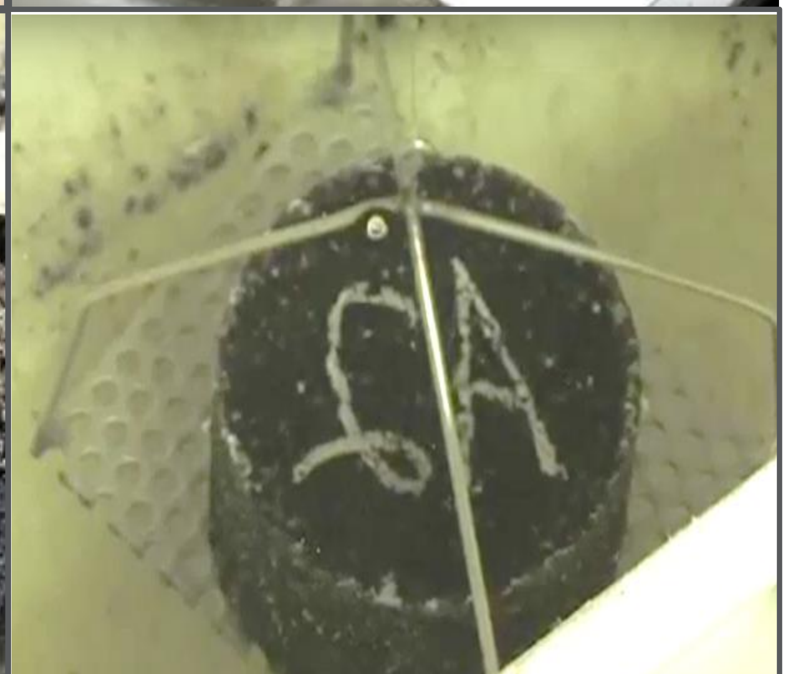
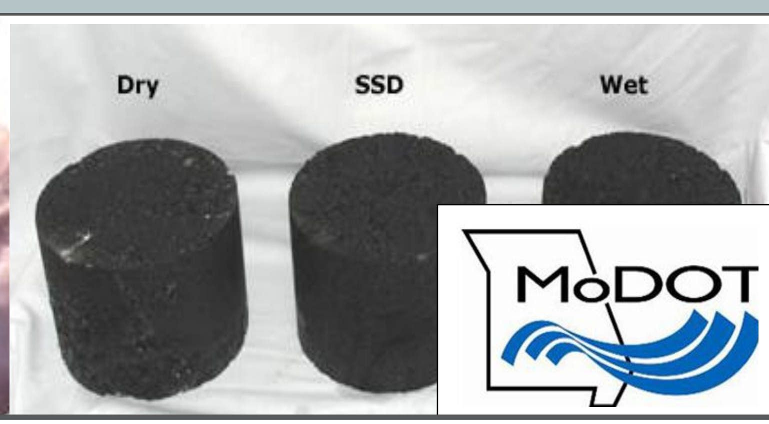
2026 Edition



BITUMINOUS TECHNICIAN



Bituminous Technician Updates

2026: **AASHTO T308:** Binder Ignition removed from Superpave and added to Bituminous Technician

AASHTO T166:

- Updated slides to highlight when to use T331

2025: **AASHTO T166:**

- **Added definitions:** Immersion Thermometer, Mass, Weight.
- **Clarification** of specimen preparations, Moist vs Recently Molded.
- **Added** Thermometer information to the appendix.
  - **Water Bath Thermometer Requirements:**
    - Immersion Thermometer
    - Meets M339M/M339
    - Temp range includes testing temperature.
    - Resolution 0.2°F (0.1°C)
    - Max error of 1°F (0.5°C)
  - **Suitable Thermometers:**
    - Glass thermometer ASTM 17F/17C
    - Thermistor as described in E879.
    - Digital thermometer as described in E2877.
    - Thermocouple thermometer, Type T, Class 1
- **Equipment:** Added Oven, and info to potable water.
- Added information on T331 – Gmb by vacuum sealing.

2024 – No Updates

2023: **AASHTO T166:**

- **Water Bath**: The thermometer for measuring the temperature of the water bath shall meet the requirements of M339M/M339 with a temperature range of at least 20 to 45°C (68 to 113°F) and an accuracy of ±0.25°C (±0.45°F) (see note 2),
  - NOTE 2: Thermometer types to use include:
    - ASTM E1 Mercury Thermometer
    - ASTM E879 thermistor thermometer
    - ASTM E1137/E1137M Pt-100 RTD platinum resistance thermometer, Class A
    - IEC 60751: 2008 Pt-100 RTD platinum resistance thermometer, Class AA

        - **Room Temperature**: Meeting the requirements of M339M/M339 with a temperature range of at least 15 to 45°C (59 to 113°F) and an accuracy of ± 0.5°C (± 0.9 °F) (see note 3),
            - NOTE 3: Thermometer types to use include:
                - ASTM E1 Mercury Thermometer
                - ASTM 2877 digital metal stem thermometer
                - ASTM E230/E230M thermocouple thermometer, Type T, Special Class
                - IEC 60584: thermocouple thermometer, Type T, Class 1
        - **Oven**: The thermometer for measuring the oven temperature shall meet the requirements of M339M/M339 with a range of at least 40 to 60°C (104 to 140°F) and an accuracy of ± 0.75°C (± 1.35°F) (see note 4),
            - NOTE 4: Thermometer types to use include:
                - ASTM E1 Mercury Thermometer
                - ASTM 2877 digital metal stem thermometer
                - ASTM E230/E230M thermocouple thermometer, Type T, Special Class
                - IEC 60584: thermocouple thermometer, Type T, Class 1
- **AASHTO T329:**
    - **Asphalt Mixtures**: The thermometer for measuring the temperature of asphalt mixtures shall meet the requirements of M339M/M339 with a temperature range of at least 50 to 200°C (122 to 392°F) and an accuracy of ±2°C (±3.6°F) (see note 1),
        - NOTE 1: Thermometer types to use include:
            - ASTM E1 Mercury Thermometer
            - ASTM 2877 digital metal stem thermometer
            - ASTM E230/E230M thermocouple thermometer, Type T, Standard Class
            - IEC 60584 thermocouple thermometer, Type T, Class 2
            - Dial gauge metal stem (Bi-metal) thermometer
- **AASHTO TM 54:**
    - The thermometer shall meet the requirements of M339M/M339 with a range of at least 10 to 260°C (50 to 500°F) and an accuracy of ± 0.5°C (± 9°F)
        - NOTE 1: Thermometer types to use include:
            - ASTM E1 Mercury Thermometer
            - ASTM 2877 digital metal stem thermometer
            - ASTM E230/E230M thermocouple thermometer, Type T, Special Class
            - IEC 60584: thermocouple thermometer, Type T, Class 1

2022: AASHTO T166:

- updated temperature (77 ± 1.8 °F) to (77 ± 2 °F)

2021 – NO Updates

COURSE CONTENT

BITUMINOUS TECHNICIAN

MoDOT TM 20	Measurement of Air, Surface or Asphalt Mixture Temperature
AASHTO R 66	Sampling Asphalt Materials
AASHTO R 97	Sampling Asphalt Mixtures
AASHTO R 47	Reducing Samples of Asphalt Mixtures to Testing Size
AASHTO T 329	Moisture Content of Asphalt Mixtures by Oven Method
AASHTO T 166	Bulk Specific Gravity of Compacted Asphalt Materials Using Saturated Surface-Dry Specimens • AASHTO R79 – Vacuum dry • AASHTO T331 - Bulk SpG by Vacuum Sealing
AASHTO T 269	Percent Air Voids in Compacted Dense and Open Asphalt Mixtures
MoDOT TM 54 **AASHTO T287**	Determining the Asphalt Content of an Asphalt Mixture
AASHTO T308	Binder Ignition Oven AC Content

Appendix
Glossary

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Notes if Needed

MoDOT TM 20

Measurement of Air, Surface, or Asphalt Mixture Temperature

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MoDOT TM 20

Measurement of Air, Surface or Asphalt Mixture Temperature

1

Why is Temperature Important?

- The temperature is required of many AASHTO specifications in testing of asphalt materials as well as concrete.
- Temperature is used to provide quality assurance and to prevent early pavement deterioration.

2

2

Equipment Calibration

- Calibrate thermometers **annually**.
- Calibration of a thermometer will establish a **correction factor** to adjust the thermometer reading to the true temperature.
- Information on how MoDOT owned thermometers are verified may be obtained from the District Materials Staff.
- Thermometers can be sent to the manufacturer on a yearly basis to be verified/calibrated.

3

3

National Institute of Standards And Technology

- A record of calibration/verification that is traceable to National Institute of Standards and Technology.
- (NIST) Traceable standards is needed for thermometers.
- Keep a Copy of this record in the Laboratory's Quality Control Manual.

4

Infrared Thermometer

Surface, Asphalt Mixture

Range: 20° F to 400° F

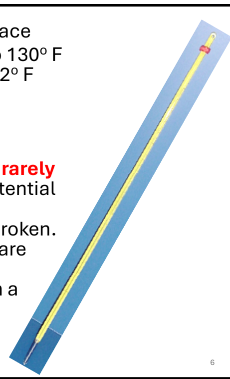
Increment: 2° F

5

Mercury Thermometer

Air and Surface
Range: 20° F to 130° F
Increment: 2° F

Note: Mercury Thermometers are **rarely** used due to the potential of mercury contamination, if broken. Today technicians are using digital type thermometers with a metal probe.



6

Digital Thermometer

Air, Surface, Asphalt Mixture
Range: 0°F to 400°F,
Increment: 1°F
NIST Traceable

7

Max-Min Thermometer

Air, Surface
Range: 20° F to 130° F
Increment: 2° F

8

Spot Check Disc Thermometer

Surface
Range: 32° F to 250° F
Increment: 2° F

9

BI-Therm Dial Thermometer

Asphalt Mixture
Range: 50° F to 400° F
Increment: 5° F

10

10

Armored Thermometer

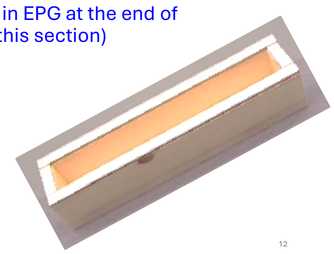
Asphalt Mixture
Range: 50° F to 400° F
Increment: 5° F

11

11

Wooden Box

Surface
See EPG Test Method TM 20 for dimensions.
(included in EPG at the end of this section)



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12

Precautions

- Do not use BI-Therm Dial thermometer (poker) for surface or air temperature.
- Infrared thermometers are for surface or asphalt mixture temperature only.
- Do not check surface temperature of asphalt immediately after roller has passed.
- Always check surface temperatures on a stationary target.

13

13

Procedure Air Temperature

Thermometers

- Mercury
- Digital
- Max – Min

Location

- Shaded Area – Not exposed to direct sunlight.
- Sare Area

Position: 4.5 ft. above the surface

Report to nearest 2°F

14

14

Surface Temperature

Infrared Thermometer

- Follow the manufacturer's recommendations.

Spot Check Disc Thermometer

- Place on surface
- Read when needle stops moving
- Report to nearest 2°F

15

15

Surface Temperature (continued)

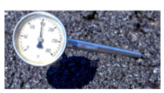
- Max-Min or Mercury Thermometer
  - Place thermometer on surface.
  - Place wooden box over top.
    - Open side covering thermometer.
  - Leave thermometer under box for a minimum of 5 minutes.
  - Lift the box enough to read the temperature
    - Report to the nearest 2°F

16

16

Asphalt Mixture Temperature

- Digital, Armored or BI-Therm Dial Thermometer
  - Place stem in loose asphalt mixture.
  - Do not disturb until reading the stabilized.
  - Read Temperature.
  - Report to nearest 5°F



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17

Asphalt Mixture Temperature (continued)

- Infrared Thermometer
  - Follow manufacturers instructions.
  - Direct reading of asphalt loose mix located in truck, a receiving hopper, or material at the end of paver augers.
  - Read Temperature.
  - Report to nearest 5°F

18

18

Documentation

- Read and record the air, surface or asphalt mixture temperature to the accuracy listed below in bound field book.
  - Air, nearest 2°F
  - Surface, nearest 2°F
  - Asphalt Mixture, nearest 5°F

19

19

Required Audits

- **All testers** on Federal-Aid Projects (MoDOT or Off-System) are required by the FHWA to be audited at least once per year.
- **Reasons:**
  - To ensure proper test procedures are being utilized.
  - To ensure testing equipment is calibrated and operating properly.
- **Types of Audits;** procedure or comparison.
- **Be Proactive;** schedule your audit as early as possible with MoDOT Materials in district offices, do NOT wait until the end of the year.
- **Provide Proof;** when audited, present a MoDOT Certification Card, or a MoDOT Letter.

20

20

For more information and guidance please refer to the Engineering Policy Guide (EPG) 106.3.2.20.

https://epg.modot.org/index.php?title=106.3.2.20_TM-20,_Measurement_of_Air,_Surface_or_Bituminous_Mixture_Temperature

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Notes if Needed

MoDOT TM 20
Measurement of Air, Surface, and Asphalt Mixture Temperature
PROFICIENCY CHECKLIST

Applicant: ____

Employer: ____

Trial #	1	2
Certificates or Report of Verification of Accuracy (Annual calibration) available?		
AIR		
1. Pick correct thermometer		
2. Location - *Mercury, Digital, Max-Min thermometers* - shade, no direct sunlight - position 4.5 feet above surface - safe location		
3. Document to nearest 2° F		

SURFACE		
4. Pick correct thermometer		
5. Procedure - *Spot Check Disc*: place on surface until needle stops moving. - *Infrared*; follow manufacturer recommendations. - *Mercury or Max-Min*; place under wooden box wait 5 minutes. - *Digital* ; follow manufacturer recommendations		
6. Document to nearest 2° F		

ASPHALT MIXTURE		
7. Pick correct thermometer		
8. Procedure - *Infrared*; follow manufacturer recommendations. - *Armored, BI-Therm Dial, or Digital*; place stem into mixture and wait until thermometer reading has stabilized		
9. Document to nearest 5° F		

PASS PASS

FAIL FAIL

Examiner:____Date:______________

AASHTO R 66

Sampling Asphalt Materials

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Notes if Needed

SAMPLING ASPHALT MATERIALS

1

Scope

- This standard applies to sampling asphalt materials at production facilities, storage facilities, or the point of delivery. Samples may be taken from tanks, stockpiles, vehicles, or containers used for the storage or shipping of asphalt materials.

2

Significance & Use

- Sampling is a critical step in determining the quality of the material being sampled. Care shall be exercised to ensure that the sample is representative of the material in the line or vessel being sampled.

3

Definitions

Asphalt Materials: A solid, liquid, or semisolid mixture of heavy hydrocarbons and nonmetallic derivatives; obtained from naturally occurring bituminous deposits or from residues of petroleum refining.

Bituminous Materials: Materials containing bitumen, bitumen is a sticky black liquid or semi-solid form of petroleum.

Note: More definitions are in the back of this manual.

4

Safety First

- When sampling HOT asphalt material, always wear the proper safety attire and follow required safety procedures.
- Always use extreme caution when sampling HOT asphalt material around pipes and valves.
- A supply of clean cool water should be readily available in case of exposure to HOT asphalt materials. If not carry have several ice packs with you in a cooler and have it near you as you sample.

5

Safety Continue

- If HOT Asphalt Material lands on your clothing, remove the article of clothing, unless it adheres to your skin. In that instance, submerse in cool water. (A bucket or cooler with Ice Water is best)
- If it lands on your skin, DO NOT touch it, rub it, or try to remove solidified asphalt binder. Instead, immediately submerse the affected area in cool water or cover with ice packs until you can get help.
- DO NOT try to remove the material from your skin with solvents. (BAD IDEA!)
- SEEK IMMEDIATE MEDICAL ATTENTION!

6

Equipment

- Safety equipment
- Hardhat
- Insulated gloves
- Eye protection
- Long sleeve shirt
- Bucket of water or source of cool water, Ice packs
- Different types of sample containers
- Appropriate dipper or sampling device
- Labeling materials, such as markers, tags, clean dry cloth
- Thermal cooler; if needed

7

Types of Containers

- Containers for liquid asphalt materials, except emulsified asphalt, shall be double-seal friction top cans, cans with screw caps or small-mouth cans with screw caps.
- Containers for emulsified asphalt samples (tack coats) shall be in plastic wide-mouth jars or bottles with screw caps.

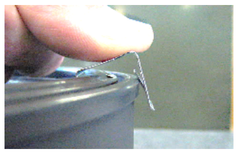
8

Sample Containers

- Must be new
- Clean and dry
- Lid and container shall fit tightly together.
- Shall correspond to the required amount of sample

9

Optional Clips

- Clips can provide additional security in protecting friction type cans from leakage and contamination.

10

Sampling Asphalt Materials

- **Liquid Materials**
  - Sample from – Pipes, Tanks, Drums, or Barrels
    - Types of Liquid Asphaltic Materials
      - Perform Graded (PG) Binders, Emulsions, & Cut-Backs
- **Semisolid Materials**
  - Sampled from – Drums, Barrels, Cartons, or Bags
    - Types of Semisolid Materials
      - Crack Sealers or Asphalt Patch Materials

11

Liquid Materials

- Liquid asphaltic materials can be sampled two ways
  - **Sample Valve** attached to a tank or a line. (This is the preferred method)
  - **Dip Method** from above down into a tank or barrel.

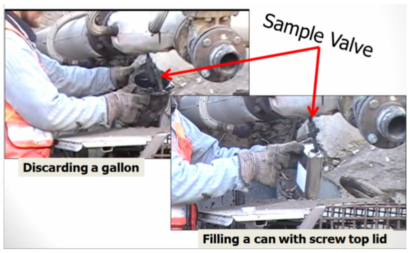
- NOTE: It is recommended that the contractor personnel obtain the sample under the inspector's observation.

12

Sampling Valve on a Storage Tank

13

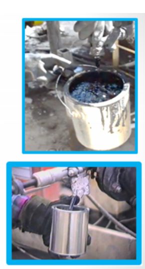
Sample Valve on a Line located down stream of blending or other processing at plant



14

Procedure

1. Wear safety gear and have a water source available.
   a. Everything may be hot.
2. Find a Sample Valve on the tank or line.
3. Discard at least one gallon of the material.
4. Have a new clean dry container ready.
5. Fill the container to within ½" from the top.
6. Immediately put the lid on the container.

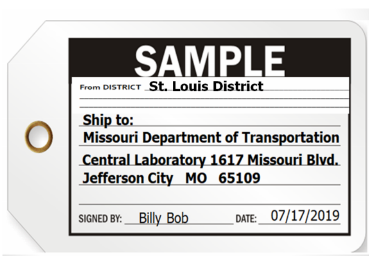


15

Procedure Continued

7. Use a clean dry cloth to wipe the can clean while it is still warm.
8. Write the ID #, Supplier, Grade and Date sampled on the can, not the lid.
9. Place the can into a heavy-duty sealable plastic bag and place into a proper shipping container.
10. ID the shipping container and ship or deliver to the MoDOT Central Lab ASAP.

16



Sample Tag

17

Things to Know about…

- The use of filters or screens in sampling devices or nozzles are not allowed.
- Avoid transferring the sample from one container to another, except where required by the sampling method.
- DO NOT submerge the container in solvent or wipe it down with a solvent-saturated cloth.
- Avoid breathing any fumes, mists, or vapors.
- Do not smoke near asphalt materials.

18

Sampling Liquids by the Dip Method

- Liquid asphalt materials, including the materials liquefied by heating may be taken by the **Dip Method** using a clean wide-mouth plastic jar or friction-top can in a suitable holder.
- A clean container must be used to take each sample, and the materials sampled shall then be transferred to another new and clean container for retaining or testing the sample.

19

Sampling Liquids from Drums/Barrels

- Select barrels or drums at random, thoroughly mix the material in the drum or barrel, use the **Dip Method** to take a quart of material from each barrel or drum selected.
- Combine the quart samples, thoroughly mix and take a gallon from the combined material.

20

Sampling Semisolid Materials

- Drums, Barrels, Cartons, & Bags
  - When the lot of material is from a single run or batch, one container shall be selected at random.
  - When the lot is NOT from a single run or batch, select the number of samples at random indicated in Table 1.

21

Table 1 – Sample Size Selection

Containers in Shipment	Containers to Select
2 to 8	2
9 to 27	3
28 to 64	4
65 to 125	5
126 to 216	6
217 to 343	7
344 to 512	8
513 to 729	9
730 to 1000	10

22

Sampling Materials

- Samples shall be taken from at least 3 inches below the surface and at least 3 inches from the side of the container.
- A clean hatchet may be used if the materials is hard enough to shatter or a stiff putty knife may be used it the material is soft.
- When more than one container is a lot is sampled, each individual sample shall have a mass of ¼ lb. or more.

23

Sampling Materials – Continue

- When the lot of material is from a single run or batch, all samples from the lot shall be melted and thoroughly mixed, and an average of **one-gallon** sample taken from the combined material.
- If more than a single run or batch is included and the batches can be clearly differentiated, a composite one-gallon sample shall be prepared from each batch.
- Where it is not possible to differentiate between the various batches, each sample shall be tested separately.

24

Sampling: Point of Shipment Delivery

- Sampling of asphalt materials shall be completed as soon as practical after the asphalt material has arrived at the site or at the time of unloading.
- Deliver the samples to the MoDOT laboratory as soon as practicable.

25

Examples of Liquid Asphalt Materials

26

PG Binders

- Acts as a binding agent to glue aggregate particles into a cohesive mass called Asphalt Mixture to create pavement. Binders are liquid when hot, when cooled it becomes sticky and hardens into a solid.
  Sample PG Binders while HOT.
- PG stand for – Performance Grade
- Do not use solvent to clean the outside of the cans.
- Do not leave the samples out in the rain.

27

PG Binders Grades

- PG 64-22
- PG 64-22H
- PG 58-28
- PG 70-22
- PG 64-22VH, etc.
  - Note:
    - PG – Performance Grade
    - Heavy Traffic
    - Very Heavy Traffic

28

PG Binders: Containers

- Use sample containers with double-seal friction type lids
  - Gallon Can – For Trial Mixes
  - Quart Can – For Tank Samples
  - Pint Can – For Daily Plant Samples

➢**Double-Seal Friction Lid**

29

PG Binders – Other Information

- Material Inspector will sample or observe sampling of liquid asphalt materials at the source.
- Truck shipments of liquid asphalt materials may be accepted by a copy of the shipping tickets.
- Plant inspectors must ensure that properly certified asphalt is on hand prior to use and obtain daily plant samples during production.

30

Emulsions

- A mixture of asphalt cement, water and emulsifying agent (free flowing liquid at room temperature 34 - 86°F).

31

Emulsion – Grades

- RS-2
- RS-1
- CPEM-1
- SS-1
- HFMS-2H
- EA-90
- EA-150
- CSS-1HM
- SCRUB SEAL
- CMS-2M, etc.

Note: - Tack Coat materials
- MS – Medium Set
- RS – Rapid Set

The number describe the viscosity of the emulsion.

One gallon plastic container with screw top needed.

32

Emulsified Asphalt Samples

- Protect from freezing.
- Do not sample under pressure.
- Limit air in the container by
  - Filling a container with emulsified asphalt until a small amount of space remains, squeeze the container to cause the content to fill to the top then place the cap and tighten it.
- Use plastic gallon container with screw tight lid.
- Used for tack coats, seal coats, surface treatments, and cold mix asphalt. Cost Efficiency

33

Cutback Asphalt

- Manufactured by blending asphalt cement with a petroleum solvent like kerosene. Cutback Asphalt is liquid at room temperature 34 - 86°F.
- Used for Patching.

34

Cutback Asphalt – Grades

- RC-70
- MC-800
- RC-800
- MC-3000
- SC-250 etc.

Note: Need one quart (1L) screw top can placed in a sealed bag in an approved box.

35

MoDOT Sampling Notes

- For truck, refinery, or terminal sampling requirements, see EPG section 1015.
- For daily plant samples of asphalt binder, see EPG section 460.
- Sampling prcedures are further defined, see EPG section 106 and EPG section 400.
- EPG is located on MoDOT website at:
  - https://epg.modot.org/index.php/Main_Page

36

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Notes if Needed

EXAMPLE OF A BILL OF LADING

Jebro Inc.

MOTOR CARRIER BILL OF LADING
ORIGINAL

This shipment shall be governed by (a) the contract between shipper and carrier, if carrier is a contract carrier; or (b) the terms of applicable bill of lading form described in National Motor Freight Classification No. A3 MF-I.C.C. No. 8 issued by F. G. Freund, Agent, supplements thereto or reissues thereof, if carrier is a common carrier, provided that, if this is an intrastate shipment by common carrier in a state where bills of lading have been legally prescribed, this shipment shall be governed by the terms of the applicable bill of lading.

INVOICE TO:
Unassigned Control Record
Unassigned
Sioux City, IA 51111

DESTINATION:
5 miles west off of exit 234 on I29

MILEAGE: 230
DELIVERY TIME: 13:00
DELIVERY DATE: 05/08/98

PROJECT NUMBER: Test BOL Project

CONTRACT NUMBER: 0
PURCHASE ORDER #: 0

CONSIGNEE: Jebro Incorporated
FREIGHT TYPE: Prepaid
TIME IN: 5/8/98 6:00
TIME OUT: 5/8/98 6:30
CARRIER: Jebro Incorporated
UNIT NUMBERS: Jeb524 /Jeb223

Carrier certifies that the cargo tank supplied for this shipment is a proper container for transportation of this commodity as described by this shipper and that proper placards have been applied.

I hereby certify that the maximum legal weight for the vehicle transporting the goods described above is: ____________

DRIVER

CUSTOMER

Arrival Time: ____________
Unloading Began: ____________
Unloading Complete: ____________
Pump Used or Ordered: ____________
Reason For Delay:

CUSTOMER SIGNATURE

PRODUCT INFORMATION
Elevated Temperature Liquid,
n.o.s., 9, UN 3257, PG III
Chemtrec: 1-800-424-9300
Jebro: 1-800-831-8037
PG64-28
SP.G. 1.0290
lb/gal: 8.5701 kg/lit: 1.0269
Temp 329 F 165 C Temp adj 0.90920
EMERGENCY CONTACT: 1-712-277-8855

LOAD WEIGHTS AND QUANTITIES

Gross lbs	79,500	(36,061 kg)
Tare lbs	27,500	(12,474 kg)
Net lbs	52,000	(23,587 kg)
Net Tons	26.00	(23.59 Mg)
Net Gallons @60F	6,068	(22,970 l)

This is to certify that the above named articles are properly described, and are packed and marked and are in proper condition for transportation according to the regulations by the Interstate Commerce Commission.

TEMPERATURE FOR KINEMATIC VISCOSITY OF:

300 Cs =	275
150 Cs =	307
200 Cs =	291
50 Cs =	369

SEAL NUMBERS:

CERTIFICATE OF COMPLIANCE
I certify that the asphalt material shipped on this bill of lading complies with Department of Transportation specifications for the state of Missouri

The transport tank was examined and found suitable for loading.

SHIPPER: JEBRO INC.

SUPPLIER AUTHORIZED REP. & WEIGHER
Need:
This certifies that the weights shown hereon were obtained on MoDOT approved scales and are correct within the specified scale requirements

Terminal: Sioux City, IA
Bill of Lading Number: 0

CUSTOMER COPY

For more information and guidance please refer to the Engineering Policy Guide (EPG) 460.3.12, 106.3.2.2, 460.3.13.

https://epg.modot.org/index.php?title=460.3_Plant_Inspection#460.3.12_Asphalt_Binder

https://epg.modot.org/index.php?title=106.3.2.20_TM-20,_Measurement_of_Air,_Surface_or_Bituminous_Mixture_Temperature

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AASHTO R 66: Sampling Asphalt Materials
PROFICIENCY CHECKLIST

Applicant: ____

Employer: ____

Trial #	1	2

Describe procedure for taking a daily plant asphalt binder sample:		
1. Wear safety clothing, including insulated gloves, long sleeves, bring a marker, and tags.		
2. Obtain a clean dry sample container with lid: 1 pint friction top. Option: Write the sample information on the can before sampling.		
3. Open valve and discard at least 1 gallon of material.		
4. Shut off valve, place can underneath the spout.		
5. Open valve, fill can to within ½" of top.		
6. Shut off valve, wait until material quits flowing.		
7. Remove can and put on lid.		
8. Immediately wipe can with clean cloth, while hot. (do not use solvent to clean)		
9. Identify the sample on the can itself, include the ID Number, Supplier, Grade of the Binder, and Date.		
10. Place the sample in a sealed bag, and a MoDOT shipper if needed, deliver to the lab.		

PASS PASS

FAIL FAIL

Examiner: ____Date:____________

AASHTO R 97

Sampling Asphalt

Mixtures

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Notes if Needed

AASHTO R97

Sampling Asphalt Mixtures

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Scope

This standard covers the procedures for sampling of asphalt mixtures at points of manufacture, storage, delivery, or in place.

Contractors
QC: Quality Control

MoDOT
QA: Quality Assurance

2

Significance & Use

Importance of Proper Sampling

- Sampling is as important as testing
- Use care to obtain samples that are representative of the material
- Avoid segregation and contamination of material during sampling

Sampling Requirements

- Exercise care that samples are obtained according to the appropriate requirements for different locations
- Use R 67 for sampling compacted asphalt mixtures

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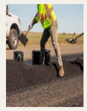
Equipment



- ❑ Sampling Containers
- ❑ Quartering Equipment
- ❑ Labeling Material
- ❑ Mechanical Sampling Systems
- ❑ Shovel, Metal Scoop
- ❑ Belt Template
- ❑ Sampling Plate
- ❑ Cookie Cutter Sampling Device
- ❑ Release Agent

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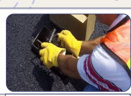
Sampling Procedure Options




1. Roadway Samples
   - Plate with Square Template
   - Square Template
   - Plate & Shovel
2. Stockpile Samples
3. Truck Samples
   - Maybe used for TSR Samples
4. Stream Sampling

*Note: MoDOT does not sample asphalt mixtures from windrows, bin storage, hopper, conveyer belt, or from paver auger.

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Roadway Samples

- ❑ Roadway samples are obtained to determine the properties of the material being placed on the roadway.
- ❑ Roadway samples are the ***only*** choice for pay factor volumetric tests.

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MoDOT Roadway Sampling Procedure

- Sample should be taken in one increment, selected at a random location behind the paver by the inspector.
  - If using a "Cookie Cutter" template, may need to use more than once to acquire enough material for the increment.
- The quantity should be roughly 100 lbs. for QC and 100 lbs. for QA.

* NOTE: This varies from AASHTO R 97 which requires 3 locations be sampled.

7

MoDOT Roadway Sampling Information

- It is acceptable to place a metal sheet on the base or pavement to be paved to reduce chances for contamination by the underlying material
- If the option of a metal plate is used under the template, place the metal plate at the prescribed location prior to paver passing over that location
- Using a template or a square nose shovel, clearly mark out an area to be removed
- Remove all mixture within the area
- Place material into a clean container

****Do Not** contaminate sample with underlying material

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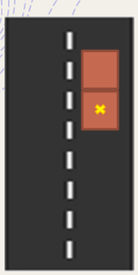
MoDOT Roadway Sampling Location

- When using a template, if you need more material to obtain 200 lbs. in the selected spot, move the template up the road adjacent to the first cut-out for more sample.



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MoDOT Roadway Sampling Template

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MoDOT Roadway Sampling Metal Sheet & Shovel

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MoDOT Roadway Sampling “Square” Template

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Caution! MoDOT Roadway Sampling

- Filling one box (or bucket) at a time may render different characteristics box to box (or bucket to bucket), better to place one shovelful per box at a time

13

Stockpile Samples

- Stockpile samples are collected under special circumstances defined by MoDOT procedures.
- Examples: tensile strength ratio (TSR) testing or other testing requiring a large amount of mix.

14

Stockpile Sampling Procedure

1) Create horizontal surfaces with vertical faces in the top, middle, and bottom third of the stockpile with a shovel or a loader (if available)
2) Shove a flat board against the vertical face behind the sampling location to prevent sloughing of asphalt
3) Obtain the sample from the horizontal surface to the intersection as possible of both faces

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Stockpile Sampling Procedure

4) Gather at least one sample increment of equal size from each of the three sections as shown in Figure 3

5) Combine the sample increments to form a single sample

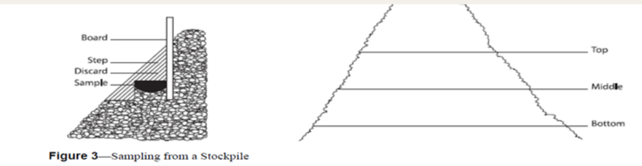

Figure 3—Sampling from a Stockpile

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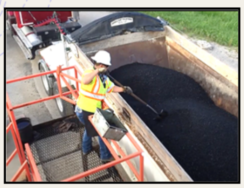
Truck & Plant Sampling



- Make sure there is a safety rail
- Used for loose mix samples
- Commonly used to obtain TSR Samples
- Shovel and sample container
- Hard to get a representative sample (see figure 3)

17

Stream Sampling

- Stream samples are collected under special circumstances defined by MoDOT procedures
- 3 equal increments are to be taken to complete the sample
- An increment is a pass of the sample catcher completely through the stream of the flow at an even speed
- Examples: Tensile Strength Ratio testing and plant control testing requiring a large amount of mix.

18

Stream Sampling

- If the passes of the sample catcher yields the proper amount of material combine the material into a sample container for shipping.
- If it yields more material than necessary for the sample, then reduce the material to the proper size by AASHTO R 47.
- Pass the sample catcher through the full flow of the material with NO Overflow

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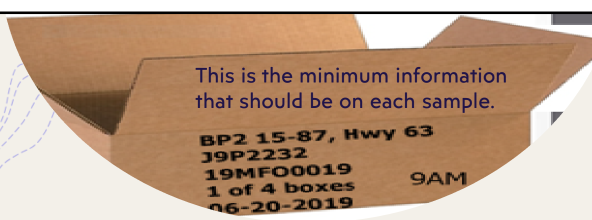

- Material Type
- ID # (AWP #)
- Job Mix Formula (JMF)
- Date
- Time and Sample Location
- Contract ID

21

Additional Sample Information

- Sampled from the 4th truck
- Phone Results
- Possible Contamination
- Needed: AC Content, Gmm, Gmb, etc
- Lot#, Sublot#, Comparison Sample #

22

Sampling Errors

- Segregating the material while sampling.
- Not taking sample in designated location.
- Contaminating sample with underlying material.
- Not getting the amount of field samples from the production to be sufficient to give a representative sample for testing.
- Over filling the sample catcher.
- Inconsistent speed of moving the sample catcher through the flow.

23

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Notes if Needed

For more information and guidance please refer to the Engineering Policy Guide (EPG) 403.1.5.

https://epg.modot.org/index.php?title=Category:403_Asphaltic_Concrete_Pavement#403.1.5_Mixture_Production_Specification_Limits_(Sec_403.5)

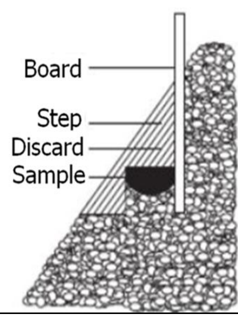
AASHTO R 97
Sampling Asphalt Paving Mixtures
PROFICIENCY CHECKLIST

Applicant: ______________________________________

Employer: ______________________________________

Trial#	1	2
Describe procedure for taking a loose mix sample from:		
Roadway		
1. Obtain proper sample container for the application		
2. Use template or square nose shovel to define sample location		
3. Using a square nose shovel, obtain sample from defined area, including all fines and not disturbing underlying material		
4. Place collected material in non-absorbent, insulated container for transportation to lab		
5. Label the container: Material type, ID No., JMF, date, time, and location		

Stockpiles		
1. Remove 4 inches from the surface of the stockpile		
2. Create a step like below with a board and shovel and take the sample as shown		



3. Obtain at least 1 increment from the top, middle, & bottom		
4. Combine to form a field sample		
5. Label the container: Material type, ID No., JMF, date, time, and location		

Streams		
1. Take 3 approximately equal increments with a sample catcher (Do not overflow the sample catcher)		
2. Combine to form a field sample		
3. Label the container: Material type, ID No., JMF, date, time, and location		

PASS PASS

FAIL FAIL

Examiner: ________________________________ Date: __________________

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AASHTO R 47

Reducing Samples of Asphalt Mixtures
to
Testing Size

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Notes if Needed**

REDUCING SAMPLES OF ASPHALT MIXTURES TO TESTING SIZE

AASHTO R47

SCOPE

This standard practice outlines methods for the reduction of large samples of asphalt mixtures to the appropriate size for testing, employing techniques that are intended to minimize variations in the measured characteristics between test samples.

- Example of tests for these samples: Gyratory, Gmm, Moisture, % AC

SIGNIFICANCE & USE

- Specifications for asphalt mixtures require sampling portions of the total material for testing.
- Larger samples tend to be more representative of the total supply. Which is why this method provides procedures for reducing the large sample obtained from the field.

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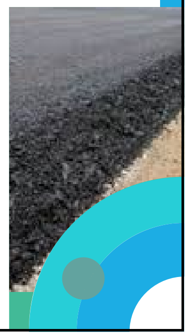
SAMPLING

- Obtain sample of asphalt mixture following R 97 or by the test method requirements
- Ensure that the initial field sample is adequate for all additional test



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EQUIPMENT

- Heat-Resistant Gloves, Safety Glasses, Apron, Long Sleeves
- Scoop, Buckets, Cans, Hot-Plate, Spoon
- MoDOT approved Release Agent
- Mechanical Splitter A or B
- Quartering Template
- Flat-Bottom Scoop
- Large Spatulas, Trowels, Metal Straight Edge
- Nonstick Heavy Paper or Heat-Resistant Plastic

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RELEASING AGENT

- Use Sparingly – avoid contamination of sample.
- Must be approved for use by MoDOT.
- Release agent used shall not contain any solvents or petroleum-based products that could affect asphalt binder properties.

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SELECTION OF METHOD

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- The selection of a particular method to reduce the large sample to test size depends on the amount of material comprising the large sample
- It is recommended that a mechanical splitter be used when possible
- To further reduce the sample size the quartering method can be used
- Minimizing the loss of temperature or loss of material is importing when selecting the method to reduce sample size- Splitter A or B & Accessory may be heated up to 230° F (110°C)

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SELECTION OF METHOD- METHOD OPTIONS

Mechanical Splitter Method	Quartering Method	Incremental Method (not recommended)
• Type A: Quartermaster • Type B: Riffle Splitter	• Quartering Template	• Incremental Loaf • See Appendix for Details

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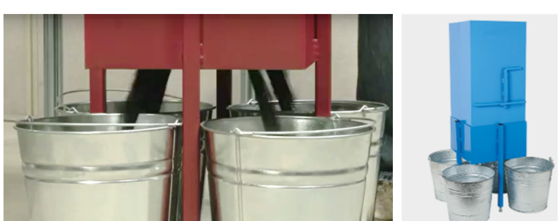

MECHANICAL SPLITTER METHOD TYPE A: QUARTERMASTER

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MECHANICAL SPLITTER METHOD TYPE A: QUARTERMASTER

- Designed for field sample to flow smooth and free through the dividers without restriction or loss of material into 4 equal portions
- Splitter has 4 equal width chutes
- Hopper is released with handle

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QUARTERMASTER SPLITTER PROCEDURE

1. Place Splitter on a level surface, check for cleanliness, lightly coat the surfaces with a releasing agent.
2. Place the receptacles to receive the quartered portions so there is no loss of material
3. Close and secure the hopper door. Fill the hopper with asphalt sample.
   - Ensure the continuous flow or segmented pour from multiple directions
4. Release the handle to drop the mixture through the dividers
5. Reintroduce selected reciprocals from opposite corners into the splitter hopper as many times to get to desired sample size

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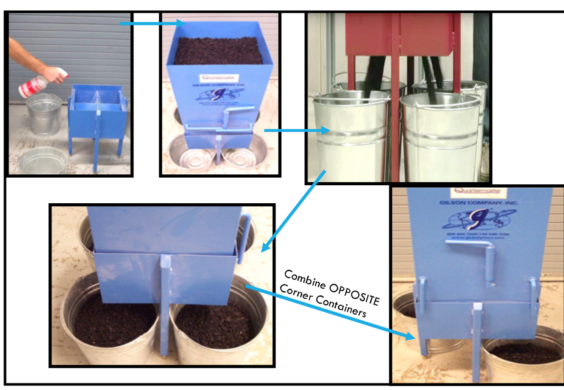

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MECHANICAL SPLITTER METHOD
TYPE B: RIFFLE SPLITTER

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MECHANICAL SPLITTER METHOD
TYPE B: RIFFLE SPLITTER

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- Shall have even number of equal width chutes, which discharge alternately to each side, with no less than a total of eight chutes
- Openings 50% larger than largest particle to be split
- Shall be equipped with 2 receptacles to catch the 2 halves of the sample following the splitting
- Hopper or straight-edged pan that has a width equal to or slightly less than the overall width of the assembly of chutes
- Use for asphalt mixture having a nominal maximum aggregate size not over 1 inch
- The portion of mix collected in the other receptacle may be reserved for another test

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RIFFLE SPLITTER PROCEDURE

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1. Check for cleanliness and coat the surface with an approved releasing agent
2. Place the receptacles under the splitter
3. Place the sample uniformly into the holler from edge to edge- @ a rate to allow for free flow through he chutes into the receptacles
4. Reintroduce the portion of the sample from one of the receptacles into the pan or hopper as many times as need to get to test sample size

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QUARTERING METHOD TEMPLATE

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QUARTERING METHOD: TEMPLATE

- Quartering Template: Manufactured from a suitable metal that withstands heats and without deforming is recommended.
- Template should be configured in the form of a cross with sides of equal length sufficient to be 1.1 times the diameter of a flattened conte of Asphalt Mix to be quartered.
- The height of the sides should be sufficient to extend above the thickness of the flattened cone of the asphalt mix sample.
- The sides shall form a 90° angle at their juncture.

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QUARTERING TEMPLATE PROCEDURE 18

Place the sample on a hard, non-stick, clean, level surface

Mix the sample thoroughly- turn it over 4 times using a FLAT scoop (or non-stick paper/plastic)

Create a conical pile- each scoop full to the top. Flatten the pile into a uniform thickness & diameter by pressing down on the apex (Approximately 4-8 times the thickness)

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QUARTERING TEMPLATE PROCEDURE CONT.

Divide the flattened mass into FOUR quarters using the template. Press the quartering template down until it has complete contact with the surface.

Select and remove two diagonally opposite quarters as "quarter" material

Repeat steps 2- 6 until the desired sample size is obtained.

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- Not keeping equipment adequately clean.
- Using unapproved release agent.
- Not thoroughly cleaning equipment when changing mixes (binder type or source).

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For more information and guidance please refer to the Engineering Policy Guide (EPG) 460.3.14.1.

https://epg.modot.org/index.php?title=460.3_Plant_Inspection#460.3.14.1_Loose_Mix_Sampling

AASHTO R 47

Reducing Samples of Asphalt Mixtures to Testing Size
PROFICIENCY CHECKLIST

Name: ____

Company: ____

Mechanical Splitter Methods Trial #	1	2
Type A Splitter (Quartermaster)		
1. Level, clean, lightly coated with release agent?		
2. Position 4 receptacles to receive the quartered portions, without loss of material?		
3. Hopper doors closed and secured?		
4. Poured sample using a continuous or segmented pour from multiple directions around the hopper?		
5. Released the handle to drop the asphalt mixture through the dividers into the receptacles?		
6. Removed any material retained on surface into the appropriate receptacle?		
7. Samples taken from opposing corners for reintroduction into hopper?		
8. Split as many times as necessary for appropriate test?		

Type B Splitter (Riffle Splitter)		
1. Checked for cleanliness? (Optional: Riffle Splitter can be heated, not exceeding 230°F or 110°C)		
2. All surfaces in contact with the asphalt mixture coated with approved release agent?		
3. Properly placed the receptacles under the splitter		
4. Placed the sample uniformly in the hopper from edge to edge? (Can use a straight edge pan)		
5. Introduced the sample at a rate that allows free flow into sample containers?		
6. Above steps, repeated until sample size obtained?		

Quartering Method		
1. Placed asphalt mixture on a non-stick, clean, and level surface? (Approved asphalt release agent can be used)		
2. Thoroughly mixed the material by turning it over at least 4 times using a flat bottom scoop?		
3. After the last turning, formed conical pile depositing each scoop full on top of the previous one?		
4. Flattened the pile into uniform thickness and diameter by pressing down on the apex? (Diameter should be approximately 4 to 8 times the thickness)		
5 Pressed quartering templates completely down to bottom surface dividing the pile into four quarters?		
6. Removed two opposite quarters, including the fines?		
7. Repeated steps 2 through 6 until desired sample size was attained?		

PASS PASS

FAIL FAIL

Proctor/Auditor Signature: ____ Date: ________________

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AASHTO T 329

Moisture Content of Asphalt Mixtures

by Oven Method

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AASHTO T 329

Moisture Content of Asphalt Mixtures by Oven Method

Rev 09/29/2025

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SCOPE

Scope

- This method is intended for the determination of moisture content of asphalt mixtures by drying in an oven.
- Moisture content is an indicator of potential stripping, leading to poor asphalt coating of the aggregate which produces early failure of the bituminous mix.

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TERMINOLOGY

Terminology

- **Asphalt Mixture**: A mixture of asphalt binder and graded mineral aggregate, mixed at an elevated temperature and compacted to form a relatively dense pavement layer.

(≈ 5% binder and ≈ 95% aggregate)
- **Moisture Content:** The amount of water present in the mixture (effects the qualtity & longevity of the mix.
- **Constant Mass**: The mass at which further drying does not alter the mass by more than 0.05%.

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EQUIPMENT

Equipment

- **Balance or Scale** – 2,000 gram capacity, readable to 0.1 g.
- **Oven** – Forced-Air, Ventilated, or Convection, capable of maintaining 325 ± 25°F (163 ± 14°C)
- **Sample Container** – A clean and dry container of sufficient size to allow sample to be evenly distributed in a manner that allows completion of test quickly.
- **Insulated Gloves**
- **Thermometers** – Readable to nearest 5°F (2°C), armored-glass, dial type, or digital thermometers with metal stems are recommended.

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SAMPLING

Sampling

- A sample of asphalt mixture shall be obtained in accordance with AASHTO R 97.
- See EPG section 460.
- The sample shall be reduced in size in accordance with AASHTO R 47. The size of the test sample shall be a **minimum of 1,000 grams.**

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PROCEDURE

Procedure

1. Determine and record the mass of the sample container to the nearest **0.1 g**.
2. Place the test sample in the container, distributed evenly, take the initial temperature, and record as the Original Temperature.
3. Determine and record the total mass of the sample and container to the nearest **0.1 g.**
4. Calculate the mass of the moist sample by subtracting the container mass from the total mass. **(M_i)**

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Procedure

Dry the test sample at 325 ± 25°F to a constant mass.

- **Constant Mass**: When the change in mass is less than or equal to 0.05%.

5. Dry the sample initially for 90 minutes.
6. After 90 minutes, determine the sample mass, write it down. **(A)**
7. Put the sample back in the oven and dry an additional 30 minutes.
8. After 30 minutes, determine the sample mass, write it down. **(B)**

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Procedure

9. Calculate the PERCENT CHANGE as follows:

$$\% \text{ Change} = \frac{(A - B)}{A} \times 100$$

A = Previous mass determination

B = Newest mass determination

REPORT = To the nearest **0.05%**

Reminder:

First subtract the container weight from the total weight for A and B then record the weights to the nearest **0.1g** before calculating % change.

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Procedure

10. Determine if constant mass was reached.

- If the change in mass was NOT ≤ 0.05% = NOT constant mass, return the sample back to the oven for another 30-minute cycle of drying.
- If the change in mass was ≤ 0.05% = Constant mass; begin cooling the sample to approximately the same temperature as determined prior to drying and proceed to step 11.

≤0.05% = Constant Mass has been reached

STEPS 7 through 10 may need to be repeated several times to reach constant mass.

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REMINDER: Cool the sample container and the test sample to approximately the same temperature as the original temperature.

11. After cooling, weigh the sample and calculate the final mass of the moist sample by subtracting the container mass from the total mass. **(M_f)**

12. Calculate the % Moisture Content of the Asphalt Mixture to the nearest **0.01%**.

Procedure

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MOISTURE CALCULATIONS

$$\text{Moisture Content, \%} = \frac{(M_i - M_f)}{M_f} \times 100$$

Where:

M_i = mass of initial, moist test sample

M_f = mass of the final, dry test sample

Report = % Moisture to the nearest **0.01%**

Moisture Calculations

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NOTE: The following examples are set up for practice and designed like what will be on the written exam.

- However, in a normal laboratory setting you may do several more "30-minute drying cycles" than what is shown in the practice problems.
- Also, in the real world the "30- minute drying cycles" will stop when constant mass is achieved.

Moisture Calculations

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Calculate the percent change using the data below. Circle the weight at which the asphalt sample would be considered at constant mass. Determine the % moisture.

Container mass = 650.0 g

(Remember to subtract the weight of the container from each weight.)

	GRAMS
Initial Weight	1) 2543.2 – 650.0 and so on...
After 90 min	2) 2538.5
+30 min.	3) 2536.1
+30 min.	4) 2535.4

EXAMPLE PROBLEM

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ENLARGED

Pan wt.

M_i 1. Initial: 2543.2 – 650.0 = 1893.2

2. After 90 min: 2538.5 – 650.0 = 1888.5 After 90min, no need to calculate

3. After 30 min: 2536.1 – 650.0 = 1886.1

M_f 4. After 30 min: 2535.4 – 650.0 = 1885.4

$$\% \text{ Change} = \frac{(A - B)}{A} \times 100$$

3. $\frac{(1888.5 - 1886.1)}{1888.5} \times 100 = 0.127 = 0.13\%$ Not ≤ 0.05%

Back to the oven for 30 min.

4. $\frac{(1886.1 - 1885.4)}{1886.1} \times 100 = 0.037 = 0.04\%$ ≤ 0.05% = Constant Mass

At this point, cool back to the original temperature.

% Moisture Calculation:

$$\frac{(M_i - M_f)}{M_f} \times 100 \qquad \frac{(1893.2 - 1885.4)}{1885.4} \times 100 = 0.413 = 0.41\% \text{ Moisture}$$

EXAMPLE PROBLEM

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Classroom Practice on your own,

Calculate the percent change using the data below. Circle the weight at which the sample would be considered at constant mass. Determine the % moisture.

Container mass = 450.5 g

Initial Weight	**1.**	2250.8 g
Weight after 90 min	**2.**	2248.3 g
After 30 min	**3.**	2246.3 g
After another 30 min	**4.**	2245.6 g
After another 30 min	**5.**	2245.2 g

Classroom Practice

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1. Initial: 2250.8 – 450.5 = 1800.3
2. After 90 min: 2248.3 – 450.5 = 1797.8
3. After 30 min: 2246.3 – 450.5 = **1795.8**
4. After 30 min: 2245.6 – 450.5 = 1795.1
5. Not necessary

ENLARGED

3. $\frac{(1797.8 - 1795.8)}{1797.8} \times 100 = \mathbf{0.11\%}$

Back to the oven for 30 min.

4. $\frac{(1795.8 - 1795.1)}{1795.8} \times 100 = \mathbf{0.04\ \%}$

At this point, cool back to the original temperature.

% Moisture Calculation:

$\frac{(1800.3 - 1795.1)}{1795.1} \times 100 =$ **0.29% Moisture**

ANSWER CLASSROOM PRACTICE

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Practice on your own,
Calculate the percent change using the data below.
Circle the weight at which the sample would be considered at constant mass.
Determine the % moisture.

Container mass = 232.6 g

Initial Weight	**1.**	1367.5 g
Weight after 90 min	**2.**	1361.8 g
After 30 min	**3.**	1360.4 g
After another 30 min	**4.**	1359.9 g
After another 30 min	**5.**	1359.6 g
After another 30 min	**6.**	1359.5 g

Practice

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Common Errors

- Not subtracting weight of container from total weight in moisture calculation.
- Not drying until mass is constant.
- Not allowing the sample to cool to original temperature before weighing the final time.

Common Errors

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Notes if Needed

ANSWER TO EXAMPLE PROBLEM

ENLARGED

Pan wt.

M_i	1. Initial:	2543.2 – 650.0 = 1893.2	
	2. After 90 min:	2538.5 – 650.0 = 1888.5	After 90min, no need to calculate
	3. After 30 min:	2536.1 – 650.0 = 1886.1	
M_f	4. After 30 min:	2535.4 – 650.0 = 1885.4	

$$\% \text{ Change} = \frac{(A - B)}{A} \times 100$$

3. $$\frac{(1888.5 - 1886.1)}{1888.5} \times 100 = 0.127 = 0.13\%$$

Not ≤ 0.05%

4. $$\frac{(1886.1 - 1885.4)}{1886.1} \times 100 = 0.037 = 0.04\%$$

≤ 0.05% = Constant Mass

% Moisture Calculation:

$$\frac{(M_i - M_f)}{M_f} \times 100 \quad \frac{(1893.2 - 1885.4)}{1885.4} \times 100 = 0.413 = 0.41\%$$

Moisture

ANSWER TO CLASSROOM PRACTICE PROBLEM

Answer to Classroom Practice

1. Initial: 2250.8 – 450.5 = 1800.3
2. After 90 min: 2248.3 – 450.5 = 1797.8
3. After 30 min: 2246.3 – 450.5 = 1795.8
4. After 30 min: 2245.6 – 450.5 = 1795.1
5. Not necessary

ENLARGED

3. $$\frac{(1797.8 - 1795.8)}{1797.8} \times 100 = 0.11\%$$

4. $$\frac{(1795.8 - 1795.1)}{1795.8} \times 100 = 0.04\ \%$$

% Moisture Calculation:

$$\frac{(1800.3 - 1795.1)}{1795.1} \times 100 = 0.29\%\ \text{Moisture}$$

Moisture Worksheet

-container

Initial Weight **1.** __________ – _________ = _______

Weight after 90 min **2.** __________ – _________ = _______

After 30 min **3.** __________ – _________ = _______

After another 30 min **4.** __________ – _________ = _______

After another 30 min **5**. __________ – _________ = _______

After another 30 min **6**. __________ – _________ = _______

$$\% \text{ Change} = \frac{(A - B)}{A} \times 100$$

Moisture Worksheet

		-container	
Initial Weight	**1.** ________	– ________	= _______
Weight after 90 min	**2.** ________	– ________	= _______
After 30 min	**3.** ________	– ________	= _______
After another 30 min	**4.** ________	– ________	= _______
After another 30 min	**5**. ________	– ________	= _______
After another 30 min	**6**. ________	– ________	= _______

$$\% \text{ Change} = \frac{(A - B)}{A} \times 100$$

For more information and guidance please refer to the Engineering Policy Guide (EPG) 460.3.14.4.

https://epg.modot.org/index.php?title=460.3_Plant_Inspection#460.3.14.4_Moisture_Content

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Notes if Needed

AASHTO T 329: Moisture Content of Asphalt Mixtures by Oven Method
PROFICIENCY CHECKLIST

Applicant___________________________________

Employer___________________________________

Trial#	1	2
Sampling		
Test sample obtained by AASHTO R 97		
Representative sample obtained; 1000 g minimum		

Procedure		
1. Mass of the sample container determined to the nearest 0.1 g		
2. Sample placed into container, distributed evenly, and initial temperature taken and recorded = <u>original temperature</u>		
3. Mass of sample and container determined to nearest 0.1 g		
4. Calculate the mass of the moist sample = **(M_i)**		
5. Sample placed in a drying oven 325 ± 25°F (163 ± 14°C) for 90 ± 5 minutes		
6. After 90 minutes, determined the sample mass = **(A)**		
7. Returned to oven for 30 ± 5 minutes		
8. After 30 minutes, determine the sample mass = **(B)**		

Calculations		
1. Calculate the percent change and determine if the sample is at constant mass $\% \text{ Change} = \frac{(A - B)}{A} X\ 100$		
2. Continued to dry the sample in 30 minute intervals until reached constant mass, when change in mass was ≤ 0.05%		
3. Sample and container cooled to <u>original temperature</u>, then weighed = (**M_f**)		
4. Percent Moisture calculated and reported to the nearest 0.01% $\text{Moisture Content, } \% = \frac{(M_i - M_f)}{M_f} X\ 100$		

`

	PASS	PASS
	FAIL	FAIL

Proctor/Auditor: ______________________________ Date: _____________

AASHTO T 166

Bulk Specific Gravity of Compacted Asphalt Mixtures

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Notes if Needed

BULK SPECIFIC GRAVITY OF COMPACTED ASPHALT MIXTURES USING SURFACE-DRY SPECIMENS

AASHTO T166

1

Scope

- This test method covers the determination of bulk specific gravity (G_{mb}) of specimens of compacted asphalt mixtures.
- The G_{mb} of the compacted asphalt mixture maybe used in calculating the unit mass of the mixture.

2

2

Scope

- This test is to determine density & volume properties; bother are key indicators for how the mix will preform.
- We will only review **METHOD A**

** There are 3 variations of this test method defined in AASHTO:

A. Suspension
B. Use of Volumeter
C. Rapid Test

3

3

THE MOST IMPORTANT QUESTION

Does this sample contain open or interconnecting voids that absorb more then 2% of water by volume?

- ✓ Yes= STOP & Switch to T331
- ✗ No= Continue with this test

4

4

Constant Mass	The mass at which further drying of a specimen does not alter the mass by more then 0.05% when weighted in 2hr intervals
Mass Vs. Weight	Mass is the measure of the amount of matter in the body. Weight is The force acting on mass because of the acceleration of gravity
Gram	Denoted/referred to with a “g”

Terminology

5

5

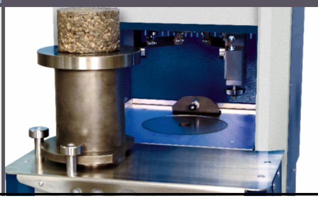
Saturated Surface-Dry	SSD is the condition of a material when it has absorbed. No free water on the surface
Immersion Thermometer	Immersion refers to the length that the thermometer is submerged into a liquid. Liqui-in-glass thermometers are categorized into 2 immersion types; Partial Immersion (76mm) & Total Immersion
Room Temperature	77 ± 9° F (25 ± 5° C)

Terminology

6

6

Test Specimens



- Test specimens maybe either laboratory compacted or cored from the roadway.

7

Test Specimens Care

- Specimens shall be stored in a safe, cool place
- Specimens shall be free from foreign materials such as seal coat, tack coat, foundation material, soil, paper, or foil
- Avoid distortion, bending, or cracking of specimens during & after removal from pavement

8

8

Test Specimens Size

- The diameter of the compacted or cored specimen should be at least or equal to 4 times the max size of the aggregate size
- The thickness of specimens be at least 1.5 times the max size of aggregate

9

9

SPECIMEN PREPARATION

- Before testing, a specimen must be dry & at room temperature 77 ± 9° F (25 ± 5° C)
- **DRY** the specimen to a constant mass, if needed, either by **oven drying** or **vacuum drying.**

10

Sample Preparation- Oven Drying

1. Initially dry the specimen overnight @ 125 ± 5 °F (52± 3°C)
2. Next day weigh in **2-hour** intervals until change in weight is no more than 0.05%.
3. Weigh to nearest **0.1g**

11

11

Sample Preparation-Vacuum Drying

1. Specimen surface temp more then 60°F (15°C)
2. Remove water from the surface with a towel
3. Weigh the specimen
4. Complete @ least TWO cycles in the vacuum drying apparatus
5. Weigh the specimen after each cycle and report to the nearest 0.1g
6. Continue vacuum cycles until the weight change is not more then 0.3g of each other repeat the drying until they do

12

12

Specimens Not Exposed to Moisture

Specimens that have NOT been exposed to moisture, do not require drying.

(i.e. Gyratory Pucks)

13

13

Equipment

- Scale: Sufficient capacity to weigh to the nearest 0.1g
- Suspension Apparatus: Attachable to scare- consisting of a hanger and specimen basket
- Immersion Thermometer: Temperature range includes the test temperature
- Damp Towels
- Timer

14

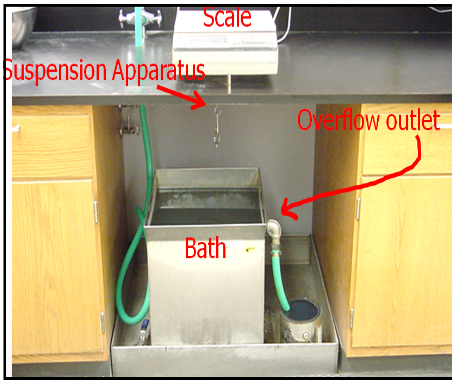
14

Equipment

- Water Container: Large enough to completely immerse the specimen basket with a water flow outlet for maintaining a constant water level; Capable of maintaining the test temp. 77 ± 2°F (25 ± 1°C)
- Potable Water: Must always be clear; Does not need to maintain a potable condition once used
- Oven: Can maintain temperature: 126 ± 5°F (52 ± 3°C).

15

15



Method A

16

16

Equipment - Preparation

- Hang the specimen backet from the scale & shake to remove any clinging air bubbles.
- Make sure the basket is centered in the tank, hanging freely and completely immersed in the water
- Bring water to the proper testing level by adding water to the bath until it comes out of the overflow outlet
- Check the temperature of the water bath, adjust as needed: 77 ± 2°F (25 ± 1°C)

17

17

Procedure: Method A- Suspension

1. Dry the specimen to a constant mass by oven drying at 126 ± 5°F (52 ± 3°C) or vacuum dry AASHTO R79
2. Cool the specimen to room temperature 77 ± 9°F (25 ± 5°C)
3. Tare the scale (with basket attached) then weigh the **specimen in air** to nearest **0.1g**, record as **A** (Dry Mass)
4. Remove specimen from the scale, tare the .scale, then immerse the specimen in 77 ± 2°F (25 ± 1°C) water bath for **4 ± 1** minutes
5. Record the weight of the **specimen in .water** to nearest **0.1g** record as **C**
6. **With in 15 seconds,** remove specimen from the water; damp-dry by **blotting** it with a damp towel; tare the scale; **weigh** the surface-dry specimen (SSD) to the nearest **0.1g** as "**B**"

18

Procedure: Method A Notes

- Rolling the specimen in a damp towel for SSD weight is NOT allowed.
- Any water that seeps from the specimen while weighing is considered part of the saturated specimen weight.
- Each specimen shall be immersed and weighed individually.
- A damp towel, is attained when no water can be wrung from the towel.
- Wring the excess water from the towel between specimens or prepare more than one damp towel in advance.

19

19

Calculations & Reporting

Determine the bulk specific gravity of a compacted specimen by using the following formula:

$$\textbf{Gmb} = \textit{Bulk Specific Gravity} = \frac{A}{(B - C)}$$

where:
A = mass in grams of specimen in air, **0.1 g**
B = mass in grams of the surface-dry specimen (SSD) **0.1 g**
C = mass in grams of the specimen in water, **0.1 g**

20

G_{mb} is reported to the nearest 0.001

20

$$\textit{Bulk Specific Gravity} = \frac{A}{(B - C)}$$

$$\text{Bulk Specific Gravity} = \frac{1940.1}{(1946.8 - 1163.9)} = 2.478$$

Example: Determining the G_{mb}

A:Dry weight in air= 1,940.1g
B:Surface dry weight (SSD)=1,946.8 g
C: Weight in water= 1,163.9 g

21

21

Calculations & Reporting

Determine the % of water absorbed by volume of a compacted specimen by using the following formula:

$$\text{Percent of Water Absorbed}_{\text{by volume}} = \frac{(B - A)}{(B - C)} \times 100$$

where:
A = mass in grams of specimen in air, **0.1 g**
B = mass in grams of the surface-dry specimen (SSD) **0.1 g**
C = mass in grams of the specimen in water, **0.1 g**

** NOTE: If % of water absorbed by specimen exceeds 2.0% this method can not be used.

22

Report Volume reported to the nearest 0.01%

22

$$\text{Percent of Water Absorbed}_{\text{by volume}} = \frac{(B - A)}{(B - C)} \times 100$$

$$\text{Percent of Water Absorbed}_{\text{by volume}} = \frac{(1946.8 - 1940.1)}{(1946.8 - 1163.9)} x100 = 0.86\%$$

0.86% < 2.0% T166 is OKAY to use

Example: % Absorbed by Vol.

A:Dry weight in air= 1,940.1g

B:Surface dry weight (SSD)=1,946.8 g

C: Weight in water= 1,163.9 g

23

23

Classroom Exercise

Enlarged

SPECIMEN #	1	2	3
A: WEIGHT IN AIR	3795.2	3775.0	3778.2
B: SSD WEIGHT	3813.8	3802.0	3795.8
C: WEIGHT IN WATER	2209.0	2193.4	2194.2
% WATER ABSORBED BY VOL.			
Gmb			

24

24

Classroom Exercise Answer

Enlarged

SPECIMEN #	1	2	3
A: WEIGHT IN AIR	3795.2	3775.0	3778.2
B: SSD WEIGHT	3813.8	3802.0	3795.8
C: WEIGHT IN WATER	2209.0	2193.4	2194.2
% WATER ABSORBED BY VOL.	1.16%	1.68%	1.10%
Gmb	2.365	2.347	2.359

25

25

ATTENTION

ATTENTION

Information Only

AASHTO T331

Bulk Specific Gravity (Gmb) and Density of Compacted Asphalt Mixtures Using Automatic Vacuum Sealing Method.

Use this method for samples that contain open or interconnecting voids and/or absorb more than 2.0% of water by volume, as determined of T 166.

See the next few Pages for more information.

26

26

COMMON MISTAKES

- Specimen temperature not 77° ± 9 °F (25° ± 5 °C)
- Water level not maintained
- Going over the 15 second time limit for blotting and weighing the specimen for SSD.
- Not wringing the excess water from the towel between specimens.
- Not maintaining water temperature at 77° ± 2°F (25° ± 1 °C) and/or using dirty water

27

27

Classroom Exercise 1

SPECIMEN #	1	2	3
A. WEIGHT IN AIR	3795.2	3775.0	3778.2
B. SSD WEIGHT	3813.8	3802.0	3795.8
C. WEIGHT IN WATER	2209.0	2193.4	2194.2
% WATER ABSORBED BY VOL.			
Gmb			

24

REVISED INFORMATIONAL

AASHTO T331
BULK SPECIFIC GRAVITY (G_{mb}) AND DENSITY OF COMPACTED ASPHALT MIXTURES USING AUTOMATIC VACUUM SEALING METHOD

SCOPE

This method covers the determination of bulk specific gravity (G_{mb}) of compacted asphalt mixture specimens in accordance with AASHTO T 331-22.

OVERVIEW

This method is used when specimens have open or interconnecting voids or absorb more than 2.0 percent of water by volume, or both, according to AASHTO T 166.

Bulk specific gravity (G_{mb}) determined by this method may be lower, and air voids higher, than the results determined according to AASHTO T 166. The differences may be more pronounced for coarse and absorptive mixtures. This procedure should be followed during laboratory mix designing if it will be used for control or assurance testing.

TEST SPECIMENS

Test specimens may be either laboratory-molded or sampled from asphalt mixture pavement. For specimens it is recommended that the diameter be equal to four times the maximum size of the aggregate and the thickness be at least one and one half times the maximum size of the aggregate.

APPARATUS

- Bag cutter: knife or scissors
- Balance or scale: 5 kg capacity, readable to 0.1 g, and fitted with a suitable suspension apparatus and holder to permit weighing the specimen while suspended in water, conforming to AASHTO M 231.
- Suspension apparatus: Wire of the smallest practical size and constructed to permit the container to be fully immersed.
- Water bath: For immersing the specimen in water while suspended under the balance or scale and equipped with an overflow outlet for maintaining a constant water level. Thermometer for measuring the temperature of the water bath shall have a temperature range of at least 25±1°C and an accuracy of ±0.25°C (±0.45°F)
- Oven: Capable of maintaining a temperature of 52 ±3°C (126 ±5°F) for drying the specimens to a constant mass.
- Thermometer for measuring the room temperature: Accurate to ±0.1°C (±0.2°F) and with a temperature range of at least 15 to 45°C (59 to 113°F)

- Plastic bags: puncture resistant impermeable plastic bags that will not stick to the specimen and capable of withstanding temperatures up to 70°C (158°F). Between 0.102 mm (0.004 in.) and 0.178 mm (0.007 in.) thick. The bag correction factor (apparent specific gravity) is supplied by the manufacturer.
  - Small bag: less than 35 g with an opening between 235 mm (9.25 in.) and 267 mm (10.50 in.)
  - Large bag: 35 g or more with an opening between 368 mm (14.50 in.) and 394 mm (15.5 in.)

Note 1: The bag correction factor is usually located in the operator's manual. See the manufacturer's recommendations to ensure proper handling of bags.

- Specimen sliding plates: removable level and smooth-sided planar filler plates shall be inserted into the chamber to keep the samples of various heights level with the seal bar while being sealed.
- Specimen support plate: a plate with a cushioning membrane on top large enough to fully support the specimen and can easily slide on top of the smooth-sided plates.
- Vacuum chamber and sealing device: meeting the requirements of AASHTO T 331
- Vacuum gauge: meeting the requirements of AASHTO T 331

PROCEDURE

Recently molded laboratory samples that have not been exposed to moisture do not need drying.

1. Dry the specimen to constant mass, if required.
   a. Oven method
      i. Initially dry overnight at 52 ±3°C (125 ±5°F).
      ii. Determine and record the mass of the specimen. Designate as M_p.
      iii. Return the specimen to the oven for at least 2 hours.
      iv. Determine and record the mass of the specimen. Designate as M_n.
      v. Determine percent change by subtracting the new mass determination, M_n, from the previous mass determination, M_p, divide by the previous mass determination, M_p, and multiply by 100.
      vi. Continue drying until there is no more than 0.05 percent change in specimen mass after 2-hour drying intervals (constant mass).
      vii. Constant mass has been achieved; sample is defined as dry.
   b. Vacuum dry method according AASHTO R 79.

2. Cool the specimen in air to 25 ±5°C (77 ±9°F), and determine and record the dry mass to the nearest 0.1 g. Designate this mass as A.

Note 1: 3000 to 6000 g laboratory compacted specimens may be considered room temperature after 2 hr. under a fan. Cooling time may be reduced for smaller specimens.

3. Fill the water bath to overflow level with water at 25 ±1°C (77 ±1.8°F) and allow the water to stabilize.
4. Seal the specimen:
   a. Use a large bag for 150 mm (6 in.) in by 75 mm (3 in.) or greater specimens. Use a small bag for smaller specimens.
   b. Set the heat-sealing bar temperature according to manufacturer's directions.
   c. Inspect the bag for holes and irregularities.
   d. Determine and record the mass of the bag. Designate as B.
   e. Adjust filler plates in the vacuum chamber, adding or removing plates as needed.
   f. Place specimen support plate on top of filler plates.
   g. Place the bag on top of the specimen support plate in the vacuum chamber.
   h. Insert the specimen into the bag with the smoothest plane of the specimen on the bottom.

   Note 2: Inserting the specimen into the bag may be done inside the chamber while holding the bag open with one hand over the sliding plate and gently inserting the specimen with the other hand. There should be about 25 mm (1 in.) of slack between the presealed bag end and the specimen.

   i. Grab the unsealed end of the bag on each side.
   j. Gently pull and center the bag over the seal bar, overlapping at least 25 mm (1 in.). Ensure that there are no wrinkles in the bag along the seal bar before closing the lid.
   k. Close the lid and engage the lid-retaining latch.

   Note 3: The vacuum pump light will illuminate "red," and the vacuum gauge on the exterior of the chamber will become active, or a digital reading will show the vacuum state. It is normal for the bag to expand or "puff up" during this process.

   l. Once sealed, the 'de-vac' valve will open, and air will enter the chamber, causing atmospheric pressure to collapse the bag around the specimen.
   m. Disengage the lid-retaining latch, and carefully remove the sealed specimen from the chamber. Gently pull on the bag where it appears loose. Loose areas indicate a poor seal, and the process must then be restarted at Step 4 with a new bag and a new initial mass.
5. Zero or tare the balance with the immersion apparatus attached, ensuring that the device is not touching the sides or the bottom of the water bath.
6. Fully submerge the specimen and bag shaking to remove the air bubbles. Ensure no air is trapped under the bag or in the bag creases. Place the specimen on its side in the suspension apparatus.
7. Allow water level and scale to stabilize.

8. Determine and record the submerged weight to the nearest 0.1 g. Designate this submerged weight as E.

   Note 4: Complete Steps 4 through 7 in 1 min. or less to reduce potential for bag leaks.

9. Cut the bag open.
10. Remove the specimen from the bag.
11. Determine the mass of the specimen. Designate as C.
12. Compare this mass, C, with initial dry mass determined in Step 2, A.

    If more than 0.08 percent is lost or more than 0.04 percent is gained, return to Step 1.
13. Calculate G_{mb} and record to three decimal places.

Calculations

$$G_{mb} = \frac{A}{(C + (B - A) - E - \left[\frac{(B - A)}{F}\right]}$$

Report to nearest 0.001

Where:

G_{mb} = specimen bulk specific gravity;
A = initial mass of the dried specimen in air, g;
B = calculated mass of the dry, sealed specimen, g;
C = final mass of the specimen after removal from the sealed bag, g;
E = mass of the sealed specimen underwater, g; and
F = apparent specific gravity of the plastic sealing material at 77°F, provided by the Manufacture.

REPORT

- Results on forms approved by the agency.
- Sample ID
- G_{mb} to the nearest 0.001

For more information and guidance please refer to the Engineering Policy Guide (EPG) 460.3.16.

https://epg.modot.org/index.php?title=460.3_Plant_Inspection#460.3.16_Density

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AASHTO T 166

Bulk Specific Gravity of Compacted Asphalt Mixtures Using Saturated Surface Dry Specimens

PROFICIENCY CHECKLIST

Name: ______________________________ Company: ______________________________

SAMPLE PREPARATION Trial	1	2
1. Core samples taken from asphalt pavements. Note: Cores are to be oven dried overnight at 125 ± 5ºF (52±3ºC) and at successive 2 hr. intervals to constant mass or vacuum dried R79 to constant mass.		
2. Laboratory-compacted specimens. Note: Recently compacted samples not exposed to moisture do not require drying.		
3. Does this sample contain open or interconnecting voids that absorb more than 2%? YES=Switch to ASSHTO T331 NO=Continue with AASTHO T166		

PROCEDURE METHOD A - Suspension		
1. Specimens dry and at room temperature?		
2. Tared the scale to zero with immersed basket attached?		
3. Mass of dry sample in air determined?		
a. Reported weight to **0.1g**		
4. Immersed mass of sample determined?		
a. Immersed 4 ±1 min.?		
b. Water is at 77 ± 2°F? (25 ± 1°C)		
c. Reported weight to **0.1g**		
5. Saturated surface dry mass determined?		
a. Removed specimen from water?		
b. Quickly blotted specimen with a damp towel within 15 seconds? Note: Damp is when no water can be wrung from wet towel.		
c. Reported weight to **0.1g?**		

CALCULATONS AND REPORTING:		
Calculate Bulk Specific Gravity (Gmb) and report the result to the nearest **0.001g** $\frac{\text{Weight in Air (A)}}{\text{Weight Surface Dry (B) - Weight in Water (C)}}$		
Calculate Percent of Water Absorbed by Volume and report to nearest **0.01%**. **(Test T166 not valid if over 2.0% must redo testing using T331 Vacuum Seal Method.)** $\frac{\text{Weight Suface Dry} - \text{Weight in Air}}{\text{Weight Surface Dry} - \text{Weight in Water}} x100$		

PASS PASS

FAIL FAIL

Proctor/Auditor Signature: ______________________________ Date: ______________

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Notes if Needed

AASHTO T 269

Percent Air Voids in

Compacted Dense and

Open Asphalt Paving Mixtures

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Notes if Needed

% Air Voids in Compacted Dense & Open Asphalt Mixtures

AASHTO T269

1

Scope

- This method covers the determination of % air voids (V_a) in compacted dense and open asphalt mixtures.
- The (V_a) in an asphalt mix is used as one of the criteria in the design methods and evaluation of the compaction achieved on asphalt paving projects.

2

Air Voids (V_a)
- Internal Spaces in a compacted mix surrounded by asphalt-coated particles, expressed as a percentage by volume of the total compacted mix.

Asphalt Mixture
- Aggregate + Binder + Air Voids

Dense Asphalt Mixture
- Asphalt paving mixture which the (V_a) < 10% when compacted

Density
- Field maximum specific gravity

Terminology

3

Terminology

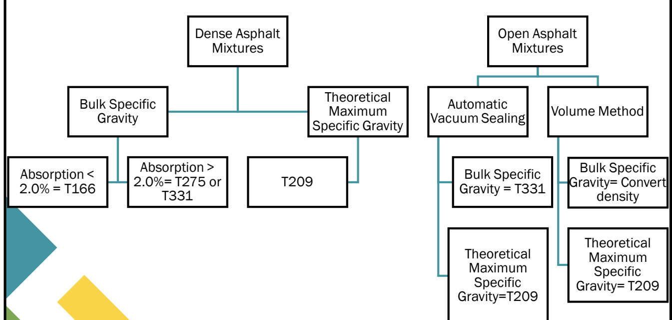
Bulk Specific Gravity
- G_{mb}, Laboratory molded specimen
- AASHTO T166

Gravity Mixture Core
- G_{mc}, Cored Specimen
- AASHTO T166

Maximum Gravity Mixture
- AKA Rice
- G_{mm}, has 0 air voids

Theoretical Maximum Specific Gravity
- G_{mm}, specific gravity excluding air voids
- AASHTO T209

4



5

Procedure – Step One

<u>For Dense Bituminous Paving Mixtures</u>:
(Air Voids (V_a) < 10% when Compacted)

Determine the bulk specific gravity ($\boldsymbol{G_{mb}}$) of the compacted mixture by using either:

- AASHTO T166
(Bulk Specific Gravity, Suspension in Water)
or
- AASHTO T331
(Bulk Specific gravity, Vacuum Sealing)

6

Procedure – Step Two

Determine the theoretical specific gravity (G_{mm}) of the compacted mixture by using either:

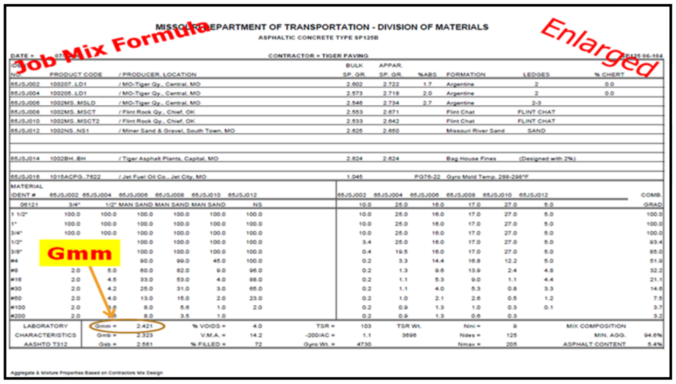
- AASHTO T209 (Rice Test)

or

- JMF "Job Mix Formula"

(G_{mm} can be found on the JMF sheet)

7



MISSOURI DEPARTMENT OF TRANSPORTATION - DIVISION OF MATERIALS
ASPHALTIC CONCRETE TYPE SP125B

DATE = 07[illegible] CONTRACTOR = TIGER PAVING SP125 06-104

IDENT NO.	PRODUCT CODE	/ PRODUCER, LOCATION	BULK SP. GR.	APPAR. SP. GR.	%ABS	FORMATION	LEDGES	% CHERT
65JSJ002	100207..LD1	/ MO-Tiger Qy., Central, MO	2.602	2.722	1.7	Argentine	2	0.0
65JSJ004	100205..LD1	/ MO-Tiger Qy., Central, MO	2.573	2.718	2.0	Argentine	2	0.0
65JSJ006	1002MS..MSLD	/ MO-Tiger Qy., Central, MO	2.546	2.734	2.7	Argentine	2-3	
65JSJ008	1002MS..MSCT	/ Flint Rock Qy., Chief, OK	2.553	2.671		Flint Chat	FLINT CHAT	
65JSJ010	1002MS..MSCT2	/ Flint Rock Qy., Chief, OK	2.533	2.642		Flint Chat	FLINT CHAT	
65JSJ012	1002NS..NS1	/ Miner Sand & Gravel, South Town, MO	2.625	2.650		Missouri River Sand	SAND	
65JSJ014	1002BH..BH	/ Tiger Asphalt Plants, Capital, MO	2.624	2.624		Bag House Fines	(Designed with 2%)	
65JSJ016	1015ACPG..7622	/ Jet Fuel Oil Co., Jet City, MO	1.045		PG76-22	Gyro Mold Temp. 288-298°F		

MATERIAL IDENT #	65JSJ002	65JSJ004	65JSJ006	65JSJ008	65JSJ010	65JSJ012	65JSJ002	65JSJ004	65JSJ006	65JSJ008	65JSJ010	65JSJ012	COMB.
06121	3/4"	1/2"	MAN SAND	MAN SAND	MAN SAND	NS	10.0	25.0	16.0	17.0	27.0	5.0	GRAD.
1 1/2"	100.0	100.0	100.0	100.0	100.0	100.0	10.0	25.0	16.0	17.0	27.0	5.0	100.0
1"	100.0	100.0	100.0	100.0	100.0	100.0	10.0	25.0	16.0	17.0	27.0	5.0	100.0
3/4"	100.0	100.0	100.0	100.0	100.0	100.0	10.0	25.0	16.0	17.0	27.0	5.0	100.0
1/2"	[illegible]	[illegible]	100.0	100.0	100.0	100.0	3.4	25.0	16.0	17.0	27.0	5.0	93.4
3/8"	[illegible]	[illegible]	100.0	100.0	100.0	100.0	0.4	19.5	16.0	17.0	27.0	5.0	85.0
#4	[illegible]	[illegible]	90.0	99.0	45.0	100.0	0.2	3.3	14.4	16.8	12.2	5.0	51.9
#8	2.0	5.0	60.0	82.0	9.0	96.0	0.2	1.3	9.6	13.9	2.4	4.8	32.2
#16	2.0	4.5	33.0	53.0	4.0	88.0	0.2	1.1	5.3	9.0	1.1	4.4	21.1
#30	2.0	4.2	25.0	31.0	3.0	65.0	0.2	1.1	4.0	5.3	0.8	3.3	14.6
#50	2.0	4.0	13.0	15.0	2.0	23.0	0.2	1.0	2.1	2.6	0.5	1.2	7.5
#100	2.0	[illegible]	8.0	5.6	1.0	2.0	0.2	0.9	1.3	1.0	0.3	0.1	3.7
#200	2.0	[illegible]	8.0	3.5	1.0		0.2	0.9	1.3	0.6	0.3		3.2

LABORATORY	Gmm =	2.421	% VOIDS =	4.0	TSR =	103	TSR Wt.	Nini =	9	MIX COMPOSITION	
CHARACTERISTICS	Gmb =	2.323	V.M.A. =	14.2	-200/AC =	1.1	3696	Ndes =	125	MIN. AGG.	94.6%
AASHTO T312	Gsb =	2.561	% FILLED =	72	Gyro Wt. =	4730		Nmax =	205	ASPHALT CONTENT	5.4%

Aggregate & Mixture Properties Based on Contractors Mix Design

8

Calculations- Volume

$$Volume = B - C$$

B= Mass in grams of the surface-dry specimen (SSD)

C= Mass in grams of the specimen in water

**All reported to the nearest tenth (0.1 grams)

9

Calculations- Bulk Specific Gravity

AASHTO T166 or AASHTO T331

$$\mathbf{Gmb} = \textit{Bulk Specific Gravity} = \frac{A}{(B - C)}$$

where:

A = mass in grams of specimen in air, **0.1 g**

B = mass in grams of the surface-dry specimen (SSD) **0.1 g**

C = mass in grams of the specimen in water, **0.1 g**

Report G_{mm} to 3 decimal places →0.001

$\textbf{Bulk Specific Gravity} = G_{mb}$ or G_{mc}

10

Calculations- % Air Voids

$$\%\ Air\ Voids = 1 - \left(\frac{G_{mb}}{G_{mm}}\right) * 100$$

$\textbf{Bulk Specific Gravity} = G_{mb}$ or G_{mc}

$\textit{Maximum Specific Gravity} = G_{mm}$

Report % Air Voids to the nearest tenth → 0.1%

11

Calculations- Density

$$\%\ Density = \left(\frac{G_{mb}}{G_{mm}}\right) * 100$$

$\textbf{Bulk Specific Gravity} = G_{mb}$ or G_{mc}

$\textit{Maximum Specific Gravity} = G_{mm}$

Report % Density to the nearest tenth → 0.1%

12

Example Problem

Given:

G_{mb} or G_{mc} = 2.323

$G_{mm} = 2.433$

Find % Air Voids (V_a) & % Density

$\% V_a = 1 - (\frac{2.323}{2.433})*100 = 4.5\%$

$\% \text{Density} = (\frac{2.323}{2.433})*100 = 95.5\%$

13

Mix ID : SUPERGOOD SMA

NOTE: Gmm comes from T209 or JMF

Enlarged

Superpave SMA
Air Voids = 6 ± 0.5%

Gmm = 2.515

Specimen#		1	2	3	4	5	6
Weight in Air	A.	3795.2	3775.0	3778.2	3786.7	3790.7	3788.5
SSD Weight	B.	3813.8	3802.0	3795.8	3806.1	3811.4	3806.1
WT In Water	C.	2209.0	2193.4	2194.2	2203.5	2213.0	2212.0
Volume	(B – C)						
SpG (G_{mb})	A/(B – C)						
% Air Voids	$1 - \left[\frac{Gmb}{Gmm}\right] \times 100$						
% Density	$\left[\frac{Gmb}{Gmm}\right] \times 100$						
Absorption by Volume	$\frac{(B-A)}{(B-C)} \times 100$						

Classroom Exercise

14

Mix ID : SUPERGOOD SMA

NOTE: Gmm comes from T209 or JMF

Answers

Superpave SMA
Air Voids = 6 ± 0.5%

Gmm = 2.515

Specimen#		1	2	3	4	5	6
Weight in Air	A.	3795.2	3775.0	3778.2	3786.7	3790.7	3788.5
SSD Weight	B.	3813.8	3802.0	3795.8	3806.1	3811.4	3806.1
WT In Water	C.	2209.0	2193.4	2194.2	2203.5	2213.0	2212.0
Volume		1604.8	1608.6	1601.6	1602.6	1598.4	1594.1
SpG (G_{mb})		2.365	2.347	2.359	2.363	2.372	2.377
% Air Voids		6.0	6.7	6.2	6.0	5.7	5.5
% Density		94.0	93.3	93.8	94.0	94.3	94.5
Absorption by Volume		1.16	1.68	1.10	1.21	1.30	1.10

Classroom Exercise- Answers

Notice specimen # 2 Air Voids are out of tolerance.

15

Job Mix Formula

Enlarged

MISSOURI DEPARTMENT OF TRANSPORTATION - DIVISION OF MATERIALS

ASPHALTIC CONCRETE TYPE SP125B

DATE = 07/24/06 CONTRACTOR = TIGER PAVING SP125 06-104

IDENT. NO.	PRODUCT CODE	/ PRODUCER, LOCATION	BULK SP. GR.	APPAR. SP. GR.	%ABS	FORMATION	LEDGES	% CHERT
65JSJ002	100207..LD1	/ MO-Tiger Qy., Central, MO	2.602	2.722	1.7	Argentine	2	0.0
65JSJ004	100205..LD1	/ MO-Tiger Qy., Central, MO	2.573	2.718	2.0	Argentine	2	0.0
65JSJ006	1002MS..MSLD	/ MO-Tiger Qy., Central, MO	2.546	2.734	2.7	Argentine	2-3	
65JSJ008	1002MS..MSCT	/ Flint Rock Qy., Chief, OK	2.553	2.671		Flint Chat	FLINT CHAT	
65JSJ010	1002MS..MSCT2	/ Flint Rock Qy., Chief, OK	2.533	2.642		Flint Chat	FLINT CHAT	
65JSJ012	1002NS..NS1	/ Miner Sand & Gravel, South Town, MO	2.625	2.650		Missouri River Sand	SAND	
65JSJ014	1002BH..BH	/ Tiger Asphalt Plants, Capital, MO	2.624	2.624		Bag House Fines	(Designed with 2%)	
65JSJ016	1015ACPG..7622	/ Jet Fuel Oil Co., Jet City, MO	1.045		PG76-22	Gyro Mold Temp. 288-298°F		

MATERIAL IDENT #	65JSJ002	65JSJ004	65JSJ006	65JSJ008	65JSJ010	65JSJ012	65JSJ002	65JSJ004	65JSJ006	65JSJ008	65JSJ010	65JSJ012	COMB.
06121	3/4"	1/2"	MAN SAND	MAN SAND	MAN SAND	NS	10.0	25.0	16.0	17.0	27.0	5.0	GRAD
1 1/2"	100.0	100.0	100.0	100.0	100.0	100.0	10.0	25.0	16.0	17.0	27.0	5.0	100.0
1"	100.0	100.0	100.0	100.0	100.0	100.0	10.0	25.0	16.0	17.0	27.0	5.0	100.0
3/4"	[illegible]	[illegible]	100.0	100.0	100.0	100.0	10.0	25.0	16.0	17.0	27.0	5.0	100.0
1/2"	[illegible]	[illegible]	100.0	100.0	100.0	100.0	3.4	25.0	16.0	17.0	27.0	5.0	93.4
3/8"	[illegible]	[illegible]	100.0	100.0	100.0	100.0	0.4	19.5	16.0	17.0	27.0	5.0	85.0
#4	2.0	13.2	90.0	99.0	45.0	100.0	0.2	3.3	14.4	16.8	12.2	5.0	51.9
#8	2.0	5.0	60.0	82.0	9.0	96.0	0.2	1.3	9.6	13.9	2.4	4.8	32.2
#16	2.0	4.5	33.0	53.0	4.0	88.0	0.2	1.1	5.3	9.0	1.1	4.4	21.1
#30	2.0	4.2	25.0	31.0	3.0	65.0	0.2	1.1	4.0	5.3	0.8	3.3	14.6
#50	2.0	4.0	13.0	15.0	2.0	23.0	0.2	1.0	2.1	2.6	0.5	1.2	7.5
#100	2.0	[illegible]	8.0	5.6	1.0	2.0	0.2	0.9	1.3	1.0	0.3	0.1	3.7
#200	2.0	[illegible]	8.0	3.5	1.0		0.2	0.9	1.3	0.6	0.3		3.2

Gmm

LABORATORY CHARACTERISTICS AASHTO T312										
	Gmm = 2.421	% VOIDS = 4.0	TSR = 103	TSR Wt.	Nini =	9	MIX COMPOSITION	
	Gmb = 2.323	V.M.A. = 14.2	-200/AC = 1.1	3696	Ndes =	125	MIN. AGG.	94.6%
	Gsb = 2.561	% FILLED = 72	Gyro Wt. = 4730		Nmax =	205	ASPHALT CONTENT	5.4%

CALIBRATION NUMBER 60126 MASTER GAUGE BACK CNT. = 2143 A1 = -4.063767

MASTER GAUGE SER. NO. = 2502 SAMPLE WEIGHT = 7200 A2 = 3.103065

Aggregate & Mixture Properties Based on Contractors Mix Design

Classroom Exercise

Enlarged

Mix ID : SUPERGOOD SMA

NOTE: Gmm comes from T209 or JMF

Superpave SMA **Air Voids = 6 ± 0.5%**		**Gmm = 2.515**					
	Specimen#	**1**	**2**	**3**	**4**	**5**	**6**
Weight in Air	**A.**	3795.2	3775.0	3778.2	3786.7	3790.7	3788.5
SSD Weight	**B.**	3813.8	3802.0	3795.8	3806.1	3811.4	3806.1
WT In Water	**C.**	2209.0	2193.4	2194.2	2203.5	2213.0	2212.0
Volume	(B – C)						
SpG (G_{mb})	A/(B – C)						
% Air Voids	$1 - \left[\frac{Gmb}{Gmm}\right] \times 100$						
% Density	$\left[\frac{Gmb}{Gmm}\right] \times 100$						
Absorption by Volume	$\frac{(B - A)}{(B - C)} \times 100$						

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Notes if Needed

AASHTO T269: HOMEWORK

Applicant______________________________________

Employer______________________________________

PROCEDURE	1	2
1. For Dense Bituminous Paving Mixtures		
a. Bulk specific Gravity determined by T166 (suspension) or T331 (Vacuum Sealing)?		
b. Theoretical maximum specific gravity determined by T209 (Rice Test) or from the JMF?		
2. Percent air voids calculated in accordance with test method T269?		

Calculate both % Density and % Air Voids using the following information:
Report values to the correct decimal place.

Mix Number Supergood

Gmm= 2.485

SPECIMEN #	1	2	3	4	5	6
WEIGHT IN AIR	3690.3	3691.9	3692.8	3690.6	3698.1	3693.4
SSD WEIGHT	3714.4	3715.6	3715.3	3716.4	3722.8	3715.2
WT IN WATER	2100.9	2101.2	2108.0	2099.6	2106.1	2113.7
VOLUME						
SpG (Gmb)						
% AIR VOIDS						
% Density						

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Notes if Needed

AASHTO T269

Percent Air Voids in Compacted Dense and Open Bituminous Paving Mixtures

PROFICIENCY CHECKLIST

Name: ___________________________________

Company: ___________________________________

PROCEDURE	1	2
1. For Dense Bituminous Paving Mixtures		
a. Bulk specific Gravity determined by T166 (suspension) or T331 (Vacuum Sealing)?		
b. Theoretical maximum specific gravity determined by T209 (Rice Test) or from the JMF?		
2. Percent air voids calculated in accordance with test method T269?		

CALCULATONS:		

<u>Theoretical Maximum Specific Gravity</u> (Gmm)

The Gmm can be found on the Job Mix Formula. OR from testing T209 (Rice Test)

$$Gmm = \frac{A}{(A + D - E)}$$

- A=Dry Sample Mass in Air
- D=Container & Water
- E=Container, Water & Sample

Report *Gmm* to nearest 0.001

<u>Bulk Specific Gravity</u> (Gmb)

$$Gmb = \frac{Weight\ in\ \text{Air (A)}}{Weight\ \text{Surface Dry (B)} - \text{Weight in Water (C)}}$$

Report Gmb to the nearest 0.001

<u>Percent Air Voids</u> (Va)

$$\text{Air voids } (V_a) = 100 * \left[\frac{Gmm - Gmb}{Gmm}\right]$$

Or

$$\text{Air voids } (V_a) = 100 * \left[1 - \frac{Gmb}{Gmm}\right]$$

Report Air Voids to the nearest 0.1%

PASS PASS

FAIL FAIL

Proctor/Auditor Signature: ___________________________________ Date: _______________

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Notes if Needed

MoDOT TM 54

AASHTO T287

Determining the Asphalt Content

of an Asphalt Mixture

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Notes if Needed

MoDOT TM 54

AASHTO T287

DETERMINING THE ASPHALT CONTENT OF ASPHALT MIXTURE

1

SCOPE

- Asphalt content affects the aggregate coating and volumetric properties of an asphalt mix.
- The gauge determines that asphalt content by measuring the amount of hydrogen atoms in the mix.
- Nuclear AC content is covered in EPG Section 460.3.14.20.

2

EQUIPMENT

- **Gauge**- Troxler Model 3241-C
- **Gloves**
- **Plywood or Metal Plate**- Plywood: ¾ in or thicker; Metal Plate: 3/8 in or thicker, to compact the mix in the sample pans
- **Sample Pan**
- **Scale**- Capable of weighing up to 12 kg and readable to 1 g
- **Spoons, scoop, trowel & Pans**

3

PRECAUTIONS

- Keep any other source of hydrogen and neutron radiation @ least **30 feet away.**
- Inspectors should stay at lest **15 feet away** from the gauge while running the test.
- Visually evaluate the surroundings to determine if conditions are present which would affect the operation of the gauge.
- Use a 2-barrier system when securing the gauge after testing is completed.

* 2 locks on the same barrier does NOT constitute 2 barriers

4

GUAGE PREPARATION

- Every **3 Months** a Stability test should be completed when the gauge is in use
  - Stability test is **20 Counts** for **1 Minutes**
- Complete a **16 Minute** background count @ least **ONCE a DAY**; more if conditions change (see photo next slide)
  - Background test should be ±1% of previous background test
    - If this fails continue 2 consecutive readings are within 1%. If still unachievable consult technical support

5

16-minute background count

6

SAMPLING

Obtain a proper loose mix sample according to:
AASHTO R97 or EPG 460.3.14.1

Location: From behind the paver

7

FIELD TESTING

1. Prepare sample using an approved method
2. Place mix in a clean, tarred sample pan in 2 lifts
3. Fill the pan one-half full- DO NOT exert pressure on the mix while distributing evenly in the pan
4. Fill the pan with more mix until within **±5 grams** of the weight listed on the JMF
5. Level the mixture in the pan to an even head above the lip of the pan

<u>NOTE:</u> Do not segregate while adjusting weight.**
(i.e, Don't just remove large pieces or fines, keep a representative as possible)

8

FIELD TESTING

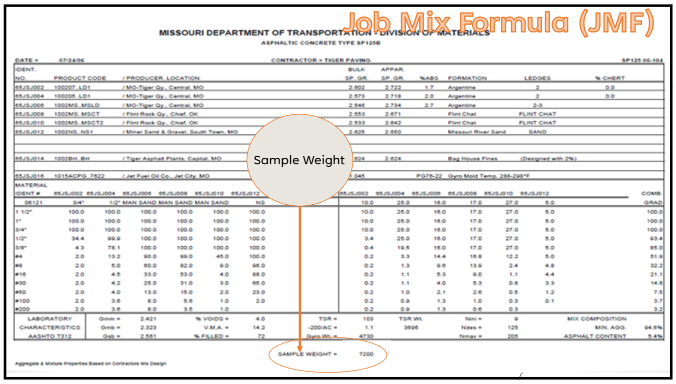
6. Reweigh the pan to assure it is still within **±5 grams**

→

7. Run the test to obtain the asphalt content of the sample

<u>NOTE:</u> If weight will not fit in pan, mix maybe too cool to compact properly.**
Reheat and try again.

9



MISSOURI DEPARTMENT OF TRANSPORTATION - DIVISION OF MATERIALS

ASPHALTIC CONCRETE TYPE SP125B

DATE = 07/24/06 CONTRACTOR = TIGER PAVING SP125 06-104

IDENT. NO.	PRODUCT CODE	/ PRODUCER, LOCATION	BULK SP. GR.	APPAR. SP. GR.	%ABS	FORMATION	LEDGES	% CHERT
65JSJ002	100207..LD1	/ MO-Tiger Qy., Central, MO	2.602	2.722	1.7	Argentine	2	0.0
65JSJ004	100206..LD1	/ MO-Tiger Qy., Central, MO	2.573	2.718	2.0	Argentine	2	0.0
65JSJ006	1002MS..MSLD	/ MO-Tiger Qy., Central, MO	2.546	2.734	2.7	Argentine	2-3	
65JSJ008	1002MS..MSCT	/ Flint Rock Qy., Chief, OK	2.553	2.671		Flint Chat	FLINT CHAT	
65JSJ010	1002MS..MSCT2	/ Flint Rock Qy., Chief, OK	2.533	2.642		Flint Chat	FLINT CHAT	
65JSJ012	1002NS..NS1	/ Miner Sand & Gravel, South Town, MO	2.626	2.650		Missouri River Sand	SAND	
65JSJ014	1002BH..BH	/ Tiger Asphalt Plants, Capital, MO	[illegible]	2.624		Bag House Fines	(Designed with 2%)	
65JSJ016	1015ACPG..7622	/ Jet Fuel Oil Co., Jet City, MO	[illegible]		PG76-22	Gyro Mold Temp. 288-298°F		

MATERIAL IDENT #	65JSJ002	65JSJ004	65JSJ006	65JSJ008	65JSJ010	65JSJ012	65JSJ002	65JSJ004	65JSJ006	65JSJ008	65JSJ010	65JSJ012	COMB.
06121	3/4"	1/2"	MAN SAND	MAN SAND	MAN SAND	NS	10.0	25.0	16.0	17.0	27.0	5.0	GRAD.
1 1/2"	100.0	100.0	100.0	100.0	100.0	100.0	10.0	25.0	16.0	17.0	27.0	5.0	100.0
1"	100.0	100.0	100.0	100.0	100.0	100.0	10.0	25.0	16.0	17.0	27.0	5.0	100.0
3/4"	100.0	100.0	100.0	100.0	100.0	100.0	10.0	25.0	16.0	17.0	27.0	5.0	100.0
1/2"	34.4	99.9	100.0	100.0	100.0	100.0	3.4	25.0	16.0	17.0	27.0	5.0	93.4
3/8"	4.3	78.1	100.0	100.0	100.0	100.0	0.4	19.5	16.0	17.0	27.0	5.0	85.0
#4	2.0	13.2	90.0	99.0	45.0	100.0	0.2	3.3	14.4	16.8	12.2	5.0	51.9
#8	2.0	5.0	60.0	82.0	9.0	96.0	0.2	1.3	9.6	13.9	2.4	4.8	32.2
#16	2.0	4.5	33.0	53.0	4.0	88.0	0.2	1.1	5.3	9.0	1.1	4.4	21.1
#30	2.0	4.2	25.0	31.0	3.0	65.0	0.2	1.1	4.0	5.3	0.8	3.3	14.6
#50	2.0	4.0	13.0	15.0	2.0	23.0	0.2	1.0	2.1	2.6	0.5	1.2	7.5
#100	2.0	3.6	8.0	5.6	1.0	2.0	0.2	0.9	1.3	1.0	0.3	0.1	3.7
#200	2.0	3.6	8.0	3.5	1.0		0.2	0.9	1.3	0.6	0.3		3.2

LABORATORY CHARACTERISTICS AASHTO T312											
Gmm =	2.421	% VOIDS =	4.0	TSR =	103	TSR Wt.	Nini =	9	MIX COMPOSITION	
Gmb =	2.323	V.M.A. =	14.2	-200/AC =	1.1	3696	Ndes =	125	MIN. AGG.	94.6%
Gsb =	2.561	% FILLED =	72	Gyro Wt. =	4730		Nmax =	205	ASPHALT CONTENT	5.4%

SAMPLE WEIGHT = 7200

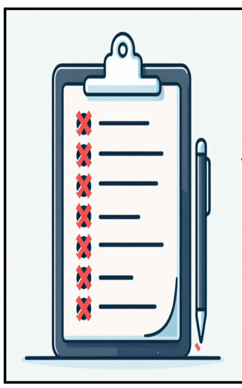
Aggregate & Mixture Properties Based on Contractors Mix Design

10

REPORTING

- Subtract moisture(derived from, AASHTO T329 test) from AC and report actual AC to the nearest 0.1%
- Record the gauge readings for; background count, test count, and % AC on the daily plant inspector reports, plant or project diary.

11



COMMON ERRORS

- Locating the nuclear gauge too close to people, water tanks, trucks loaded with asphalt, or traffic movement.
- Not running a current background count when changes occur in the lab environment.
- Not having the mix hot when compacting it in pan.
- Not properly securing the nuclear gauge.

12

For more information and guidance please refer to the Engineering Policy Guide (EPG) 106.3.2.54, 460.3.14.

https://epg.modot.org/index.php?title=106.3.2.54_TM-54,_Asphalt_Cement_Content_of_Bituminous_Mixtures_by_the_Nuclear_Method

https://epg.modot.org/index.php?title=460.3_Plant_Inspection#460.3.14_Asphalt_Binder_Content

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Notes if Needed

MoDOT TM 54 (T287)
Determining the Asphalt Content of an Asphalt Mixture

PROFICIENCY CHECKLIST

Name: ____

Company: ____

Trial#	1	2
Preparation Note: AC = Asphalt Content		
1. Current 20 count – 1 minute stability test report, 3 months or less?		
2. Ran a 16-minute background daily or when conditions change?		
3. Background count within ±1 % of previous background test? - If not, more tests ran until two consecutive readings are w/n 1%?		

Procedure		
1. Obtained an asphalt mixture sample by R97, reduced by R47		
2. Tared a sample pan on the scale?		
3. Placed the sample in the pan in two lifts?		
4. Placed the sample on tared scale, check weight? (See JMF)		
5. Adjusted weight by adding or subtracting material from the pan to reach ± 5g of JMF sample weight? (do not segregate while adjusting)		
7. Compacted the sample in the pan using a leveling plate?		
8. Pressed down on the leveling plate to compact the sample level with top of the pan? • If the sample is not fitting, reheat the mix, try again.		
9. Rechecked the weight? Within ± 5g of JMF?		
10. Placed the sample pan in the nuclear machine and pressed the start/enter button (16 min count test)		
11. Get the results from a printed report or computer?		

Reporting		
1. Subtracted the moisture (T329), from the AC and report actual AC to the nearest **0.1%**		
2. Recorded the gauge readings for: Background count, Test count, and %AC on daily plant inspectors report or diary.		

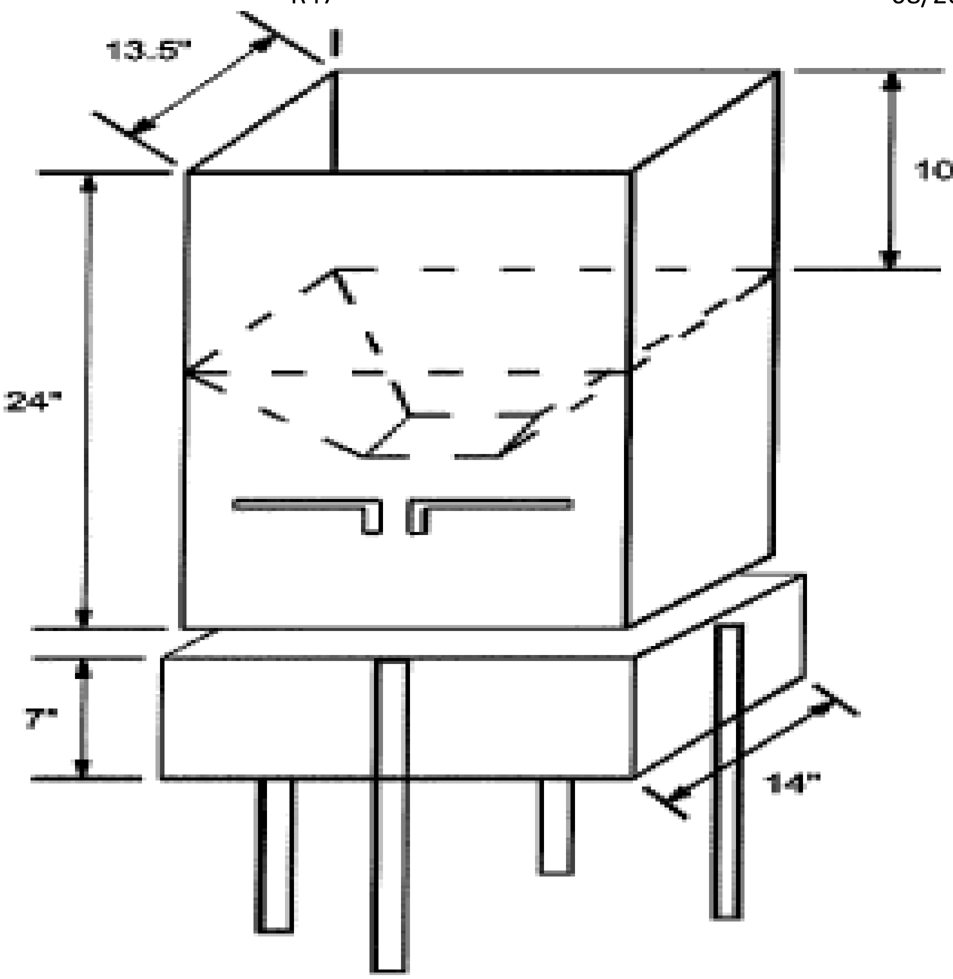
PASS PASS

FAIL FAIL

Proctor/Auditor's Signature: ______________________ Date: ______________

Intentionally Left Blank-
Notes if Needed

Appendix



Metric Equivalents

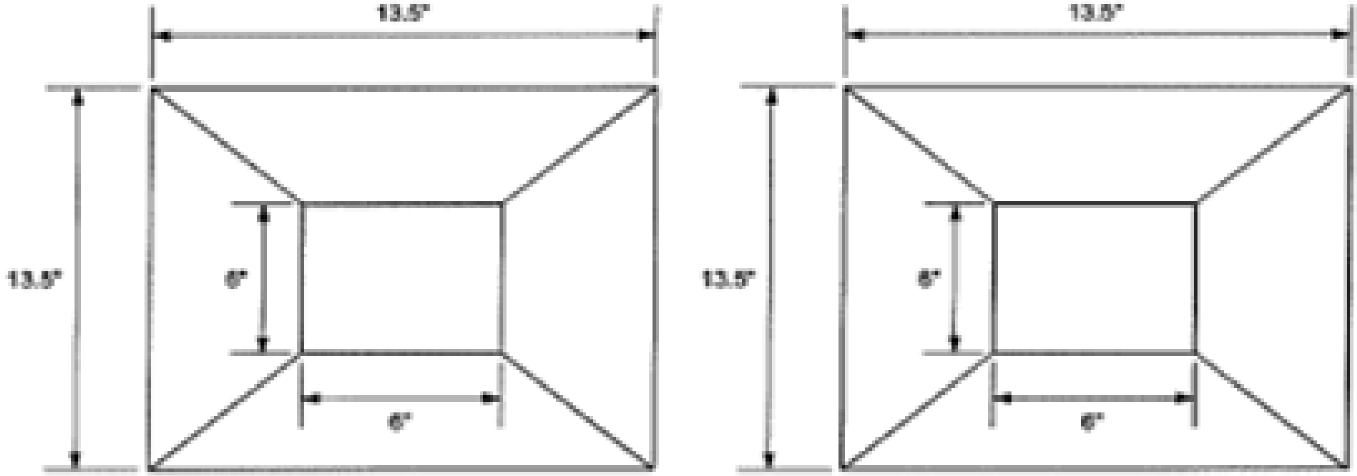
in.	mm
7	178
10	254
13.5	343
14	356
24	610

Note: All dimensions shown in inches unless otherwise noted.

Figure 1—Mechanical Splitter Type A

Mechanical splitter Type A –

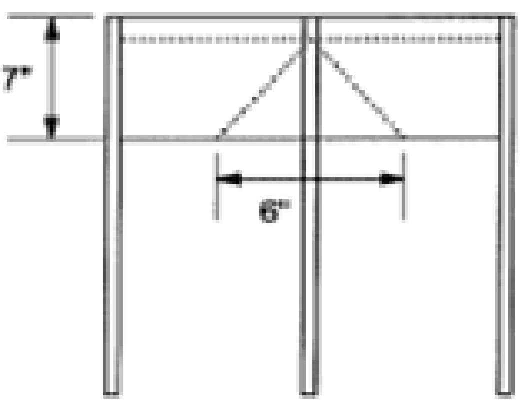
- Shall have 4 equal width chutes that discharge the material into 4 appropriately sized containers
- Shall be designed with a receiving hopper that will hold the field sample until a handle releases the material to fall through a divider and distributes it into 4 equal portions.
- Shall be designed so that the field sample will flow smoothly and freely through the divider without restriction or the loss of material.



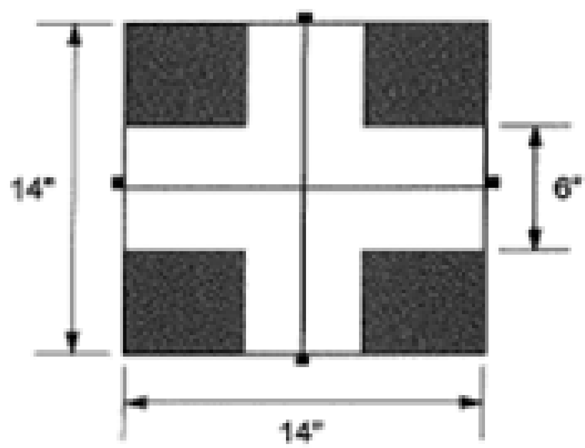
Metric Equivalents	
in.	mm
6	152
13.5	343

Note: All dimensions shown in inches unless otherwise noted.

Figure 2—Plan View of Splitter



a. Elevation View of Bottom Portion of Splitter



b. Plan View of Bottom Portion of Splitter

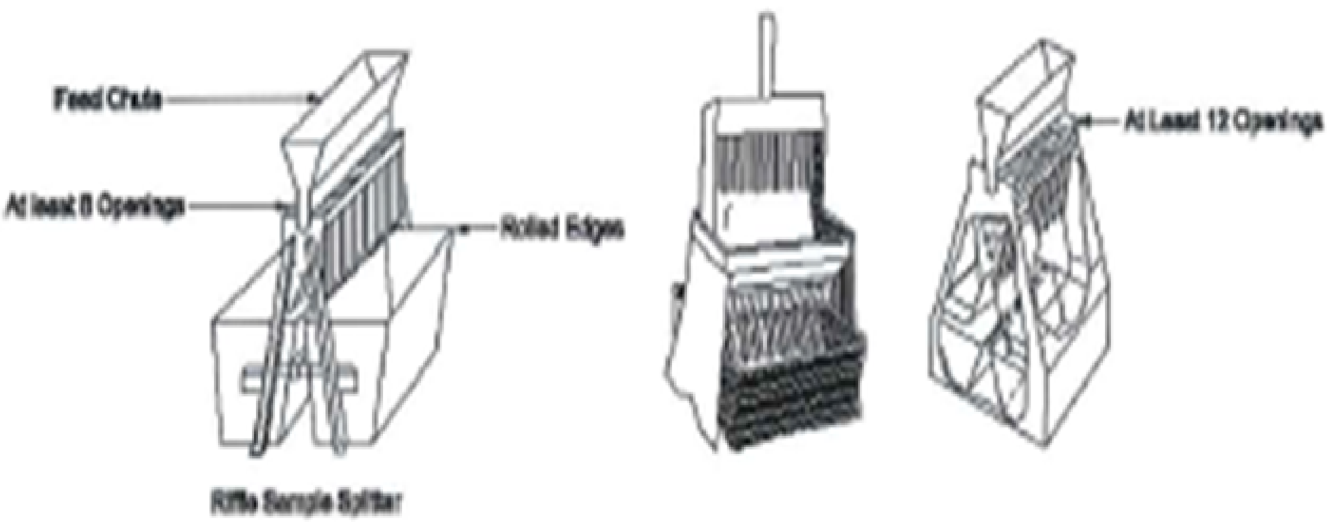
Metric Equivalents	
in.	mm
6	152
7	178
14	356

Note: All dimensions shown in inches unless otherwise noted.

Mechanical splitter Type A

Mechanical Splitter Type B

- Shall have an even number of equal-width chutes (no fewer than a total of 8 for a large splitter and no fewer than 12 for a small splitter), which discharge alternately to each side of the splitter.
- Minimum width of the individual chutes shall be approximately 50% larger than the largest particle to be split.
- Shall be equipped with 2 receptacles to catch the 2 halves of the sample follosing splitting
- Shall also be equipped with a gopper or straight-edge pan that has a width equal to or slightly less than the overall width of the assembly of chutes, by whigh the sample may be fed at a controlled rate to the chutes.
- Shall be designed so that the sample will flow smoothly and freely without restriction or the loss of material.



a. Large Splitter for Large Samples b. Small Splitters for Small Samples

Splitter Type B

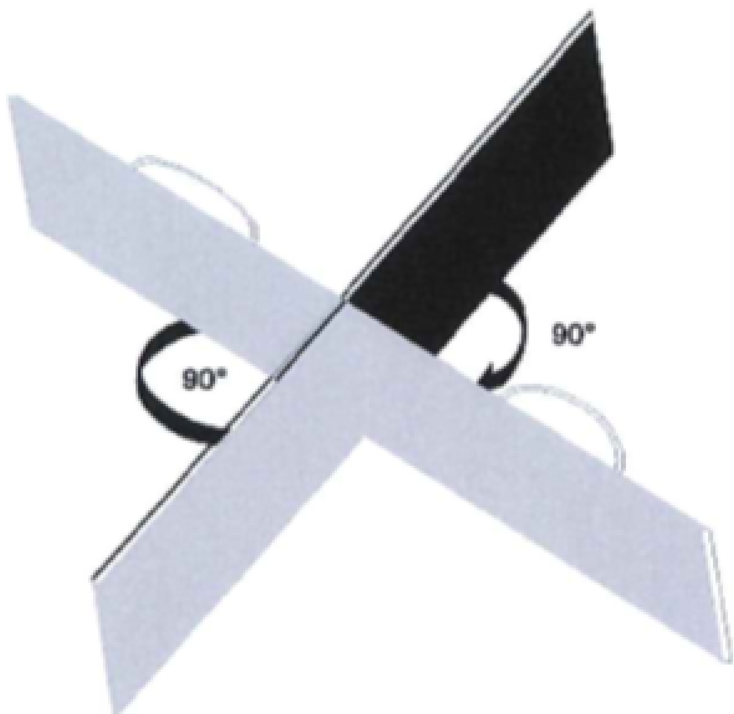
Note 1 – Type B mechanical splitters are commonly available in sizes adequate for asphalt mixtures having a nominal maximum aggregate size not over 1 inch. Use closed versions for larger sizes.

Noncontact Temperature Device (optional) – a noncontact temperature device suitable for determining the temperature of a heated splitter.

Asphalt Release Agent – Shall not contain any solvents or petroleum-based products that could affect asphalt binder properties.

Quartering Template –

- Template manufactured from a suitable metal that withstands heat and use without deforming
- Should be configured in the form of a cross with sides of equal length sufficient to be 1.1 times the diameter of the flattened cone of the asphalt mixture to be quartered.
- Height of the sides should be sufficient to extend above the thickness of the flattened cone of the asphalt sample to be quartered.
- Sides shall form a 90° angel at their juncture. See image below:



Flat –Bottom Scoop

- A large, straight-edged, flat-bottom scoop should be used to sample the asphaklt mixture
- A square shovel or trowel will meet the requirement

Straightedge

- Large spatula, trowel, or metal straightedge

INCREMENTAL METHOD APPARATUS:

Flat - Bottom Scoop

- A large, straight-edged, flat-bottom scoop should be used to sample the asphalt mixture.
- A square shovel or trowel will meet this requirement.

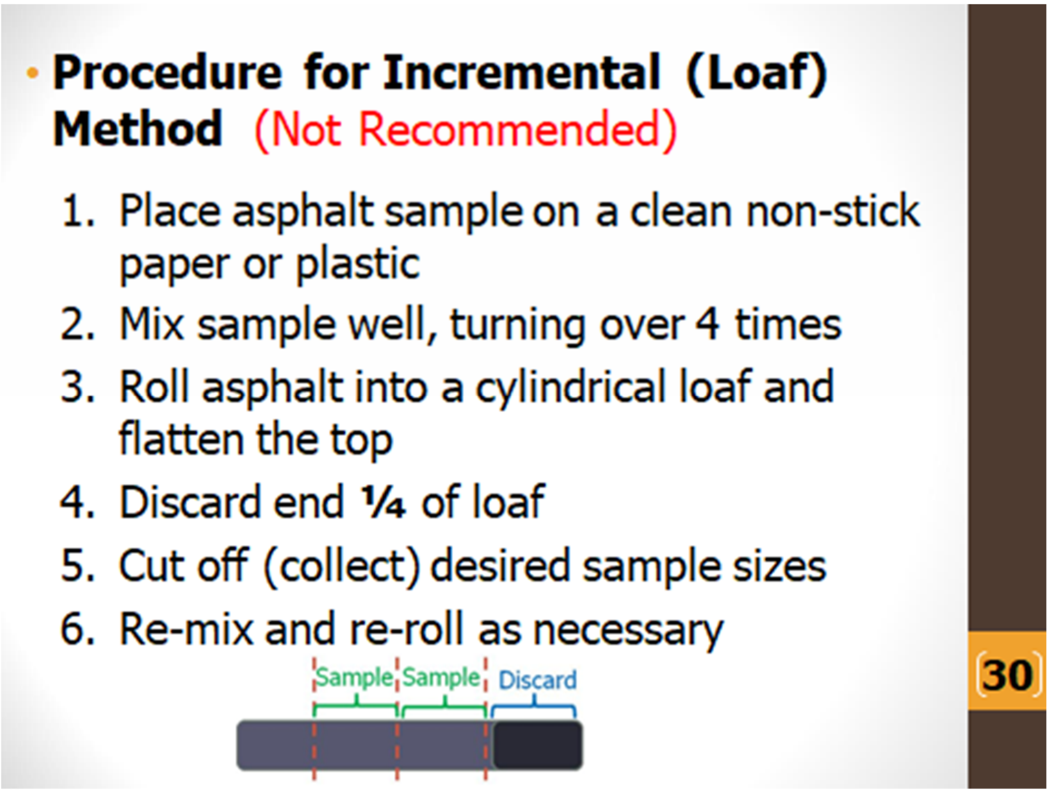
Nonstick heavy paper

Large spatulas, trowels, metal straightedge, or drywall taping knife

Miscellaneous Equipment

- Hot plate
- Non-asbestos heat resistant gloves or mittens
- Pans, Buckets, cans

AASHTO R47


Procedure for Incremental (Loaf) Method (Not Recommended)
1. Place asphalt sample on a clean non-stick paper or plastic
2. Mix sample well, turning over 4 times
3. Roll asphalt into a cylindrical loaf and flatten the top
4. Discard end ¼ of loaf
5. Cut off (collect) desired sample sizes
6. Re-mix and re-roll as necessary
Sample
Sample
Discard
30

Appendix for AASHTO T166

Equipment:

THERMOMETERS:

Updated : 08/20/2024

- **Added** Thermometer information to the appendix.
  - **Water Bath Thermometer Requirements:**
    - Immersion Thermometer
    - Meets M339M/M339
    - Temp range includes testing temperature.
    - Resolution 0.2°F (0.1°C)
    - Max error of 1°F (0.5°C)
  - **Suitable Thermometers:**
    - Glass thermometer ASTM 17F/17C
    - Thermistor as described in E879.
    - Digital thermometer as described in E2877.
    - Thermocouple thermometer, Type T, Class 1

EQUIPMENT FOR T331

- **Bag Cutter** – knife, scissors, or other types of clipping devices may be used to open bags.
- **Oven** – same as for T166
- **Weighing device** – same as for T166
- **Plastic Bags** – Two most used size of bags are designated as small and large size bags.
  - Small bags: Minimum opening of 241mm (9.50 in.) and a maximum opening of 267mm (10.50 in.) with a mass of less than 35g.
  - Large bags: Minimum opening of 368 mm (14.50 in.) and a maximum opening of 394mm (15.5 in.) with a mass of 35g or more.

  Bags shall be made of a plastic material that will not adhere to asphalt film and shall be puncture-resistant, capable of withstanding sample temperature of up to 158ºF, impermeable to water, and contain no air channels for evacuation of air from the bag. The bags shall have a minimum thickness of 0.127 mm (0.005 in.) and a maximum thickness of 0.178 mm (0.007in.). The manufacturer shall provide the bag correction factor (apparent specific gravity) of the bags (usually located in the operator's manual).
- **Specimen Sliding Plates** – The plate shall be large enough to fully support the specimen but small enough to allow movement during the sealing process.
- **Vacuum chamber** – Large enough to seal samples of 6 x 14 x 6 inches. The heat setting shall be set according to the manufacturer's recommendations and the bag composition. The device shall automatically seal the plastic bag and exhaust air back into the chamber in a controlled manner to ensure proper conformance of the plastic bag to the specimen. The air exhaust and vacuum operation time should be calibrated to bring the chamber to atmospheric pressure in 80 to 120 sec after completion of the vacuum operation.
- **Vacuum Gauge** – Standardized vacuum gauge shall be capable of being placed inside the automatic vacuum sealing device to verify vacuum performance and seal integrity. The gauge shall have a minimum range of 10 to 0 mmHg and shall be readable to 1 mmHg increments, as a minimum.
- **Water Bath** – Same as T166

Glossary

Asphalt Industry Glossary of Terms

This is an alphabetical listing of the terms and descriptions commonly used in the asphalt industry

A	B	C	D	E	F	G	H	I	K	L
M	N	O	P	R	S	T	U	V	W	

Another valuable resource for terms is MS-4 Asphalt Handbook

A

Absolute Viscosity	A measure of the viscosity of asphalt with respect to time, measured in poises, conducted at 60°C (140°F). The test method utilizes a partial vacuum to induce flow in the viscometer.
Aggregate Spreaders	Machines used for spreading aggregate evenly at a uniform rate on a surface.
Aggregate Storage Bins	Bins that store the necessary aggregate sizes and feed them to the dryer in substantially the same proportions as are required in the finished mix.
Aggregate Trucks	Trucks equipped with hydraulic lifts to dump the aggregate into the spreader or storage area.
Aggregate	A hard inert mineral material, such as gravel, crushed rock, slag, or crushed stone, used in pavement applications either by itself or for mixing with asphalt.
Air Voids	Internal spaces in a compacted mix surrounded by asphalt-coated particles, expressed as a percentage by volume of the total compacted mix.
Asphalt (asphalt cement)	A dark brown to black cementitious material in which the predominating constituents are bitumens, which occur in nature or are obtained in petroleum processing. Asphalt is a constituent in varying proportions of most crude petroleum and used for paving, roofing, industrial and other special purposes.
Alligator Cracks	Interconnected cracks forming a series of small blocks resembling an alligator's skin or chicken-wire, and caused by excessive deflection of the surface over unstable subgrade or lower courses of the pavement.
Asphalt Application	The application of sprayed asphalt coatings not involving the use of aggregates.
Asphalt Binder	Asphalt cement that is classified according to the Standard Specification for Performance Graded Asphalt Binder, AASHTO Designation MP1. It can be either unmodified or modified asphalt cement, as long as it complies with the specifications.
Asphalt Concrete	A mixture of asphalt binder and aggregate thoroughly mixed and compacted into a mass.

Another valuable resource for terms is MS-4 Asphalt Handbook

Asphalt Distributor	A truck or a trailer having an insulated tank, heating system and distribution system. The distributor applies asphalt to a surface at a uniform rate.
Asphalt Emulsion	An emulsion of asphalt binder and water that contains a small amount of an emulsifying agent. Emulsified asphalt droplets may be of either the anionic (negative charge), cationic (positive charge) or nonionic (neutral).
Asphalt Emulsion Mix (Cold)	A mixture of unheated mineral aggregate and emulsified (or cutback) asphalt binder. It can be plant-mixed or mixed in-place.
Asphalt Emulsion Mix (Warm)	A mixture of asphalt emulsion and mineral aggregate usually prepared in a conventional hot mix asphalt plant at a temperature less than 95°C (200°F). It is spread and compacted at a temperature above 65°C (150°F).
Asphalt Emulsion Slurry Seal	A mixture of slow-setting emulsified asphalt, fine aggregate, and mineral filler with a slurry consistency
Asphalt Leveling Course	A course of hot mix asphalt of variable thickness used to eliminate irregularities in the contour of an existing surface prior to placing the subsequent course.
Asphalt Pavement Structure	A pavement structure that is designed and constructed so that all courses above the subgrade are asphalt concrete (Full-Depth Asphalt Pavement).
Asphalt Pavements	Pavements consisting of a surface course of asphalt concrete over supporting courses such as asphalt concrete bases, crushed stone, slag, gravel, Portland Cement Concrete (PCC), brick, or block pavement.
Asphalt Prime Coat	An application of asphalt primer to an absorbent surface. It is used to prepare an untreated base for an asphalt surface. The prime penetrates or is mixed into the surface of the base and plugs the voids, hardens the top and helps bind it to the overlying asphalt course.
Asphalt Primer	Low viscosity asphalt (highly liquid) that penetrates into a non-bituminous surface upon application.
Asphalt Rubber - Asphalt Concrete (AR-AC)	High quality, thoroughly controlled hot mixture of asphalt rubber binder (AR) and well-graded, high quality aggregate, which can be thoroughly compacted into a uniform dense mass.
Asphalt Rubber Binder (AR)	Conventional asphalt cement to which recycled ground tire rubber has been added, that when reacted with the hot asphalt cement causes a swelling and/or dispersion of the tire rubber particles.

A	B	C	D	E	F	G	H	I	K	L
M	N	O	P	R	S	T	U	V	W	

Another valuable resource for terms is MS-4 Asphalt Handbook

Asphalt Tack Coat	A relatively thin application of asphalt binder applied to an existing asphalt concrete or PCC surface at a prescribed rate. Asphalt emulsion diluted with water is the preferred type. It is used to form a bond between an existing surface and the overlying course.
Asphaltenes	The high molecular weight hydrocarbon fraction precipitated from asphalt by a designated paraffinic naphtha solvent at a specified solvent-asphalt ratio.
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 self-acting mechanical or electrical machinery without any intermediate manual control. The system includes preset timing devices to control the desired periods of dry and wet mixing cycles.
Automatic Dryer Control	A system that automatically maintains the temperature of aggregates discharged from the dryer within a preset range.
Automatic Proportioning Control	A system in which proportions of the aggregate and asphalt fractions are controlled by means of gates or valves, which are opened and closed by means of self-acting mechanical or electronic machinery without any intermediate manual control.

B

Back-calculation	An analytical technique used to determine the equivalent elastic moduli of pavement layers corresponding to the measured load and deflections. In the iterative method, layer moduli are selected and adjusted until the difference between the calculated and measured deflections are within selected tolerances, or the maximum number of iterations has been reached.
Bank Gravel	Gravel found in natural deposits, usually intermixed with fine material such as sand or clay or a combination thereof; includes gravelly clay, gravelly sand, clayey gravel, and sandy gravel (the names indicate the relative proportion of the materials in the mixture).
Base Course	The layer in the pavement system immediately below the binder and surface courses. It usually consists of crushed stone, although it may consist of crushed slag or other stabilized or unstabilized material.

A	B	C	D	E	F	G	H	I	K	L
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Another valuable resource for terms is MS-4 Asphalt Handbook

Batch Plant	A manufacturing facility for producing asphalt paving mixtures that proportions blending. They manufacture asphalt in batches rather than continuously and are more suited for small manufacturing runs and (frequent) changes in mixture types.
Binder Course	The hot mix asphalt course immediately below the surface course, generally consisting of larger aggregates and less asphalt (by weight) than the surface.
Bitumen	A class of black or dark-colored (solid, semisolid, or viscous) cementitious substances, natural or manufactured, composed principally of high molecular weight hydrocarbons, of which asphalts, tars, pitches, and asphaltites are typical.
Blast-Furnace Slag	The nonmetallic product, consisting essentially of silicates and alumino-silicates of lime and of other bases, that is developed simultaneously with iron in a blast furnace.
Bleeding or Flushing Asphalt	The upward migration of asphalt binder in an asphalt pavement resulting in the formation of asphalt film on the surface.

C

California Bearing Ratio (CBR)	A test used for evaluating bases, subbases, and subgrades for pavement thickness design it is a relative measure of the shear resistance of a soil (see Soils Manual, MS-10). CBR = load required to force a calibrated piston into a soil specimen / load required to force a like piston into a crushed stone specimen capacity and ride quality of the pavement system.
Cape Seal	A surface treatment where a chip seal is followed by the application of either slurry seal or micro-surfacing.
Channels (Ruts)	Channeled depressions that sometimes develop in the wheel paths of an asphalt pavement.
Chemical modification of asphalt	The chemical modification of asphalt is typically with Polyphosphoric Acid (PPA).
Clinker	A fused or partially fused by-product of the combustion of coal. Also includes lava and Portland Cement and partially vitrified slag and brick.
Coal Tar	A dark brown to black cementitious material produced by the destructive distillation of bituminous coal.

Another valuable resource for terms is MS-4 Asphalt Handbook

Coarse Aggregate	Aggregate retained on the 2.36 mm (No. 8) sieve.
Coarse-Graded Aggregate	One having a continuous grading in sizes of particles from coarse through fine with a predominance of coarse sizes.
Cold In-place Recycling Train	A unit consisting of a large milling machine towing a screening/crushing plant and pugmill mixer for the addition of asphalt emulsion and production of cold mix base.
Compaction	The act of compressing a given volume of material into a smaller volume.
Consensus Properties	Aggregate characteristics that must follow certain criteria to satisfy a Superpave mix design. Specified test values for these properties are not source specific but widely agreed upon. They include Coarse Aggregate Angularity, Fine Aggregate Angularity, Flat or Elongated Particles, and Clay Content.
Consistency	The degree of fluidity of asphalt cement at any particular temperature. The con-sistency of asphalt cement varies with its temperature; therefore, it is necessary to use a common or standard temperature when comparing the consistency of one asphalt cement with another.
Corrugations (Washboarding) and Shoving	A type of pavement distortion. Corrugation is a form of plastic deformation typified by ripples across the pavement surface. These distortions usually occur at points where traffic starts and stops, on hills where vehicles brake on the downgrade, on sharp curves, or where vehicles hit a bump and bounce up and down. They occur in asphalt layers that lack stability.
Crack	An approximately vertical random cleavage of the pavement caused by traffic loading, thermal stresses and/or aging of the binder.
Crack and Seat	A fractured slab technique used in the rehabilitation of PCC pavements that minimizes slab action in a jointed concrete pavement (JCP) by fracturing the PCC layer into smaller segments. This reduction in slab length minimizes reflective cracking in new HMA overlays.
Crack-Relief Layer	A large stone, open graded asphalt mixture placed over a distressed pavement that minimizes reflective cracking by absorbing the energy produced by movement in the underlying pavement.
Crusher-Run	The total unscreened product of a stone crusher.

Another valuable resource for terms is MS-4 Asphalt Handbook

Curing	The development of the mechanical properties of the asphalt binder. This occurs after the emulsion has broken and the emulsion particles coalesce and bond to the aggregate.
Cutback Asphalt	Asphalt cement that has been liquified by blending with petroleum solvents (diluents). Upon exposure to atmospheric conditions the diluents evaporate, leaving the asphalt cement to perform its function.

D

Deep Strength Asphalt Pavement	Pavements containing at least four inches of HMA over non-stabilized base courses.
Deflection	A load-induced, downward movement of a pavement section.
Deflection Basin	The idealized shape of the deformed pavement surface as a result of a cyclic or impact load as depicted from the peak measurements of five or more deflection sensors.
Rebound Deflection	The amount of surface rebound when a load is removed.
Representative Rebound Deflection	The mean value of measured rebound deflections in a test section, plus two standard deviations, adjusted for temperature and most critical period of the year for pavement performance.
Residual Deflection	The difference between original and final elevations of the pavement surface resulting from the application to, and removal of, one or more loads from the surface.
Deflection Sensor	The term that shall be used to refer to the electronic device(s) capable of measuring the vertical movement of the pavement; and, mounted in such a manner as to minimize angular rotation with respect to its measuring plane at the expected movement. Sensor types include seismometers, velocity transducers, and accelerometers.
Delivery Tolerances	Permissible variations from the exact desired proportions of aggregate and bituminous material as manufactured by an asphalt plant.
Dense-Graded Aggregate	An aggregate that has a particle size distribution such that when it is compacted, the resulting voids between the aggregate particles, expressed as a percentage of the total space occupied by the material, are less than 10%.
Densification	The act of increasing the density of a mixture during the compaction process.

A	B	C	D	E	F	G	H	I	K	L
M	N	O	P	R	S	T	U	V	W	

Another valuable resource for terms is MS-4 Asphalt Handbook

Design ESAL	The total number of equivalent 80-kN (18,000-lb.), single-axle load applications (equivalent single axle loads) expected throughout the design period.
Design Lane	The lane on which the greatest number of equivalent 80-kN (18,000-lb.) single axle loads (ESAL) is expected. This will normally be either lane of a two-lane roadway or the outside lane of a multi-lane highway.
Design Period	The number of years from the initial application of traffic until the first planned major resurfacing or overlay. This term should not be confused with pavement life or analysis period. Adding hot mix asphalt overlays as required will extend pavement life indefinitely or until geometric considerations (or other factors) make the pavement obsolete.
Design Subgrade Resilient Modulus	The value of the Subgrade Resilient Modulus (MR) used for designing the pavement structure. It is a percentile value of the subgrade resilient modulus test data distribution that varies with design ESAL.
Disintegration	The breaking up of a pavement into small, loose fragments caused by traffic or weathering (e.g. raveling).
Distortion	Any change of a pavement surface from its original shape.
Drum Mix Plant	A manufacturing facility for producing asphalt paving mixtures that proportions the aggregate, then dries and coats the aggregate with a proportional amount of asphalt in the same drum. Variations of this type of plant use several types of drum modifications, separate (and smaller) mixing drums, and coating units (coater) to accomplish the mixing process. They are more suited for long runs of the same product.
Dryer	An apparatus that will dry the aggregates and heat them to the specified temperatures.
Ductility	The ability of a substance to be drawn out or stretched thin. While ductility is considered and important characteristic of asphalt cements in many applications, the presence or absence of ductility is usually considered more significant than the actual degree of ductility.
Durability	The property of an asphalt pavement that represents its ability to resist disintegration by weathering and traffic.

A	B	C	D	E	F	G	H	I	K	L
M	N	O	P	R	S	T	U	V	W	

Another valuable resource for terms is MS-4 Asphalt Handbook

E

Edge Joint Cracks	The separation of the joint between the pavement and the shoulder, commonly caused by the alternate wetting and drying beneath the shoulder surface. Other causes are shoulder settlement, mix shrinkage, and trucks straddling the joint.
Effective Thickness	The ratio of the thickness of an existing pavement material compared to the equivalent thickness of a new HMA layer.
Emulsifying Agent or Emulsifier	The chemical added to the water and asphalt that keeps the asphalt in stable suspension in the water. The emulsifier determines the charge of the emulsion and controls the breaking rate.
ESAL (equivalent single axle loads)	The effect on pavement performance of any combination of axle loads of varying magnitude equated to the number of 80-kN (18,000-lb.) single-axle loads that are required to produce an equivalent effect.

F

Fatigue Resistance	The ability of asphalt pavement to resist crack initiation caused by repeated flexing.
Fault	A difference in elevation of two slabs at a joint or crack.
Fine Aggregate	Aggregate passing the 2.36 mm (No. 8) sieve.
Fine-Graded Aggregate	One having a continuous grading in sizes of particles from coarse through fine with a predominance of fine sizes.
Flexibility	The ability of an asphalt pavement structure to conform to settlement of the foundation. Generally, flexibility of the asphalt paving mixture is enhanced by high asphalt content.
Fog Seal	A light application of diluted asphalt emulsion. It is used to renew old asphalt surfaces, seal small cracks and surface voids, and inhibit raveling.
Fractured Slab Techniques	Processes used to rehabilitate PCC pavements by eliminating slab action through the reduction of slab size (crack/break and seat) or the pulverization of the PCC slab (rubblization) into essentially a granular base.
Full-Depth Asphalt Pavement	The term FULL-DEPTH (registered by the Asphalt Institute with the U.S. Patent Office) certifies that the pavement is one in which asphalt mixtures are employed for all courses above the subgrade or improved subgrade. A Full-Depth asphalt pavement is placed directly on the prepared subgrade.

Another valuable resource for terms is MS-4 Asphalt Handbook

G

Grade Depressions	Localized low areas of limited size.

H

Heavy Trucks	Two-axle, six-tire trucks or larger. Pickup, panel and light four-tire trucks are not included. Trucks with heavy-duty, wide-base tires are included.
Hot Aggregate Storage Bins	Bins that store heated and fractionated aggregates prior to their final proportioning into the mixer.
Hot Mix Asphalt (HMA)	High quality, thoroughly controlled hot mixture of asphalt binder (cement) and well-graded, high quality aggregate, which can be compacted into a uniform dense mass.
Hot Mix Asphalt (HMA) Overlay	One or more courses of HMA over an existing pavement.

I

Impermeability	The resistance an asphalt pavement has to the passage of air and water into or through the pavement.

K

Kinematic Viscosity	A measure of the viscosity of asphalt, measured in centistokes, conducted at a temperature of 275°F (135°C).

L

Lane Joint Cracks	Longitudinal separations along the seam between two paving lanes.
Lift	A layer or course of paving material applied to a base or a previous layer.
Lime Treated Subgrade	A subgrade preparation technique in which the subgrade soil and added lime are mechanically mixed and compacted to produce a higher modulus base material than the in-situ material.
Lime-Fly Ash Base	A road base material consisting of a blend of mineral aggregate, lime, fly ash, and water, which when combined in proper proportions and compacted produces a dense mass of increased strength.

Another valuable resource for terms is MS-4 Asphalt Handbook

Load Equivalency Factor (LEF)	The number of 18,000-lb. (80-kN) single-axle load applications (ESAL) contributed by one passage of an axle.
Longitudinal Crack	A vertical crack in the pavement that follows a course approximately parallel to the centerline.

M

Maintenance Mix	A mixture of asphalt emulsion and mineral aggregate for use in relatively small areas to patch holes, depressions, and distressed areas in existing pavements. Appropriate hand or mechanical methods are used in placing and compacting the mix.
Mechanical Spreaders	Spreader boxes that are mounted on wheels. The spreaders are attached to and pushed by dump trucks (HMA boxes are pulled and chip spreaders are pushed).
Medium-Curing (MC) Asphalt	Cutback asphalt composed of asphalt cement and a diluent of medium volatility.
Mesh	The square opening of a sieve.
Micro-Surfacing	A mixture of polymer modified asphalt emulsion, crushed dense graded aggregate, mineral filler, additives and water. It provides a thin resurfacing of 3/8 to 3/4 inch (10 to 20 mm) to the pavement.
Milling Machine	A self-propelled unit having a cutting head equipped with carbide-tipped tools for the pulverization and removal of layers of asphalt materials from pavements.
Mineral Dust	The portion of the fine aggregate passing the No. 200 (0.075 mm) sieve.
Mineral Filler	A finely divided mineral product, at least 70 percent of which will pass a No. 200 (0.075 mm) sieve. Pulverized limestone is the most commonly manufactured filler, although other stone dust, hydrated lime, portland cement, and certain natural deposits of finely divided mineral matter are also used.
Modified Asphalt Rubber - Asphalt Concrete (MAR-AC)	High quality, thoroughly controlled hot mixture of modified asphalt rubber binder (AR) and well-graded, high quality aggregate, which can be thoroughly compacted into a uniformly dense mass.
Modified Asphalt Rubber Binder (MAR)	Conventional asphalt cement to which recycled ground tire rubber and compounds have been added, that when reacted with the hot asphalt cement causes a dispersion of the tire rubber particles and compounds.

Another valuable resource for terms is MS-4 Asphalt Handbook

Multiple Surface Treatment	**Two or more surface treatments placed one on the other. The maximum aggregate size of each successive treatment is usually 1/2 the previous one. It may be a series of single treatments that produces a pavement course up to 1 in. (25mm) or more in thickness. A multiple surface treatment is a denser wearing and waterproofing course than a single surface treatment.**

N

Natural (Native) Asphalt	Asphalt occurring in nature, which has been derived from petroleum through natural processes of evaporation of volatile fractions, leaving the asphalt fractions. The native asphalt of most importance is found in the Trinidad and Bermudez Lake deposits. Asphalt from these sources is often called lake asphalt.
Nondestructive Testing (NDT)	In the context of pavement evaluation, NDT is deflection testing, without destruction to the pavement, to determine a pavement's response to pavement loading.

O

Open-Graded Aggregate	One containing less-fine aggregate in which the void spaces in the compacted aggregate are relatively large and interconnected, usually 10% more.
Open-Graded Asphalt Friction Course	A pavement surface course that consists of a high-void, asphalt plant mix that permits rapid drainage of rainwater through the course and out the shoulder. The mixture is characterized by a large percentage of one-sized coarse aggregate. This course prevents tires from hydroplaning and provides a skid-resistant pavement surface with significant noise reduction.

P

Pascal-Seconds	The SI unit for viscosity. 1 Pascal-second equals 10 poises.
Pavement Base	The lower or underlying pavement course atop the subbase or subgrade and under the top or wearing course.
Pavement Structure	The entire pavement system of selected materials from subgrade to the surface.

Another valuable resource for terms is MS-4 Asphalt Handbook

Penetration Grading	A classification system of asphalt cements based on penetration in 0.1 mm at 25°C (77°F). There are five standard penetration grades for paving: 40-50, 60-70, 85-100, 120-150, and 200-300.
Penetration	The consistency of a bituminous material expressed as the distance (in tenths of a millimeter) that a standard needle penetrates a sample vertically under specified conditions of loading, time and temperature.
Performance Graded (PG)	Asphalt binder grade designation used in Superpave. It is based on the binder's mechanical performance at critical temperatures and aging conditions.
Planned Stage Construction	A construction process where stages of the project are performed sequentially according to design and a predetermined time schedule.
Plant Mix (Cold)	A mixture of emulsified (or cutback) asphalt and unheated mineral aggregate prepared in a central mixing plant and spread and compacted with conventional paving equipment while the mixture is at or near ambient temperature.
Plant Mix Base	A foundation course produced in an asphalt mixing plant, which consists of a mineral aggregate uniformly coated with asphalt cement or emulsified asphalt.
Plant Screens	Screens located between the dryer and hot bins, which separate heated aggregates into proper hot bin sizes.
Pneumatic-Tire Roller	A compactor with a number of tires spaced so their tracks overlap delivering a kneading type of compaction.
Poise	A centimeter-gram-second unit of absolute viscosity equal to the viscosity of a fluid in which a value of stress one dyne per square centimeter is required to maintain a difference of velocity of one centimeter per second between two parallel planes in the fluid that lie in the direction of flow and are separated by a distance of one centimeter.
Polished Aggregate	Aggregate particles in a pavement surface that have been worn smooth by traffic.
Polymer-Modified Asphalt (PMA) Binder	Conventional asphalt cement to which one or more polymer compounds (typically SBS or SBR) have been added to improve resistance to deformation at high pavement temperatures and often cracking resistance at low temperatures.

A	B	C	D	E	F	G	H	I	K	L
M	N	O	P	R	S	T	U	V	W	

Another valuable resource for terms is MS-4 Asphalt Handbook

Potholes	Bowl-shaped openings in the pavement resulting from localized disintegration.
Power Sweeper	A power operated rotary broom used to clean loose material from the pavement surface.
Present Serviceability Index (PSI)	A mathematical combination of values obtained from certain physical measurements of a large number of pavements, so formulated as to determine, within prescribed limits, the Present Serviceability Rating (PSR) for those pavements.
Present Serviceability Rating (PSR)	The rating assigned to a specific pavement section.
Present Serviceability	The ability of a specific section of pavement to serve its intended use in its existing condition.
Pumping	Slab deflection under passing loads sometimes resulting in the discharge of water and subgrade soils along joints, cracks and pavement edges.

R

Rapid-Curing (RC) Asphalt	Cutback asphalt composed of asphalt cement and a naphtha or gasoline-type diluent of high volatility.
Raveling	The progressive separation of aggregate particles in a pavement from the surface downward or from the edges inward.
Reclaimed Asphalt Pavement (RAP)	Excavated asphalt pavement that has been pulverized, usually by milling, and is used like an aggregate in the recycling of asphalt pavements.
Reclaiming Machine	A self-propelled unit having a transverse cutting and mixing head inside of a closed chamber for the pulverization and mixing of existing pavement materials with asphalt emulsion. Asphalt emulsion (and mixing water) may be added directly through the machine by a liquid additive system and spray bar.
Recycled Asphalt Mix	A mixture produced after processing existing asphalt pavement materials. The recycled mix may be produced by hot or cold mixing at a plant, or by processing the materials cold and in-place.
Reflection Cracks	Cracks in asphalt overlays (usually over deteriorated PCC pavements) that reflect the crack pattern in the pavement structure below it.

Another valuable resource for terms is MS-4 Asphalt Handbook

Residue	**The asphalt binder that remains from an asphalt emulsion after the emulsifying agent has broken and cured, or the remains of a cutback after the volatiles have cured.**
Resilient Modulus of Elasticity (MR)	A laboratory measurement of the behavior of pavement materials to characterize their stiffness and resiliency (see Soils Manual, MS-10). A confined or unconfined test specimen (core or recompacted) is repeatedly loaded and unloaded at a prescribed rate. The resilient modulus is a function of load duration, load frequency, and number of loading cycles.
Resistance Value (R-value)	A test for evaluating bases, subbases, and subgrades for pavement thickness design.
Road Oil	Asphalt cement and oils of low volatility, usually similar to one of the slow-curing (SC) grades.
Roadway	All facilities on which motor vehicles are intended to travel such as secondary roads, interstate highways, streets and parking lots.
Roughometer	An instrumented, single-wheel trailer, which measures the roughness of a pavement surface in accumulated millimeters, or inches, per mile.
Rubblization	The pulverization of a portland cement concrete pavement into smaller particles, reducing the existing pavement layer to a sound, structural base that will be compatible to an asphalt overlay.

S

Sand Asphalt	A mixture of sand and asphalt cement, cutback asphalt or emulsified asphalt. It may be prepared with sand or clay or combinations thereof including gravelly clay, gravelly sand, clayey gravel, and sandy gravel (the names indicate the relative proportions of the materials in the mixture). Either mixing-in-place or plant mix construction may be employed. Sand asphalt is used in construction of both base and surface course and may or may not contain mineral filler.
Sand	Fine aggregate (any fraction below a No. 8 sieve) resulting from natural disintegration and abrasion or processing of rock.
Sandwich Seal	A surface treatment consisting of the application of a large aggregate, then a spray applied asphalt emulsion, and covered with a smaller aggregate.

Another valuable resource for terms is MS-4 Asphalt Handbook

Sandy Soil	A material consisting essentially of fine aggregate particles smaller than 2.36 mm (No. 8) sieve and usually containing material passing a 75 µm (No. 200) sieve. This material usually exhibits some plasticity characteristics.
Saw-Cut and Seal	A method of controlling reflective cracking in HMA overlays that involves constructing joints in the new overlay exactly over the joints in the existing pavement.
Scaling	The peeling away or disintegrating of the surface of portland cement concrete.
Seal Coat	A thin surface treatment used to improve the surface texture and protect an asphalt surface. The main types of seal coats are fog seals, sand seals, slurry seals, micro-surfacing, cape seals, sandwich seals and chip seals.
Self-Propelled Spreaders	Spreaders having their own power units and two hoppers. The spreader pulls the truck as it dumps its load into the receiving hopper. Conveyor belts move the aggregate forward to the spreading hopper.
Sheet Asphalt	A hot mixture of asphalt binder with clean, angular, graded sand and mineral filler. Its use is ordinarily confined to reservoir liners and landfill caps; usually laid on an intermediate or leveling course.
Shoving	A form of plastic movement resulting in localized bulging of the pavement.
Shrinkage Cracks	Interconnected cracks forming a series of large blocks, usually with sharp corners or angles.
Sieve	An apparatus for laboratory work in which the openings in the mesh are square for separating sizes of material.
Single Surface Treatment	A single application of asphalt to a road surface followed immediately by a single layer of aggregate. The thickness of the treatment is about the same as the nominal, maximum size aggregate particles.
Skid Hazard	Any condition that might contribute to the reduction of friction forces on the pavement surface.
Skid Resistance	The ability of a paved surface, particularly when wet, to offer resistance to slipping or skidding. Proper asphalt content and aggregate with a rough surface texture are the greatest contributors. The aggregate must not only have a rough surface texture, but also resist polishing.

Another valuable resource for terms is MS-4 Asphalt Handbook

Slippage Cracks	Crescent-shaped cracks resulting from traffic-induced horizontal forces that are open in the direction of the thrust of wheels on the pavement surface. They result when severe or repeated shear stresses are applied to the surface and there is a lack of bond between the surface layer and the course beneath.
Slow-Curing (SC) Asphalt	Cutback asphalt composed of asphalt cement and oils of low volatility.
Slurry Seal	A mixture of emulsified asphalt, well-graded fine aggregate, mineral filler or other additives, and water. A slurry seal will fill minor cracks, restore a uniform surface texture, and restore friction values.
Soil/Cement Base	A hardened material formed by curing a mechanically mixed and compacted mixture of pulverized soil, portland cement and water used as a layer in a pavement system to reinforce and protect the subgrade or subbase.
Solubility	A measure of the purity of asphalt cement. The ability of the portion of the asphalt cement that is soluble to be dissolved in a specified solvent.
Source Properties	Aggregate characteristics that must follow certain criteria to satisfy a Superpave mix design. Specified values are established by local agencies. They include Toughness, Soundness, and Deleterious Materials.
Spalling	The breaking or chipping of a PCC pavement at joints, cracks, or edges, usually resulting in fragments with featheredges.
Stability	The ability of an asphalt paving mixture to resist deformation from imposed loads. Stability is dependent upon both internal friction and cohesion.
Standard Deviation	The root-mean-square of the deviations about the arithmetic mean of a set of values.
Stationary Plants	Asphalt plants that are so constructed that moving them is not considered economically feasible.
Steel-Wheel Static Rollers	Tandem or three-wheel rollers with cylindrical steel rolls that apply their weight directly to the pavement.
Steel-Wheel Vibratory Rollers	A compactor having single or double cylindrical steel rolls that apply compactive effort with weight and vibration. The amount of compactive force is adjusted by changing the frequency and amplitude of vibration.

Another valuable resource for terms is MS-4 Asphalt Handbook

Stoke	A unit of kinematic viscosity equal to the viscosity of a fluid in poises divided by the density of the fluid in grams per cubic centimeter.
Structural Overlay	A HMA overlay constructed for the purpose of increasing the structural value and ride quality of the pavement system.
Subbase	The course in the asphalt pavement structure immediately below the base course. If the subgrade soil has adequate support, it may serve as the subbase.
Subgrade Resilient Modulus	The modulus of the subgrade determined by repeated load, triaxial compression tests on soil samples. It is the ratio of the amplitude of the accepted axial stress to the amplitude of the resultant recoverable axial strain, generally designated by the symbol MR.
Subgrade, Improved	Subgrade that has been improved as a working platform by: 1) the incorporation of granular materials or stabilizers such as asphalt, lime, or portland cement into the subgrade soil; 2) any course or courses of select or improved material placed on the subgrade soil below the pavement structure.
Subgrade	The soil prepared to support a pavement structure or a pavement system. It is the foundation of the pavement structure.
Superpave Gyratory Compactor (SGC)	A device used during Superpave mix design or quality control activities for compacting samples of hot mix asphalt into specimens used for volumetric analysis. Continuous densification of the specimen is measured during the compaction process.
Superpave Mix Design	An asphalt mixture design system that integrates the selection of materials (asphalt, aggregate) and volumetric proportioning with the project's climate and design traffic.
Superpave™	Short for "Superior Performing Asphalt Pavement" a performance-based system for selecting and specifying asphalt binders and for designing asphalt mixtures.

T

Transverse Crack	A crack that follows a course approximately at right angles to the centerline.

A	B	C	D	E	F	G	H	I	K	L
M	N	O	P	R	S	T	U	V	W	

Another valuable resource for terms is MS-4 Asphalt Handbook

Travel Plants	Self-propelled pugmill plants that proportion and mix aggregates and asphalt as they move along the road. There are three general types of travel plants: 1. One that moves through a prepared aggregate windrow on the roadbed, adds and mixes the asphalt as it goes, and rear discharges a mixed windrow ready for aeration and spreading. 2. One that receives aggregate into its hopper from haul trucks, adds and mixes asphalt, and spreads the mix to the rear as it moves along the roadbed. 3. Batch mixing units, such as slurry machines, that haul materials to the site and then mix and apply the materials.
Truck Factor	The number of ESALs contributed by one passage of a vehicle. Truck Factors can apply to vehicles of a single type or class or to a group of vehicles of different types.

U

Upheaval	The localized upward displacement of a pavement due to swelling of the subgrade or some portion of the pavement structure.

V

Viscosity Grading	A classification system of asphalt cements based on viscosity ranges at 60°C (140°F). A minimum viscosity at 135°C (275°F) is also usually specified. The purpose is to prescribe limiting values of consistency at these two temperatures. 60°C (140°F) approximates the maximum temperature of an asphalt pavement surface in service in the U.S. 135°C (275°F) approximates the mixing and laydown temperatures for hot mix asphalt pavements.
Viscosity	A measure of a liquid's resistance to flow with respect to time.

W

Well-Graded Aggregate	Aggregate graded with relatively uniform proportions, from the maximum size down to filler.
Wet Mixing Period	The interval of time between the beginning of application of asphalt material into a pugmill and the opening of the discharge gate.
Whirl Spreaders	Spreaders that are attached to or are built onto dump trucks. Aggregate is fed onto the spreader disc through an adjustable opening. The speed of the disc controls the width of spread.
Workability	The ease with which paving mixtures may be placed and compacted.

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Notes if Needed

2026 Edition

Binder Ignition

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Notes if Needed

BINDER IGNITION

UPDATES

- **2026- Binder Ignition: Added to Bituminous Technician Certification**

- **2024 – 2025 No Method updates**

• **2023** – Module 1 – Binder Ignition Oven AASHTO T308- Updates

  o Thermometers for measuring temperature See Appendix Item Equipment for more information on Thermometers.

  o Ignition furnace updates on temperature control, see Appendix Item Equipment

• **2022 –** New manual, but no method updates.

COURSE CONTENT

BINDER IGNITION OVEN TEST

Module 1

Binder Ignition
AASHTO T308

MoDOT

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Notes if Needed

MODULE 9

BINDER IGNITION OVEN AC CONTENT AASHTO T308

Rev 2/6/2025

1

SCOPE

This test method AASHTO T308:

- Covers the determination of asphalt binder content of asphalt mixtures by ignition at temperatures that reach the flashpoint of the binder in a furnace.
- Heating may be convection method or direct infrared (IR) irradiation method.
- Two Methods,
  - **Method A** requires an ignition furnace with an internal balance.
  - **Method B** requires an ignition furnace with an external balance.

2

2

SIGNIFICANCE AND USE

This method can be used for:

- Quantitative determinations of asphalt binder content.
- Gradation in asphalt mixture and pavement specimens for quality control.
- Specification acceptance.
- Mixture evaluation studies.
- For gradation analysis according to AASHTO T30.

3

3

EQUIPMENT

- **Ignition Furnace** – A forced air oven that heats by convection or direct IR irradiation. The convection type must be capable of maintaining 538 ± 5°C (1000 ± 9°F).
  - For Method A the oven shall have an internal balance.
- Specimen basket assembly consisting of
  - Specimen Baskets
  - Catch Pan
  - Assembly guard
- See appendix, Item #7 for more information on equipment.

4

4

Oven Verification:

- The oven must be "verified' every 12 months and after each move.
  - Temperature
  - Balance

Methods:

- Yearly outside service (usually along with gyro and mold calibrations, etc.)
- In-house

5

5

Ignition Oven Basics:

- **% Binder**: Loss in mass of specimen
- **Problem:** Other materials also burn off
  - Moisture
  - Aggregate
  - Miscellaneous

6

6

CORRECTIONS

1. Moisture
   - Moisture Content "MC"
2. Aggregate Burn Loss
   - Aggregate Correction Factor "Cf"
3. Temperature effects on weighing
   - Temperature Correction Factor "TCF"

7

7

1. Moisture

- Moisture in mix will evaporate.
- This will count as binder unless corrected.
- Correction (2 methods):

Method 1
- Dry mix to a constant mass at 110 ± 5°C (230 ±9°F) prior to testing.
- "Aging"—must still verify that constant mass has been achieved.

OR

Method 2
- Determine moisture content of mix (AASHTO T 329), subtract it from the apparent binder content.

8

8

Moisture Content (AASHTO T 329): Method 2

- Temperature: **(See BT Manual for T329)**
  - Within the JMF mixing temperature range.
  - If unavailable, use 163 ±14°C (325 ±25°F)
- ≥1,000g sample, Initial drying time is 90 ± 5 min.
- Continue drying checking at 30 ± 5 min intervals until the mass changes less than 0.05% from the previous mass = Constant Mass.

  Report to nearest 0.01%
- Moisture is calculated based on *dry* weight of HMA.

9

9

Rounding:

- When calculating, moisture content, binder content, and Cf, round to nearest 0.01%

Side note:

Binder Content: When comparing to specification, round binder content to nearest 0.1%.

Moisture Content

10

10

$$\% \text{ Change} = \frac{(A - B)}{A} \times 100$$

A = Previous mass determination

B = Newest mass determination

REPORT = To the nearest **0.01%**

Reminder from BT certification:

First subtract the container weight from the total weight for A and B then record the weights to the nearest **0.01 g** before calculating % change.

11

11

Moisture Content (AASHTO T 329): Method 2

$$\text{Moisture Content} = \frac{(M_i - M_f)}{M_f} \times 100$$

Where:

M_i = Mass of initial, moist test sample

M_f = Mass of the final, dry test sample

Report = % Moisture to the nearest **0.01%**

Updated slide

11

12

Moisture Content (AASHTO T 329): Method 2

$$Moisture\ Content = \frac{(M_i - M_f)}{M_f} \times 100$$

Classroom Practice

M_i = 1134.9

M_f = 1127.3

% Moisture = ____________ %

Report to the nearest 0.01%

13

Rounding:

Method 2

- When calculating, moisture content, binder content, and Cf, round to nearest 0.01%

Side note:

Binder Content: When comparing to specification, round binder content to nearest 0.1%.

Moisture Content

13

14

Moisture Testing Frequency:

"Common Wisdom" as needed . . .

- High RAP/RAS mixtures especially prone to moisture.
- Rainy weather
- "Warm mix"
- New aggregate
- If plant operator reports burning more fuel to maintain temperature.
- Fluctuating volumetrics or binder contents
- Watering piles per DNR.
- Same stockpiles
- Dry weather
- No moisture when tested

Moisture Content

14

15

2. Aggregate Burn Loss

Aggregate Correction Factor :

- To correct for loss of mass during the mix ignition due to aggregate burn-off.
- Determined during mix design by mix designer (usually QC).
- Re-determined if mix design changes (e.g. >5% change in stockpiled aggregate proportions).
- Re-determined if a different oven is used (QA or QC).

Aggregate Correction 15

16

C_F Procedure:

- Mix specimen in lab with dry aggregate at a known (***actual***) % binder.
- Input "zero" for the C_F
- Burn, obtain ***measured*** ***(apparent)*** % binder.
- The difference between the ***measured*** and the ***actual*** % binder is the Asphalt Binder Correction Factor (C_F).
- If the C_F is > 1.0%, re-determine at a lower temperature.

Aggregate Correction 16

17

Definitions:

- **M** = mass (g)
- **Mi(dry)** = Mass of mix before burning, dry already.
- **Mf** = Final mass of mix after burning (binder and some aggregate burned off).
- **(Mi(dry) – Mf)** = Binder & aggregate burned off.
- **Magg** = Initial unburned mass of just the aggregate, dry.
- **(Mi(dry) – Mi(agg))** = Mix mass minus aggregate mass is the mass of binder, initially.

Aggregate Correction 17

18

C_F Calculations:

$C_f = Measured - Actual$

- Lab-produced sample (dry)

$$C_f = \left[\frac{M_{i(dry)} - M_f}{M_{i(dry)}}\right] - \left[\frac{M_{i(dry)} - M_{i(agg)}}{M_{i(dry)}}\right]$$

- The difference is the aggregate mass loss
- The ***Measured*** binder content can be from the oven ticket
- The ***Actual*** binder content can be from a bench scale
- If the C_F is > 1.0%, re-determine at a lower temp.
- Report to the nearest 0.1%

Aggregate Correction

18

19

Two types of Ovens

Infrared Oven

Convention Oven

New Slide

19

20

Convection Oven Temperatures :

- **AASHTO**:
  - Normal: 538 °C (1000.4 °F)
  - High C_F's (>1.0%): 482 °C (899.6 °F)
- **MoDOT**:
  - Normal: 538 °C (1000.4 °F)
  - High C_F's: if >1.0% try 482 C (899.6 °F)
  - Very high C_F's: if >1.0% at 482 C, use 427 C

    Very high C_F's: if >1.0% at (899.6 °F), use (800.6°F)

Aggregate Correction

21

21

Cf Determination:
Number of Replicate Specimens

- Use two
- If the difference in measured asphalt contents is > 0.15%, test two more replicates.
- For the four replicates, discard the high and low results.

Aggregate Correction

21

22

Asphalt Binder Correction Factor
(Aggregate Correction Factor)
Data Sheet

Enlarged

ASPHALT CONTENT IGNITION METHOD
AASHTO T 308
METHOD A

Aggregate Correction Factor
[Asphalt Binder Correction Factor] D

Total Dry Mass – Tare Basket Mass = Initial Dry Specimen Mass

Sample__________ Lab No.______ Date_____ Initials_____

Replicate	1	2	3	4
Test Temperature	538	538		
Tare (basket, etc.) Mass (g)	3000.0	3000.0		
Total Dry Mass (g)	5000.1	5005.2		
Initial Dry Specimen Mass (g)	2000.1	2005.2		
Loss in Weight (g)	125.2	126.1		
%AC, measured = M	6.26	6.29		
%AC, actual = A	6.00	6.01		
$\%AC_{diff}$ $(M_1 - M_2)$	0.03	> 0.15%? If so, 2 more replicates		
$C_F = M - A$	0.26	0.28		
C_F Average	0.27			

$$\%AC, \text{measured} = M = \frac{\text{Loss in weight}}{\text{Initial Dry Mass}} \times 100$$

Updated Slide

22

23

ASPHALT CONTENT IGNITION METHOD
AASHTO T 30
METHOD A

Classroom Practice

Aggregate Correction Factor
[Asphalt Binder Correction Factor] Determina...

Sample__________ Lab No.______ Date_____ Initials_____

Replicate	1	2	3	4
Test Temperature	538	538		
Tare (basket, etc.) Mass (g)	3000.0	3000.0		
Total Dry Mass (g)	4129.2	4123.8		
Initial Dry Specimen Mass (g)				
Loss in Weight (g)	65.7	62.9		
%AC, measured = M				
%AC, actual = A	5.25	5.23		
$\%AC_{diff}$ $(M_1 - M_2)$		> 0.15%? If so, 2 more replicates		
$C_F = M - A$				
C_F, average				

New Slide

23

24

Asphalt Binder Correction Factor

(Aggregate Correction Factor)

Data Sheet

Enlarged

ASPHALT CONTENT IGNITION METHOD
AASHTO T 308
METHOD A

Aggregate Correction Factor
[Asphalt Binder Correction Factor]

Total Dry Mass – Tare Basket Mass = Initial Dry Specimen Mass

Sample____________________ Lab No.________ Date______ Initials______

Replicate	1	2	3	4
Test Temperature	538	538		
Tare (basket, etc.) Mass (g)	3000.0	3000.0		
Total Dry Mass (g)	5000.1	5005.2		
Initial Dry Specimen Mass (g)	2000.1	2005.2		
Loss in Weight (g)	125.2	126.1		
%AC, measured = M	6.26	6.29		
%AC, actual = A	6.00	6.01		
$\%AC_{diff}$ $(M_1 - M_2)$	0.03	> 0.15%? If so, 2 more replicates		
$C_F = M - A$	0.26	0.28		
C_F Average	0.27			

$$\%AC,\ measured = M = \frac{\text{Loss in weight}}{\text{Initial Dry Mass}} \times 100$$

Updated Slide

ASPHALT CONTENT IGNITION METHOD
AASHTO T 30
METHOD A

Classroom Practice

Aggregate Correction Factor
[Asphalt Binder Correction Factor] Determina

Sample______________________ Lab No.__________ Date_______ Initials_______

Replicate	1	2	3	4
Test Temperature	538	538		
Tare (basket, etc.) Mass (g)	3000.0	3000.0		
Total Dry Mass (g)	4129.2	4123.8		
Initial Dry Specimen Mass (g)				
Loss in Weight (g)	65.7	62.9		
%AC, measured = M				
%AC, actual = A	5.25	5.23		
$\%AC_{diff}$ ($M_1 - M_2$)		> 0.15%? If so, 2 more replicates		
$C_F = M - A$				
C_F, average		New Slide		

Asphalt Binder Correction Factor
(Aggregate Correction Factor)
Data Sheet

Key

ASPHALT CONTENT IGNITION METHOD
AASHTO T 308
METHOD A

Aggregate Correction Factor
[Asphalt Binder Correction Factor] Determination

Sample__________ Lab No._______ Date_____ Initials_____

Replicate	1	2	3	4
Test Temperature	538	538		
Tare (basket, etc.) Mass (g)	3000.0	3000.0		
Total Dry Mass (g)	4129.2	4123.8		
Initial Dry Specimen Mass (g)	1129.2	1123.8		
Loss in Weight (g)	65.7	62.9		
%AC, measured = M	5.82	5.60		
%AC, actual = A	5.25	5.23		
$\%AC_{diff}$ ($M_1 - M_2$)	0.22	> 0.15%? If so, 2 more replicates		
$C_F = M - A$	0.57	0.37		
C_F, average	0.47			

Need 2 more replicates

24

25

Use of Cf :

- Before production, when Cf is the *unknown*:

Cf = Measured Content – Actual Content

- During production, when Actual Content is *unknown*:

Actual = Measured Content – Cf

Aggregate Correction

25

26

Infrared Burn Profiles:

- **"Default"**
  Most mixes

- **"Option 1"**
  (Less) - For C_f > 1.0% e.g., RAP containing dolomite.

- **"Option 2"**
  (More) – Hard to burn mixes

Aggregate Correction

26

27

RAP Aggregate Correction Factor :
(Asphalt Binder Correction Factor)

- **Follow TM-77:**
  - Assumes aggregate C_F for RAP aggregate is same as C_F for virgin aggregate.
  - Follow the standard procedure as if there was no RAP, i.e., use only the virgin aggregate, and only the binder content associated with the virgin aggregate portion when fabricating the specimen.
  - So, the Cf from the virgin materials test is used as the Cf for the whole mix.

Aggregate Correction

27

28

3. Temperature Effects on Weighing
Temperature Compensation Factor (TCF)

Convention Oven:

- Material "weighs" differently at elevated temperatures.
- Mass loss shown on the oven printout must be corrected.
- Oven calculates and prints the "Temperature Correction Factor (TCF)" for the particular test run.
- ***TCF = Apparent loss in mass due to heating.***

28

29

Use of Temperature Correction Factor:

- When determining the Aggregate Correction Factor, if the oven printout is used for determination of the Measured Asphalt Content, include the Temperature Correction Factor (TCF).
- If all weighing is performed outside of the oven and specimen is cooled to room temperature, do not use the TCF.

29

30

Second Generation Infrared oven:

- No Temperature Correction Factor
- **Anecdotal**: Scale is better insulated from the chamber.

30

31

PROCEDURE FOR T308

Determining the Asphalt Binder Content of Asphalt Mixtures by the Ignition Method

31

32

Test Methods

- Method A – Furnace with internal scale
- Method B – Furnace without internal scale

32

33

SAMPLING/REHEATING

EPG 403.1.5 Link: Engineering_Policy_Guide (modot.org)

Sampling:

- Obtain samples of Loose Mix according to AASHTO R97. (See Module 5 on Sampling)

Reheating:

- Place the box or bucket of sample in an oven 110 ± 5°C (230 ± 9°F) gently warm the sample until workable.
- Remove the sample from box or bucket.

33

34

Reducing:

- Reduce the sample per AASHTO R47 (see module 6) to amount listed on Table 1.
- Spread sample in a large pan or two.

  If needed, reheat the pan just until sample is workable. 110 ± 5°C (230 ± 9°F)

NOTE: Monitor the heating, do not leave sample in the oven too long.

Sampling 34

35

Ignition Oven Specimen Size (TABLE 1)

Mix	NMS, in.	Specimen Size, g
SP048 & BP-3	#4	1200-1700
SP095	3/8	1200-1700
SP125, BP-1 & BP-2	1/2	1500-2000
SP190 & Bit Base	3/4	2000-2500
SP250	1	3000-3500

Sampling 35

36

PROCEDURE Method A

- Preheat the furnace to 538±5°C (1000±9°F), or use temperature determined by the correction factor.
- Enter the ***chamber set point*** .

37

At the bench…

- Record weight of empty basket assembly. (0.1g)
- Place ~ half of the mix in each basket.
- Use a spatula or trowel to level and move the mix about an inch away from the edges of the basket.

Method A

37

38

- Cool to room temp.
- Weigh the test specimen and basket on external bench scale. (0.1g)
- Calculate and record the initial weight of the sample. Record to nearest 0.1g

$$\begin{array}{l} \text{Total weight}_{initial} \\ \text{- Empty Basket weight} \\ \hline \text{= Sample Weight}_{initial} \end{array}$$

Method A

38

39

- Input the initial sample weight in whole grams into the ignition furnace controller.
- Enter the ***asphalt correction factor (C_F).***
- Reset the internal scale to zero.

Method A

40

- Put on safety gear.
- Open the chamber door and place the specimen basket with sample in the furnace.
  - Make sure basket is not touching the walls.
- Close the door.

Method A

40

41

- Verify that the specimen weight is displayed on the furnace scale equals the **total mass$_{inital}$** weighed on bench scale **± 5 grams**.
- Start the oven. "Burn"

Method A

42

- Oven will stop when burn is complete.
- Tare off ticket of burn results.
- Put on safety gear, open the door, carefully pull out the basket and place it on a cooling plate.
- Place a protective cage on top of the basket assembly.
- Allow to cool to room temperature. ~ 60min.

Method A

43

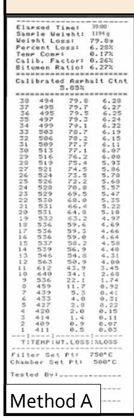
- Move the basket assembly with sample to a scale and record the total weight after ignition. (0.1g)
- Calculate and record the final weight of the specimen to nearest 0.1g

Method A

43

44

CALCULATION/REPORTING



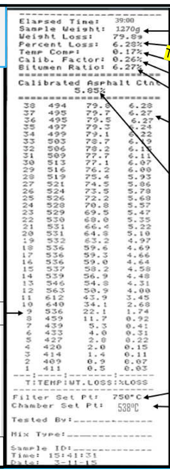
- The furnace will calculate % binder based on the:
  - Original specimen weight entered
  - Total loss
  - Asphalt correction factor (C_F) that you entered.
  - "Temperature Compensation Factor" that the oven calculates = apparent loss in weight due to heating.
- ***You*** must then correct (subtract) for ***moisture*** if started with a wet sample.

Method A

44

45

Test Results Printout



You Entered 1270

Enlarged

=79.8/1270 x 100 = 6.28%

Temp Compensation

Agg. Correction

Apparent loss of wt. due to heat 0.17%

Aggregate Loss; you entered 0.26%

% AC by wt. of Aggregate 6.27%

3 consecutive readings w/in 0.01% loss

% AC by wt. of Mix 5.85%

6.28
-0.17
-0.26
5.85%

Probable Ignition

Starts Here

You set, (Factory Default)

You set, (Typically 538 C)

Method A

45

46

Asphalt Content Ignition Method

(AASHTO T 308-10) Method A

Reproducing Oven Ticket Values

Enlarged

*If w_i = wet

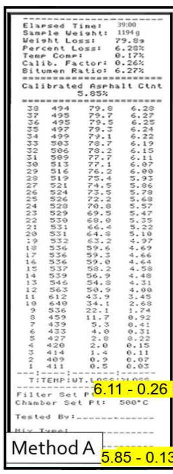
Project No.	Job No.	Route	County
Technician	Date	Sublot No.	Mix No.

Empty Basket Assembly Weight (g), $[T_e]$	3000.2
Basket Assembly + Wet (or dry) Sample Weight (g), $[T_i]$	4270.2
Wet (or dry) Sample Weight (g), $[W_i = (T_i - T_e)]$	
Loss in Weight (g), [L] (from tape)	
Total % Loss, $[P_L = (L / W_i) x100]$	
Temperature Compensation (%), $[C_{tc}]$ (from tape)	
% AC, uncorrected, $[P_{bu} = P_L - C_{tc}]$	
Aggregate Correction (Calibration) Factor (%), $[C_f]$ (from tape)	
Calibrated %AC (from ignition oven tape), $[P_{bcal} = P_{bu} - C_f]$	
% Moisture Content, [MC] (previous test)*	0.13
% AC, corrected (by weight of mix), $[P_b = P_{bcal} - MC]$*	

Method A

46

47



Asphalt Content Ignition Method

(AASHTO T 308-10) Method A

Reproducing Oven Ticket Values

KEY

*If w_i = wet

Project No.	Job No.	Route	County
Technician	Date	Sublot No.	Mix No.

Empty Basket Assembly Weight (g), $[T_e]$	3000.2
Basket Assembly + Wet (or dry) Sample Weight (g), $[T_i]$	4270.2
Wet (or dry) Sample Weight (g), $[W_i = (T_i - T_e)]$	1,270.0
Loss in Weight (g), [L] (from tape)	79.8
Total % Loss, $[P_L = (L / W_i) x100]$ (79.8 / 1270.0) X 100 = 6.289	6.28
Temperature Compensation (%), $[C_{tc}]$ (from tape)	0.17
% AC, uncorrected, $[P_{bu} = P_L - C_{tc}]$ 6.28 – 0.17 = 6.11	6.11
Aggregate Correction (Calibration) Factor (%), $[C_f]$ (from tape)	0.26
Calibrated %AC (from ignition oven tape), $[P_{bcal} = P_{bu} - C_f]$	5.85
% Moisture Content, [MC] (previous test)*	0.13
% AC, corrected (by weight of mix), $[P_b = P_{bcal} - MC]$*	5.72

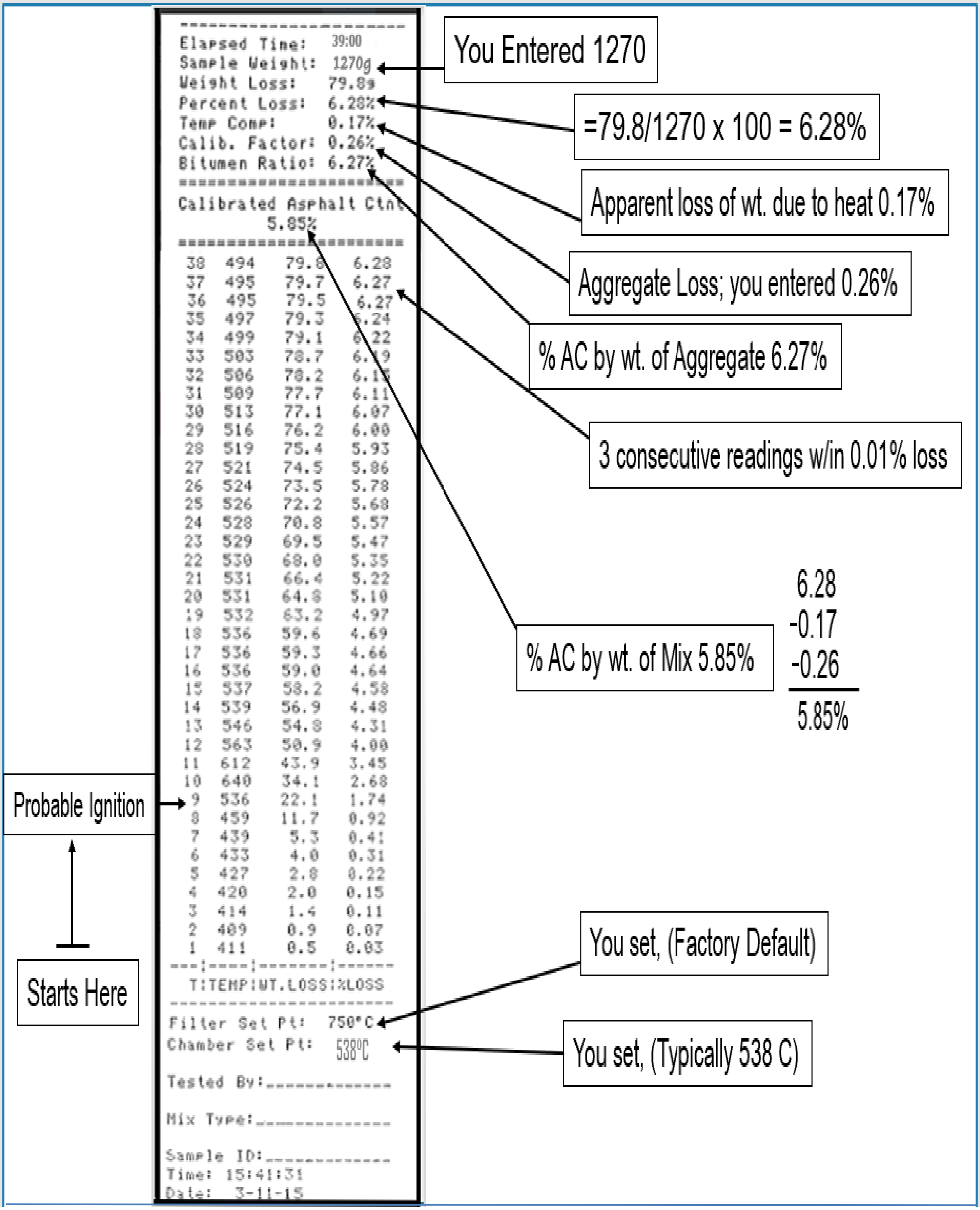
6.11 - 0.26 = 5.85

Method A

5.85 - 0.13 = 5.72

48

TEST RESULTS PRINT OUT FROM IGINITION OVEN



Asphalt Content Ignition Method
(AASHTO T 308-10) Method A
Reproducing Oven Ticket Values

Enlarged

Classroom Practice

*If w_i = wet

Project No.	Job No.	Route	C
…nician	Date	Sublot No.	Mix No.
Empty Basket Assembly Weight (g), [T_e]			3000.2
Basket Assembly + Wet (or dry) Sample Weight (g), [T_i]			4270.2
Wet (or dry) Sample Weight (g), [$W_i = (T_i - T_e)$]			
Loss in Weight (g), [L] (from tape)			
Total % Loss, [$P_L = (L / W_i) \times 100$]			
Temperature Compensation (%), [C_{tc}] (from tape)			
% AC, uncorrected, [$P_{bu} = P_L - C_{tc}$]			
Aggregate Correction (Calibration) Factor (%), [C_f] (from tape)			
Calibrated %AC (from ignition oven tape), [$P_{bcal} = P_{bu} - C_f$]			
% Moisture Content, [MC] (previous test)*			0.13
% AC, corrected (by weight of mix), [$P_b = P_{bcal} - MC$]*			

Method A

Asphalt Binder Correction Factor
(Formerly Aggregate Correction Factor)
Calculation

If final weighing is performed on bench top scale, calculation:

$$P_b = \left[\frac{M_i - M_f}{M_i} \times 100\right] - C_f - MC$$

Where:

M_i = initial weight of mix, wet or dry
M_f = final mass of mix
MC = % moisture
C_f = Asphalt Binder Correction Factor
(old Aggregate Correction Factor)

Method A

48

49

PROCEDURE
Method B

- Note the special heat resistant shirt.

Use SAFETY gear!

50

Method B - No internal scale – Manual Weigh

- Weigh out specimen.
- Burn for about 45 minutes.
- Remove, cool, weigh.
- Burn for another 15 minutes.
- Remove, cool, weigh.
- Keep repeating the 15-minute burn intervals until 2 consecutive mass weighings do not change by > 0.05%.
- Subtract moisture % if necessary.

Method B

50

51

Method B - No internal scale – Manual Weigh

Information needed for the report:

- Moisture = 0.05%
- C_f = 0.22%
- Initial wet mass = 5400.2 g
- Final burned mass (after cooling to room temperature) = 5256.2 g

Weight = Mass
Mass = Weight

Method B

51

52

Asphalt Content Ignition Method B

(AASHTO T 308-10)
Method B
Manual Weighing Method

Teacher Only

Project No.	Job No.	Route	County
Technician	Date	Sublot No.	Mix No.

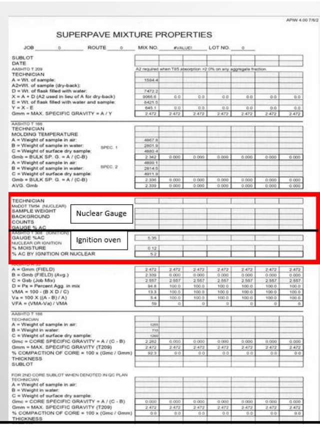
Empty Basket Assembly Weight (g), [T_e]	3000.2
Initial Basket Assembly + Wet (or dry) Sample Weight (g), [T_i]	5400.2
Initial **Wet** (or dry) Sample Weight (g), [$W_i = (T_i - T_e)$]	2400.0
Final Basket Assembly + Burned Sample Weight (g), [T_f]	5256.2
Loss in Weight (g), [$L = T_i - T_f$]	144.0
% Loss, [$P_L = (L / W_i) \times 100$]	6.00
Aggregate Correction (Calibration) Factor (%), [C_f]	-0.22
Calibrated %AC, [$P_{bcal} = P_L - C_f$]	5.78
% Moisture Content, [MC]*	0.05
% AC, corrected (by weight of mix), [$P_b = P_{bcal} - MC$]*	5.73

Method B

- *If non-dried specimen was used (wi = wet)

53

Reporting binder content of mix



Enlarged

52

54

Reporting binder content of mix

Binder Portion

Enlarged

TECHNICIAN							
MoDOT TM54 (NUCLEAR)							
SAMPLE WEIGHT							
BACKGROUND							
COUNTS							
GAUGE % AC							
AASHTO T 308 (IGNITION)							
GAUGE %AC	5.35						
NUCLEAR OR IGNITION							
% MOISTURE	0.12						
% AC BY IGNITION OR NUCLEAR	5.2						

53

55

Binder content of RAP

RAP Binder Content

- **Per Spec 403.19.3;** RAP binder content must be determined
- **QC:** 1 per 4 sublots
- **QA:** 1 per project
- T164 (solvent extraction)
- Can use T308 (ignition) if a correction factor is determined which is the difference between T164 & T308 (best to use your own oven when T164 is determined by another lab).

54

56

Binder content of RAP

RAP & RAS

- Some contractors stockpile RAP & RAS, prepare (grind) it, and sample it.
- Send sample to a commercial lab to have extractions run (T164), obtain binder content & gradation.
- This is what is submitted to MoDOT during mix design.
- During production, RAP is sampled, and ignition oven used to get binder content & gradation.

55

57

SUPERPAVE MIXTURE PROPERTIES

JOB 0 ROUTE 0 MIX NO. #VALUE! LOT NO. 0

SUBLOT							
DATE							
AASHTO T 209	A2 required when T85 absorption >2.0% on any aggregate fraction.						
TECHNICIAN							
A = Wt. of sample:	1594.4						
A2=Wt. of sample (dry-back):							
D = Wt. of flask filled with water:	7472.2						
X = A + D (A2 used in lieu of A for dry-back)	9066.6	0.0	0.0	0.0	0.0	0.0	0.0
E = Wt. of flask filled with water and sample:	8421.5						
Y = X - E	645.1	0.0	0.0	0.0	0.0	0.0	0.0
Gmm = MAX. SPECIFIC GRAVITY = A / Y	2.472	2.472	2.472	2.472	2.472	2.472	2.472

AASHTO T 166								
TECHNICIAN								
MOLDING TEMPERATURE								
A = Weight of sample in air:	SPEC. 1	4867.8						
B = Weight of sample in water:		2801.9						
C = Weight of surface dry sample:		4880.4						
Gmb = BULK SP. G. = A / (C-B)		2.342	0.000	0.000	0.000	0.000	0.000	0.000
A = Weight of sample in air:	SPEC. 2	4899.1						
B = Weight of sample in water:		2814.5						
C = Weight of surface dry sample:		4911.9						
Gmb = BULK SP. G. = A / (C-B)		2.336	0.000	0.000	0.000	0.000	0.000	0.000
AVG. Gmb		2.339	0.000	0.000	0.000	0.000	0.000	0.000

Nuclear gage

TECHNICIAN							
MoDOT TM54 (NUCLEAR)							
SAMPLE WEIGHT							
BACKGROUND							
COUNTS							
GAUGE % AC							

Ignition oven

AASHTO T 308 (IGNITION)							
GAUGE %AC	5.35						
NUCLEAR OR IGNITION							
% MOISTURE	0.12						
% AC BY IGNITION OR NUCLEAR	5.2						

AASHTO R 35							
A = Gmm (FIELD)	2.472	2.472	2.472	2.472	2.472	2.472	2.472
B = Gmb (FIELD) (Avg.)	2.339	0.000	0.000	0.000	0.000	0.000	0.000
C = Gsb (Job Mix)	2.557	2.557	2.557	2.557	2.557	2.557	2.557
D = Ps = Percent Agg. in mix	94.8	100.0	100.0	100.0	100.0	100.0	100.0
VMA = 100 - (B X D / C)	13.3	100.0	100.0	100.0	100.0	100.0	100.0
Va = 100 X ((A - B) / A)	5.4	100.0	100.0	100.0	100.0	100.0	100.0
VFA = (VMA-Va) / VMA	59	0	0	0	0	0	0

AASHTO T 166							
TECHNICIAN							
A = Weight of sample in air:	1255						
B = Weight in water:	710						
C = Weight of surface dry sample:	1260						
Gmc = CORE SPECIFIC GRAVITY = A / (C - B)	2.282	0.000	0.000	0.000	0.000	0.000	0.000
Gmm = MAX. SPECIFIC GRAVITY (T209)	2.472	2.472	2.472	2.472	2.472	2.472	2.472
% COMPACTION OF CORE = 100 x (Gmc / Gmm)	92.3	0.0	0.0	0.0	0.0	0.0	0.0
THICKNESS							
SUBLOT							

FOR 2ND CORE SUBLOT WHEN DENOTED IN QC PLAN							
TECHNICIAN							
A = Weight of sample in air:							
B = Weight in water:							
C = Weight of surface dry sample:							
Gmc = CORE SPECIFIC GRAVITY = A / (C - B)	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Gmm = MAX. SPECIFIC GRAVITY (T209)	2.472	2.472	2.472	2.472	2.472	2.472	2.472
% COMPACTION OF CORE = 100 x (Gmc / Gmm)	0.0	0.0	0.0	0.0	0.0	0.0	0.0
THICKNESS							
SUBLOT							

Binder Portion

TECHNICIAN							
MoDOT TM54 (NUCLEAR)							
SAMPLE WEIGHT							
BACKGROUND							
COUNTS							
GAUGE % AC							
AASHTO T 308 (IGNITION)							
GAUGE %AC	5.35						
NUCLEAR OR IGNITION							
% MOISTURE	0.12						
% AC BY IGNITION OR NUCLEAR	5.2						

Aggregate Gradation

Gradation Samples

- MoDOT allows gradation sample testing to be satisfied by using the residue from the HMA ignition oven sample.
- An aggregate (gradation) correction factor (AGCF) may be necessary to account for the breakdown in rock.
- RAP gradation in the field is determined with ignition oven.

56

58

Aggregate Gradation

RAS Gradation

- Not recommended to use T308 on RAS (too dangerous).
- Fan will suck fines out.
- Use extraction to get gradation or use the standard gradation.

57

59

Aggregate Gradation

RAS Gradation

- Ground to minus 3/8 inch.
- Gradation from solvent extraction, or assumed from table:

Sieve Size	% Passing
3/8"	100
#4	95
#8	85
#16	70
#30	50
#50	45
#100	35
#200	25

58

60

Aggregate Gradation

Mix Gradation Samples

- When determining the ***aggregate (gradation) correction factor*** (AGCF), prepare an aggregate blank (no binder) specimen.
- Do a washed gradation analysis (T 30) of the blank.
- Do a washed gradation analysis of the burned HMA specimen (T 30): Two replicates.

59

61

When is Aggregate Gradation Correction Factor Required?

60

62

Gradation Samples

Burned and Unburned

Plus #200 Portion

- Determine a difference for each sieve, each replicate, say, for the #4 sieve:

$(\%\text{-}\#4)_{blank} - (\%\text{-}\#4)_{burned,\ replicate\ \#1}$

$(\%\text{-}\#4)_{blank} - (\%\text{-}\#4)_{burned,\ replicate\ \#2}$

- Calculate the average difference for that sieve (#4).
- The difference is called the AGCF for #4 sieve material.

61

63

Gradation Samples
Burned and Unburned
Plus #200 Portion

- If the difference on ***any*** sieve exceeds the allowable (see below), then each sieve must have its own AGCF applied to the result.
- **Allowable differences**:
  - ≥ #8: ± 5.0%
  - ≥ #200 to < #8: ± 3.0%
  - ≤#200 ± 0.5%

62

64

Gradation Samples
Passing the #200 Portion

- If only the #200 sieve exceeds the limit, apply the AGCF only to the #200 sieve

63

65

Example
Adapted From FHWA "Addendum T308"

Enlarged

Sieve	Burned Rep#1	Burned Rep#2	Unburned Blank	Rep#1 Diff	Rep#2 Diff	Avg. Diff= AGCF	Allowable
1"	100.0	100.0	100.0	0.0	0.0	0.0	±5.0
¾"	100.0	100.0	100.0	0.0	0.0	0.0	±5.0
½"	86.5	89.5	89.7	3.2	0.2	1.7	±5.0
3/8"	69.3	72.1	70.4	1.1	-1.7	-0.3	±5.0
#4	52.1	55.6	53.9	1.8	-1.7	0.1	±5.0
#8	38.5	42.3	41.0	2.5	-1.3	0.6	±3.0
#30	32.7	37.0	34.4	1.7	-2.6	-0.5	±3.0
#40	16.1	17.9	18.3	2.2	0.4	1.3	±3.0
#50	12.6	13.4	14.5	1.9	1.1	1.5	±3.0
#200	6.8	7.4	7.1	0.3	-0.3	0.0	±0.5

For #4 sieve:

Rep#1: 53.9-52.1 = 1.8

Rep#2: 53.9-55.6 = -1.7

Avg diff = [1.8 + (-1.7)] /2 = 0.05 = 0.1 (rounded)

Compare to ±5.0: 0.1 < 5.0 OK

64

66

Common Testing Errors/Source
of
Non-Comparison/Early Shut-off

- Starting test when oven is cold: incomplete burn; can affect TCF.
- Neglecting to push "Start" (binder burns but is not recorded).
- Not cleaning oven & vents often enough.
  - Tip: Perform "Lift" test regularly to verify clean oven.
- Using vent pipe less than 4 in, diameter (NTO clogs more quickly).

65

67

- Asphalt correction factor (C_F) not used.
- Not cleaning baskets.
- Allowing scale plate or support tubes to rub.
- Not spreading specimen out.
- Not tearing off ticket before opening oven door.
- Allowing door to not latch correctly.
- Not correcting for moisture (e.g., when plant speed increases, etc).

Common Testing Errors

66

68

- Using an oversize specimen.
- Not using the same size specimen for asphalt correction factor (C_F) determination and all production tests.
- Using a plant-made specimen instead of a lab-made specimen for (C_F) determination.
- Not double-checking specimen weight on oven scale against exterior scale weight.

Common Testing Errors

67

69

Example

Adapted from FHWA "Addendum T308"

Sieve	Burned Rep#1	Burned Rep#2	Unburned Blank	Rep#1 Diff	Rep#2 Diff	Avg Diff= AGCF	Allowable
1"	100.0	100.0	100.0	0.0	0.0	0.0	±5.0
¾"	100.0	100.0	100.0	0.0	0.0	0.0	±5.0
½"	86.5	89.5	89.7	3.2	0.2	1.7	±5.0
3/8"	69.3	72.1	70.4	1.1	-1.7	-0.3	±5.0
#4	52.1	55.6	53.9	1.8	-1.7	0.1	±5.0
#8	38.5	42.3	41.0	2.5	-1.3	0.6	±3.0
#30	32.7	37.0	34.4	1.7	-2.6	-0.5	±3.0
#40	16.1	17.9	18.3	2.2	0.4	1.3	±3.0
#50	12.6	13.4	14.5	1.9	1.1	1.5	±3.0
#200	6.8	7.4	7.1	0.3	-0.3	0.0	±0.5

For #4 sieve:

Rep#1: 53.9-52.1 = 1.8

Rep#2: 53.9-55.6 = -1.7

Avg diff = [1.8 + (-1.7)] /2 = 0.05 = 0.1 (rounded)

Compare to ±5.0: 0.1 < 5.0 OK

- Materials used for (C_F) determination not the same as project materials.
- Inaccurate asphalt contents used for (C_F) determination.
- QA & QC starting with different temperature specimens.
- Door left open too long between loadings.
- Wrong chamber set point.
- Wrong burn profile.
- Weighing on bench balance when specimen is hot.

Common Testing Errors

68

70

Operation Problems

- Oven won't shut itself off—it's OK to manually shut off as long as **3** consecutive readings show less than 0.01% loss, and the sample appears to be completely burned (EPG 403.1.5).

69

71

Premature Burn Stop

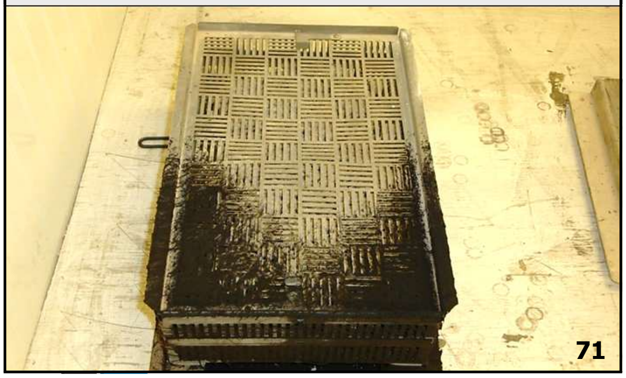
- Vibrations
- Basket or strap up against wall or top of chamber.
- Clogged port
- Used U.S. date, not European date (1998-2000 NCAT models).

More information on Binder Ignition in the Appendix item #5.

70

72

NTO Incomplete Burn Pattern: Shingle Mix



71

73

Soot

72

74

Coke

73

75

Intentionally Left Blank-
Notes if Needed

AASHTO T 308: Asphalt Content by Ignition; Method A

Trial#	1	2	R
Pre-Production Oven Parameters Checklist: (Demonstrate oven setup)			
Input required parameters for routine production of a particular mix:			
1. Enter TEMP setpoint [chamber temperature]			
2. Enter CALIB. FACTOR [binder (aggregate) correction factor]			
Routine Production Ignition Oven Procedure: (Demonstrate test procedure with proctor instruction)			
3. Obtain weight of empty basket assembly			
4. Place ~½ of hotmix sample in each basket; move mix ~¾" away from sides; re-assemble basket. Cool to room temperature.			
5. Obtain total weight of sample plus basket then calculate initial weight of hotmix sample			
6. Enter initial sample WEIGHT			
7. Zero oven scale (push the number 0)			
8. After putting on safety gloves, face shield, etc., carefully load sample into oven, making sure basket is not touching walls; close door			
9. Check total weight: oven vs. exterior scale: No good if > 5 grams difference: Is it?			
10. Initiates burn-off program by pressing START/STOP			
11. After burn-off stops, remove and examine paper readout			
12. Again, with safety gear on, open oven door, remove basket & place on cooling rack. Cool to room temperature.			
13. Determine and record basket + specimen weight, then calculate and record final specimen weight (for manual calculations and/or verification of %AC).			
14. Obtain Calibrated %AC through calculations (NOTE: in the field, this value will automatically be on the printout tape)			
15. Correct the Calibrated %AC for moisture			
PASS?			
FAIL?			

Proctor____ Date__________________

Reviewer______________________________________ Date__________________

Intentionally Left Blank-
Notes if Needed

ASPHALT CONTENT IGNITION METHOD
(AASHTO T 308-18) METHOD A
Asphalt Binder Correction Factor (C_F) Determination
(formerly "aggregate correction factor")

1. Run a butter mix through the mixing equipment.

2. For a given mix, prepare two asphalt binder correction factor (C_F) specimens at the design asphalt content using oven dry aggregate. It is recommended that the C_F and field verification specimen sizes be the same.

3. Obtain the tare weight of the baskets, pan, and lid.

4. Place the hot mix into the sample basket. If the mix has cooled, oven dry at 110 ± 5°C to constant mass prior to placing in the basket. Spread the mix in the basket, being careful to keep the mix away from the sides. Allow at least ¾" clearance.

5. Test (burn) the specimens as discussed in "Test Procedure."

6. If the difference between the measured binder contents of the two replicate specimens is more than 0.15%, test two more specimens. Discard the high and low values.

7. Calculate the C_F by determining the difference between the actual and measured asphalt binder contents [Actual %AC – Measured %AC] for each sample, and averaging the two differences. The "Actual %AC" is the amount weighed out in the batching process, expressed as a percent by weight of the mix.

8. If the C_F exceeds 1.0%, MoDOT Standard Specification Section 403.19.3.1.1 modifies AASHTO T 308-18 in the following manner:

   A. According to AASHTO T 308-18, if the C_F exceeds 1.0% at the typical chamber temperature of 538°C (1000°F), lower the chamber temperature to 482 ± 5°C (900 ± 8°F). If the C_F determined at this lower temperature is less than or equal to 1.0%, use that C_F for subsequent testing on that particular mix.

   B. However, according to MoDOT Standard Specification Section 403.19.3.1.1, if the C_F determined at 482 ± 5°C (900 ± 8°F) exceeds 1.0%, lower the chamber temperature to 427 ± 5°C (800 ± 8°F). Use the C_F obtained at 427°C even if it exceeds 1.0%.

ASPHALT CONTENT IGNITION METHOD
(AASHTO T 308-18)
METHOD A

Asphalt Binder Correction Factor (C_F) Determination

Sample______________________Lab No._________Date______Initials______

Replicate	1	2	3	4
Test Temperature	538	538		
Tare (basket, etc.) Mass (g)	3000.0	3000.0		
Total Dry Mass (g)	4530.0	4517.1		
Initial Dry Specimen Mass (g)				
Loss in Weight (g)	82.5	81.4		
%AC, measured = M				
%AC, actual = A	5.00	5.04		
$\%AC_{diff}$ ($M_1 – M_2$)		> 0.15%? If so, 2 more replicates		
C_F = M – A				
C_F, average				

ASPHALT CONTENT IGNITION METHOD
(AASHTO T 308-18)
METHOD A

Specimen size: Use the following table. It is recommended that the field verification specimen size be the same as the correction factor specimen size.

NMS (mm)	Sieve Size	Minimum Specimen Size* (g)
4.75	#4	1200
9.5	3/8”	1200
12.5	1/2”	1500
19.0	3/4"	2000
25.0	1”	3000
37.5	1 ½”	4000

*Specimen sizes shall not be more than 500g greater than the minimum.

POSSIBLE SETTING CHANGES

1. To change the Stability Threshold:

   A. With oven off, press the “Calibration Factor” key while simultaneously pressing the Power Switch “on.”

   B. Enter new Stability Threshold value. Observe the Percent Loss window for the new value. Maximum allowable = 0.02.

   C. Press the Power Switch “off” then “on” to return oven to normal operation.

2. To change filter (afterburner) temperature (750°C typically):

   A. Press #5 key while simultaneously pressing the Power Switch “on.”

   B. Enter new temperature.

   C. Press “Enter.”

   D. New setpoint will be displayed.

MAINTENANCE

1. To check to see if the venting system is clogged, use the “Lift Test” procedure while the oven is at room temperature. With the power on, initiate a test (push “Start” button) without anything in the oven chamber. The blower fan will turn on. Watch the balance display. The display should read between -4 and -6 grams if the venting is adequate.

2. Burn accumulated soot out of the chamber by running the testing procedure at an elevated temperature without a sample.

TEST PROCEDURE

1. To change setpoint (furnace) temperature (538°C is typical):

   A. Press “Temp”

   B. Enter new setpoint

   C. Press “Enter”

   D. Press “Temp” again to verify new setpoint

2. To change the Asphalt Binder Correction Factor (C_F):

   A. Press “Calib. Factor”

   B. Enter new C_F

   C. Press “Enter”

   D. Press “Calib. Factor” again to verify

3. Preheat the oven to the setpoint, typically 538°C.

4. If the moisture content will not be determined, oven-dry the specimen at 110 ± 5°C to a constant mass.

5. Weigh the empty basket, etc. on an external scale to the nearest gram.

6. Place half the sample in the bottom basket and the other half in the top. Keep the specimen at least ¾” away from the basket sides. For larger samples, some operators make a hole in the middle of the mix.

7. Cool the loaded assembly to room temperature.

8. Weigh the loaded assembly. Calculate the mass of the specimen.

9. Press the “Weight” key and enter the specimen mass. Press “Enter.”

10. Press the “Weight” key again to verify specimen mass entry.

11. Press the “0” (zero) key to tare the internal balance.

12. Don your clean gloves, safety face shield, and safety attire.

13. Carefully load the specimen into the oven by inserting the basket until the handle tines touch the back of the oven. Make sure the basket is centered and is not touching the walls. Shut the door.

14. Observe the internal scale reading. The displayed value should check with the external scale value of basket assembly + dry specimen within ± 5 grams.

15. Press the “Start/Stop” key to initiate the ignition procedure.

16. When weight loss stabilizes (the change in %AC readings will not exceed 0.01% for three consecutive minutes), the oven will automatically end the test and print out the results. Depending on the oven setup, an alarm may sound and one may have to press the “Start/Stop” key to unlock the door.

17. Remove the printed results before opening the door as the tape is heat-sensitive.

18. Again don the safety gear, open the door, and remove the basket and mount it on the cooling plate. Cover with the cooling cage and allow to cool to room temperature.

19. Determine and record the final mass of the specimen, M_f.

20. From the total % loss, the oven will automatically subtract the C_F and the Temperature Compensation to give the %AC (by weight of mix). The %AC by weight of aggregate is the “Bitumen Ratio.”

21. Check for unburned asphalt (coke). If present, start with a new specimen.

NOTE: Read the manufacturer’s manual for additional information on safety and more detailed instructions on maintenance and operation.

ASPHALT CONTENT IGNITION METHOD
(AASHTO T 308-18)
METHOD A
Manual Weighing Method

Project No.	Job No.	Route	County
Technician	Date	Sublot No.	Mix No.
Empty Basket Assembly Weight (g), [T_e]			
Initial Basket Assembly + Wet (or dry) Sample Weight (g), [T_i]			
Initial Wet (or dry) Sample Weight (g), [$W_i = T_i - T_e$]			
Final Basket Assembly + Burned Sample Weight (g), [T_f]			
Loss in Weight (g), [$L = T_i - T_f$]			
% Loss, [$P_L = (L / W_i) \times 100$]			
Aggregate Correction (Calibration) Factor (%), [C_f]			
Calibrated %AC, [$P_{bcal} = P_L – C_f$]			
% Moisture Content, [MC]			
% AC, corrected (by weight of mix), [$P_b = P_{bcal} – MC$]			

Ignition Ovens Forms.doc (11-24-06;12-28-06;12-12-08;3-9-10;12-14-10;4-14-11; 12-18-13; 4-22-15;12-9-15; 12-28-16; 12-26-18)

Equipment Information

for

AASHTO T 308

Determining the Asphalt Binder Content of asphalt Mixtures by the Ignition Method

- M 339M/M 339, Thermometers Used in the Testing of Construction Materials

5. APPARATUS

5.1. *Ignition Furnace*—A forced-air ignition furnace that heats the specimens by either the convection or direct IR irradiation method. The convection-type furnace must be capable of maintaining a temperature of 538 ± 5°C (1000 ± 9°F). The furnace chamber dimensions shall be adequate to accommodate a specimen size of 3500 g. The furnace door shall be equipped so that the door cannot be opened during the ignition test. A method for reducing furnace emissions shall be provided. The furnace shall be vented into a hood or to the outside and, when set up properly, shall have no noticeable odors escaping into the laboratory. The furnace shall have a fan capable of pulling air through the furnace to expedite the test and reduce the escape of smoke into the laboratory. The ignition furnace shall be capable of operation at the temperatures required, between at least 530 and 545°C (986 and 1013°F), and have a temperature control accurate within ±5°C (±9°F) as corrected, if necessary, by standardization. More than one furnace may be used, provided each is used within its proper operating temperature range. When measuring temperature during use, the thermometer for measuring the temperature of materials shall meet the

TS-2c T 308-2 AASHTO

requirements of M 339M/M 339 with a temperature range of at least 530 to 545°C (986 to 1013°F) and an accuracy of ±1.25°C (±2.25°F) (Note 1).

Note 1—Thermometer types suitable for use include ASTM E1 mercury thermometers; ASTM E230/E230M thermocouple thermometer, Type J or K, Special Class; or IEC 60584 thermocouple thermometer, Type J or K, Class 1.

5.1.1. For Method A, the furnace shall also have an internal balance thermally isolated from the furnace chamber and accurate to 0.1 g. The balance shall be capable of weighing a 3500-g specimen in addition to the specimen baskets. A data collection system will be included so that the mass can be automatically determined and displayed during the test. The furnace shall have a built-in computer program to calculate the change in mass of the specimen baskets and provide for the input of a correction factor for aggregate loss. The furnace shall provide a printed ticket with the initial specimen mass, specimen mass loss, temperature compensation, correction factor, corrected asphalt binder content (percent), test time, and test temperature. The furnace shall provide an audible alarm and indicator light when the specimen mass loss does not exceed 0.01 percent of the total specimen mass for 3 consecutive min. The furnace shall also allow the operator to change the ending mass loss percentage to 0.02 percent.

5.2. *Specimen Basket Assembly*—Consisting of specimen basket(s), catch pan, and an assembly guard to secure the specimen basket(s) to the catch pan.

5.2.1. *Specimen Basket(s)*—Of appropriate size to allow the specimens to be thinly spread and allow air to flow through and around the specimen particles. Sets with two or more baskets shall be nested. The specimen shall be completely enclosed with screen mesh, perforated stainless steel plate, or other suitable material.

Note 2—Screen mesh or other suitable material with maximum and minimum openings of 2.36 mm (No. 8) and 0.600 mm (No. 30), respectively, has been found to perform well.

5.2.2. *Catch Pan*—Of sufficient size to hold the specimen basket(s) so that aggregate particles and melting asphalt binder falling through the screen are caught.

5.3. *Oven*—Capable of maintaining 110 ± 5°C (230 ± 9°F). The oven(s) for heating shall be capable of operation at the temperatures required, between 100 and 120°C (212 and 248°F), within ±5°C (±9°F) as corrected, if necessary, by standardization. More than one oven may be used, provided each is used within its proper operating temperature range. The thermometer for measuring the oven temperature shall meet the requirements of M 339M/M 339 with a temperature range of at least 90 to 130°C (194 to 266°F) and an accuracy of ±1.25°C (±2.25°F) (Note 3).

Note 3—Thermometer types suitable for use include ASTM E1 mercury thermometers; ASTM E2877 digital metal stem thermometer; ASTM E230/E230M thermocouple thermometer, Type J or K, Special Class, Type T any Class; IEC 60584 thermocouple thermometer, Type J or K, Class 1, Type T any Class; or dial gauge metal stem (bi-metal) thermometer.

5.4. *Balance*—Of sufficient capacity and conforming to the requirements of M 231, Class G 2.

5.5. *Safety Equipment*—Safety glasses or face shield, dust mask, high-temperature gloves, long-sleeved jacket, a heat-resistant surface capable of withstanding 650°C (1202°F), and a protective cage capable of surrounding the specimen baskets during the cooling period.

5.6. *Miscellaneous Equipment*—A pan larger than the specimen basket(s) for transferring the specimen after ignition, spatulas, bowls, and wire brushes.