets and hardens by chemical reaction with water.

**Independent assurance** – Unbiased and independent evaluation of all the sampling and testing procedures, equipment, and technicians involved with Quality Control (QC) and Verification/Acceptance.

**In situ** – Rock or soil in its natural formation or deposit.

**J-Ring** – a rigid ring made of steel connecting 100 mm (4 in.) vertical smooth bars used in testing the passing ability of SCC.

**Liquid limit** – Moisture content corresponding to the boundary between the liquid and plastic states.

**Loam** – A mixture of sand, silt or clay, or a combination thereof, with organic matter.

**Lot** – A quantity of material to be controlled. It may represent a specified mass, a specified number of truckloads, or a specified time period during production.

**Manual proportioning control** – A control system in which proportions of the aggregate and asphalt binder fractions are controlled by means of gates or valves that are opened and closed by manual means. The system may or may not include power assisted devices in the actuation of gate and valve opening and closing.

**Materials and methods specifications** – Also called prescriptive specifications. Specifications that direct the Constructor to use specified materials in definite proportions and specific types of equipment and methods to place the material.

**Maximum size** – One sieve larger than nominal maximum size.

**Mesh** – The square opening of a sieve.

**Moisture content** – The ratio, expressed as a percentage, of the mass of water in a material to the dry mass of the material.

**Nominal maximum size** – One sieve larger than the first sieve to retain more than 10 percent of the material using an agency specified set of sieves based on cumulative percent retained. Where large gaps in specification sieves exist, intermediate sieve(s) may be inserted to determine nominal maximum size.

*Note:* The first sieve to normally retain more than 10 percent of the material usually is the second sieve in the stack but may be the third sieve.

**Nuclear gauge** – Instruments used to measure in-place density, moisture content, or asphalt binder content through the measurement of nuclear emissions.

**Optimum moisture content (optimum water content)** – The water content at which a soil can be compacted to a maximum dry density by a given compactive effort.

**Organic soil** – Soil with a high organic content.

**Owner** – The organization that conceives of and eventually operates and maintains a project. A State Transportation Departments (STD) is an Owner.

**Passing ability** – An indication of the ability of the SCC to flow around and between reinforcement without blocking.

**Paste** – Mix of water and hydraulic cement that binds aggregate in Portland cement concrete (PCC).

**Penetration** – The consistency of a bituminous material, expressed as the distance in tenths of a millimeter (0.1 mm) that a standard needle vertically penetrates a sample of the material under specified conditions of loading, time, and temperature.

**Percent of Absorbed (asphalt) Binder ( $P_{ba}$ )** – The total percent of the asphalt binder that is absorbed into the aggregate, expressed as a percentage of the mass of aggregate rather than as a percentage of the total mass of the mixture. This portion of the asphalt binder content does not contribute to the performance of the mix.

**Percent aggregate (stone) ( $P_s$ )** – The percent aggregate (stone) content, expressed as a percentage of the total mass of the sample.

**Percent of Effective (asphalt) Binder ( $P_{be}$ )** – The total asphalt binder content of a paving mixture minus the portion of asphalt binder that is lost by absorption into the aggregate

particles, expressed as a percentage of the mass of aggregate. It is the portion of the asphalt binder content that remains as a coating on the outside of the aggregate particles.

**Percent compaction** – The ratio of density of a soil, aggregate, or asphalt mixtures in the field to a maximum density determined by a standard compaction test, expressed as a percentage.

**Performance specifications** – Specifications that describe how the finished product should perform. For highways, performance is typically described in terms of changes over time in physical condition of the surface and its response to load, or in terms of the cumulative traffic required to bring the pavement to a condition defined as “failure.” Specifications containing warranty/guarantee clauses are a form of performance specifications.

**Plant screens** – Screens located between the dryer and hot aggregate storage bins that separate the heated aggregates by size.

**Plastic limit** – Moisture content corresponding to the boundary between the plastic and the semisolid states.

**Plasticity** – Property of a material to continue to deform indefinitely while sustaining a constant stress.

**Plasticity index** – Numerical difference between the liquid limit and the plastic limit and, thus, the range of water content over which the soil is plastic.

**Portland cement** – Hydraulic cement produced by pulverizing Portland cement clinker.

**Portland cement concrete (PCC)** – A controlled mix of aggregate, Portland cement, and water, and possibly other admixtures.

**PCC batch plant** – A manufacturing facility for producing Portland cement concrete.

**Prescriptive specifications** – See Materials and Methods specification.

**Proficiency samples** – Homogeneous samples that are distributed and tested by two or more laboratories. The test results are compared to assure that the laboratories are obtaining the same results.

**Pugmill** – A shaft mixer designed to mix aggregate and cement.

**Quality assurance** – Planned and systematic actions necessary to provide confidence that a product or service will satisfy given requirements for quality. The overall system for providing quality in a constructed project, including Quality Control (QC), Verification/Acceptance, and Independent Assurance (IA).

**Quality assurance specifications** – Also called QC/QA specifications. A combination of end-result (performance) specifications and materials and methods (prescriptive)

specifications. The Constructor is responsible for quality control, and the Owner (highway agency) is responsible for acceptance of the product.

**Quality control (QC)** – Operational, process control techniques or activities that are performed or conducted to fulfill contract requirements for material or equipment quality.

**Random sampling** – Procedure for obtaining non-biased, representative samples.

**Recycled (reclaimed) asphalt materials** – Recycled asphalt pavement (RAP) and recycled asphalt shingles (RAS) used as a component in asphalt mixtures.

**Sand** – Particles of rock passing the No. 4 (4.75 mm) sieve and retained on the No. 200 (75  $\mu$ m) sieve.

**Saturated surface dry (SSD)** – Condition of an aggregate particle, asphalt mixtures or Portland cement concrete (PCC) core, or other porous solid when the permeable voids are filled with water, but no water is present on exposed surfaces. (See bulk specific gravity.)

**Sectoring** – An alternate method for further reducing quarters of a sample of material.

**Self-Consolidating Concrete (SCC)** – A highly flowable non-segregating concrete mix that spreads into place and is able to flow and fill all corners of the formwork, even in the presence of congested reinforcement by means of its own mass with no mechanical vibration.

**Segregation** – The separation of aggregate by size resulting in a non-uniform material.

**Sieve** – Laboratory apparatus consisting of wire mesh with square openings, usually in circular or rectangular frames.

**Silt** – Material passing the (75  $\mu$ m) sieve that is non-plastic or very slightly plastic, and that exhibits little or no strength when dry and unconfined. Also, that portion of the soil finer than 75  $\mu$ m and coarser than 2  $\mu$ m.

**Slump** – Measurement related to the workability of concrete.

**Slump flow** – Assesses the horizontal free flow, filling ability of self-compacting concrete in the absence of obstructions and may give some indication of resistance to segregation. It does not indicate the ability of the SCC to pass between reinforcement without blocking.

**Smartly** – Quickly and usually done with force.

**Soil** – Sediments or unconsolidated accumulations of solid particles produced by the physical and chemical disintegration of rocks, and which may or may not contain organic matter.

**Specific gravity** – The ratio of the mass of a volume of a material to the mass of an equal volume of water at a stated temperature.

- **G<sub>mm</sub>** – theoretical maximum specific gravity (Gravity<sub>mix max</sub>)  
The ratio of the mass of a given volume of asphalt mixtures with no air voids to the mass of an equal volume of water, both at a stated temperature.
- **G<sub>mb</sub>** – measured bulk specific gravity (Gravity<sub>mix bulk</sub>)  
The ratio of the mass, in air, of a volume of compacted asphalt mixture (including the permeable and impermeable voids in the particles but not including the voids between particles) to the mass of an equal volume of water at a stated temperature.
- **G<sub>sb</sub>** – oven-dry bulk specific gravity of aggregate (Gravity<sub>stone bulk</sub>)  
The ratio of the mass, in air, of a volume of aggregate (including the permeable and impermeable voids in the particles but not including the voids between particles) to the mass of an equal volume of water at a stated temperature.
- **G<sub>sa</sub>** – apparent specific gravity of aggregate (Gravity<sub>stone apparent</sub>)  
The ratio of the mass, in air, of a volume of the impermeable portion of aggregate to the mass of an equal volume of water at a stated temperature.
- **G<sub>se</sub>** – effective specific gravity of aggregate (Gravity<sub>stone effective</sub>)  
The ratio of the mass in air of a unit volume of a permeable material (excluding voids permeable to asphalt binder) at a stated temperature to the mass in air (of equal density) of an equal volume of gas-free distilled water at a stated temperature.
- **G<sub>b</sub>** – specific gravity of the binder (Gravity<sub>binder</sub>)  
The ratio of the mass of a volume of asphalt binder to the mass of an equal volume of water at a stated temperature.

**Spine** – smooth line extending through the point of maximum density and optimum moisture content of a family of moisture-density curves.

**Stability** – The ability of an asphalt mixture to resist deformation from imposed loads. Stability is dependent upon internal friction, cohesion, temperature, and rate of loading.

**Static segregation** - The tendency for coarse aggregate to separate from the sand-cement mortar in SCC.

**Stratified random sampling** – Procedure for obtaining non-biased, representative samples in which the established lot size is divided into equally-sized sublots.

**Subbase** – A layer of selected material constructed between the subgrade and the base course in a flexible asphalt mixture roadway, or between the subgrade and Portland cement concrete (PCC) pavement in a rigid PCC roadway.

**Subgrade** – Natural soil prepared and compacted to support a structure or roadway pavement.

**Sublot** – A segment of a lot chosen to represent the total lot.

**Superpave™** – Superpave™ (Superior Performing Asphalt Pavement) is a trademark of the Strategic Highway Research Program (SHRP). Superpave™ is a product of the SHRP asphalt research. The Superpave™ system incorporates performance-based asphalt materials characterization with design environmental conditions to improve performance by controlling rutting, low temperature cracking and fatigue cracking. The three major components of Superpave™ are the asphalt binder specification, the mix design and analysis system, and a computer software system.

**Theoretical maximum specific gravity ( $G_{mm}$ )** – The ratio of the mass of a given volume of asphalt mixtures with no air voids to the mass of an equal volume of water, both at a stated temperature.

**Topsoil** – Surface soil, usually containing organic matter.

**Uniformity coefficient** –  $C_u$ , a value employed to quantify how uniform or well-graded an aggregate is:  $C_u = D_{60}/D_{10}$ . 60 percent of the aggregate, by mass, has a diameter smaller than  $D_{60}$  and 10 percent of the aggregate, by mass, has a diameter smaller than  $D_{10}$ .

**Unit weight** – The ratio of weight to volume of a substance. The term “density” is more commonly used.

**μm** – Micrometer (micron), a millionth of a meter. Used as a measurement for sieve size.

**Vendor** – Supplier of project-produced material that is other than the constructor.

**Verification** – Process of sampling and testing performed to validate Quality Control (QC) sampling and testing and, thus, the quality of the product. Sometimes called Acceptance.

**Viscosity modifying admixture** – chemical additives used in concrete to control flow properties and enhance durability.

**Visual stability index (VSI)** – The Visual Stability Index (VSI) is used to assess the stability of SCC. The stability (or segregation resistance) of an SCC mixture is the ability of the mixture to remain homogeneous during transport, during placement, and after placement. The VSI determination is useful for quality control and consistency testing.

**Void in the mineral aggregate (VMA)** – The volume of inter-granular void space between aggregate particles of compacted asphalt mixtures that includes air and asphalt binder; expressed as a percentage of the bulk volume of the compacted paving mixture.

**Void filled with asphalt (VFA)** – The portion of the void in the mineral aggregate (VMA) that contains asphalt binder; expressed as a percentage of the bulk volume of mix or the VMA.

**Wet mixing period** – The time interval between the beginning of application of asphalt binder and the opening of the mixer gate.

**Zero air voids curve (saturation curve)** – Curve showing the zero air voids density as a function of water content.

**SAFETY**

The procedures included in this manual may involve hazardous materials, operations, and equipment. The procedures do not address all of the safety issues associated with their use. It is the responsibility of the employer to assess workplace hazards and to determine whether personal protective equipment (PPE) must be used. PPE must meet applicable American National Standards Institute (ANSI) standards and be properly used and maintained. The employer must establish appropriate safety and health practices, in compliance with applicable state and federal laws, for these procedures and associated job site hazards. Hazardous materials must be addressed in a Hazard Communication program, and Material Safety Data Sheets (MSDS) must be obtained and available to workers. Supervisors and employees should be aware of job site hazards and comply with their employer's safety and health program. The following table identifies some areas that may affect individuals performing the procedures in this manual.

<b>Body Part Affected</b>	<b>Potential Hazards</b>	<b>PPE/Procedures That May Be Appropriate</b>
Head	Falling or fixed overhead objects; electrical shock	Hard hat or other protective helmet
Eyes and Face	Flying objects, radiation, molten metal, chemicals	Safety glasses, goggles, face shields; prescription or filter lenses
Ears	Noise	Ear plugs, earmuffs
Respiratory System	Inhalation of dusts, chemicals; O <sub>2</sub> deficiency	Properly fit and used respiratory protection consistent with the hazard
Skin	Chemicals including cement; heat	Appropriate chemical or heat resistant gloves, long-sleeve shirts, coveralls
Mouth, digestive system	Ingestion of toxic materials	Disposable or washable gloves, coveralls; personal hygiene
Hands	Physical injury (pinch, cut, puncture), chemicals	Appropriate gloves for physical hazards and compatible with chemicals present
Feet	Falling, sharp objects; slippery surfaces, chemicals	Safety shoes or boots (steel toed, steel shank); traction soles; rubber boots – chemicals, wet conditions
Joints, muscles, tendons	Lifting, bending, twisting, repetitive motions	Proper training and procedures; procedure modifications
Body/Torso	Falls; Burial	Fall protection; trench sloping or shoring
Miscellaneous	Traffic	Visibility, awareness, communication; driver training, safety awareness
Whole body	Radiation	Radiation safety training



**RANDOM SAMPLING OF CONSTRUCTION MATERIALS**

01

**Significance**

Sampling and testing are two of the most important functions in quality control (QC). Data from the tests are the tools with which the quality of product is controlled. For this reason, great care must be used in following standardized sampling and testing procedures.

02

In controlling operations, it is necessary to obtain numerous samples at various points along the production line. Unless precautions are taken, sampling can occur in patterns that can create a bias to the data gathered. Sampling at the same time, say noon, each day may jeopardize the effectiveness of any quality program. This might occur, for example, because a material producer does certain operations, such as cleaning screens at an aggregate plant, late in the morning each day. To obtain a representative sample, a reliable system of random sampling must be employed.

**Scope**

The procedure presented here eliminates bias in sampling materials. Randomly selecting a set of numbers from a table or calculator will eliminate the possibility for bias. Random numbers are used to identify sampling times, locations, or points within a lot or subplot. This method does not cover how to sample, but rather how to determine sampling times, locations, or points.

**Sampling Concepts**

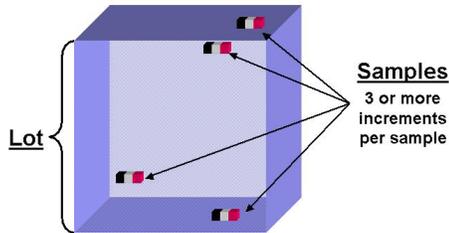
03

04

A lot is the quantity of material evaluated by QC procedures. A lot is a preselected quantity that may represent hours of production, a quantity or number of loads of material, or an interval of time. A lot may be comprised of several portions that are called sublots or units. The number of sublots comprising a lot will be determined by the agency's specifications.

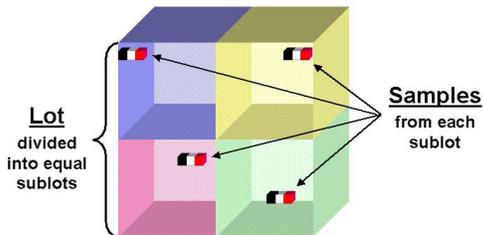
**Straight Random Sampling**

One or more sample locations may be selected, using the entire lot as a single unit



**Stratified Random Sampling**

The lot is divided into two or more equal sublots. Samples are taken from each subplot



05

**Straight Random Sampling vs. Stratified Random Sampling:** Straight random sampling considers an entire lot as a single unit and determines each sample location based on the entire lot size. Stratified random sampling divides the lot into a specified number of sublots or units and then determines each sample location within a distinct subplot. Both methods result in random distribution of samples to be tested for compliance with the agency’s specification.

06

Agencies stipulate when to use straight random sampling or stratified random sampling. AASHTO R 90, Sampling Aggregate Products, for example, specifies a straight random sampling procedure.

07

**Picking Random Numbers from a Table**

Table 1 contains pairs of numbers. The first number is the “pick” number and the second is the Random Number, “RN”. The table was generated with a spreadsheet and the cells (boxes at the intersection of rows and columns) containing the RNs actually contain the “random number function.” Every time the spreadsheet is opened or changed, all the RNs change.

1. Select a Pick number in a random method. The first two or last two digits in the next automobile license plate you see would be one way to select. Another would be to start a digital stop watch and stop it several seconds later, using the decimal part of the seconds as your Pick number.
2. Find the RN matching the Pick number.

08

**Picking Random Numbers with a Calculator**

09

Many calculators have a built-in random number function. To obtain a random number, key in the code or push the button(s) the calculator’s instructions call for. The display will show a number between 0.000 and 1.000 and this will be your random number.

**TABLE 1**  
**Random Numbers**

Pick	RN								
01	0.998	21	0.758	41	0.398	61	0.895	81	0.222
02	0.656	22	0.552	42	0.603	62	0.442	82	0.390
03	0.539	23	0.702	43	0.150	63	0.821	83	0.468
04	0.458	24	0.217	44	0.001	64	0.187	84	0.335
05	0.407	25	0.000	45	0.521	65	0.260	85	0.727
06	0.062	26	0.781	46	0.462	66	0.815	86	0.708
07	0.370	27	0.317	47	0.553	67	0.154	87	0.161
08	0.410	28	0.896	48	0.591	68	0.007	88	0.893
09	0.923	29	0.848	49	0.797	69	0.759	89	0.255
10	0.499	30	0.045	50	0.638	70	0.925	90	0.604
11	0.392	31	0.692	51	0.006	71	0.131	91	0.880
12	0.271	32	0.530	52	0.526	72	0.702	92	0.656
13	0.816	33	0.796	53	0.147	73	0.146	93	0.711
14	0.969	34	0.100	54	0.042	74	0.355	94	0.377
15	0.188	35	0.902	55	0.609	75	0.292	95	0.287
16	0.185	36	0.674	56	0.579	76	0.854	96	0.461
17	0.809	37	0.509	57	0.887	77	0.240	97	0.703
18	0.105	38	0.013	58	0.495	78	0.851	98	0.866
19	0.715	39	0.497	59	0.039	79	0.678	99	0.616
20	0.380	40	0.587	60	0.812	80	0.122	00	0.759

**Examples of Straight Random Sampling Procedures Using Random Numbers**

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**Sampling from a Belt or Flowing Stream:**

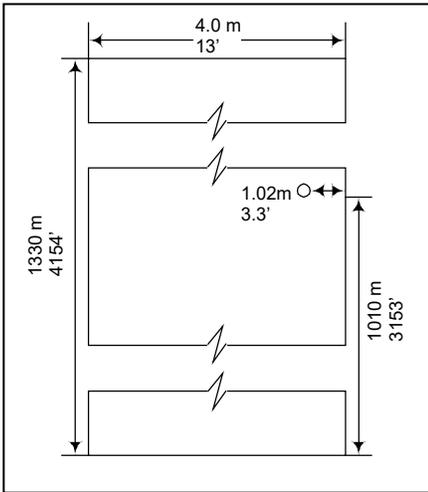
Agencies specify the frequency of sampling in terms of time, volumes, or masses. The specification might call for one sample from every 1,000,000 kg(1000 t) or 1100 Tons(T) of aggregate. If the random number was 0.317, the sample would be taken at  $(0.317)(1,000,000 \text{ kg}) = 317,000 \text{ kg}$  (317 t). Or  $(.317) (1100 \text{ T}) = 349 \text{ T}$ .

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One sample per day might also be specified. If the day were 9 hours long and the random number 0.199, the sample would be taken at  $(0.199) (9 \text{ hrs}) = 1.79 \text{ hr} = 1 \text{ hr}, 48 \text{ minutes}$  into the day.

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**Sampling from Transport Units:** Based on the agency’s specifications – in terms of time, volume, or mass – determine the number of transport units that comprise a lot. Multiply the selected random number(s) by the number of units to determine which unit(s) will be sampled.



Sampling from a roadway

For example, if 20 transport units comprise a lot and one sample is needed, pick one RN. If the RN were 0.773, then the sample would be taken from the  $(0.773)(20) = 15.46$ , or 16th transport unit.

**Sampling from a Roadway with Previously Placed Material:**

The agency’s specified frequency of sampling – in time, volume, or mass – can be translated into a location on a job. For example, if a sample is to be taken every  $800 \text{ m}^3$  ( $1000 \text{ yd}^3$ ) and material is being placed 0.15 m (0.50 ft) thick and 4.0 m (13 ft) wide, then the lot is 1330 m (4154 ft) long. You would select two RNs in this case. To convert  $\text{yd}^3$  to  $\text{ft}^3$  multiply by 27.

The first RN would be multiplied by the length to determine where the sample would be taken along the project. The second would be multiplied by the width to determine where, widthwise, the sample would be taken. For example, a first RN of 0.759 would specify that the sample would be taken at  $(0.759)(1330 \text{ m})$  or  $(4154 \text{ ft}) = 1010 \text{ m}$  or 3153 ft from the beginning. A second RN of 0.255 would specify that the sample would be taken at  $(0.255)(4.0 \text{ m})$  or  $(13 \text{ ft}) = 1.02 \text{ m}$  or 3.3 ft from the right edge of the material. To avoid problems associated with taking samples too close to the edge, no sample is taken closer than 0.3 m (1 ft) to the edge. If the RN specifies a location closer than 0.3 m (1 ft), then 0.3 m (1 ft) is added to or subtracted from the distance calculated.

**Sampling from a Stockpile:** AASHTO R 90 recommends against sampling from stockpiles. However, some agencies use random procedures in determining sampling locations from a stockpile. Bear in mind that stockpiles are prone to segregation and that a sample obtained from a stockpile may not be representative. Refer to AASHTO R 90 for guidance on how to sample from a stockpile.

**In-Place Density Testing:** Agency specifications will indicate the frequency of tests. For example, one test per  $500 \text{ m}^3$  ( $650 \text{ yd}^3$ ) might be required. If

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the material is being placed 0.15 m (0.50 ft) thick and 10.0 m (33 ft) wide, then the lot is 333 m (1090 ft) long. You would select two RNs in this case.

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The first RN would be multiplied by the length to determine where the sample would be taken along the project. The second would be multiplied by the width to determine where, widthwise, the sample would be taken. For example, a first RN of 0.387 would specify that the sample would be taken at  $(0.387)(333 \text{ m})$  or  $(1090 \text{ ft}) = 129 \text{ m}$  or  $(422 \text{ ft})$  from the beginning. A second RN of 0.558 would specify that the sample would be taken at  $(0.588)(10.0 \text{ m})$  or  $(33 \text{ ft}) = 5.88 \text{ m}$  or  $(19 \text{ ft})$  from the right edge of the material. To avoid problems associated with taking samples too close to the edge, no sample is taken closer than 0.3 m (1 ft) to the edge. If the RN specifies a location closer than 0.3 m (1 ft), then 0.3 m (1 ft) is added to or subtracted from the distance calculated.



**BASICS OF SAMPLING & REDUCTION**

Class	Type	Family
Igneous	Intrusive	Granite
	Extrusive	Basalt
Sedimentary	Calcareous	Limestone
	Siliceous	Sandstone
Metamorphic	Foliated	Slate
	Non-foliated	Marble

**Rock class, type, family**

**Introduction – Aggregate**

Properties of aggregate materials depend upon the mineral constituents present in parent rock formations. Rock is grouped in three major classes:

- Igneous
- Sedimentary
- Metamorphic

Classes are divided into types, which are further divided into families.

**Geology**

Igneous rocks are formed by solidification of molten rock. Grain size depends on the rate of cooling. Rapid cooling, which occurs when lava flows on land, tends to produce fine-grained rock such as basalt. Molten material cooled within the earth at slow rates tends to consist of large-grained rock such as granite.

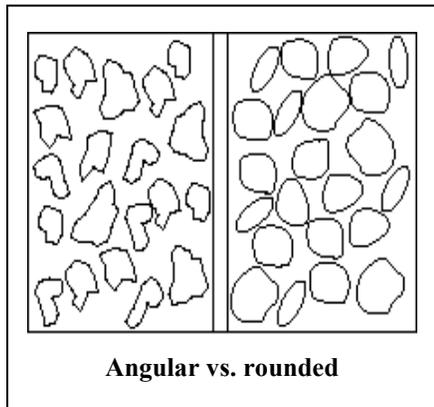
Sedimentary rock forms when sediments are mechanically deposited by wind, water, or glaciers, or chemically created by direct precipitation of dissolved material in water. Sandstone is an example of mechanically deposited rock, while limestone is an example of chemically created rock.

Metamorphic rocks result from the “re-working” of existing rock (igneous, sedimentary, or older metamorphic) under the influence of high temperatures and pressures within the earth. Quartzite is metamorphosed sandstone, while marble is metamorphosed limestone.

All three classes of rock have been used as aggregates in road construction. The suitability of aggregate material from a given source must be determined from a combination of tests and mineralogical examinations.

Accurate standard sampling and testing methods are essential to obtaining results that represent the

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characteristics of the aggregate. Depending on the characteristics, the aggregate may be used for road base, concrete, or asphalt mixtures.

**Properties**

Physical, chemical, and mechanical properties influence the suitability of aggregate for roadway construction. Physical properties include particle shape, particle size, size distribution, surface texture, absorption, specific gravity, unit weight, and void content. Chemical or electrochemical properties include solubility, reactivity with or resistance to attack by other chemicals, and affinity to asphalt cement. Mechanical properties include resistance to the effects of applied traffic loads.

Table 1 summarizes basic properties of aggregate relative to three specific uses:

- Base – Aggregate Base Course
- PCC – Portland Cement Concrete
- Asphalt Mixtures

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**Summary**

Appropriate aggregate properties are essential to the quality of road base, embankment, and concrete and asphalt mixtures. The testing technician plays a critical role by testing materials according to proper procedures to determine these properties. As sources for aggregates are depleted, more emphasis on identifying suitable resources is required.

**Table 1**  
**Effects of Aggregate Properties on Base, PCC, and Asphalt Mixtures** 8

Aggregate Property	Effect on Material Produced		
	Base	PCC	Asphalt Mixtures
Grading – general	Impacts workability, density, strength, stability	Impacts workability, density, strength, stability	Impacts workability, density, strength, stability
Dense grading	Required for strength and stability	Not commonly used	Commonly used
Gap grading	May be OK	Commonly used	May be OK
Open grading	Good for drainage, poor for strength	Poor choice	May be OK
Rounded and rough	Poor interlocking causes weakness	Good for normal use	Good adhesion, poor interlocking
Rounded and smooth	Poorest choice	Lowers bond but good for normal use	Poorest choice
Angular and smooth	Acceptable	Lower bond may result	Good interlocking, poor adhesion
Angular and rough	Best for normal use	Workability will be poor, but high strength will result	Good adhesion, good interlocking
Flakiness	Weak base material	Weak mix may result	Bridging (high voids and low strength), may degrade
Porosity	Susceptible to frost action	Reduces bond and freeze/thaw resistance, lowers strength	Excessive values cause high binder absorption, reduces durability
Specific gravity	Related to toughness	Required for mix design calculations, related to toughness	Required for mix design calculations, related to toughness
Cleanliness	Impurities, dust increase frost susceptibility	Impurities, dust reduce adhesion	Impurities, dust reduce adhesion
Toughness	Critical to strength	Usually not important	Critical to mix stability
Chemistry	Usually not important	Alkali-silica reactivity is a serious concern	Electrochemical charge of aggregates must be matched with appropriate binders



Slice through asphalt core

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**Introduction – Asphalt Mixtures**

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Asphalt mixtures are comprised of two primary ingredients: aggregate and asphalt binder. The asphalt binder coats and holds the aggregate together in a moderately flexible rock-like mass. Hot mix asphalts (HMA) are mixes that are produced at high temperature. Warm mix asphalts (WMA) are mixtures that, due to a variety of technologies, are mixed and placed at relatively lower temperatures.

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Asphalt mixtures are generally divided into three types based on the gradation of the aggregate: dense-graded, open-graded, and gap-graded.

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Dense-graded asphalt mixtures consist of asphalt binder and well-graded aggregate, which is aggregate having an even distribution of particle sizes.

Open-graded asphalt mixtures consist primarily of coarse aggregate, minimal fine aggregate, and asphalt binder. These mixtures have an open surface texture that allows water to drain into the mix. The large aggregate and stone-to-stone contact carries the load of vehicles traveling over the surface.

Gap-graded asphalt mixtures are similar to open-graded mixes except that mid-size aggregate, between the 4.75 mm (No. 4) and 425 μm (No. 40) sieves, is missing or present only in small amounts.

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The asphalt binder is divided into two categories: asphalt binder that is absorbed into the aggregate ( $P_{ba}$ ) and effective asphalt binder ( $P_{be}$ ), asphalt binder that coats the surfaces and binds aggregate particles together. Asphalt mixtures also have air voids as well as aggregate and asphalt binder.

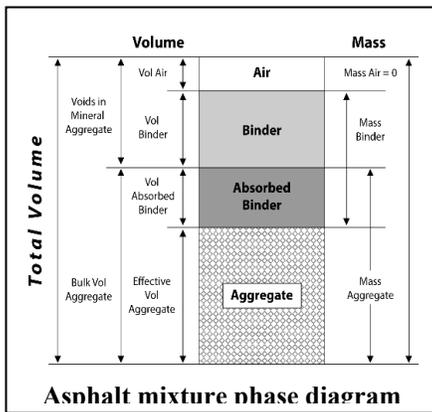
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Five factors affect pavement performance:

- structural design of pavement layers
- mix design properties
- workmanship used to produce, place, and compact the mix

- loading factors
- environmental conditions

The best specifications, if not followed, will not ensure a high quality, long-lasting pavement. The best mix design, if not duplicated at the plant, will not guarantee the life of the pavement. The most sophisticated equipment, if not operated properly, will not produce a roadway that withstands the effects of traffic and the environment. Poor workmanship can negate all those items and cause premature failure of pavement materials or pavement structure, or both. Accurate materials testing, and construction inspection are critical to a successful project.



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### Design Parameters

The total volume of the mix includes entrapped air voids, moisture, effective and absorbed asphalt binder, and mineral aggregate.

Whether a mix design is developed through a Marshall, Hveem, or Superpave mix design process there are common volumetric requirements. Volumetric properties (measurements by volume) include bulk specific gravity ( $G_{mb}$ ), theoretical maximum specific gravity ( $G_{mm}$ ), air voids ( $V_a$ ), voids in mineral aggregate (VMA), and voids filled with asphalt (VFA).

The total mass of a specimen divided by the corresponding total volume (bulk) of a specimen is known as bulk density. Bulk density is calculated by determining the bulk specific gravity,  $G_{mb}$ , of the sample and multiplying by the density of water.

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There are two procedures for calculating  $G_{mb}$  in the FOP for AASHTO T 166 – suspension and volumeter. In the suspension procedure,  $G_{mb}$  is calculated as follows.

$$G_{mb} = \frac{A}{B - C}$$

where:

$G_{mb}$  = Bulk specific gravity

A = Mass of dry, compacted specimen in air

B = Mass of saturated surface dry (SSD) compacted specimen in air

C = Weight of compacted specimen in water at 25°C (77°F)

21 The combined masses of asphalt binder and aggregate divided by the volume of these components is the maximum density. Maximum density contains no air voids. The maximum density provides a reference to determine the amount of air in the compacted mix, among other things. Maximum density is determined on uncompact asphalt mixtures by determining the theoretical maximum specific gravity,  $G_{mm}$ , according to the FOP for AASHTO T 209 and multiplying by the density of water.

22 There are two procedures for calculating  $G_{mm}$  – bowl and flask. In the flask procedure,  $G_{mm}$  is calculated as follows.

$$G_{mm} = \frac{A}{A + D - E}$$

where:

$G_{mm}$  = Theoretical maximum specific gravity

A = Mass of dry specimen in air

D = Mass of flask filled with water at 25°C (77°F)

E = Mass of flask filled with water and specimen at 25°C (77°F)

23 Air voids are expressed as a percentage of total sample volume. Percent air voids,  $V_a$ , is calculated as follows:

$$V_a = \left( \frac{G_{mm} - G_{mb}}{G_{mm}} \right) \times 100$$

where:

$V_a$  = Percent air voids of total mix mass

$G_{mb}$  = Bulk specific gravity of compacted mix

$G_{mm}$  = Theoretical maximum specific gravity

24 Voids between aggregate particles may contain air or asphalt binder. Voids in the mineral aggregate, VMA, are those spaces in laboratory compacted specimens that include air and effective, but not absorbed, asphalt binder.

$$25 \quad VMA = 100 - \left( \frac{G_{mb} \times P_s}{G_{sb}} \right)$$

where:

VMA = Voids in the mineral aggregate

$G_{mb}$  = Bulk specific gravity of compacted mix

$G_{sb}$  = Bulk specific gravity of aggregate

$P_s$  = Percent aggregate content in mix by mass of total mix

26 Finally, the voids filled with asphalt (VFA) is expressed as the percentage of the VMA that contains asphalt.

$$VFA = \left( \frac{VMA - V_a}{VMA} \right) \times 100$$

where:

VFA = Voids filled with asphalt

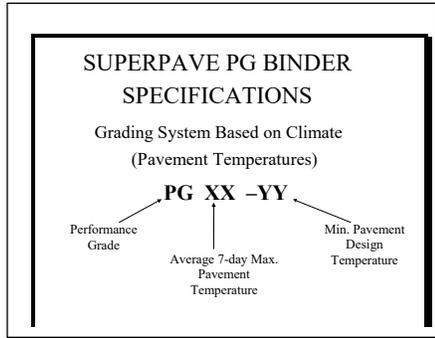
VMA = Voids in the mineral aggregate

$V_a$  = Percent air voids by total mass of mix

These properties are used to design asphalt mixtures and need to be verified during construction to ensure a quality pavement.

## 27 **Asphalt Binder**

Performance Graded (PG) asphalt binders were introduced in 1994 and are now the industry standard. The PG system of specifying asphalt binder is based on a complex series of performance-based tests. The specification system includes modified and unmodified asphalt binders.



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**Superpave PG Asphalt Binder specification**

The Superpave PG asphalt binder specification, as outlined in *AASHTO M 320, Performance Graded Asphalt Binder*, measures the physical properties of asphalt binders that are related to field performance.

The Superpave asphalt binder grading system indicates the range of in-service temperatures of the asphalt binder capable of resisting rutting, fatigue and thermal cracking. The first number is the “high temperature grade,” and means the asphalt binder possesses adequate physical properties up to this pavement temperature. The second number is the “low temperature grade,” and means the asphalt binder possesses adequate physical properties down to this pavement temperature. A PG 64-34 performs up to 64°C (147° F) maximum pavement temperature and down to -34°C (-29°F)

**Asphalt Binder selection**

The selection of the asphalt binder depends on the climate of the project site:

- Low temperature
  - Lowest pavement temperature (not air temperature)
- High temperature
  - Average 7-day maximum pavement temperature (not air temperature)

The asphalt binder selection also adjusts for the anticipated traffic load known as the ‘equivalent single axle load (ESAL).’

**Types of Manufacturing Plants**

Drum plants and batch plants are two common types of plants. Both are capable of producing asphalt mixtures. They are similar in that both have cold feed systems for aggregate. Aggregate material of different sizes is dropped from bins onto belts, transported to a mixer, blended, and then dropped onto another belt for transport to the dryer. The plants are different in the means of production following heating in the dryer.

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**Aggregate feed bins**

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**Drum Plants** – In drum plants, scales under the belts from each bin control the mass flow rate of each aggregate size. The percent of asphalt binder is based on dry mass, so the mass of aggregate is mathematically corrected for moisture. The introduction of asphalt binder is controlled by a metered delivery pump. Aggregate and asphalt binder are mixed in the far end (near the exit) of the drum and then stored temporarily in a silo.



**Drum plants**

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When the drum plant is supplying to a single project, the amount of aggregate and asphalt binder, as measured by the scales and meter, can be compared with the amount of material delivered to the project.

Drum plants are typically used for large jobs and are more portable. Drum plants continuously feed aggregate and asphalt binder into the drum and produce large quantities of asphalt mixtures during the course of a run. Drum plants, however, cannot switch mix designs with ease and require close control of material being fed to the dryer. Drum plants are better suited to produce the same mix over an extended period, not several different mixes in a day as with batch plants.



**Batch Plant**

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**Batch Plants** – In batch plants, aggregate is rescreened and stored in separate bins after drying. Aggregate is taken from each bin, based on the mix design, and the mass is determined in the aggregate hopper. A separate hopper is used for determining the mass of the asphalt binder. Aggregate and asphalt binder are mixed in a chamber, or pugmill, and then dropped into a truck or stored temporarily in a silo.

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Batch plants are less efficient than drum plants because they only mix a certain amount of asphalt mixture at a time. They are more flexible, however, because several different mixtures can be made in a day. In fact, a batch plant can switch from one mix to another fairly quickly, as long as both mixes use aggregates from the same source.

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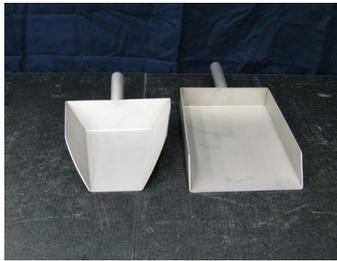
**Summary**

High quality asphalt mixtures require a proper combination of materials and workmanship. The testing technician plays a critical role by testing materials according to proper procedures to determine if the materials meet the project specification. No amount of proper workmanship can compensate for poor material quality.

**SAMPLING AGGREGATE PRODUCTS  
FOP FOR AASHTO R 90**



**Sampling aggregate**



**Scoops**

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**Significance**

Tests cannot be performed on all the material included in an entire project, so samples are taken from the whole. Proper material sampling is critical to all subsequent testing. If the representative portion obtained through sampling does not truly represent the material, any analysis of that portion is inappropriate for the project at hand. Since only a portion of the whole is used, that portion must be a reliable reflection of the whole. The size of the sample will depend upon the tests to be run and on the nominal maximum size of the aggregate.

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**Scope**

This procedure covers sampling of coarse, fine, or a combination of coarse and fine aggregates (CA and FA) in accordance with AASHTO R 90-18. Sampling from conveyor belts, transport units, roadways, and stockpiles is covered.

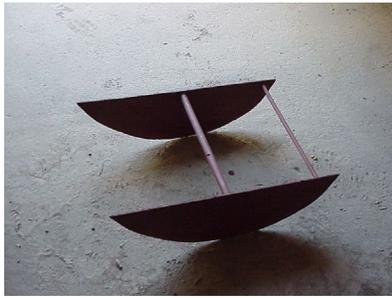
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**Apparatus**

- Shovels or scoops, or both
- Brooms, brushes, and scraping tools
- Sampling tubes of acceptable dimensions
- Mechanical sampling systems: normally a permanently attached device that allows a sample container to pass perpendicularly through the entire stream of material or diverts the entire stream of material into the container by manual, hydraulic, or pneumatic operation
- Belt template
- Sampling containers

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**Procedure - General**

Sampling is as important as testing. Use every precaution to obtain samples that are representative of the material. Determine the time or location for sampling in a random manner.

1. Wherever samples are taken, obtain multiple increments of approximately equal size.
2. Mix the increments thoroughly to form a field sample that meets or exceeds the minimum mass recommended in Table 1.

**TABLE 1  
Recommended Sample Sizes**

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Nominal Maximum Size*		Minimum Mass	
mm (in.)		g (lb)	
90	(3 1/2)	175,000	(385)
75	(3)	150,000	(330)
63	(2 1/2)	125,000	(275)
50	(2)	100,000	(220)
37.5	(1 1/2)	75,000	(165)
25.0	(1)	50,000	(110)
19.0	(3/4)	25,000	(55)
12.5	(1/2)	15,000	(35)
9.5	(3/8)	10,000	(25)
4.75	(No. 4)	10,000	(25)
2.36	(No. 8)	10,000	(25)

\* One sieve larger than the first sieve to retain more than 10 percent of the material using an agency specified set of sieves based on cumulative percent retained. Where large gaps in specification sieves exist, intermediate sieve(s) may be inserted to determine nominal maximum size. Maximum size is one size larger than nominal maximum size.

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**Note 1:** Sample size is based upon the test(s) required. As a general rule, the field sample size should be such that, when split twice will provide a testing sample of proper size. For example, the sample size may be four times that shown in Table 1 of the FOP for AASHTO T 27/T 11, if that mass is more appropriate.

Nominal maximum size and maximum size are not the same.

**Example:**

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Sieve Size, mm (in)		Cumulative Percent Retained
75	(3)	0
63	(2 1/2)	0
50	(2)	0
37.5	(1 1/2)	7
25.0	(1)	32
19.0	(3/4)	38
12.5	(1/2)	47
9.5	(3/8)	58
4.75	(No. 4)	72

First sieve to cumulatively retain >10 percent: 25.0 mm (1 in.)  
 Nominal maximum size: 37.5 mm (1 1/2 in.)  
 Maximum size: 50 mm (2 in.)



**Sampling from the belt**

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**Procedure – Specific Situations**

**Conveyor Belts**

Avoid sampling at the beginning or the end of an aggregate run due to the potential for segregation. Be careful when sampling in the rain. Make sure to capture fines that may stick to the belt or that the rain tends to wash away.

**Method A (From the Belt)**

1. Stop the belt.
2. Set the sampling template in place on the belt, avoiding intrusion by adjacent material.
3. Remove the material from inside the template, including all fines.
4. Obtain at least three approximately equal increments.
5. Combine the increments and mix thoroughly to form a single sample.

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**Method B (From the Belt Discharge)**

The sampling device may be manually, semi-automatic or automatically powered.

1. Pass a sampling device through the full stream of the material as it runs off the end of the conveyor belt.

- Once in each direction
- Without overfilling
- Maintaining a constant speed during the sampling process

2. When emptying the sampling device into the container, include all fines.
3. Combine the increments and mix thoroughly to form a single sample.

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**Automatic Sampling Device in Stream**

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**Transport Units**

1. Visually divide the unit into four quadrants.
2. Identify one sampling location in each quadrant.
3. Dig down and remove approximately 0.3 m (1 ft) of material to avoid surface segregation. Obtain each increment from below this level.
4. Combine the increments and mix thoroughly to form a single sample.

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**Sampling from a Transport**

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**Roadways**

**Method A (Berm or Windrow)**

1. Obtain sample before spreading.
2. Take the increments from at least three random locations along the fully formed windrow or berm. Do not take the increments from the beginning or the end of the windrow or berm.
3. Obtain full cross-section samples of approximately equal size at each location. Take care to exclude the underlying material.
4. Combine the increments and mix thoroughly to form a single sample.

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26 *Note 2:* Obtaining samples from berms or windrows may  
yield extra-large samples and may not be the preferred  
sampling location.

27 **Method B (In-Place)**

- 27 1. Obtain sample after spreading and before  
compaction.
- 28 2. Take the increments from at least three  
random locations.
- 28 3. Obtain full-depth increments of  
approximately equal size from each  
location. Take care to exclude the  
underlying material.
4. Combine the increments and mix  
thoroughly to form a single sample.

**Stockpiles**

29 **Method A– Loader sampling**

- 29 1. Direct the loader operator to enter the  
stockpile with the bucket at least 150 mm  
(6 in.) above ground level without  
contaminating the stockpile.
- 30 2. Discard the first bucketful.
- 30 3. Have the loader re-enter the stockpile and  
obtain a full loader bucket of the material,  
tilt the bucket back and up.
4. Form a small sampling pile at the base of  
the stockpile by gently rolling the material  
out of the bucket with the bucket just high  
enough to permit free flow of the material.  
(Repeat as necessary.)
5. Create a flat surface by having the loader  
back drag the small pile.
- 31 6. Visually divide the flat surface into four  
quadrants.
7. Collect an increment from each quadrant by  
fully inserting the shovel into the flat pile as  
vertically as possible, take care to exclude  
the underlying material, roll back the shovel  
and lift the material slowly out of the pile to  
avoid material rolling off the shovel.



Top, middle, bottom

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8. Combine the increments and mix thoroughly to form a single sample.

**Method B – Stockpile Face Sampling**

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1. Create horizontal surfaces with vertical faces in the top, middle, and bottom third of the stockpile with a shovel or loader.

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2. Prevent sloughing by shoving a flat board against the vertical face. Sloughed material will be discarded to create the horizontal surface.

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3. Obtain sample from the horizontal surface as close to the intersection as possible of the horizontal and vertical faces.

4. Obtain at least one increment of equal size from each of the top, middle, and bottom thirds of the pile.

5. Combine the increments and mix thoroughly to form a single sample.

**Method C – Alternate Tube Method (Fine Aggregate)**

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1. Remove the outer layer that may have become segregated.
2. Using a sampling tube, obtain one increment of equal size from a minimum of five random locations on the pile.
3. Combine the increments and mix thoroughly to form a single sample.

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**Identification and Shipping**

- Identify samples according to agency standards.
- Include sample report (below).
- Ship samples in containers that will prevent loss, contamination, or damage.

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**Report**

- On forms approved by the agency
- Date
- Time
- Sample ID
- Sampling method
- Location
- Quantity represented
- Material type
- Supplier

**Tips!**

- Remember, the sample must be representative of the whole.
- And the sample must be selected at random to avoid bias.
- Automatic mechanical sampling is preferred.

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**REVIEW QUESTIONS**

1. How can loaders be used to collect aggregate samples?
2. Describe the process for sampling from a conveyor belt using method “A.”
3. Describe sampling from roadways.
4. What are the differences in Methods A, B, and C when sampling from a stockpile?



**PERFORMANCE EXAM CHECKLIST**

**SAMPLING AGGREGATE PRODUCTS  
FOP FOR AASHTO R 90**

Participant Name \_\_\_\_\_ Exam Date \_\_\_\_\_

**Record the symbols “P” for passing or “F” for failing on each step of the checklist.**

<b>Procedure Element</b>	<b>Trial 1</b>	<b>Trial 2</b>
<b>Conveyor Belts – Method A (From the Belt)</b>		
1. Belt stopped?	_____	_____
2. Sampling template set on belt, avoiding intrusion of adjacent material?	_____	_____
3. Sample, including all fines, scooped off?	_____	_____
4. Samples taken in at least three approximately equal increments?	_____	_____
5. Increments combined and mixed to form a single sample?	_____	_____
<b>Conveyor Belts – Method B (From the Belt Discharge)</b>		
6. Sampling device passed through full stream of material once in each direction as it runs off end of belt?	_____	_____
7. Increments combined and mixed to form a single sample?	_____	_____
<b>Transport Units</b>		
8. Unit divided into four quadrants?	_____	_____
9. Increment obtained from each quadrant, 0.3 m (1ft.) below surface?	_____	_____
10. Increments combined and mixed to form a single sample?	_____	_____
<b>Roadways Method A (Berm or Windrow)</b>		
11. Sample taken before spreading?	_____	_____
12. Full depth of material taken?	_____	_____
13. Underlying material excluded?	_____	_____
14. Samples taken in at least three approximately equal increments?	_____	_____
15. Increments combined and mixed to form a single sample?	_____	_____
<b>Roadways Method B (In-place)</b>		
16. Sample taken after spreading?	_____	_____
17. Full depth of material taken?	_____	_____

**OVER**

18. Underlying material excluded? \_\_\_\_\_

19. Samples taken in at least three approximately equal increments? \_\_\_\_\_

20. Increments combined and mixed to form a single sample? \_\_\_\_\_

**Stockpile Method A– (Loader sampling)**

21. Loader operator directed to enter the stockpile with the bucket at least 150 mm (6 in.) above ground level without contaminating the stockpile? \_\_\_\_\_

22. First bucketful discarded? \_\_\_\_\_

23. The loader re-entered the stockpile and obtained a full loader bucket of the material with the bucket tilted back and up? \_\_\_\_\_

24. A small sampling pile formed at the base of the stockpile by gently rolling the material out of the bucket with the bucket just high enough to permit free-flow of the material? \_\_\_\_\_

25. A flat surface created by the loader back dragging the small pile? \_\_\_\_\_

26. Increment sampled from each quadrant by fully inserting the shovel into the flat pile as vertically as possible, care taken to exclude the underlying material? \_\_\_\_\_

27. Increments combined and mixed to form a single sample? \_\_\_\_\_

**Stockpile Method B (Stockpile Face)**

28. Created horizontal surfaces with vertical faces? \_\_\_\_\_

29. At least one increment taken from each of the top, middle, and bottom thirds of the stockpile. \_\_\_\_\_

30. Increments combined and mixed to form a single sample? \_\_\_\_\_

**Stockpile Method C – Alternate Tube Method (Fine Aggregate)**

31. Outer layer removed? \_\_\_\_\_

32. Increments taken from at least five locations with a sampling tube? \_\_\_\_\_

33. Increments combined and mixed to form a single sample? \_\_\_\_\_

Comments: First attempt: Pass \_\_\_\_\_ Fail \_\_\_\_\_ Second attempt: Pass \_\_\_\_\_ Fail \_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

Examiner Signature \_\_\_\_\_ WAQTC #: \_\_\_\_\_

**PERFORMANCE EXAM CHECKLIST (ORAL)**

**SAMPLING AGGREGATE PRODUCTS  
FOP FOR AASHTO R 90**

Participant Name \_\_\_\_\_ Exam Date \_\_\_\_\_

Record the symbols “P” for passing or “F” for failing on each step of the checklist.

<b>Procedure Element</b>	<b>Trial 1</b>	<b>Trial 2</b>
<b>1. How is a sample obtained from a conveyor belt using Method A?</b>		
a. Stop the belt.	_____	_____
b. Set the sampling template on belt, avoiding intrusion of adjacent material.	_____	_____
c. All the material is removed from belt including all fines.	_____	_____
d. Take at least three approximately equal increments.	_____	_____
e. Combine and mix to form a single sample.	_____	_____
<b>2. How is a sample obtained from a conveyor belt using Method B?</b>		
a. Pass the sampling device through a full stream of material as it runs off the end of the belt.	_____	_____
b. The device must be passed through once in each direction.	_____	_____
c. Increments combined and mixed to form a single sample.	_____	_____
d. Combine and mix to form a single sample.	_____	_____
<b>3. How is a sample obtained from a Transport Unit?</b>		
a. Divide the unit into four quadrants.	_____	_____
b. Dig 0.3 m (1 ft.) below surface.	_____	_____
c. Obtain an increment from each quadrant.	_____	_____
d. Combine and mix to form a single sample.	_____	_____
<b>4. Describe the procedure for sampling from roadways Method A (Berm or Windrow).</b>		
a. Sample before spreading	_____	_____
b. Sample the material full depth without obtaining underlying material.	_____	_____
c. Take at least three approximately equal increments.	_____	_____
d. Combine and mix to form a single sample.	_____	_____

**OVER**

<b>Procedure Element</b>	<b>Trial 1</b>	<b>Trial 2</b>
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**5. Describe the procedure for sampling from roadway Method B (In-place).**

- a. Sample after spreading, before compaction. \_\_\_\_\_
- b. Sample the material full depth without obtaining underlying material. \_\_\_\_\_
- c. Take at least three approximately equal increments. \_\_\_\_\_
- d. Combine and mix to form a single sample. \_\_\_\_\_

**6. Describe the procedure for sampling a stockpile Method A (Loader Sampling).**

- a. Loader enters the stockpile at least 150 mm (6in.) above ground level. \_\_\_\_\_
- b. Loader discard first bucket full. \_\_\_\_\_
- c. Loader obtains a full bucket of material and forms a small sampling pile. \_\_\_\_\_
- d. Loader back drags pile to create a flat surface. \_\_\_\_\_
- e. Divide the flat surface into four quadrants. \_\_\_\_\_
- f. Take an approximately equal increment from each quadrant, excluding the underlying material. \_\_\_\_\_
- g. Combine and mix to form a single sample. \_\_\_\_\_

**7. Describe the procedure for sampling a stockpile Method B (Stockpile Face Sampling).**

- a. Create horizontal surfaces with vertical faces with a shovel. \_\_\_\_\_
- b. At least one increment taken from each of the top, middle, and bottom thirds of the stockpile. \_\_\_\_\_
- c. Combine and mix to form a single sample. \_\_\_\_\_

**8. Describe the procedure for sampling a stockpile Method C – Alternate Tube Method (Fine Aggregate).**

- a. Remove the outer layer of segregated material. \_\_\_\_\_
- b. Obtain increments using sampling tube from at least five locations. \_\_\_\_\_
- c. Combine and mix to form a single sample. \_\_\_\_\_

Comments: First attempt: Pass \_\_\_\_\_ Fail \_\_\_\_\_ Second attempt: Pass \_\_\_\_\_ Fail \_\_\_\_\_

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Examiner Signature \_\_\_\_\_ WAQTC #: \_\_\_\_\_

**REDUCING SAMPLES OF AGGREGATE TO TESTING SIZE  
FOP FOR AASHTO R 76**



**Adjustable Mechanical Splitter**



**Quartered sample**



**Mechanical splitter**

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**Significance**

Aggregates and other materials sampled in the field in accordance with AASHTO R 90 are large composites and need to be reduced to the appropriate size for testing. It is extremely important that the procedure used to reduce the field sample not modify the material.

**Scope**

This procedure covers the reduction of samples to the appropriate size for testing in accordance with AASHTO R 76-23. Techniques are used that minimize variations in characteristics between test samples and field samples. Method A (Mechanical Splitter) and Method B (Quartering and Sectoring) are covered.

This FOP applies to fine aggregate (FA), coarse aggregate (CA), and combinations of the two (FA/CA) and may also be used on soils.

**Terminology**

Saturated Surface-Dry (SSD) – condition of an aggregate particle when the permeable voids are filled with water, but no water is present on exposed surfaces.

*Note 1:* As a quick approximation, if the fine aggregate will retain its shape when molded in the hand, it may be considered wetter than saturated surface-dry.

**Apparatus**

**Method A Mechanical Splitter**

Splitter must allow the sample to flow smoothly without restriction or loss of material.

Splitter chutes:

- Even number of equal width chutes
- Discharge alternately to each side
- Minimum of 8 chutes total for CA and FA / CA, 12 chutes total for FA
- Width:



**Mechanical (riffle) splitter**

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- Minimum 50 percent larger than largest particle
- Maximum chute width of 19 mm (3/4 in.) for fine aggregate passing 9.5 mm (3/8 in.) sieve
- Feed control:
  - Hopper or straightedge pan with a width equal to or slightly less than the overall width of the assembly of chutes
  - Capable of feeding the splitter at a controlled rate
- Splitter Receptacles / Pans:
  - Capable of holding two halves of the sample following splitting



**Method B Apparatus**

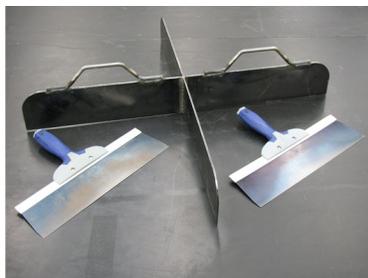
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**Method B Quartering and Sectoring**

- Straightedge scoop, shovel, or trowel
- Broom or brush
- Stick or pipe
- Tarp: A tear resistant rectangular tarp, appropriate for the amount and size of the material being reduced
- Quartering Template: Formed in the shape of a 90-degree cross with equal length sides that exceed the diameter of the flattened pile of material sufficient to allow complete separation of the quartered sample. The height of the sides must be sufficient to extend above the thickness of the flattened pile of the sample to be quartered.



**Tarp**



**Quartering template and straight edges**

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**Method Selection**

Selecting the method of sample reduction depends on:

- The type of material: fine aggregate (FA), coarse aggregate (CA), and combinations of the two (FA / CA)
- The moisture content: drier than saturated surface-dry (SSD), SSD, or wetter than SSD.

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**Note 2:** To use Method A on samples of FA and CA/FA that are at SSD or wetter, the entire sample may be dried – using temperatures that do not exceed those specified for any of the tests contemplated – and then reduced.

Select from the following methods based on the material type and moisture condition.

**Method A Mechanical**

- CA
- FA/CA drier than SSD
- FA drier than SSD

**Method B Quartering**

- CA
- FA/CA
- FA at SSD or wetter

**Method B Sectoring**

- FA at SSD or wetter

**Table 1**

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	<b>Drier than SSD</b>	<b>SSD or Wetter</b>
Fine Aggregate (FA)	Method A Mechanical	Method B Quartering Method B Sectoring
Mixture of FA/CA	Method A Mechanical Method B Quartering	Method B Quartering
Coarse Aggregate (CA)	Method A Mechanical Method B Quartering	Method A Mechanical Method B Quartering

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**Procedure**

**Method A Mechanical Splitter**

1. Place the splitter on a level surface.
2. Place two clean empty receptacles under the splitter.

- 21 3. Empty the sample into the hopper or pan without loss of material.
- 4. Uniformly distribute the material in the hopper or pan from edge to edge so that approximately equal amounts flow through each chute.
- 5. Discharge the material at a uniform rate, allowing it to flow freely through the chutes.
- 22 6. Remove any material retained on the surface of the splitter and place into the appropriate receptacle.
- 7. Using one of the two receptacles containing material, repeat Steps 1 through 6 until the material in one of the two receptacles is the appropriate sample size for the required test.
- 8. Retain and properly identify the remaining unused sample for further testing if required.
- 23 **Mechanical Splitter Check**
  - Determine the mass of each reduced portion. If the percent difference of the two masses is greater than 5 percent, corrective action must be taken.

**Calculation**

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$$\frac{\textit{Smaller Mass}}{\textit{Larger Mass}} = \textit{Ratio} \quad (1 - \textit{ratio}) \times 100 = \% \textit{ Difference}$$

Splitter check: 5127 g total sample mass

Splitter pan #1: 2583 g

Splitter pan #2: 2544 g

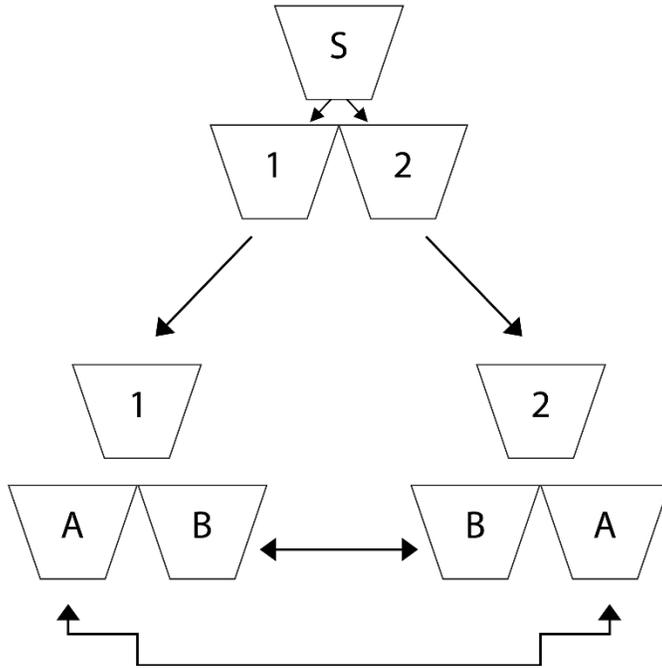
$$\frac{2544 \text{ g}}{2583 \text{ g}} = 0.985 \quad (1 - 0.985) \times 100 = 1.5\%$$

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**Alternative to Mechanical Splitter Check**

- In lieu of determining the mass of each reduced portion, use the method illustrated in Figure 1 or 2 during reduction.

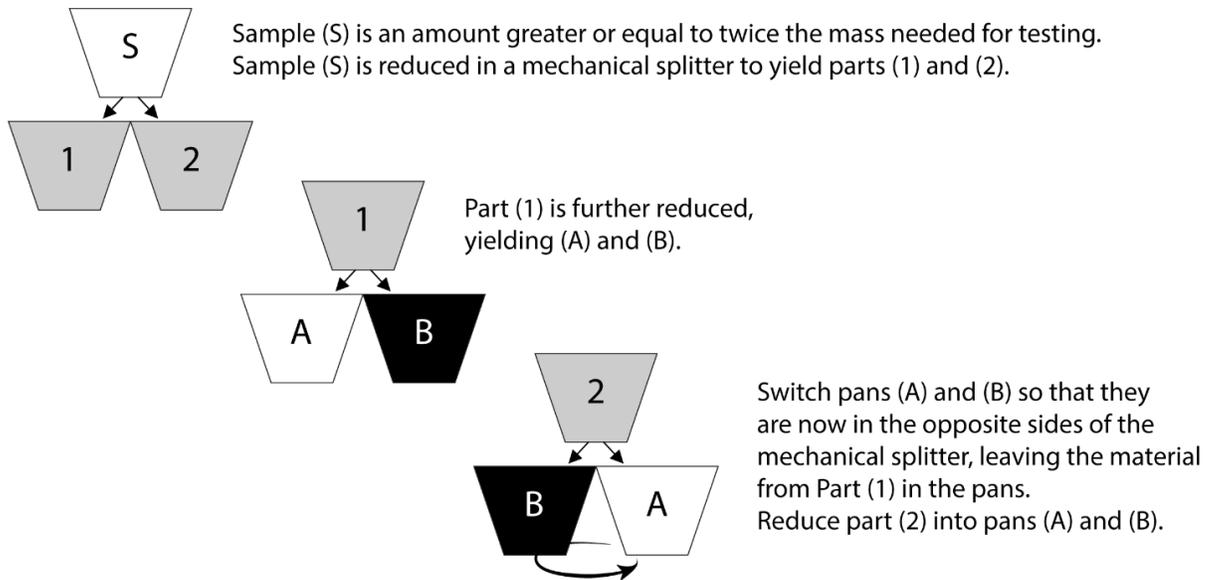
**Figure 1**



- Sample (S) is an amount greater than or equal to twice the mass needed for testing. Sample (S) is reduced in a mechanical splitter to yield parts (1) and (2).
- Part (1) is further reduced yielding (A) and (B) while part (2) is reduced to yield (B) and (A).
- Final testing sample is produced by combining alternate pans, i.e. A/A or B/B only.

**Figure 2**

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**Flattening pile**



**Dividing pile**



**Mixing the sample**



**Quartered sample**

**Method B Quartering**

1. Place the sample on a hard, clean, level surface or tarp where there will be neither loss of material nor the accidental addition of foreign material.
2. Mix the material thoroughly a minimum of four times by one of the following:
  - a. Turning the entire sample over with a shovel or scoop.
  - b. Pulling each corner of the tarp horizontally over the sample toward the opposite corner.
3. After the final turn, form a conical pile.
4. Flatten the conical pile to a uniform thickness and diameter by pressing down with a shovel. The diameter should be four to eight times the thickness.
5. Divide the flattened pile into four approximately equal quarters:
  - a. Using a shovel or trowel
  - b. Inserting a stick or pipe beneath the tarp and under the center of the pile, then lift both ends of the stick, dividing the sample into two roughly equal parts. Remove the stick leaving a fold of the tarp between the divided portions. Insert the stick under the center of the pile at right angles to the first division and again lift both ends of the stick, dividing the sample into four roughly equal quarters.
6. Remove two diagonally opposite quarters, including all fine material, and brush the cleared spaces clean.
7. Successively mix and quarter the remaining material until the sample is reduced to the desired size.

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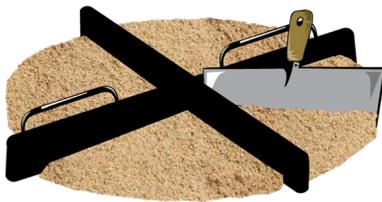
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8. The final test sample consists of two diagonally opposite quarters.

**Method B Sectoring**

1. Place the sample on a hard, clean, level surface or tarp where there will be neither loss of material nor the accidental addition of foreign material.
2. Mix the material thoroughly a minimum of four times by one of the following:
  - a. Turning the entire sample over with a shovel or scoop.
  - b. Pulling each corner of the tarp horizontally over the sample toward the opposite corner.
3. After the final turn, form a conical pile.

32



4. Flatten the conical pile to a uniform thickness and diameter by pressing down with a shovel or scoop. The diameter should be four to eight times the thickness.
5. Divide the flattened pile into four approximately equal quarters using a quartering template, straightedge, shovel, or trowel, assuring complete separation.

**Sectoring of the quarter to the outer edge.**

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6. Using a straightedge, obtain a sector by slicing through a quarter of the material from the center point to the outer edge of the quarter.

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7. Pull or drag the sector from the quarter with two straight edges or hold one edge of the straightedge in contact with quartering device.

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**Equal sector from the diagonally opposite quarter**

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8. Remove an equal sector from the diagonally opposite quarter and combine to create the appropriate sample mass.

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9. Continue obtaining sectors from diagonally opposite quarters until the required sample size has been obtained for all required tests.

**Tips!**

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- Remember, the reduced sample must be representative of the whole.
- Method A – mechanical splitter – is preferred.
- Method A cannot be used for FA wetter than SSD condition.
- Keep the mechanical splitter dry to avoid having particles “stick” to it.
- Make sure your splitter is level.





**PERFORMANCE EXAM CHECKLIST**

**REDUCING SAMPLES OF AGGREGATE TO TESTING SIZE  
FOP FOR AASHTO R 76**

Participant Name \_\_\_\_\_ Exam Date \_\_\_\_\_

Record the symbols “P” for passing or “F” for failing on each step of the checklist.

	<b>Trial 1</b>	<b>Trial 2</b>
<b>Method A – Mechanical Splitter</b>		
1. Splitter placed on a level surface?	_____	_____
2. Chutes appropriate size and number?	_____	_____
3. Material spread uniformly on feeder?	_____	_____
4. Rate of feed slow enough so that sample flows freely through chutes?	_____	_____
5. Splitter on level surface?	_____	_____
6. Material in one pan re-split until desired mass is obtained?	_____	_____
7. Mechanical splitter checked or alternative used?	_____	_____
<b>Method B</b>		
1. Sample placed on a tarp or clean, hard, and level surface?	_____	_____
2. Mixed by turning over 4 times with shovel or by pulling the tarp horizontally over pile?	_____	_____
3. Conical pile formed without loss of material?	_____	_____
4. Pile flattened to uniform thickness and diameter?	_____	_____
5. Diameter equal to about 4 to 8 times thickness?	_____	_____
6. Divided into 4 equal portions without loss of material?	_____	_____
a. Using a shovel or trowel?		
b. Placing stick or pipe under the tarp?		
c. Using straight edge or quartering template?		
7. Quartering		
a. Two diagonally opposite quarters, including all fine material, removed?	_____	_____
b. Process continued until desired sample size is obtained when two opposite quarters combined?	_____	_____

**OVER**

8. Sectoring

- a. Using two straightedges or a quartering device and one straightedge, sector obtained from one of the quarters from the center point to the outer edge of the quarter? \_\_\_\_\_
- b. Equal sector obtained taken from the diagonally opposite quarter? \_\_\_\_\_

9. Increments combined to produce appropriate sample mass? \_\_\_\_\_

Comments:      First attempt:    Pass\_\_\_\_Fail\_\_\_\_      Second attempt: Pass\_\_\_\_Fail\_\_\_\_

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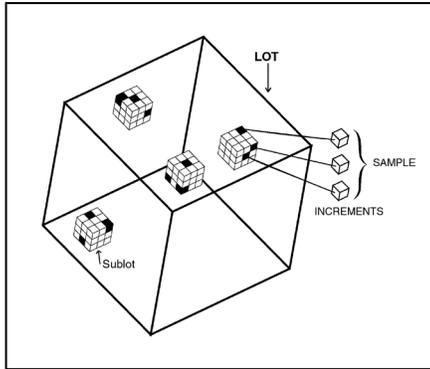
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**Examiner Signature** \_\_\_\_\_ **WAQTC #:** \_\_\_\_\_

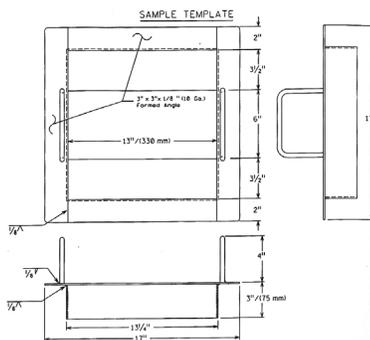
**SAMPLING ASPHALT MIXTURES  
FOP FOR AASHTO R 97**



**Sampling from a lot**



**Asphalt mixture sample**



**Cookie Cutter Sampling Device**

**Significance**

Testing asphalt mixtures in the field begins with obtaining and preparing the sample to be tested. Standardized procedures for obtaining a representative sample have been established. Producing strong, durable, reliable pavement in roadways requires careful sampling and accurate testing.

Technicians must be patient and follow these procedures. If one considers that the specifications require tests to be performed on only a small portion of the total material placed, the need for a truly representative sample is apparent.

**Scope**

This procedure covers sampling of asphalt mixtures from plants, transport units, and roadways, in accordance with AASHTO R 97-19. Sampling is as important as testing. Use care to obtain a representative sample. Avoid segregation and contamination of the material during sampling.

*This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.*

**Apparatus**

- Shovel or Metal Scoops, or Other Equipment: square-head metal shovels at least 125 mm (5.5 in.) wide.
- Sample containers: cardboard boxes, metal cans, stainless steel bowls, or other agency-approved containers
- Sampling plate: thick metal plate, minimum 8 gauge, sized to accommodate sample requirements, with a wire attached to one

corner long enough to reach from the center of the paver to the outside of the farthest auger extension. A minimum of one hole 6 mm (0.25 in.) in diameter must be provided in a corner of the plate.

- Cookie cutter sampling device: formed steel angle with two 100 by 150 mm by 9 mm (4 in. by 6 in. by 3/8 in.) handles, sized to accommodate sample requirements. Minimum 50 mm (2 in.) smaller than the sampling plate when used together.

*Example:* Sampling plate 380 mm (15 in.) square and a cookie cutter sampling device 330 mm (13 in.) square.

- Mechanical sampling device: a permanently attached device that allows a sample receptacle to pass perpendicularly through the entire stream of material or diverts the entire stream of material into the container by manual, hydraulic, or pneumatic operation.
- Agency approved release agent: a non-stick product that prevents the asphalt mixture from sticking to the apparatus and does not contain solvents or petroleum-based products that could affect asphalt binder properties.

**Sample Size**

07 Sample size depends on the test methods specified by the agency for acceptance. Check agency requirement for the size required.

**Procedure**

**General**

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- Select sample locations using a random or stratified random sampling procedure, as specified by the agency. The material shall be tested to determine variations. The supplier/contractor shall provide equipment for safe and appropriate sampling including sampling devices on plants, when required.
- Ensure the container(s) and sampling equipment are clean and dry before sampling.



**Attached sampling device**

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**Belt template**

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- For dense graded mixture samples use cardboard boxes, stainless steel bowls or other agency approved containers.
- For hot open graded mixture samples use stainless steel bowls. Cardboard boxes can be used if the sample has cooled to the point that asphalt binder will not migrate from the aggregate.

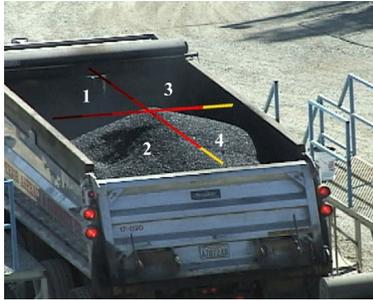
**Attached Sampling Devices**

These are normally permanently attached devices that allow a sample container to pass perpendicularly through the entire stream of material. Operation may be manual, pneumatic, or hydraulic and allow the sample container to pass through the stream twice without overflowing. A sampling device may divert the entire stream of material into the container.

1. Lightly coat the container attached to the sampling device with an agency-approved release agent or preheat it, or both to approximately the same discharge temperature of the mix.
2. Pass the container twice, once in each direction, through the material perpendicularly without overflowing the container.
3. Transfer the asphalt mixture to an agency-approved container without loss of material.
4. Repeat until proper sample size has been obtained.
5. Combine the increments to form a single sample.

**Conveyor Belts**

1. Avoid sampling at the beginning or end of an asphalt mixture production run due to the potential for segregation.
2. Stop the belt containing asphalt mixture.
3. Set the sampling template into the asphalt mixture on the belt, avoiding intrusion by adjacent material.



Quadrants in a load



Asphalt mixture in a transport



Sampling from paver auger

15

4. Remove the asphalt mixture from inside the template, including all fines, and place in a sample container.
5. Repeat, obtaining equal size increments, until proper sample size has been obtained.
6. Combine the sample increments to form a single sample.

**Transport Units**

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1. Visually divide the transport unit into approximately four equal quadrants.
2. Identify one sampling location in each quadrant.
3. Dig down and remove approximately 0.3 m (1 ft.) of material to avoid surface segregation. Obtain each increment from below this level.
4. Combine the increments to form a sample of the required size.

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**Paver Auger**

1. Obtain samples from the end of the auger using a square head shovel.
2. Place the shovel in front of the auger extension, with the shovel blade flat upon the surface to be paved over.
3. Allow the front face of the auger stream to cover the shovel with asphalt mixture, remove the shovel before the auger reaches it by lifting as vertically as possible.
4. Place asphalt mixture in a sample container.
5. Repeat until proper sample size has been obtained.
6. Combine the sample increments to form a sample of the required size.

*Note 1:* First full shovel of material may be discarded to preheat and 'butter' the shovel.

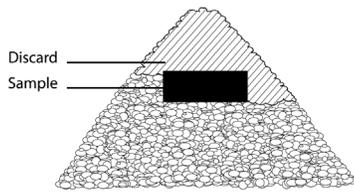
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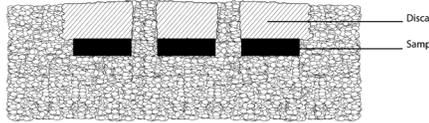
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**Windrow**

1. Obtain samples from the windrow of a transport unit. Avoid the beginning or the end of the windrow section.



Windrow cross section



Windrow side view

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2. Visually divide the windrow into three approximately equal sections.
3. Remove approximately 0.3 m (1 ft) from the top.
4. Fully insert the shovel into the flat surface as vertically as possible, exclude the underlying material, roll back the shovel and lift the material slowly out of the windrow to avoid material rolling off the shovel.
5. Place in a sample container.
6. Repeat, obtaining equal size increments, in each of the remaining thirds.
7. Combine the increments to form a sample of the required size.

**Roadway before Compaction**

There are two conditions that will be encountered when sampling asphalt mixtures from the roadway before compaction. The two conditions are:

- Laying asphalt mixture on grade or untreated base material requiring Method 1.
- Laying asphalt mixture on existing asphalt or laying a second lift of asphalt mixture allowing Method 2.

**SAFETY:**

Sampling is performed behind the paving machine in front of the breakdown roller. For safety, the breakdown roller must remain at least 3 m (10 ft.) behind the sampling operation until the sample has been obtained and the hole filled with loose asphalt mixture.

Method 1 requires a plate to be placed in the roadway in front of the paving operation. There is always concern when working in the path of moving equipment. It is safest to stop the paving train while a plate is installed in front of the paver. When this is not possible the following safety rules must be followed.

1. The plate placing operation must be at least 3 m (10 ft.) in front of the paver or pickup device. The technician placing the plate must have eye contact and communication with the



Cookie cutter and plate

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paving machine operator. If eye contact cannot be maintained at all times, a third person must be present to provide communication between the operator and the technician.

- 2. No technician is to be between the asphalt supply trucks and the paving machine. The exception to this rule is if the supply truck is moving forward creating a windrow, in which case the technician must be at least 3 m (10 ft.) behind the truck.

If at any time the Engineer feels that the sampling technique is creating an unsafe condition, the operation is to be halted until it is made safe, or the paving operation will be stopped while the plate is being placed.

**Method 1 - Obtaining a Sample on Grade or Untreated Base (Plate Method)**

- 1. Following the safety rules detailed above, the technician is to:
  - a. Smooth out a location in front of the paver at least 0.5 m (2 ft.) inside the edge of the mat.
  - b. Lay the plate down diagonally with the direction of travel, keeping it flat and tight to the base with the lead corner facing the paving machine.

*Note 2:* The plate may be secured by driving a nail through the hole in the lead corner of the plate.

- 2. Pull the wire, attached to the outside corner of the plate, taut past the edge of the asphalt mixture mat and secure it. Let the paving operation pass over the plate and wire.
- 3. Using the exposed end of the wire, pull the wire up through the fresh asphalt mixture to locate the corner of the plate.
  - a. Plate only:
    - i. Using a small square head shovel, scoop, or both, remove the full depth of the asphalt mixture from the plate.

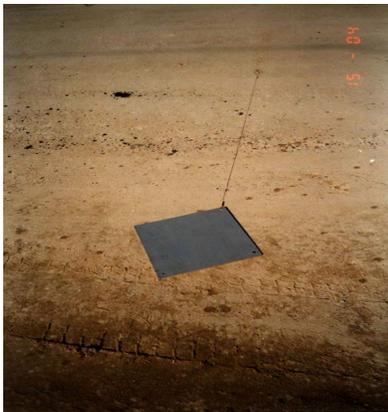


Plate on untreated base

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- Take care to prevent sloughing of adjacent material.
  - ii. Place asphalt mixture, including any material adhering to the plate and scoop or shovel in a sample container.
  - iii. Remove the plate from the roadway. The hole made from the sampling must be filled by the contractor with loose asphalt mixture.
- b. “Cookie Cutter”:
- i. Place the “cookie cutter” sampling device, just inside the end of the wire; align the cutter over the plate. Press “cookie cutter” device down through the asphalt mixture to the plate.
  - ii. Using a small square tipped shovel, scoop, or both, carefully remove all the asphalt mixture from inside of the cutter and place in a sample container.
  - iii. Remove the sample cutter and the plate from the roadway. The hole made from the sampling must be filled by the contractor with loose asphalt mixture.



Using the cookie cutter

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**Method 2 – Obtaining a Sample on Asphalt Surface (Non-plate Method)**

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1. After the paving machine has passed the sampling point, immediately place the “cookie cutter” sampling device on the location to be sampled.
2. Push the cutter down through the asphalt mixture until it is flat against the underlying asphalt mat.
3. Using a small square-tipped shovel or scoop, or both, carefully remove all the asphalt mixture from inside of the cutter and place in a sample container.

4. Remove the cutter from the roadway. The hole made from the sampling must be filled by the contractor with loose asphalt mixture.

**Stockpiles**

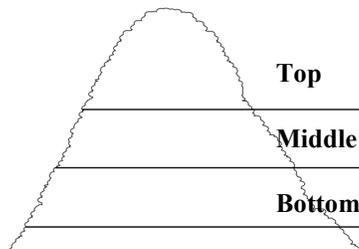
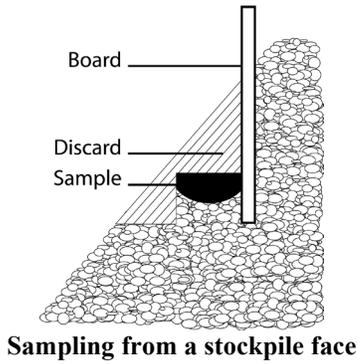
31 Remove at least 0.1 m (4 in.) from the surface before sampling; mixtures in a stockpile may develop an oxidized crust.

**Method 1 – Loader**

- 32 1. Direct the loader operator to enter the stockpile with the bucket at least 0.3 m (1 ft) above ground level without contaminating the stockpile.
2. Obtain a full loader bucket of the asphalt mixture; tilt the bucket back and up.
3. Form a small sampling pile at the base of the stockpile by gently rolling the asphalt mixture out of the bucket with the bucket just high enough to permit free flow of the mixture. Repeat as necessary.
4. Create a flat surface by having the loader "back-drag" the small pile.
- 33 5. Obtain approximately equal increments from at least three randomly selected locations on the flat surface at least 0.3 m (1 ft) from the edge.
6. Fully insert the shovel, exclude the underlying material, roll back the shovel and lift the asphalt mixture slowly out of the pile to avoid mixture rolling off the shovel.
7. Combine the sample increments to form a sample.

**Method 2 – Stockpile Face**

- 34 1. Create horizontal surfaces with vertical faces in the top, middle, and bottom third of the stockpile with a shovel or a loader if one is available.
2. Shove a flat board against the vertical face behind the sampling location to prevent sloughing of asphalt mixture. Discard the



**Tips!**

Check agency requirements for:

- Sample size needed
- Sampling device requirements
- Allowable sampling techniques

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sloughed mixture to create the horizontal surface.

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3. Obtain the sample from the horizontal surface as close as possible to the intersection of the horizontal and vertical faces.
4. Obtain at least one sample increment of equal size from each of the top, middle, and bottom thirds of the pile.
5. Combine the increments to form a single sample.

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**Identification and Shipping**

1. Identify sample containers as required by the agency.
2. Ship samples in containers that will prevent loss, contamination, or damage.

38

**Report**

- On forms approved by the agency
- Sample ID
- Date
- Time
- Location
- Quantity represented

39



**REVIEW QUESTIONS**

1. Asphalt mixture sample sizes are based on what?
  
2. What types of containers are used for asphalt mixture samples?
  
3. Describe how samples are obtained from:
  - Attached sampling devices
  
  - Conveyor belt
  
  - Transport units
  
  - Auger
  
  - Windrow
  
  - Roadway
  
  - Stockpile



**PERFORMANCE EXAM CHECKLIST**

**SAMPLING ASPHALT MIXTURES  
FOP FOR AASHTO R 97**

Participant Name \_\_\_\_\_ Exam Date \_\_\_\_\_

**Record the symbols “P” for passing or “F” for failing on each step of the checklist.**

<b>Procedure Element</b>	<b>Trial 1</b>	<b>Trial 2</b>
<b>Attached Sampling Device</b>		
1. Container coated or preheated or both?	_____	_____
2. Sampling device passed through stream twice perpendicular to material?	_____	_____
3. Sampling device not over filled?	_____	_____
<b>Conveyor Belt</b>		
4. Belt stopped?	_____	_____
5. Sampling template set on belt, avoiding intrusion of adjacent material?	_____	_____
6. Sample, including all fines, scooped off?	_____	_____
<b>Transport Units</b>		
7. Unit divided into four quadrants?	_____	_____
8. Increment obtained from each quadrant, 0.3 m (1ft.) below surface?	_____	_____
9. Increments combined to make up the sample?	_____	_____
<b>Paver Auger</b>		
10. Shovel blade flat on the surface to be paved?	_____	_____
11. Shovel lifted vertically after it is filled?	_____	_____
<b>Windrow</b>		
12. Beginning and end avoided?	_____	_____
13. Equal increments obtained from three sections?	_____	_____
14. Approximately 0.3 m (1 ft) removed from top of each section?	_____	_____
15. Underlying material excluded?	_____	_____
<b>Roadway Before Compaction (Method 1)</b>		
16. Plate placed well in front of paver?	_____	_____
17. Wire pulled to locate plate corner?	_____	_____

**OVER**

<b>Procedure Element</b>	<b>Trial 1</b>	<b>Trial 2</b>
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18. Cookie cutter (if used) placed on asphalt and pushed through to plate?	_____	_____
--	-------	-------

19. All material removed from inside the cutter?	_____	_____
--	-------	-------

**Roadway Before Compaction (Method 2)**

20. Cookie cutter placed on asphalt and pushed through to underlying material?	_____	_____
--	-------	-------

21. All material removed from inside the cutter?	_____	_____
--	-------	-------

**Stockpile Method 1– (Loader sampling)**

22. Loader operator directed to enter the stockpile with the bucket at least 0.3 m (1 ft) above ground level without contaminating the stockpile?	_____	_____
---	-------	-------

23. The loader obtained a full loader bucket of the material with the bucket tilted back and up?	_____	_____
--	-------	-------

24. A small sampling pile formed at the base of the stockpile by gently rolling the material out of the bucket with the bucket just high enough to permit free-flow of the material?	_____	_____
--	-------	-------

25. A flat surface created by the loader back dragging the small pile?	_____	_____
--	-------	-------

26. Increment sampled from three locations at least 0.3 m (1 ft) from the edge by fully inserting the shovel into the flat pile as vertically as possible, care taken to exclude the underlying material?	_____	_____
---	-------	-------

**Stockpile Method 2 (Stockpile Face)**

27. Created horizontal surfaces with vertical faces?	_____	_____
--	-------	-------

28. Sample obtained from the horizontal face as close as possible to the vertical face?	_____	_____
---	-------	-------

29. At least one increment taken from each of the top, middle, and bottom thirds of the stockpile?	_____	_____
--	-------	-------

**General**

30. Sample placed in appropriate container?	_____	_____
---	-------	-------

31. Sample size meets agency requirements?	_____	_____
--	-------	-------

32. Sample identified as required?	_____	_____
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**Comments:**      First attempt:    Pass\_\_\_\_\_Fail\_\_\_\_\_      Second attempt:    Pass\_\_\_\_\_Fail\_\_\_\_\_

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**Examiner Signature** \_\_\_\_\_

**WAQTC #:** \_\_\_\_\_

**PERFORMANCE EXAM CHECKLIST (ORAL)**

**SAMPLING ASPHALT MIXTURES  
FOP FOR AASHTO R 97**

Participant Name \_\_\_\_\_ Exam Date \_\_\_\_\_

Record the symbols “P” for passing or “F” for failing on each step of the checklist.

<b>Procedure Element</b>	<b>Trial 1</b>	<b>Trial 2</b>
<b>1. At the hot plant, how must a sample be obtained using an attached sampling device?</b>		
a. Coat or preheat sample container.	_____	_____
b. Sampling device passed through stream twice, once in each direction, perpendicular to material.	_____	_____
c. The sampling device cannot be overfilled.	_____	_____
<b>2. How is a sample obtained from a conveyor belt?</b>		
a. Stop the belt.	_____	_____
b. Set the sampling template on belt, avoiding intrusion of adjacent material.	_____	_____
c. All the material is removed from belt including all fines.	_____	_____
<b>3. What must be done to sample from transport units?</b>		
a. Divide the unit into four quadrants.	_____	_____
b. Obtain increments from each quadrant, 0.3 m (1 ft) below surface.	_____	_____
<b>4. How is a sample obtained from the paver auger?</b>		
a. Shovel blade is placed flat on the surface to be paved in front of the auger extension.	_____	_____
b. Shovel is filled and removed by lifting as vertically as possible.	_____	_____
<b>5. Describe the procedure for sampling from a windrow.</b>		
a. Do not sample from the beginning or end of the windrow.	_____	_____
b. Approximately 0.3 m (1 ft) removed from the top.	_____	_____
c. Underlying material is excluded	_____	_____
d. Equal increments obtained from 3 locations along the windrow.	_____	_____

**OVER**

<b>Procedure Element</b>	<b>Trial 1</b>	<b>Trial 2</b>
--------------------------	----------------	----------------

- |   |       |       |
|---|-------|-------|
| <b>6. Describe how to take samples from the roadway using Method 1 (plate).</b>   |       |       |
| a. Place the plate well in front of the paver.  | _____ | _____ |
| b. Pull the wire to locate the corner of the plate.   | _____ | _____ |
| c. Place the cutter (if used) on the asphalt material above the plate and push it down to the plate.                      | _____ | _____ |
| d. Collect all the material inside the cutter.  | _____ | _____ |
| <b>7. Describe how to take samples from the roadway using Method 2.</b>   |       |       |
| a. Place the cutter on the asphalt material and push it down to the underlying material.                                  | _____ | _____ |
| b. Collect all the material inside the cutter.  | _____ | _____ |
| <b>8. Describe the procedure for sampling a stockpile Method 1 (Loader Sampling).</b>                                     |       |       |
| a. Loader removes surface and creates sampling pile.  | _____ | _____ |
| b. Loader back drags pile to create a flat surface.   | _____ | _____ |
| c. Take three approximately equal increments from at least 0.3 m (1 ft) from the edge, excluding the underlying material. | _____ | _____ |
| <b>9. Describe the procedure for sampling a stockpile Method 2 (Stockpile Face Sampling).</b>                             |       |       |
| a. Create horizontal surfaces with vertical faces with a shovel.  | _____ | _____ |
| b. At least one increment taken from each of the top, middle, and bottom thirds of the stockpile.                         | _____ | _____ |
| <b>10. Increments combined to form a sample of required size?</b>   | _____ | _____ |
| <b>11. What types of containers can be used?</b>  |       |       |
| a. Cardboard boxes, stainless steel bowls, or other agency approved containers.   | _____ | _____ |
| <b>12. What dictates size of sample?</b>  |       |       |
| a. Agency requirements.   | _____ | _____ |
| b. Specified by test method.  | _____ | _____ |

Comments:      First attempt:    Pass\_\_\_\_\_Fail\_\_\_\_\_      Second attempt:    Pass\_\_\_\_\_Fail\_\_\_\_\_

\_\_\_\_\_

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\_\_\_\_\_

**Examiner Signature** \_\_\_\_\_      **WAQTC #:** \_\_\_\_\_

**REDUCING SAMPLES OF ASPHALT MIXTURES TO TESTING SIZE  
FOP FOR AASHTO R 47**



**Mix sample**



**Mechanical Splitter Type A  
(Quartermaster)**

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**Significance**

Samples of asphalt mixtures taken in accordance with the FOP for AASHTO R 97 are composites and typically large in size. Materials sampled in the field need to be reduced to appropriate sizes for testing. It is extremely important that the procedure used to reduce the field sample not modify the material properties.

**Scope**

This procedure covers sample reduction of asphalt mixtures to testing size in accordance with AASHTO R 47-23. The reduced portion is to be representative of the original sample.

**Apparatus**

- Thermostatically controlled oven capable of maintaining a temperature of at least 110°C (230°F) or high enough to heat the material to a pliable condition for splitting.
- Non-contact temperature measuring device.
- Metal spatulas, trowels, metal straightedges, drywall taping knives, or a combination thereof; for removing asphalt mixture samples from the quartering device, cleaning surfaces used for splitting, etc.
- Square-tipped flat-bottom scoop, shovel, or trowel for mixing asphalt mixture before quartering.
- Miscellaneous equipment: hot plate, non-asbestos heat-resistant gloves or mittens, pans, buckets, and cans.
- Sheeting: Non-stick heavy paper or other material as approved by the agency.
- Agency-approved release agent, free of solvent or petroleum-based material that could affect asphalt binder.

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- Mechanical Splitter Type A (Quartermaster): having four equal-width chutes that discharge the material into four appropriately sized sample containers, designed with a receiving hopper to hold the asphalt mixture field sample until a handle releases the material to fall through a divider and distribute it into four equal portions without restriction or the loss of material.

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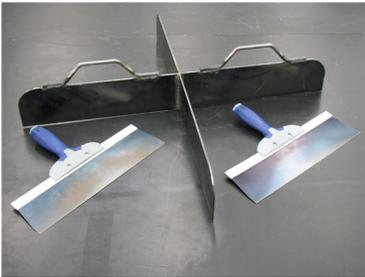
- Mechanical Splitter Type B (Riffle): having a minimum of eight equal-width chutes discharging alternately to each side with a minimum chute width of at least 50 percent larger than the largest particle size. A hopper or straight-edged pan with a width equal to or slightly smaller than the assembly of chutes in the riffle splitter to permit uniform discharge of the asphalt mixture through the chutes without segregation or loss of material. Sample receptacles of sufficient width and capacity to receive the reduced portions of asphalt mixture from the splitter without loss of material.



**Mechanical Splitter Type B (Riffle)**

09

- Quartering Template: formed in the shape of a 90-degree cross with equal sides that exceed the diameter of the flattened cone of material sufficient to allow complete separation of the quartered sample. The height of the sides must be sufficient to extend above the thickness of the flattened cone of the sample to be quartered. Manufactured of metal that will withstand heat and use without deforming. Non-stick mixing surface that is hard, heat-resistant, clean, level, and large enough to permit asphalt mixture samples to be mixed without contamination or loss of material.



**Quartering template and straight edges**

10

**Sampling**

Obtain samples according to the FOP for AASHTO R 97.

**Sample Preparation**

The sample must be warm enough to separate. If not, warm in an oven until it is sufficiently soft to mix and separate easily. Do not exceed either

the temperature or time limits specified in the test method(s) to be performed.

**Selection of Procedure (Method)**

11 Refer to agency requirements when determining the appropriate method(s) of sample reduction. In general, the selection of a particular method to reduce a sample depends on the initial size of the sample vs. the size of the sample needed for the specific test to be performed. It is recommended that, for large amounts of material, the initial  
12 reduction be performed using a mechanical splitter. This decreases the time needed for reduction and minimizes temperature loss. Further reduction of the remaining asphalt mixture may be performed by a combination of the following methods, as approved by the agency.

The methods for reduction are:

- 13 • Mechanical Splitter
  - Type A (Quartermaster) Method
  - Type B (Riffle) Method
- Quartering and Sectoring Methods
  - Quartering
  - Sectoring
- Incremental Method

14 **Procedure**

When heating of the equipment is desired, heat to a temperature not to exceed the maximum mixing temperature of the job mix formula (JMF).

If the reduced sample mass does not fall within the test sample size limits, continue reducing to achieve the correct sample mass. Do not adjust sample mass by adding or removing material after reduction.

**Mechanical Splitter Type A  
(Quartermaster) Method**

- 15 1. Place the splitter on a level surface.
- 2. Clean the splitter and apply a light coating of approved release agent to the surfaces that will contact asphalt mixture.
- 3. Close and secure hopper gates.
- 4. Position the four sample receptacles under the splitter chutes to collect all the material.
- 5. Remove the sample from the agency-approved container(s) and place it in the mechanical splitter hopper. Avoid segregation, loss of asphalt mixture, or addition of foreign material.
- 16 6. Release the handle, allowing the asphalt mixture to drop through the divider chutes and discharge into the four receptacles.
- 7. Remove asphalt mixture retained on the surface of the splitter and place into the appropriate receptacle.
- 8. Close and secure the hopper gates.
- 9. Combine the material contained in the receptacles from opposite corners.
- 17 10. Reduce the remaining asphalt mixture until an appropriate sample size is obtained by this method or a combination of the following methods as approved by the agency.
- 11. Retain and properly identify the remaining unused portion of the asphalt mixture sample for further testing if required by the agency.

**Mechanical Splitter Type B (Riffle)  
Method**

- 18 1. Place the splitter on a level surface.
- 2. Clean the splitter and apply a light coating of agency-approved release agent to the surfaces that will come in contact with the asphalt mixture (hopper or straight-edged pan, chutes, receptacles).
- 3. Place two empty receptacles under the splitter.

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4. Carefully empty the asphalt mixture from the agency-approved container(s) into the hopper or straight-edged pan without loss of material. Uniformly distribute from side to side of the hopper or pan.
5. Discharge the asphalt mixture at a uniform rate, allowing it to flow freely through the chutes.
6. Any asphalt mixture that is retained on the surface of the splitter shall be removed and placed into the appropriate receptacle.
7. Reduce the remaining asphalt mixture as needed by this method or a combination of the following methods as approved by the agency.
8. Using one of the two receptacles containing asphalt mixture, repeat the reduction process until the asphalt mixture contained in one of the two receptacles is the appropriate size for the required test.
9. After each split, remember to clean the splitter hopper and chute surfaces if needed.

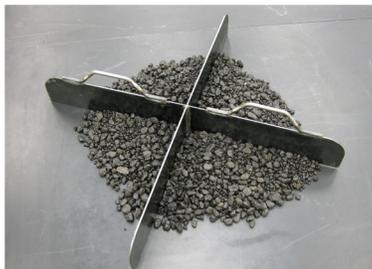
Retain and properly identify the remaining unused asphalt mixture sample for further testing if required by the agency.

**Quartering and Sectoring Methods**

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1. If needed, apply a light coating of agency-approved release agent to quartering template.
2. Place the sample from the agency approved container(s) into a conical pile on a hard, “non-stick,” clean, level surface where there will be neither a loss of material nor the accidental addition of foreign material. The surface can be made non-stick by the application of an agency-approved release agent or sheeting.
3. Mix the material thoroughly by turning the entire sample over a minimum of four times with a flat-bottom scoop; or by alternately lifting each corner of the sheeting and pulling it over the sample diagonally toward

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**Quartering Template  
(In Place)**

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**Quartered sample**

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**Diagonally opposite quarters removed**

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the opposite corner, causing the material to be rolled. Create a conical pile by either depositing each scoop or shovelful of the last turning on top of the preceding one or lifting both opposite corners.

4. Flatten the conical pile to a uniform diameter and thickness where the diameter is four to eight times the thickness. Make a visual observation to ensure that the material is homogeneous.
5. Divide the flattened cone into four equal quarters using the quartering template or straightedges assuring complete separation.
6. Reduce to appropriate sample mass by quartering or sectoring.

**Quartering**

- a. Remove diagonally opposite quarters, including all the fine material, and place in a container to be retained.
- b. Remove the quartering template, if used
- c. Combine the remaining quarters.
- d. If further reduction is necessary, repeat Quartering Method Step 4 through 6.
- e. Repeat steps until appropriate sample mass is obtained. The final sample must consist of the two remaining diagonally opposite quarters.
- f. Retain and properly identify the remaining unused portion of the asphalt mixture sample for further testing if required by the agency.



**Asphalt mixture from the apex of the quarter to the outer edge.**



**Equal portion from the diagonally opposite quarter**



**Mixing the sample**

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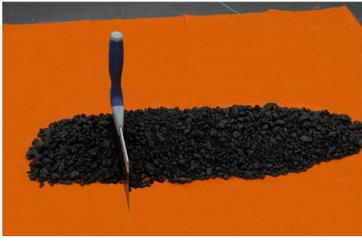
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**Sectoring**

- a. Using a straightedge, obtain a sector by slicing through a quarter of the asphalt mixture from the center point to the outer edge of the quarter.
- b. Pull or drag the sector from the quarter with two straight edges or hold one edge of the straightedge in contact with quartering device.
- c. Remove an approximately equal sector from the diagonally opposite quarter.
- d. If necessary, repeat until the appropriate sample mass has been obtained.
- e. Continue using sectoring with the unused portion of the asphalt mixture until samples have been obtained for all required tests.
- f. Retain and properly identify the remaining unused portion of the asphalt mixture sample for further testing if required by the agency.

**Incremental Method**

- 1. Cover a hard, clean, level surface with sheeting. This surface shall be large enough that there will be neither a loss of material nor the accidental addition of foreign material.
- 2. Place the sample from the agency approved container(s) into a conical pile on that surface.
- 3. Mix the material thoroughly by turning the entire sample over a minimum of four times.
  - a. Use a flat-bottom scoop; or
  - b. Alternately lift each corner of the sheeting and pull it over the sample diagonally toward the opposite corner, causing the material to be rolled.
- 4. Create a conical pile by depositing each scoop or shovelful of the last turning on top



**Slicing off one quarter**

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of the preceding one or lifting both opposite corners of the sheeting.

5. Grasp the sheeting and roll the conical pile into a cylinder (loaf), then flatten the top. Make a visual observation to determine that the material is homogenous.

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6. Remove one quarter of the length of the loaf and place in a container to be saved by either:

- a. Pull sheeting over the edge of the counter and drop into a container.
- b. Use a straightedge at least as wide as the full loaf to slice off material and place into a container.

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7. Obtain an appropriate sample mass for the test to be performed, by either:

- a. Pull sheeting over edge of counter and drop cross sections of the material into container until proper sample mass has been obtained.
- b. Use a straightedge at least as wide as the full loaf to slice off cross sections of the material until proper sample mass has been obtained and place into container.



**Appropriate sample mass dropped into container**

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**Note 1:** When reducing the sample to test size it is advisable to take several small increments, determining the mass each time until the proper minimum size is achieved. Unless the sample size is grossly in excess of the minimum or exceeds the maximum test size, use the sample as reduced for the test.

8. Repeat step 7 until all the samples for testing have been obtained or until the final quarter of the original loaf is reached.

9. Retain and properly identify the remaining unused portion of the asphalt mixture sample for further testing if required by the agency.

**Tips!**

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- Remember, the reduced sample must be representative of the whole.
- Proceed quickly so that splitting is done when the material is hot.
- Check agency requirements about what splitting device(s) or method(s) may be used.
- Inspect mechanical splitter surfaces for build-up of asphalt mixture, ensuring they are cleaned such that the material falls into the appropriate receptacles.
- With full quartering, remember that the final sample consists of the two remaining diagonally opposite quarters.



**REVIEW QUESTIONS**

1. Describe how the material is mixed before quartering.
  
2. Describe how the equipment is heated?
  
3. What is the difference between quartering and sectoring?
  
4. Are any of the reduction methods preferred? When and why?
  
5. Can multiple splitting methods be used in reducing a sample?



**PERFORMANCE EXAM CHECKLIST**

**REDUCING SAMPLES OF ASPHALT MIXTURES TO TESTING SIZE  
FOP FOR AASHTO R 47**

Participant Name \_\_\_\_\_ Exam Date \_\_\_\_\_

Record the symbols “P” for passing or “F” for failing on each step of the checklist.

Procedure Element	Trial 1	Trial 2
1. Sample made soft enough to separate easily without exceeding temperature limits?	_____	_____
2. Splitting apparatus and tools, if preheated, not exceeding maximum mixing temperature from the JMF?	_____	_____
<b>Mechanical Splitter Type A (Quartermaster) Method</b>		
1. Splitter placed on a level surface?	_____	_____
2. Splitter cleaned, and surfaces coated with release agent?	_____	_____
3. Hopper closed and receptacles in place?	_____	_____
4. Sample placed into hopper without segregation or loss of material?	_____	_____
5. Hopper handle released allowing the asphalt mixture to uniformly flow into receptacles?	_____	_____
6. Splitter surfaces cleaned of all retained asphalt mixture, allowing it to fall into appropriate receptacles?	_____	_____
7. Further reduction with the quartermaster:		
a. Material in receptacles from opposite corners combined?	_____	_____
b. Splitting process repeated until appropriate sample mass is obtained?	_____	_____
8. Remaining unused asphalt mixture stored in suitable container and properly labeled?	_____	_____
<b>Mechanical Splitter Type B (Riffle) Method</b>		
1. Splitter placed on a level surface?	_____	_____
2. Splitter cleaned, and surfaces coated with release agent?	_____	_____
3. Two empty receptacles placed under splitter?	_____	_____

**OVER**

<b>Procedure Element</b>	<b>Trial 1</b>	<b>Trial 2</b>
4. Sample placed in hopper or straight edged pan without loss of material and uniformly distributed from side to side?	_____	_____
5. Material discharged across chute assembly at controlled rate allowing free flow of asphalt mixture through chutes?	_____	_____
6. Splitter surfaces cleaned of all retained asphalt mixture allowing it to fall into appropriate receptacles?	_____	_____
7. Further reduction with the riffle splitter:		
a. Material from one receptacle discharged across chute assembly at controlled rate, allowing free flow of asphalt mixture through chutes?	_____	_____
b. Splitting process continued until appropriate sample mass obtained, with splitter surfaces cleaned of all retained asphalt mixture after every split?	_____	_____
8. Remaining unused asphalt mixture stored in suitable container, properly labeled?	_____	_____

**Quartering Method**

Sample placed in a conical pile on a hard, non-stick, heat-resistant splitting surface such as metal or sheeting? \_\_\_\_\_

1. Sample mixed by turning the entire sample over a minimum of 4 times?	_____	_____
2. Conical pile formed and then flattened uniformly to diameter equal to about 4 to 8 times thickness?	_____	_____
3. Sample divided into 4 equal quarters either with a metal quartering template or straightedges such as drywall taping knives?	_____	_____
4. Quartering:		
a. Two diagonally opposite quarters removed and placed in a container to be retained?	_____	_____
b. Two other diagonally opposite quarters combined?	_____	_____
c. Process continued, if necessary, until appropriate sample mass has been achieved?	_____	_____
5. Sectoring:		
a. Using two straightedges or a quartering device and one straightedge, sector obtained from one of the quarters from the center point to the outer edge of the quarter?	_____	_____
b. Equal sector obtained taken from the diagonally opposite quarter?	_____	_____

**OVER**

**Procedure Element**

**Trial 1    Trial 2**

- 6. Increments combined to produce appropriate sample mass? \_\_\_\_\_
- 7. Remaining unused asphalt mixture stored in suitable container, properly labeled? \_\_\_\_\_

**Incremental Method**

- 1. Sample placed on hard, non-stick, heat-resistant splitting surface covered with sheeting? \_\_\_\_\_
- 2. Sample mixed by turning the entire sample over a minimum of 4 times? \_\_\_\_\_
- 3. Conical pile formed? \_\_\_\_\_
- 4. Asphalt mixture rolled into loaf and then flattened? \_\_\_\_\_
- 5. The first quarter of the loaf removed by slicing off or dropping off edge of counter and set aside? \_\_\_\_\_
- 6. Proper sample mass sliced off or dropped off edge of counter into sample container? \_\_\_\_\_
- 7. Process continued until all samples are obtained or final quarter is remaining? \_\_\_\_\_
- 8. All remaining unused asphalt mixture stored in suitable container, properly labeled? \_\_\_\_\_

Comments:      First attempt:    Pass\_\_\_\_\_Fail\_\_\_\_\_      Second attempt:    Pass\_\_\_\_\_Fail\_\_\_\_\_

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**Examiner Signature** \_\_\_\_\_ **WAQTC #:** \_\_\_\_\_



**SAMPLING ASPHALT MATERIALS  
FOP FOR AASHTO R 66**

01

**Significance**

The quality of asphalt materials has a tremendous impact on a roadway project. The grade of binder selected is based on a number of factors, including local temperature extremes and characteristics of expected traffic. Using a grade of binder material other than that specified will have serious impacts on roadway performance and durability.

02

03

**Scope**

The procedure covers obtaining samples of liquid asphalt materials in accordance with AASHTO R 66-16. Sampling of solid and semi-solid asphalt materials – included in AASHTO R 66 – is not covered here.

Agencies may be more specific on exactly who samples, where to sample, and what type of sampling device to use.

**Warning:** Always use appropriate safety equipment and precautions for hot liquids.

04

**Terminology**

- Asphalt binder: Asphalt cement or modified asphalt cement that binds the aggregate particles into a dense mass.
- Asphalt emulsion: A mixture of asphalt binder and water.
- Cutback asphalt: Asphalt binder that has been modified by blending with a chemical solvent.

05

**Containers**

Sample containers must be new, and the inside may not be washed or rinsed. The outside may be wiped with a clean, dry cloth.

All samples shall be put in 1 L (1 qt) containers and properly identified on the outside of the container with contract number, date sampled, data sheet number, brand and grade of material, and sample



**Metal cans**



Wide-mouth plastic jar



Sampling liquid binder



Sampling from the spray bar

**Tips!**

- Remember to identify sample on outside of container.

06

number. Include lot and subplot numbers when appropriate.

07

- Asphalt binder and cutbacks: Use metal cans.
- Emulsified asphalt: Use wide-mouth plastic jars with screw caps. Protect the samples from freezing since water is a part of the emulsion. The sample container should be completely filled to minimize a skin formation on the sample.

*Note:* The filled sample container shall not be submerged in solvent, nor shall it be wiped with a solvent saturated cloth. If cleaning is necessary, use a clean dry cloth.

**Procedure**

08

1. Coordinate sampling with contractor or supplier.
2. Allow a minimum of 4 L (1 gal) to flow before obtaining samples.
3. Obtain samples of:

09

- Asphalt binder from the line between the storage tank and the mixing plant while the plant is in operation, or from the delivery truck.

10

11

- Cutback and emulsified asphalt from distributor spray bar or application device, or from the delivery truck before it is pumped into the distributor: Sample emulsified asphalt at delivery or before dilution.

12

**Report**

13

- On forms approved by the agency
- Sample ID
- Date
- Time
- Location
- Quantity represented

14

**REVIEW QUESTIONS**

1. Describe how liquid asphalt material is obtained at an asphalt mixture plant.
2. Describe how liquid asphalt material is obtained from a spray distributor.
3. Describe the containers used for sampling.



**APPENDIX A  
FIELD OPERATING PROCEDURES – SHORT FORMS**

<b><u>Chapter</u></b>	<b><u>Section</u></b>
8	FOP for AASHTO R 90 Sampling of Aggregates
9	FOP for AASHTO R 76 Reducing Samples of Aggregate to Testing Size
10	AASHTO R 97 Sampling Asphalt Mixtures
11	AASHTO R 47 Reducing Samples of Asphalt Mixtures to Testing Size
12	AASHTO R 66 Sampling Asphalt Materials



## **SAMPLING AGGREGATE PRODUCTS FOP FOR AASHTO R 90**

### **Scope**

This procedure covers sampling of coarse, fine, or a combination of coarse and fine aggregates (CA and FA) in accordance with AASHTO R 90-18. Sampling from conveyor belts, transport units, roadways, and stockpiles is covered.

### **Apparatus**

- Shovels or scoops, or both
- Brooms, brushes, and scraping tools
- Sampling tubes of acceptable dimensions
- Mechanical sampling systems: normally a permanently attached device that allows a sample container to pass perpendicularly through the entire stream of material or diverts the entire stream of material into the container by manual, hydraulic, or pneumatic operation
- Belt template
- Sampling containers

### **Procedure – General**

Sampling is as important as testing. Use every precaution to obtain samples that are representative of the material. Determine the time or location for sampling in a random manner.

1. Wherever samples are taken, obtain multiple increments of approximately equal size.
2. Mix the increments thoroughly to form a field sample that meets or exceeds the minimum mass recommended in Table 1.

**TABLE 1**  
**Recommended Sample Sizes**

<b>Nominal Maximum Size*</b>		<b>Minimum Mass</b>	
<b>mm (in.)</b>		<b>g (lb)</b>	
90	(3 1/2)	175,000	(385)
75	(3)	150,000	(330)
63	(2 1/2)	125,000	(275)
50	(2)	100,000	(220)
37.5	(1 1/2)	75,000	(165)
25.0	(1)	50,000	(110)
19.0	(3/4)	25,000	(55)
12.5	(1/2)	15,000	(35)
9.5	(3/8)	10,000	(25)
4.75	(No. 4)	10,000	(25)
2.36	(No. 8)	10,000	(25)

\* One sieve larger than the first sieve to retain more than 10 percent of the material using an agency specified set of sieves based on cumulative percent retained. Where large gaps in specification sieves exist, intermediate sieve(s) may be inserted to determine nominal maximum size. Maximum size is one size larger than nominal maximum size.

*Note 1:* Sample size is based upon the test(s) required. As a general rule, the field sample size should be such that, when split twice will provide a testing sample of proper size. For example, the sample size may be four times that shown in Table 1 of the FOP for AASHTO T 27/T 11, if that mass is more appropriate.

**Procedure – Specific Situations**

**Conveyor Belts**

Avoid sampling at the beginning or end of the aggregate run due to the potential for segregation. Be careful when sampling in the rain. Make sure to capture fines that may stick to the belt or that the rain tends to wash away.

**Method A (From the Belt)**

1. Stop the belt.
2. Set the sampling template in place on the belt, avoiding intrusion by adjacent material.
3. Remove the material from inside the template, including all fines.
4. Obtain at least three approximately equal increments.
5. Combine the increments and mix thoroughly to form a single sample.

**Method B (From the Belt Discharge)**

The sampling device may be manually, semi-automatic or automatically powered.

1. Pass sampling device through the full stream of the material as it runs off the end of the conveyor belt.
  - Once in each direction
  - Without overfilling
  - Maintaining a constant speed during the sampling process
2. When emptying the sampling device into the container, include all fines.
3. Combine the increments and mix thoroughly to form a single sample.

**Transport Units**

1. Visually divide the unit into four quadrants.
2. Identify one sampling location in each quadrant.
3. Dig down and remove approximately 0.3 m (1 ft.) of material to avoid surface segregation. Obtain each increment from below this level.
4. Combine the increments and mix thoroughly to form a single sample.

**Roadways****Method A (Berm or Windrow)**

1. Obtain sample before spreading.
2. Take the increments from at least three random locations along the fully formed windrow or berm. Do not take the increments from the beginning or the end of the windrow or berm.
3. Obtain full cross-section samples of approximately equal size at each location. Take care to exclude the underlying material.
4. Combine the increments and mix thoroughly to form a single sample.

*Note 2:* Obtaining samples from berms or windrows may yield extra-large samples and may not be the preferred sampling location.

**Method B (In-Place)**

1. Obtain sample after spreading and before compaction.
2. Take the increments from at least three random locations.
3. Obtain full-depth increments of approximately equal size from each location. Take care to exclude the underlying material.
4. Combine the increments and mix thoroughly to form a single sample.

## Stockpiles

### Method A – Loader Sampling

1. Direct the loader operator to enter the stockpile with the bucket at least 150 mm (6 in.) above ground level without contaminating the stockpile.
2. Discard the first bucketful.
3. Have the loader re-enter the stockpile and obtain a full loader bucket of the material, tilt the bucket back and up.
4. Form a small sampling pile at the base of the stockpile by gently rolling the material out of the bucket with the bucket just high enough to permit free flow of the material. (Repeat as necessary.)
5. Create a flat surface by having the loader back drag the small pile.
6. Visually divide the flat surface into four quadrants.
7. Collect an increment from each quadrant by fully inserting the shovel into the flat pile as vertically as possible, take care to exclude the underlying material, roll back the shovel and lift the material slowly out of the pile to avoid material rolling off the shovel.
8. Combine the increments and mix thoroughly to form a single sample.

### Method B – Stockpile Face Sampling

1. Create horizontal surfaces with vertical faces in the top, middle, and bottom third of the stockpile with a shovel or loader.
2. Prevent continued sloughing by shoving a flat board against the vertical face. Sloughed material will be discarded to create the horizontal surface.
3. Obtain sample from the horizontal surface as close to the intersection as possible of the horizontal and vertical faces.
4. Obtain at least one increment of equal size from each of the top, middle, and bottom thirds of the pile.
5. Combine the increments and mix thoroughly to form a single sample.

### Method C – Alternate Tube Method (Fine Aggregate)

1. Remove the outer layer that may have become segregated.
2. Using a sampling tube, obtain one increment of equal size from a minimum of five random locations on the pile.
3. Combine the increments to and mix thoroughly form a single sample.

**Identification and Shipping**

- Identify samples according to agency standards.
- Include sample report (below).
- Ship samples in containers that will prevent loss, contamination, or damage of material.

**Report**

- On forms approved by the agency
- Date
- Time
- Sample ID
- Sampling method
- Location
- Quantity represented
- Material type
- Supplier



## REDUCING SAMPLES OF AGGREGATE TO TESTING SIZE FOP FOR AASHTO R 76

### Scope

This procedure covers the reduction of samples to the appropriate size for testing in accordance with AASHTO R 76-23. Techniques are used that minimize variations in characteristics between test samples and field samples. Method A (Mechanical Splitter) and Method B (Quartering) are covered.

This FOP applies to fine aggregate (FA), coarse aggregate (CA), and combinations of the two (FA / CA) and may also be used on soils.

### Terminology

Saturated Surface-Dry (SSD) – condition of an aggregate particle when the permeable voids are filled with water, but no water is present on exposed surfaces.

*Note 1:* As a quick approximation, if the fine aggregate will retain its shape when molded in the hand, it may be considered wetter than saturated surface-dry.

### Apparatus

#### Method A – Mechanical Splitter

Splitter must allow the sample to flow smoothly without restriction or loss of material.

Splitter chutes:

- Even number of equal width chutes
- Discharge alternately to each side
- Minimum of 8 chutes total for CA and FA / CA, 12 chutes total for FA
- Width:
  - Minimum 50 percent larger than largest particle
  - Maximum chute width of 19 mm (3/4 in.) for fine aggregate passing the 9.5 mm (3/8 in.) sieve
- Feed Control:
  - Hopper or straightedge pan with a width equal to or slightly less than the overall width of the assembly of chutes
  - Capable of feeding the splitter at a controlled rate
- Splitter receptacles / pans:
  - Capable of holding two halves of the sample following splitting

**Method B – Quartering and Sectoring**

- Straightedge scoop, shovel, or trowel
- Broom or brush
- Stick or pipe
- Tarp: A tear resistant rectangular tarp, appropriate for the amount and size of the material being reduced.
- Quartering Template: Formed in the shape of a 90-degree cross with equal length sides that exceed the diameter of the flattened pile of material sufficient to allow complete separation of the quartered sample. The height of the sides must be sufficient to extend above the thickness of the flattened pile of the sample to be quartered.

**Method Selection**

Selecting the method of sample reduction depends on

- The type of material: fine aggregate (FA), coarse aggregate (CA), and combinations of the two (FA / CA)
- The moisture content: drier than saturated surface-dry (SSD), SSD, or wetter than SSD.

*Note 2:* To use Method A on samples of FA and CA/FA that are at SSD or wetter, the entire sample may be dried – using temperatures that do not exceed those specified for any of the tests contemplated – and then reduced.

Select from the following methods based on the material type and moisture condition.

**Method A Mechanical**

- CA
- FA/CA drier than SSD
- FA drier than SSD

**Method B Quartering**

- CA
- FA/CA
- FA at SSD or wetter

**Method B Sectoring**

- FA at SSD or wetter

**Table 1**

	<b>Drier than SSD</b>	<b>SSD or Wetter</b>
Fine Aggregate (FA)	Method A Mechanical	Method B Quartering Method B Sectoring
Mixture of FA/CA	Method A Mechanical Method B Quartering	Method B Quartering
Coarse Aggregate (CA)	Method A Mechanical Method B Quartering	Method A Mechanical Method B Quartering

**Procedure**

**Method A – Mechanical Splitter**

1. Place the splitter on a level surface.
2. Place two clean empty receptacles under the splitter.
3. Empty the sample into the hopper or pan without loss of material.
4. Uniformly distribute the material in the hopper or pan from edge to edge so that approximately equal amounts flow through each chute.
5. Discharge the material at a uniform rate, allowing it to flow freely through the chutes.
6. Remove any material retained on the surface of the splitter and place into the appropriate receptacle.
7. Using one of the two receptacles containing material, repeat Steps 1 through 6 until the material in one of the two receptacles is the appropriate sample size for the required test.
8. Retain and properly identify the remaining unused sample for further testing if required.

**Mechanical Splitter Check**

- Determine the mass of each reduced portion. If the percent difference of the two masses is greater than 5 percent, corrective action must be taken.

**Calculation**

$$\frac{\text{Smaller Mass}}{\text{Larger Mass}} = \text{Ratio} \quad (1 - \text{ratio}) \times 100 = \% \text{ Difference}$$

Splitter check: 5127 g total sample mass

Splitter pan #1: 2583 g

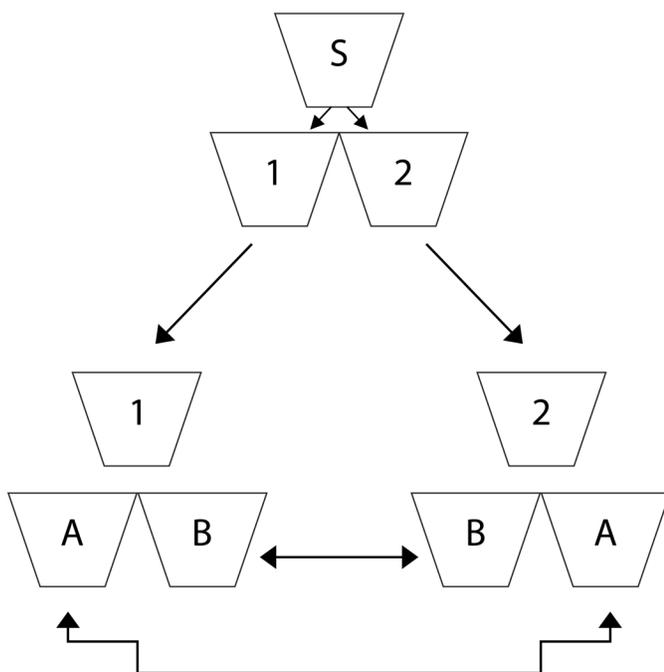
Splitter pan #2: 2544 g

$$\frac{2544 \text{ g}}{2583 \text{ g}} = 0.985 \quad (1 - 0.985) \times 100 = 1.5\%$$

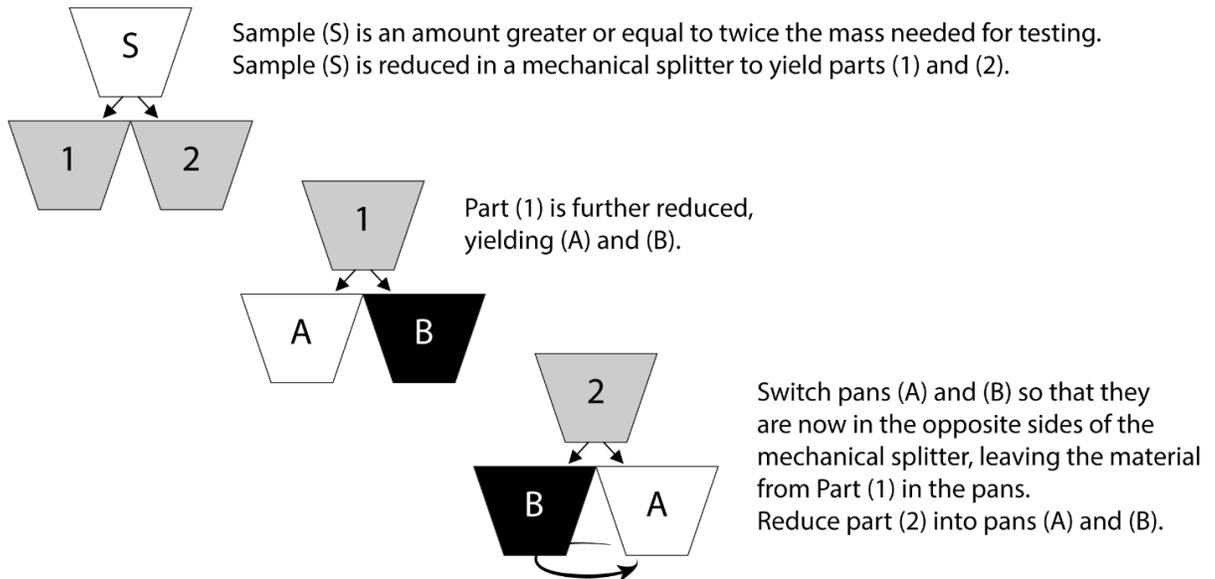
**Alternative to Mechanical Splitter Check**

- In lieu of determining the mass of each reduced portion, use the method illustrated in Figure 1 or 2 during reduction.

**Figure 1**



- Sample (S) is an amount greater than or equal to twice the mass needed for testing. Sample (S) is reduced in a mechanical splitter to yield parts (1) and (2).
- Part (1) is further reduced yielding (A) and (B) while part (2) is reduced to yield (B) and (A).
- Final testing sample is produced by combining alternate pans, i.e. A/A or B/B only.

**Figure 2**

## Method B Quartering and Sectoring

### Method B Quartering

1. Place the sample on a hard, clean, level surface or tarp where there will be neither loss of material nor the accidental addition of foreign material.
2. Mix the material thoroughly a minimum of four times by one of the following:
  - a. Turning the entire sample over with a shovel or scoop.
  - b. Pulling each corner of the tarp horizontally over the sample toward the opposite corner.
3. After the final turn, form a conical pile.
4. Flatten the conical pile to a uniform thickness and diameter by pressing down with a shovel. The diameter should be four to eight times the thickness.
5. Divide the flattened pile into four approximately equal quarters:
  - a. Using a shovel or trowel
  - b. Inserting a stick or pipe beneath the tarp and under the center of the pile, then lift both ends of the stick, dividing the sample into two roughly equal parts. Remove the stick leaving a fold of the tarp between the divided portions. Insert the stick under the center of the pile at right angles to the first division and again lift both ends of the stick, dividing the sample into four roughly equal quarters.

6. Remove two diagonally opposite quarters, including all fine material, and brush the cleared spaces clean.
7. Successively mix and quarter the remaining material until the sample is reduced to the desired size.
8. The final test sample consists of two diagonally opposite quarters.

### **Method B Sectoring**

1. Place the sample on a hard, clean, level surface or tarp where there will be neither loss of material nor the accidental addition of foreign material.
2. Mix the material thoroughly a minimum of four times by one of the following:
  - a. Turning the entire sample over with a shovel or scoop.
  - b. Pulling each corner of the tarp horizontally over the sample toward the opposite corner.
3. After the final turn, form a conical pile.
4. Flatten the conical pile to a uniform thickness and diameter by pressing down with a shovel or scoop. The diameter should be four to eight times the thickness.
5. Divide the flattened pile into four approximately equal quarters using a quartering template, straightedge, shovel, or trowel, assuring complete separation.
6. Using a straightedge, obtain a sector by slicing through a quarter of the material from the center point to the outer edge of the quarter.
7. Pull or drag the sector from the quarter with two straight edges or hold one edge of the straightedge in contact with quartering device.
8. Remove an equal sector from the diagonally opposite quarter and combine to create the appropriate sample mass.
9. Continue obtaining sectors from diagonally opposite quarters until the required sample size has been obtained for all required tests.

## **SAMPLING ASPHALT MIXTURES FOP FOR AASHTO R 97**

### **Scope**

This procedure covers sampling asphalt mixtures from plants, transport units, and roadways in accordance with AASHTO R 97-19. Sampling is as important as testing. Use care to obtain a representative sample. Avoid segregation and contamination of the material during sampling.

*This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.*

### **Apparatus**

- Shovel or Metal Scoops, or Other Equipment: square-head metal shovels at least 125 mm (5.5 in.) wide.
- Sample containers: such as cardboard boxes, metal cans, stainless steel bowls, or other agency-approved containers
- Sampling plate: thick metal plate, minimum 8 gauge, sized to accommodate sample requirements, with a wire attached to one corner long enough to reach from the center of the paver to the outside of the farthest auger extension. A minimum of one hole 6 mm (0.25 in.) in diameter must be provided in a corner of the plate.
- Cookie cutter sampling device: formed steel angle with two 100 mm by 150 mm by 9 mm (4 in. by 6 in. by 3/8 in.) handles, sized to accommodate sample requirements. Minimum 50 mm (2 in.) smaller than the sampling plate when used together.

*Example:* Sampling plate 380 mm (15 in.) square and a cookie cutter sampling device 330 mm (13 in.) square.

- Mechanical sampling device: a permanently attached device that allows a sample receptacle to pass perpendicularly through the entire stream of material or diverts the entire stream of material into the container by manual, hydraulic, or pneumatic operation.
- Agency approved release agent: a non-stick product that prevents the asphalt mixture from sticking to the apparatus and does not contain solvents or petroleum-based products that could affect asphalt binder properties.

### **Sample Size**

Sample size depends on the test methods specified by the agency for acceptance. Check agency requirement for the size required.

## Procedure

### General

- Select sample locations using a random or stratified random sampling procedure, as specified by the agency. The material shall be tested to determine variations. The supplier/contractor shall provide equipment for safe and appropriate sampling, including sampling devices on plants when required.
- Ensure the container(s) and sampling equipment are clean and dry before sampling.
- For dense graded mixture samples use cardboard boxes, stainless steel bowls or other agency-approved containers.
- For hot open graded mixture samples use stainless steel bowls. Cardboard boxes can be used if the sample has cooled to the point that asphalt binder will not migrate from the aggregate.

### Attached Sampling Devices

These are normally permanently attached devices that allow a sample container to pass perpendicularly through the entire stream of material. Operation may be manual, pneumatic, or hydraulic and allow the sample container to pass through the stream twice without overfilling. A sampling device may also divert the entire stream into container.

1. Lightly coat the container attached to the sampling device with an agency-approved release agent or preheat it, or both, to approximately the same discharge temperature of the mix.
2. Pass the container twice, once in each direction, through the material perpendicularly without overfilling the container.
3. Transfer the asphalt mixture to an agency-approved container without loss of material.
4. Repeat until proper sample size has been obtained.
5. Combine the increments to form a single sample.

### Conveyor Belts

1. Avoid sampling at the beginning or end of an asphalt mixture production run due to the potential for segregation.
2. Stop the belt containing asphalt mixture.
3. Set the sampling template into the asphalt mixture on the belt, avoiding intrusion by adjacent material.
4. Remove the asphalt mixture from inside the template, including all fines, and place in a sample container.
5. Repeat, obtaining equal size increments, until proper sample size has been obtained.
6. Combine the increments to form a single sample.

### Transport Units

1. Visually divide the transport unit into approximately four equal quadrants.
2. Identify one sampling location in each quadrant.
3. Dig down and remove approximately 0.3 m (1 ft.) of material to avoid surface segregation. Obtain each increment from below this level.
4. Combine the increments to form a sample of the required size.

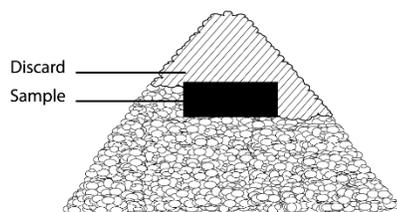
### Paver Auger

1. Obtain samples from the end of the auger using a square head shovel.
2. Place the shovel in front of the auger extension, with the shovel blade flat upon the surface to be paved over.
3. Allow the front face of the auger stream to cover the shovel with asphalt mixture, remove the shovel before the auger reaches it by lifting as vertically as possible.
4. Place asphalt mixture in a sample container.
5. Repeat until proper sample size has been obtained.
6. Combine the increments to form a sample of the required size.

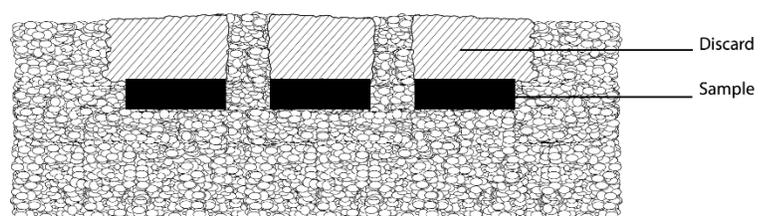
*Note 1:* First full shovel of material may be discarded to preheat and 'butter' the shovel.

### Windrow

1. Obtain samples from the windrow of a transport unit. Avoid the beginning or the end of the windrow section.
2. Visually divide the windrow into three approximately equal sections.
3. Remove approximately 0.3 m (1 ft) from the top of each section.
4. Fully insert the shovel into the flat surface as vertically as possible, exclude the underlying material, roll back the shovel and lift the material slowly out of the windrow to avoid material rolling off the shovel.
5. Place in a sample container.
6. Repeat, obtaining equal size increments, in each of the remaining thirds.
7. Combine the increments to form a sample of the required size.



**Windrow cross section**



**Windrow side view**

### **Roadway before Compaction**

There are two conditions that will be encountered when sampling asphalt mixtures from the roadway before compaction. The two conditions are:

- Laying asphalt mixture on grade or untreated base material requiring Method 1.
- Laying asphalt mixture on existing asphalt or laying a second lift of asphalt mixture allowing Method 2.

### **SAFETY:**

Sampling is performed behind the paving machine, in front of the breakdown roller. For safety, the breakdown roller must remain at least 3 m (10 ft.) behind the sampling operation until the sample has been obtained and the hole filled with loose asphalt mixture.

Method 1 requires a plate to be placed in the roadway in front of the paving operation. There is always concern with moving, operating equipment. It is safest to stop the paving train while a plate is installed in front of the paver. When this is not possible the following safety rules must be followed.

1. The plate placing operation must be at least 3 m (10 ft.) in front of the paver or pickup device. The technician placing the plate must have eye contact and communication with the paving machine operator. If eye contact cannot be maintained at all times, a third person must be present to provide communication between the operator and the technician.
2. No technician is to be between the asphalt supply trucks and the paving machine. The exception to this rule is if the supply truck is moving forward creating a windrow, in which case the technician must be at least 3 m (10 ft.) behind the truck.

If at any time the Engineer feels that the sampling technique is creating an unsafe condition, the operation is to be halted until it is made safe, or the paving operation will be stopped while the plate is being placed.

### **Method 1 - Obtaining a Sample on Grade or Untreated Base (Plate Method)**

1. Following the safety rules detailed above, the technician is to:
  - a. Smooth out a location in front of the paver at least 0.5 m (2 ft.) inside the edge of the mat.
  - b. Lay the plate down diagonally with the direction of travel, keeping it flat and tight to the base with the lead corner facing the paving machine.

*Note 2:* The plate may be secured by driving a nail through the hole in the lead corner of the plate.

2. Pull the wire, attached to the outside corner of the plate, taut past the edge of the asphalt mixture mat and secure it. Let the paving operation pass over the plate and wire.
3. Using the exposed end of the wire, pull the wire up through the fresh asphalt mixture to locate the corner of the plate.

- a. Plate only:
  - i. Using a small square head shovel, scoop, or both, remove the full depth of the asphalt mixture from the plate. Take care to prevent sloughing of adjacent material.
  - ii. Place asphalt mixture, including any material adhering to the plate and scoop or shovel in a sample container.
  - iii. Remove the plate from the roadway. The hole made from the sampling must be filled by the contractor with loose asphalt mixture.
- b. "Cookie Cutter":
  - i. Place the "cookie cutter" sample device, just inside the end of the wire; align the cutter over the plate. Press "cookie cutter" device down through the asphalt mixture to the plate.
  - ii. Using a small square tipped shovel or scoop, or both, carefully remove all the asphalt mixture from inside of the cutter and place in a sample container.
  - iii. Remove the sample cutter and the plate from the roadway. The hole made from the sampling must be filled by the contractor with loose asphalt mixture.

### **Method 2 - Obtaining a Sample on Asphalt Surface (Non-plate Method)**

1. After the paving machine has passed the sampling point, immediately place the "cookie cutter" sampling device on the location to be sampled.
2. Push the cutter down through the asphalt mixture until it is flat against the underlying asphalt mat.
3. Using a small square tipped shovel, scoop, or both, carefully remove all the asphalt mixture from inside of the cutter and place in a sample container.
4. Remove the cutter from the roadway. The hole made from the sampling must be filled by the contractor with loose asphalt mixture.

### **Stockpiles**

Remove at least 0.1 m (4 in.) from the surface before sampling; mixtures in a stockpile may develop an oxidized crust.

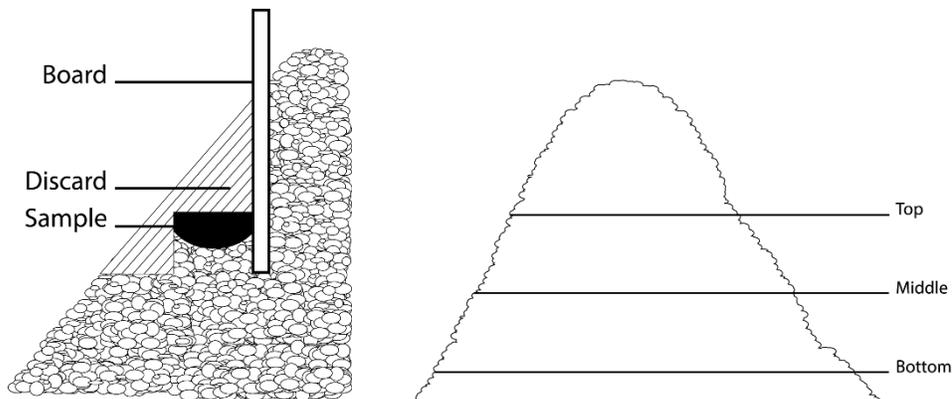
#### **Method 1 – Loader**

1. Direct the loader operator to enter the stockpile with the bucket at least 0.3 m (1 ft) above ground level without contaminating the stockpile.
2. Obtain a full loader bucket of the asphalt mixture; tilt the bucket back and up.
3. Form a small sampling pile at the base of the stockpile by gently rolling the asphalt mixture out of the bucket with the bucket just high enough to permit free flow of the mixture. Repeat as necessary.
4. Create a flat surface by having the loader "back-drag" the small pile.

5. Obtain approximately equal increments from at least three randomly selected locations on the flat surface at least 0.3 m (1 ft) from the edge.
6. Fully insert the shovel, exclude the underlying material, roll back the shovel and lift the asphalt mixture slowly out of the pile to avoid mixture rolling off the shovel.
7. Combine the increments to form a sample.

### Method 2 – Stockpile Face

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



### Identification and Shipping

1. Identify sample containers as required by the agency.
2. Ship samples in containers that will prevent loss, contamination, or damage.

**Report**

- On forms approved by the agency
- Sample ID
- Date
- Time
- Location
- Quantity represented



## REDUCING SAMPLES OF ASPHALT MIXTURES TO TESTING SIZE FOP FOR AASHTO R 47

### Scope

This procedure covers sample reduction of asphalt mixtures to testing size in accordance with AASHTO R 47-23. The reduced portion is to be representative of the original sample.

### Apparatus

- Thermostatically controlled oven capable of maintaining a temperature of at least 110°C (230°F) or high enough to heat the material to a pliable condition for splitting.
- Non-contact temperature measuring device.
- Metal spatulas, trowels, metal straightedges, drywall taping knives, or a combination thereof; for removing asphalt mixture samples from the quartering device, cleaning surfaces used for splitting, etc.
- Square-tipped, flat-bottom scoop, shovel, or trowel for mixing asphalt mixture before quartering.
- Miscellaneous equipment including hot plate, non-asbestos heat-resistant gloves or mittens, pans, buckets, and cans.
- Sheeting: Non-stick heavy paper or other material as approved by the agency.
- Agency-approved release agent, free of solvent or petroleum-based material that could affect asphalt binder.
- Mechanical Splitter Type A (Quartermaster): having four equal-width chutes that discharge the material into four appropriately sized sample containers, designed with a receiving hopper to hold the asphalt mixture field sample until a handle releases the material to fall through a divider and distribute it into four equal portions without restriction or the loss of material.
- Mechanical Splitter Type B (Riffle): having a minimum of eight equal-width chutes discharging alternately to each side with a minimum chute width of at least 50 percent larger than the largest particle size. A hopper or straight-edged pan with a width equal to or slightly smaller than the assembly of chutes in the riffle splitter to permit uniform discharge of the asphalt mixture through the chutes without segregation or loss of material. Sample receptacles of sufficient width and capacity to receive the reduced portions of asphalt mixture from the splitter without loss of material.
- Quartering Template: formed in the shape of a 90-degree cross with equal sides that exceed the diameter of the flattened cone of material sufficient to allow complete separation of the quartered sample. The height of the sides must be sufficient to extend above the thickness of the flattened cone of the sample to be quartered. Manufactured of metal that will withstand heat and use without deforming.

- Non-stick mixing surface that is hard, heat-resistant, clean, level, and large enough to permit asphalt mixture samples to be mixed without contamination or loss of material.

## Sampling

Obtain samples according to the FOP for AASHTO R 97.

## Sample Preparation

The sample must be warm enough to separate. If not, warm in an oven until it is sufficiently soft to mix and separate easily. Do not exceed either the temperature or time limits specified in the test method(s) to be performed.

## Selection of Procedure (Method)

Refer to agency requirements when determining the appropriate method(s) of sample reduction. In general, the selection of a particular method to reduce a sample depends on the initial size of the sample vs. the size of the sample needed for the specific test to be performed. It is recommended that, for large amounts of material, the initial reduction be performed using a mechanical splitter. This decreases the time needed for reduction and minimizes temperature loss. Further reduction of the remaining asphalt mixture may be performed by a combination of the following methods, as approved by the agency.

The methods for reduction are:

- Mechanical Splitter
  - Type A (Quartermaster) Method
  - Type B (Riffle) Method
- Quartering and Sectoring Methods
  - Quartering
  - Sectoring
- Incremental Method

## Procedure

When heating of the equipment is desired, heat to a temperature not to exceed the maximum mixing temperature of the job mix formula (JMF).

If the reduced sample mass does not fall within the test sample size limits, continue reducing to achieve the correct sample mass. Do not adjust sample mass by adding or removing material after reduction.

### Mechanical Splitter Type A (Quartermaster) Method

1. Place the splitter on a level surface.
2. Clean the splitter and apply a light coating of approved release agent to the surfaces that will contact asphalt mixture.
3. Close and secure hopper gates.

4. Position the four sample receptacles under the splitter chutes to collect all the material.
5. Remove the sample from the agency-approved container(s) and place it in the mechanical splitter hopper. Avoid segregation, loss of asphalt mixture, or addition of foreign material.
6. Release the handle, allowing the asphalt mixture to drop through the divider chutes and discharge into the four receptacles.
7. Remove asphalt mixture retained on the surface of the splitter and place into the appropriate receptacle.
8. Close and secure the hopper gates.
9. Combine the material contained in the receptacles from opposite corners.
10. Reduce the remaining asphalt mixture until an appropriate sample size is obtained by this method or a combination of the following methods as approved by the agency.
11. Retain and properly identify the remaining unused portion of the asphalt mixture sample for further testing if required by the agency.

### **Mechanical Splitter Type B (Riffle) Method**

1. Place the splitter on a level surface.
2. Clean the splitter and apply a light coating of agency-approved release agent to the surfaces that will come in contact with asphalt mixture (hopper or straight-edged pan, chutes, receptacles).
3. Place two empty receptacles under the splitter.
4. Carefully empty the asphalt mixture from the agency-approved container(s) into the hopper or straight-edged pan without loss of material. Uniformly distribute from side to side of the hopper or pan.
5. Discharge the asphalt mixture at a uniform rate, allowing it to flow freely through the chutes.
6. Any asphalt mixture that is retained on the surface of the splitter shall be removed and placed into the appropriate receptacle.
7. Reduce the remaining asphalt mixture as needed by this method or a combination of the following methods as approved by the agency.
8. Using one of the two receptacles containing asphalt mixture, repeat the reduction process until the asphalt mixture contained in one of the two receptacles is the appropriate size for the required test.
9. After each split, remember to clean the splitter hopper and chute surfaces if needed.
10. Retain and properly identify the remaining unused asphalt mixture sample for further testing if required by the agency.

## Quartering and Sectoring Methods

1. If needed, apply a light coating of agency-approved release agent to quartering template.
2. Place the sample from the agency approved container(s) into a conical pile on a hard, “non-stick,” clean, level surface where there will be neither a loss of material nor the accidental addition of foreign material. The surface can be made non-stick by the application of an agency-approved release agent, or sheeting.
3. Mix the material thoroughly by turning the entire sample over a minimum of four times with a flat-bottom scoop; or by alternately lifting each corner of the sheeting and pulling it over the sample diagonally toward the opposite corner, causing the material to be rolled. Create a conical pile by either depositing each scoop or shovelful of the last turning on top of the preceding one or lifting both opposite corners.
4. Flatten the conical pile to a uniform diameter and thickness where the diameter is four to eight times the thickness. Make a visual observation to ensure that the material is homogeneous.
5. Divide the flattened cone into four equal quarters using the quartering template or straightedges assuring complete separation.
6. Reduce to appropriate sample mass by quartering or sectoring.

### Quartering

- a. Remove diagonally opposite quarters, including all the fine material, and place in a container to be retained.
- b. Remove the quartering template, if used.
- c. Combine the remaining quarters.
- d. If further reduction is necessary, repeat Quartering Method Steps 3 through 6.
- e. Repeat until appropriate sample mass is obtained. The final sample must consist of the two remaining diagonally opposite quarters.
- f. Retain and properly identify the remaining unused portion of the asphalt mixture sample for further testing if required by the agency.

### Sectoring

- a. Using a straightedge, obtain a sector by slicing through a quarter of the asphalt mixture from the center point to the outer edge of the quarter.
- b. Pull or drag the sector from the quarter with two straight edges or hold one edge of the straightedge in contact with quartering device.
- c. Remove an approximately equal sector from the diagonally opposite quarter and combine.
- d. If necessary, repeat until the appropriate sample mass has been obtained.
- e. Continue sectoring with the unused portion of the asphalt mixture until samples have been obtained for all required tests.

- f. Retain and properly identify the remaining unused portion of the asphalt mixture sample for further testing if required by the agency.

### **Incremental Method**

1. Cover a hard, clean, level surface with sheeting. This surface shall be large enough that there will be neither a loss of material nor the accidental addition of foreign material.
  2. Place the sample from the agency approved container(s) into a conical pile on that surface.
  3. Mix the material thoroughly by turning the entire sample over a minimum of four times:
    - a. Use a flat-bottom scoop; or
    - b. Alternately lift each corner of the sheeting and pull it over the sample diagonally toward the opposite corner, causing the material to be rolled.
  4. Create a conical pile by depositing each scoop or shovelful of the last turning on top of the preceding one or lifting both opposite corners of the sheeting.
  5. Grasp the sheeting and roll the conical pile into a cylinder (loaf), then flatten the top. Make a visual observation to determine that the material is homogenous.
  6. Remove one quarter of the length of the loaf and place in a container to be saved by either:
    - a. Pull sheeting over edge of counter and drop material into container.
    - b. Use a straightedge at least as wide as the full loaf to slice off material and place into container.
  7. Obtain an appropriate sample mass for the test to be performed; by either:
    - a. Pull sheeting over edge of counter and drop cross sections of the material into container until proper sample mass has been obtained.
    - b. Use a straightedge at least as wide as the full loaf to slice off cross sections of the material until proper sample mass has been obtained and place into container.
- Note 1:* When reducing the sample to test size it is advisable to take several small increments, determining the mass each time until the proper minimum size is achieved.
8. Repeat Step 7 until all the samples for testing have been obtained or until the final quarter of the original loaf is reached.
  9. Retain and properly identify the remaining unused portion of the asphalt mixture sample for further testing if required by the agency.



## SAMPLING ASPHALT MATERIALS FOP FOR AASHTO R 66

### Scope

This procedure covers obtaining samples of liquid asphalt materials in accordance with AASHTO R 66-16. Sampling of solid and semi-solid asphalt materials – included in AASHTO R 66 – is not covered here.

Agencies may be more specific on exactly who samples, where to sample, and what type of sampling device to use.

**Warning:** Always use appropriate safety equipment and precautions for hot liquids.

### Terminology

- Asphalt binder: Asphalt cement or modified asphalt cement that binds the aggregate particles into a dense mass.
- Asphalt emulsion: A mixture of asphalt binder and water.
- Cutback asphalt: Asphalt binder that has been modified by blending with a chemical solvent.

### Containers

Sample containers must be new, and the inside may not be washed or rinsed. The outside may be wiped with a clean, dry cloth.

All samples shall be put in 1 L (1 qt) containers and properly identified on the outside of the container with contract number, date sampled, data sheet number, brand and grade of material, and sample number. Include lot and subplot numbers when appropriate.

- Emulsified asphalt: Use wide-mouth plastic jars with screw caps. Protect the samples from freezing since water is a part of the emulsion. The sample container should be completely filled to minimize a skin formation on the sample.
- Asphalt binder and cutbacks: Use metal cans

**Note:** The sample container shall not be submerged in solvent, nor shall it be wiped with a solvent saturated cloth. If cleaning is necessary, use a clean dry cloth.

**Procedure**

1. Coordinate sampling with contractor or supplier.
2. Allow a minimum of 4 L (1 gal) to flow before obtaining samples.
3. Obtain samples of:
  - Asphalt binder from the line between the storage tank and the mixing plant while the plant is in operation, or from the delivery truck.
  - Cutback and emulsified asphalt from distributor spray bar or application device; or from the delivery truck before it is pumped into the distributor. Sample emulsified asphalt at delivery or before dilution.

**Report**

- On standard agency forms
- Sample ID
- Date
- Time
- Location
- Quantity represented