HOT MIX ASPHALT PLANT TECHNICIAN CERTIFICATION

VERSION 24.0

Division of Materials and Tests

2024

Regional Materials & Tests Team Leads

Region 1:	Brad Baskette	(865) 594-4552
Region 2:	Tony Renfro	(423) 510-1190
Region 3:	Kevin Isenberg	(615) 350-4312
Region 4:	Lindsey Skaggs	(731) 935-0216

Headquarters

State Bituminous Engineer:	Derek Gaw, PE	Derek.Gaw@tn.gov
Asphalt Field Operations:	Dr. Hong J. Park	Hong.Park@tn.gov
Central Asphalt Laboratory:	Joseph Kerstetter	Joseph.Kerstetter@tn.gov
Training Coordinator:	Kim Whitby	Kimberly.Whitby@tn.gov

Helpful Links

Std Specs, Circulars, Etc:

Standard Operating Procedure

1

Introduction

TN TDOT Department of Transportation

Certified Asphalt Technician Course

Division of Materials and Tests

1

ADA Notice of Requirements

- Can be found at the following website:
- To be in compliance with TDOTs requirements listed on the website above, it is our goal to provide reasonable accommodations to those who identify themselves as having a disability and request such accommodations.
- Please feel free to bring it to any of the course instructors and accommodations will be administered as discretely as possible.

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2

No Tobacco Related Product Inside Building!!!!!!!!

No Electronic Cigarette
No Chewing Tobacco Allowed
<u>Spitting into a bottle disturbs others</u>

3

Plant Tech School

Class Expectations

- You are responsible for all the content presented on the slides even if we don't talk about them.
  - You are expected to read what we don't talk about
- Ask Questions: Each day will start with a 30 min. review/Question and Answer Session.

4

Plant Tech School

- Workbook Description General Information/Presentations
  - Operations
  - Sampling & Testing
  - AASHTO/ASTM/TDOT Test Methods
  - Department Specifications
  - Reports
  - Electronic Workbook

TN

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Plant Tech School

- Presentations
- Performing Calculations
- Test (Half Day)
  - Test Methods
  - Specifications/Results Interpretation

TN

6

Why have a Plant Tech course?

- QUALITY!
- In the past, plants were set up by TDOT and ran by TDOT.
  - Now this is no longer the case.

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407.03.D.2
Contractor Quality Control System

"Develop, implement, and maintain a quality control system that will provide reasonable assurance that all materials and products submitted to the Department for acceptance conform to the specified requirements."

TN

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407.03.D.2.a
Quality Control Technician

"Ensure that a Quality Control Technician, who is currently certified by the Department as a Certified Asphalt Plant Technician, is present at the asphalt plant during mix production. If the Department finds that the Quality Control Technician cannot perform as required by the position, the Department will revoke the certification and require replacement with a certified technician."

TN

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Code of Federal Regulations (CFR 637)

- *"Each SHA's quality assurance program shall provide for an acceptance program and an independent assurance (IA) program consisting of…"*
- *"The sampling and testing has been performed by qualified laboratories and qualified sampling and testing personnel."*

TN

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TDOT's Mission & Vision

- ***Mission***
  - To provide a safe and reliable transportation system that supports economic growth and quality of life.
- ***Vision***
  - Commitment to excellence in managing and improving the state's transportation system…

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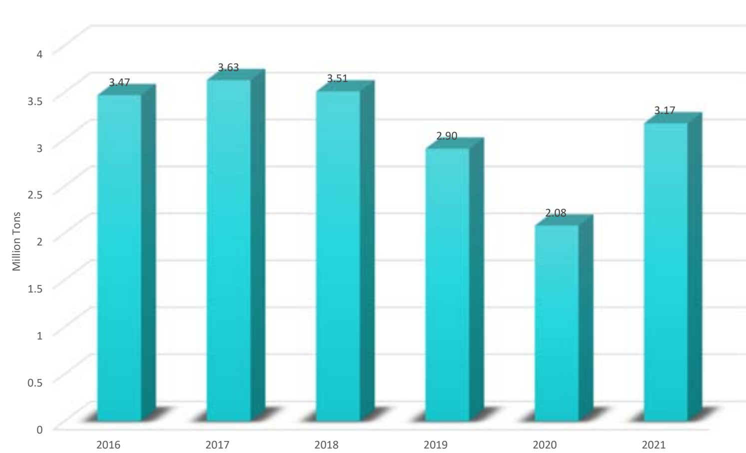
This Job Is Important!

Tons of Asphalt Mixture Placed for TDOT Projects



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2

Basic Materials

Basic Materials

Asphalt Binder, Aggregates, and Additives

Division of Materials and Tests

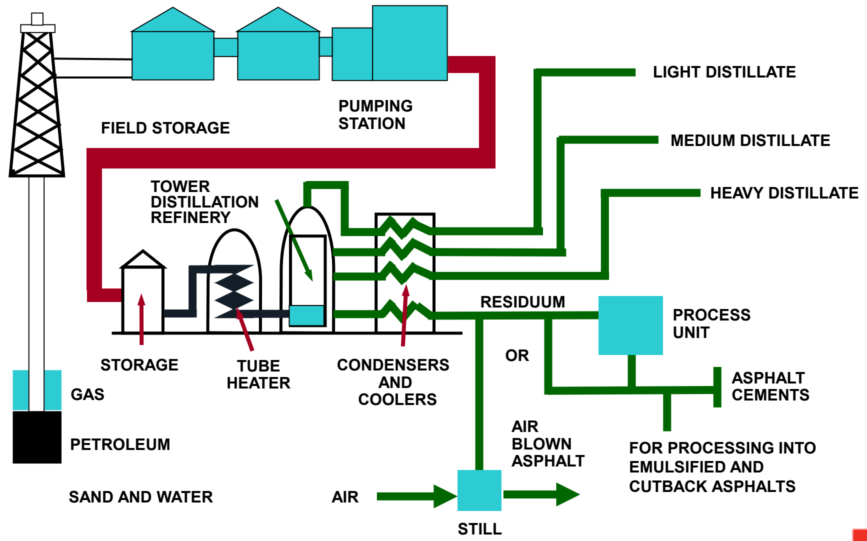
1

Materials

- Asphalt
  - Background
  - Properties
- Additives
- Aggregates
  - Background
  - Properties

2

Refinery Operation



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Asphalt Binder Spec (Section 904.01)

The **Performance Grade** (**PG**) system is the method of categorizing an asphalt cement **binder** used in asphalt pavement relative to its rated **performance** at different temperatures.

PG 64-22 (Pronounced PG 64 "minus" 22)

- 22 → Minimum pavement design temp (°C) – Thermal Cracking
- 64 → Average-7 day Max Pavement Design temp (°C) – Resist Rutting
- PG → Performance Grade

64°C = 147.2°F
-22°C = -7.6°F

4

"Rule of 90"

- **Between High and Low Temp Physical Properties**
  - Absolute difference between high and low temp grade
  - Difference **less than 90** probably unmodified asphalt
  - Difference **greater than 90** probably modified asphalt
- **PG 64-22**
  - Difference = 86
  - Probably unmodified
  - Probably AC-20
- **PG 70-22**
  - Difference = 92
  - Very well-balanced AC-20 or lightly modified AC-10

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Asphalt Additives

- Additives include:
  - Anti-strip Additive (Section 921.06.B.1)
  - Lime (Section 921.06.B.1)
  - Silicone (921.06.B.2)
  - Warm Mix Additives (921.06.B.3)

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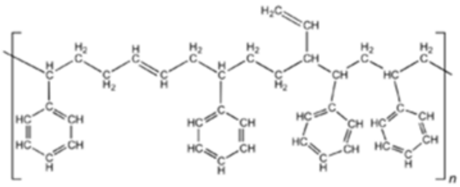
Asphalt Modifiers

- Permitted Asphalt Modifiers:
  - Styrene butadiene (SB)
  - Styrene-butadiene-styrene (SBS)
  - Styrene butadiene rubber (SBR)
  - Ground Tire Rubber (GTR)



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Aggregates

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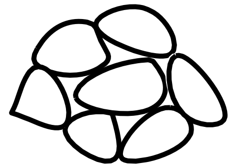
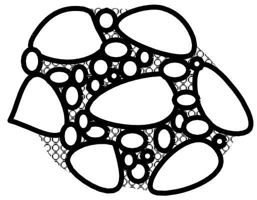
Aggregate Gradations

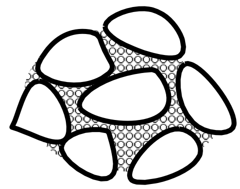
- Uniformly-Graded
  - Few points of contact.
  - Poor interlock (Shape dependent).
  - High permeability.



- Well-Graded
  - Good interlock.
  - Low permeability.



- Gap-Graded
  - Only limited sizes.
  - Good interlock.
  - Low permeability.



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Sieve for Aggregates

Individual Sieve

Stack of Sieves

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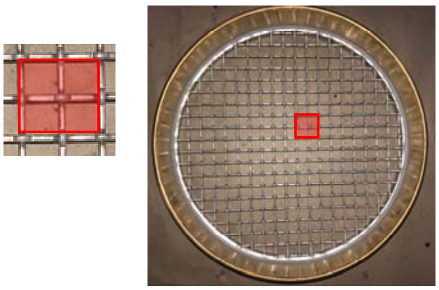
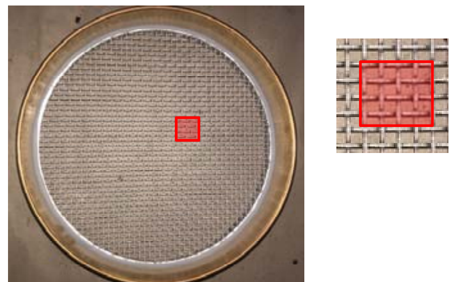
Aggregate Gradation Terms

- Sieve Size – The opening size for a given sieve, i.e. 1-inch. Numbered sieves (i.e. #50, #16, etc) indicate the number of openings per linear inch.



1/2-in. Sieve



No. 4 Sieve

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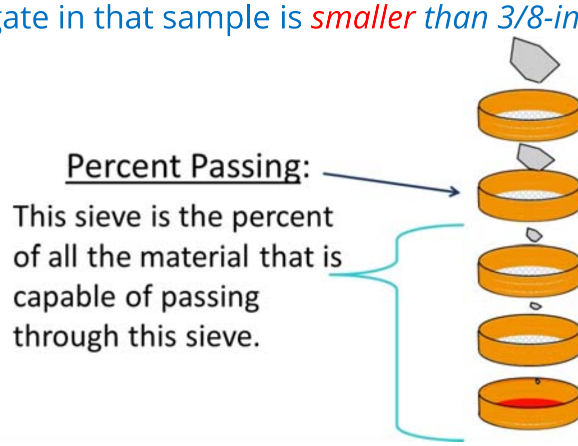
Aggregate Gradation Terms

- Percent Passing: The percent of material that is *smaller* than a given sieve value.

  (i.e. "75% passing 3/8-in sieve" indicates 75% of the aggregate in that sample is *smaller than 3/8-inch.)*



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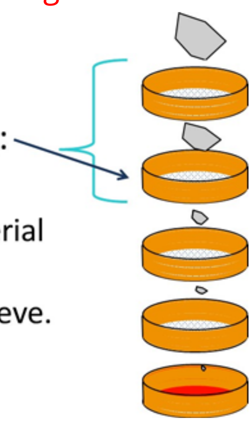
Aggregate Gradation Terms

- Percent Retained: The percent of material that is *larger* than a given sieve value. It's cumulative value.
  (i.e. "25% retained 3/8-in sieve" indicates 25% of the aggregates in that sample is *larger than 3/8-inch.)*

<u>Percent Retained</u>:

On this sieve is the percent of all the material that is NOT capable of passing through this sieve.



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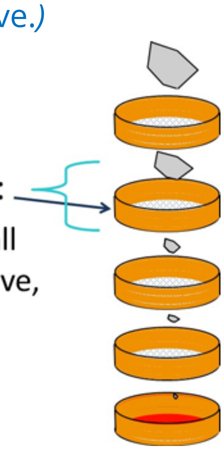
Aggregate Gradation Terms

- Individual Percent Retained: The percent of material that sits on a single sieve in a stack.
  (i.e. "10% retained 3/8-in sieve" indicates 10% of the aggregates sits on the 3/8-in sieve.*)*

<u>Individual Percent Retained</u>:

On this sieve is the percent of all the material makes it to this sieve, but does not pass through.



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Aggregate Gradation Terms

- Nominal Maximum Aggregate Size (NMAS):
  - One size larger than the first sieve to retain more than 10%.
- Maximum Aggregate Size:
  - One size larger than nominal maximum size.

TN

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Aggregate Gradation Terms

- ***Example 1:***

What is the NMAS for the mixture shown here?

Max aggregate size?

3/4"	100
5/8"	100
1/2"	91
3/8"	72
No.4	65
No.8	48
No.16	36
No.30	22
No.50	15
No.100	9
No.200	4

TN

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Aggregate Gradation Terms

- ***Example 2:***

What is the NMAS for the mixture shown here?

Max aggregate size?

3/4"	100
5/8"	99
1/2"	89
3/8"	72
No.4	65
No.8	48
No.16	36
No.30	22
No.50	15
No.100	9
No.200	4

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Coarse vs. Fine Aggregate

- Coarse Aggregate is Material retained above the #4 Sieve.
- Fine Aggregate is Material that passes through the #4 Sieve.

	% Retained Individual	% Retained Cumulative	% Passing
3/4"	0	0	**100**
5/8"	1	1	**99**
1/2"	10	11	**89**
3/8"	8	19	**81**
No.4	27	46	**54**
No.8	7	53	**47**
No.16	12	65	**35**
No.30	14	79	**21**
No.50	7	86	**14**
No.100	6	92	**8**
No.200	5	97	**3**

What % of this sample is Fine Aggregate?

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NMAS of TDOT Mixtures

- These are values of what we could expect based on gradation specifications in 903.
  - There is a way to know the actual NMAS of a mixture.

Mixture	NMAS	
	in	mm
307-ACRL	1-1/2	37.5
307-AS	1-1/2	37.5
307-A	1-1/2	37.5
307-B	1-1/2	37.5
307-BM	3/4	19.5
307-BM2	3/4	19.5
307-C	3/8 - 3/4	9.5 - 19.5
307-CW	3/8	9.5
307-CS	1/4	4.75
411-TL	1/4	4.75
411-TLD/TLE	3/8	9.5
411-D	1/2	12.5
411-E	1/2	12.5
411-OGFC	1/2	12.5

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Basic Materials Summary

- Asphalt
  - Hot, Black, and Sticky.
  - Correct performance grade.
- Aggregates
  - Angular, with good surface texture.
  - Hard and Sound.
  - Well-Blended with Consistent Gradations.

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Additional Reference Material

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Overview of TDOT Mixtures

- 307 Mixes: A, ACRL, AS, B, BM, BM2, CS, and CW
  - These mixes are called "307" mixes because they are specified in Section 307 of the Standard Specification book for Bituminous Plant Mix Base.
  - Not all of the mixes listed are true base mixes.

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Overview of TDOT Mixtures

- 307 Mixes:
  - BASE Mixes (Lowest in the pavement structure)
    - A – Dense-Graded Base
    - ACRL – Crack Relief Base
    - AS – Gap-Graded Base

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Overview of TDOT Mixtures

- 307 Mixes:
  - BINDER Mixes (Intermediate – in between base and surface)
    - B – Not used often. Can be a base or binder.
    - BM – aka "B Modified."
    - BM2 – Most common binder mix.

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Overview of TDOT Mixtures

- 307 Mixes:
  - CW – Occasionally used for surface mix in areas with low traffic volume and slow-moving traffic.
    - (i.e. – County, Local Programs projects.)
  - CS – "Scratch mix" or leveling course. Fine-graded, higher asphalt content mix used to correct uneven surface or other surface deficiencies prior to placement of final surface mix.

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Overview of TDOT Mixtures

- 313 Mixes:
  - TPB – Treated Permeable Base
    - Drainable base mostly used under concrete pavements.

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Overview of TDOT Mixtures

- 411 Mixes: D, E, E-Shoulder
  - Surface mixes are the wearing courses that make direct contact with automotive tires.
  - D – Most common TDOT surface mix.
  - E – Occasionally in low-traffic areas.
  - E-Shoulder – Similar to D and E with slight modifications for application on shoulders.

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Overview of TDOT Mixtures

- 411 Mixes: TL, TLD, TLE, OGFC
  - TL – Fine-graded (~1/4") mix for thin surface paving. Placed as thin as 5/8".
  - TLD – Moderately fine-graded (~3/8") mix for thin surface paving. Placed as thin as 7/8".
  - TLE – Similar to TLD, but allows non-surface aggregates.
  - Open-Graded Friction Course (OGFC) – A porous, open-graded mixture used at surface to reduce hydroplaning.

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Plant Overview

TN TDOT Department of Transportation

Asphalt Plant Overview

Division of Materials and Tests

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Requirements for all Asphalt Plants

Requirements for all Asphalt Plant (TDOT 407.04)

1. Liquid Asphalt Storage Tanks
2. Feeders for Dryer
3. Dryer for aggregate
4. Screens
5. Metering system
6. Capable of determining mix temperature
7. Dust Collector
8. Safety Requirements
9. Field Lab
10. Surge and Storage System

TN

2

Types of Plants

Batch Plant

Drum-Mix Plant

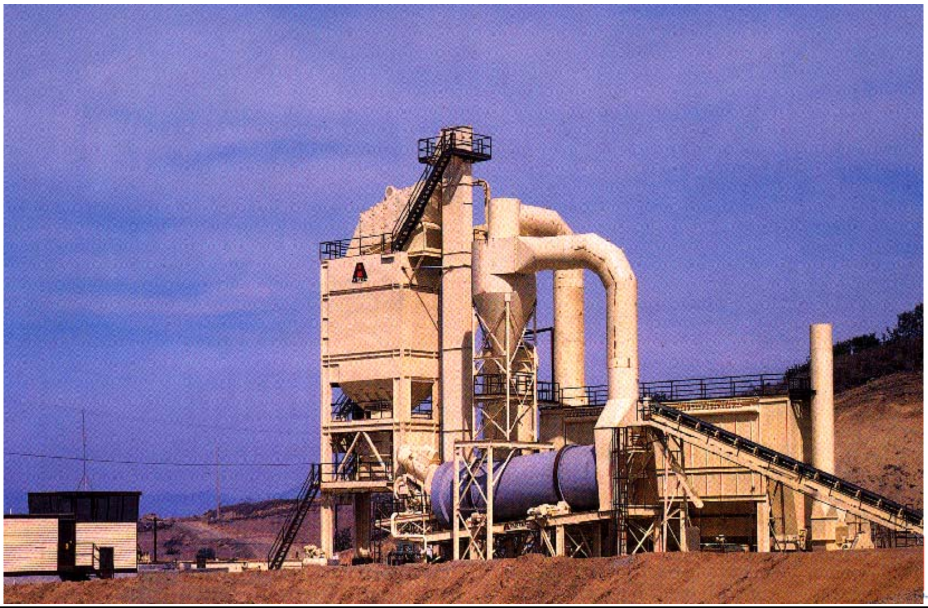
3

What is The Difference?

- Batch plants make a set amount of hot mix.
- Batch plants handle smaller projects.
  - Patching, parking lots, driveways, city work, etc.
- Continuous drum plants are constantly producing hot mix asphalt at a rate.
- Continuous Drum plants do not have Hot Bins
- A large continuous drum plant can produce 400 tph.

4

Batch Plant



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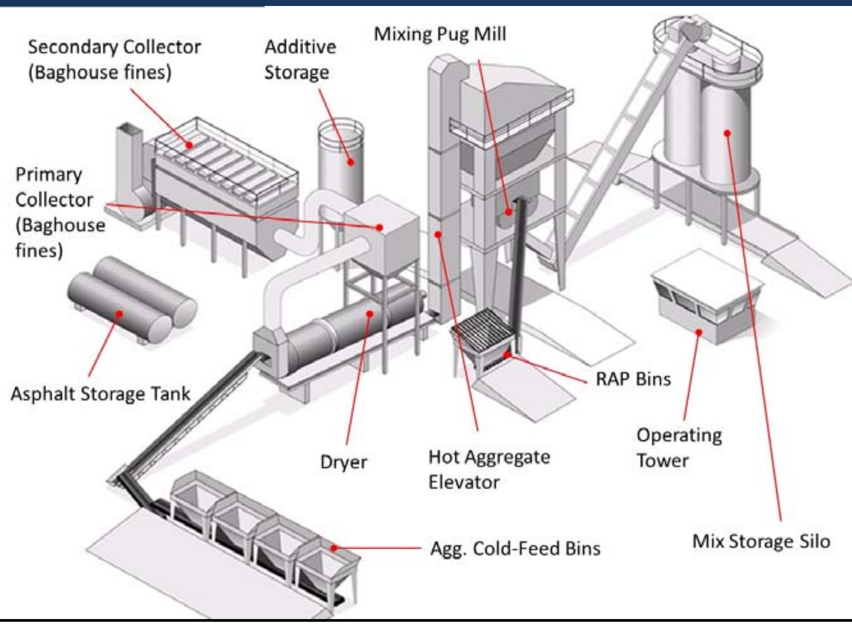
Batch Plant



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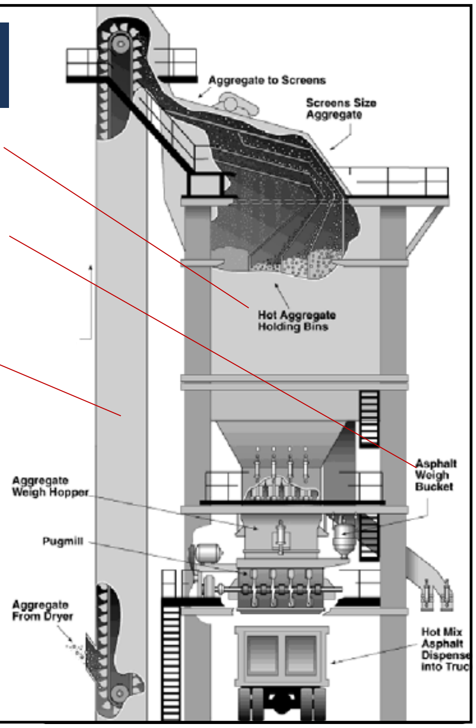
Batch Plant

- Gradation control at the hot bins.
- Asphalt control at the weigh bucket.
- Aggregate elevator



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Batch Plant (RAP)

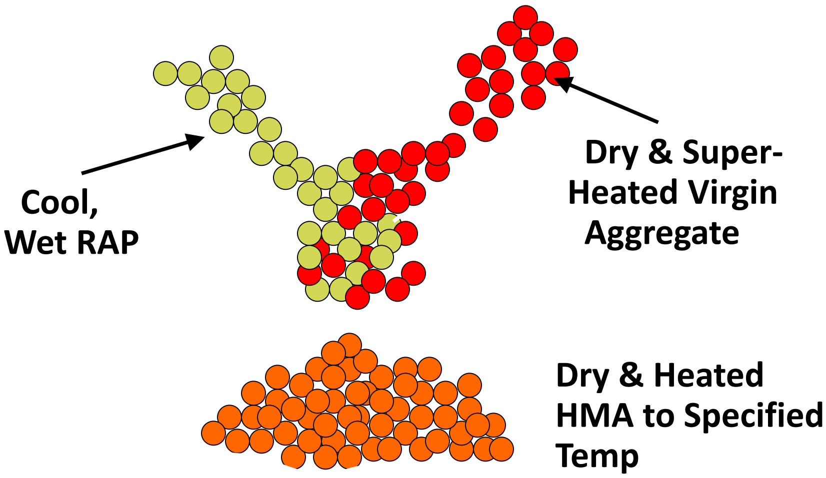
Introducing RAP in a Batch Plant Facility

- Types of RAP feeding system
  - RAP into batch plant hot elevator.
  - Batch tower fifth hot bin for RAP.
  - RAP directly into weigh hopper.
  - Controlled feed to weigh hopper.
  - RAP heater for batch plant.
- Most Common methods are using weigh hopper and bucket elevator. This common methods rely on conductive heat transfer.

8

Batch Plant (RAP)

- Conductive Heat Transfer



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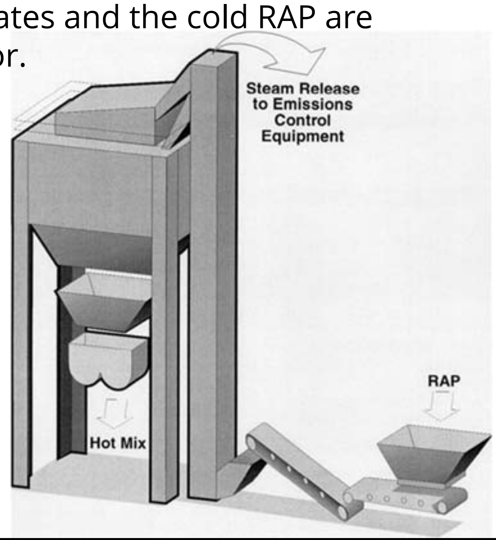
Batch Plant (RAP Feeding)

RAP into batch plant hot elevator.

- Superheated virgin aggregates and the cold RAP are introduced into hot elevator.
- The mixed material is screened and stored in hot bins.
- It is necessary to avoid excessive moisture in RAP to prevent blinding of the screens.



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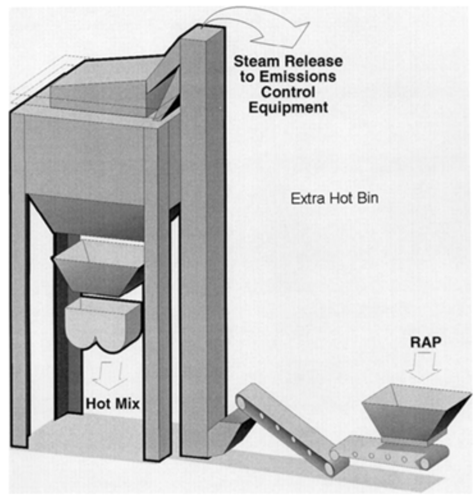
Batch Plant (RAP Feeding)

Batch tower fifth hot bin for RAP.

- The batch tower is required to have a fifth hot bin.
- The virgin aggregate is screened, superheated and then deposited into hot elevator along with the cold RAP.
- The blended material is introduced in the fifth hot bin without going through the screens in the tower.

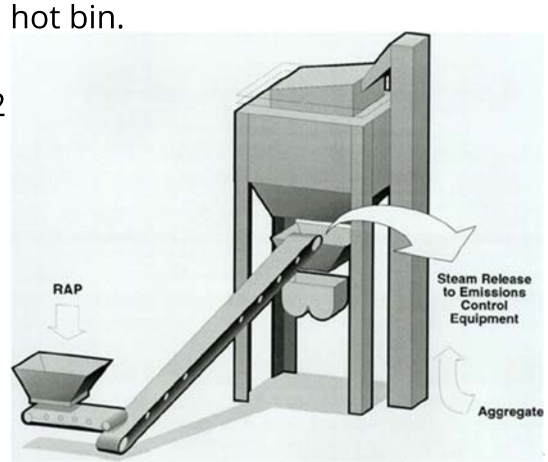


11

Batch Plant (RAP Feeding)

RAP directly into weigh hopper.

- Cold pre-screened RAP is delivered directly into the weigh hopper of the batch tower along with the superheated virgin aggregate from a hot bin.
- RAP material added in between bin1 and bin 2 to weigh hopper to heat up.
- In this way the RAP is sandwiched between the hot virgin aggregates and gets more time to heat up.



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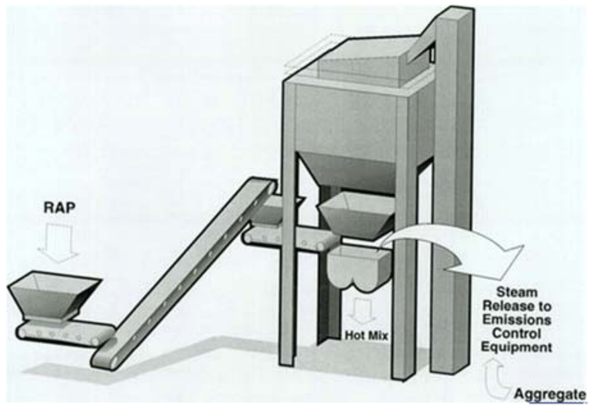
Batch Plant (RAP Feeding)

Controlled feed to weigh hopper.

- This is a new control feed system.
- the RAP is fed onto a third scale to obtain a set amount of RAP.
- After the RAP is weighed, it is dropped into a bin with a feeder. The feeder introduces the RAP into the pugmill.



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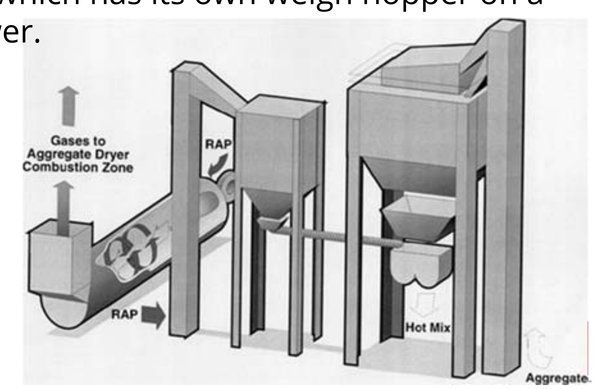
Batch Plant (RAP Feeding)

RAP heater for batch plant.

- preheats the RAP in a separate dryer before mixing it with the virgin aggregates.
- Heated RAP materials are then conveyed to a separate, heated storage bin which has its own weigh hopper on a typical batching tower.
- This is the most expensive system.



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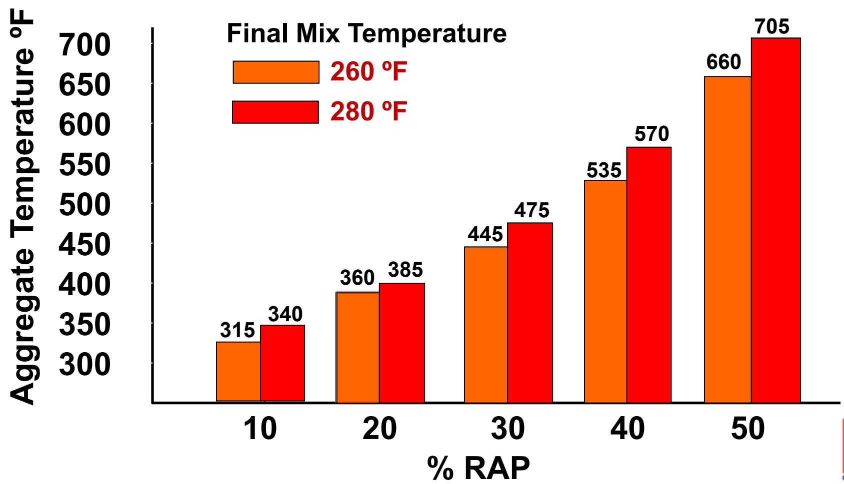
Batch Plant (RAP)

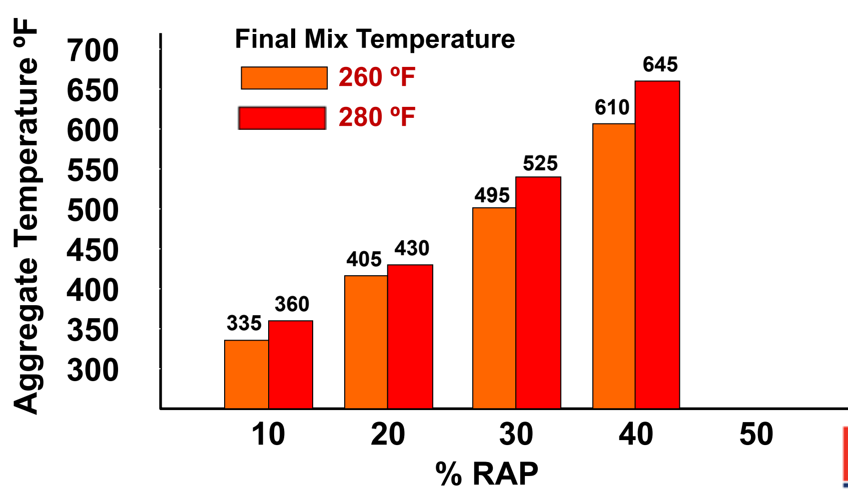
Required Virgin Aggregate Temperature for RAP with **3% moisture** in Batch Plant.



15

Batch Plant (RAP)

Required Virgin Aggregate Temperature for RAP with **5% moisture** in Batch Plant.



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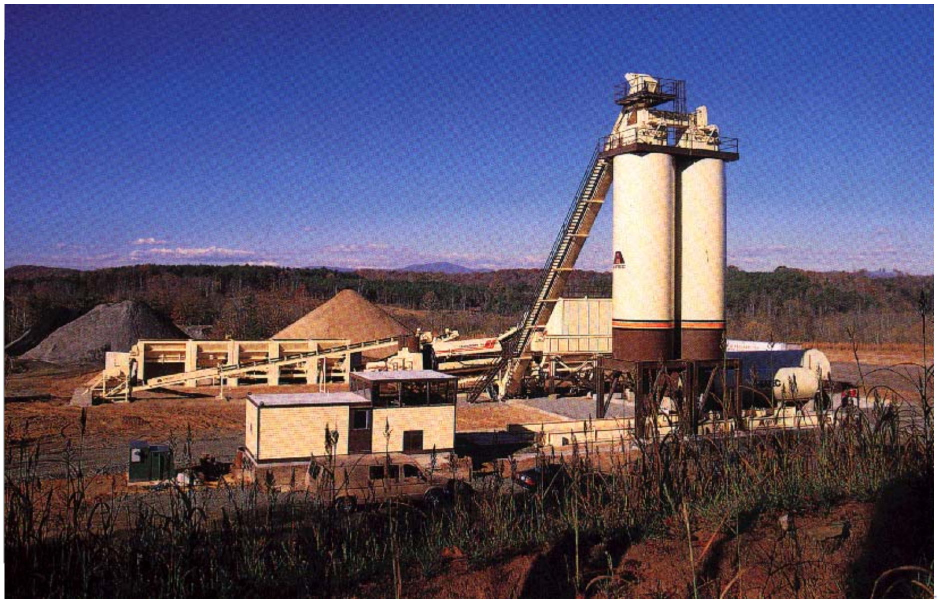
Drum Mix Plant



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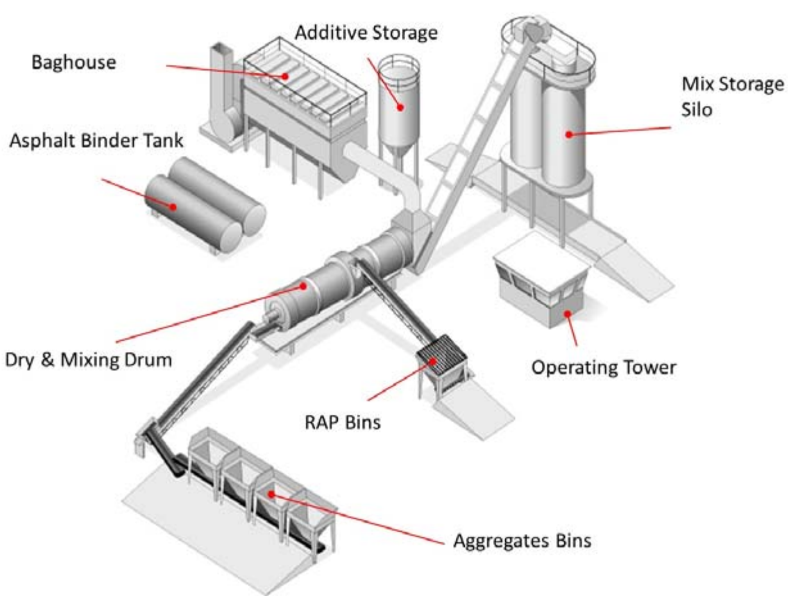
Drum Mix Plant



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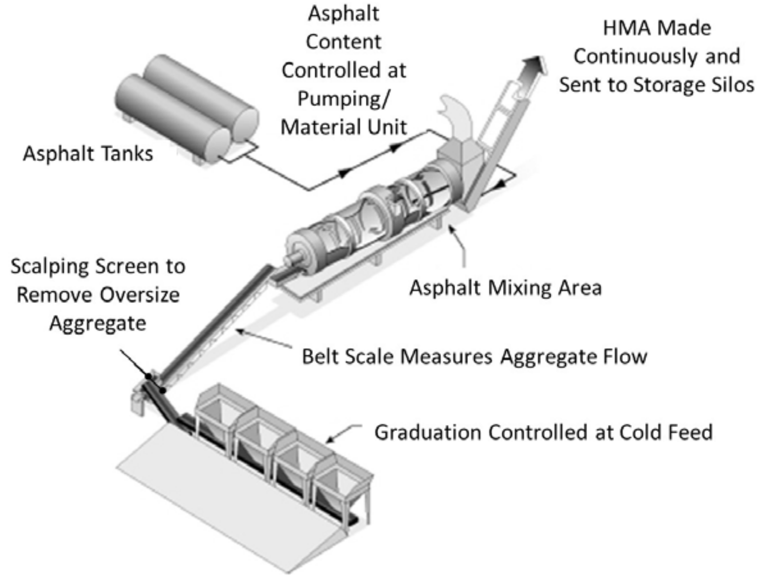
Drum Mix Plant



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Drum Mix Plant

- The primary difference between "drum-mix" facilities and a "batch" style facility is that aggregate is blended, dried, and mixed with liquid asphalt in a one-step continuous basis, rather than the batch-at-a-time basis common with a batching style facility.
- Unlike a batching style plant that has sizing screens at the top of the batching tower to size the aggregate, and holding bins and a weigh scale for proportioning the aggregate blend; drum-mixers control gradation at the aggregate feeders.

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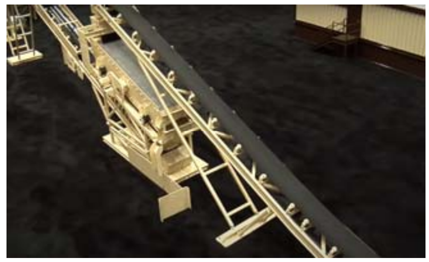
Drum Mix Plant

Scalping Screen

- The only screens installed in drum-mix plants are for scalping screen that rejects oversized or tramp materials from the aggregate blend.

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Types of Drum-Mixers

- New types of drums have been introduced since the 1980's.
- Environmental excellence and more RAP use were manufacturer's goal.
- Today there are
  - Parallel-flow drum-mixers
  - Counter-flow drum-mixer facilities,
  - Unitized dryer/mixer facilities, and
  - Separate dryer-mixer facilities.
  - All are called "drum-mixers".

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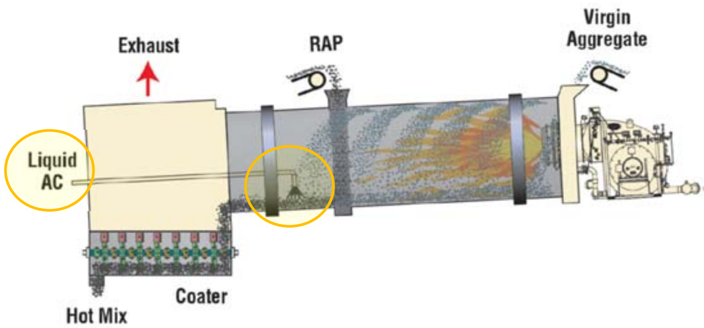
Drum Mix Plant (Parallel-flow drum-mixers)

Parallel-flow drum-mixers

- Burners are on the “feed end” of the drum
- Aggregate enter the drum from the burner end. First half of the drum does heating.
- Mixing takes place in the second half of the drum



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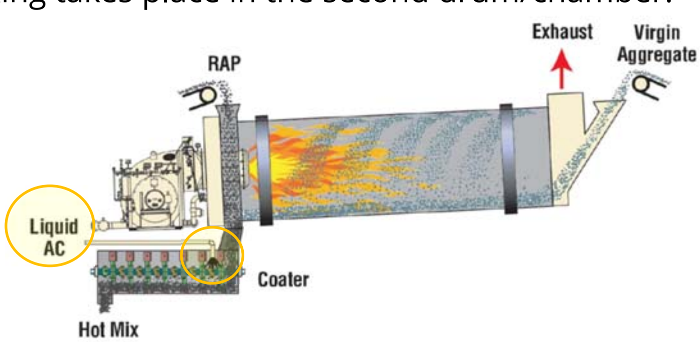
Drum Mix Plant (Counter-flow drum-mixers)

Counter-flow drum-mixers

- The burner flame is up inside in the drum, and the aggregate flows toward the flame.
- Aggregate enter the first drum from opposite end of the burner. Only drying takes place in this first drum
- Mixing takes place in the second drum/chamber.



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Drum-Mixer (RAP)

- Parallel-flow drum-mixers heat RAP convectively with hot gases in dryer.
- Counter-flow drum-mixers heat RAP conductively with super-heated virgin aggregate.
- Regardless of drum-mix type, RAP is introduced similar to another aggregate in the plant process.
- Plant automation adjusts for asphalt content and moisture in the RAP.

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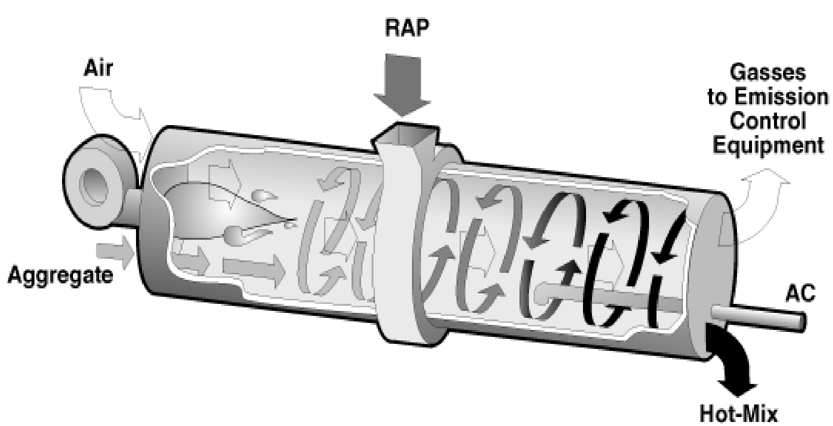
Drum-Mixer (RAP)

Parallel-Flow Drum Mixer

- RAP is being heated in the hot gas stream with the other aggregates.



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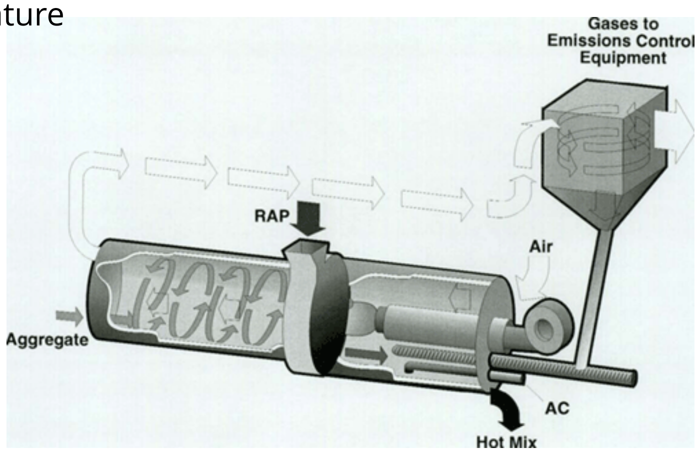
Drum-Mixer (RAP)

Parallel-Flow Drum Mixer

- RAP is introduced in the mixing area of the drum, where superheated virgin aggregates heat the RAP to temperature



TN

27

Batch or Drum-Mixer?

Q: Which is Best?

A: Choice based mostly on economics.
Both make quality mix.

TN

28

ADDITIONAL INFORMATION

- BATCH PLANTS
  - Screen Deck
  - Hot Storage Bins
    - Overflow Shute
    - Gates
  - Weigh Hopper
  - AC Feed
  - Pugmill

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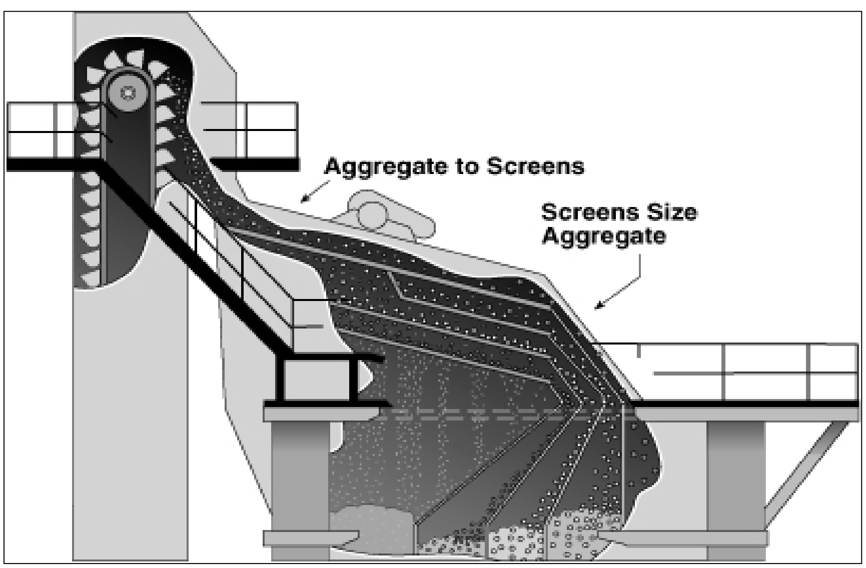
Screen Deck



30

Screen Deck

31

Best Management Practices: Screen Deck

- Check for worn cloth or holes (hot bin gradations typically get coarser)
- Check side plates for wear (can contaminate bins by causing fine particles to flow to coarse bins)
- Check chutes for worn holes (hot bin gradations get coarser)
- All these items negatively affect gradations in hot bins.

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Section 407.04 (a)

Screens:

- Plant screens, capable of screening all aggregates to the specified sizes and proportions and having normal capacities in excess of full capacity of the mixer, shall be provided.
- A consistent carry-over, but not to exceed 20 per cent, will be allowed on any screen. If any bin contains more than 20 per cent of material which is undersized for that bin, the bin shall be emptied and correction of the cause for such condition shall be made.
- Approved scalping screens shall be required on all dryer-drum mixing plants, but additional screens will not be required.

TN

33

Best Management Practices: Screen Deck

- Do not overfeed a screen beyond its capability (causes finer material to carry over into the larger hot bins)
- Make sure the aggregate is dry…wet material can “blind” a screen (also causes finer material to carry over into the larger hot bins)
- All these items negatively affect gradations in hot bins.

TN

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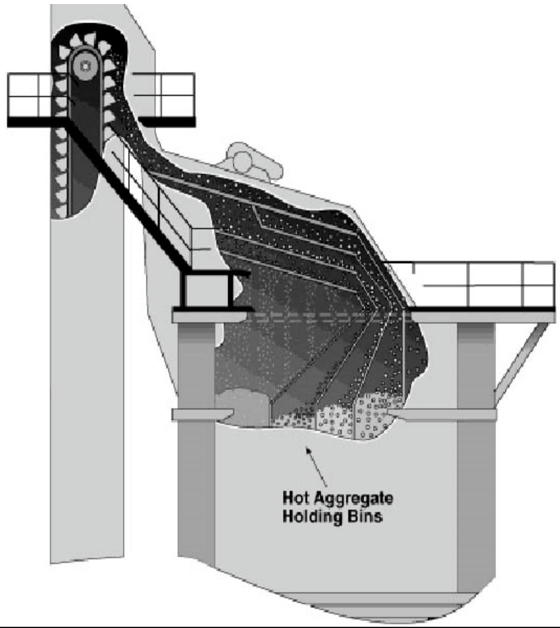
Hot Storage Bins



35

Section 407.04 (a)

Bins:

- The plant shall include storage bins of sufficient capacity to supply the mixer when it is operating at full capacity. Bins shall be arranged to assure separate and adequate storage of appropriate fractions of the mineral aggregates.
- The bins shall be provided with overflow pipes of such size and at such location as to prevent backing up of material into other compartments or bins. Each compartment shall be provided with an outlet gate constructed so that when closed there shall be no leakage.

TN

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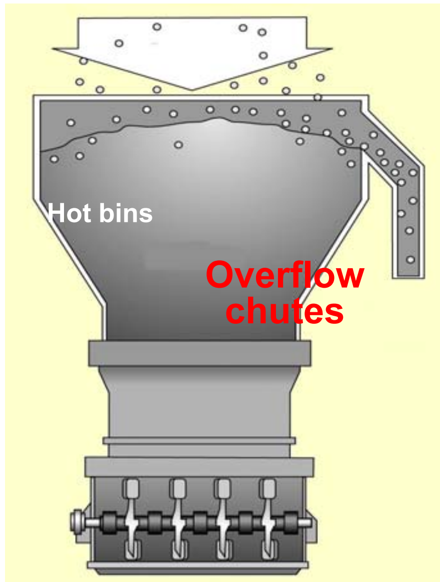
Overflow Chutes



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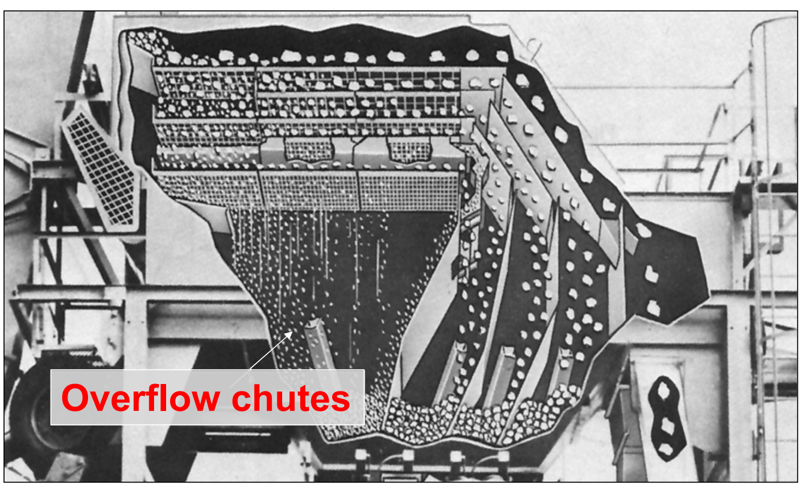
Overflow Chutes



38

Over Flow Chute (Why two chutes?)

39

Best Management Practices: Hot Bins

- Watch side wall wear (contaminates other hot bins - gradations typically get finer due to slope of bin wall).
- Watch overflow chutes from filling up or plugging up (damage to screen and carryover to other bins).
- All these items negatively affect gradation.

40

Best Management Practices: Hot Bins

- Malfunctioning hot bin indicators can also cause carryover to another bin by incorrectly over-filling a bin.
- Match cold feed flow to hot bin pull, especially on plant with small hot bins (can affect both production rates and consistency of mix)
- All these items negatively affect gradation.

TN

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Hot Bin Gates

42

Aggregate Sampling at Hot Bin Gate

43

Best Management Practices: Hot Bins Gates

- Gates wear (can cause overflow into weigh hopper)
- Gates hinge pins fail (causing gates not to close correctly - negatively affecting gradation)
- Gate/bin opening clearances wear (can also cause leakage)
- All items affect material gradation.

44

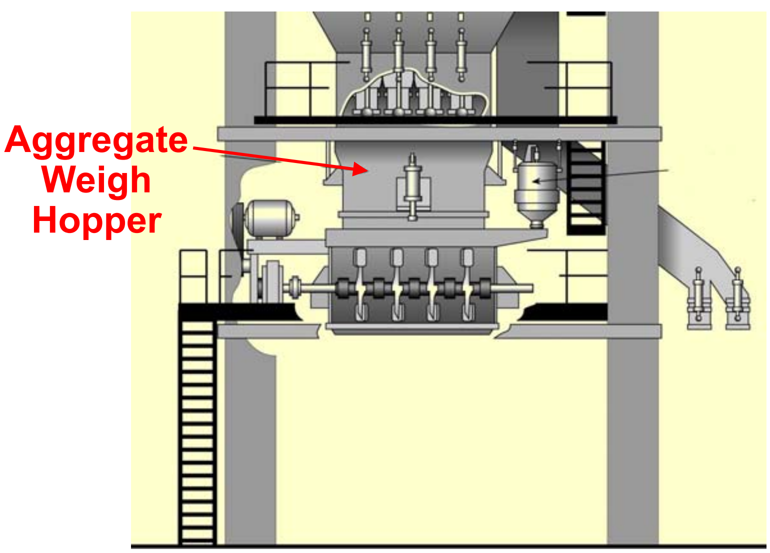
Best Management Practices: Hot Bins Gates

- Take samples across full flow of material from hot bin (might not represent actual hot bin gradation)
- Gate cylinders wear causing them to not close smoothly or quickly (can affect cutoff values on hot bin draws changing gradation)
- All items affect material gradation.

TN

45

Aggregate Weigh Hopper



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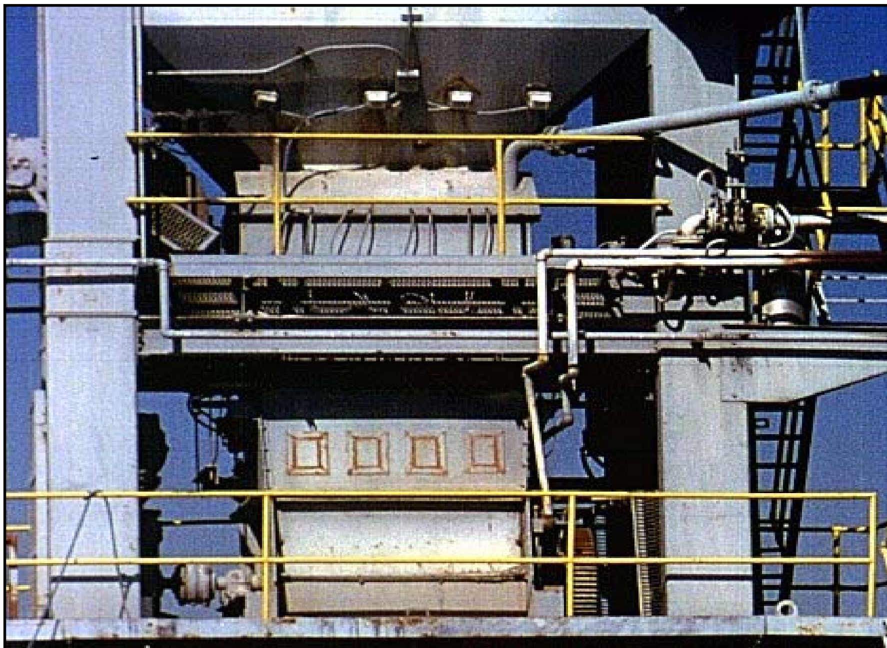


Weigh Hopper

47

Section 407.04(b.2)

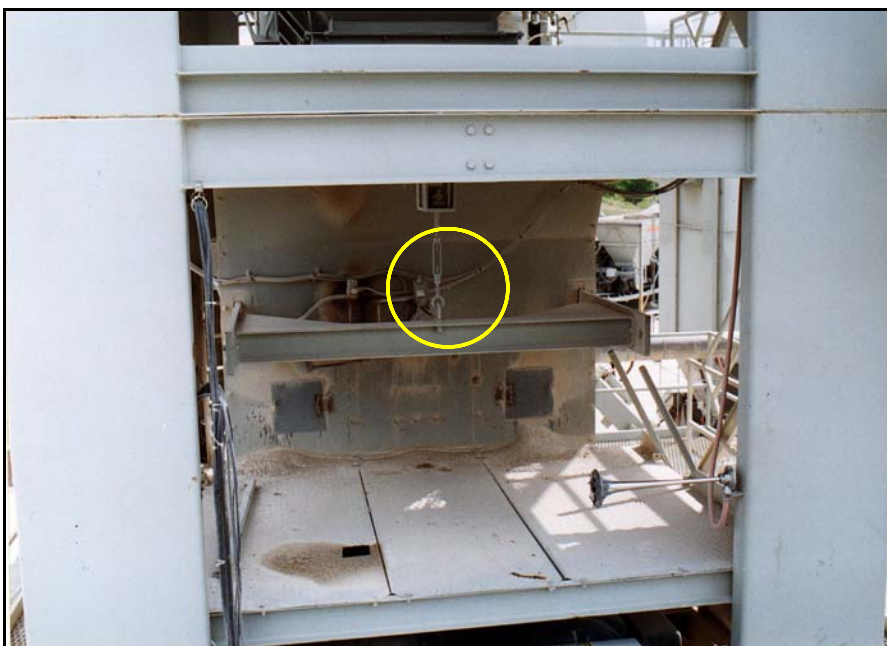
Weigh box or hopper:

- The equipment shall include a means for accurately weighing each size of aggregate and mineral filler in a weigh box or hopper suspended on scales.
- The weigh box or hopper shall be of ample size to hold a full batch without hand raking or running over.
- The gate shall close tightly so that no material is allowed to leak into the mixer while a batch is being weighed.

48

Mechanical Lever Scales for Weigh Hopper

49



Modern Load Cell Style Weigh Hopper
with Lever Arm Scale

50

Best Management Practices: Aggregate Weigh Hopper

- Check "knife edges" and linkage for wear and buildup (hopper won't weigh correctly)
- Watch cylinders and solenoids for wear (causing hopper to not release material completely)
- Watch for gate not closing completely or leaking (causes material to flow from hopper)
- Items can negatively affect gradation & batch weights.

TN

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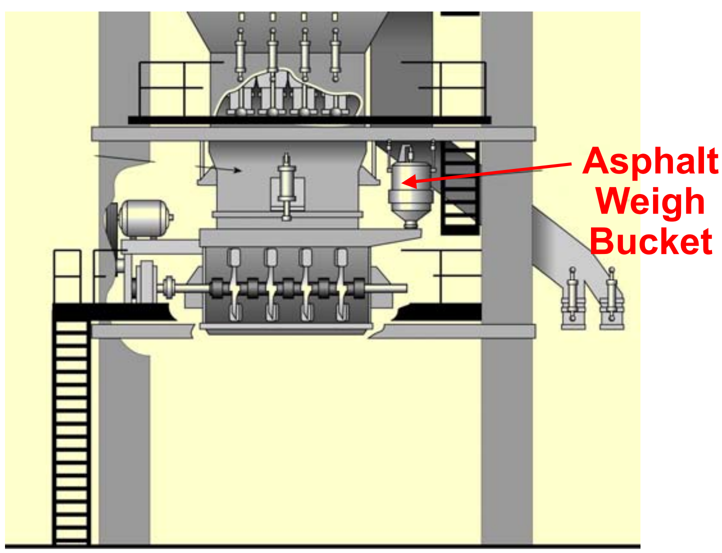
Aggregate Weigh Bucket



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4

Aggregate Storage and Metering Systems

TN TDOT Department of Transportation

Aggregate Storage and Metering System

Division of Materials and Tests

1

What You Will Learn

- Aggregate Stockpiling Alternatives
- Managing Stockpiles for Quality
- Types of Feeders
- Managing Feeders for Quality & Accuracy
- Unique Aspects of Storing and Feeding RAP

TN

2

Agg. Quality is Determined at the Quarry

- Regardless of the type of asphalt plant, ultimately both **the quality and gradation of the aggregate is controlled at the quarry** and not the asphalt plant
- Aggregate quality and gradation is assured at the quarry it originated from.
  - Quality cannot be fixed at the asphalt plant (hardness, soundness, deleterious material, etc.) .

TN

3

Agg. Quality is Determined at the Quarry

- Hot Mix Producer must make sure they have quality aggregates with consistent gradations.
- The individual stone gradations are controlled at the quarry.
- Technicians must know the materials they work with!

TN

4

Agg. Quality

Materials (TDOT's std spec. 407.02)

"Store each size and type of aggregate in a separate pile, bin, or stall. Maintain the storage yard in an orderly condition, clearing a walkway between stockpiles that are not separated by partitions. Make the stockpiles readily accessible for sampling."

TN

5

Contractor's Quality Control Plan

(Section 407.03.D.3)

Table 407.03-3, A

1. Stockpiles
   - a) Determine gradation of all incoming aggregates.
   - b) Inspect stockpiles for separation, contamination, segregation, etc.
   - c) Conduct a fractured face count when gravel is used as coarse aggregate.

TN

6

Contractor's Quality Control Plan

(Section 407.03.D.3)

Table 407.03-3, A

1. Stockpiles
   - d) Determine the percent of glassy particles in slag coarse aggregate.
   - e) Determine gradation and asphalt content of reclaimed asphalt pavement when used as a component material.

7

Stockpiling

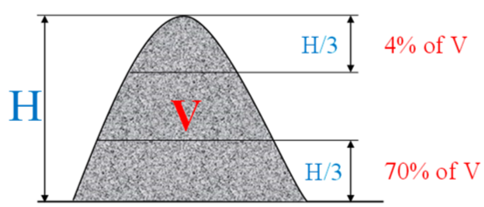
8

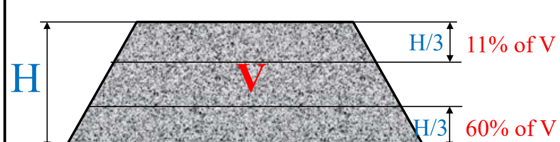
Horizontal Stockpiling

- Horizontally stockpiled aggregates can be delivered by:
  - Transport truck and dumped in yard.
  - Barge and unloaded with crane.

9

Volume Distribution of agg. in Stockpiling





10

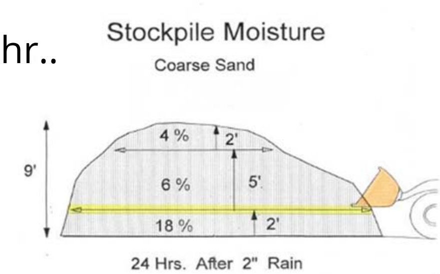
Main Reasons Driving JMF Adjustment

1. Stockpile moisture excessive / variable
2. Specific Gravities different / variable from design
3. Blend water and/or binder absorption different than design
4. Supply inconsistent (grading)
5. Segregation (stockpiling and loadout)
6. Feed issues at cold feed

11

Stockpile Moisture

- Coarse sand stockpile 24 hr.. after a 2 in. rain
  - Moisture varied widely (18 to 4%) throughout 9' tall stockpile

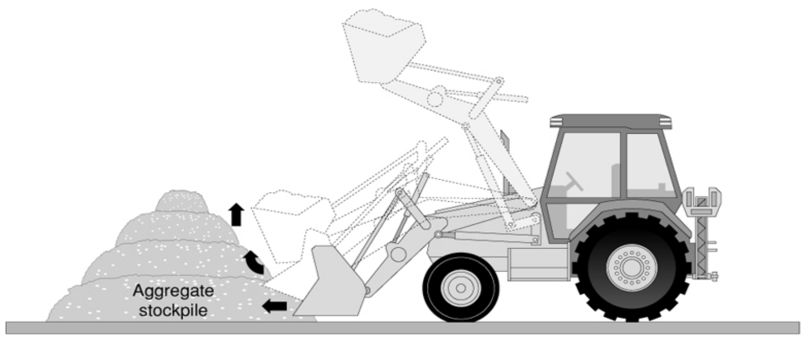


- Water retention is maximized with well-graded fine aggregate with high - #200 content (i.e., screenings)
- Screenings will typically hold more moisture than manufactured sand
- RAP and RAS stockpiles are also very prone to holding moisture

12

Proper Removal Technique

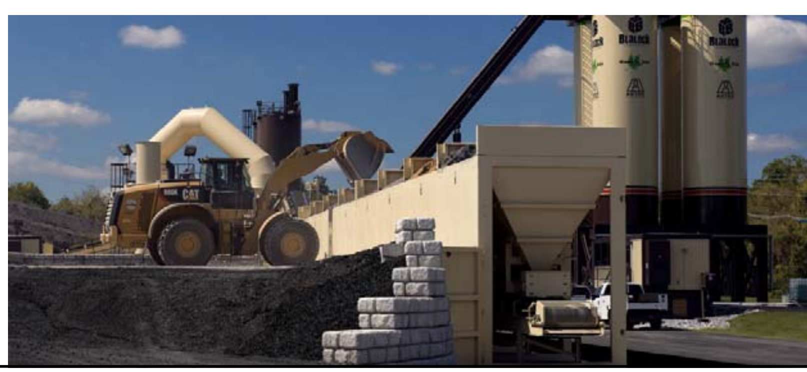
- Remove material from just above grade.
  – Avoids contamination.
- Rotate up and through material.
  – Reduces possibility of segregation.



13

Proper Operation of Cold Feed Bins

- Most common form of feeding into plants.
- Typically charged with rubber-tired loader.
- One bin for each material.
- Used on both batch and drum plants.



14

Proper Operation of Cold Feed Bins

Material bins should not be heaped above divider walls.

TN

15

Cold Feed Bins (Best Management Practice)

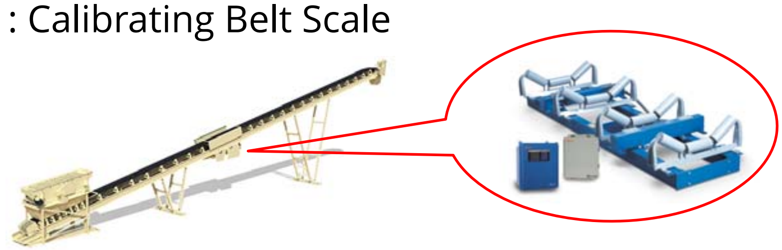
- Avoid contamination caused by removing material from grade.
  - The ground the stockpile sits on is not part of the stockpile.
- Have dividers between cold feed bins.
  - Avoids co-mingling of different materials.
- Do not overfill bins with bin wall dividers.
  - Avoids co-mingling of different materials.

TN

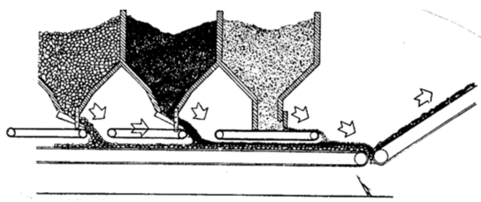
16

Plant Calibration

- Step 1: Calibrating Belt Scale



- Step 2: Belt Feeder Calibration
  - After belt scale has been calibrated.



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Plant Calibration

Step 1 - Calibrating Belt Scale

- Verify belt scale reads zero per manufacturer's guidelines.
- Set the cold feed gates at an opening that will allow a good material feed.
- Start main conveyor belt.
- Run the variable speed belt feeder for the coarse aggregate bin - about 50% of desired production rate.
- Starting with empty belt run material in tared truck and stop material flow to end with empty belt.

18

Plant Calibration

Step 1 - Calibrating Belt Scale

- Record the total weight indicated on the belt scale.
- Compare weight total on belt scale with actual weight on truck.
- Following manufacturers guidelines, adjust belt scale instrument based on weight difference.
- Repeat test, adjusting instrument, until two consecutive tests are within tolerance.

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Plant Calibration

Step 1 - Calibrating Belt Scale

Calculate Percent Error

$$\% \text{ Error} = \frac{(\text{Applied Weight - Measured Weight})}{\text{Applied Weight}} \times 100$$

$$\% \text{ Error} = \frac{(\text{Truck Weight} - \text{Scale Weight})}{\text{Truck Weight}} \times 100$$

20

Plant Calibration

Example of Calibrating Belt Scale

- Start belt scale and verify reads zero.
- Start feeder at approximately 50% flow.
- Fill truck and stop and empty belt.
- Tonnage on aggregate scale was 9.22 tons.
- Tonnage in the truck at 9.51 tons.

$$\%\ Error = \frac{Truck\ Wt. - Scale\ Wt.}{Truck\ Weight} \times 100$$

TN

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Plant Calibration

Example of Calibrating Belt Scale

$$\%\ Error = \frac{Truck\ Weight\ - Scale\ Weight}{Truck\ Weight} \times 100$$

TN

22

Plant Calibration

Scale and Metering Systems
(TDOT's std spec. 407.04)

".....All dial scales shall be accurate within a tolerance of 0.5 percent."

- Our % Error is _____?
- What do we do?

23

Plant Calibration (Best Management Practice)

Calibrating Belt Scales

- Larger truck tests rather than smaller truck tests decrease probability of error.
- Weigh bridges should be checked for wear and binding prior to tests.
- If belt scale is out of tolerance on one flow rate, but not another, and adjustments to instrument do not correct error consider re-aligning weigh bridge.

24

Plant Calibration (Best Management Practice)

Calibrating Belt Scales

- Wind can affect scale readings - consider installing wind guard over weigh bridge.
- Belts should have gravity take-up to keep belt tension constant.
- Belts of different widths and thicknesses are very difficult to calibrate.

TN

25

Plant Calibration (Best Management Practice)

Calibrating Belt Scales

- Weigh bridge must be "square" with "weigh idler" slightly higher than other belt idlers.
- Watch for build up on the belt and weigh idler.
  - Remove or install scraper.
- Belts of different widths and thicknesses are very difficult to calibrate

TN

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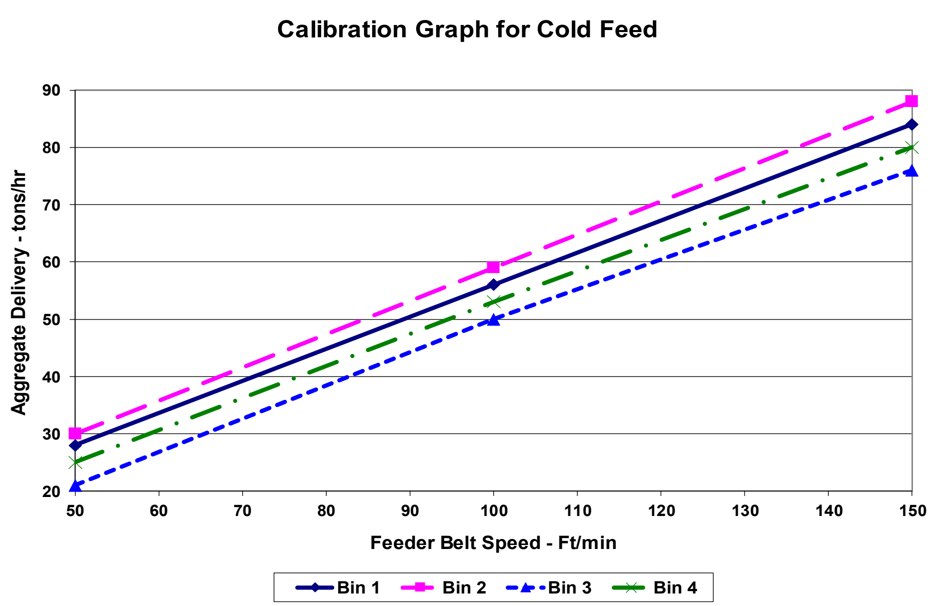
Plant Calibration

Step 2 – Belt Feeder Calibration

- After belt scale has been calibrated.
- Develop a chart of aggregate rate (tons per hour) vs. belt speed (feet per minute) for each cold feed bin.

27

Plant Calibration



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Plant Calibration

Step 2 – Belt Feeder Calibration

Manually Establish Belt Speeds

- Example
  - Desired plant production 200 tph.
  - Aggregate proportions:
    - Bin #1: 20%
    - Bin #2: 35%
    - Bin #3: 30%
    - Bin #4: 15%
  - Asphalt content: 6 %

TN

29

Plant Calibration

Step 3 (a) – Correct each aggregates percentage for total weight of aggregates

- Bin # 1: 20% x 0.94 =
- Bin # 2: 35% x 0.94 =
- Bin # 3: 30% x 0.94 =
- Bin # 4: 15% x 0.94 =

Actual percentage of aggregate in a mixture

TN

30

Plant Calibration

Step 3 (b) – Compute demand for each aggregate in Tons/Hour

- Bin # 1: 18.8% x 200 tons =
- Bin # 2: 32.9% x 200 tons =
- Bin # 3: 28.2% x 200 tons =
- Bin # 4: 14.1% x 200 tons =

Desired plant production rate **per hour**

TN

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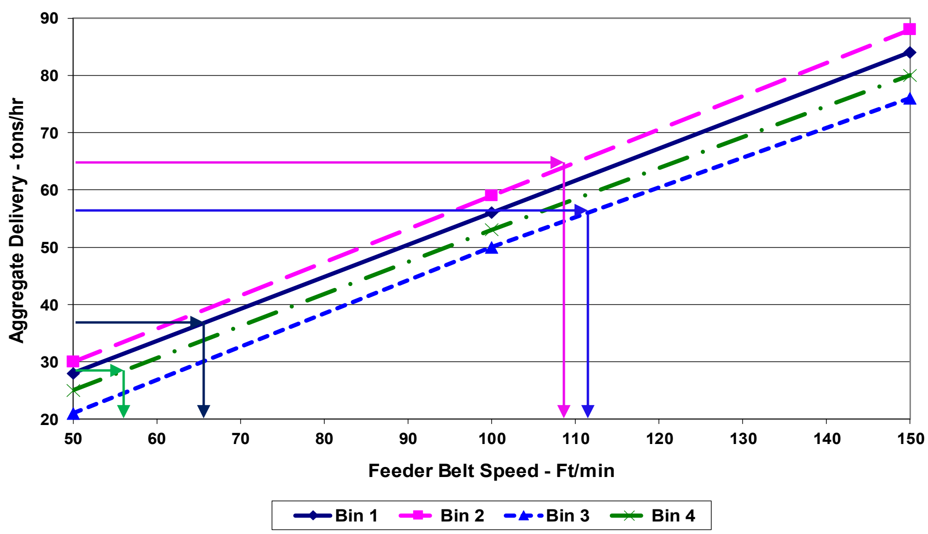
Plant Calibration

Step 3 (b) – Pick optimum belt speed



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RAP Cold Feed Bins

- Special Requirements and Designs:
  - More horsepower (larger output required).
  - Special designs to promote flow of material.
  - RAP more prone to bridge.
  - “Lump breaker” often found at discharge.
- Why have a separate bin for RAP?
  - The drying flame for the virgin aggregate should not come into contact with the binder on the RAP.

33

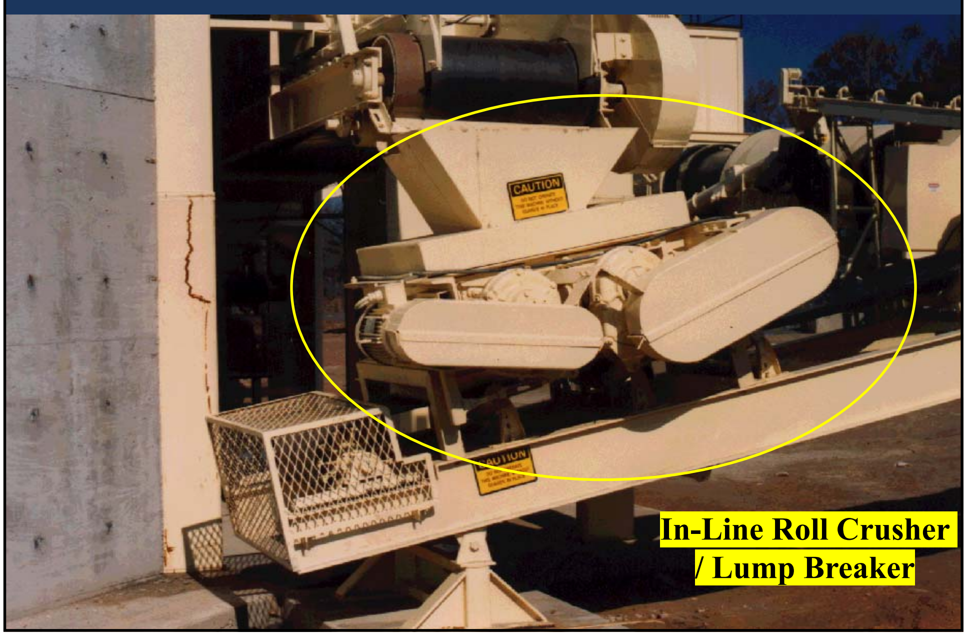
RAP Cold Feed Bins

34

RAP Cold Feed Bins

35

RAP Cold Feed Bins



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5

Liquid Asphalt Storage and Metering Systems

TN TDOT Department of Transportation

Asphalt Storage and Metering Systems

Division of Materials and Tests

1

What You Will Learn

- Asphalt storage tank systems.
- TDOT requirements all AC systems.
- Hot oil heat systems.
- BMPs for maintaining asphalt cement integrity.

TN

2

Asphalt Storage Tank System

Requirements for All Asphalt Plant

(TDOT std spec 407.04A.6)

Bituminous control unit.

"Provide means for weighing or metering the bituminous material to ensure the proper amount of material is added to the mix within the tolerance specified. Provide means for checking the quantity or rate of flow of bituminous material into the mixer."

TN

3

Asphalt Storage Tank System

Requirements for Batching Plants

(TDOT std spec 407.04B.3)

Bituminous Control.

- Provide a bituminous material bucket of a non-tilting type.
- The length of the discharge opening or spray bar shall be not less than 3/4 the length of the mixer, and it shall discharge directly into the mixer.
- Shall be adequately heated.
- Shall be at least 15% in excess of the weight of bituminous material required in any batch.
- Shall have a scale with divisions measuring in gallons equivalent to a weight sensitivity of 0.04% of the total batch weight.
- The meter shall be accurate within a tolerance of 0.5%.

TN

4

Asphalt Storage Tank System

Requirements for Continuous Mixing Plants

(TDOT std spec 407.04C.3)

Synchronization of aggregate feed and bituminous material feed.

- Provide positive interlocking control between the flow of aggregate from the bins and the flow of bituminous material from the meter or other proportioning device.
- This control may be achieved using mechanical means or any other positive method satisfactory to the Engineer.

5

Asphalt Storage Tank System

Requirements for Dryer-Drum Mixing Plants

(TDOT std spec 407.04D.2)

Synchronization of agg. feed and bituminous material feed.

- Provide satisfactory means to allow a positive interlocking control between cold aggregate feed and asphalt.
- Base the control setting for the asphalt flow on the dry weight of the aggregate.
- Provide an acceptable method for proportioning asphalt flow as variations in aggregate flow take place.
- Provide a metering system to measure the flow of asphalt into the drum, and locate an approved method of checking and calibrating the metering system in the control house.
- Provide an automatic interlock system that will shut off the asphalt flow and the burner when the aggregate flow ceases

6

Maintaining AC Temperature (Best Management Practice)

Why maintaining temperature of the liquid asphalt cement in the tank and the lines is so important?

- Critical to proper coating of the aggregate.
- Critical for proper placement and compaction.
- Critical for a quality paving product.
- TDOT controls AC temps through tolerances on Mixing temperatures.

TN

7

Temperature Requirement

Preparing the Bituminous Material

(TDOT std spec 407.11.A)

Heat the bituminous materials for HMA mixes to the required mixing temperature specified in Table 407.11-1.

PG Binder Grade	Min. Temp.	Max. Temp.
PG 64-22, PG67-22	270° F	310° F
PG 70-22	290° F	330° F
PG 76-22	290° F	330° F
PG 82-22	290° F	330° F

TN

8

Temperature Requirement

Preparing the Bituminous Material for WMA
(TDOT std spec 407.11.B)

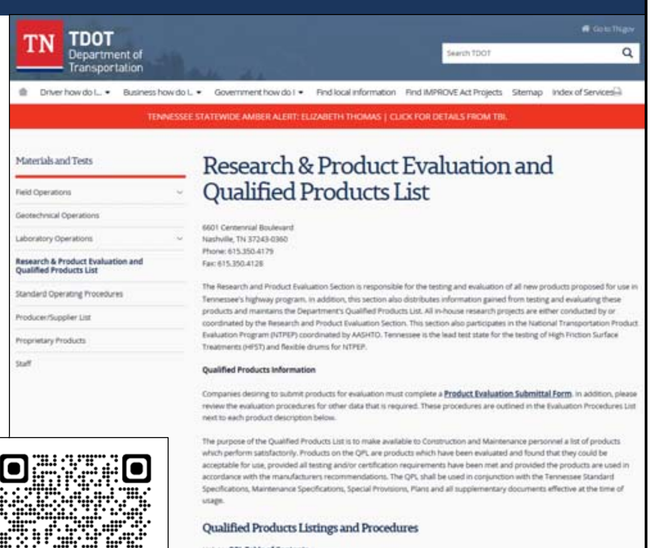
- The Contractor may subject the produced mixture to reduced production and placement temperatures by adding a chemical warm mix additive meeting **921.06.B.3** or by making plant modifications as specified in **407.04.A.12.**
- When using either WMA technology, the maximum mixing temperature for any grade of asphalt cement shall be no more than 300 °F.

9

Temperature Requirement (Warm Mix Asphalt)

TDOT 407.04.12 "Ensure that modifications made to the plant to reduce mixing temp meet the requirement listed for WMA additives in the Dept's QPL."

Link to QPL 39 for WMA additives:



10

Temperature Requirement

Why Have Min and Max Temperature Requirements?

- Protects asphalt from over-cooking.
  - Blue Smoke.
  - Loss of light ends.
- Having a minimum temperature helps with compaction on the road.
  - Ensures that the mixture will stay in a condition favorable to achieve compaction.
- Manufacturer recommends it.

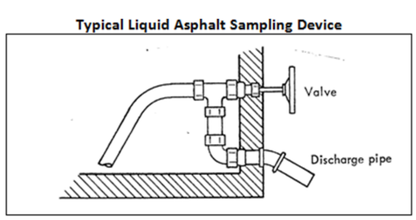
TN

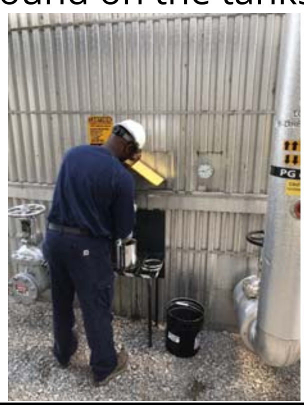
11

Asphalt Storage Tanks

Sampling Device is required

- Samples for binder testing must be taken from the transport tanker or tank.
- Testing valves are typically found on the tanks.





TN

12

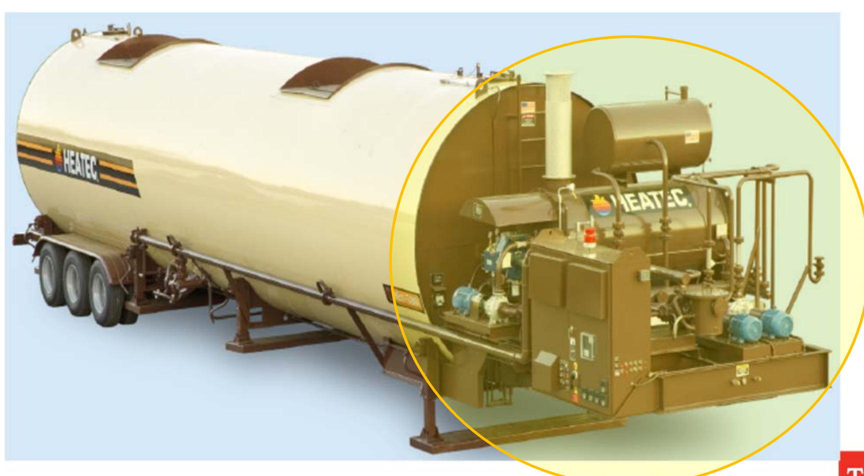
Asphalt Storage Tanks

- Tanks can be horizontal or vertical.
- Tanks typically have hot oil heating coils.
  - Some are heated electrically or with a burner.

13

Asphalt Storage Tanks

Fossil Fuel Fired Hot Oil Heater



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Asphalt Storage Tanks

Fossil Fuel Fired Hot Oil Heater

TN

15

Asphalt Storage Tanks

Storing & Using Modified Asphalts

- Need to be kept in circulation.
- Asphalts are typically blended at the terminal, but they can be blended at the plant.
- Several equipment options exist.

Natural Convective Currents
In an Asphalt Storage Tank

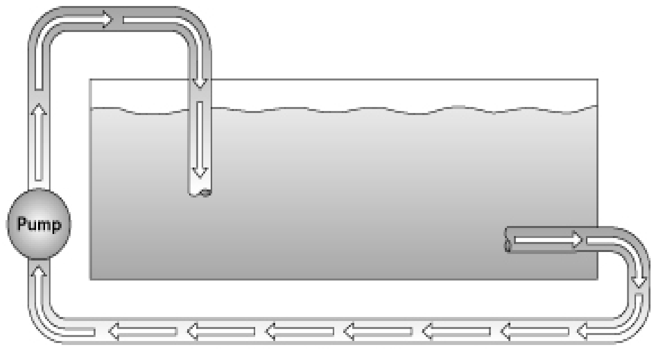
TN

16

Asphalt Storage Tanks

Storing & Using Modified Asphalts

- If the natural convective currents are not sufficient, the simplest method of agitation is to keep the asphalt circulating through the tank.



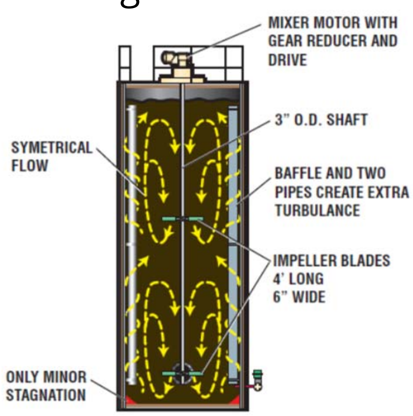
Recirculating with a pump is suggested for some modified asphalts

17

Asphalt Storage Tanks

Storing & Using Modified Asphalts

If simply pumping the modified asphalt through the tank is not adequate for storage requirements, mechanical agitators can be installed in the tanks.



18

Asphalt Storage Tanks

Multiple Storage Tanks

- Multiple storage tanks offer mix flexibility to the producer, but create management issues as well.

TN

19

Asphalt Storage Tanks (Best Management Practice)

Multiple Tank Installation

- Do not mix asphalt types.
  - Affects asphalt binder properties.
- Care should be exercised when switching valves to direct asphalt storage.
  - It can potentially contaminate asphalt.
- Tanks should be pulled down or emptied before a new type binder is stored.

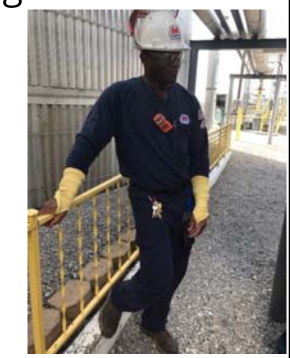
TN

20

Asphalt Storage Tanks

Safety Issues

- Condensation in empty tanks very dangerous. Moisture turns to steam when charging tank with hot asphalt.
- Never look inside a tank being charged with asphalt.
- CAUTION when loading, unloading, sampling.
  - Asphalt is HOT. Be aware of first aid procedures at any facility that you visit.



21

Asphalt Distribution

- Understanding asphalt distribution:
  - Calculating Flow Requirements.
  - Calibrating Asphalt Meter.

TN

22

Calculating AC Flow for DRUM PLANT

Equation for determining the number of gallons/minute of asphalt cement that is to be delivered:

$$R = \frac{P}{100} \times T \times \frac{2000}{W} \times \frac{1}{60}$$

Where: *R* = Asphalt to be delivered, gpm.
P = Optimum Asphalt Content.
T = Production Rate, TPH.
W = Unit Weight of Asphalt (typically about 8.4 lb/gal).

TN

23

Calculating AC Flow (Example)

Determine the number of gallons/minute of asphalt cement assuming 6.0 % asphalt content at 200 TPH:

TN

24

Calculating AC Flow (Example)

Determine the number of gallons/minute of asphalt cement assuming 5.7 % asphalt content at 300 TPH:

TN

25

Calculating AC for BATCH PLANTS

- Calculating the necessary asphalt content for a batch plant varies from the original equation.
- Batch plants make a specific amount of mixture per batch that runs through the plant.
  - R is not expressed as a rate!

TN

26

Calculating AC for Batch Plants

Equation for determining the number of gallons of asphalt cement inside of each batch:

$$R = \frac{P}{100} \times T \times \frac{2000}{W} \times \cancel{\frac{1}{60}}$$

Where: *R* = Asphalt Content, *Gallons*.
P = Optimum Asphalt Content.
T = Batch Weight, *Tons*.
W = Unit Weight of Asphalt (typically about 8.4 lb/gal).

TN

27

Asphalt Distribution

Automatic Control

- Asphalt binder flow is controlled by the plant automation.
- Automation adjusts asphalt binder flow at the asphalt pumping/metering unit.
- Manual calculations not required.

TN

28

Asphalt Distribution

Calibrating Binder Meter

1. Tare empty truck or vessel and pump asphalt all the way to end of fill line, suspending line to ensure no asphalt leaks from line (CAUTION - AC HOT!).
2. Record totalizer on AC meter, or set totalizer to zero.
3. Pump asphalt into truck or vessel at rate representing normal production flow.
4. When stopping AC flow, make sure line is not allowed to drain into vessel.
5. Record gallons or tons on AC meter.
6. Weigh truck and calculate net weight in truck.

29

Asphalt Distribution

Calibrating Binder Meter

7. Convert gallons to weight if meter reads in gallons.
8. Compare registered meter weight with actual weight on truck.
9. Following manufacturers guidelines, adjust meter based on weight difference.
10. Repeat test, adjusting instrument, until two consecutive tests are within tolerance.
11. Repeat test at high flow rate, then low flow rate.
12. Adjust meter until all flow rates are within tolerance.

30

Asphalt Distribution

Calibration Binder Meter (Example)

- Set pump at approximately 50% flow and fill truck.
- Record binder weight/gallon at 8.54 lbs/gallon.
- Calculate weight of binder pumped is 10,402 lbs.
- Actual weight in truck is 10,800 lbs
- Re-test and re-adjust until two consecutive tests pass.

31

Asphalt Distribution (Best Management Practice)

Calibrating Binder Meters

- Larger tests rather than smaller truck tests decrease probability of error (1,000 gallon minimum typically used in industry).
- Thermocouples or RTD's used to measure temperature of binder at meter for temperature calibration should be checked against known calibrated thermometers to make sure proper binder temperature is being taken.

32

Asphalt Distribution (Best Management Practice)

Calibrating Binder Meters

- Charged binder lines must not be allowed to drain at start or stop or binder quantities in tests will be off.
- Verify proper specific gravity or AC weight/gallon is entered in meter.
- Truck scales are calibrated +/- 20 pounds.
- Small binder test sample sizes should be avoided.
- 40 pound tolerance on a truck scale is 4.7 gallons of binder.

33

Asphalt Distribution (Best Management Practice)

Troubleshooting AC Content

- If binder extractions are consistently high or consistently low, suspect meter recalibration or belt scale recalibration, or binder thermocouple recalibration.
- If binder extractions vary, but meter checks on calibration test, suspect flow control device problem at binder pumping skid.
- Plant automation is typically not the problem on binder content variations (typically belt scale, meter, or flow control device).

34

Asphalt Distribution (Best Management Practice)

Troubleshooting AC Content

- Air leaks in binder lines can cause meters measuring gallons to count air as asphalt.
  - Extracted binder content will be low.
- Thermocouples or RTD's measuring binder temperature for temperature compensation will cause binder content errors if not registering proper temperature (replace unit).

TN

35

Anti Stripping Additives

What is Stripping?

- The loss of bond between aggregates and asphalt binder that typically begins at the bottom of the HMA layer and progresses upward.
- When stripping begins at the surface and progresses downward it is usually called raveling.

36

Anti Stripping Additives

Bituminous Additives

(TDOT's std spec 921.06.B)

- When hydrated lime is the ASA, use an amount equal to 1% by weight of agg. Uniformly coat the agg. with the lime before adding the binder to the mix.
- When using an anti-stripping additive other than hydrated lime, use a dosage rate of **0.3%,** unless either gravel is used as a coarse aggregate or test results indicate moisture susceptibility, in which case mix at a dosage rate of **0.5%**.
- The Department's QPL identifies qualified antistripping products. Do not use any product unless it appears on this list."

37

Anti Stripping Additives

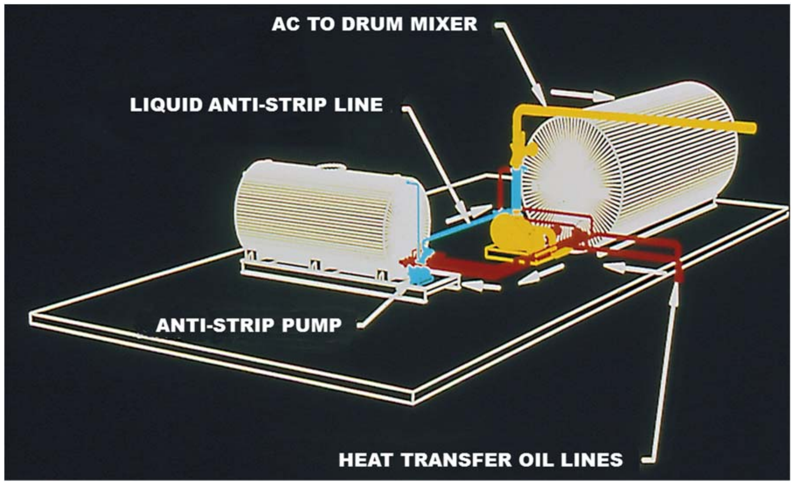
Anti Stripping Additives (ASA) can be introduced at

- The Asphalt Terminal
  - Contractor buys binder with ASA already added.
- The Asphalt Plant
  - Blended in-line during production.
  - Blended into tanks during unloading of binder transport units.

38

Anti Stripping Additives

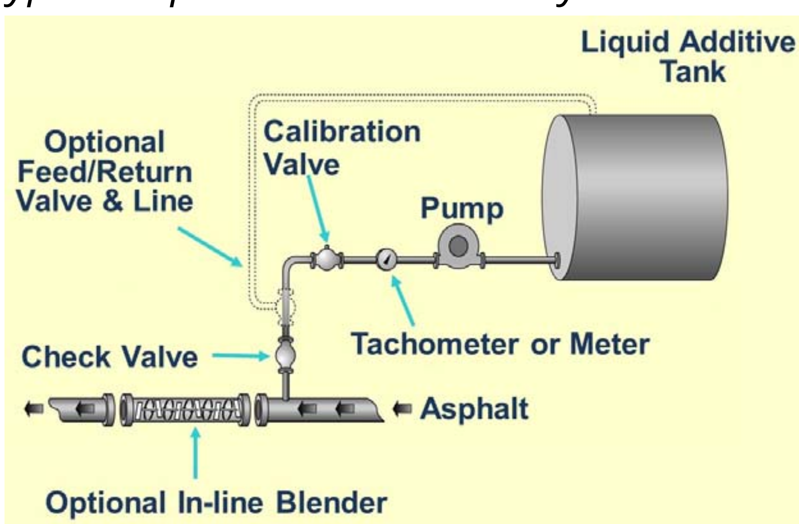
- *ASA Injection System (Blended during production)*



39

Anti Stripping Additives

- *Typical Asphalt Additive Tank System*

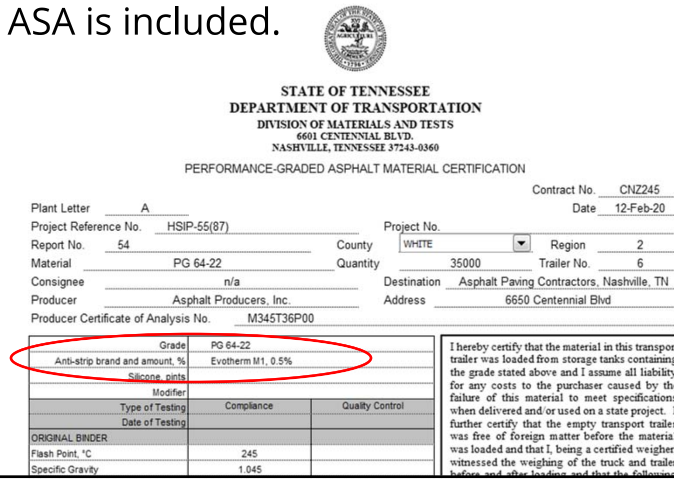


40

Anti Stripping Additives

Added at Asphalt Terminal

Asphalt certifications that come with truckloads will indicate if ASA is included.



STATE OF TENNESSEE
DEPARTMENT OF TRANSPORTATION
DIVISION OF MATERIALS AND TESTS
6601 CENTENNIAL BLVD.
NASHVILLE, TENNESSEE 37243-0360

PERFORMANCE-GRADED ASPHALT MATERIAL CERTIFICATION

Contract No. CNZ245
Plant Letter A — Date 12-Feb-20
Project Reference No. HSIP-55(87) — Project No.
Report No. 54 — County WHITE — Region 2
Material PG 64-22 — Quantity 35000 — Trailer No. 6
Consignee n/a — Destination Asphalt Paving Contractors, Nashville, TN
Producer Asphalt Producers, Inc. — Address 6650 Centennial Blvd
Producer Certificate of Analysis No. M345T36P00

Grade	PG 64-22	
Anti-strip brand and amount, %	Evotherm M1, 0.5%	
Silicone, pints		
Modifier		
Type of Testing	Compliance	Quality Control
Date of Testing		
ORIGINAL BINDER		
Flash Point, °C	245	
Specific Gravity	1.045	

I hereby certify that the material in this transport trailer was loaded from storage tanks containing the grade stated above and I assume all liability for any costs to the purchaser caused by the failure of this material to meet specifications when delivered and/or used on a state project. I further certify that the empty transport trailer was free of foreign matter before the material was loaded and that I, being a certified weigher, witnessed the weighing of the truck and trailer before and after loading and that the following

41

Anti Stripping Additives

Added at Plant When Unloading

- Some plants may be equipped with systems that pump ASA into storage tanks while tanker units are being unloaded.

42

Anti Stripping Additives

Calculate ASA Needed in Gallons

$$ASA_{TOT} = \frac{\left[HMA_{Total\ Ton} \times \left(\frac{\%\ AC}{100}\right) \times \left(\frac{\%\ ASA}{100}\right) \times 2{,}000\right]}{ASA_{DEN}}$$

ASA_{TOT} =Gallons of Anti-Stripping Additives
$HMA_{Total\ Ton}$=Total Tonnage of Mixture Produced in the Date
%AC =Percent Binder (from JMF)
%ASA = Percent of Anti-Stripping Additives (From JMF)
ASA_{DEN} = Density of Anti-Stripping Additive (8.4 lbs/gal)

43

Anti Stripping Additives

Calculate ASA Needed in Gallons

- 2,200 tons of 411-D produced today.
- 5.8% Asphalt Content.
- 0.5% Anti-Strip Additive.
- Anti-Strip Additive weighs 8.4 lbs/gallon.

44

6

Hot Mix Asphalt Storage and Delivery

TN TDOT Department of Transportation

Hot Mix Asphalt Storage and Delivery

Division of Materials and Tests

1

What You Will Learn

- Surge/Storage Silos:
  - Operational Concepts
  - Benefits
  - Concerns
- Best Management Practices for:
  - Maximizing Storage Capability
  - Silo Loadout

TN

2

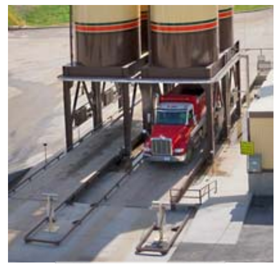
Storage Silos

Many configurations:

- Portable
- Stationary
- Single Silo
- Multiple Silos
- Over Truck Scale


Portable Surge Silo


Multiple Surge/Storage Silos


Truck Scale

3

Storage Silos

- Minimize trucks required on a project.
- Increase daily productivity of batch plants.
- Silos are required for drum-mix plants.

4

Storage Silos (Best Management Practice)

- With silos we are mostly concerned about:
  - Segregation.
  - Temperature Loss.
  - Oxidation.

5

Storage Silos

Surge and Storage Systems

(TDOT std spec 407.04.A.11)

- Surge or Storage systems may be used at the option of the Contractor provided each system is approved by the Department prior to use.
- The surge and storage system shall be of such design that there is no appreciable difference between material being discharged from the bin or silo and material being discharged directly from the pugmill or drum.

6

Storage Silos

- When using a silo, the contractor shall deliver material that is:
  - within the tolerance ranges as set forth on the Job Mix Formula.
  - without segregation.
  - without balling or hardening.

TN

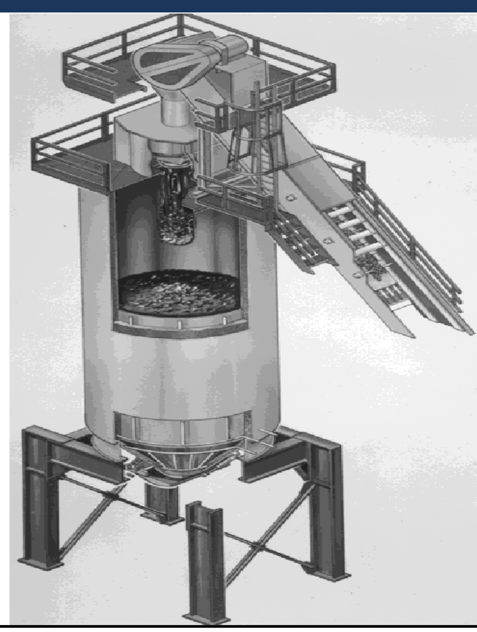
7

Storage Silos

Several design elements have evolved to address our concerns over storage

- Batcher
- Top and Bottom sealing
- Insulation
- Cone Design

Let's look at what those are.

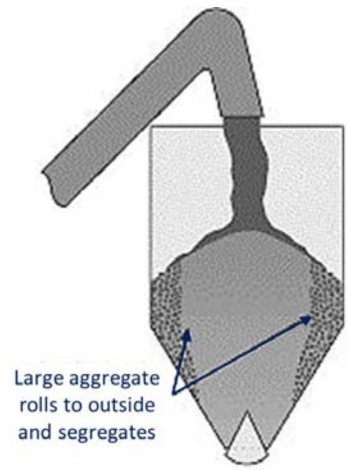


8

Storage Silos

Segregation without a Batcher on Silo

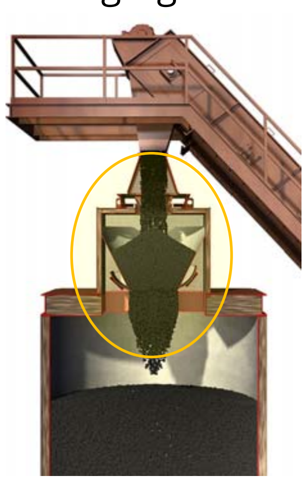
- Silos without batchers are prone to segregation.
- As the material drops from the height of the slat conveyor to the bottom of the silo, large stones can roll to the outside of the silo cylinder, causing mix to be coarser to the outside.

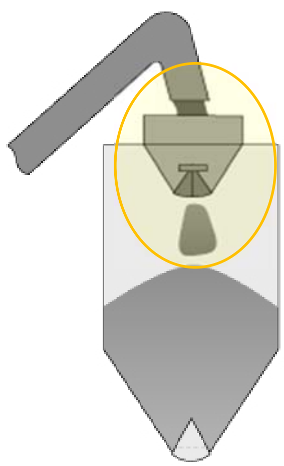


9

Storage Silos

Batchers drop a large mass of material at one time to reduce segregation.





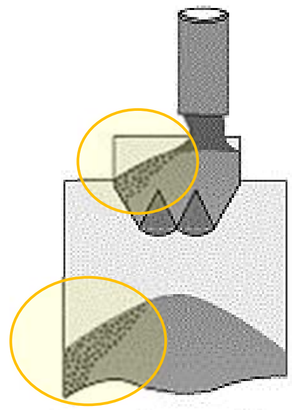
Silo batcher

10

Storage Silos

Feed all batchers in center

- Feeding batchers in the center eliminates any possibility of mix segregating in the batcher.
- If batchers are not fed in the center, the possibility exists for large stones in the mix rolling to the outside of the cone in the batcher itself.



Segregation caused by not feeding batcher in center

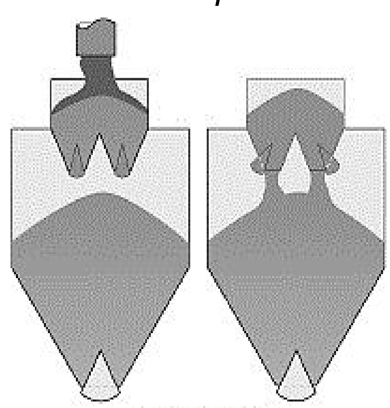
TN

11

Storage Silos

Feed split-feed type batcher in-line with splitter.

- The mix must not be allowed to roll down the edge of the divider in the batcher. Or segregation can be caused the same as not feeding a center-drop batcher in the center.



Split feed batcher charging and discharging

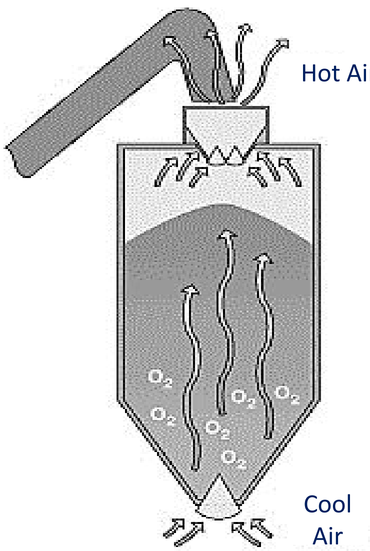
TN

12

Storage Silos

Sealing

- In storage mode, it is crucial to seal the silo. Oxidation happens in the silo when the mix is exposed to air. In storage mode, silos need to be completely sealed from top to bottom
- Heat can escape out the batcher and draws in cool air to oxidize the mix.

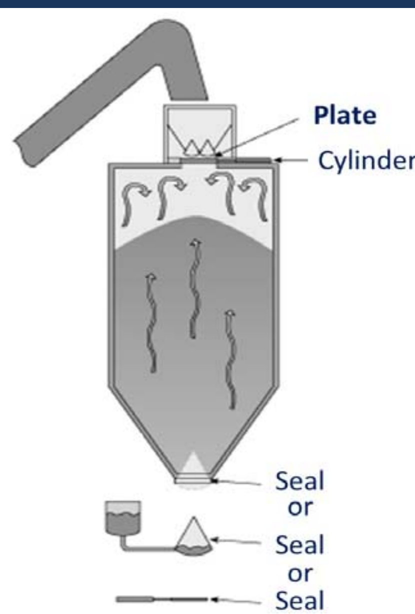


13

Storage Silos

Sealing

- Seals on the bin top and silo gate area lengthen storage times by reducing the “Chimney Effect.”
- Air is trapped in an insulated and sealed environment.

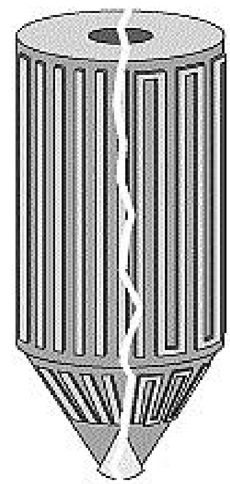


14

Storage Silos

Insulation

- Insulation allows longer mix storage periods.
- Insulation and hot oil heat helps reduce the effects of heat loss to the atmosphere.
- Silo top, Cone, and Batchers should be insulated to prevent heat loss

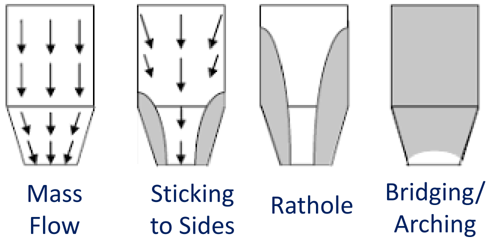


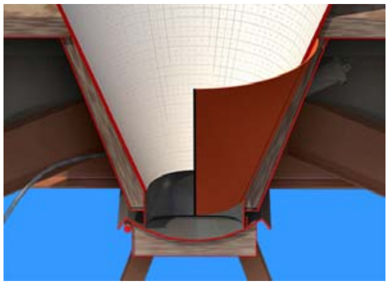
15

Storage Silos

Cone Design

- Good cone design prevents segregation and mix build-up with its mass-flow slope.
- Properly angled cones allow mix to move by "mass flow," helping prevent mix build-up on silo walls.
- Cone insulation and an electric blanket surround the lower part of cone, preventing excessive heat loss.





16

Storage Silos (Best Management Practice)

- To reduce the opportunity for segregation:
  - Feed all batchers in center.
  - Feed split-feed type batcher in-line with splitter.
  - Adjust timer-style batchers for full discharge (varies with production rate).
  - Adjust close timers to leave some material in batcher on closing.

17

Silo Loadout

- Once mix is stored adequately in the silo, it is ready for dispatch to the job site. There are proper procedures for loading trucks to protect the quality of the mix.

18

Silo Loadout (Best Management Practice)

- Specific gate designs and loadout procedures have been developed to minimize segregation in the loading process.

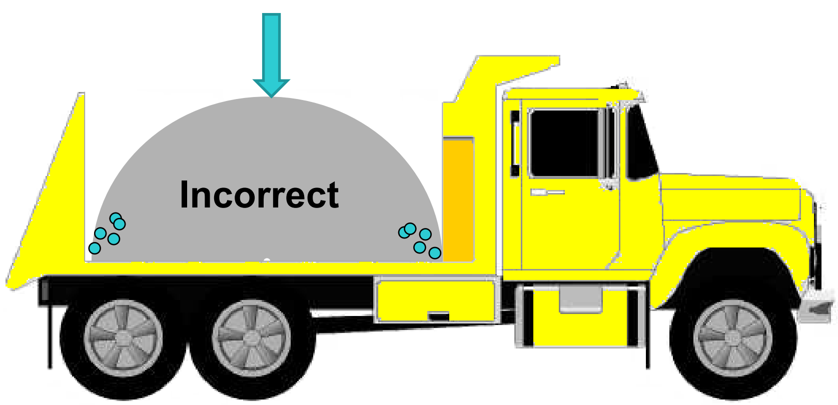
Round Opening

2 Rectangular Openings

19

Silo Loadout

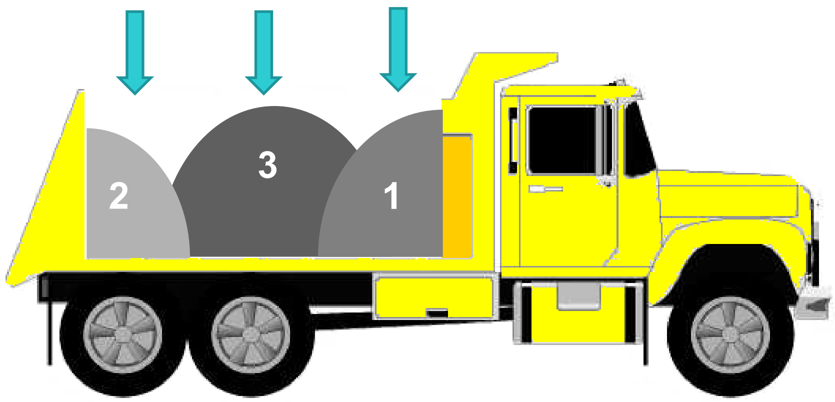
Incorrect Loading



20

Silo Loadout

Correct Loading



21

Questions?

22

7

Job Mix Formula Overview

TN TDOT Department of Transportation

Overview of the Job Mix Formula (JMF)

(Provided for Reference)

Division of Materials and Tests

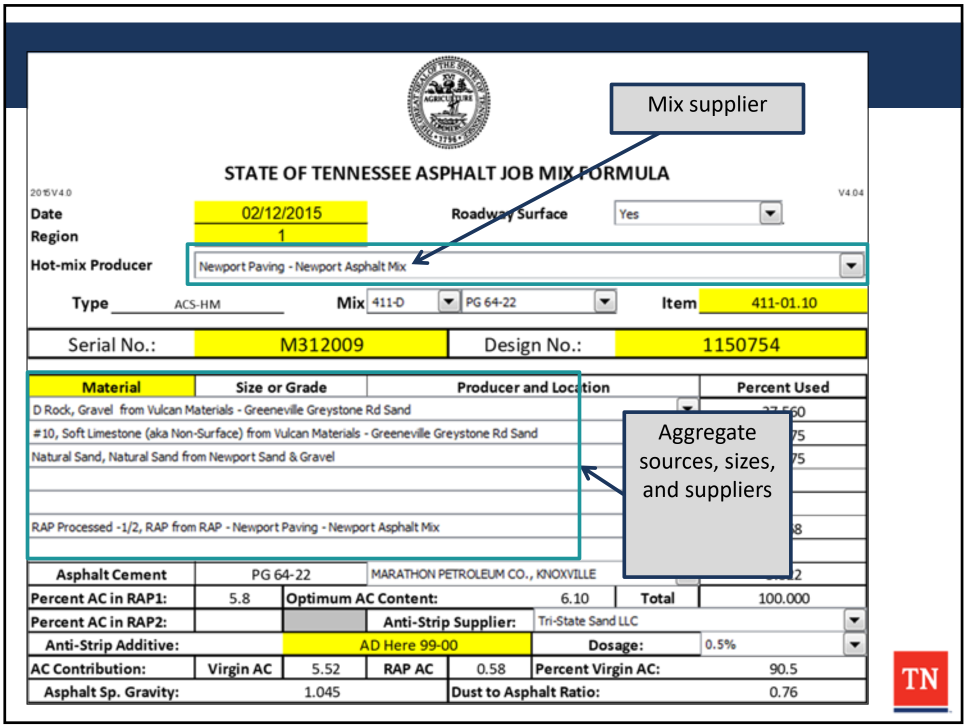
1

What is a JMF?

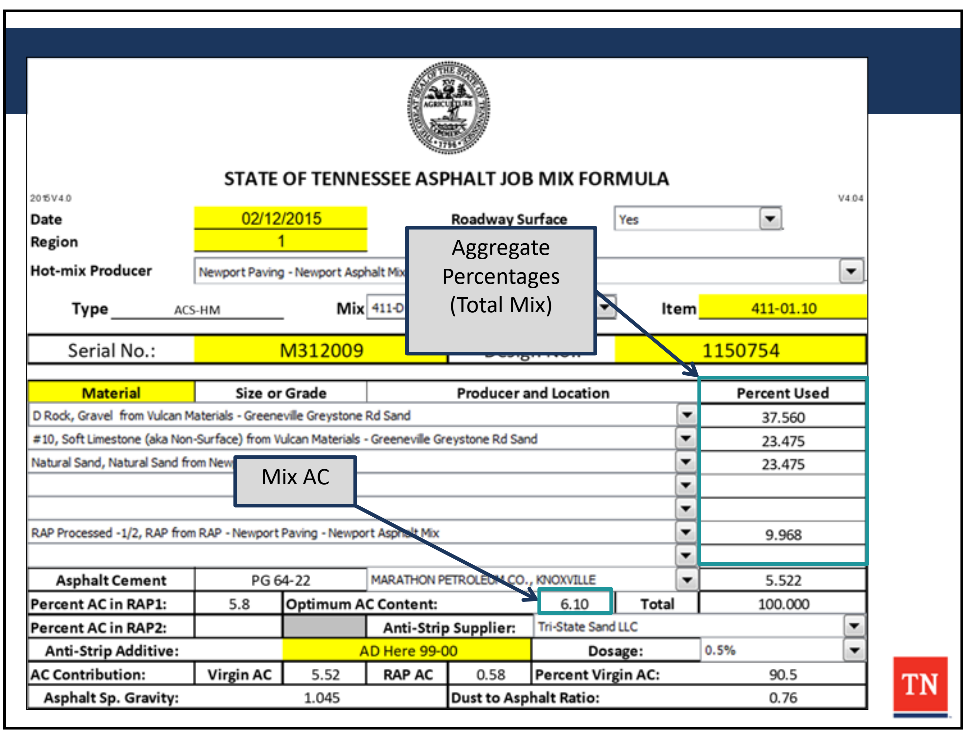
- It is a valuable document to all inspectors.
- On this document you will find:
  - Materials being used and their source.
  - Proportions of each material.
  - What Plant is being used.
  - Type of Mix.
  - Gradations.
  - Approval of the Materials Engineer.

TN

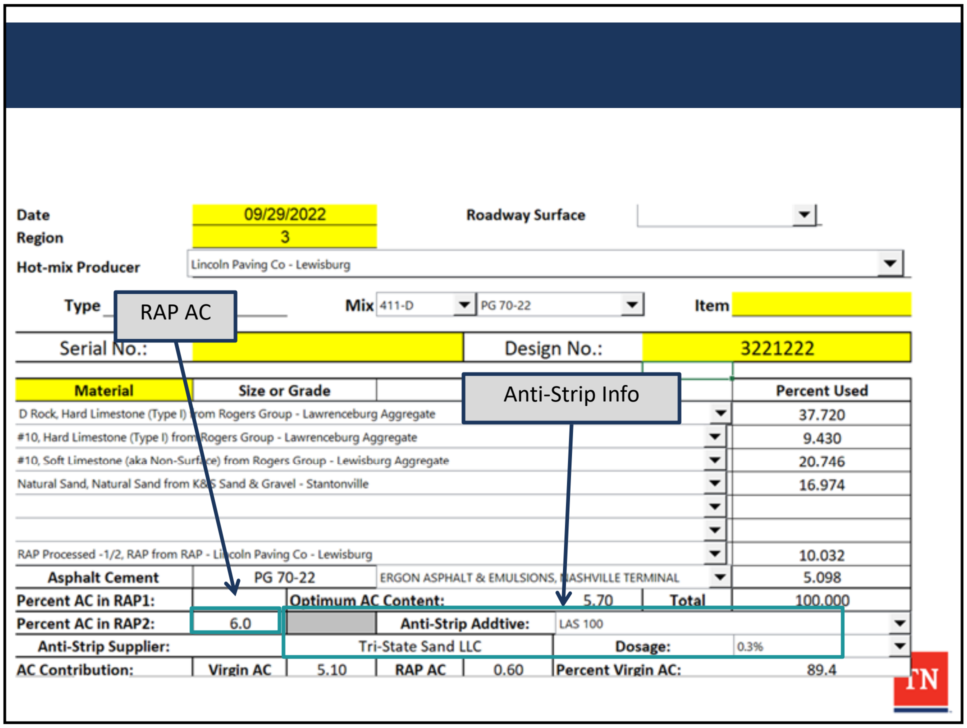
2


STATE OF TENNESSEE ASPHALT JOB MIX FORMULA
Mix supplier
Date 02/12/2015
Region 1
Roadway Surface Yes
Hot-mix Producer Newport Paving - Newport Asphalt Mix
Type ACS-HM
Mix 411-D PG 64-22
Item 411-01.10
Serial No.: M312009
Design No.: 1150754
Material
Size or Grade
Producer and Location
Percent Used
D Rock, Gravel from Vulcan Materials - Greeneville Greystone Rd Sand
#10, Soft Limestone (aka Non-Surface) from Vulcan Materials - Greeneville Greystone Rd Sand
Natural Sand, Natural Sand from Newport Sand & Gravel
RAP Processed -1/2, RAP from RAP - Newport Paving - Newport Asphalt Mix
Aggregate sources, sizes, and suppliers
Asphalt Cement PG 64-22 MARATHON PETROLEUM CO., KNOXVILLE
Percent AC in RAP1: 5.8
Optimum AC Content: 6.10
Total 100.000
Percent AC in RAP2:
Anti-Strip Supplier: Tri-State Sand LLC
Anti-Strip Additive: AD Here 99-00
Dosage: 0.5%
AC Contribution: Virgin AC 5.52 RAP AC 0.58
Percent Virgin AC: 90.5
Asphalt Sp. Gravity: 1.045
Dust to Asphalt Ratio: 0.76
TN

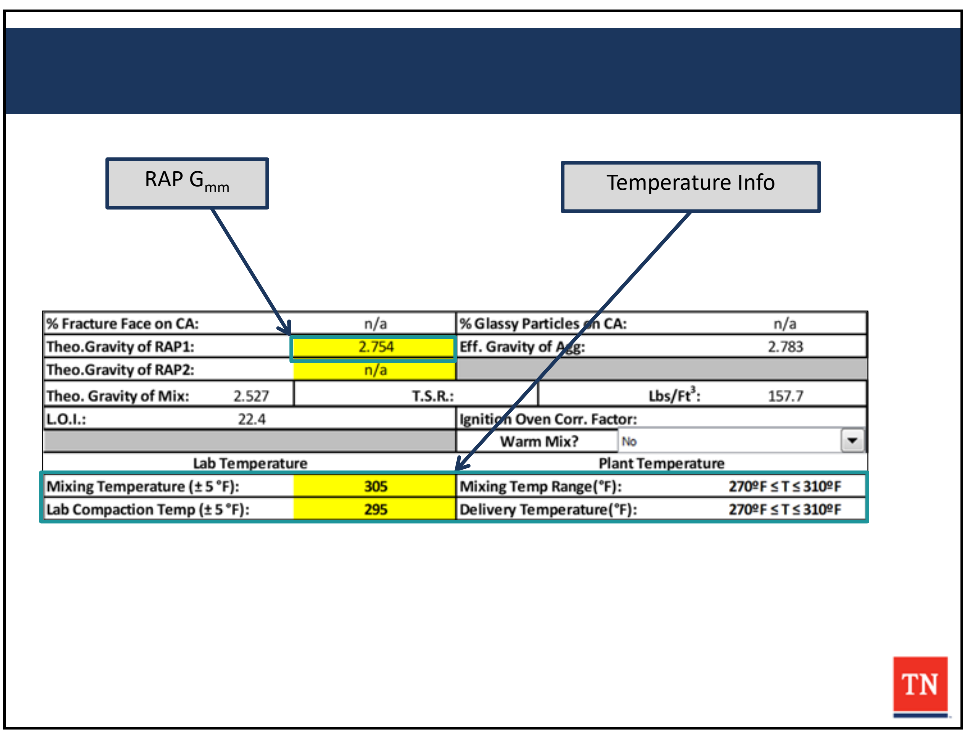
3


STATE OF TENNESSEE ASPHALT JOB MIX FORMULA
Aggregate Percentages (Total Mix)
Date 02/12/2015
Region 1
Roadway Surface Yes
Hot-mix Producer Newport Paving - Newport Asphalt Mix
Type ACS-HM
Mix 411-D
Item 411-01.10
Serial No.: M312009
1150754
Material
Size or Grade
Producer and Location
Percent Used
D Rock, Gravel from Vulcan Materials - Greeneville Greystone Rd Sand 37.560
#10, Soft Limestone (aka Non-Surface) from Vulcan Materials - Greeneville Greystone Rd Sand 23.475
Natural Sand, Natural Sand from New 23.475
Mix AC
RAP Processed -1/2, RAP from RAP - Newport Paving - Newport Asphalt Mix 9.968
Asphalt Cement PG 64-22 MARATHON PETROLEUM CO., KNOXVILLE 5.522
Percent AC in RAP1: 5.8
Optimum AC Content: 6.10
Total 100.000
Percent AC in RAP2:
Anti-Strip Supplier: Tri-State Sand LLC
Anti-Strip Additive: AD Here 99-00
Dosage: 0.5%
AC Contribution: Virgin AC 5.52 RAP AC 0.58
Percent Virgin AC: 90.5
Asphalt Sp. Gravity: 1.045
Dust to Asphalt Ratio: 0.76
TN

4


RAP AC
Anti-Strip Info
Date 09/29/2022
Region 3
Roadway Surface
Hot-mix Producer Lincoln Paving Co - Lewisburg
Type
Mix 411-D PG 70-22
Item
Serial No.:
Design No.: 3221222
Material
Size or Grade
Percent Used
D Rock, Hard Limestone (Type I) from Rogers Group - Lawrenceburg Aggregate 37.720
#10, Hard Limestone (Type I) from Rogers Group - Lawrenceburg Aggregate 9.430
#10, Soft Limestone (aka Non-Surface) from Rogers Group - Lewisburg Aggregate 20.746
Natural Sand, Natural Sand from K&S Sand & Gravel - Stantonville 16.974
RAP Processed -1/2, RAP from RAP - Lincoln Paving Co - Lewisburg 10.032
Asphalt Cement PG 70-22 ERGON ASPHALT & EMULSIONS, NASHVILLE TERMINAL 5.098
Percent AC in RAP1:
Optimum AC Content: 5.70 Total 100.000
Percent AC in RAP2: 6.0
Anti-Strip Addtive: LAS 100
Anti-Strip Supplier: Tri-State Sand LLC
Dosage: 0.3%
AC Contribution: Virgin AC 5.10 RAP AC 0.60 Percent Virgin AC: 89.4
TN

5


RAP G_mm
Temperature Info
% Fracture Face on CA: n/a
% Glassy Particles on CA: n/a
Theo.Gravity of RAP1: 2.754
Eff. Gravity of Agg: 2.783
Theo.Gravity of RAP2: n/a
Theo. Gravity of Mix: 2.527
T.S.R.:
Lbs/Ft³: 157.7
L.O.I.: 22.4
Ignition Oven Corr. Factor:
Warm Mix? No
Lab Temperature
Plant Temperature
Mixing Temperature (± 5 °F): 305
Mixing Temp Range(°F): 270ºF ≤ T ≤ 310ºF
Lab Compaction Temp (± 5 °F): 295
Delivery Temperature(°F): 270ºF ≤ T ≤ 310ºF
TN

6

Aggregate Percentages

Sieve Size	Percents Used							% Req.	Design Range
	D Rock	#10	Natural Sand			RAP Processed 1/2		100	
	40.0	25.0	25.0			10.0			
2"									
1.5"									
1.25"									
1"									
3/4"									
5/8"	100	100	100			100		100	100
1/2"	89	100	100			89		95	95-100
3/8"	68	100	100			68		84	80-93
No.4	21	92	99			21		58	54-76
No.8	12	60	89			12		43	35-57
No.16									
No.30	9	23	50			9		23	17-29
No.50	7	16	16			7		11	10-18
No.100	4.5	12.0	6.1			4.5		6.8	3-10
No.200	2.7	9.6	3.5			2.7		4.6	0-6.5

Stockpile Gradations

Blend Gradation

7

RAP On the JMF

STATE OF TENNESSEE ASPHALT JOB MIX FORMULA

2015 V4.0 V4.04

Date 02/12/2015 **Roadway Surface** Yes

Region 1

Hot-mix Producer Newport Paving - Newport Asphalt Mix

Type ACS-HM **Mix** 411-D PG 64-22 **Item** 411-01.10

Serial No.: M312009 Design No.: 1150754

Material	Size or Grade	Producer and Location	Percent Used
D Rock, Gravel from Vulcan Materials - Greeneville Greystone Rd Sand			37.560
#10, Soft Limestone (aka Non-Surface) from Vulcan Materials - Greeneville Greystone Rd Sand			23.475
Natural Sand, Natural Sand from Newport Sand & Gravel			23.475
RAP Processed -1/2, RAP from RAP - Newport Paving - Newport Asphalt Mix			9.968
Asphalt Cement	PG 64-22	MARATHON PETROLEUM CO., KNOXVILLE	5.522

Percent AC in RAP1:	5.8	Optimum AC Content:	6.10	Total	100.000
Percent AC in RAP2:			Anti-Strip Supplier:	Tri-State Sand LLC	
~~Anti-Strip Additive:~~		~~AD Here 99-00~~	~~Dosage:~~	~~0.5%~~	
AC Contribution:	Virgin AC	5.52	RAP AC	0.58	Percent Virgin AC: 90.5
Asphalt Sp. Gravity:	1.045		Dust to Asphalt Ratio:	0.76	

8

8

Sampling and Testing

Sampling and Testing Materials

Division of Materials and Tests

1

What You Will Learn

- Types of Sampling and Testing
- Aggregate
  - Sampling
  - Testing
- Asphalt Mixture
  - Sampling
  - Testing
- RAP
  - Sampling
  - Testing

2

Types of Sampling and Testing:

Quality Assurance

- Performed by TDOT.
- According to TDOT Materials and Tests S.O.P. 1-1 (including the Sampling and Testing Guide).
- Testing types:
  - ✓ Acceptance
  - ✓ Verification
  - ✓ Assurance

Quality Control

- Performed by the contractor.
- According to QC plan, submitted by the contractor.
- Must align with TDOT Spec. Section 407.03.

3

Sampling and Testing

- What materials are we going to sample for testing?
  - Aggregates
  - RAP
  - Hot Mix Asphalt Mixture
  - Asphalt Binder

4

Sampling and Testing

Remind you the types of TDOT mixtures

- Surface Mixes:
  - 411-D, 411-E (Roadway, Shoulder), 411-TL, 411-TLD, 411-TLE*, 411-OGFC, 307-CW**
- Binder Mixes:
  - 307-B, 307-BM, 307-BM2, 307-C, 307-CS, 307-CW**
- Base Mixes:
  - 307-A, 307-AS, 307-ACRL, 313-TPB

*411-TLE is an alternative underlayment for OGFC.

**307-CW can be an intermediate layer or a surface layer in low volume applications.

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Sampling and Testing

- Copies of sampling and testing requirements for any material on a TDOT project can be found:
  - TDOT M&T Standard Operating Procedures
  - SOP 1-1, "Procedures for the Sampling and Testing, and Acceptance of Materials and Products"

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Sampling and Testing

SOP 1-1

June 15, 2020
January 14, 2022
October 31, 2022

Tennessee Department of Transportation
Division of Materials and Tests

Quality Assurance Program for the Sampling and Testing of Materials and Products (SOP 1-1)

Purpose: The purpose of this document is to establish the procedures and **minimum** requirements for the acceptance, verification, and certification of materials and products used on Tennessee Department of Transportation (TDOT) projects and projects under the oversight of TDOT (Local Projects, Grants, etc. that include Federal Funds).

Background: Federal Law (23 CFR 637) requires each state develop a quality assurance program which assures all materials, on projects where Federal Funds are used, conform to the requirements of the approved plans and specifications. In addition, these procedures assure projects using state funds will also be constructed using approved materials.

Policy: All materials used on TDOT projects must be accepted **prior to use**. Acceptance of materials is by:

A. Testing before product placement (e.g. hot mix asphalt, Portland cement concrete, base materials, pre-packaged concrete mixture).

B. Manufacturers' certifications followed by random verification testing (e.g. gray iron castings, cement, liquid asphalt).

C. Producer List pre-approval and testing of a product or its components (e.g. aggregate quality, reinforced concrete pipe, corrugated metal pipe).

D. The Qualified Products List (QPL) with certifications (e.g. sign sheeting, erosion control blankets, pavement marking materials, patching material).

Sampling and Testing Materials and Products

1. Test Types

There are three basic types of sampling and tests routinely conducted: acceptance, verification, and assurance. All testing shall be performed by a certified technician.

1.1 Acceptance Sampling and Testing

1.2 Verification Sampling and Testing

These tests are conducted to verify/validate that products accepted by manufacturers' certifications are in compliance with the applicable Tennessee Department of Transportation Standard Specifications for Road and Bridge Construction January 1, 2015 (Standard Specifications). In accordance with Federal Law (23 CFR 637), "The verification sampling shall be performed on samples that are taken independently of the quality control samples."

1.3 Independent Assurance Sampling and Testing

These are tests conducted to assure that acceptance sampling and testing procedures are done in accordance with the specified procedures and to compare testing equipment.

2. Material Certifications

2.1 All materials accepted on certification must have a Material Certification and/or Sampling Testing Record DT-0044 (T-2) form, completed by the Contractor, showing contract number, project number, county, item number, quantity of material being accepted, etc. Attach the T-2 form to the manufacturer's certification and forward to the Regional Materials and Tests (M&T) Supervisor. The Manufacturer's certification shall state that materials have been tested and inspected and that the manufacturer certifies that TDOT specifications have been met. The Manufacturer's certification shall contain at a minimum the manufacturer's name, contact information, and specifications that the material meets.

2.2 The manufacturer's certification may not be project specific (i.e. it will not have the contract or project number on the certification). When this occurs, do not write the contract or project number on the certification. Instead, require the contractor to complete, and have notarized, a T-2 form, and attach the manufacturer's certification. Copies of certifications will be acceptable provided originals are kept on file by the contractor, supplier, or manufacturer and available for inspection.

2.3 Any material that is on the Department's QPL may be accepted by a certification from the manufacturer stating that the material furnished to the project is the same as the material evaluated for the QPL. The Contractor shall forward the certification and a T-2 form to the Project Supervisor for review.

2.4 It is the project personnel's responsibility to provide the final inspection on all material. If for any reason the material is suspect, it should not be used until further evaluation is conducted. Contact the Regional M&T Supervisor for further evaluation(s).

2.5 All manufacturers' certifications must be signed; however, for seed, sod, and nursery materials, the Tennessee Department of Agriculture will provide the certification. Any certification that is not project specific shall be notarized.

2.6 Miscellaneous materials used on special projects (e.g. rest areas) that are overseen by an architect or consulting engineer for the Architecture Department may be accepted by a blanket certification stating that all materials meet specification requirements.

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Sampling and Testing

ASPHALT

Asphalt Plant Mix Pavements	Aggregate	Fractured Face Count	Project Inspector	Per project	Coarse aggregate stockpiles	Plus No. 4 (4.75 mm) sieve material, gravel mixes only.
		Glassy Particles by mass				Plus No. 4 (4.75 mm) sieve material, slag mixes only.
	All Plant Mix Asphalt	Mix Temperature		Every 5th load	From the truck prior to leaving the plant and on the roadway prior to deposit into the paver or the material transfer device	Temperatures on the roadway are to be recorded on the delivery ticket.
		10 Minute Boil Test		Per day	From the truck at the asphalt plant	
	Plant Mix Asphalt (Grading A, B, BM, BM2, C, CW, D, E, E-Shoulder)	Density		Every 1,000 tons	As soon as practical after compaction	Each lot shall be divided into 5 equal sub-lots, and one test shall be performed per sub-lot.
	Plant Mix Asphalt (Grading B, BM, BM2, C, CS, CW, D, E, TL, TLD, TLE, and OGFC)	Loss on Ignition (Surface Mix with Limestone Only)		Per day	Completed mix in truck	LOI testing is to be run on the extracted aggregate reclaimed from the completed plant mix. If daily sample fails, take 3 cores per lot placed that day to determine LOI.
		Asphalt Content: AASHTO T-164, Method E-II by extraction, or AASHTO T-308 by ignition oven.		Every 1,000 tons		If testing completed mix, perform extraction using AASHTO T-164 Method E-II utilizing nested sieves (No. 16 and No. 20). AASHTO T-164 Method A may be used for modified asphalt or when problems are encountered filtering according to Method E-II. Not required on production days of less than 100 tons. Ignition oven may be utilized to determine gradation.
		Aggregate Gradation: AASHTO T-30 and AASHTO T-11				

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Aggregates Sampling and Testing

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Aggregates Sampling (AASHTO T-2/ ASTM D-75)

AASHTO T-2/ASTM D-75: Sampling Aggregates

Why do we do this?

- To verify quality of aggregates with representative material from the source of the aggregates

How do we do this?

- The amount of representative material will be determined by NMAS in TABLE 1

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Aggregates Sampling (AASHTO T-2/ ASTM D-75)

Minimum Sample Size

Aggregate Size[A]	Field Sample Mass, min, kg[B] [lb]
	Fine Aggregate
2.36 mm [No. 8]	10 [22]
4.75 mm [No. 4]	10 [22]
	Coarse Aggregate
9.5 mm [⅜ in.]	10 [22]
12.5 mm [½ in.]	15 [35]
19.0 mm [¾ in.]	25 [55]
25.0 mm [1 in.]	50 [110]
37.5 mm [1½ in.]	75 [165]
50 mm [2 in.]	100 [220]
63 mm [2½ in.]	125 [275]
75 mm [3 in.]	150 [330]
90 mm [3½ in.]	175 [385]

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Aggregates Sampling (AASHTO T-2/ ASTM D-75)

Sample obtained. What is next?

- For QC, we can run following tests:
  - Stockpile Moisture Contents.
  - T-27 / T-11 Washed Sieve Analysis on ALL aggregates.
  - TDOT Glassy Particle Test.
    - If **slag** is used as a coarse aggregate.
  - TDOT Fractured Face Count.
    - If **gravel** is used as a coarse aggregate.
  - Loss on Ignition

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Aggregate Testing (AASHTO T-11 and T-27)

AASHTO T-11 or T-27: Sieve Analysis of Aggregate

Why do we do this?

- T-11 is for fine aggregates and T-27 is coarse aggregates.
- To determine the particle size distribution of fine and coarse aggregates by sieving.
- Longevity of asphalt pavement is directly affected by the gradation of aggregate so that we need to make sure the gradation should be close enough to the that in JMF.

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Aggregate Testing (AASHTO T-11 and T-27)

How do we do this?

- We collected materials per AASHTO T-2.
- The mass of the sample of aggregate shall conform with the table in 6.2 (T-11) or 7.4 (T-27).
- Let's check Yellow Spec Book.
- Stack set of sieves by the size and pour the prepared material into the set of sieve.
- Put the set of sieve in sieve shaker
- After shaking the sieves, measure amount of material retained at each sieve.

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Aggregate Testing (AASHTO T-11)

How do we do T-11?

- You watched T-11 method with mechanical agitator.
- Let's looks at how to do manually.
- Weigh the oven-dried aggregate and record its mass.
- Required amount of material presented in section 6.2 of T-11.
- Add a bit of wetting agent (mild soap).
- Be careful not to pour water too much.

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Aggregate Testing (AASHTO T-11)

Add water and stir gently.

Then carefully decant liquid over a nest of sieves.

Continue washing until the liquid is reasonably clear.

Oven dry the aggregate at 230°F to a constant mass.

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Aggregate Testing (AASHTO T-27)

How do we do T-27?

- After recording the mass of the oven-dried, washed aggregate, the material must be shaken though a stack of sieves.
- Once the material has been shaken for a sufficient period of time, each sieve must be cleaned out.
- The mass of its contents recorded cumulatively.

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Aggregate Testing (AASHTO T-11 and T-27)

How do we record and find % passing?

- Sieve analysis result in this table came from the material after washing.
- Finding original weight of material is the beginning point to understand this.
- % retained come from original weight of material.
- Percent passing is 100% minus % retained.

Sieve Size	Weight Retained	Percent Retained	Percent Passing	JMF or Specification
5/8"	0			100
1/2"	32.6			97
3/8"	157.4			86
#4	510.9			59
#8	764.2			47
#16	935.6			
#30	1060.6			27
#50	1225.4			12
#100	1319.7			6.5
#200	1342.8			4.4
Pan	1347.2			

Material Passing #200 Sieve

T-11

Original Dry Weight Sample Weight (A) 1392.7 grams
Weight of Sample After Wash (B) ________ grams
Wash Loss (A-B) ________ grams

T-27

Pan Weight (C) ________ grams
Passing #200 Material
(C - weight retained #200) ________ grams

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Aggregate Testing (TDOT's Glassy Particle)

TDOT std spec 903.11.a.4: Glassy Particle Weight Percentage

Why do we do this?

- Slag is the glass-like by-product left over after a desired metal has been separated from its raw ore.
- Crushed slag was used as a coarse aggregate, but excessive use of slag may reduce friction on pavement surface.
- So we do this for safety!

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Aggregate Testing (TDOT's Glassy Particle)

How do we do this?

- When slag is used as a coarse aggregate, a check for glassy particles must be performed.
- Obtain minimum 300 g of representative coarse (greater than #4) aggregates.
- Measure the weight of representative aggregates.
- Manually separate glassy particles and measure the weight of glassy particles.
- Cannot exceed 20% glassy particles by weight.

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Aggregate Testing (TDOT's Glassy Particle)

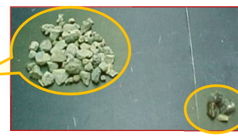
Glassy Particles (Slag)
Subsection 903.11(a)(4)

Does mix contain slag used as coarse aggregate? Yes ● No ○

Crushed slag coarse aggregate shall contain no more than 20%, by weight, of glassy particles; except that where used in Grading G mix, the percent of glassy particles, by weight, shall not exceed 10%.

A representative sample containing at least 300 grams of the (+4) slag should be used.*

* DOT Policy



292 g

18 g

$$\%\ \text{Glassy Particles} = \frac{\text{Mass of Glassy Particles}}{\text{Total Mass of Sample Used}} \times 100\%$$

Mass of Glassy Particles ______ g
Total Mass of Sample Used ______ g

% Glassy Particles = %

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Aggregate Testing (ASTM D-5821)

ASTM D5821: Percentage of Fractured Particles in Coarse Aggregate

Why do we do this?

- Fractured particles increase inter-locking between aggregate particles
- To increase shear strength by increased inter-locking in either bound or unbound aggregate mixtures.
- To provide increased friction for surface courses

Cubical Aggregate

Rounded Aggregate

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Aggregate Testing (ASTM D-5821)

How do we do this?

- By counting number of particles with two or more fractured faces.
- Typically done with gravels.
- Fractured faces provide structural support within asphalt mixtures.
- When gravel is used as a coarse aggregate, some of the material is crushed, leaving one or more fractured faces. Some particles, however, will not be affected by this process.
- We need to determine the percent of particles with 2 or more fractured faces by count (not by mass).

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Aggregate Testing (ASTM D-5821)

How do we do this?

- When gravel is used as a coarse aggregate, some of the material is crushed, leaving one or more fractured faces. Some particles, however, will not be affected by this process.
- We need to determine the percent of particles with 2 or more fractured faces **by count** (not by mass).

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Aggregate Testing (ASTM D-5821)

Fractured Face Count
Subsection 903.11(a)(3)

Is Crushed Gravel used as a coarse aggregate in this mix? Yes ◉ No ○

At least 70% by count, of the material retained on the 4.75 mm (No. 4) sieve shall have a minimum of two fractured faces, one of which must be fractured for the approximate average diameter or thickness of the particle.

A representative sample containing at least 200 grams should be used.

$$\% \text{ Fractured} = \frac{\text{No. of Particles Fractured}}{\text{Total No. of Particles Inspected}} \times 100$$

No. of Particles Fractured ______
Total No. of Particles Inspected ______

% Fractured = ________ %

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Aggregate Testing (Loss on Ignition)

Test for Percent loss on ignition of the Mineral Aggregate in a Asphalt Paving Mixture.

Why do we do this?

LOI is simply before and after burn material weight difference

- L.O.I. is a **PAY FACTOR** (TDOT std spec 407.20.C.3)
- Perform on surface mixtures only.
  (i.e., 411D, 411OGFC, 411TL, 411TLD)
- Perform in accordance with TDOT std spec. 407.03.E.3
- Results Compared to Value Listed on JMF

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Aggregate Testing (Loss on Ignition)

How do we do this?

- Obtain a representative aggregate sample (approximately **600** g).
- Assign them to 4 clay crucibles (150g each).
- Record the mass of each container with and without aggregates
- The crucible must have a cover to prevent pop-out of aggregate while heating.
- Insert them into the furnace.

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Aggregate Testing (Loss on Ignition)

How do we do this?

- The covered crucible and its contents is then ignited in a muffle furnace at 1742° F **(950° C)** to constant weight (minimum of **8 hours**).
- The crucible and contents are cooled to room temperature and weighed.
- Record the mass of all of the containers filled with the ignited aggregate.
- If the aggregate sample has been obtained by extraction with a vacuum extractor, the weights before and after ignition must be corrected for filter aid

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Aggregate Testing (Loss on Ignition)

How do we calculate LOI?

Remarks: No filter aid used. Sample taken from burnout oven

1 Determining Weight of Sample

Note : Minimum Sample Size = 600 Grams

(A) Weight of Agg. From Burnout Oven		**900.0**
Weight of Sample Container (Crucible)	+	**1100.0**
Total Wt. Of Agg. + Sample Container	=	

2 Determining Weight Loss

Wt. of Container + Test Sample (Before Ignition)	
Wt. of Container + Test Sample (After Ignition)	
(B) Weight Loss	

3 Calculating L.O.I. :

L.O.I. = (B) Divided by (A) x 100

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Aggregate Testing (Loss on Ignition)

How do we calculate Pay Factor with LOI result?

Please open TDOT std spec 407.20.C.3

Case 1:

JMF L.O.I. Value:	**10.0%**	Difference:	**1.1%**
Mix L.O.I. Value:	**11.1%**	Percent Pay:	**100%**

Case 2:

JMF L.O.I. Value:	**10.0%**	Difference:	**3.2%**
Mix L.O.I. Value:	**13.2%**	Percent Pay:	**94%**

(% pay = 100 - (1.2 x 5)

Case 1:

JMF L.O.I. Value:	**10.0%**	Difference:	**7.2%**
Mix L.O.I. Value:	**17.2%**	Percent Pay:	**0% !!!**

MILL IT UP !!!!!!

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Asphalt Mixtures Sampling and Testing

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Asphalt Mixture Sampling (ASTM D-979)

AASHTO T-168 or ASTM D-979: Sampling Bituminous Paving Mixtures

Why do we do this?

- Material shall be inspected to determine discernible variations

Where do we collect material?

- Conveyor belt, truck transport, roadway before compaction etc.

How do we do this?

- The amount of representative material will be determined by NMAS in TABLE 1

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Asphalt Mixture Sampling (ASTM D-979)

Minimum Sample Size

- Determine NMAS from JMF

TABLE 1 Guide for Estimating Minimum Sample Quantity

Maximum Size of Aggregates[A]	Uncompacted Mixture	
	Approximate Mass min, kg [lb]	Approximate Volume L [gal]
2.36 mm (No. 8)	10 [22]	8 [2]
4.75 mm (No. 4)	10 [22]	8 [2]
9.5 mm (⅜ in.)	16 [35]	12 [3]
12.5 mm (½ in.)	20 [45]	15 [4]
19.0 mm (¾ in.)	20 [45]	15 [4]
25.0 mm (1 in.)	24 [52]	18 [5]
37.5 mm (1½ in.)	30 [66]	22 [6]
50 mm (2 in.)	35 [75]	22 [6]

[A] The maximum size of aggregate is the largest sieve size listed in the applicable specification upon which any material is permitted to be retained.

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Asphalt Mixture Sampling (ASTM D-979)

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Asphalt Mixture Sampling (ASTM D-979)

Sampling from Truck Transports

- Avoid sampling the extreme top surface!
- How many different places? Why?

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Asphalt Mixture Temperature

Why we need to know about mixing and compaction temperature?

- Viscosity of AC will be changed at different temperature.
- We need more liquid like performing asphalt binder at mixing phase for easier coating.
- But we need less liquidity of asphalt binder for compaction to avoid bleeding or flushing.
- Therefore, there are different temperature requirements for mixing and compaction on both lab material fabrication and plant production.

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Asphalt Mixture Temperature

Hot Mix Asphalt

- Plant production temperature must adhere to TDOT Spec 407.11:

407.11 Preparing the Bituminous Material

A. Hot Mix Asphalt (HMA)

Heat the bituminous materials for hot mixes to the required mixing temperature specified in Table 407.11-1.

Table 407.11-1: Mixing Temperatures

PG Binder Grade	Minimum Temperature (°F)	Maximum Temperature (°F)
PG 64-22, PG 67-22	270	310
PG 70-22	290	330
PG 76-22	290	330
PG82-22	290	330

The temperature for Grading AS, Grading ACRL, and Grading TPB mixtures shall be between 225 and 275 °F, except when modified binders are used, and then the temperatures shall be between 250 and 310 °F. Aggregate should be coated and no visible drain down should occur in storage silos or hauling equipment.

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Asphalt Mixture Temperature

Warm Mix Asphalt

- Plant production temperature must adhere to Spec 407.11, Table B:

B. Warm Mix Asphalt (WMA)

The Contractor may subject the produced mixture to reduced production and placement temperatures by adding a chemical warm mix additive meeting **921.06.B.3** or by making plant modifications as specified in **407.04.A.12.**

When using either WMA technology, the maximum mixing temperature for any grade of asphalt cement shall be no more than 300 °F. At the beginning of a day's production, the producer may produce up to five truckloads at the temperatures specified in Table 407.11-1 to pre-heat placement equipment (pavers, transfer devices) before producing WMA. Indicate the laboratory mixing and compaction temperatures on the JMF during the mix design approval process. A tolerance of ±5.0 °F for each temperature will be allowed.

During test strip construction, ensure that all plant-produced WMA exhibits the ability to meet the test requirements for tensile strength ratio (TSR), conditioned tensile strength, Marshall Stability and flow, volumetrics, and boil test, as specified for HMA in specifications **307**, **407**, and **411**. Procedures for testing shall be in accordance with that which is defined for quality control and acceptance in **407.03.D.2.h** and **407.20.B.3**, respectively.

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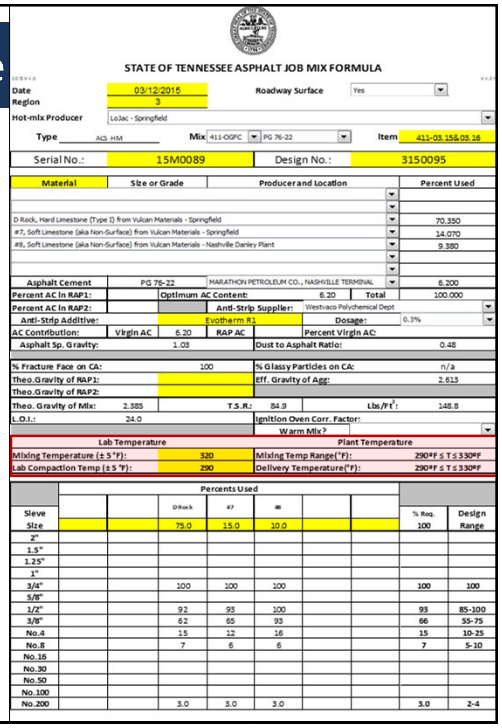
Mixture Temperature

- Mixing & Compaction temperature established by the viscosity of asphalt binder at different temperature.
- Those are determined during mix design process.
- Presented on JMF



STATE OF TENNESSEE ASPHALT JOB MIX FORMULA

Date: 03/12/2015
Region: 3
Roadway Surface: Yes
Hot-mix Producer: LoJac - Springfield
Type: ACS HM
Mix: 411-OGFC PG 76-22
Item: 411-03.15&03.16
Serial No.: 15M0089
Design No.: 3150095

Material	Size or Grade	Producer and Location	Percent Used
D Rock, Hard Limestone (Type I) from Vulcan Materials - Springfield			70.350
#7, Soft Limestone (aka Non-Surface) from Vulcan Materials - Springfield			14.070
#8, Soft Limestone (aka Non-Surface) from Vulcan Materials - Nashville Danley Plant			9.380
Asphalt Cement	PG 76-22	MARATHON PETROLEUM CO., NASHVILLE TERMINAL	6.200

Percent AC in RAP1: — Optimum AC Content: 6.20 — Total: 100.000
Percent AC in RAP2: — Anti-Strip Supplier: Westvaco Polychemical Dept
Anti-Strip Additive: Evotherm R1 — Dosage: 0.3%
AC Contribution: Virgin AC 6.20 — RAP AC — Percent Virgin AC:
Asphalt Sp. Gravity: 1.03 — Dust to Asphalt Ratio: 0.48
% Fracture Face on CA: 100 — % Glassy Particles on CA: n/a
Theo.Gravity of RAP1: — Eff. Gravity of Agg: 2.613
Theo.Gravity of RAP2:
Theo. Gravity of Mix: 2.385 — T.S.R.: 84.9 — Lbs/Ft³: 148.8
L.O.I.: 24.0 — Ignition Oven Corr. Factor:
Warm Mix?

Lab Temperature		Plant Temperature	
Mixing Temperature (± 5 °F):	320	Mixing Temp Range(°F):	290°F ≤ T ≤ 330°F
Lab Compaction Temp (± 5 °F):	290	Delivery Temperature(°F):	290°F ≤ T ≤ 330°F

Sieve Size	Percents Used		D Rock	#7	#8			% Req.	Design Range
			75.0	15.0	10.0			100	
2"									
1.5"									
1.25"									
1"									
3/4"			100	100	100			100	100
5/8"									
1/2"			92	93	100			93	85-100
3/8"			62	65	93			66	55-75
No.4			15	12	16			15	10-25
No.8			7	6	6			7	5-10
No.16									
No.30									
No.50									
No.100									
No.200			3.0	3.0	3.0			3.0	2-4

Lab Temperature	
Mixing Temperature (± 5 °F):	320
Lab Compaction Temp (± 5 °F):	290
Plant Temperature	
Mixing Temp Range(°F):	290ºF ≤ T ≤ 330ºF
Delivery Temperature(°F):	290ºF ≤ T ≤ 330ºF

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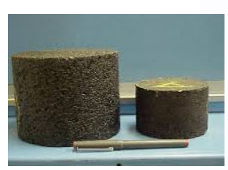
Asphalt Mixture Testing (Marshall Specimen)

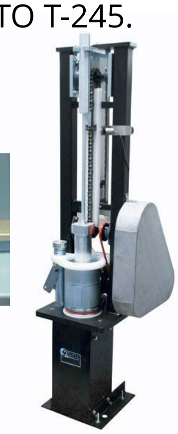
Compacting Marshall Specimen for Testing

- Marshall specimen fabricating procedure is presented in AASHTO T-245 (plastic flow test).
- Detailed info can be found section 3 of AASHTO T-245.

Why do we do this?

- Bulk specific gravity, Air void, Compaction Density, Resistance to Plastic Flow, Effect of Moisture in Asphalt Mixture can be tested with the specimen compacted by Marshall hammer.





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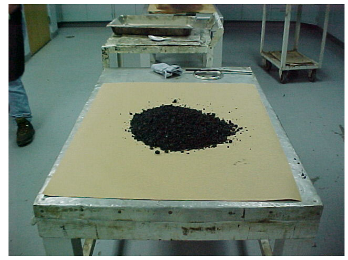
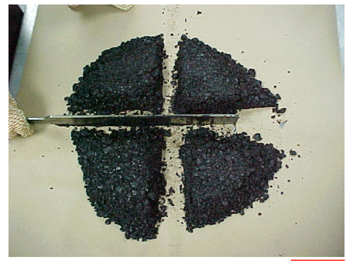
Asphalt Mixture Testing (Marshall Specimen)

How do we do this?

- Reduce sampled mix to appropriate specimen sizes (about 1200g) by splitting and quartering.
- How many specimens do we need to compact?
- Select three divided portions for compaction and one for Gmm.





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Asphalt Mixture Testing (Marshall Specimen)

How do we do this?

- Assemble the preheated specimen molds and place a protection disc in the bottom.
- At what temperature should the molds be kept preheated?
- Load or "charge" the mold in one lift.

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Asphalt Mixture Testing (Marshall Specimen)

How do we do this?

- Spade the mix with a flat-blade spatula.
- How many times should the mix be spaded?
- Do not forget to add the top specimen disc!
- Compact mixture with 75 compaction blows per side.
- Once compaction is complete, remove the protection papers and carefully extrude the specimen from the mold.

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Asphalt Mixture Testing (AASHTO T-166)

AASHTO T-166: Bulk Specific Gravity Using SSD Method

Why do we do this?

- This test used to determine the bulk specific gravity of a compacted specimen (G_{mb})
- G_{mb} may be used to calculate % air void, density, unit weight of mix for construction.
- Can be performed on either a lab or field compacted specimen (core)
- Three weights needed:
  - Dry Weight
  - Saturated Surface-Dry Weight (SSD)
  - Weight Submerged in Water

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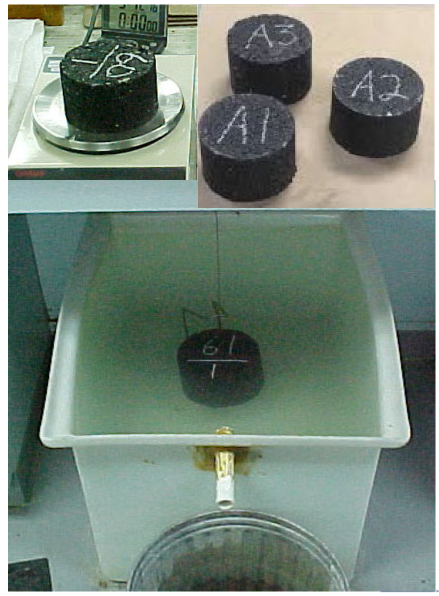
Asphalt Mixture Testing (AASHTO T-166)

How do we do this?

- As an alternative, T-331 (auto vacuum sealing method) can be used to measure Gmb
- Record the mass of the specimen.
- Place the specimen in a basket suspended in water under a balance for 4 ± 1 minutes.



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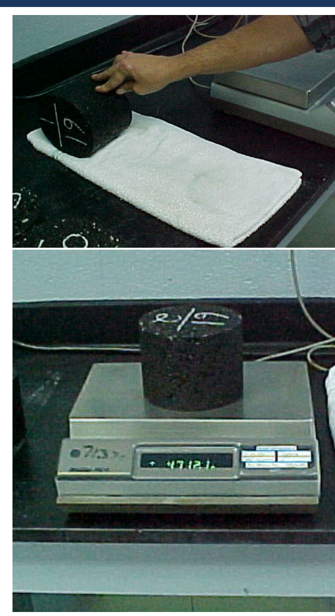
Asphalt Mixture Testing (AASHTO T-166)

How do we do this?

- Blot lightly with a damp towel to remove excess exterior moisture.
- Don't forget consistency to reduce person-to-person variation.
- Re-weigh the specimen and record its SSD mass.



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Asphalt Mixture Testing (AASHTO T-166)

How do we calculate bulk specific gravity?

Bulk Specific Gravity (G_{mb})= $\frac{Dry\ Weight}{SSD\ Weight - Weight\ in\ Water}$

Example

Dry weight is 1,156 g, surface saturated dry weight is 1,161g, and specimen weight in water is 665g. What is G_{mb}?

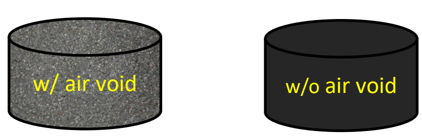
47

Asphalt Mixture Testing (AASHTO T-209)

AASHTO T-209: Theoretical Maximum Specific Gravity and Density of Bituminous Paving Mixtures

Why do we do this?

- The theoretical maximum specific gravity (Gmm) of an asphalt mixture is the specific gravity without air voids.
- Theoretically, if all the air voids were eliminated from an asphalt mix, no further densification is possible.
- If the mix is compacted and has 90% density, we can say that the compacted sample has 90% density out of maximum (100%) density.



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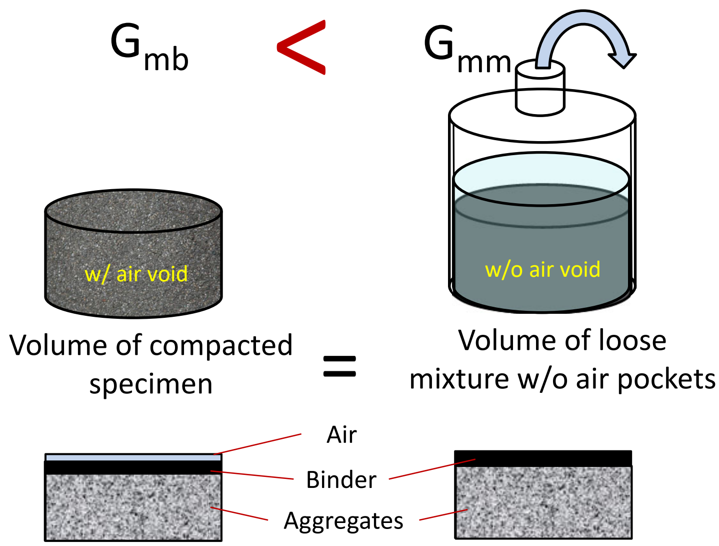
Asphalt Mixture Testing (AASHTO T-209)

Why do we do this?

G_{mb} < G_{mm}



TN

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Asphalt Mixture Testing (AASHTO T-209)

Why do we do this? (continued)

Ultimately, we can find the density of the compacted mixture with theoretical maximum specific gravity of the mixture.

Example

Gmb is 2.464 and Gmm is 2.672. What is the density of the compacted specimen?

TN

50

Asphalt Mixture Testing (AASHTO T-209)

How do we do this?

- Open YELLOW SPEC book (AASHTO T-209, section 6)
- Collect minimum amount of material
- Fully dry material before testing

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Asphalt Mixture Testing (AASHTO T-209)

- Always remember to record all measurable weight of materials and apparatus.
- Loose mix is allowed to cool to room temperature.
  - You already quartered mixture and used 3 of them for fabricating specimen
  - Now use the 4th remainder for this Gmm
- The mix will also have to be crumbled into small particles. What is the largest conglomerate particle that can remain?

52

Asphalt Mixture Testing (AASHTO T-209)

- The mix is placed into a calibrated volumetric flask and the dry mass is determined.
- The mix is then covered (by about an inch) with water that is 77° F (25° C)

TN

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Asphalt Mixture Testing (AASHTO T-209)

- Remove air trapped in the mixture by applying vacuum until the residual pressure manometer reads 3.7±0.3kPa (27.5±2.5 mmHg).
- Maintain this residual pressure for 15±2 minute.
- Turn on vibrator to agitate the container and content during the vacuum period.
- Slowly bleed the vacuum off using the required valve.

TN

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Asphalt Mixture Testing (AASHTO T-209)

- You can determine mass of maximum densified material either in water or in air.
- If you decide to put the container into water bath, slowly submerge the container to prevent the densified material inflowing water.
- If you decide to measure it in air, fill the flask with 77° water.
- Always remember to record the temperature of water. Why?

55

Asphalt Mixture Testing (AASHTO T-209)

- After letting the flask sit for 10±1 minutes, record the water temperature and place the lid on the flask.
- Top off the water level, dry the outside of the flask, and record the mass.
- For in water bath method, record the mass of material after 10±1 minutes immersion.

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Asphalt Mixture Testing (AASHTO T-209)

How can we calculate Gmm?

- In water bath method

$$G_{mm} = \frac{A}{A + B - C}$$

- In Air method

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

A= mass of oven-dry loose mixture,
B= mass of container submerged in water,
C= mass of sample and container in water,
D= mass of container filler with water, and
E= mass of container filled with sample and water.

TN

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Asphalt Mixture Testing (AASHTO T-209)

- *How can we calculate Gmm?*

Example

CALCULATION OF MAXIMUM SPECIFIC GRAVITY:

WT. DRY SAMPLE (A)	1604.0
WT. FLASK FILLED WITH WATER (D)	7399.0
WT. FLASK FILLED WITH WATER & DRY SAMPLE (E)	8347.2

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

Remember all specific gravity values should be displaced by three decimal point (X.XXX).

TN

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Asphalt Mixture Testing (AASHTO T-269)

AASHTO T-269: Percent Air Void in Compacted Asphalt Mixtures

Why do we do this?

Percent air void in asphalt mixture is used as one f the criteria in design methods and for evaluation of the compaction after construction.

Remember

TDOT determines the quality of construction by % Density.

% Air Void = 100- % Density

It means increased % Air Void results in decreased % Density

TN

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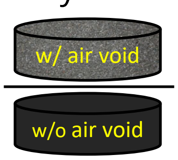
Asphalt Mixture Testing (AASHTO T-269)

- How do we do this?

We calculated density with G_{mb} and G_{mm}.

Density = 

X 100 = $\frac{G_{mb}}{G_{mm}} X100$

% Air Void = 100 - % Density = $100 - \left(\frac{G_{mb}}{G_{mm}} X100\right)$

Example

G_{mb} is 2.331, and G_{mm} is 2.446. What is the air void?

TN

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Asphalt Mixture Testing (AASHTO T-245)

AASHTO T-245: Resistance to Plastic Flow of Asphalt Mixture Using Marshall Apparatus

Why do we do this?

- Marshall stability is related to the resistance of bituminous materials to distortion, displacement, rutting and shearing stresses.
- The stability is derived mainly from internal friction and cohesion.
- As bituminous pavement is subjected to severe traffic loads from time to time, it is necessary to adopt bituminous material with good stability and flow.

TN

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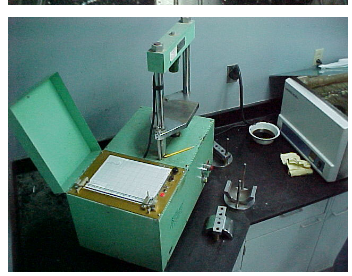
Asphalt Mixture Testing (AASHTO T-245)

How do we do this test?

- Prior to testing in a Stability and Flow testing device, the pills must be conditioned in water bath at 140° F (60°C) for 30~40 min or in oven for 2 hours.
- The testing-head temperature shall be maintained between 70 to 100° F (21.1 to 37.8 °C) using water bath when required.



TN

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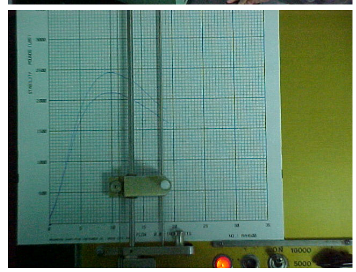
Asphalt Mixture Testing (AASHTO T-245)

How do we do this test?

- Once taken out of the conditioning bath, the specimen must be tested within 30 seconds. Why?
- Apply load to specimen by means of the constant rate of movement of the loading head of 2 in. (50.8mm) per minutes until maximum load is reached.
- The stability/flow test data is recorded on a special graph chart. Multiple specimens can be shown on the same chart.



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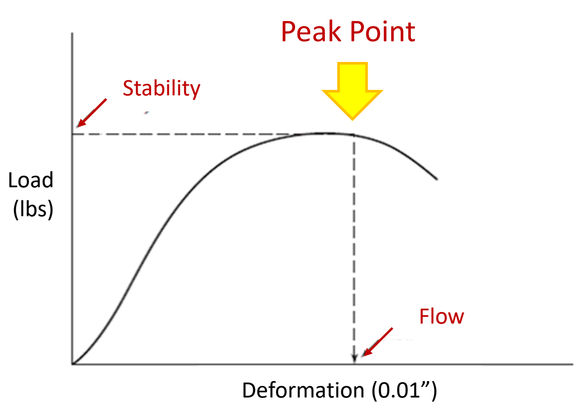
Asphalt Mixture Testing (AASHTO T-245)

How do we understand test result?

- Report average maximum load in pounds-force of at least three specimens.



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Asphalt Mixture Testing (AASHTO T-164, E-II)

AASHTO T-164: Quantitative Extraction of Bitumen from Bituminous Paving Mixtures

Why do we do this?

- Need to make sure volumetric properties of the mixture matching with JMF
- We can check AC content and aggregate gradation after removing AC from mixture
- T-164's E-II test is TDOT's **STANDARD** test method for determining the AC Content of either RAP or HMA.
- As an alternate method, AASHTO T-308 (Ignition Furnace) may be used.

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Asphalt Mixture Testing (AASHTO T-164, E-II)

Remember:

- Mix wt = wt of AC+ wt of Agg
- If we remove all the AC and are just left with the aggregate, we can find the amount of AC
- Mix wt – Agg. wt = AC wt
- We really want the %AC and not the weight though…

$$\% \, AC = \frac{wt.of \; AC}{wt.of \; Mixture} \times 100$$

Example:

- We extract an asphalt mixture. Weight of Mixture before extraction was 1000 grams.
- The extracted aggregate weighs 943 grams.
- What is the AC%?

66

Asphalt Mixture Testing (AASHTO T-164, E-II)

Given:
- HMA sample = 1000 g
- After Extraction, aggregate = 943 g

Solution:
- Determine Wt of AC
- Wt of AC = HMA Sample – Extracted Aggregate
- Wt of AC = 1000 g – 943 g = 57 g
- $\% AC = \frac{wt.of\ AC}{wt.of\ Mixture} \times 100 = \frac{57}{1000} \times 100 = 5.7\%$
- %AC = wt of AC/wt of HMA * 100
- %AC = 57/1000 * 100 = 5.7%

- We also need to check the aggregate gradation…

TN

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Asphalt Mixture Testing (AASHTO T-164, E-II)

How do we do this?
- Open YELLOW SPEC book (T-164, section 25.2.10)
- Collect minimum amount of material
- Fully dry material before testing (RAP!!!!!)

TN

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Asphalt Mixture Testing (AASHTO T-164, E-II)

- Always remember to record all measurable weight of materials and apparatus.
- Record the initial sample mass.
  - Mass of mixture (aggregates covered with asphalt binder)
  - Mass of the pitcher as well.

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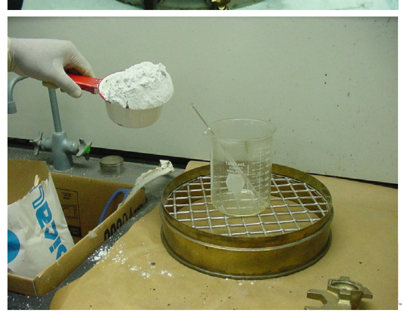
Asphalt Mixture Testing (AASHTO T-164, E-II)

- Place the distributor plate over the seal.
- Fasten the extractor collar with the spacers and wing nuts.
- Center the paper filter on the plate.
- 50~200 grams of filter aid to help trap the dust within the mixture.
- Don't forget to record the weight of the paper filter and filter aid.



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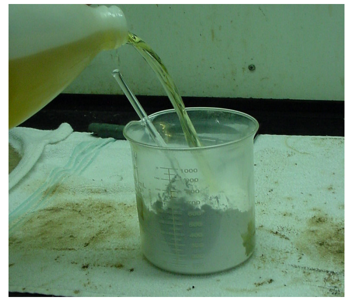
Asphalt Mixture Testing (AASHTO T-164, E-II)

- Add about 500mL solvent into the flask with filter aid and swirl until the filter aid is completely in suspension.
- Immediately pour the filter aid slurry over the filter evenly.
- Start vacuum pump and let it run until filter aid looks dry.
- Place sieves (#200 and protective sieve) on a collar of vacuum.



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Asphalt Mixture Testing (AASHTO T-164, E-II)

- Add solvent into the pitcher containing the asphalt mixture.
- Vigorously stir contents after allowing the mix to soak a couple minutes.
- Pour extracted binder over the sieves without letting aggregate escape pitcher.

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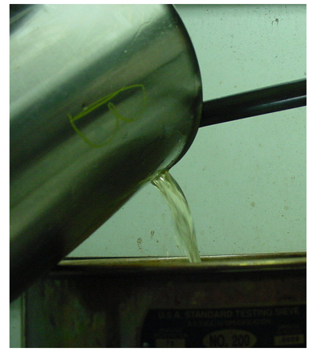
Asphalt Mixture Testing (AASHTO T-164, E-II)



- Continue previous step until aggregate appears clean.
- A good indicator is the solvent leaving the pitcher the same color it entered.
- Allow the vacuum extractor to pull the solvent through the filter material completely.
- Turn off the vacuum.
- Empty the solvent and extracted asphalt into the hazardous waste container then transport the material to the hazardous waste disposal site at your facility.

TN

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Asphalt Mixture Testing (AASHTO T-164, E-II)

- Rinse the extracted aggregate with water.
- Continue to rinse the aggregate and pour the water out until the water leaving the pitcher is clear.
- Add enough water to cover the aggregate and gently agitate it before pouring the aggregate out onto the sieves.
- Allow water to drain completely before turning the vacuum off.
- Remove sieves and disassemble the extractor carefully.
- Carefully place filter paper into metal pan.
- Place sieves and pan into oven to dry material for sieve analysis.

TN

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Asphalt Mixture Testing (AASHTO T-30)

AASHTO T-30: Mechanical Analysis of Extracted Aggregate

Why do we do this?

- This test determine the particle-size distribution of aggregates extracted from a mixture using sieves.
- This test is one of our primary QA/QC methods for evaluating plant production of the mix
- One of the ways that TDOT accepts for the mix

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Asphalt Mixture Testing (AASHTO T-30)

Sieve Size	Weight Retained	Percent Retained	Percent Passing	JMF or Spec.
5/8"	0			100
1/2"	32.6			97
3/8"	157.4			86
#4	510.9			59
#8	764.2			47
#30	1060.6			27
#50	1225.4			12
#100	1319.7			6.5
#200	1342.8			4.4
Pan	1347.2			

TDOT std spec Table 407.20-2

Characteristics	Pay Factor	Average Arithmetic Deviation of the Lot Acceptance Test from the JMF	
		1 Test	2 Tests or more
Gradation 3/8 inch sieve and larger	1.00	0.00-6.50	0.00-5.70
	0.95	6.51-7.08	5.71-6.20
	0.90	7.09-7.66	6.21-6.69
	0.80 (2)	over 7.66	over 6.69
Gradation No. 4 sieve (3)	1.00	0.00-4.62	0.00-4.00
	(0.95	4.63-5.20	4.01-4.50
	0.90	5.21-5.77	4.51-5.00
	0.80 (2)	over 5.77	over 5.00
Gradation No. 8, 16, 30 & 50 sieves (3)	1.00	0.00-3.80	0.00-3.30
	0.95	3.81-4.46	3.31-3.91
	0.90	4.47-5.12	3.92-4.52
	0.80 (2)	over 5.12	over 4.52
Gradation No. 100 & 200 sieves (3)	1.00	0.00-1.80	0.00-1.60
	0.95	1.81-2.00	1.61-1.75
	0.90	2.01-2.20	1.76-1.90
	0.80 (2)	over 2.20	over 1.90

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Asphalt Mixture Testing (D.A.R.)

Dust to Asphalt Ratio (DAR)

DAR is the ratio of the percentage by weight of aggregate finer than the No. 200 (75 µm) sieve to the asphalt content expressed as a percent by weight of total mix.

$$D.A.R = \frac{Percent\ Aggregate\ Passing\ \#200\ Sieve}{Asphalt\ Binder\ Content}$$

TN

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Asphalt Mixture Testing (D.A.R.)

Why TDOT limits amount of dust in asphalt mixture?

> Remember
> TDOT determines the quality of construction by % Density.
> % Density = 100- % Air Void
> It means increased % Air Void results in decreased % Density

- Air voids may be increased or decreased by lowering or raising the binder content.
- Air voids may also be increased or decreased by controlling the amount of material passing the No. 200 sieve in the asphalt mixture.
- Increasing % AC in the most expensive way of reducing AV
- The more fines added to the asphalt mixture generally the lower the air voids.

TN

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Asphalt Mixture Testing (D.A.R.)

What if we do not use dust? Is it good for longevity of mixture?

- Optimum dust-to-binder ratios will typically stiffen the mixture and improve permanent deformation resistance.

How we calculate DAR?

- Given that 4.91% of aggregates passed the #200 sieve and a binder contents of 5.86% in 411D mixture.
- What is the DAR? And how do we use this number?

TN

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Asphalt Mixture Testing (ASTM D 3625)

ASTM D 3625: Effect of Water on Bituminous-Coated Aggregate Using Boiling Water

Why do we do this?

- Moisture damage is the result of moisture interaction with the asphalt binder-aggregate adhesion within a HMA mixture.
- This test is useful as an indicator of the relative susceptibility of asphalt-coated aggregate to water.
- AKA 10 min boiling test

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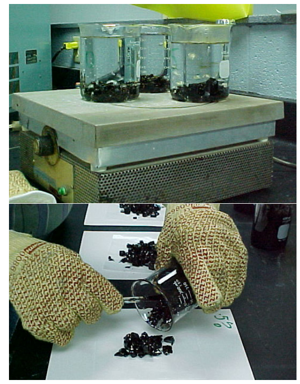
Asphalt Mixture Testing (ASTM D 3625)

How do we do this?



- From a sample of the completed mix, visually select a minimum of 50 grams of the **plus No. 4** (4.75 millimeters) material.
- placed in a container of boiling distilled water and boiled for 10 min±15 s.
- pour off water and place coated aggregate on a paper towel.
- The coated aggregate shall not show any evidence of stripping as determined by a visual inspection.

Who run this test?

- **Test performed by project inspector**

TN

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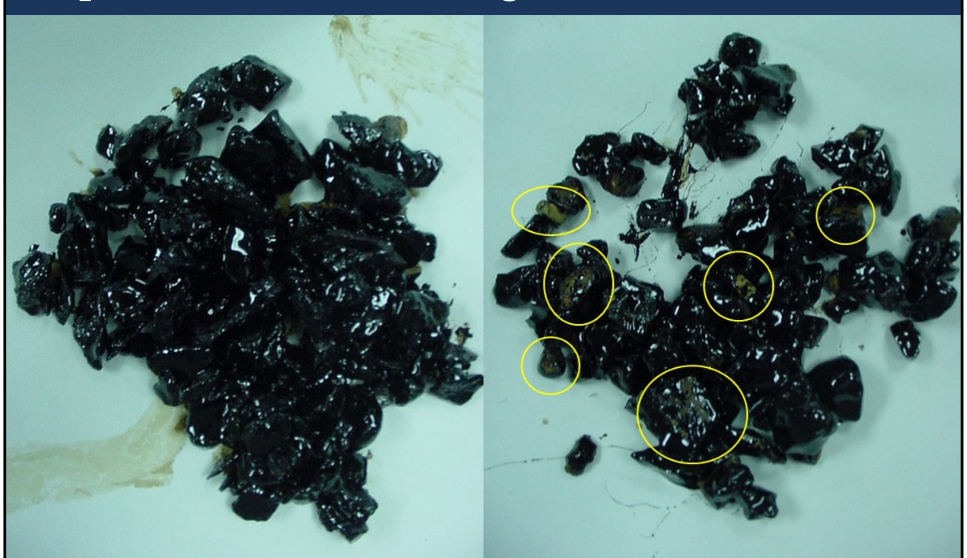
Asphalt Mixture Testing (ASTM D 3625)



Not Stripping | Stripping

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Asphalt Mixture Testing (AASHTO T-308)

AASHTO T-308: Determining the Asphalt Binder Content of HMA by the Ignition Method

Why do we do this?

- TDOT's ***STANDARD*** test method for determining the AC Content of either RAP or HMA is T-164-EII, extractions.
- As an alternate method, AASHTO T-308 (Ignition Furnace) may be used. The Engineer shall determine the correction factor.

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Asphalt Mixture Testing (AASHTO T-308)

What we need to know about ignition oven.

- Furnace must be calibrated to each different mix. Because each aggregate source has different correction factor.
- Use of the furnace must be backed up monthly with a solvent extraction.
- Test is to be run at 538 ° C unless infrared furnace is used.
- Watch for broken aggregate.

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Asphalt Mixture Testing (AASHTO T-308)

How do we do this?

- Begin by determining the correct sample size for the HMA being tested.
- Please open yellow book Table 1 in Section 6 of AASHTO T-308.
- Split the sample evenly between the two sample baskets.

TN

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Asphalt Mixture Testing (AASHTO T-308)

How do we do this?

- Spread the material into a thin, even layer to ensure complete ignition of the binder.
- Stack baskets and lock cover into place.
- Don't forget to record weight of empty basket and material.

TN

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Asphalt Mixture Testing (AASHTO T-308)

How do we do this?

- Place the basket/sample assembly into the furnace.
- Be careful not to let the assembly touch any part of the furnace wall.
- Always recommend to were heat protective glove covering to elbow.
- Enter the sample mass, the testing temperature, and the pre-determined correction factor. Furnace will stop test when AC content is determined.

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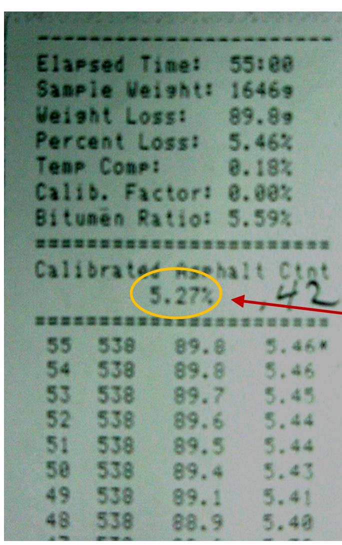
Asphalt Mixture Testing (AASHTO T-308)

How to read test result?



(Before Burnout)	
Total Wt. Sample & Basket	5000.0
Basket Wt.	3000.0
Wt. of Sample	2000.0
(After Burnout)	
Total Wt. Sample & Basket	4891.6
Basket Wt.	3000.0
Wt. of Sample	1891.6
Design A. C.	5.4
A. C. Content from N.C.A.T.tape	5.27
A.C. Content Deviation	**-0.13**

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Correction Factor

Reading Value – True Value = Oven Correction Factor

- Example: Known asphalt binder content was 6%, but after burn weight loss was 6.5% with the same mix. OCF?
  6.5% (after burn reading value) – 6.0% (known true value) = 0.5%
- With this correction factor, need to deduct OFC from oven reading value to find actual %AC in the future.

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Asphalt Mixture Testing (ASTM D-4867)

ASTM D-4867: Effect of Moisture on Asphalt Concrete Paving Mixture (AKA TSR test)

What is Tensile Strength Ratio Test?

Determine the tensile strength of 3 selected specimens

$$Tensile\ Strength\ Ratio\ (\%) = \frac{Avg.\ Wet\ Tensile\ Strength}{Avg.\ Dry\ Tensile\ Strength} \text{X}\, 100$$

To minimize moisture damage, wet conditioned samples Tensile Strength should be 80% or greater of unconditioned sample’s Tensile Strength!

TN

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Asphalt Mixture Testing (ASTM D-4867)

Why do we do this?

- The tensile strength ratio indicates the stripping and moisture susceptibility characteristics of the mix.
- This test method can be used to test asphalt mixture in conjunction with mix design to determine:
  - the potential for moisture damage,
  - effectiveness of anti-stripping additive, and
  - optimum anti-stripping dosage rate.
- This test method can also be used to test plant produced mixtures to determine the effectiveness of additives under the condition in the field.

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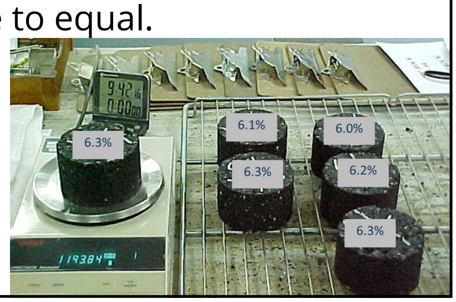
Asphalt Mixture Testing (ASTM D-4867)

How do we do this?

- Prepare six compacted specimens.
- Determine the G_{mb} and calculate the % air voids
- Verify they are in the acceptable range of 6.0 – 8.0 %.
- Record the thickness or height of each specimen.
- Sort the specimens into two so that average air void of the two subsets are close to equal.
- Select three to be “wet pills” and the other three will be “dry pills” (unconditioned).



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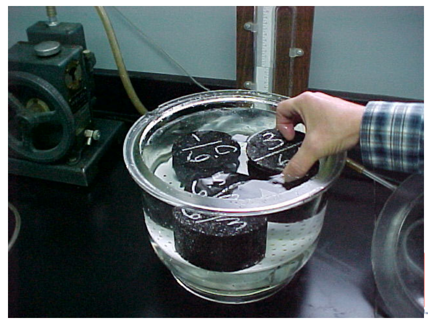
Asphalt Mixture Testing (ASTM D-4867)

How do we do this? (continued)

- Saturate the “wet pills” in a container of water by using a vacuum to “pull” water into the specimens for just a few seconds.
- The acceptable saturation range is from 55% to 80 % of the volume of air voids for each specimen.
- If the saturation is less than 55 %, then the vacuum must be reapplied. What if it is greater than 80 %?



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Asphalt Mixture Testing (ASTM D-4867)

How do we do this? (continued)

- Place partially saturated “wet pills” in distilled water at 140±1.8°F (60±1.0°C) for 24 hours.
- Meanwhile, the unconditioned “dry pills” sit on a shelf.

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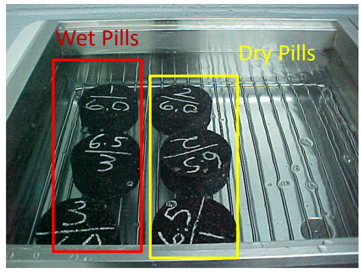
Asphalt Mixture Testing (ASTM D-4867)

How do we do this? (continued)

- At the end of the conditioning period of partially saturated "wet pills", place specimen into water bath for 1 hour at 77±1.8°F (25±1°C).
- "Dry Pills" are also need to be placed in same water bath, but only for 20 minutes.
- Finally, all 6 specimens are tested for tensile strength. (*Note the loading head is different to stability & flow testing)*



TN

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Asphalt Mixture Testing (ASTM D-4867)

How do we calculate TSR% Saturation?

- % Saturation = $\frac{Vol\ of\ Abosorbed\ Water}{Vol\ of\ Air\ Void} \times 100$

$$= \frac{Saturated\ SSD\ Mass - Dry\ Mass}{(SSD\ mass - mass\ in\ water)\ X\ \left(\frac{\%\ Air\ Void}{100}\right)} \times 100$$

TN

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Asphalt Mixture Testing (ASTM D-4867)

How do we calculate Tensile Strength?

$$S_t\,(psi) = \frac{2 \times Maximum\ Load\ (lbs)}{3.14 \times Specimen\ Height\,(in.) \times Specimen\ Diameter\,(in.)}$$

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Asphalt Mixture Testing (ASTM D-4867)

How do we calculate TSR?

The Tensile Strength Ratio (TSR) is the ratio of conditioned (wet) strength to unconditioned (dry).

$$\text{Tensile Strength Ratio (\%)} = \frac{S_{tm}}{S_{td}} \text{ X100}$$

S_{tm} = Average conditioned (wet) tensile strength, psi

S_{td} = Average unconditioned (dry) tensile strength, psi

Example

Average conditioned (wet) strength is 181.2 psi. and average conditioned (dry) strength is 195.9 psi. What is the TSR?

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Asphalt Mixture Testing (ASTM D-4867)

- Test run during verification on surface and binder mixes.
- Contractor's Quality Control (TDOT std spec 403.03.D.2)
  - If the tensile strength ratio results are not in compliance with the specifications, immediately stop production until mixture adjusts are made.
  - TDOT std spec for TSR (TDOT std spec 407.03.E.1)

Table 407.03-4: Criteria for Stripping and Moisture Susceptibility

Asphalt Cement	Minimum Tensile Strength	Minimum TSR
Polymer Modified	100 psi	80%
Non-Polymer Modified	80 psi	80%

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Asphalt Mixture Testing (Field Cores)

Plant Tech may be required to test Cores for:

- Correlating Nuclear Gauge
- Calculating In-Place Density for SP407DEN Projects
- Perform on test strip cores in laboratory.
- Remember AASHTO T-166 (G_{mb})
- Field core density test is run by <u>TDOT Plant Inspector</u>

100

RAP Sampling and Testing

101

RAP Sampling

Reclaimed Asphalt Pavement

The contractor may use asphalt pavement that has been removed from a Department project or other State Highway Agency project by an approved method and stored in a Department approved stockpile.

How do we sample RAP for testing?

- Contractor obtain a proper sample in accordance with AASHTO T-2 and T-248 or ASTM D-75 and C-702.
- Same way to collect aggregate and to reduce sample size for lab testing.

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RAP Testing

Why do we need to test with RAP?

- RAP stockpile tends to absorb more moisture than virgin aggregate stockpile.
  - Run a preliminary moisture content test.
    - AASHTO T-329: Moisture Content
- We need to know how much AC remained on RAP can be transfer to RAP blended new mixture. We also need to check aggregate gradation of the RAP to establish blended aggregate gradation.
  - Run a preliminary extraction/gradation.
    - AASHTO T-164: AC content
    - AASHTO T-30: Aggregate Gradation

103

RAP Testing

How do we use RAP test result?

- Compare results with the JMF and TDOT Specification 307.03.b.
- Example: T-30 test result presented in the table below.

T-30 Test Results

Sieve	% Passing	JMF
5/8"	100	100
1/2"	93.4	98
3/8"	79.2	81
No.4	58.3	64
No.8	40.5	48
No.30	29.7	34
No.50	16.6	17
No.100	10.9	13.4
No.200	5.4	7.3

The stockpile gradation tolerance for all recycled material on each sieve is listed in Table 307.03-4 (TDOT std spec)

Sieve Size	Tolerance
3/8 inch and larger	± 10%
No. 4	± 10%
No. 8	± 10%
No. 30	± 10%
No. 200	± 10%

104

RAP Testing

How often RAP quality should be checked?

- Sampling and Testing of RAP should be done at the beginning of a project and every 2,000 tons of material used in the mix (TDOT std spec 307.03.B).

Who sample and test?

- The Contractor obtain sample and determine gradation & asphalt content

105

RAP Testing (AASHTO T-329)

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

Every asphalt mixture with RAP must check moisture content before compaction because RAP stockpile tends to absorb more moisture than virgin aggregate stockpile

- Sampled from behind of the paver.
- Test should be performed by contractor weekly.
- Maximum allowed moisture content is 0.1% as determined by AASHTO T-329 (411.03.C).

106

Sampling and Testing

- What tests do Plant Technicians do daily?
- Where could we find out what is required?
  - SOP 1-1 (in Field Manual)

November 16, 2016
January 30, 2017
July 12, 2017
January 30, 2019
December 10, 2019

Tennessee Department of Transportation
Division of Materials and Tests

Quality Assurance Program for the Sampling and Testing
of Materials and Products
(SOP 1-1)

Purpose: The purpose of this document is to establish the procedures and **minimum** requirements for the acceptance, verification, and certification of materials and products used on Tennessee Department of Transportation (TDOT) projects and projects under the oversight of TDOT (Local Projects, Grants, etc. that include Federal Funds).

Background: Federal Law (23 CFR 637) requires each state develop a quality assurance program which assures all materials, on projects where Federal Funds are used, conform to the requirements of the approved plans and specifications. In addition, these procedures assure projects using state funds will also be constructed using approved materials.

Policy: All materials used on TDOT projects must be accepted **prior to use**. Acceptance of materials is by:

TN

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Sampling and Testing

Gradings: A, AS, ACRL, TPB have different requirements.

- Gradation check is all that is required at the plant, AC content not required.
- Where we can obtain material for gradation?
  - Sampling from Bin at Batch Plant
  - Sampling from Conveyor Belt at Dryer-Drum Plant
  - Aggregates after extraction is possible but not recommended

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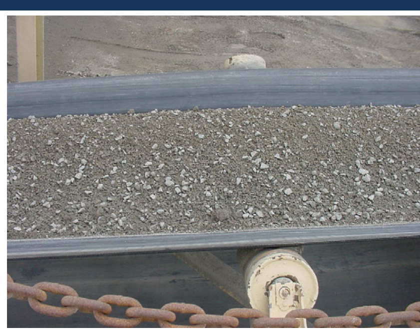
Additional Reference Material
(REVIEW SLIDES FROM AGGREGATE CLASS)

109

AASHTO T-2/ASTM D-75



AASHTO recommends obtaining belt samples of aggregates whenever possible.

A belt-shaped template must be used.

110

AASHTO T-2/ASTM D-75

Use a scoop to remove the aggregate from the portioned section.

Make sure to sweep the fine aggregate off the belt entirely.

111

AASHTO T-2/ASTM D-75

Most raw materials must be sampled from a stockpile.

112

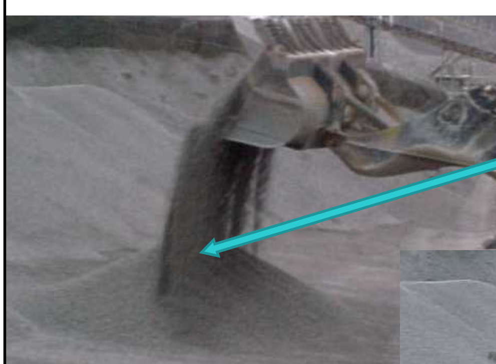
AASHTO T-2/ASTM D-75

Use power equipment whenever available.

Ensure that the material is re-blended before the loader takes a sample.

113

AASHTO T-2/ASTM D-75



Create a small pile adjacent to the original stockpile.

Strike off the top of the pile to create a flat surface.

114

AASHTO T-2/ASTM D-75

Approach the pile as 4 separate quadrants. Take 1 equal sample from each quadrant.

115

AASHTO T-2/ASTM D-75

Sample from at Least 3 locations (preferably top, middle, and bottom of the pile).

116

AASHTO T-2/ASTM D-75

For sampling fine aggregates, a sampling tube may be used.

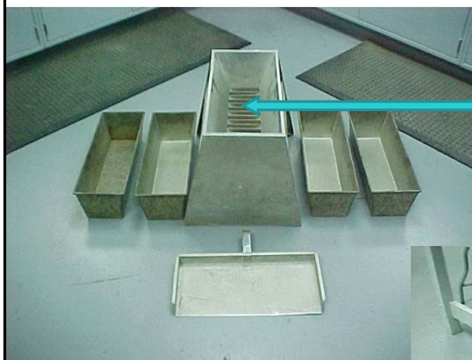
When using this method, sample in 5 locations.

117

AASHTO T-248
Reducing Aggregate Samples for Testing

118

Method A: Mechanical Splitter



Openings may either be fixed or adjustable.

Their widths are dependent upon aggregate size.

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Method B: Split and Quarter

1. Start with a small stockpile of material.

2. Flatten the pile to help avoid aggregate roll down.

3. Use a straight edge to cut pile in half.

4. Halve each half with the straight edge for quarters.

120

AASHTO T-255
Moisture Content of Aggregate by Drying

121

Aggregate Moisture Content

- Sample material IAW AASHTO T-2
- Reduce Sample IAW Table 1 in AASHTO T-255
- Record Initial Weight
- Dry to a CONSTANT MASS
- Record Final Weight
- Calculate Moisture Percentage

$$Moisture\ Content = \frac{(WET - DRY)}{DRY} \times 100$$

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Aggregate Moisture Content

- Initial (Wet) Weight: 2,140 grams
- Final (Dry) Weight: 1,940 grams

123

AASHTO T-11 Materials Finer Than #200 Sieve in Mineral Aggregate by Washing

124

AASHTO T-11


Weigh the oven-dried aggregate and record its mass. Add a bit of wetting agent (mild soap). Be careful not to add too much!

125

AASHTO T-11

Add water and stir gently.

Then carefully decant liquid over a nest of sieves.

126

AASHTO T-11

Continue washing until the liquid is reasonably clear.

Oven dry the aggregate at 230°F to a constant mass.

127

AASHTO T-27
Sieve Analysis of Fine and Coarse Aggregate

128

AASHTO T-27

After recording the mass of the oven-dried, washed aggregate, the material must be shaken though a stack of sieves.

129

AASHTO T-27

Once the material has been shaken for a sufficient period of time, each sieve must be cleaned out.

The mass of its contents recorded cumulatively.

130

Questions?

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Emulsion Tests

TN TDOT Department of Transportation

Emulsion Test

Division of Materials and Tests

1

Emulsions

What is Emulsion?

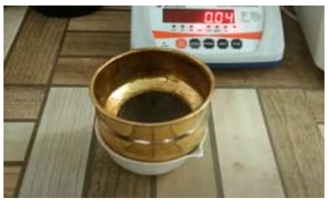
- An asphalt emulsion is liquid asphalt cement emulsified in water.
- It is composed of asphalt, water and an emulsifying agent.
- Material primarily used in paving for tack coat, prime coat, and surface sealers.
- Normally sampled by the roadway tech and sent to HQ lab, but…
- SOP 3-2 requires any emulsion that is being used for tack coat that is more than 2 weeks old to be tested at the contractors' plants.

2

Emulsions

How do we test the quality of Emulsion?

- If being tested at field lab the following are required:
  - Sieve Test
  - Residue Test



3

Emulsions (AASHTO T-59: Sieve Test)

- This test method measures the degree to which an emulsified asphalt may contain particles of asphalt or other discrete solids retained on an 0.850-mm (No. 20) mesh sieve.
- The retention of an excessive amount of particles on the sieve indicates that problems may occur in handling and application of the material.
- Test to determine if the emulsion has clumped to the point of being un-sprayable.
- Field samples must be less than 0.3%

4

Emulsions (AASHTO T-59: Sieve Test)

How do we do Sieve Test?

- Record the mass of the #20 sieve and pan. (Tare Mass)
- Wet the wire cloth with distilled water.
- Pour minimum 1000 g of the emulsion through the sieve. (typically allow to drain into sand trap)

5

Emulsions (AASHTO T-59: Sieve Test)

- Wash the container and residue on the sieve with distilled water until the washings run clear.
- 2-% sodium oleate solution shall be used instead of distilled water for determining if anionic or nonionic emulsions break on the sieve.
- Place the pan under the sieve and place both in oven at 325°F (163°C) for 2 hours.
- Cool them and determine the mass of the sieve, pan, and residue. (Final Mass)

6

Emulsions (AASHTO T-59: Sieve Test)

How do we calculate % retained?

$$\% \, Retained = \frac{Final\ Mass - Tare\ Mass}{Poured\ Emulsion\ Mass} X100$$

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Emulsions (AASHTO T-59: Residue Test)

- This test may be used to determine compositional characteristics of emulsified asphalt.
- Verifies the emulsion has not been diluted or has not separated into oil and water.

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Emulsions (AASHTO T-59: Residue Test)

How do we do Residue Test?

- Record the mass of 4 beakers containing a glass rod and screen (if used). (Tare Mass)
- Pour 50 ± 0.1g of emulsion into each of four beakers (see Section 7.2.2).
- Place stirring rod in beaker and cover with screen.

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Emulsions (AASHTO T-59: Residue Test)

- Place all 4 beakers in oven at 325 ± 5°F(163 ± 3°C) for 2 hours
- At the end of this period, remove each beaker, and stir the residue thoroughly.
- Replace the beakers in the oven for additional 1 h then remove the beakers from the oven.
- Cool them and determine the mass of beaker with rod and residue. (Final Mass)

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Emulsions (AASHTO T-59: Residue Test)

How do we calculate % Residue?

- Calculate individual % residue for all 4 beakers.
- Final % residue is the average value from all 4 % residue.

$$\%\ Residue\ (individual) = \frac{Final\ Mass - Tare\ Mass}{Poured\ Emulsion\ Mass} X100$$

$$\%\ Residue\ (average) = \frac{\%Res1 + \%Res2 + \%Res3 + \%Res4}{4}$$

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