Hot-Mix Asphalt Construction

NATIONAL HIGHWAY INSTITUTE

Federal Highway Administration

NAPA National Asphalt Pavement Association

JOINT AASHTO FHWA INDUSTRY TRAINING COMMITTEE ON ASPHALT

"Partners in Performance"

Asphalt Pavement Association of West Virginia

State of West Virginia Department of Transportation

West Virginia University Asphalt Technology Program

Presentation Format

- Lecture/discussion
- Protocol:
  - Informal
  - Questions are encouraged
  - Class participation is essential
  - Respect others!
  - Observe class schedule

Module 1

Course Introduction, Communication, and Project Documents

Need for the Course (Why are you here?)

- Training for individuals assigned to asphalt paving projects
- Asphalt construction isn't simple!
- Confidence in work
- More cost effective use of tax dollars spent on asphalt pavements
- FHWA requirement!
- One person on paving crew certified

From the 2017 Standard Specifications

- The Contractor shall maintain necessary equipment and qualified personnel including at least one certified Asphalt Field and Compaction Technician at each project during paving operations.
- Additionally, a certified Asphalt Field and Compaction Technician with certification to perform nuclear density testing of asphalt pavements shall perform all testing necessary to assure compaction of the asphalt meets specification requirements.

1-5

Overall Course Objectives

1. Describe the purpose of project documents and cooperative communication on the job
2. List the steps involved in preparing bases and existing surfaces for asphalt overlays
3. Define a proper asphalt delivery process to the job site
4. Explain the effect of the various components of an asphalt paving machine on the finished mat
5. Describe what effect the compaction process has on the finished pavement

1-6

Overall Course Objectives

6. Identify the roles and responsibilities of the WV DOH Inspector
7. Describe how density measurements are taken
8. Explain the different processes of QC/QA for testing
9. Define the key components of PWL paving
10. Describe the process for troubleshooting if things go wrong

1-7

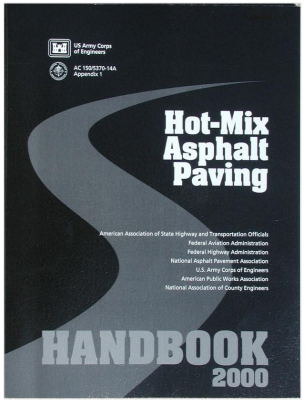
Local Issues

- Typical design
  - Superpave? Marshall? SMA? OGFC?
- Contractors/material suppliers
  - Aggregate source? Skid??
- Specs…401, 410?
- Hauling
- Laydown
- Compaction
- Other?

1-8

Course Reference Materials

- Participant's Workbook
- Hot-Mix Asphalt Paving Handbook 2000
- WVDOH Materials
  - MP 401.05.20
  - Compaction Worksheets 401 & 407
  - Daily Work Report
  - Tack Coat Form (SM)



Safety

Communication

- Schedule
- Weather forecast
- Closed Lanes
- Traffic Control
- Plant issues
- Other requirements/ restrictions
- CHANGES

Project Documents

- Reports
- Pay Estimates
- Traffic Control Plan
- Compaction Forms
- Tack Coat Forms
- Daily Work Report
- Change Orders
- As-Built Plans
- Job Mix Formula
- Environmental Documents
- QC Plan

Project Documents

Hierarchy

1. Special Provisions
2. Plans
3. Supplemental Specifications
4. Standard Specifications

Project Documents

1. Special Provisions
   - Project specific additions or revisions to the standard or supplemental specifications
2. Plans
   - Drawings of location, character, dimensions, and details of work
   - Plan notes

Project Documents

3. Supplemental Specifications
   - Approved additions and/or revisions to standard specifications
   - Typos are issued as errata

Project Documents

4. Standard Specifications
   - Directions, provisions, and requirements for performing the work illustrated and described in the plans
   - Methods of performing the work, desired outcome, or qualities and quantities of materials and labor to be furnished

West Virginia Challenges

- WV is one of only four states that take care of both state and county routes
  - Delaware, Virginia, and North Carolina are the others
- WV has the 6th largest state-maintained highway system in the nation
  - DOH owns 36,000 miles…24,500 miles are paved
- LOWEST total $ Disbursements/mile
  - US Avg: $178,000
  - WV: $35,000
- Highest Percentage of narrow lanes
  - US Avg: 10%
  - WV: 52%
- Source: 23rd Annual Highway Report on the Performance of State Highway Systems, 2018

1-17

The "Team"

- Owners
  - Long-term performance
  - Ensure quality
- HMA Industry
  - Provide quality
  - Increase performance
  - Lower costs

1-18

Teamwork and Cooperation

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Questions

1-20

Quality Control/ Quality Assurance

Learning Objectives

1. Describe and differentiate between quality control (QC) and quality assurance (QA)
2. Relate different types of specifications to pavement performance and to risk
3. Identify sources of variability within HMA construction process
4. Explain the use of statistical analysis of test results for QC and QA

What does QC/QA mean?

Quality Control

- QC refers to the ***control*** component of the production or construction process
- Also referred to as *process control*
- QC *ensures* the production of uniform materials that meet specification
- QC is achieved through *periodic inspection and testing*
- QC is the responsibility of the producer or contractor!

Quality Assurance

- QA refers to the ***assurance*** portion of the overall inspection process
- QA *assures* the buyer/owner that the producer's test results are accurate
- Sampling and testing for acceptance are typically conducted at less *frequency* and with greater *randomization* than the producer's process
- QA is the responsibility of the buyer!

Elements of QA

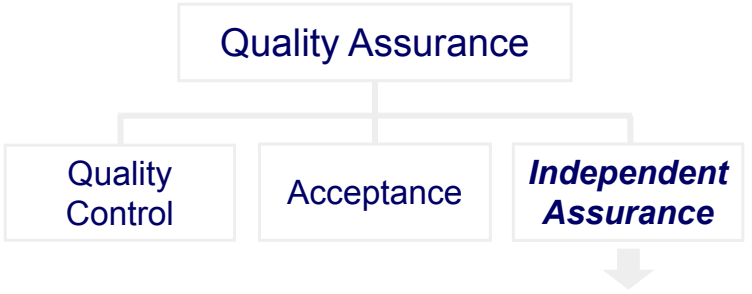
Elements of QA

Producer / Contractor provides documentation that the material / end product met specification.

Elements of QA

Buyer / Owner determines if the quality of the product as specified in the contract requirements

Elements of QA



Activities that combine to produce an unbiased and independent evaluation of all the sampling and testing procedures used in the acceptance program

QA in Various Settings

Buyer/ Owner	Product	QC Process	Accept-ance	Independent Assurance
Individual	New Car	?	?	?
Individual	Fast Food	?	?	?
Public Agency	Road-way	?	?	?

Specifications

- Types
- Relationship to performance
- Risk considerations

Types of Specifications

- Method (Recipe)
- QC/QA
- End-Result
- Performance

Method Specifications

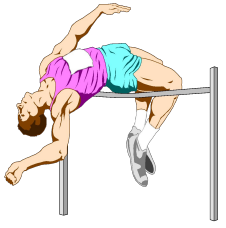
- Old school
- Owner prepares designs and sets requirements for structure, materials and construction processes
- Contractor supplies manpower, materials and equipment
- Owner is responsible for inspection
- Payment based on labor, materials, and equipment use

Method Specifications

- Problems:
  - Little or no testing
  - Question of quality
  - Uncertainty of performance

End-Result Specifications

- Owner specifies the expected end-result of the finished pavement such as:
  - Layer thickness
  - Mix properties
  - Smoothness



- Establishes criteria for acceptance (including rejection and pay adjustment)

End-Result Specifications

- Owner does NOT specify equipment nor methods of construction
- Increased testing, statistically rigorous, and considers owner and contractor risk
- Requires both QC and QA
- Third party (for independent assurance) often required
- Commonly used

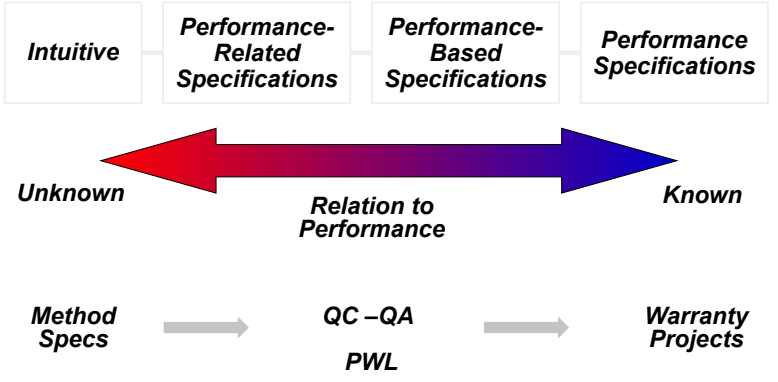
QC/QA Specifications

- Lies between method and end-result specifications
- Separates QC from QA
- Applies statistical approach to both QC and QA
- Requires inspection and testing
- Introduced pay adjustment as a function of QA testing
- Gaining popularity

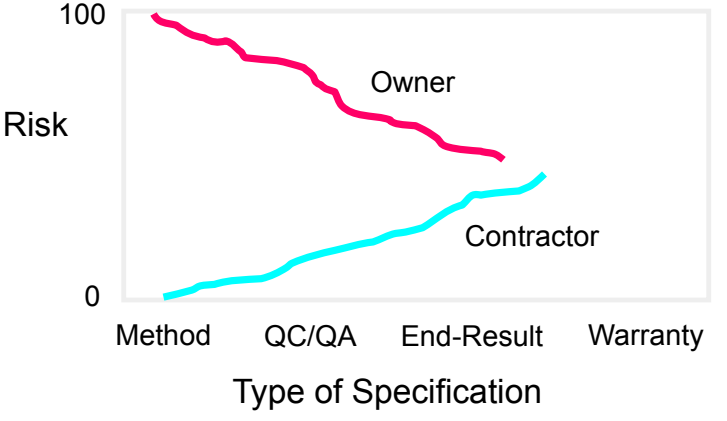
Performance Specifications

- Performance-related
- Performance-based
- Guarantee and Warranty

Relationship to Performance

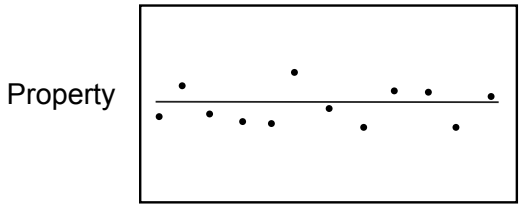


Risk Considerations



Material and Construction Variability

- What is it?



- Importance
- Properties affected
- Standard measures
- Sources

Importance of Variability

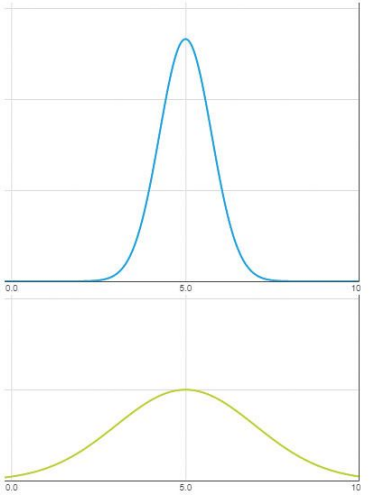
- Major effect on:
  - Quality control
  - Quality assurance
  - Pay adjustment
  - Pavement performance

Key Properties Affected by Construction Variability

- Thickness
- Aggregate gradation
- Asphalt content
- Air void content (or density)
- Smoothness

Standard Measures of Variability

- Range
- Standard deviation



Sources of Variability

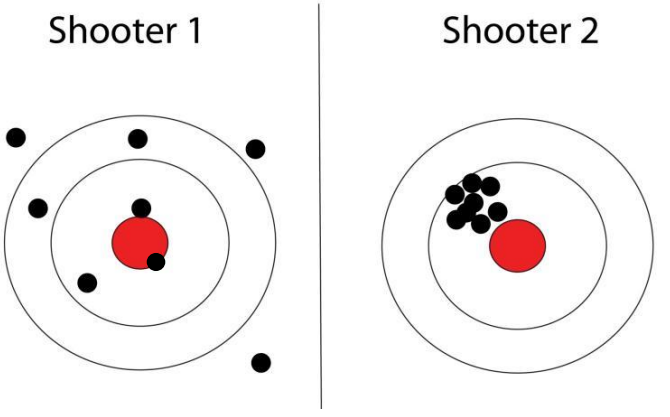
- Materials and construction:
  - Plant (stockpiles, cold feeds, binder addition, additives, mixing, transfer and storage)
  - Hauling (loading, transport, unloading)
  - Paver (operation)
  - Compaction (roller equipment and patterns)
- Sampling and testing….

Reduce Sampling and Testing Variability

- Technician Training
- Certification (Qualified Workforce)
- Laboratory Accreditation (AASHTO Re:Source)
- Regionalize/Standardize Test Methods
- Regionalize/Standardize Test Method Options
- Proficiency Sample Programs (Round Robins)

Use of Statistical Analysis for Quality Control

Who is the better shooter?

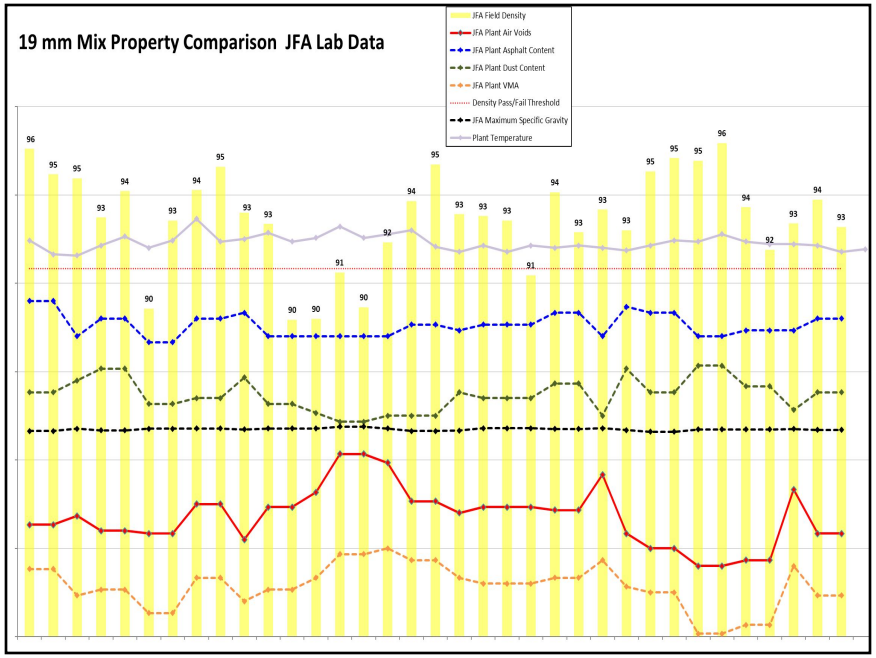


Control Charts

- What is plotted?
  - Control sieves
  - Asphalt content
  - Specific gravities
  - Voids and VMA
  - In-place density
  - Layer thickness

Benefits of Control Charts

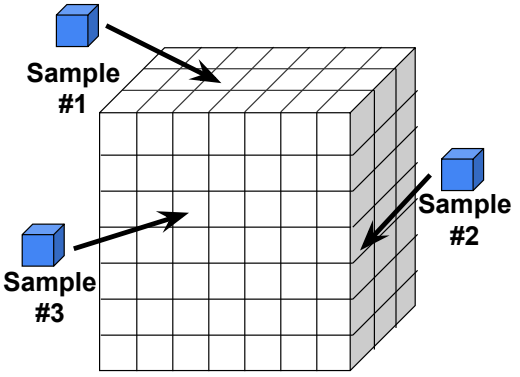
- Early detection of trends
- Establish process capability
- Decrease inspection frequency
- Permanent record of quality
- Provide a basis for acceptance
- Instill quality awareness
- Taking corrective measures
- Evaluating data for cost savings
- Recording and reporting



Use of Statistical Analysis for Quality Assurance

- Sampling
- Testing
- Apply acceptance criteria
- Determine pay adjustment

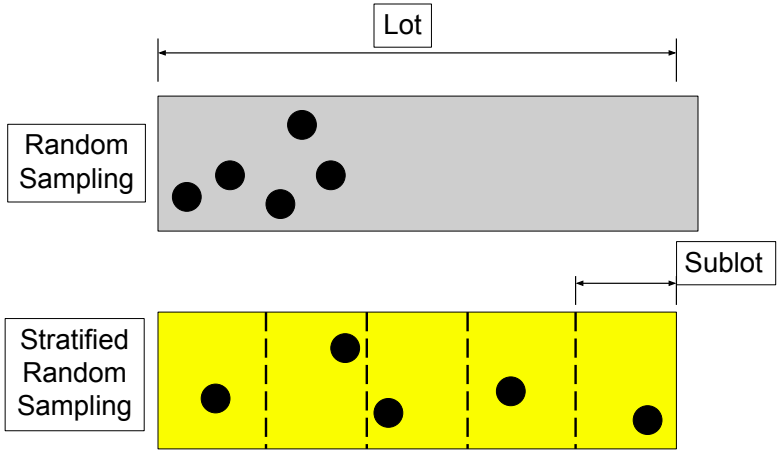
Sampling



Random Sampling

- Any portion of the population has equal chance of being selected
- Bias is introduced when judgment is used
- Use random number tables

Lots and Sublots



Pay Adjustment

- Most QA processes apply pay factor to adjust payment on a lot-by-lot basis
  - PWL and/or PD are commonly used to calculate Pay Factors (both penalty and bonus)
  - Pay Factors are typically determined for different factors and then combined
  - Max and limits on Pay Factors are established
- Not common to consider the Contractor's QC process

Payment Based on PWL

- Small number of tests results outside the specification limits is normal and not necessarily detrimental to performance
- Can also define Acceptable Quality Level (AQL) for key M&C factors (within which no pay adjustment is made)

Summary

1. Differentiate between quality control (QC) and quality assurance (QA)
2. Different types of specifications (relate to performance and risk)
3. Sources of variability within HMA construction process (emphasis on M&C variability)
4. Statistical analysis for QC (control charts) and QA (sampling to payment)

Questions?

Module 2
Preparation for Paving

Module Outline

- Preparation for Paving
  - New Construction
  - Overlays
    - Asphalt
    - PC Concrete
- Tack Coats
  - Introduction
  - Materials
  - Application
  - Verification

Preparation for Paving

- Often doesn't get due consideration
- It is often time consuming and labor intensive
- Asphalt layers cover up the potential problems
- THE PROBLEMS WE DO NOT FIX TODAY WILL NOT GO AWAY
  - Often the problems get worse
  - And more costly to fix the second time

Preparation for Paving

- The most common surfaces overlaid:
  - Subgrade
  - Granular Base Course (Aggregate Base)
  - Existing Asphalt Pavement
  - Existing Portland Cement Concrete Pavement
- Each have their own unique requirements

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New Construction

- Subgrade Preparation
  - The foundation
    - Thickness design uses soil type
  - Support all three stages
    - Construction equipment
    - Pavement
    - Anticipated traffic
  - Must be properly graded
    - Transversely & longitudinally
    - For drainage
    - Cross slope & smoothness
  - Uniformly compacted density

New Construction

- Aggregate Base Preparation
  - Mix to proper moisture content
  - Best Practice:
    - Use an old paver
  - 4 to 10-inch compacted lifts
  - Stagger joints
    - Longitudinal and transverse
    - At least one-foot in each layer
  - Compact to percentage of Proctor specified

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Preparing Existing Asphalt

May be as simple as:

- Sweeping
  - Multiple passes may be necessary
- Applying tack coat

Surface Preparation

Thoroughly clean the surface

Preparing to Overlay Asphalt

Patching

- DOH responsible for patching
- Contractor responsible for overlay
  - Patch & level corrections on isolated local spots

Cleaning and filling cracks

- Remove cold patch material

Placing a leveling course

- 1” thick Scratch Course

Milling the surface

Failed areas MUST be cleaned, repaired to good structural condition before overlaying

Asphalt Patching Material

Hot Mix Asphalt (HMA)

- Long lasting patches when correctly constructed
- Use WV DOT:
  - Wear 1 NMAS 3/8
  - Wear 4 NMAS 3/4
- Use appropriate PG-binder

Standardizd Aggregate Sizes

Nominal Maximum Aggregate Size (NMAS) - One sieve size larger than the first sieve to retain more than 10 percent

Maximum Aggregate Size (MAS) - one sieve size larger than the NMAS

Sieve Size	*Percent Passing*	
3/4”	100	- MAS
1/2”	94	- NMAS
3/8”	89	
No. 4	60	
No. 8	35	
No. 16	23	
No. 30	13	
No. 50	9	
No. 100	6	
No. 200	4.8	

1st sieve to retain cumulative 10% or greater

Full Depth and Deep Patching

Definitions:

- Full depth patching
  - Removal & replacement entire pavement cross section
  - Down to the subgrade or granular base
- Deep Patching
  - Removal & replacement of 4 inches of asphalt
  - Not all of the way to the subgrade or granular base

Full Depth and Deep Patching

Applications:

- Full depth patching
  - Applicable
    - Flexible (asphalt) pavements
    - Rigid (PC Concrete) pavements
- Deep patching
  - When patching with asphalt
  - Applicable to flexible pavements only

Both types of patches are intended to be permanent

Full Depth and Deep Patching

Step 1:

- Remove distressed material to firm support:
  - May include removing some of the subgrade
  - Excavation should extend at least 1-foot into existing pavement

Full Depth and Deep Patching

Step 1 (continued):

Patches:

- Square-edged and rectangular in shape
- Clean, vertical faces
  - Using a pavement saw
  - Chisel faces to vertical below sawcut
- If approaches width of lane
  - Patch the full lane

Full Depth and Deep Patching

Irregular patch

- Compaction is difficult

Straight rectangular lines

- No distress outside patch

What's Wrong Here?

Full Depth and Deep Patching

Expedite removal

Medium mill for large patches

Skid steer mill for small patches

Full Depth and Deep Patching

Step 2:

- After cleaning
  - Recompact Agg base or subgrade material
  - Tack vertical faces
  - Deep patching
    - Tack bottom surface

Full Depth and Deep Patching

Step 3:

- Using a dense-graded mix
  - Placed in small piles to avoid excessive handling
  - Patches >6 in deep place lifts less than 4 inches
  - Compact each lift thoroughly

Full Depth and Deep Patching

Step 4:

- Compact the patch <u>thoroughly</u>
  - Flush with surrounding pavt
- Vibrating plate compactor for small patches & corners
- Match rollers to patches large enough to accommodate it
- Make sure corners are compacted

Full Depth Patching

Full Depth Patching

Full Depth Patching

Full Depth Patching

Full Depth Patching

Surface lift

Full Depth Patching

Full Depth Patching

Full Depth Patching

Full Depth Patching

Full Depth and Deep Patching

Step 5:

- Check the smoothness with a straightedge
  - Do not overfill in anticipation of traffic compaction

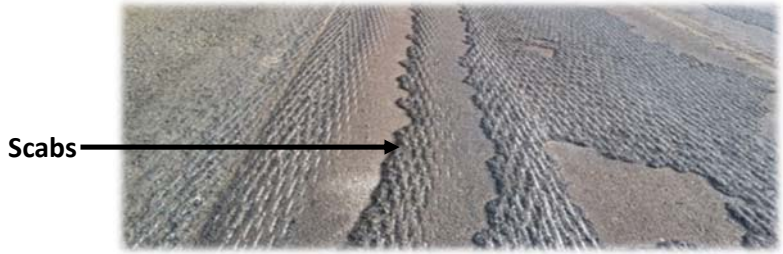
Cold Milling

Advantages of Cold Milling

- Efficiently removes deteriorated pavement
- Provides opportunity to improve smoothness
- Provides RAP for recycling operations
- Increased surface texture improves bonding

Cold Milling

- Mill below distress (rutting, raveling, top-down cracking)
- Don't leave "scabs" of asphalt
  - Avoid milling to within ½ inch of interface
- Consider properties of existing asphalt before milling
  - Increasing value of RAP obtained



Cold Milling

- How will grade be controlled?
  - Ski, string line, laser, other
- Will ride quality be measured on the milled surface?
  - Profilograph, profiler, none

Cold Milling

Surface texture is a function of:

- Carbide bit spacing and condition
- Depth of cut
- Rotational speed of cutting head
- Speed of travel
- Condition of moldboard
  - Milling strike-off

Cleaning the Surface

- Goals:
  - Free of debris
  - Minimal or no dust
  - Dry surface
- Ready for tack coat

Module Outline

- Preparation for Paving
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Preparing to Overlay Existing PCC

- Full depth replacement of distressed slabs
  - Asphalt or PCC patch
  - Correct problems in base/subgrade
- Spalled joints repaired partial depth
  - Use PCC for patching
- Stabilize rocking slabs
- Replace joint sealer as required
- Clean and tack surface

Above precautions often don't work long-term

Preparing to Overlay Existing PCC

A better way to handle PCC pavement:

- Cracking and Seating
- Breaking and Seating
- Rubblization
- Ideal for PCC that is not structurally sound
- Cost effective alternative to total reconstruction
  - Utilizes all material layers in-place
  - Reduces the size subject to movement
  - Makes them easier to seat and stabilize

Cracking/Breaking and Seating

- Reduces slab length (2-5 feet) by inducing fine vertical cracks
- Seats broken slabs against subgrade by rolling
- Crack and Seat applies to jointed plain concrete
  - Very good performance history
- Break and Seat applies to jointed reinforced concrete
  - Must rupture bond between reinforcing steel and PCC
- Rubblization is preferred due to variable performance history of break/seat (bond not always broken)

Cracking/Breaking and Seating Process

- Remove existing overlay
- Correct drainage problems
- Crack PCC slabs
  - "Guillotine" hammer
- Seat cracked PCC
  - 35-50 ton pneumatic roller
- Remove/patch any soft areas identified
- Apply structural overlay

Benefits of Crack/Break and Seat

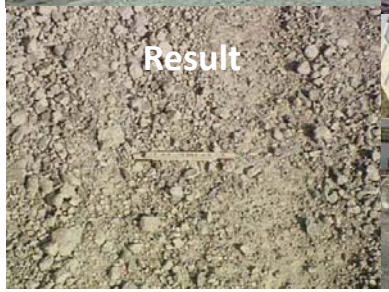
- No hauling or disposal costs since none of PCC is discarded
- Existing PCC stays in place to serve as base for the new overlay
- Saves natural resources, landfill space, environmentally friendly
- Expedites construction time
- Weather delays minimized since subgrade never exposed
- Cost effective rehabilitation technique

What is Rubblization?

- "Rubblizes" PCC slabs into high quality aggregate base
- Completely eliminates slab action & other distresses
  - Reflective cracking
  - D-cracking and ASR
  - Slab rocking, pumping, curling, etc.
- Destroys bond between concrete and steel
- Converts failed rigid system into new flexible one
- Two distinct methods and equipment types:
  - Multiple Head Breaker (MHB)
  - Resonant Pavement Breaker (RPB)

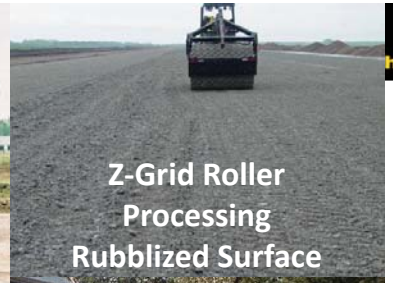

Resonant Pavement Breaker (RPB)


Roll shattered PCC


Result


Place overlay


Multi Head Breaker (MHB)


Z-Grid Roller Processing Rubblized Surface


Roll MHB broken PCC


Place HMA

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- **Tack Coats**
  - **Introduction**
  - Materials
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Definition

***Tack Coat*—sprayed application of asphalt cement upon an existing asphalt or Portland cement concrete pavement which may or may not have been milled before an overlay, or between layers of fresh asphalt concrete.**

Tack Coat

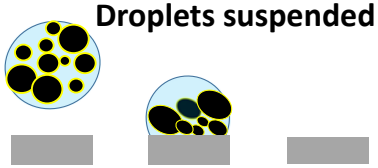
Why do we use Tack Coat?

- **Promotes bond between layers**
- **Prevents slippage**
- **Provides additional moisture barrier long transverse & longitudinal joints**

Tack Coat Definitions

- ***Undiluted Emulsion*** **- primarily an asphalt binder, water, and an emulsifying agent**
- ***Diluted Emulsion*** **- emulsion with additional water**
  - **Most common dilution rate is 1:1**
  - **One-part undiluted emulsion and one-part additional water**
- ***Residual Asphalt*** **- remaining asphalt after an emulsion has set**
  - **Typically 57-70 percent undiluted emulsion**
- ***Tack Coat Break*** **- when water separates from the asphalt to change color from brown to black**
- ***Tack Coat Set*** **- when water has evaporated, leaving only the residual asphalt. Some refer as completely broken**

Emulsion Breaking & Curing



- Breaking
  - Contact with surface changes pH; reducing charge
- Setting & Curing
  - Evaporation leads to coalescence
  - Original asphalt characteristics return

What's wrong (if anything) with the following specification regarding application rate?:

"Apply the tack coat at a rate of 0.05 gallons/yd²"

What difference does it make?

If the example spec *intended* 0.05 *gal/yd²* of residual asphalt:

Undiluted emulsion applied at 0.05 gal/yd²
using an emulsion with 60% residual asphalt,
leaves 0.03 gal/yd² on the roadway.

40% less than intended

What difference does it make?

If the example spec *intended* 0.05 *gal/yd²* of residual asphalt:

Diluted Emulsion using the same emulsion diluted 1:1
applied at *0.05 gal/yd²* leaves
0.015 gal/yd² on the roadway.

70% less than intended

What difference does it make?

If the example spec *intended* 0.05 *gal/yd²* of residual asphalt:

To get Residual Asphalt at 0.05 gal/yd²
using an emulsion with 60% residual asphalt
would need to apply a "shot rate" of:

0.083 gal/yd² of Original Emulsion or
0.167 gal/yd² of 1:1 Diluted Emulsion

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Top 5 Emulsions Used

1.	CSS-1h	(52%)
2.	Non-standard*	(48%)
3.	SS-1h	(46%)
4.	SS-1	(36%)
5.	CSS-1	(28%)

Percentage of material used, as self-reported by states in NCHRP Synthesis 516 Survey

* ***Non-standard means that a state has come up with its own nomenclature for an emulsion, outside those specified in AASHTO M 140 (Anionic Emulsions), M 208 (Cationic Emulsions), or M 316 (Polymer-Modified Cationic Emulsions)***
Examples: SS-1hp, CRS-2h, EBL

Module Outline

- Preparation for Paving
  - New Construction
  - Overlays
    - Asphalt
    - PC Concrete
- **Tack Coats**
  - Introduction
  - Materials
  - **Application**
  - Verification

Typical Requirements

- Weather
  - Minimum +40°F
  - Extra care if < +50°F
  - Fog or rain not imminent
- Application
  - Swept surface
  - Prescribed application rate
    - 10% maximum variation
  - Drying time set by engineer

Tack Coat

Apply past full-width of mat to minimize movement of unsupported edge

Application Rates?

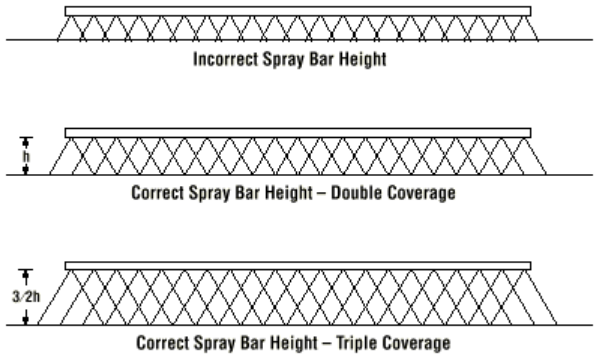
- What is the Optimal Application Rate?
  - Depends on surface Type & Condition
  - Application rate must be clearly stated in terms of:
    - Residual, Undiluted, or Diluted condition

Recommended Ranges

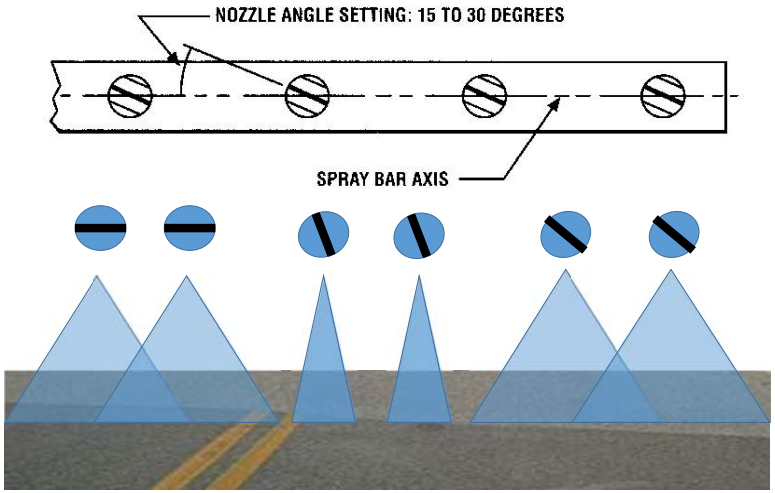
Surface Type	Residual Rate (gsy)	Appx. Bar Rate Undiluted* (gsy)	Appx. Bar Rate Diluted 1:1* (gsy)
New Asphalt	0.02 – 0.05	0.03 – 0.07	0.06 – 0.14
Existing Asphalt	0.04 – 0.07	0.06 – 0.11	0.12 – 0.22
Milled Surface	0.04 – 0.08	0.06 – 0.12	0.12 – 0.24
Portland Cement Concrete	0.03 – 0.05	0.05 – 0.08	0.10 – 0.16

*Assume emulsion is 33% water and 67% asphalt.

Spray Bar Height and Coverage



Spray Bar & Nozzles



Etnyre Spraybar Nozzles

3353788 3351008 3351009 3352368 3351015 3352204 3352205 3352210 3351014 3351010

Ref.	Part No.	Description	Application Gallons Per Square Yard	Application (Metric) Liters Per Square Meter	US Flow Gallons Per Minute Per Foot
1	3353788	V Slot Tack Nozzle	.05 - .20	.23 - .91	3.0 to 4.5
2	3351008	S36-4 V Slot	.10 - .35	.45 - 1.58	4.0 to 7.5
3	3351009	S36-5 V Slot	.18 - .45	.81 - 2.04	7.0 to 10.0
4	3352368	Multi-Material V Slot	.15 - .40	.68 - 1.81	6.0 to 9.0
5	3351015	3/32" Coin Slot	.15 - .40	.68 - 1.81	6.0 to 9.0
6	3352204*	Multi-Material V Slot	.35 - .95	1.58 - 4.30	12.0 to 21.0
7	3352205*	Multi-Material V Slot	.20 - .55	.91 - 2.49	7.5 to 12.0
8	3352210	End Nozzle (3352205)	.20 - .55	.91 - 2.49	7.5 to 12.0
9	3351014	3/16" Coin Slot	.35 - .95	1.58 - 4.30	12.0 to 21.0
10	3351010	1/4" Coin Slot	.40 - 1.10	1.81 - 4.98	15.0 to 24.0

* Recommended nozzles for seal and chip with emulsified asphalts.

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Nozzle Selection

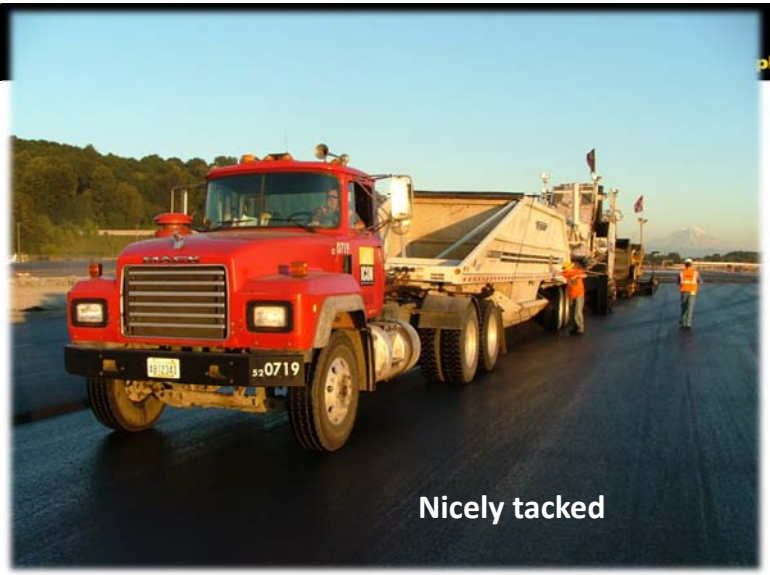
69


Where's
the Tack
Coat?


Highly inconsistent tack application


Better, but still streaky


Nicely tacked



Module Outline

- Preparation for Paving
  - New Construction
  - Overlays
    - Asphalt
    - PC Concrete
- **Tack Coats**
  - Introduction
  - Materials
  - Application
  - **Verification**

Application Calculations

Calculating field application rates

- **Three primary methods of determining field application rates**
  - **Determination by volume**
  - **Determination by weight or mass**
  - **Determination by direct measurement, ASTM D2995**

Calculating rates by Volume

- Rate of material applied is calculated by determining the volume of material distributed
- Either by:
  - Observation & record of an onboard volume meter or gauge
  - Using a tank stick method where the depth of material is measured in the tank
    - Volume is calculated with the use of a calibration table

Correcting For Temperature

- Asphalt & water expand & contracts when temperatures deviate from 60°F.
- As temperatures rise above 60°F
  - Expansion occurs and the resulting
  - Density (#/gal.) decreases
- As temperatures cool below 60°F contraction occurs and the density increases
- A Temperature–Volume correction table for asphalt emulsion is available in MS-19, page 91

Table 13. Temperature - volume corrections for asphalt emulsions [6].

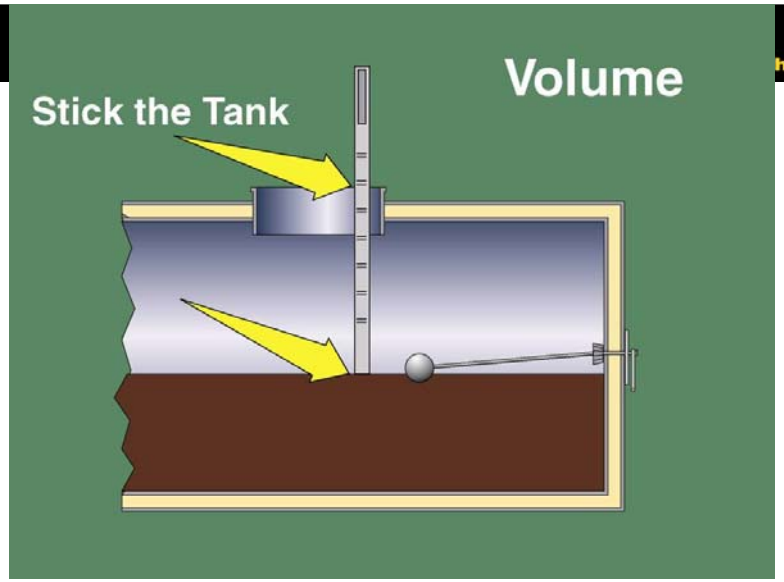
°C	°F	M	°C	°F	M	°C	°F	M
10.0	50	1.0025	35.0	95	0.9912	60.0	140	0.9800
10.6	51	1.0022	35.6	96	0.9910	60.6	141	0.9797
11.1	52	1.0020	36.1	97	0.9907	61.1	142	0.9795
11.7	53	1.0017	36.7	98	0.9905	61.7	143	0.9792
12.2	54	1.0015	37.2	99	0.9902	62.2	144	0.9790
12.8	55	1.0012	37.8	100	0.9900	62.8	145	0.9787
13.3	56							0.9785
13.9	57							0.9782
14.4	58	1.0005	39.4	103	0.9892	64.4	148	0.9780
15.0	59							0.9777
15.6	60							0.9775
16.1	61	0.9997	41.1	106	0.9885	66.1	151	0.9772
16.7	62	0.9995	41.7	107	0.9882	66.7	152	0.9770
17.2	63	0.9992	42.2	108	0.9880	67.2	153	0.9767
17.8	64	0.9990	42.8	109	0.9877	67.8	154	0.9765
18.3	65	0.9987	43.3	110	0.9875	68.3	155	0.9762
18.9	66	0.9985	43.9	111	0.9872	68.9	156	0.9760
19.4	67	0.9982	44.4	112	0.9870	69.4	157	0.9757
20.0	68	0.9980	45.0	113	0.9867	70.0	158	0.9755
20.6	69	0.9977	45.6	114	0.9865	70.6	159	0.9752
21.1	70	0.9975	46.1	115	0.9862	71.1	160	0.9750

$$Volume_{@\,°F} \times M_{value} = 60°F\,Vol.$$

$$Volume_{@\,°C} \times M_{value} = 15.6°C\,Vol.$$

Dipstick Method

1. Measure Emulsion level & use calibration chart to convert to volume
2. Record Emulsion Temperature
3. Spray Tack Coat Over a Known Area
4. Measure Emulsion level & use calibration chart to convert to volume
5. Subtract volume Step 4 from volume Step 1
6. Correct Volume for Temperature Variation from 60°F



Distributor must be level when checking volume using a measuing stick

Dipstick Equation:

$$\frac{9 \times Gallons\ Applied}{Width \times Length}$$

(feet) (feet)

Note: 9 to convert from square feet to square yards
Use as required.

Comments on Calculating by Volume

Pros:

- Quick
- Simple
- Accuracy improves with larger areas

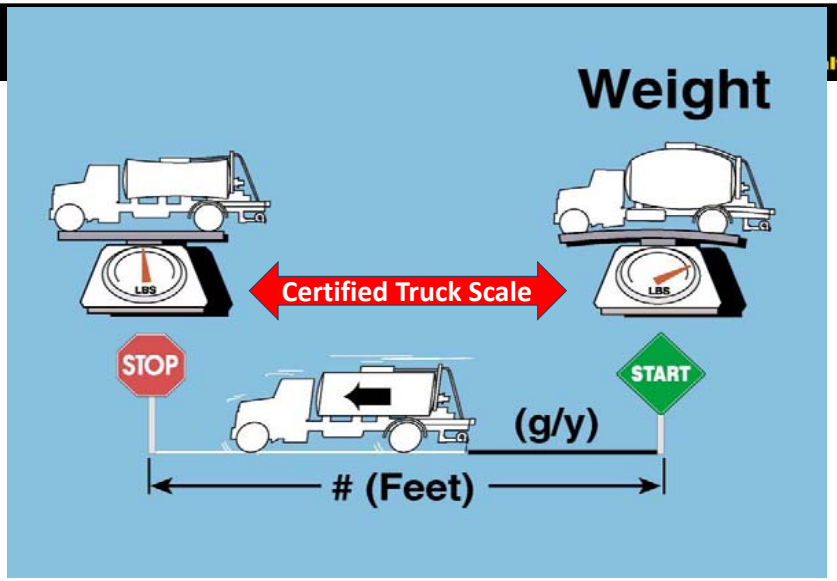
Cons:

- Volume requires
  - Dip Stick, or
  - Volumeter
- Dilution rate vital
- Temperature correction required
- Inaccurate on small areas

Calculating rates by Weight (Mass)

Calculating an application rate by weight:

- Most accurate method
- Supplier's Bill of Lading contains a 60°F weight per gallon
- Weight measurements are not affected by temperature
- Constant weighing after each shot can be complicated
- Recommend using this method:
  - Full load applications
  - Calibration



Key Items for Inspectors

- Check truck setup
  - Spray bar height (~12")
  - Appropriate nozzles
  - Uniform orientation
    - From 15-30°
  - Check application rate gauge in truck
  - Check application temperature
- Collect samples
- Know the desired application and residual rates
- Visually inspect application
- Verify application
  - Volume
  - Mass

Module 3
Delivery

Module Outline

- Transportation and delivery
  - Introduction
  - Truck types & requirements
  - Mix delivery concerns

The Hauling Operation

Hauling operation must:

- **Provide a steady and consistent flow of mixture**
- **From the plant to the paver**

This is accomplished by:

- ***Timely and proper loading of trucks at plant***
- ***Adequate number of trucks to support continuous paver speed***
- ***Consistent use of proper techniques for loading and unloading***
- ***Delivered mix meets temperature and non-segregation requirements***

Contractor must anticipate the activities to properly estimate cycle time

Typical Truck Requirements

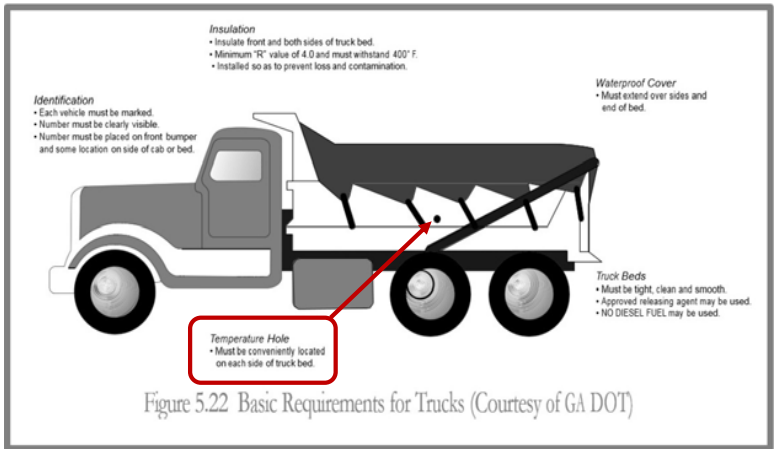
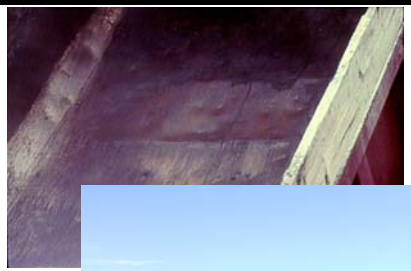


Figure 5.22 Basic Requirements for Trucks (Courtesy of GA DOT)

Truck Bed Requirements—Release Agents

- Tight, clean, smooth metal beds
- Thinly coated with min amount:
  - Soap solution
  - Lime solution
  - Other approved release agent
- Do not allow ponding of solutions in the truck bed



No diesel fuel or other contaminating solvents allowed!

Module Outline

- Transportation and delivery
  - Introduction
  - Truck types & requirements
  - Mix delivery concerns

Types of Trucks

End dump:
Typical capacity 13-15 tons

- Lowest capacity
- Shorter wheel base makes it more maneuverable
- Good for jobs in tight spaces
- Watch for overhead obstructions

Types of Trucks

Semi-trailer, high dump:
Typical capacity 20-22 tons

- Larger capacity
- Easier to segregate with improper loading
- Watch for overhead obstructions

Module Outline

- Transportation and delivery
  - Introduction
  - Truck types & requirements
  - Mix delivery concerns

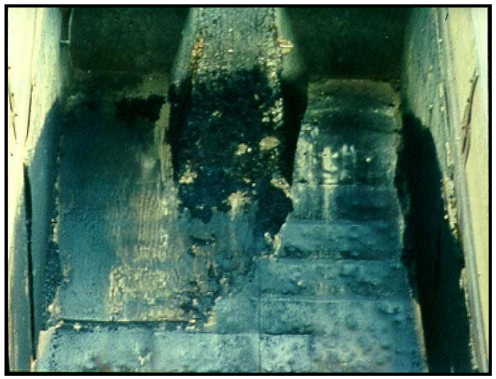
Tarping Loads

Trucks must be tarped & insulated according to the spec:

- Use it to help maintain temperature
- Protect against the elements

Proper Truck Loading Techniques

- Spot check trucks to make sure beds are clean before loading
- Cross-contamination
- Cold material will break loose and segregate mix



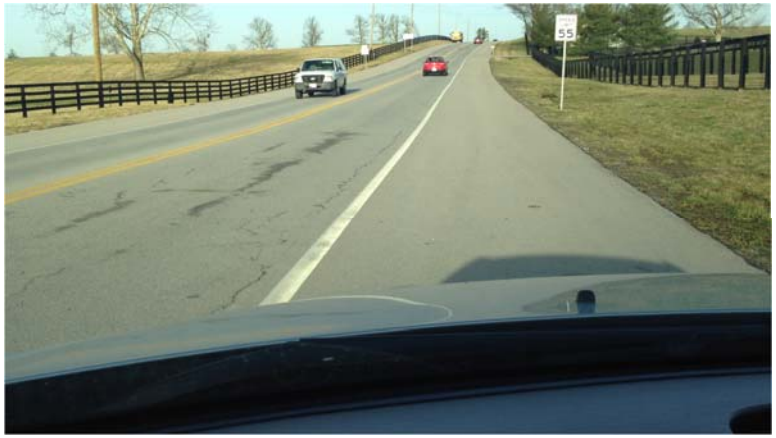
Truck-End Segregation

Load-to-load segregation

- Caused by segregation in the truck transferred through the paver.

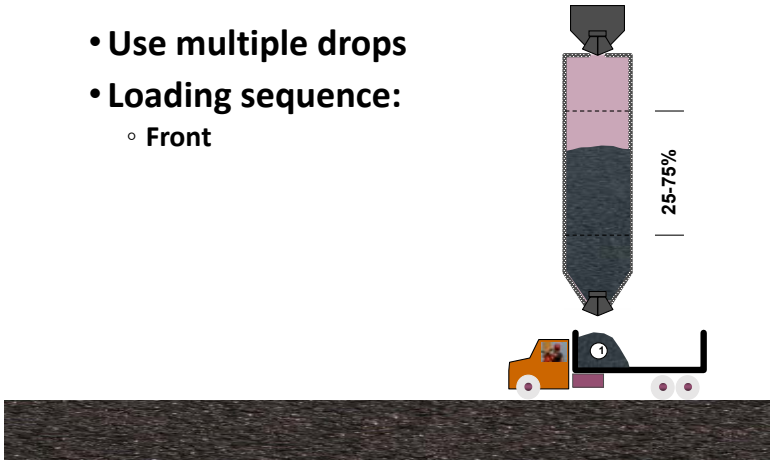
Make sure the trucks are being loaded in multiple drops!

Truck-End Segregation



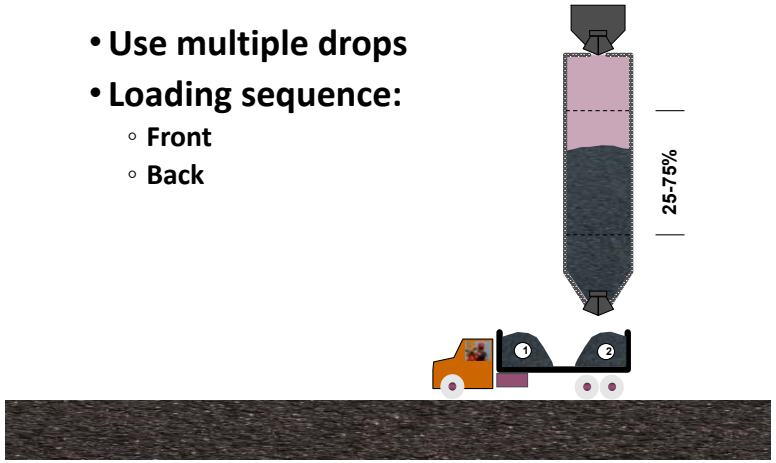
Truck Loading

- Use multiple drops
- Loading sequence:
  - Front



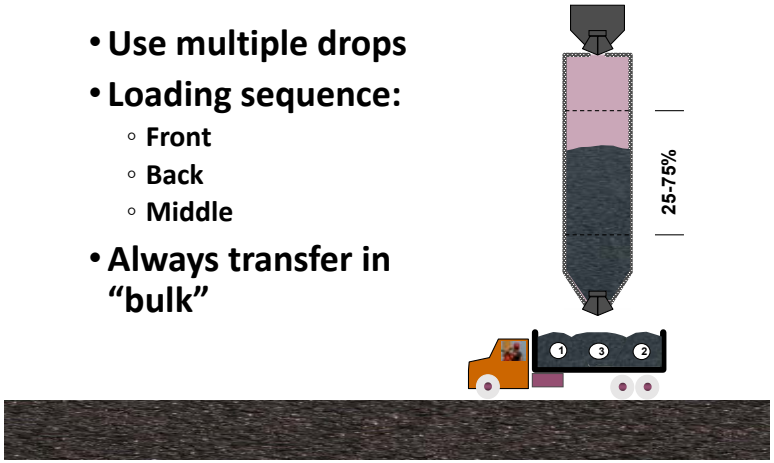
Truck Loading

- Use multiple drops
- Loading sequence:
  - Front
  - Back

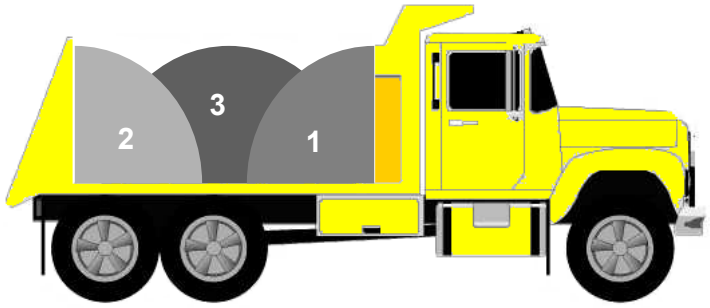


Truck Loading

- Use multiple drops
- Loading sequence:
  - Front
  - Back
  - Middle
- Always transfer in "bulk"



Proper Truck Loading Techniques



Make sure end dump trucks are loaded in this manner to help prevent segregation in the truck.

Proper Truck Loading Techniques

- **Semi-trailers more drops help prevent segregation**
- **Don't allow the mix to be dribbled-in**
  - **Ensure quick dumps in mass**

Unloading the Truck

- **Direct feed to paver**
  - **End dump trailers**
- **Material Transfer Vehicle**

Direct Feed to Paver

- **End Dump Trailer**
  - **Tarps removed off the load**
  - **Raise bed to break load (material slumps against tailgate)**
  - **Paver engages truck**
  - **Release tailgate and continue raising bed so material moves in mass**
    - **Do not chain (restrict) tailgate opening**
    - **No trickling mix into paver**
  - **Paver pushes truck**

Improperly Backing a Truck

Improperly Backing a Truck

Loading the Hopper

Break the load before opening the tailgate.
Move the mix in a mass - no trickling!

Material Transfer Vehicles

MTVs are intended to

- **Help the paving train keep moving continuously**
- **Expedite truck unloading and return trips**
  - **Use will typically reduce two trucks**
- **Eliminates truck/paver contact**
- **Reduce potential for:**
  - **Physical segregation**
  - **Thermal segregation**

Material Transfer Vehicles

- To avoid stop-and-go paving, coordinate:
  - Number of haul units
  - Paver speed
  - Plant production rate
  - MTV speed
- MTVs should continuously remix
- Use caution when crossing bridges

Material Transfer Vehicles

Specialty uses:

- Offset paving
  - Elevation differences
  - Stringlines for grade control
- Superelevated curves
- Small, odd shaped areas

Material Transfer Vehicles

- Hopper inserts are used with MTVs or windrow pickup machines
- They increase the hopper capacity by 50% to 75%
- They help reduce mix segregation

Delivery Checklist

- Use proper release agents
- Good loadout practices
- Proper, tarping, insulation, & hauling
- Proper unloading and dumpman operation
- Pay attention to temperature
- Have enough trucks for a continuous paving operation

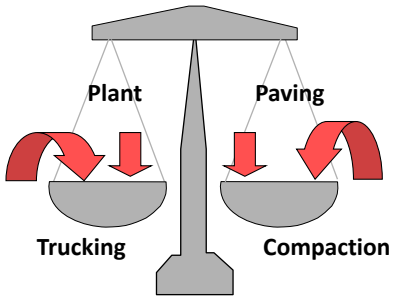
Module 4
Placement

Outline

Placement Best Practices

- **Project planning**
- **Understanding the paver**
- **Factors affecting the screed**
- **Screed Adjustments**
- **Paving process**

Project Planning



Balance:

- ***Project <u>Tonnage</u>***
- **Hot plant *<u>output</u>***
- ***<u>Length</u>* of haul**
- ***<u>Traffic</u>* conditions**
- ***<u>Number</u>* of trucks**

Consistency = Quality

Project Planning

<u>Wheeled Pavers</u>
Easy to operate, inexpensive to maintain

<u>Tracked Pavers</u>
Better for Agg surfaces
Better traction
More stabile platform

Project Planning

Paving Width

- Screed extensions
  - Variable
  - Fixed or rigid
- Auger extensions
- Retaining plates
  - Tunnels

Project Planning

Specifications

- Grade requirements
  - Match existing
  - Leveling Sensors
    - Joint matcher
    - Traveling Grade control
    - Position of sensors
  - Cross Slope

Project Planning

First Pass Must Be Straight!

- String-lines
- Other reference

Project Planning

Grade Conditions

- Patching
- Bumps
- Low spots
- Milling
- Leveling course
- Transitions

Understanding the Paver

Basic Functions

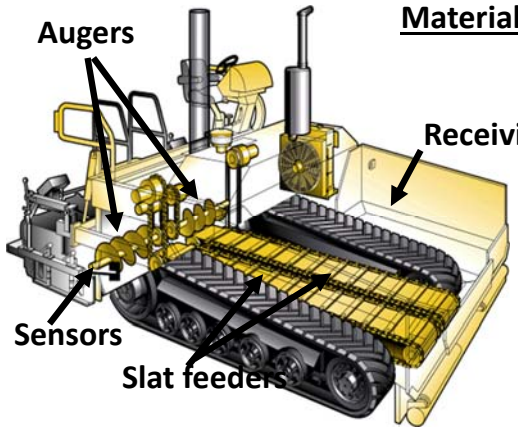
- Tractor/ power unit
- Material feed
- Self-leveling

Understanding the Paver

Tractor Self-Leveling

- Power Unit
- Screed can rise & fall
  - Free Floating
- Constant line of pull when set up properly
- Smooth's irregular grade

Understanding the Paver

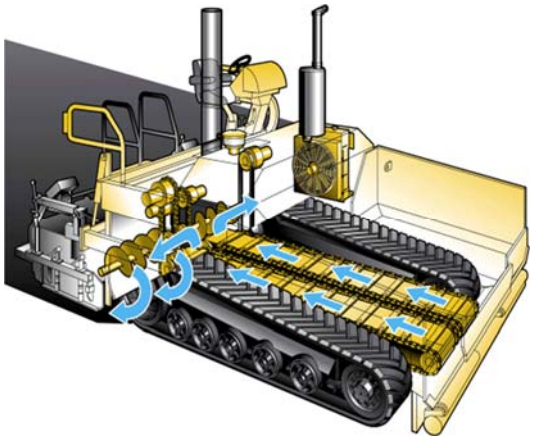


Understanding the Paver

Material Feed System

Flow of Material

- Hopper
- Through tunnel
- In front of screed
- Augers move mix transversely



Visual Inspection of Mix

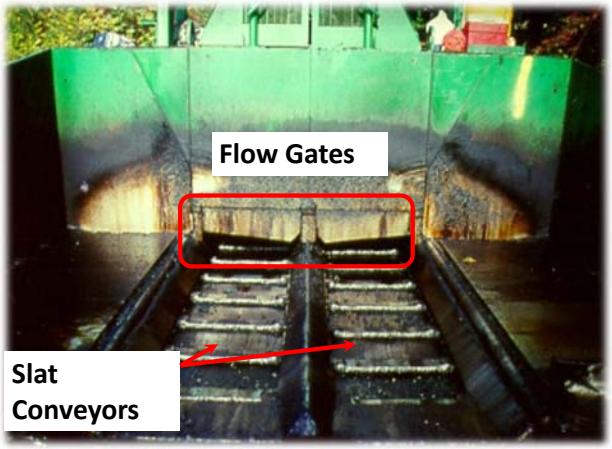
Problem Indicators

- Blue smoke
- Stiff (high peak)
- Slumped
- Dry, dull appearance
- Moisture
  - Steam
  - Condensate
- Segregation
- Contamination
  - Solid
  - Fuel or solvents

Break the Load

- Move mix in a mass
- Trickling causes segregation

Slat Conveyors and Flow Gates



Hopper Management

Never expose conveyor or fold in hopper wings:

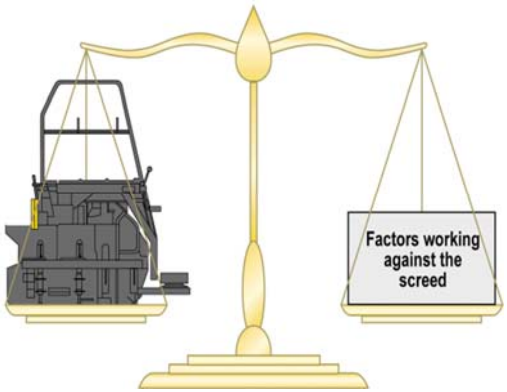
- Mix will be segregated
- Cold mix will be rolled on top of hot mix
- Augers are starved
- Remove corner built-up at end of each paving shift
- If paver stops, leave hopper 1/3 to 1/2 full

Understanding the Paver

- Keep in good condition
- Scheduled inspection
- Maintenance guidelines
- Safety Guidelines
  - Lockout/Tag out
  - Locking Pins
  - Wheel Chokes

Basic Principle Has Not Changed

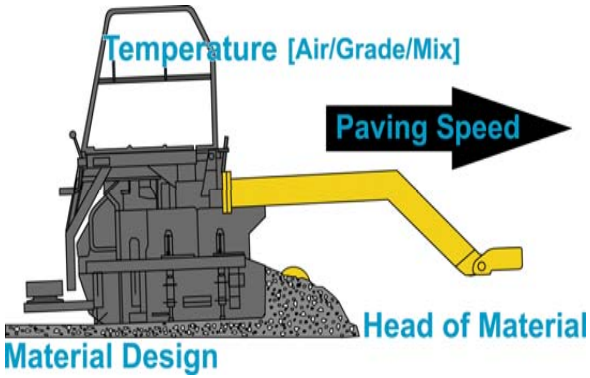
Understanding the Paver



Free-Floating Screed

- *Position* determines mat thickness
- Screed *position*
  - Will remain constant
  - *If all factors* remain constant

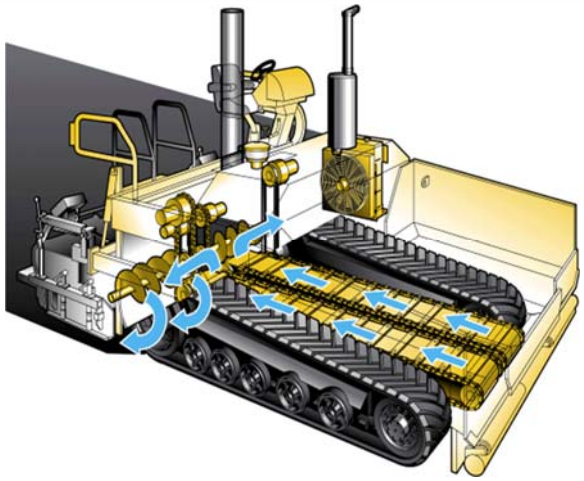
Understanding the Paver



Factors Affecting Screed

- *Head of material*
- Paving speed
- Screed adjustments
- Mix design
- Temperatures
  - Air
  - Grade
  - Mix

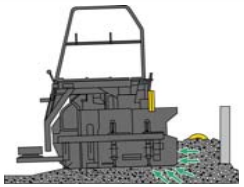
Factors Affecting Screed



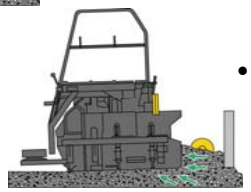
Head of Material

- **Uniform flow**
- **Uniform force against face of screed**

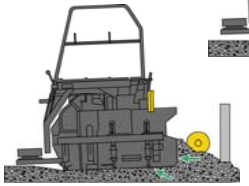
Factors Affecting Screed



- **Too much material, screed forced to rise**

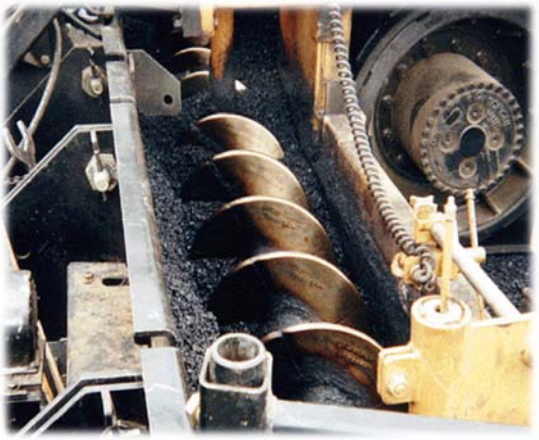


- **Correct amount of material, screed remains level**



- **Too little material, screed will dip down**

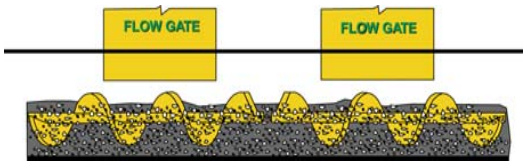
Factors Affecting Screed



Uniform Head of Material

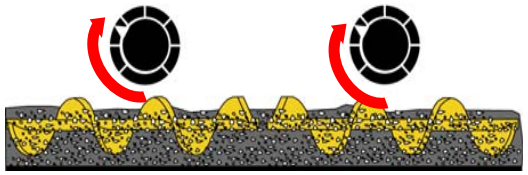
Across Width of Auger

Factors Affecting Screed



Flow Gates Set Properly

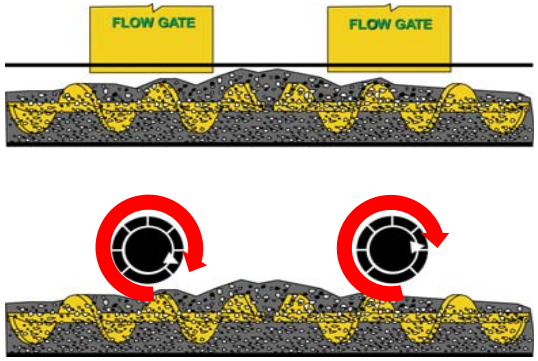
- **Material**
  - **Uniform Amount**
  - **Shafts half covered**



Feeder Ratio Set Properly

- **Same principle as flow**

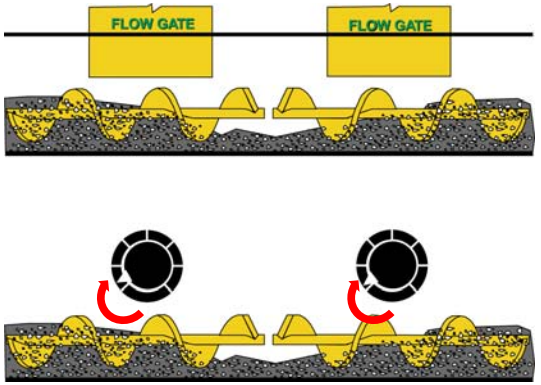
Factors Affecting Screed



Gates/Ratio Too High

- Too much in center
- Screed rises
- Depth increases

Factors Affecting Screed



Gates/Ratio Too Low

- Too little in center
- Screed falls
- Depth decreases

Factors Affecting Screed

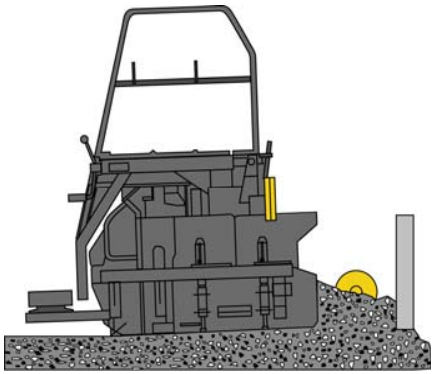
Reverse augers & paddles

- Forces mix under gearbox

✓ Simply raising the augers may help prevent centerline segregation

✓ Paddles on each auger are in place & in good condition

Factors Affecting Screed



Auger Speed

- Auger speed uniform
- 20-40 rpm
- Too high or too low
  - Cause mat streaks

Factors Affecting Screed

Feed Sensors

- Controls head of material
  - Speed of conveyor & auger
- Situated at end of auger
- Contact or a non-contact
  - Paddle or mercury switch
  - Infrared or ultrasonic sensors

Factors Affecting Screed

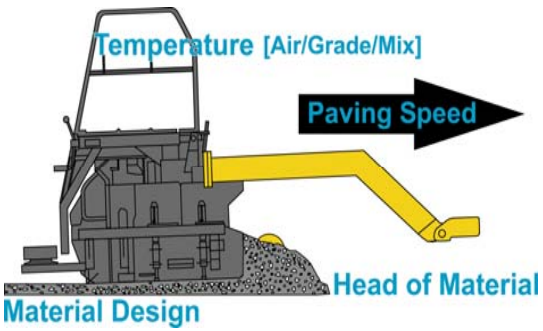
No Auger Extensions or Confinement

Auger Confinement Tunnels

- Controls mix flow to end of the Screed

Auger Extensions & Confinement

Understanding the Paver



Factors Affecting Screed

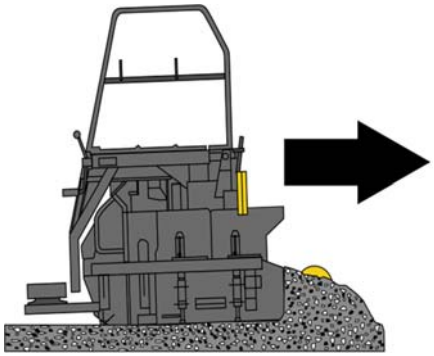
- Head of material
- *Paving speed*
- Screed adjustments
- Mix design
- Temperatures
  - Mix
  - Air
  - Grade

Factors Affecting Screed

Paving Speed

- Constant as possible
- Feeders match
  - Paving speed
  - Speed changes
- Feeders adjusted

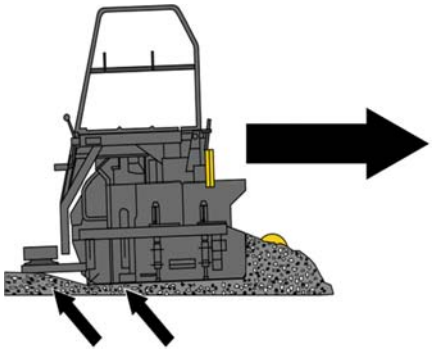
Factors Affecting Screed



Constant Speed

- **Shear factor is constant**
- **Depth remains constant**

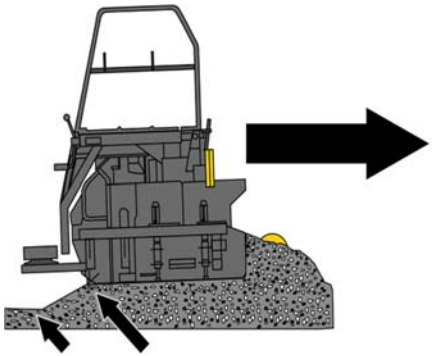
Factors Affecting Screed



Increased Speed

- **Shear force decrease**
- **Depth decreases**

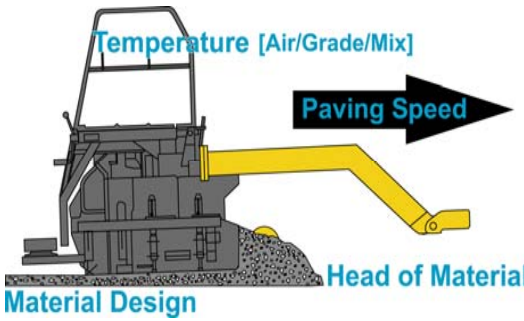
Factors Affecting Screed



Decreased Speed

- **Shear force increases**
- **Depth increases**
- **Depth change varies with speed change**
- **Type of Mix affects shear force**

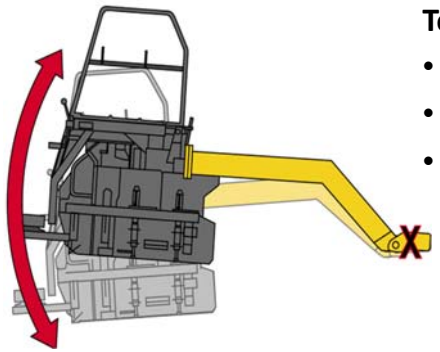
Understanding the Paver



Factors Affecting Screed

- **Head of material**
- **Paving speed**
- ***Screed adjustments***
- **Mix design**
- **Temperatures**
  - **Mix**
  - **Air**
  - **Grade**

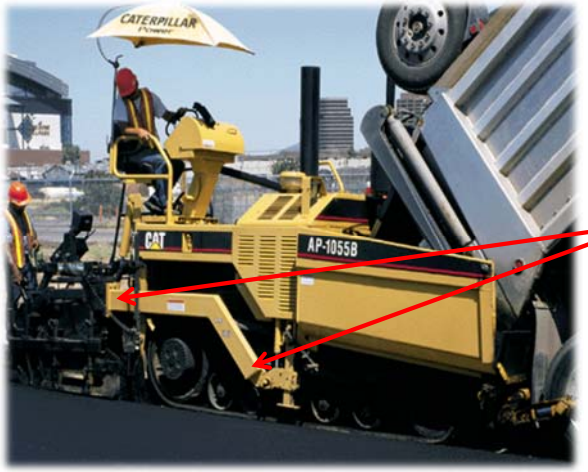
Screed Adjustments



Tow Point

- **Fixed on Tractor Unit**
- **Screed pivots**
- **Height tow point**
  - **Changes Angle of Attack**

Screed Controls



Tow Arms

Line of Pull

Free Floating Screed

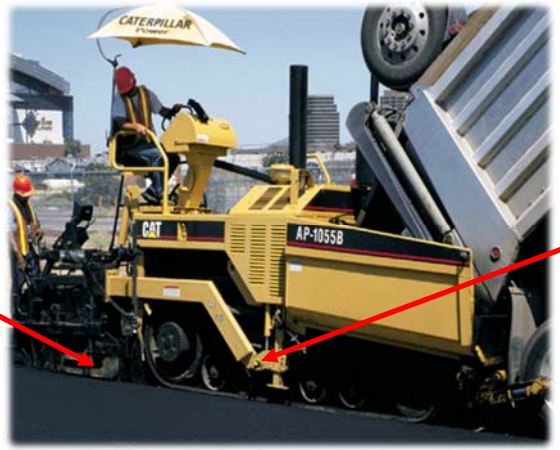
- **Levels to run parallel**
- **Imaginary line through the tow points**
- **Known as 'Line of Pull'**

Free Floating Screed Principle

Free floating provides a smooth surface finish by allowing the screed to ride over high spots & fill low spots in the base.

With each lift, smoothness is typically increased around 50%.

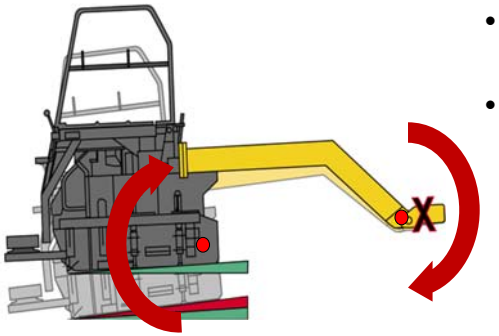
Developing the Line of Pull



1/8 inch change

1 inch change

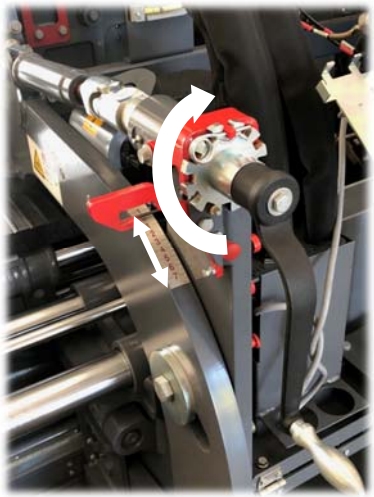
Screed Adjustments



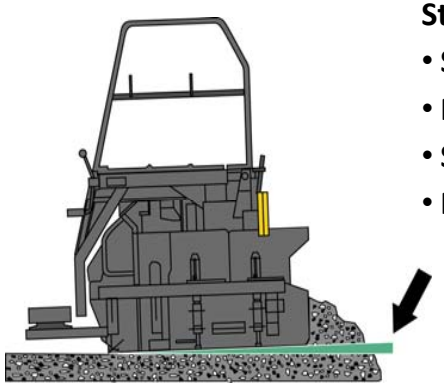
- Pivots on both ends of tow arm
- Angle of Attack

Changing the Angle of Attack

Depth Crank Increases or Decreases Attack Angle



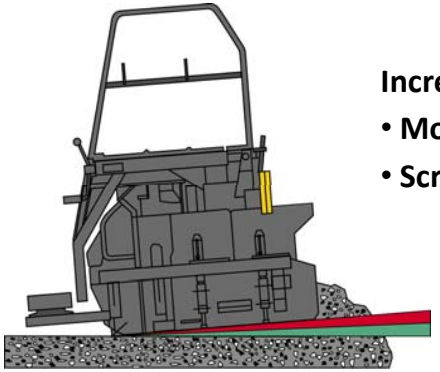
Screed Adjustments



Starting Angle of Attack

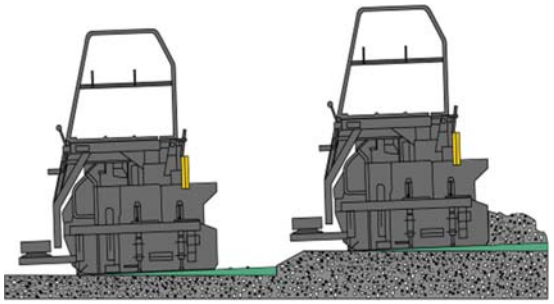
- Screed nose & grade
- Nose up attitude
- Screed in equilibrium
- Free Floating

Screed Adjustments



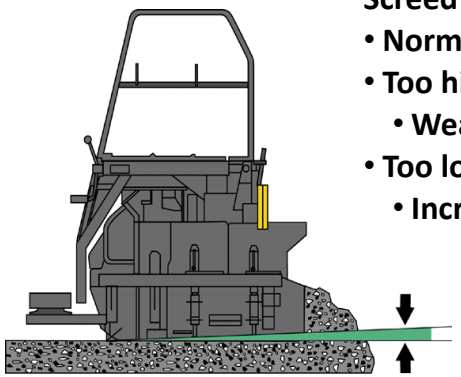
Increase Angle of Attack
- More matl under screed
- Screed rises to new level

Screed Adjustments



Increased Angle of Attack:
- Screed climbs
- Till forces balance
- Achieves equilibrium
- Returns to original angle

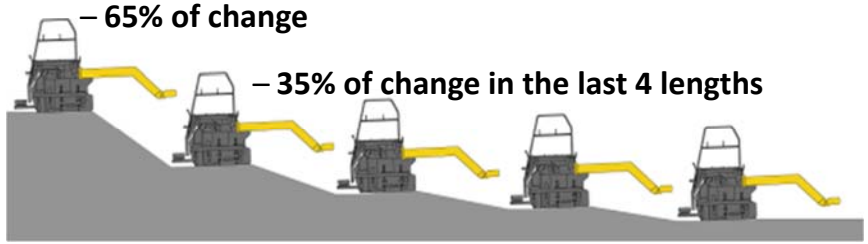
Screed Adjustments



Screed Angle of Attack
- Normally 1/8" to 1/4"
- Too high
  - Wear on trailing edge
- Too low
  - Increases wear on the nose

Screed Adjustments

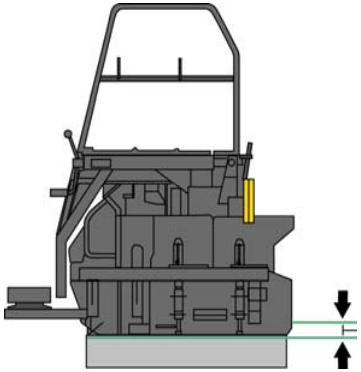
Reaction to Angle of Attack Changes



Takes over 5 tow arm lengths

- Longer tow arm equals a longer distance
  – Improves rideability

Screed Adjustments

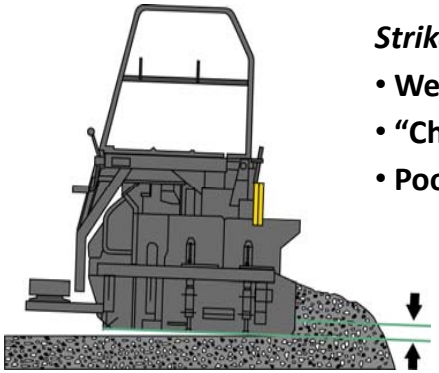


Front Strike-off

- Affects angle of attack
- Factory setting covers most mix designs
- Coarse mix set higher
- Sandy mix set lower

1 inch

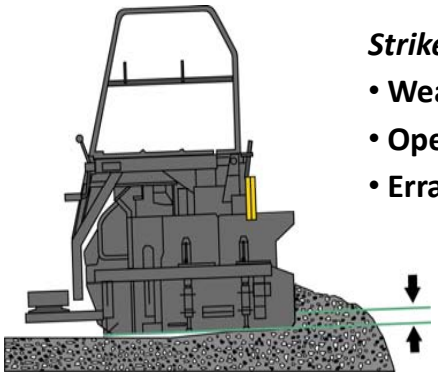
Screed Adjustments



Strike-Off Set Too High

- Wear on nose
- "Chatter"
- Poor mat texture

Screed Adjustments



Strike-Off Set Too Low

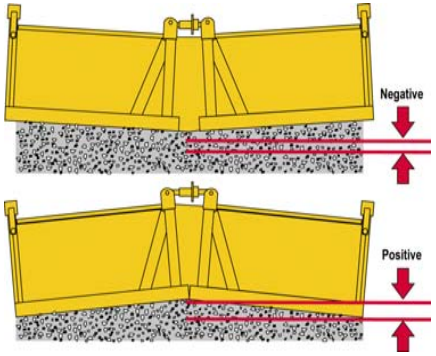
- Wear on trailing edge
- Open texture in mat
- Erratic screed behavior

Transverse Slope Control

Uses an internal pendulum

- Sets a reference level
- Dial in cross slope on control side (usually low side)
- Tow cylinders set different angles of attack

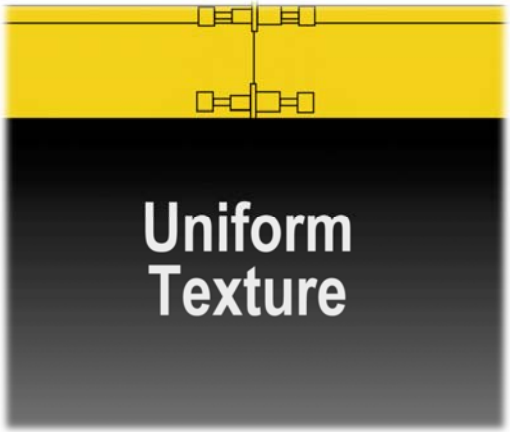
Screed Adjustments



Main Screed Crown

- "Broken"
  - Positive crown
  - Negative crown

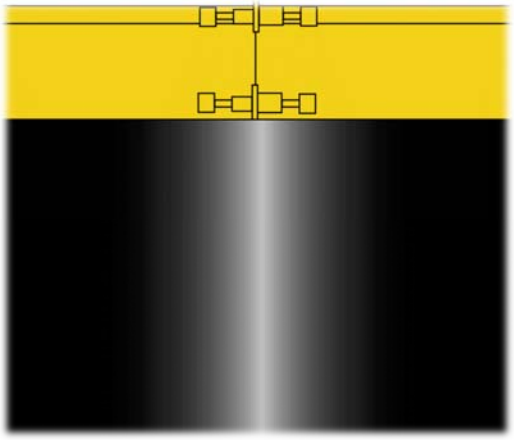
Screed Adjustments



Lead Crown Correct

- Even texture across full width
- Zero crown for most mixes

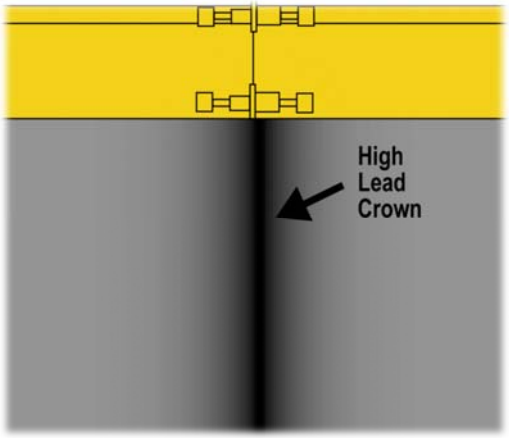
Screed Adjustments



Lead Crown Low

- Open texture in center
- Tight on sides
- Put in 1/8" crown

Screed Adjustments

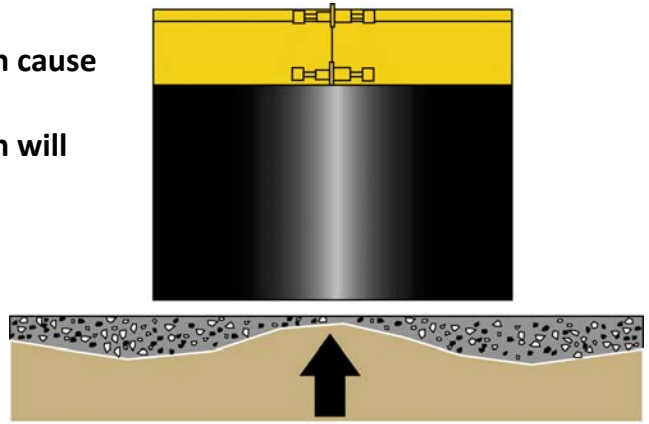


Lead Crown High

- Tight, shiny strip in center
- Open textured sides
- Reduce lead crown

Mat Defects

- Grade conditions can cause texture striping
- Adjusting lead crown will not correct problem



Due to High Point in Grade

Mat Defects

- Know grade conditions
- High points can cause screed to break aggregates

Mat Defects

- Grade conditions affect quality

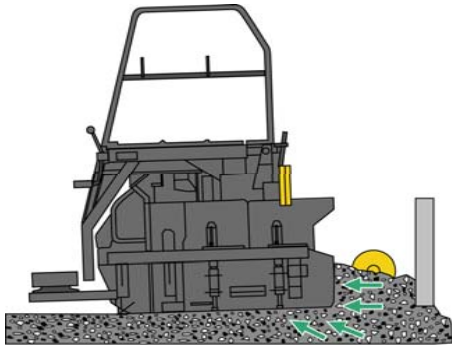
Mat Defects

- Oversized material causes:
  - Bumps
  - Streaks

Mat Defects

- Mat thickness should be 2 times greater than maximum aggregate size
- Tendency to fracture aggregate
- Lose control of screed

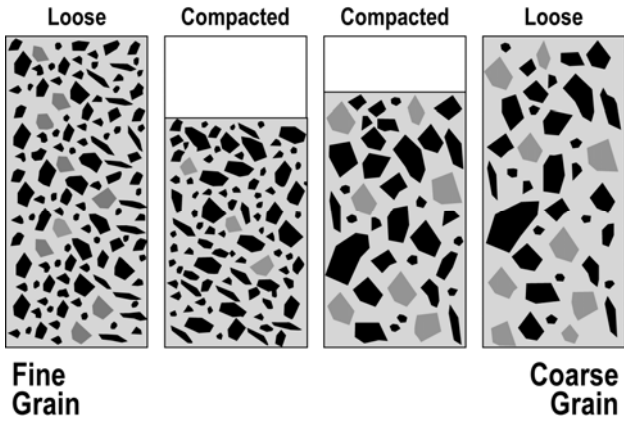
Understanding the Paver



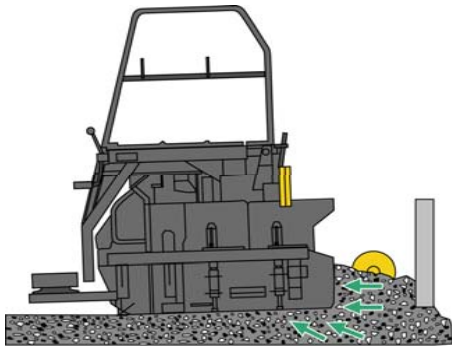
Factors Affecting Screed
- Head of material
- Paving speed
- Screed adjustments
- *Mix design*
  - *Course vs fine*
- Temperatures
  - Mix
  - Air
  - Grade

Mat Defects

- Compaction rates vary by mix design
- Adjust laydown thickness to match desired compacted thickness

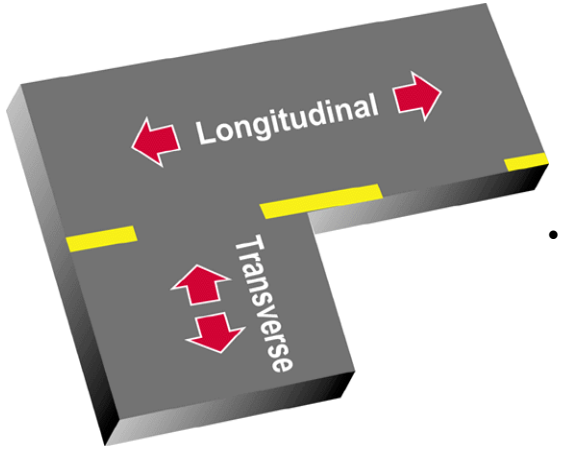


Understanding the Paver



Factors Affecting Screed
- Head of material
- Paving speed
- Screed adjustments
- Mix design
  - Course vs fine
- *Temperatures*
  - *Mix*
  - *Air*
  - *Grade*

Joint Construction

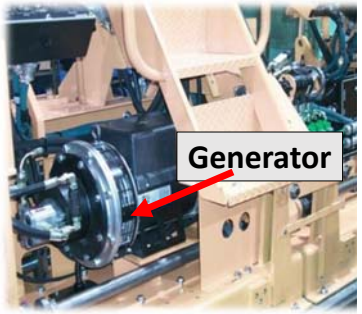


- Good joints
  - Are no mystery
  - Training & practice
  - Attention to details
  - Miles & miles of L/J

Screed Heating Systems

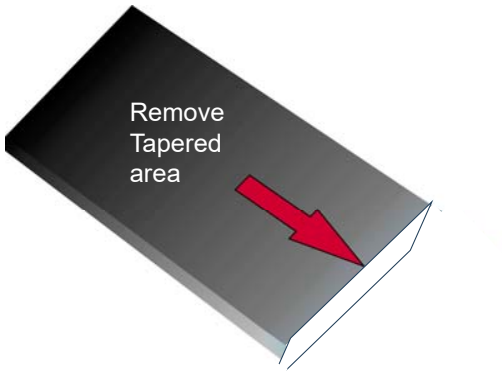
Diesel

Propane



Electric

Transverse Joints - Starting



- Pick starting point
  - Hand placed mat
  - Previous day's mat
    - Stop tacking
- Full depth of existing
- Saw cut & remove

Transverse Joints

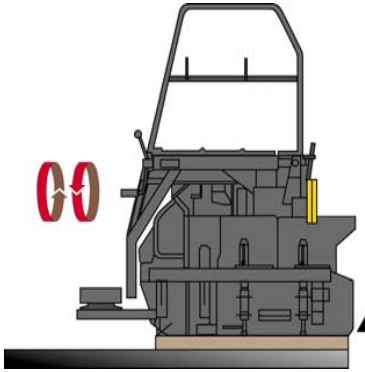
Start-up

- Vertical Edge
  - Clean
  - Tack

Tack Coat

Full width of mat
Minimizes movement
of unsupported edge

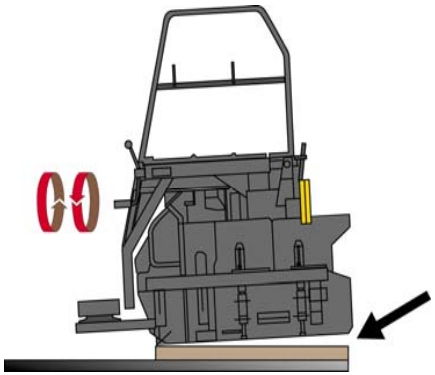
Transverse Joints



- Null screed
  - Zero out angle of Attack

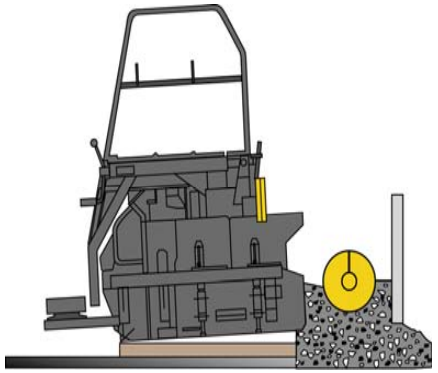
Boards allow for rolldown thickness

Transverse Joints



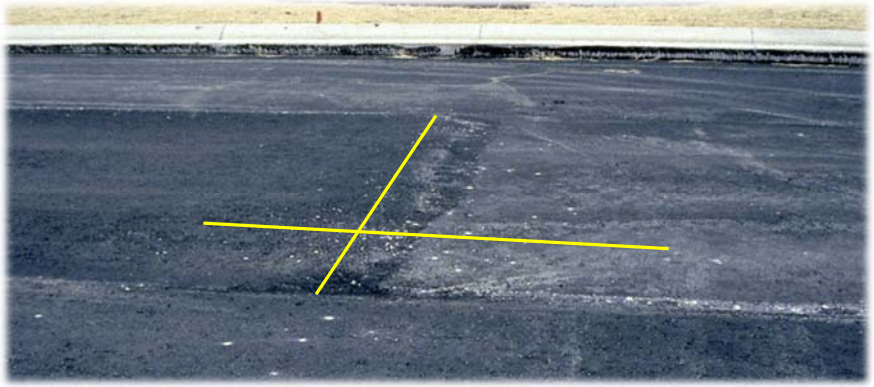
- Introduce angle of attack
- Crank until resistance is felt

Transverse Joints

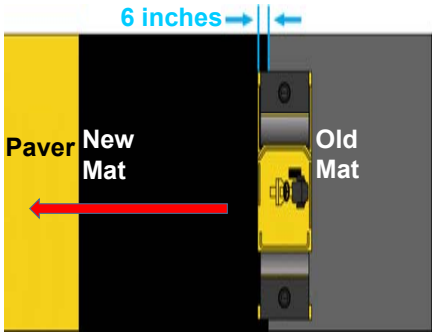


- Fill auger half full
- Conveyor manually
- Auger manually
- Shovel if needed to fill end of screed

Transverse Joints



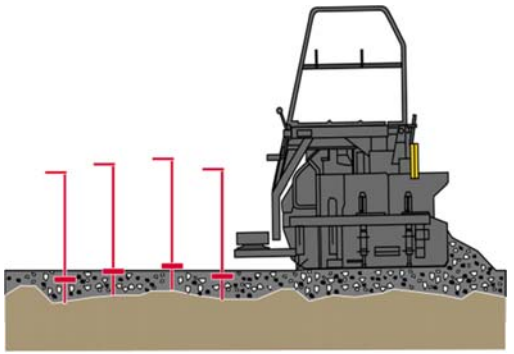
Transverse Joints



- Roll transverse
- Roll static
- Start on cold side
- Move over in 6” - 8” until on hot side

Transverse Joints

Controlling Yield



Depth Check

- One check, No correction
- Make series of checks
- Average readings
- Correct based on average
- Improves
  - Smoothness
  - Yield

Don't We Already Know How To Build a Longitudinal Joint?

Photo: Rosenberger

Photo: Rosenberger

Photo: Rosenberger

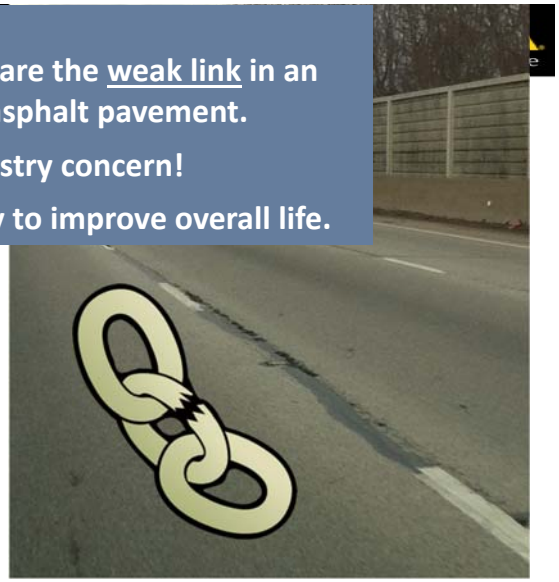
- Note condition of the rest of the mat
- Also sealed each side of patch

Photo: Grass

I-71 in Columbus, OH

Too often longitudinal joints are the weak link in an otherwise long-lasting asphalt pavement.

- **Agency and industry concern!**
- **Offers greatest opportunity to improve overall life.**



Deteriorated Joint

84

An Agency
and
Industry Concern

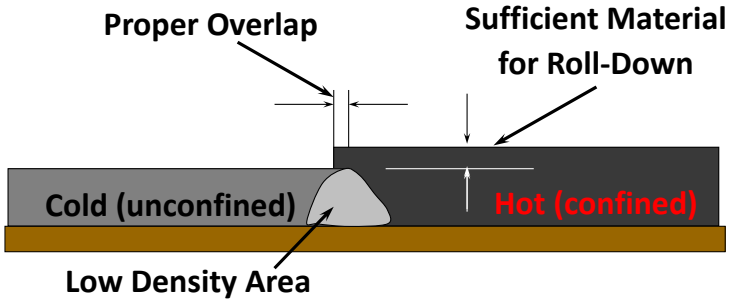
Longevity matters, it impacts:

- ❑ DOT Program Costs
- ❑ Industry's Livelihood
  - o LCCA
  - o Alternate Bid Competitiveness
- ❑ Travelling Public
  - o"…Stay Out"

Clarification of Terms

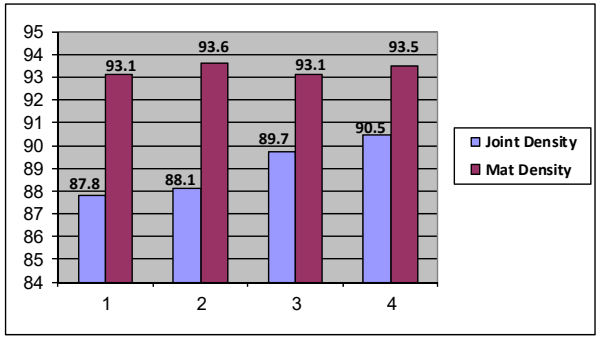
- Density: weight per volume (i.e. 140 pcf)
- Percent Relative Compaction:
  - Comparison of a measured density
  - To a reference density
    - i.e. in place density of 94% TMD
- All industries have jargon
  - Shorthand to simplify communications
- When speaker and slides refer to density, it is jargon for percent relative compaction
  - i.e. 94% density really means 94% TMD

Unsupported Edge Will Have Lower Density



Please note "Cold side" and "Hot side", are the terms used going forward

Joint vs. Mat Density

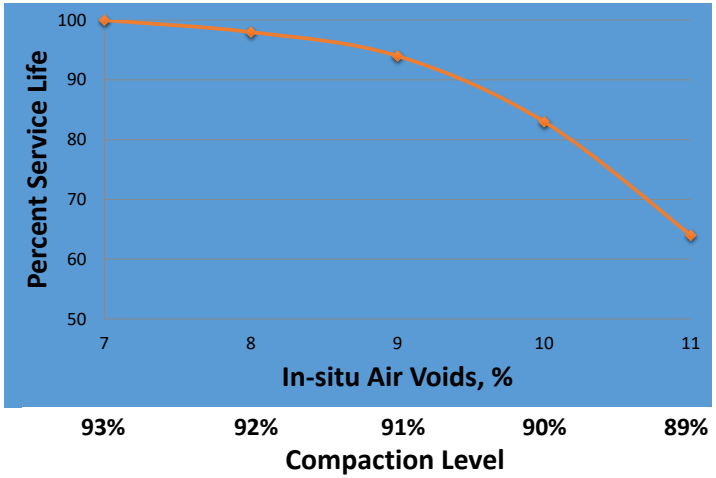


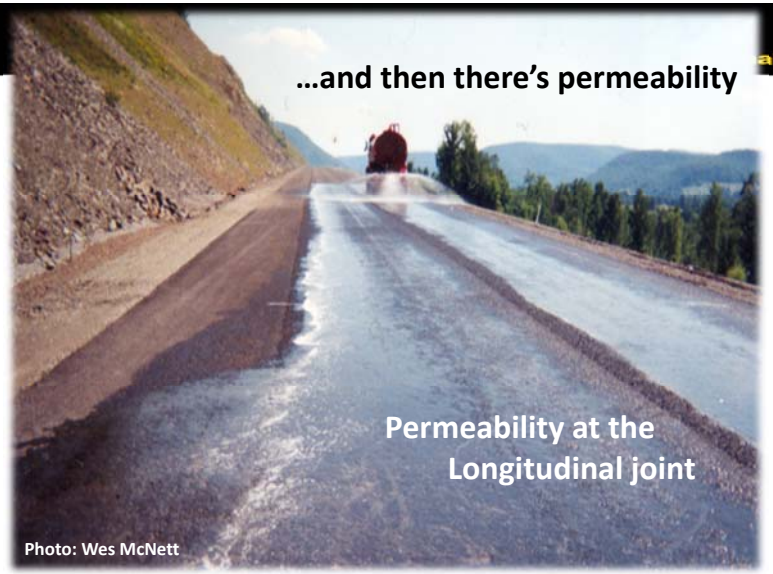
Wearing Surface 12.5mm

Binder Course 19.0mm

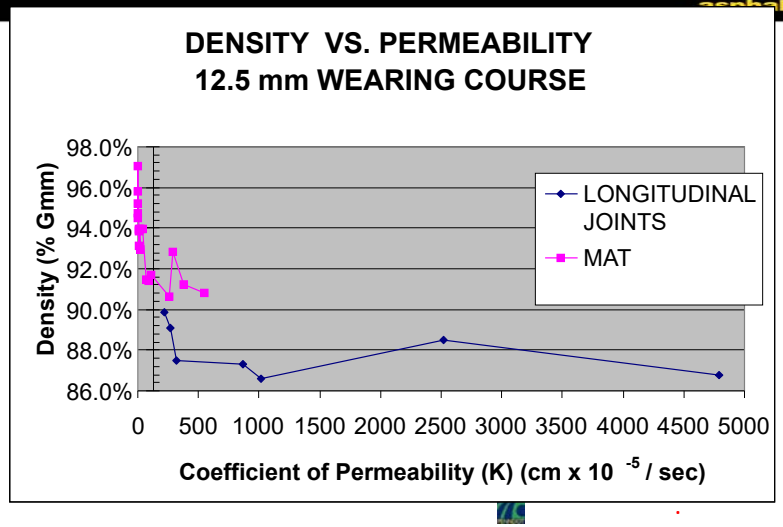
2006-2007, with 6" cores taken over joint

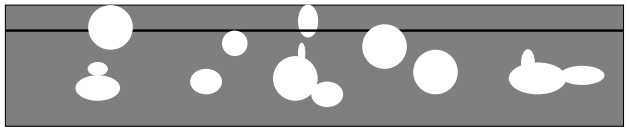
Effect of In-Place Voids on Life
Washington State DOT Study





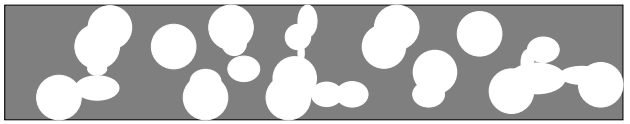
Permeability can be Catastrophic





Air Voids ≤ 7 or 8%

Mix generally not permeable



Air Voids > 10%

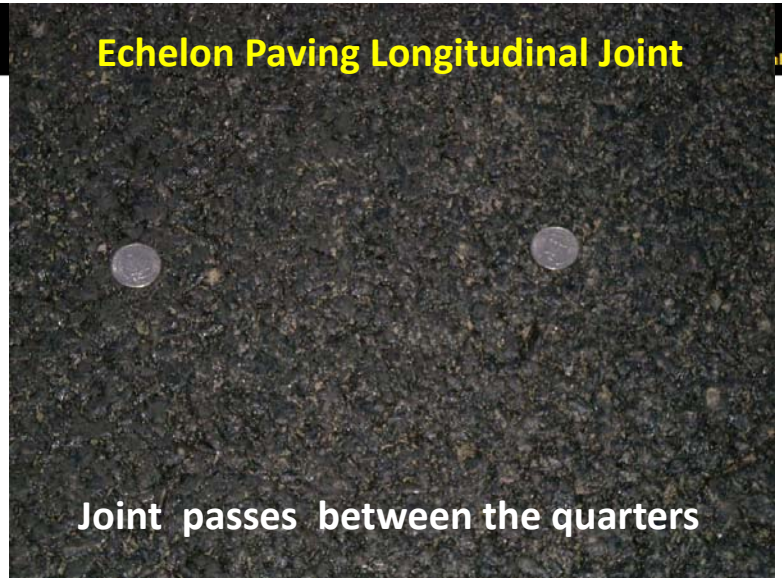
Mix generally permeable

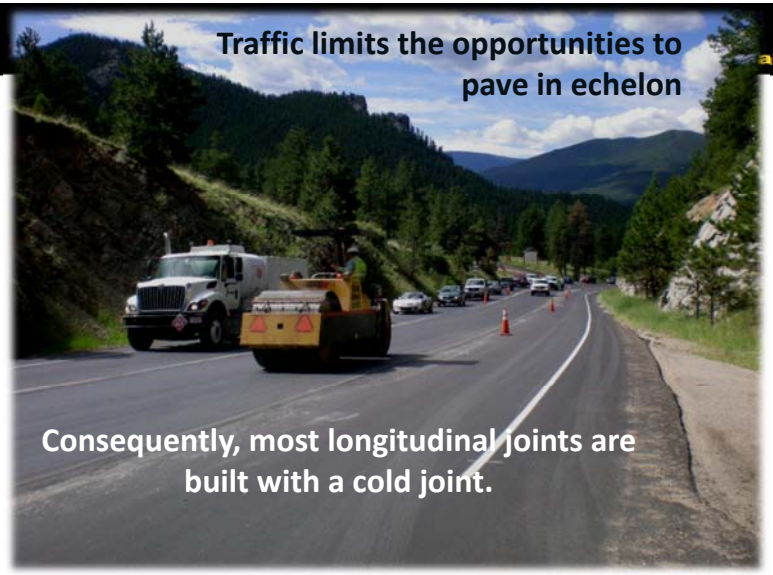
Quality Control and Acceptance of Joint Density

Break

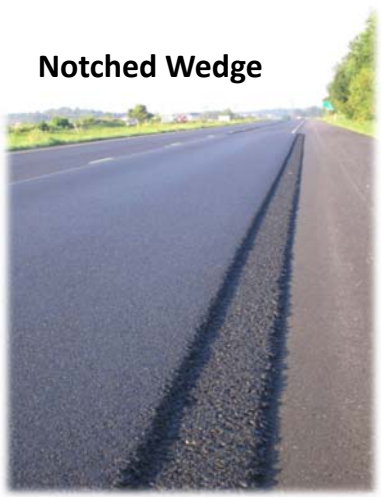
Constructing a Quality Longitudinal Joint

- Types of LJs
- Planning for the Joint
- Paving Best Practices (sequentially)





Preferred Joint Type? Experts Divided.

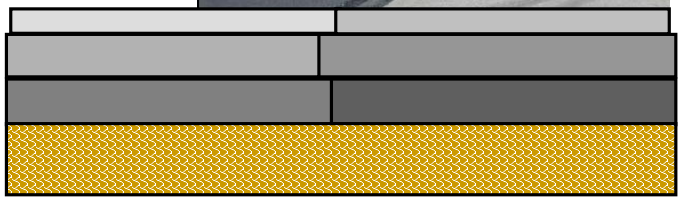


Plan for Longitudinal Joints…

- Joint Type
- Layout Plan of Final Lift showing joints
  - Recognize need to offset joints between layers
  - Avoid wheel paths, RPMs, striping (if possible)
- Testing of Joint
  - Type, location, schedule, by whom
- Joint Construction Practices
  - Paving, rolling, materials
- Pave low to high for *shingle effect*
  - Avoids holding water at joint by hot side being slightly

Plan for Longitudinal Joints…

Offset joints between layers by at least 6-inches; surface joint should be near centerline (not in wheelpath)



Poor planning – joint in wheelpath

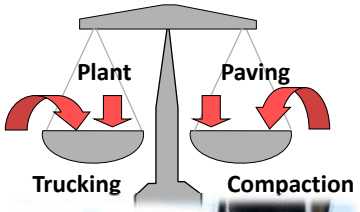
Avoid Where Striping Will Go

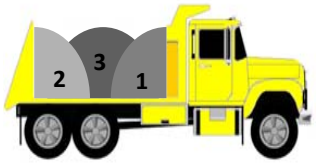
DELDOT

Which Can Result In This

DELDOT

Getting Started Off Right





Dump Person

MTV

Managing mix flow even more critical

MORE IMPORTANT

Over tacking full width of mat →

Project Planning

First Pass
Must Be Straight!
- String-lines
- Other reference

Great Results

Tough to get proper overlap (1”)

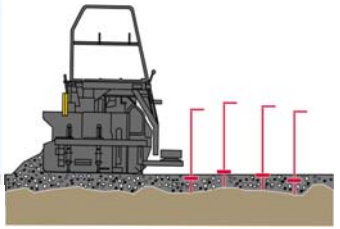
Double 55’ Ski

Contact Ski

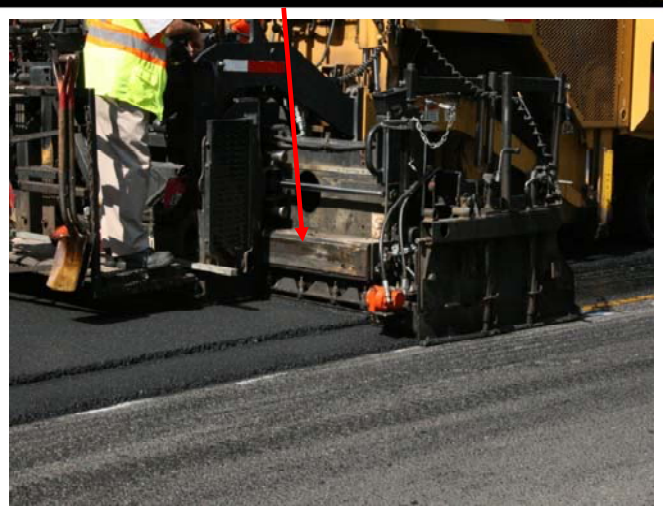
Use Automatic Grade Control (Versus Manual)

Ultrasonic Ski

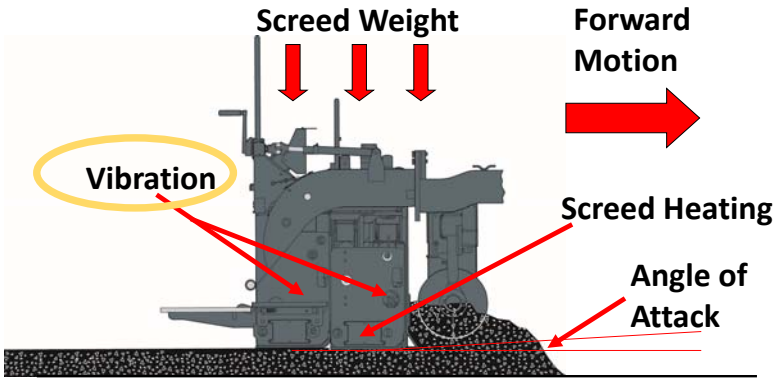
Don’t Rely on Manual Windmill Johnny



Vibratory Screed Should Always Be On



Material To Flow & Pre-compaction



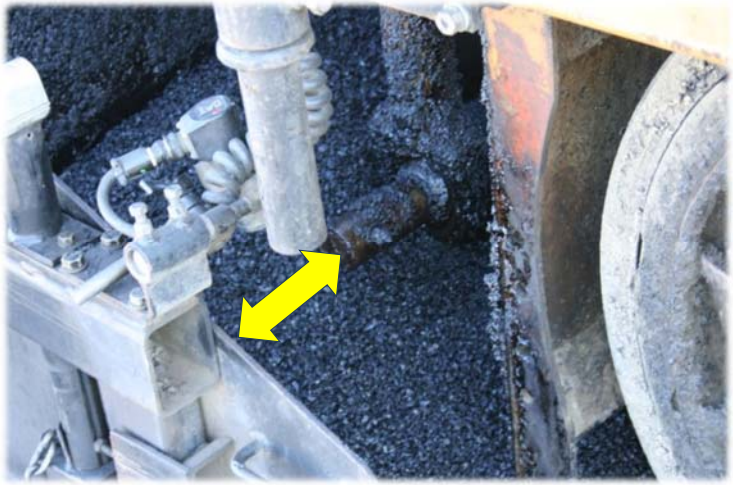
END GAME

Seated Flat on the Existing Surface

Uniform Head of Material

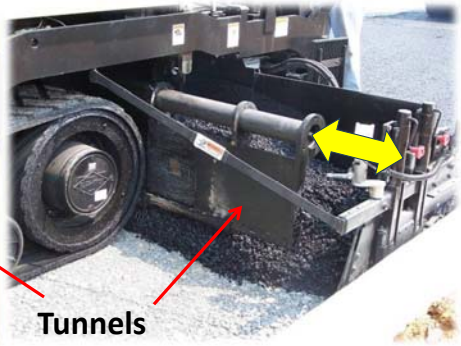
Maintained Across Width of Auger

Extend Augers 12-18 Inches Of End Gate



Extend Tunnels the Same Distance

Confine mix to outer edges of screed to deliver homogenous mix at joint

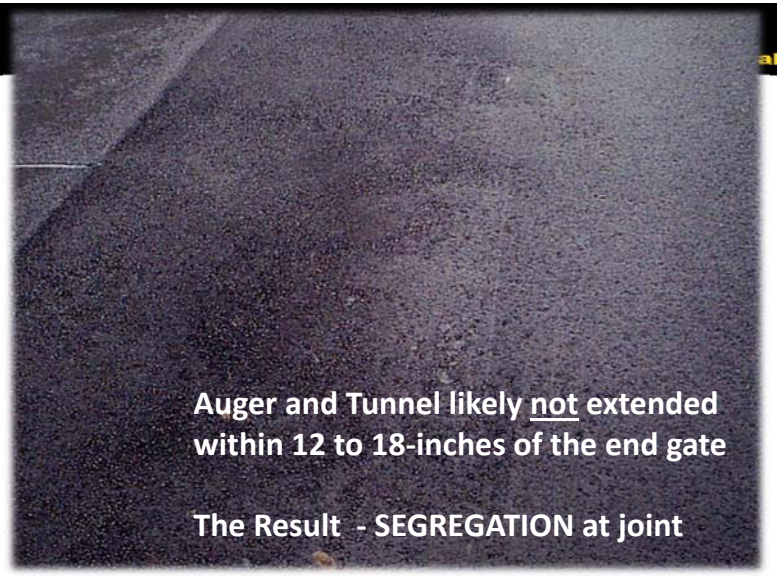


Non-segregated mix at joint:

- **Uniform head of mix**
- **Auger and tunnel extended**
- **Screed plate running flat**

Examples of Auger Overload… Leading to Segregate

Auger Speed



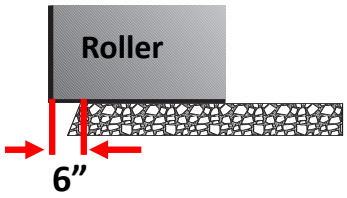
Kept Rollers Close to the Paver

Best Way to Roll a Joint

Rolling Unconfined Side?

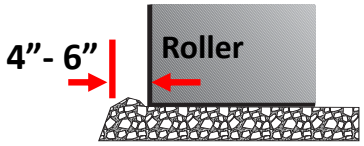
Option #1

Hang over 4-6”

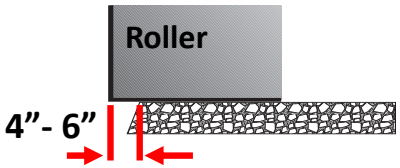


Option #2

1st Pass 4”-6” inside

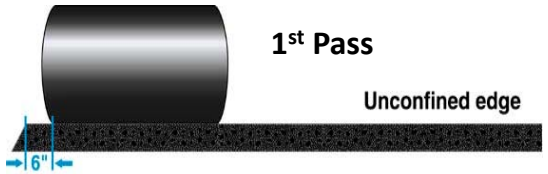


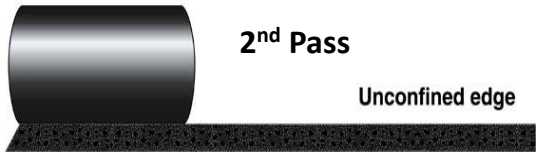
2nd Pass hang over 4”-6”



Alternative: Option #2

Stay Back 4-6 inches on 1st pass





- Merit:
  - Minimize lateral movement?
- Concern:
  - Developing stress crack?

What We Don’t Want

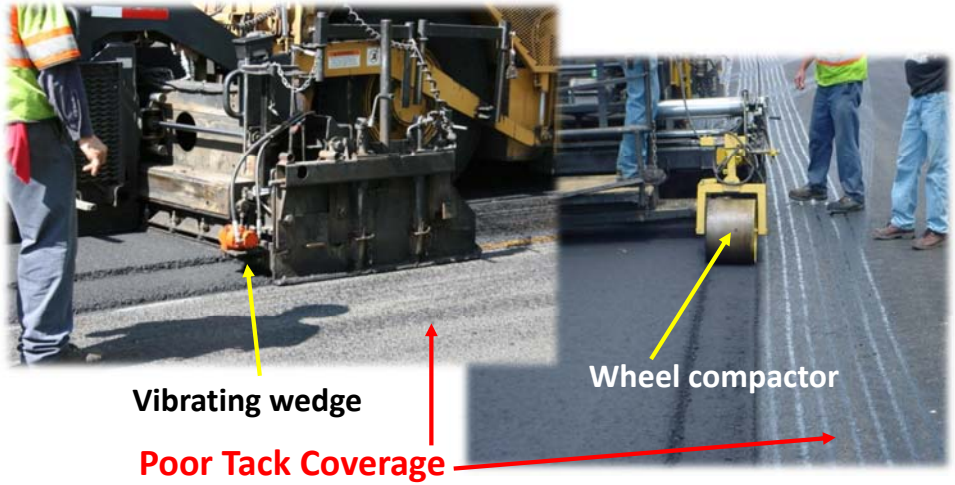
Rolling Unsupported Edge
With First Roller Pass

Drum passes inside the unsupported edge,
a stress crack can occur

Our Recommendation: Option #1

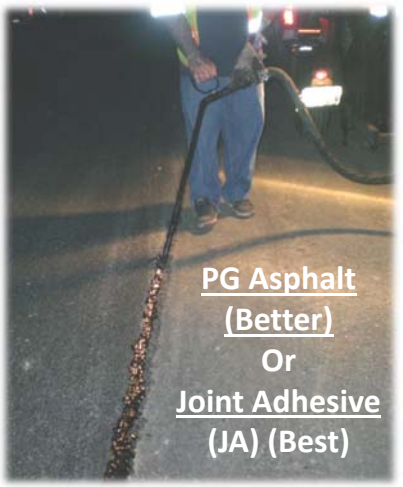
1st Roller Pass Hangs Over 4-6 inches

Compacting Notched Wedge



Sealing Joint (Butt or Wedge)

Emulsion (Good)



Sealing Joint (Butt or Wedge)

Void Reduction Asphalt Membrane

Joint Adhesive

- Polymer Modified Binder
- Mineral Filler
- Heavy duty distributor

Set Paver Automation

Never Starve the Joint of Material

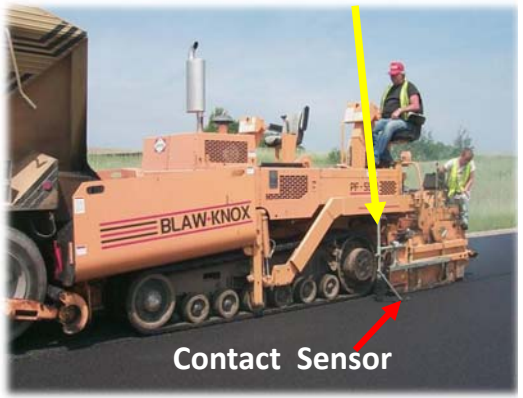
- Target final height difference of +0.1”
  - NH spec requires 1/8” higher
- Joint Matcher versus Ski
  - Best option to ensure exact thickness
- If hot-side is starved of mix
  - Roller “bridges” onto cold mat
  - No further densification occurs

More Joint Matchers

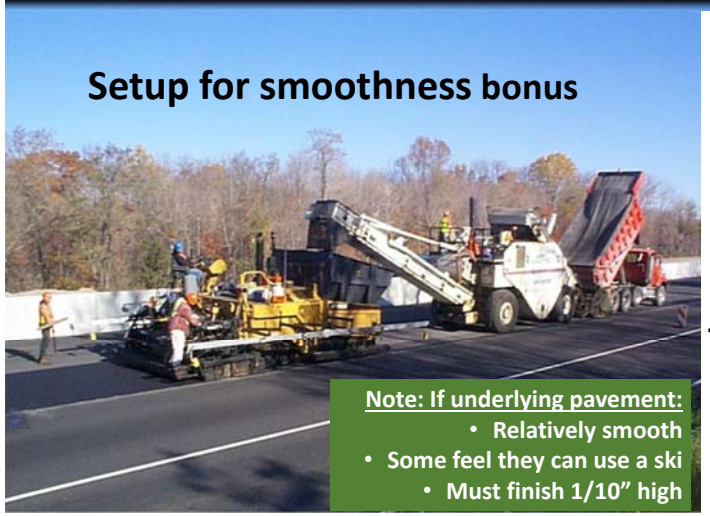
Ultrasonic Sensor

Optimum sensor location:

- Attached to front of screed



Leveling Ski vs Joint Matcher



Leveling Ski:

- On cold side for smoothness
- On hot side to insure bonus

Joint Matcher:

- Used on hot side
- 2nd Pass
- Best for joint

Destined for Failure

Hot side of joint:

- Starved of mix
- Bridging occurred
- Poorly compacted

Proper Overlap:

- 1.0 ± 0.5 inches
- Exception:
  - Milled or
  - Sawed joint
  - Should be 0.5 inches

Do NOT Broadcast Excess Mix

Lute the Longitudinal Joint

Ideal Setup

Rolling the Hot Edge

1st pass all on hot mat approx 6-8 inches

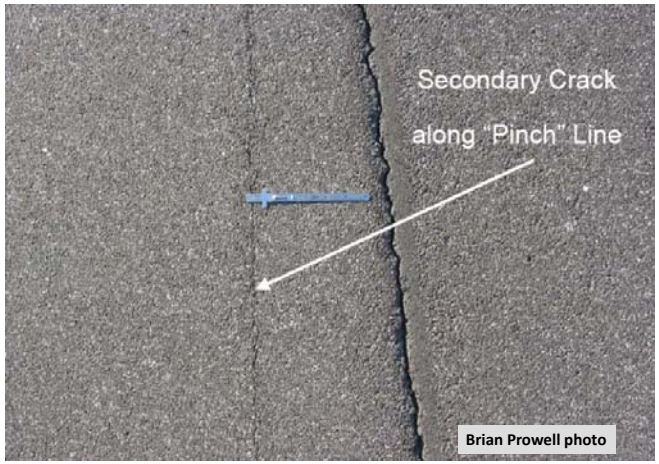
2nd pass overlaps on cold mat 3-6 inches

Still Must Watch for Stress Cracks

Staying off 6" on 1st Pass

Stress cracks at edge of the drum

Potential Problem with Hot Side "Pinch"

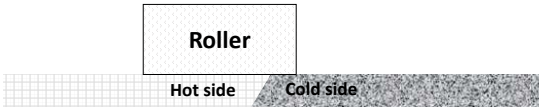


Rolling the Hot Edge

Alternate Method

1st Pass over the confined edge

Roller with edge of drum overhanging 2 to 4-inches on cold side



If insufficient mix on hot side:

- Roller supported by cold mat
- Bridging occurs
- Results in poor compaction

The final pass on a crowned section

GOAL
16 year old surface

I-65 in IN: SR252 to US31

- 12 inches HMA
- Over Rubblized JCP
- Warranty Project

HMA Construction Program

Module 5 – Compaction

1

Learning Objectives

1. Objective of compaction
2. Asphalt concrete properties related to compaction
3. Material and mix properties that affect compaction
4. Types of compaction equipment

2

Learning Objectives

5. Selection of compaction equipment
6. Identify compaction variables
7. Main components of compaction equipment maintenance
8. Calculate roller productivity
9. Describe proper compaction operating procedures

3

How to Manage Asphalt Density

FOR Construction PROS.com

BY JESSICA LOMBARDO – JANUARY 29, 2019

- Training
- Temperature
- Proper Roller & Rolling Pattern
- Communication

4

Definitions

- Density
  - the mass of the material that occupies a certain volume
- Compaction
  - the process through which the asphalt mix is compressed and reduced in volume
    - **Cannot compress the aggregate or the binder**
    - **Volume reduction of the mix is the result of squeezing out the air!**

5

Definitions

- Pass
  - the entire roller moving over one point in the mat one time
- Coverage
  - the roller moving over the entire width of the mat one time

6

Importance of Compaction

- Improve Mechanical Stability
- Improve Resistance to Permanent Deformation
- Reduce Moisture/Air Penetration
- Improve Fatigue Resistance
- Reduce Low-Temperature Cracking Potential

7

Importance Of Compaction

During the construction of HMA, compaction is considered to be <u>the most important factor</u> that contributes to the performance of the pavement.

"Density is not only a top quality indicator, in terms of how long the pavement will last, but it is also a top pay item in most state specifications,"

rollers are the last piece of equipment to touch the mat after it is placed and are the last opportunity to "undo" the smooth mat that the paver has placed

8

Topics

- Factors affecting compaction
- Time available for compaction
- Roller types
- Roller operations
- Roller pattern
- Production rate
- Roller maintenance

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Factors Affecting Compaction

- Properties of the Materials
- Environmental Variables
- Laydown Site Conditions

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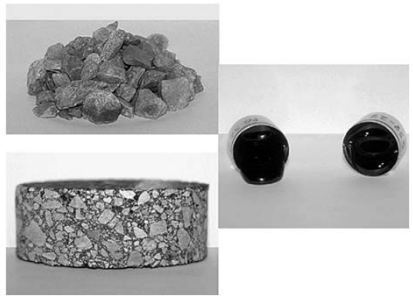
Properties of the Materials



- Aggregate
- Asphalt Binder
- Mix Properties

CAT

Courtesy of Caterpillar Paving Products

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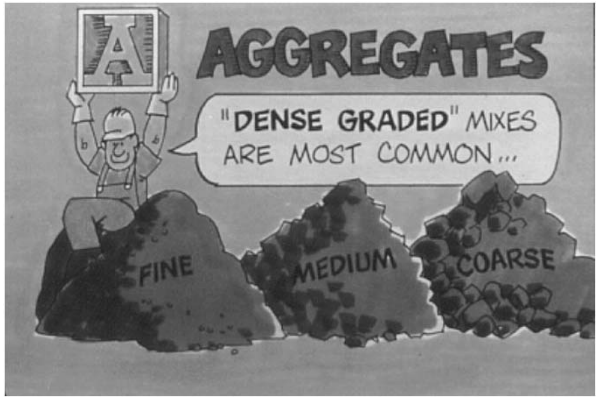

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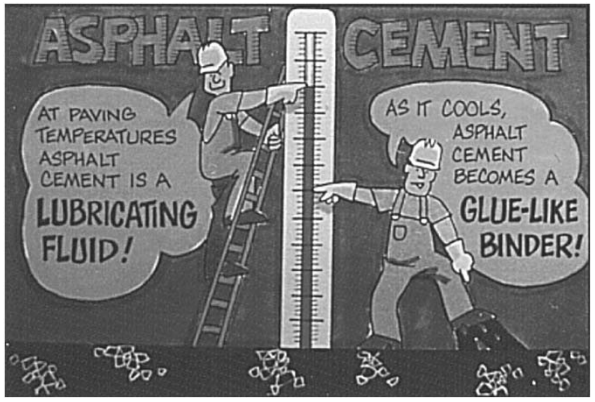
Aggregate Carries the Load

13



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Binder and Compaction

- Asphalt binder holds particles together
  - Provides lubrication at high temperatures
  - Provides cohesion at in-service temperatures
- Prevents air and water intrusion into mat

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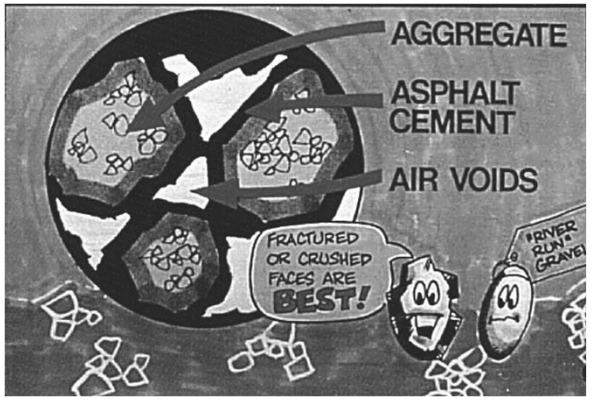
HMA



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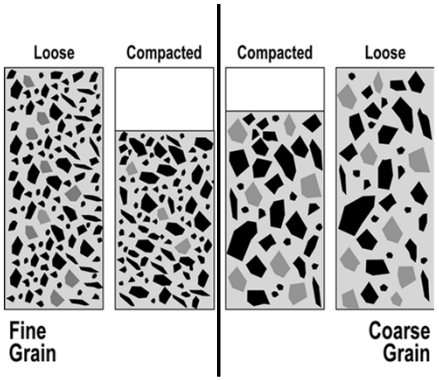
Mix Properties



- Compaction rates vary by mix design
- Adjust placement thickness to match desired compacted mat thickness

CAT

Courtesy of Caterpillar Paving Products

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Mat after Compaction

- 4%-8% theoretical air voids allow for binder expansion
- Aggregates moved closer together
- Provides cohesion, impermeability, and stability

CAT

Courtesy of Caterpillar Paving Products

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Topics

- Factors affecting compaction
- Time available for compaction
- Roller types
- Roller operations
- Roller pattern
- Production rate
- Roller maintenance

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Rate of Cooling Variables

- Layer Thickness
- Air Temperature
- Base Temperature
- Mix Laydown Temperature
- Wind Velocity
- Solar Flux

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Heat = Compaction

- Minimum temperature to achieve final density is 175 F (165 F sometimes)
- In general, an increase of mat thickness by 50% will result in almost twice as much time for compaction
- HMA delivered at 300 F, Air Temp = 40 F, and Surface Temp = 50 F, Clear and Dry, Wind = 5 mph
  - 1.0" cools to 175F in about 8 minutes
  - 1.5" cools to 175F in about 15 minutes

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DOH SPEC 401.10.4

- The required density shall be obtained prior to the mat reaching a temperature of 175F. The contractor shall be allowed to lower this temperature to 165F if they can demonstrate during the first day of placement of each lift on each project that additional densification can be achieved without causing any pavement distress.

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PaveCool

- Actual calculation of pavement cooling times based on job site conditions
- Available FREE

http://www.dot.state.mn.us/app/pavecool/

Download PaveCool 3.0 (EXE 6 MB)

November 2015 (CD available upon request)

PaveCool for Android

PaveCool for iPhone/iPad

PaveCool.exe (save this file to your desktop to run **PaveCool 3.0** without installing it)

System Requirements
Windows XP, Vista, 7, 8 or 10
20 MB disk space

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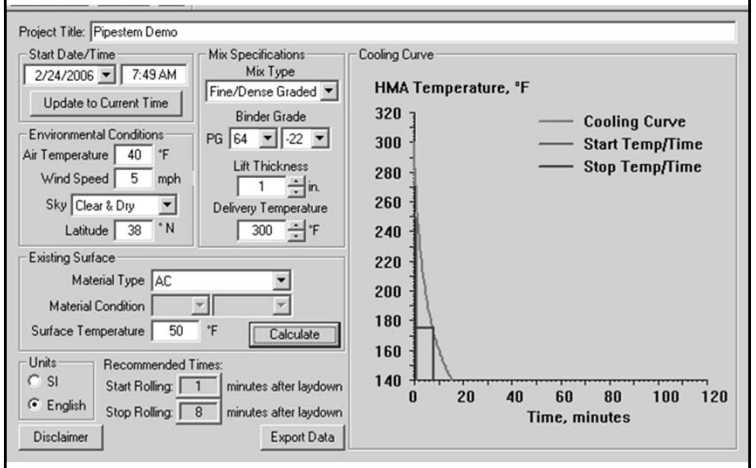

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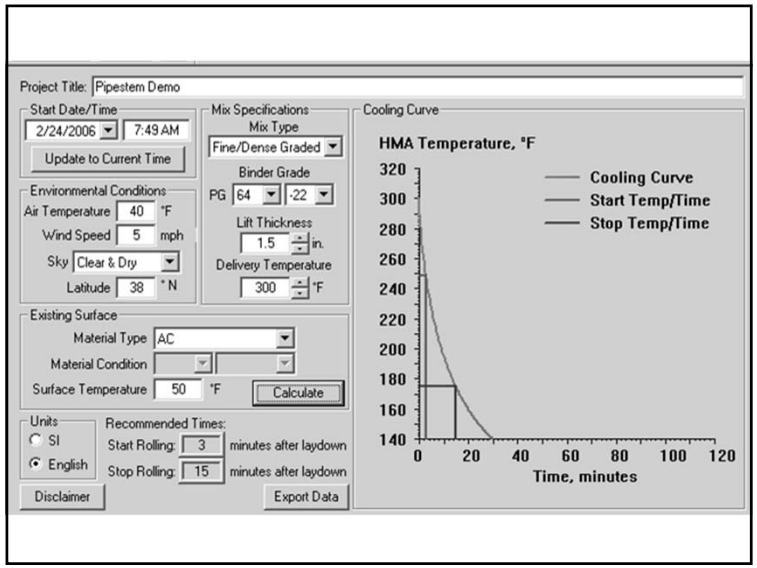

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Major Factors Affecting Rolling Time

FACTORS	To allow MORE time
Mat Thickness	?
Mix Temperature	?
Base Temperature	?

5-26

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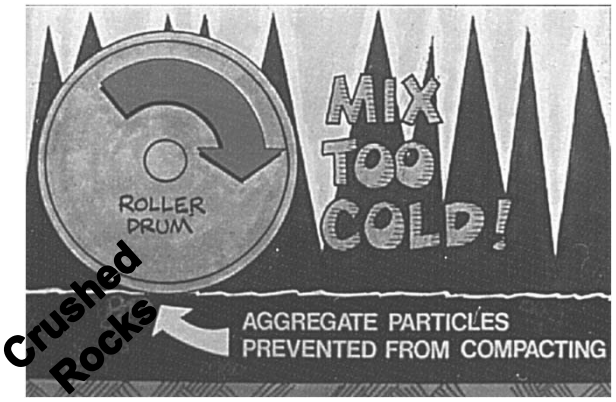

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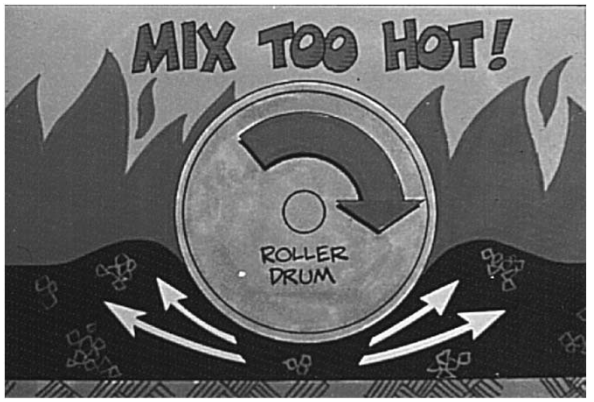

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- **Take Regular Mat Temperature Readings**

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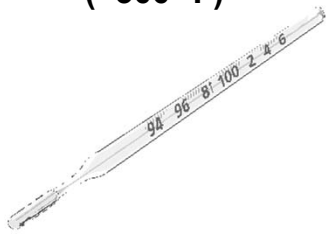
Typical Compaction Temperature Range

80 °C (175 °F) - 150 °C (~300 °F)



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Laydown Site Conditions

- Lift thickness is determined by aggregate size
  - *Marshall ~2x maximum aggregate size*
  - *Superpave ~3x nominal maximum agg. size**
  - Check with design directive 644 for specifics
- Lifts with variable thickness
  - Patch and Leveling
  - Scratch
  - Wedges and other unique conditions

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MARSHALL VS SUPERPAVE

- MARSHALL
- Wearing I
- NMAS 3/8”
- MAS 1/2”
- 2X(1/2) = 1”

- SUPERPAVE
- 9.5 mm
- NMAS 3/8”
- 3*(3/8) = 1 1/8” ➡ **1 ¼”**

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MARSHALL VS SUPERPAVE

- MARSHALL
- Wearing IV
- NMAS 3/4”
- MAS 1”
- 2X(1) = 2”

- SUPERPAVE
- 19 mm
- NMAS 3/4”
- 3*(3/4) = 2 1/4”

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Laydown Site Conditions

- Base/Existing Surface Conditions
  - Oxidized pavement
  - Rutted pavement
  - Cracked pavement
  - Soft and yielding

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Topics

- Factors affecting compaction
- Time available for compaction
- ➢Roller types and stages
- Roller operations
- Roller pattern
- Production rate
- Roller maintenance

35

Types of Rollers

- Static Steel Wheel
- Pneumatic – Rubber Tired
- Vibratory
- Oscillating

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Oscillating Roller I 79 Flatwoods

37

How Do Rollers Compact?

By applying their load
over a given area!

(Contact Pressure)

38

Static Steel Wheel Roller

- Contact Pressure
- Operation

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Static Steel Wheel Roller

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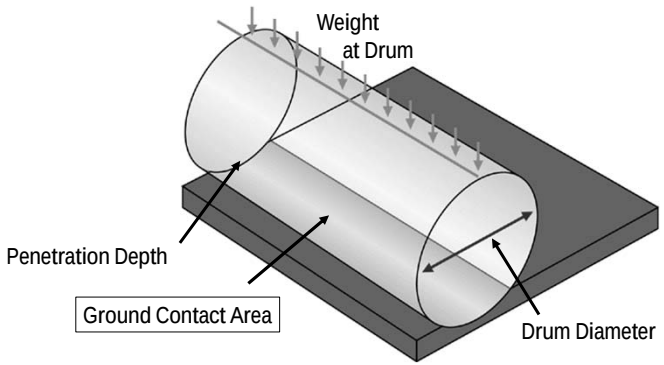
Contact Pressure



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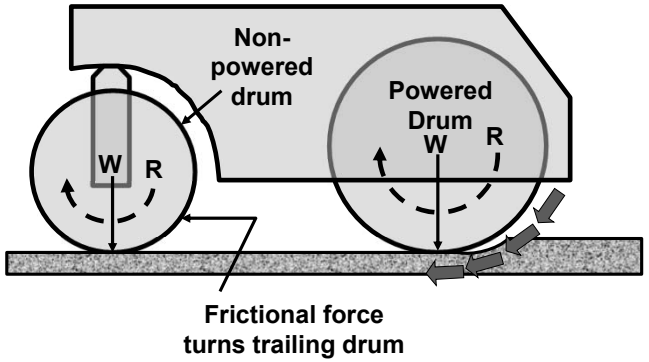
Roller Contact Pressure

Roller Contact Pressure at Varying Penetration Depths for 12 ton Static Roller

Penetration Depth (in)	**3/4”**	**1/2”**	**1/8”**	**1/16”**
Contact Pressure (psi)	**36**	**46**	**88**	**132**

42

Travel



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Pneumatic Tired Rollers

- Wheel load
- Tire design
- Inflation pressure
- Contact area

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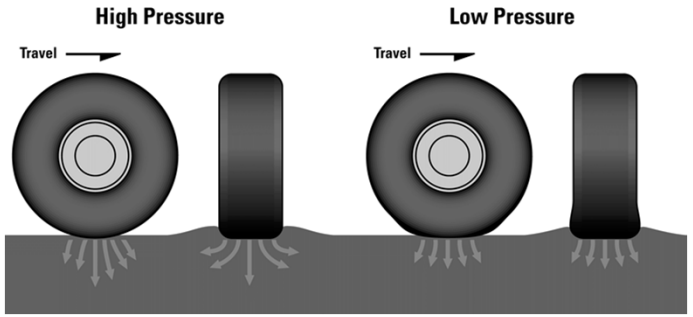
Pneumatic

45

Tire Inflation Pressure Versus Ground Contact Pressure



CAT

Courtesy of Caterpillar Paving Products

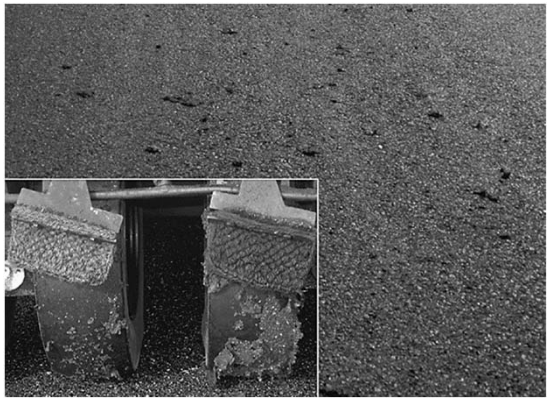
46

Pneumatic Roller I79 Flatwoods

Insufficient heat in the tires!!!

47

Tire Pick Up



48

Skirted Pneumatic Roller

49

Pneumatic Roller Operation

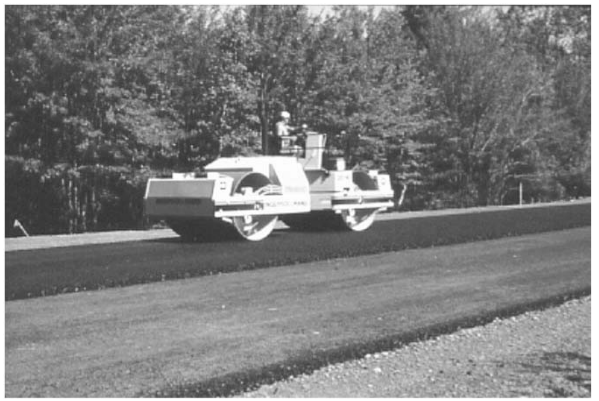
“ideal for uneven courses”

50

Vibratory Roller

51

Single Articulated Frame

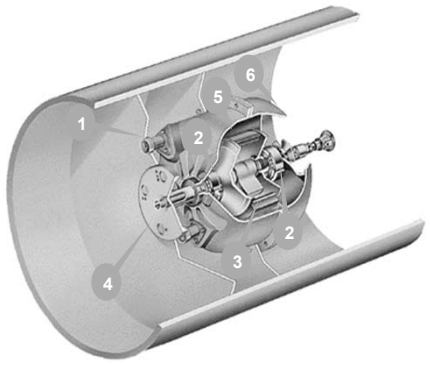


52

Double Articulated Frame

53

Eccentric Weight System



1. Oil level sight gauge
2. Eccentric weight shaft bearings
3. Three-position counterweight
4. Amplitude selection wheel
5. Fixed eccentric weight
6. Pod-style housing

CAT

Courtesy of Caterpillar Paving Products

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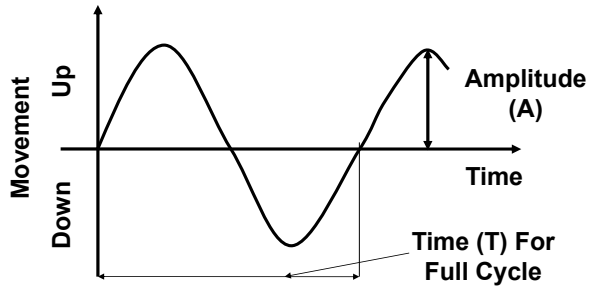
Vibratory Rollers

- Amplitude
- Frequency
- Impact Spacing
- Operation

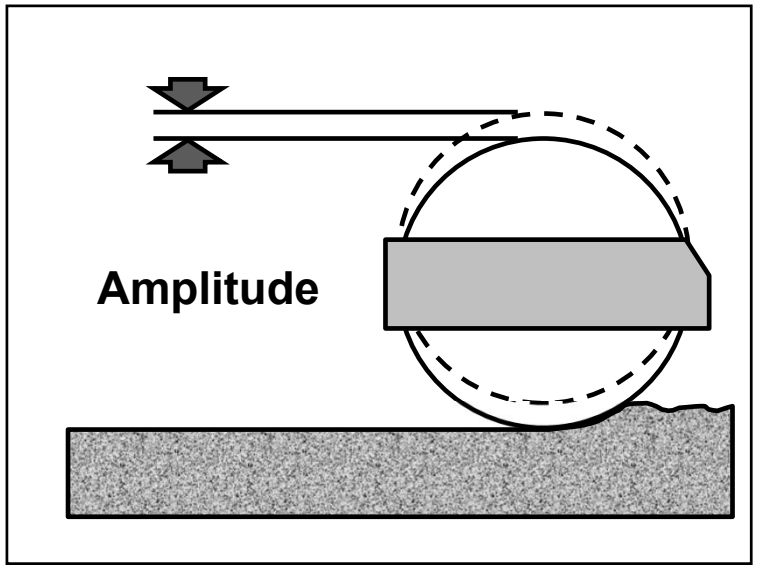
55



Frequency, f = the number of hertz (cycles/s)--a single cycle is one full rotation of the eccentric weight. Frequency = 1/T

Amplitude, A = the maximum deviation from position at rest -- one-half the total movement.

56



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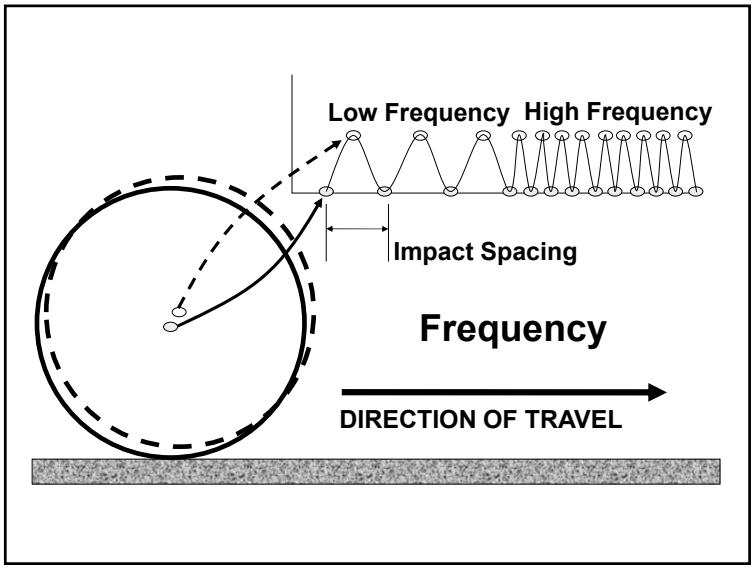

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Typical Data for Vibratory Tandem Rollers

Vibratory Steel Tandem ton	Oper. Wt. lb	Drum Diam. ft	Drum Width ft	Static Drum lb/in	Dynamic Drum lb/in	VPM	Nom. Amp. in
6.0-8.0	14,700	3.6	4.6	130	260	2,900	0.025
9.5-11.0	20,500	3.9	5.6	158	384	2,600	0.03
> 13.0	30,000	4.9	6.9	186	423	2,400	0.03

Increase due to vibration

59

Impact Spacing

- Ideal is 10-12 impacts per foot

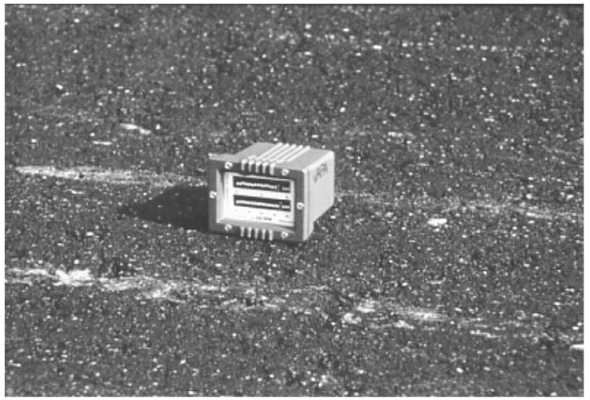
60

Example

- 2900 Vibrations (impacts) per minute
- 11 impacts/ft
- Determine speed of roller

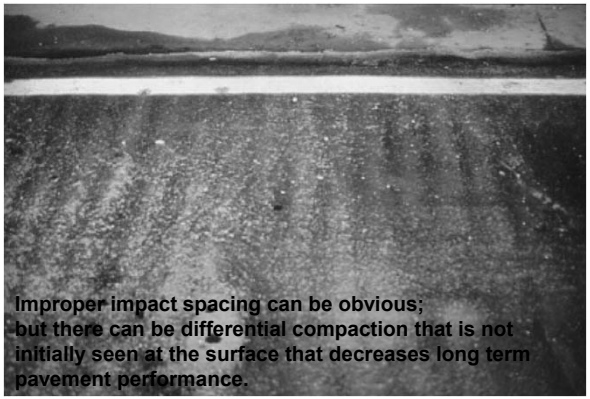
61

Reed Tachometer



62

Improper Impact Spacing



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Topics

- Factors affecting compaction
- Time available for compaction
- Roller types
- ➢ Roller operations
- Roller pattern
- Production rate
- Roller maintenance

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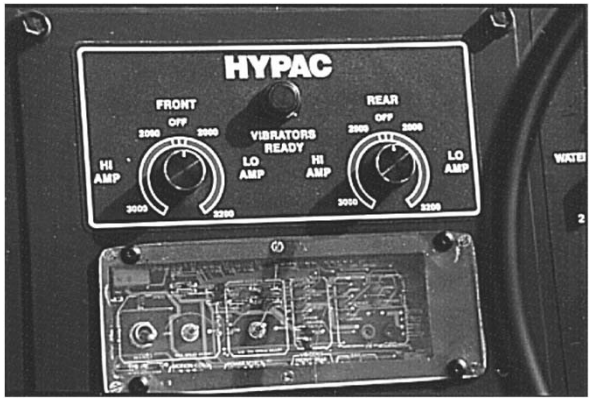
Roller Operator Controls

- Speed
- Starts & Stops
- Pattern
- Amplitude
- Frequency
- Distance to paver

65

Roller Controls



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Compaction Variables

- Roller Speed
- Number of Coverages
  - Pass - the entire roller moving over one point in the mat one time
  - Coverage - the roller moving over the entire width of the mat one time
- Rolling Zone
- Rolling Pattern

67

Stages Of Rolling

- ✓ Breakdown Rolling - Where most of the actual densification is achieved
- ✓ Intermediate Rolling - Where a small amount of additional density is achieved *(needed when breakdown rolling does not provide sufficient density)*
- ✓ Finish Rolling - Used to remove roller marks and finish the surface *(Very little additional densification is achieved)*

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Breakdown Rolling

- Determine the rolling zone by:
  - Experience
  - Estimating
- Should be completed before the surface temperature of the mix falls below 240° F.
- Operated at the highest possible frequency
- Amplitude setting that is dependent on the thickness of the asphalt concrete

https://www.forconstructionpros.com/asphalt/article/12188306/how-to-compact-asphalt-pavements

69

Intermediate Rolling

Temperature between 240°F to 190°F
Completion of density gain.

Vibratory or pneumatic rollers

70

Finish Rolling

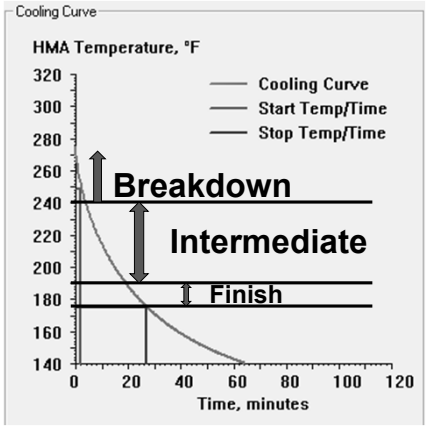
- Finish rolling normally takes place within a temperature range of 185°F down to 175°F (165°F).
- Static steel-wheel finish roller
- Marks from other rollers can be removed from the surface of the layer without adding new marks by the finish roller itself.
- Finish rolling for a stable mix is accomplished at higher temperatures than finish rolling for a tender mix.

CAT *Courtesy of Caterpillar Paving Products*

https://www.roadsbridges.com/compacting-hot-mix-asphalt-pavements-part-ii

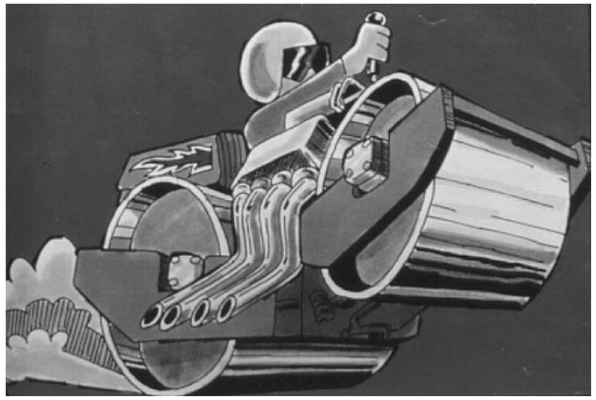
71

Approximate temperatures for stages of rolling



72

Speed



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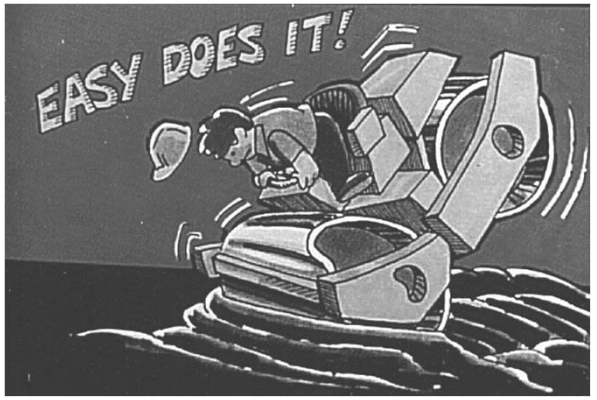
Stopping



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Typical Range of Roller Speeds (mi/hour)

Type of Roller	*Breakdown*	*Intermediate*	*Finish*
Static Steel Wheel	**2.0 to 3.5**	**2.5 to 4**	**3.0 to 5.0**
Pneumatic	**2.0 to 3.5**	**2.5 to 6.4**	**4.0 to 7.0**
Vibratory	**2.0 to 3.0**	**2.5 to 3.5**	**-------**

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Topics

- Factors affecting compaction
- Time available for compaction
- Roller types
- Roller operations
  - ➢ Roller pattern
- Production rate
- Roller maintenance

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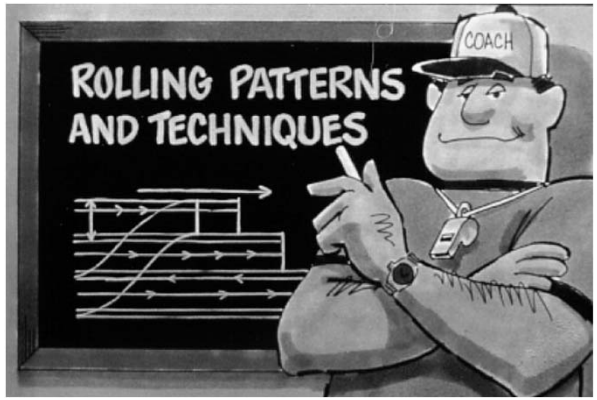

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Roller Widths

CAT Courtesy of Caterpillar Paving Products

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Paving Widths

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Passes and Coverage

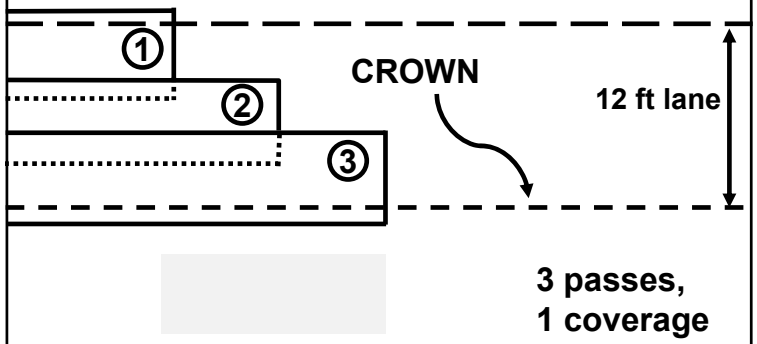
Each time the roller goes over a specific point is ONE PASS.

Paving widths are greater than roller width so more than one pass is required to complete a COVERAGE across a pavement.

How many passes of the roller are needed to cover the width of the mat one time ?

80

One Roller Coverage



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Operating Techniques

- Test Strip Construction
- Establishing Roller Patterns
- Breakdown Rolling
- Intermediate Rolling
- Finish Rolling
- Re-watering
- Concluding Operations

82

Test Strip Construction

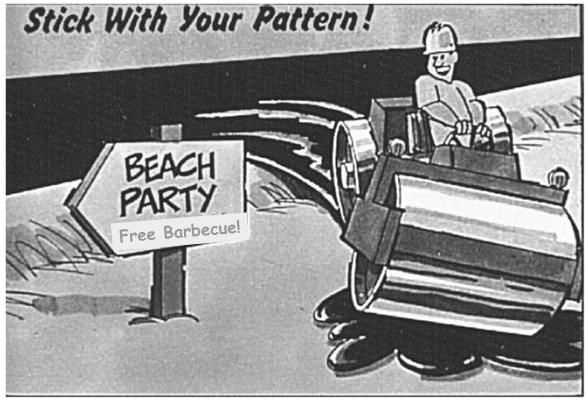
- Simulating Actual Conditions
- Establishing Roller Patterns
- Calculating Effective Roller Speed

83

Establishing Roller Pattern

- Selecting Compaction Equipment
- Width of Paving
- Width of Roller
- Number of Coverages Needed
- Nuclear Gauge

84



85

Roller Types by Application

Breakdown Rolling

Static (tons)	Pneumatic (Wheel Size)	Vibratory (tons)
8.0 to 10.5	20 in rim	10 to 11
8.0 to 12.0	24 in rim	> 12.5
10 to 7		6 to 8

Pneumatic can be used for breakdown of tender mixes but the start temperature should be lower.

86

Roller Types by Application

Intermediate Rolling

Static (tons)	Pneumatic (Wheel Size)	Vibratory (tons)
8 to 12	15 in rim	6 to 8
10 to 14	20 in rim	10 to 11
	24 in rim	> 12.5

87

Roller Types by Application

Finish Rolling

Static (tons)	Vibratory (tons) Static Mode
8 to 10.5	6 to 8
8 to 12	10 to 11
10 to 14	> 12.5

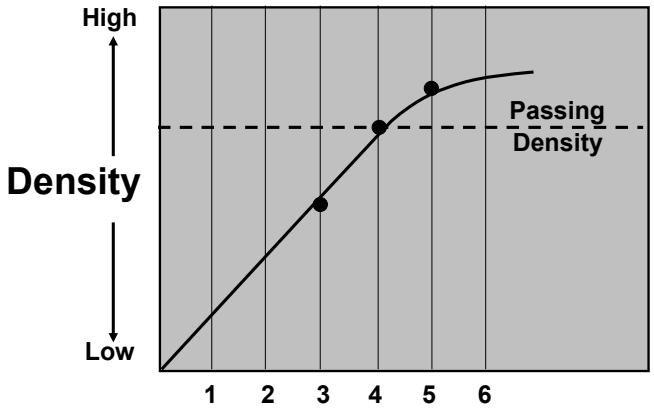
88

How Many Repeat Passes to Assure Density?

89

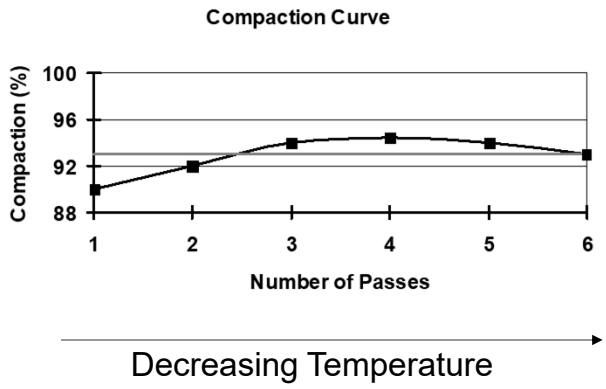
Checking Density

90



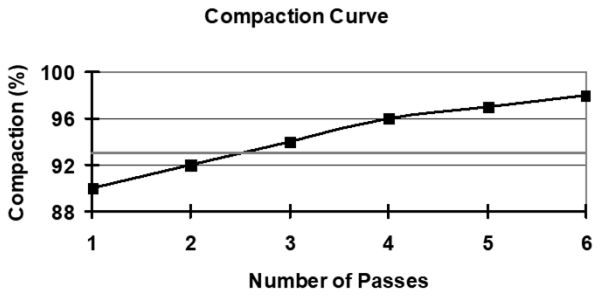
91

Roller Pattern Problem #1



92

Roller Pattern Problem #2



Decreasing Temperature

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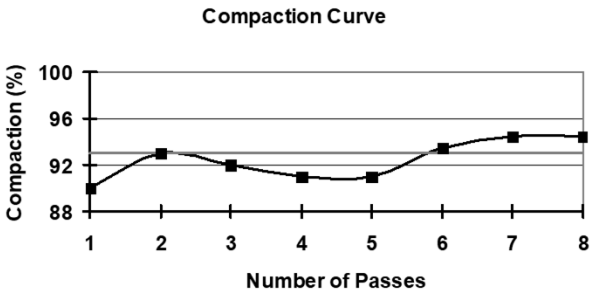
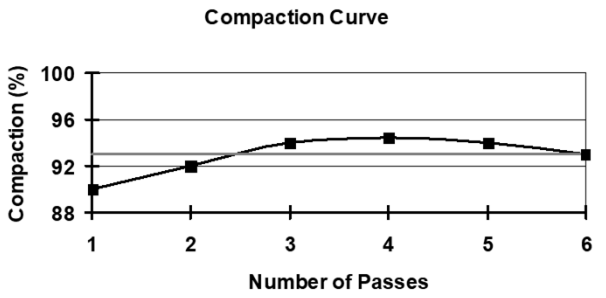
Roller Pattern Problem #3



Decreasing Temperature

94

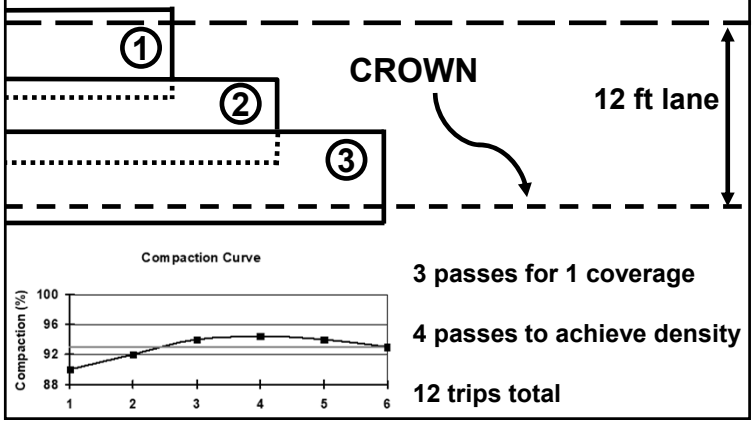
Roller Pattern Problem #1



Decreasing Temperature

95

One Roller Coverage



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Temperature Gauges

97

Interior Temperature

98

Improper Gauge Usage

99

Coring

100

Topics

- Factors affecting compaction
- Time available for compaction
- Roller types
- Roller operations
- Roller pattern
- Production rate
- Roller maintenance

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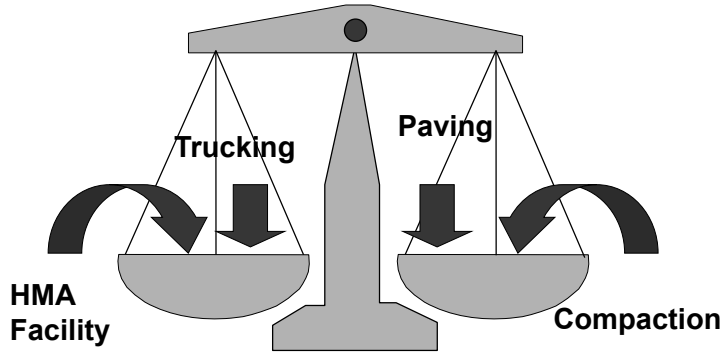
Balancing Production



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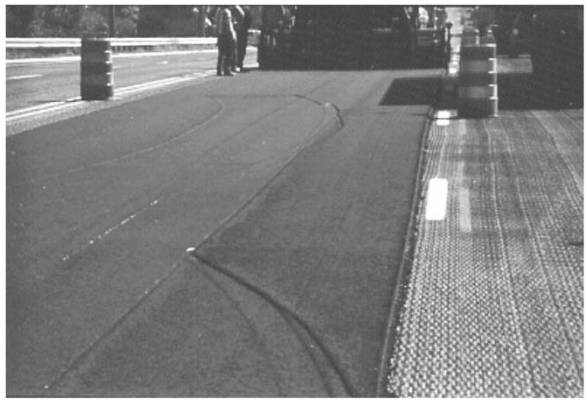
Rolling Zone



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Calculating Your Rolling Zone (Vibratory roller)

- Estimate roller speed using frequency and impacts per foot:
  - Frequency = 2800 vpm
  - 12 impacts per foot
  - Roller speed = 2800/12 = 233.3 fpm (2.7 mph)
- Adjust for reversing factor
  - Roller speed*(1-reverse factor/100)
  - 13% reverse factor
- Effective roller speed = 233.3*(1-13/100) = 203 fpm

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Calculating Your Rolling Zone

- Effective roller speed = 203 fpm
- Effective Compaction Rate =
  - Effective roller speed/(number of passes per coverage)
  - Number of passes for coverage
    - **3 passes to cover**
    - **3 coverages for density**
    - **9 total passes**
  - Adjust for roller efficiency
    - **Roller efficiency = 63%**
- Effective compaction rate = 203/9*(63/100) = 14.2 fpm

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Calculating Your Rolling Zone

- Roller rate = 14.2 fpm
- Time available for compaction (TAC)
  - From Environmental Variables chart
  - Or PaveCool
  - Example: 10 minutes
    - **2 in thick mat**
    - **mix temperature of 250 °F**
    - **base temperature of 50 °F.**
- Rolling zone
- Roller rate x TAC = 14.2 fpm X 10 minutes = 142 ft

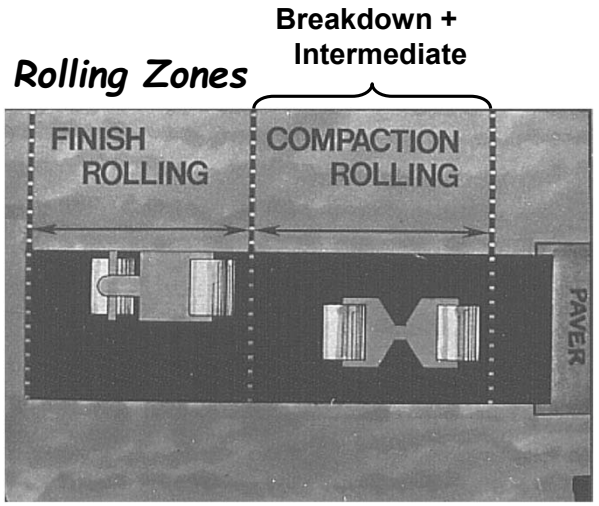
106

Balancing the paving example

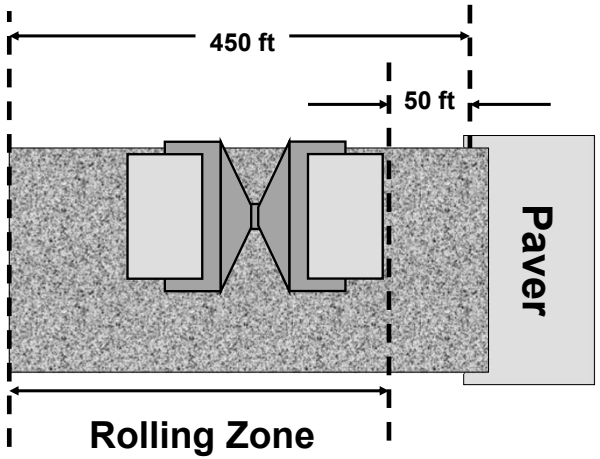
- A roller rate of 14.2 fpm would control the productivity of the paving operation
- This is a low production speed and is probably not acceptable.
- What can be done???

107

Rolling Zones



108



(Conventional HMA)

109

Roller Production Rate Problem

Spreadsheet for balancing production

MIX DELIVERY RATE			PAVING RATE			ROLLING RATE		
Plant Rate Avail.	300	tph	Paving Width	12	feet	VPM (highest)	2800	vpm
Total Mix	3000	tons	Paving Thickness	3	inches	Impacts/foot (10-12)	10	impacts/ft
Total Paving Time	10	hours	Reference Density	159.5	pcf	Reverse factor (10%)	10	%
Mix Rate							1.0	fpm
OK?							1.0	fpm
Truck Ca							84	inches
Total Trip							6	inches
Prep/Wa							50	feet
Load Tin							2	
Ticket/Ta							3	
Haul Tin							7	
Wait @ J							53	%
Dump/clean	5	min.				Roller Rate	22.7	fpm
Return Haul	25	min.				Rolling Zone	200	
Truck Cycle	1.17	hours/trip				Time Elapsed	8.8	
# of Loads	8	loads/truck						
# of Trucks	25	trucks						
OK?	Exactly enough trucks							

	Paver	Roller	
Production Rate (fpm)	22.7	22.7	**STOP!! - Whoa Pete!**
Production Rate (sq.yd/hr)	1817	1814	**Paver's outrunning Roller**

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Topics

- Factors affecting compaction
- Time available for compaction
- Roller types
- Roller operations
- Roller pattern
- Production rate
- Roller maintenance

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Roller Maintenance

- Water Systems
- Hydraulic Systems
- Mechanical Systems
- Vibratory Systems
- Rolls, Tires, Pads, Scrapers

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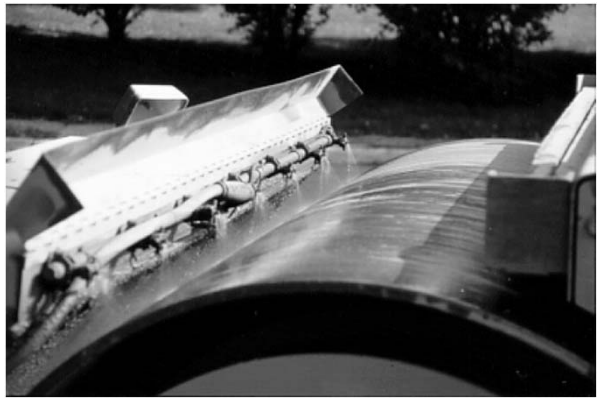
Water Spray Bar



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Pads

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Poor Maintenance

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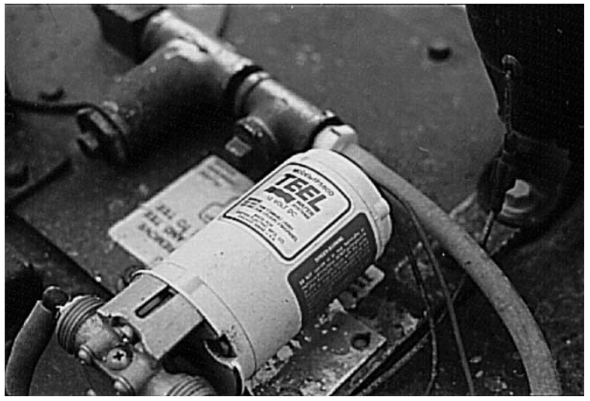
Water Pump



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Maintenance Chart

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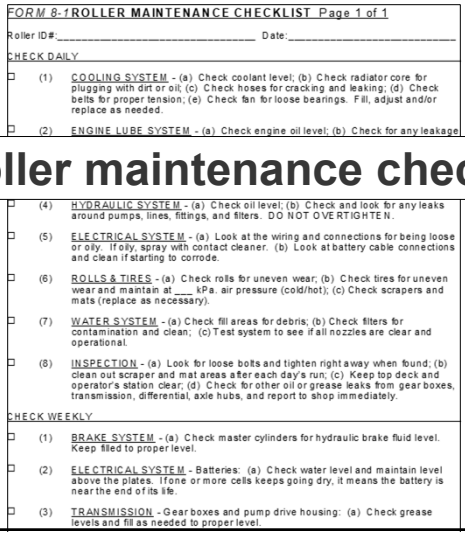

FORM 8-1 ROLLER MAINTENANCE CHECKLIST Page 1 of 1

Roller ID#:_____ Date:_____

CHECK DAILY

☐ (1) COOLING SYSTEM - (a) Check coolant level; (b) Check radiator core for plugging with dirt or oil; (c) Check hoses for cracking and leaking; (d) Check belts for proper tension; (e) Check fan for loose bearings. Fill, adjust and/or replace as needed.

☐ (2) ENGINE LUBE SYSTEM - (a) Check engine oil level; (b) Check for any leakage

☐ (4) HYDRAULIC SYSTEM - (a) Check oil level; (b) Check and look for any leaks around pumps, lines, fittings, and filters. DO NOT OVERTIGHTEN.

☐ (5) ELECTRICAL SYSTEM - (a) Look at the wiring and connections for being loose or oily. If oily, spray with contact cleaner. (b) Look at battery cable connections and clean if starting to corrode.

☐ (6) ROLLS & TIRES - (a) Check rolls for uneven wear; (b) Check tires for uneven wear and maintain at ___ kPa. air pressure (cold/hot); (c) Check scrapers and mats (replace as necessary).

☐ (7) WATER SYSTEM - (a) Check fill areas for debris; (b) Check filters for contamination and clean; (c) Test system to see if all nozzles are clear and operational.

☐ (8) INSPECTION - (a) Look for loose bolts and tighten right away when found; (b) clean out scraper and mat areas after each day's run; (c) Keep top deck and operator's station clear; (d) Check for other oil or grease leaks from gear boxes, transmission, differential, axle hubs, and report to shop immediately.

CHECK WEEKLY

☐ (1) BRAKE SYSTEM - (a) Check master cylinders for hydraulic brake fluid level. Keep filled to proper level.

☐ (2) ELECTRICAL SYSTEM - Batteries: (a) Check water level and maintain level above the plates. If one or more cells keeps going dry, it means the battery is near the end of its life.

☐ (3) TRANSMISSION - Gear boxes and pump drive housing: (a) Check grease levels and fill as needed to proper level.

Roller maintenance checklist

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Summary notes

- Maintaining proper speed
  - Roller speed has one of the greatest influences on mat quality.
    - too slow can over compact the surface
    - too fast can leave gaps and compromise safety if the operator gets too close to the paver

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Summary notes cont'd

- Maintaining proper speed
  - Roller speed has one of the greatest influences on mat quality.
    - Using the correct speed will also help to maintain the appropriate impact spacing to prevent washboarding. For most jobs, correct spacing is between 10 and 12 impacts per foot.
    - Even if the washboarding isn't readily seen at the time the road is paved, over time, it increases its affect because of the way the asphalt continues to compact

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Summary notes cont'd

- Temperature
  - Cannot improve the density of cold matts!!!
  - Breakdown >240F
  - Intermediate 240 – 190
  - Finish 190 – 175 (165)

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Summary notes cont'd

- Good vibrations
- Vibratory compaction creates shock waves that compact from the bottom up
- Static compaction works from the top down.
- Most jobs use a combination of compaction modes,
  - start with vibratory compaction
  - finishing with static
- Select the right amplitude
  - amplitude settings are determined by the depth of the lift
    - **Lower amplitude settings are recommended for lifts of 2 in. or less;**
    - **higher amplitude settings should be used for deeper lifts.**

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Summary notes cont'd

- Follow the rolling pattern
  - Gradual turns
  - Gradual acceleration and breaking
- Always stop at an angle to the direction of paving

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Finally

"The single most important thing you can do to a pavement is compact it."

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Opening to Traffic

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INSPECTOR'S DUTIES - ASPHALT PAVING

Modified by WVDOH, APAWV, and WVU ATP

Work Includes…

- **Resurfacing Projects**
  - State Funded
  - Federal Funded
  - Purchase Order Paving
  - Bond Projects (Roadway Reconstruction)
- **New Projects**
  - New Roads
  - Bridge Approaches
  - Road Widening
  - Intersection Improvements
  - Bond Projects (Construction)

Funding Programs

- ***Federal Aid Funding (National Highway System)***
  - Interstate
  - APD
  - Federal Aid Other
    - US routes
    - State NHS routes
- ***State Funding***
  - **SLS** – State and Local service Routes (County Routes)
  - Non-NHS State Routes

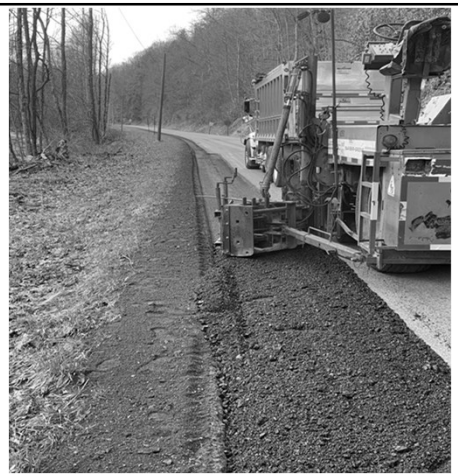
Inspector duties vary depending on the funding program, route, compaction method

Basic HMA Applications

- **Base Course** – stone or HMA course placed above the subgrade or subbase of a road and helps to further distribute the load and improve the overall structure of the pavement section.
  - Marshall Base 1 and 2
  - Superpave Base 37.5, 25 and 19
- **Wearing Course** – a single lift of constant thickness that is to be placed over the entire pavement surface and serves as the riding surface, receives the highest concentration of stress.
  - Marshall Wearing 1, 3, and 4
  - Superpave 4.75, 9 and 12.5

Basic HMA Applications

- **Patch & Level (P&L)** – placed at various locations throughout the project to remove irregularities in the existing pavement, such as dips, or to raise the outside edge of pavement to improve the template prior to placing a base or wearing course.
- **Scratch Course** – a leveling course used for deviations less than an inch and can be placed over the entire length of the project.



Edge Failure Repairs

1” thin overlay

1.5” Overlay with paved shoulders

Activities Prior to and during Construction…

- Bond and Insurance Checked – Issue NTP
- All Requested Pertinent Paperwork
  - Key Personnel
  - EEO
  - DBE Plan for Participation
  - Waste and/or Borrow Pit Agreements (SHPO)
  - Pollution and Erosion Control Plan
  - QC Plan - Available? Approved?

Resurfacing Inspector may be requested to verify these items on the project.

Activities Prior to Construction…

- Construction Layout
  - Staking the project
  - Mark Heel-ins
  - On larger projects this is usually included in contract
- Maintenance Finished?
  - Have all pipes been placed, ditches pulled, mowed, etc
- Verify Quantities In plans with Actual Field Measurements.

Activities Prior to Construction…

Activities Throughout the Project…

Activities Throughout the Project…

Activities Throughout the Project…

Activities Throughout the Project…

Activities Throughout the Project…

Activities Throughout the Project…

Activities Throughout the Project…

Activities Throughout the Project…

HMA Inspector's Requirements

- Generally needs to be trained in all aspects of materials and construction
  - Hot-mix Asphalt
  - PCC
  - Soils and Compaction
  - Environmental
  - Traffic Control
- **However, it is not a good idea to serve as the inspector and the Compaction Tech, etc.**

HMA Inspector's Requirements

- Must have an understanding of the entire paving operation
  - Plant Operations
  - Hauling Limitations
    - Bridge Postings
    - Truck weights
  - Paving Equipment
    - Paver (Screed)
    - Rollers

HMA Inspector's Requirements

- HMA Inspector has the same general duties regarding execution of the contract, but they do not have a field office. All forms, typicals, specs, etc. are kept in the "mobile field office."
- Good Inspector can visualize the entire job from beginning to end
  - Foresee contract issues ahead of time so that a plan of attack can be implemented right away

HMA Inspector's Requirements

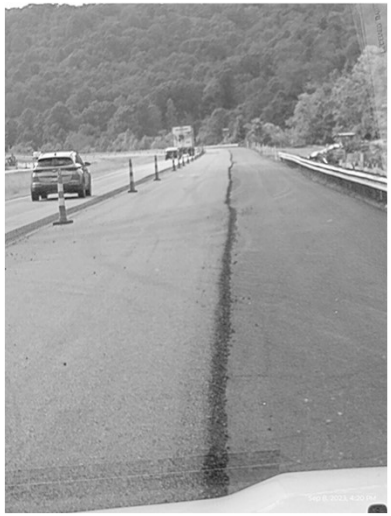
- Materials and the JMF – Job Mix Formula (Approved Mix Design)
  - Temperature Range established for the mix
  - Maintain communication with the plant inspector regarding other properties as well
    - Max Density
    - Lab Number
  - All mix designs are "Verified" at the beginning of each season

Good Workmanship

Proper Edge

What you don't want to see

What you don't want to see



Night Work

- More work is being done during night hours than in the past
  - Especially in congested areas on major routes
  - Everything is more difficult to inspect at night
- Challenge the inspector faces is much greater
- Cooler temperatures can be a killer on compaction

Night Work

Contractor's Requirements

- Contractor should have an overall paving plan including…
  - Production Rate
  - Haul Distance
  - Number of Trucks
- Properly staffed paving crew
  - Paving operator
  - Screed person
  - Broom
  - Compaction
  - Laborers

Contractor's Requirements

- On-site QC technician
  - Fully understands the process of density compliance and the operation of a nuclear gauge
    - Do they know the difference between "Lot-by-lot" and "Rollerpass" testing?
    - Are they capable of implementing the thin lift correction factors properly?
  - *Field Sampling Requirements for PWL*
  - Good technician understands the limitations of the JMF and has a general understanding of the nature of the specific mix

Activities Prior to Construction (the day of paving)…

- Traffic Control Check – need to maintain a good flow of traffic but maintain a *SAFE WORKZONE*.
  - Check all arrow boards and message boards, Type B lights
  - Make sure flaggers understand the scope of traffic
  - Remember *Night-time* Limitations
- Check Heel-ins
- Check surface conditions
- Tack Distributor – good condition
- Other Equipment?

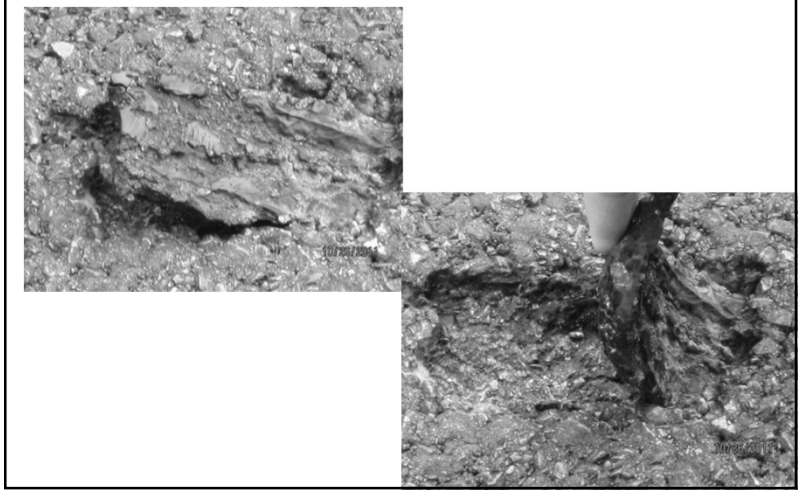
Activities Prior To and During Construction

- Check traffic control
- Check ground and air temperatures
- Check delivery tickets for correct Mix Design, Materials, and Project Number
- Check HMA temperature in the truck
- Check the depth of HMA as being placed

Inspector's Daily Duties…

- Collect tickets – JMF# and target density, truck weights
- Verify Rollerpass or Lot-by-lot
- Observe mix characteristics – mat texture, segregation, flushing, contamination (*Night-time!*)
- Mat - screed setting and mat thickness
- Paver must maintain a constant head of flow
  - Best to stop and start quickly

Contamination!!!



Contamination!!!

Issues Caught During Construction Can Be Corrected

Inspector Daily Duties…

- Be on the project from before work begins to after everything is off the road for the day.
- Get with the contractor's foreman at the end of the day to agree on quantities and hours.
- Document any changes made on project in your DWR whether big or small and note if someone authorized the changes.

Inspector Daily Duties…

- Throughout day check flagger placement and pilot truck return times to keep traffic flowing as smooth as possible.
- Document any issues that come up during the day on your DWR. Issues might not seem important at the time but could be something major down the road.

Inspector's Daily Duties…

- Is compaction being done properly and are density readings acceptable
- Application rates at minimum 2500' intervals
- Placement of temporary tape and temporary markings as needed/required
- Throughout day check your Traffic Control to make sure signs are kept up in proper work zone specifications

Inspector Daily Duties

- Most flagging subcontractors have sheets to sign daily for their time, if not make sure you talk to the one in charge of the crew to let them know their hours for the day.
- Keep a notebook for yourself of quantities placed daily to easily reference back to on project.
- Get DWR submitted daily!

Inspectors Office Duties

- Check payrolls for contracts to verify correct pay.
- Initiate change orders for projects
- Make sure all samples taken and approved sources are entered in Site Manager
- Correct mistakes on DWR in a timely manner so estimates can be run.

HMA Approximate Rate and Lift Thickness

- 1.0” Compacted = 110 PSY
- 1.5” Compacted = 165 PSY
- 2.0” Compacted = 220 PSY

Verifying Quantities

- Given: A Two Lane Road is 1 mile long, has an average width of 28’, 1.5” Overlay. How many Tons per lane of HMA?

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- Given: A Two Lane Road is 1 mile long, has an average width of 28’, 1.5” Overlay. How many Tons per lane of HMA?
  - Convert miles to Lineal Ft (1 mile x 5280 ft/mi)
    = 5,280 FT (End Station would be 52+80)

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- 147,840 sq. ft / 9 = 16,426.67 SY

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- 147,840 sq. ft / 9 = 16,426.67 SY
  - $\frac{16{,}426.67 \text{ SY} \times 165 \text{ PSY}}{2000 \text{ LB/TN}}$
  - = 1,355.2 TN

Verifying Quantities

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  - $\frac{16{,}426.67 \text{ SY} \times 165 \text{ PSY}}{2000 \text{ LB/TN}}$
  - = 1,355.2 TN
  - ANSWER = 1,355.2 TN / 2 lanes = 677.6 TN per lane

After Project Completion

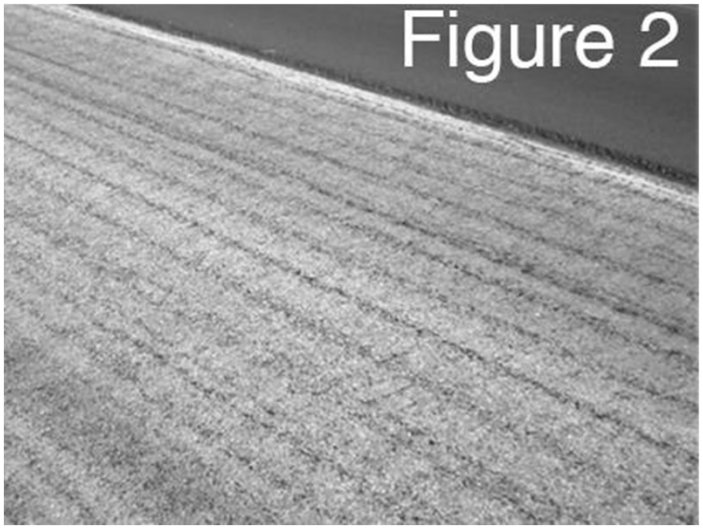
- Verify all payrolls are received and checked for compliance.
- Get final paperwork done in a timely manner.
- Get Over/under change order ready to be processed.
- Make sure any outstanding change orders are paid when they complete the process.

What is the Proper Rate for Tack?

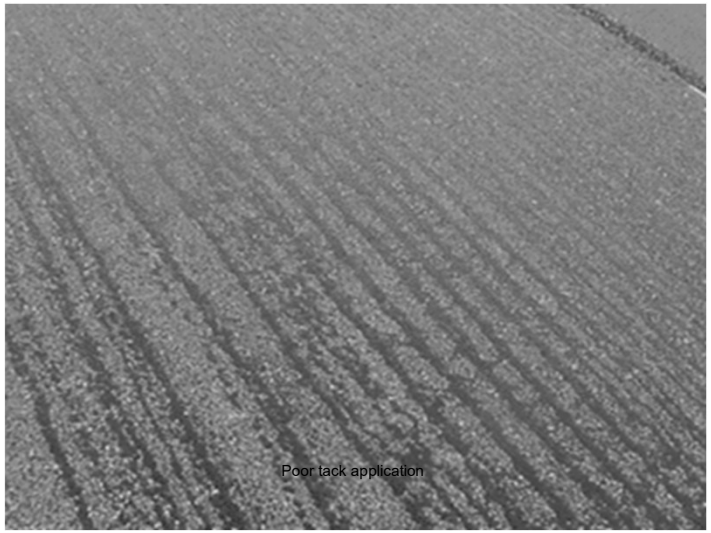
What is the Proper Rate for Tack?

- Tack Coat Specification
  - Gives guidance regarding “break” and “set”
  - Discusses rate of dilution
  - Shows a table with application rates based on paving surface
- We want to achieve a *desirable* “residual” asphalt content
- How do you calculate tack application rate?

Good Tack Application



Poor tack application



Is this a good coat?

TABLE 408.11

Condition of Existing Pavement	Application Rate (gal/sy) (Note 2)	
	Undiluted	Diluted (1:1) (Note 3)
New HMA (Note 4)	0.04 – 0.05	0.08 – 0.10
Oxidized HMA	0.07 – 0.10	0.13 – 0.20
Milled Surface	0.10 – 0.13	0.20 – 0.27
PC Concrete	0.07 – 0.10	0.13 – 0.20

Note 2: Application rates are for slow setting emulsions grades (SS and CSS) that contain approximately 60% asphalt material. Rapid setting emulsion grades may contain slightly higher or lower asphalt contents, but can usually be applied within the same application range.

Note 3: Dilution rate only applies to SS and CSS grades.

Note 4: Tack coat is normally not needed over a layer of new HMA that has been placed within the last few days, as long as the underlying new layer has not become dirty under traffic or from windblown dust.

Example Tack Calculation

- Existing roadway is very old, dried, cracked, etc. – “Oxidized” from Table 408.11
- Prior to tack placement, dial gauge reads 450 gallons. Tack is diluted.
- Tack is placed from Sta. 0+00 to Sta. 10+00. Dial gauge reads 275 gallons after tack placement.
- Road width is an average of 12’.

Example Tack Calculation

TABLE 408.11

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408.12 METHOD OF MEASUREMENT:

No materials shall be removed from the Project for any purpose until the operation has been completed and the quantities of materials incorporated into the operations have been determined, except when authorized by the Engineer.

The quantity of “Asphalt Material” for tack coat shall be the number of gallons, prior to dilution, incorporated into the completed work. Any applicable dilution rates, shall be supplied to the Engineer by the Contractor on the material delivery ticket.

Dry sand or stone chips used as a blotter course due to excessive use of tack coat shall be considered incidental to the work.

When items for maintaining traffic are included in the Contract, they will be measured and paid as provided in Section 636.

Example Tack Calculation

- Calculate the tack used
  PAY QTY. = 450 gal – 275 gal = <u>175 GALLONS</u>

- LETS CHECK THE APPLICATION RATE:
  – (12’ x 1000’) ÷ 9 ft^2 per yd^2 = 1333.33 yd^2
- Calculate Rate of Application
  – 175 gal ÷ 1333.33 yd^2 = ***0.13 gal/yd^2***

TABLE 408.11

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	Undiluted	Diluted (1:1) (Note 3)
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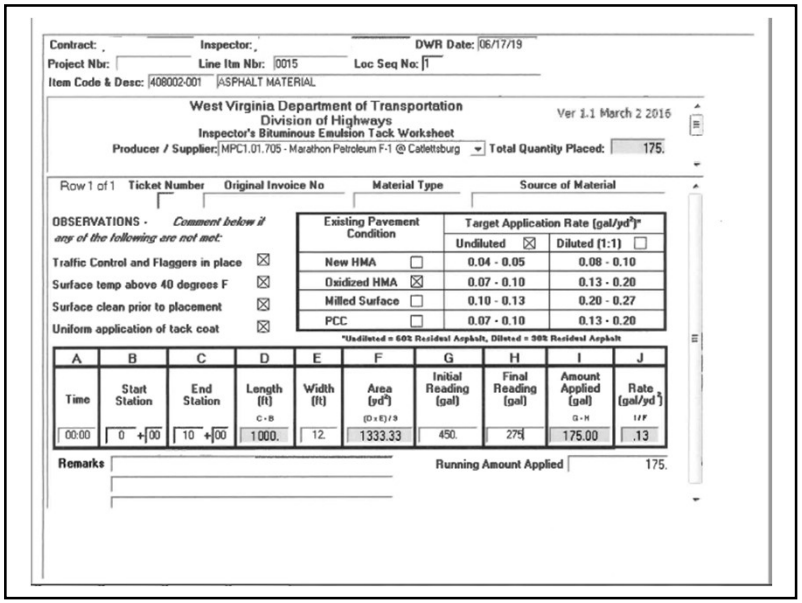

Contract: , Inspector: , DWR Date: 06/17/19
Project Nbr: , Line Itm Nbr: 0015, Loc Seq No: 1
Item Code & Desc: 408002-001 ASPHALT MATERIAL

West Virginia Department of Transportation
Division of Highways
Inspector's Bituminous Emulsion Tack Worksheet
Ver 1.1 March 2 2016

Producer / Supplier: MPC1.01.705 - Marathon Petroleum F-1 @ Catlettsburg, Total Quantity Placed: 175.

Row 1 of 1 | Ticket Number | Original Invoice No | Material Type | Source of Material

OBSERVATIONS - *Comment below if any of the following are not met:*
- Traffic Control and Flaggers in place ☒
- Surface temp above 40 degrees F ☒
- Surface clean prior to placement ☒
- Uniform application of tack coat ☒

Existing Pavement Condition	Target Application Rate (gal/yd²)* Undiluted ☒	Diluted (1:1) ☐
New HMA ☐	0.04 - 0.05	0.08 - 0.10
Oxidized HMA ☒	0.07 - 0.10	0.13 - 0.20
Milled Surface ☐	0.10 - 0.13	0.20 - 0.27
PCC ☐	0.07 - 0.10	0.13 - 0.20

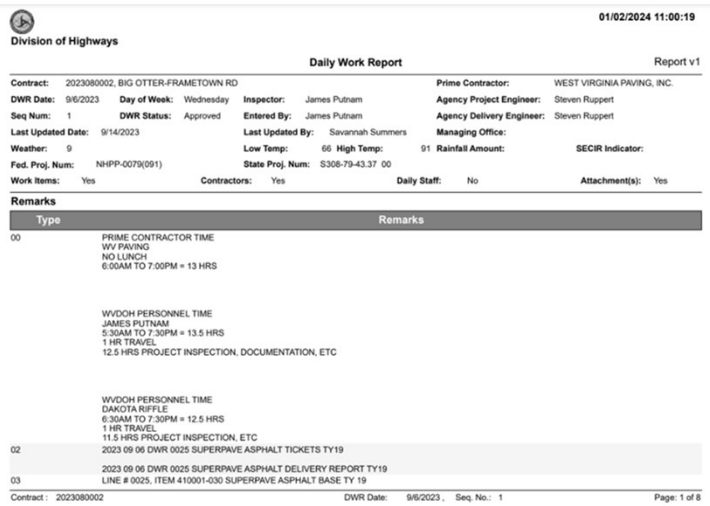
*Undiluted = 60% Residual Asphalt, Diluted = 30% Residual Asphalt

A	B	C	D	E	F	G	H	I	J
Time	Start Station	End Station	Length (ft) C - B	Width (ft)	Area (yd²) (D x E) / 9	Initial Reading (gal)	Final Reading (gal)	Amount Applied (gal) G - H	Rate (gal/yd²) I / F
00:00	0 +00	10 +00	1000.	12.	1333.33	450.	275	175.00	.13

Remarks

Running Amount Applied 175.

EXAMPLE DWR ENTRY


01/02/2024 11:00:19
Division of Highways

Daily Work Report — Report v1

Contract: 2023080002, BIG OTTER-FRAMETOWN RD — Prime Contractor: WEST VIRGINIA PAVING, INC.
DWR Date: 9/6/2023 — Day of Week: Wednesday — Inspector: James Putnam — Agency Project Engineer: Steven Ruppert
Seq Num: 1 — DWR Status: Approved — Entered By: James Putnam — Agency Delivery Engineer: Steven Ruppert
Last Updated Date: 9/14/2023 — Last Updated By: Savannah Summers — Managing Office:
Weather: 9 — Low Temp: 66 High Temp: 91 — Rainfall Amount: — SECIR Indicator:
Fed. Proj. Num: NHPP-0079(091) — State Proj. Num: S308-79-43.37 00
Work Items: Yes — Contractors: Yes — Daily Staff: No — Attachment(s): Yes

Remarks

Type	Remarks
00	PRIME CONTRACTOR TIME WV PAVING NO LUNCH 6:00AM TO 7:00PM = 13 HRS WVDOH PERSONNEL TIME JAMES PUTNAM 5:30AM TO 7:30PM = 13.5 HRS 1 HR TRAVEL 12.5 HRS PROJECT INSPECTION, DOCUMENTATION, ETC WVDOH PERSONNEL TIME DAKOTA RIFFLE 6:30AM TO 7:30PM = 12.5 HRS 1 HR TRAVEL 11.5 HRS PROJECT INSPECTION, ETC
02	2023 09 06 DWR 0025 SUPERPAVE ASPHALT TICKETS TY19 2023 09 06 DWR 0025 SUPERPAVE ASPHALT DELIVERY REPORT TY19
03	LINE # 0025, ITEM 410001-030 SUPERPAVE ASPHALT BASE TY 19

Contract: 2023080002 — DWR Date: 9/6/2023, Seq. No.: 1 — Page: 1 of 8

01/02/2024 11:00:19

Division of Highways

Daily Work Report Report v1

Item Postings

Item Description	Item ID	Seq. Num	Cont Ln	Project	Category	Proj Ln	Quantity Posted	Unit	From Station - To Station Location
SUPERPAVE ASPHALT BASE CRSE, TY 19	410001-030	1	0025	2023080002	0001	0025		SY	BIG OTTER FRAMETOWN RD PROJECT

Materials:

Material Name	Installed Quantity	Unit	Source	Work Location
19 mm Asphalt Mix, Superpave		TN		

Contractor: WEST VIRGINIA PAVING, INC.

Comments: PAY FOR THIS ITEM WILL BE MADE AT A LATER DATE ON COMPLETION OF PWL SAMPLE TESTING.

AT THE FOLLOWING LOCATIONS, THE CONTRACTOR USES A TRANSFER MACHINE AND A RUBBER TIRE PAVER TO PLACE ASPHALT BASE FOLLOWED BY 3 STEEL DRUM ROLLERS FOR COMPACTION. TERRADON TECHNICIAN, JUSTIN WHITTINGTON, ON SITE FOR DENSITY. WV PAVING, JAMEY PROPPS ON SITE FOR PWL CORE DRILLING. WVDOH TECHNICIAN DAVID SCHOOLCRAFT ON SITE.

(PAYMENT WILL BE REQUESTED FOR A 12FT LANE)

SB SLOW LANE
2611+75 TO 2596+70 = 1505
EQUALITY
2595+78 TO 2516+35 = 7943

1505 + 7943 = 9448

((9,448 X 12 = 113,376) / 9 = 12,597.333)

NB SLOW LANE
2516+35 TO 2522+80 = 645

((645 X 12 = 7,740) / 9 = 860)

12,597.333 + 860 = 13,457.333 SY

01/02/2024 11:00:19

Division of Highways

Daily Work Report Report v1

PAY QUANTITY = 0 SY

TRAFFIC CONTROL DEVICE	636011-001	1	0140	2023080002	0001	0140	0	UN	BIG OTTER FRAMETOWN RD PROJECT

Materials:

Material Name	Installed Quantity	Unit	Source	Work Location
Traffic Control Devices	0	EA		

Contractor: HIGHWAY SAFETY, INC.

Comments: ALL TRAFFIC CONTROL DEVICES ARE PROPERLY LOCATED THROUGHOUT THE PROJECT. THE SIGNS ARE CLEAN, LEGIBLE, AND CLEARLY VISIBLE. SPEED TRAILERS AND ARROW BOARDS ARE ALSO UTILIZED IN EACH LANE AS PART OF THE REQUIRED SPECIFICATIONS FOR THE TRAFFIC CONTROL SET UP AS LISTED PER THE PLAN SHEET. REFER TO THE DAILY CHECK LIST FOR ADDITIONAL INFORMATION.

PAY QUANTITY = 0 UN

TRAFFIC DIRECTOR	636014-002	1	0155	2023080002	0001	0155	11.5	HR	BIG OTTER FRAMETOWN RD PROJECT

Materials:

Material Name	Installed Quantity	Unit	Source	Work Location

Contractor: WEST VIRGINIA PAVING, INC.

Comments: CONTRACTOR USES A TRAFFIC DIRECTOR ON THIS DATE FOR THE SAFETY OF THE TRAVELING PUBLIC. PATROL VEHICLE FOLLOWED THE OPERATIONS THROUGHOUT THE PROJECT AS PER THE CONTRACTOR'S REQUEST. THE OFFICER ON DUTY THIS DATE IS BRIAN YOUNG.

HOURS ON SITE 7:00AM TO 6:30PM = 11.5 HRS

PAY QUANTITY = 11.5 HR

ELECTRIC ARROW	636021-001	1	0160	2023080002	0001	0160	2	DA	BIG OTTER FRAMETOWN RD PROJECT

Materials:

Material Name	Installed Quantity	Unit	Source	Work Location

01/02/2024 11:00:19

Division of Highways

Daily Work Report Report v1

Comments: CONTRACTOR UTILIZES 32 TYPE B WARNING LIGHTS. ALL TYPE B WARNING LIGHTS ARE PLACED PROPERLY. ALL TYPE B LIGHTS ARE ON AND WORKING PROPERLY. AS PER THE PLANS, B LIGHT PAYMENT WILL BE REQUESTED FOR PLACEMENT ON ROAD WORK 2 MILES SIGNS, ROAD WORK 1 MILE SIGNS, AND 55 MPH SIGNS.

ALL B-LIGHTS ARE WORKING THIS DATE

PAY QUANTITY = 32 DA

SHADOW VEHICLE	636028-002	1	0175	2023080002	0001	0175		MO	BIG OTTER FRAMETOWN RD PROJECT

Materials:

Material Name	Installed Quantity	Unit	Source	Work Location

Contractor: WEST VIRGINIA PAVING, INC.

Comments: CONTRACTOR UTILIZES A SHADOW VEHICLE WHILE PERFORMING WORK. I PREVIOUSLY ADVISED WV PAVING TO HAVE THE SHADOW VEHICLE SET UP TO MEET SPECIFICATIONS LISTED IN THE STANDARD DETAILS. THE SHADOW VEHICLE HAS BEEN EQUIPPED WITH FLASHING BEACONS AND A TRUCK MOUNTED ATTENUATOR. SPOKE WITH VERN WALKER, WV PAVING, ABOUT HAVING 2 SHADOW VEHICLES ON THE PROJECT WHEN PROJECT SCHEDULED FOR 1 AS PER THE PLANS. WV PAVING AGREED HAVING PAYMENT FOR THE USE OF 1 UNLESS 2 BECOMES NEEDED. ONLY 1 IS BEING UTILIZED AT THIS TIME.

PUT IN SERVICE ON 07/25/2023. NEXT PAYMENT REQUEST 9/25/2023

PAY QUANTITY = 0 MO

SPEED MONITORING TRAILER	636030-001	1	0180	2023080002	0001	0180	2	DA	BIG OTTER FRAMETOWN RD PROJECT

Materials:

Material Name	Installed Quantity	Unit	Source	Work Location
Traffic Control Devices	0	EA		

Contractor: HIGHWAY SAFETY, INC.

Comments: THERE ARE 2 SPEED MONITORING TRAILERS PLACE ON THIS PROJECT. ONE PLACED ON THE SB SIDE OF THE PROJECT AND ONE ON THE NB SIDE OF

WEST VIRGINIA DEPARTMENT OF TRANSPORTATION
DIVISION OF HIGHWAYS
INSPECTOR'S ASPHALT PAVEMENT WORKSHEET

AUTH NO: _____ PROJECT NO: _____ IDR NO: _____
LINE NO: _____ ITEM NO: _____ DATE: _____

LOAD	TICKET #	TONS / MG	CUM. TOTAL	LOAD	TICKET #	TONS / MG	CUM. TOTAL
1				25			
2				26			
3				27			
4				28			
5				29			
6				30			
7				31			
8				32			
9				33			
10				34			
11				35			
12				36			
13				37			
14				38			
15				39			
16				40			
17				41			
18				42			
19				43			
20				44			
21				45			
22				46			
23				47			
24				48			

REMARKS: _____

TOTAL Tons (Mg) THIS DATE: _____ INSPECTOR: _____
Signature

ROLLER PASS DATA _____ PCF SPEED OF ROLLER _____ MPH TYPE OF ROLLER _____
ROLLER PASS DATA _____ PCF SPEED OF ROLLER _____ MPH TYPE OF ROLLER _____
PLAN THICKNESS _____

CALCULATION OF APPLICATION RATE (ONE CALCULATION PER EACH 762 m (2500 LF))

BEGIN STATION						
END STATION						
WIDTH						
Gm (SY)						
Mg (TONS)						
Mg/Gm (LB/SY)						

OBSERVED SIMILARITY TESTS (ONE OBSERVATION PER EACH 305 m (1000 LF))

LOT NUMBER						
TEST NUMBER						
Mg/CH (LB/CY)						
STATION						

MAT THICKNESS (PRIOR TO COMPACTION) & MAT TEMPERATURE (AT TIME OF FINAL COMPACTION PASS) CHECKS (ONE CHECK PER 305 m (1000 LF))

TIME						
MAT TEMPERATURE						
MAT THICKNESS						
STATION						

TIME						
MAT TEMPERATURE						
MAT THICKNESS						
STATION						

ROLLER SPEED CHECKS (FOUR CHECKS - TWO AM AND TWO PM)

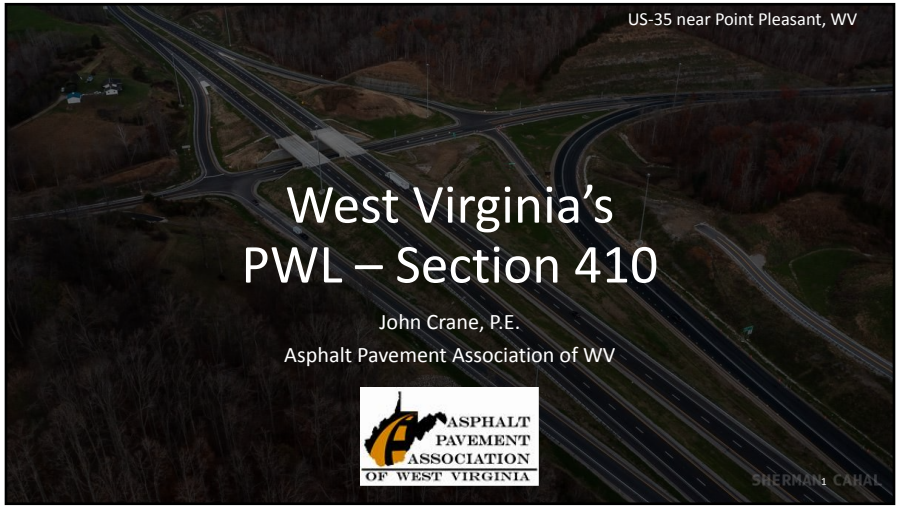
TIME						
ROLLER SPEED						

CHECKS ☐ VERIFIED PRIOR TO PLACEMENT CHECKS ☐ VERIFIED DURING PLACEMENT

- ☐ SEQUENCE OF OPERATION VERIFIED
- ☐ TRAFFIC CONTROL DEVICES AND FLAGGERS IN PLACE
- ☐ MILL-IN JOINTS CUT AND POTHOLES CORRECTED
- ☐ SURFACE CLEAN AND STRINGLINE PLACED
- ☐ ROLLER(S) AND PAVER(S) VERIFIED FOR COMPLIANCE
- ☐ CONTRACTORS DENSITY TECHNICIAN ON SITE
- ☐ LONGITUDAL JOINTS PINCHED / NO OVERLAPPED
- ☐ TRUCKS COVERED AND INSULATED WITH NO OIL LEAKS OR DAMAGED SIDES
- ☐ OPERATION CONTINUOUS AND PAVER SPEED COMPATIBLE TO PLANT PRODUCTION
- ☐ VIBRATING SCREED ON AND TEXTURE OF MAT CORRECT
- ☐ CORRECT ROLLING SEQUENCE BEING USED
- ☐ STRAIGHT EDGE CHECKS BEING MADE
- ☐ COMPLIANCE WITH QUALITY CONTROL PLAN MAINTAINED
- ☐ TEMPERATURE OF MATERIAL RECORDED ON TICKETS ONCE PER HOUR MINIMUM

AIR TEMP ____ °C (°F) AT (TIME) ____ BASE TEMP ____ °C (°F) AT TIME ____
AIR TEMP ____ °C (°F) AT (TIME) ____ BASE TEMP ____ °C (°F) AT TIME ____

At the end of the day we want the same result.

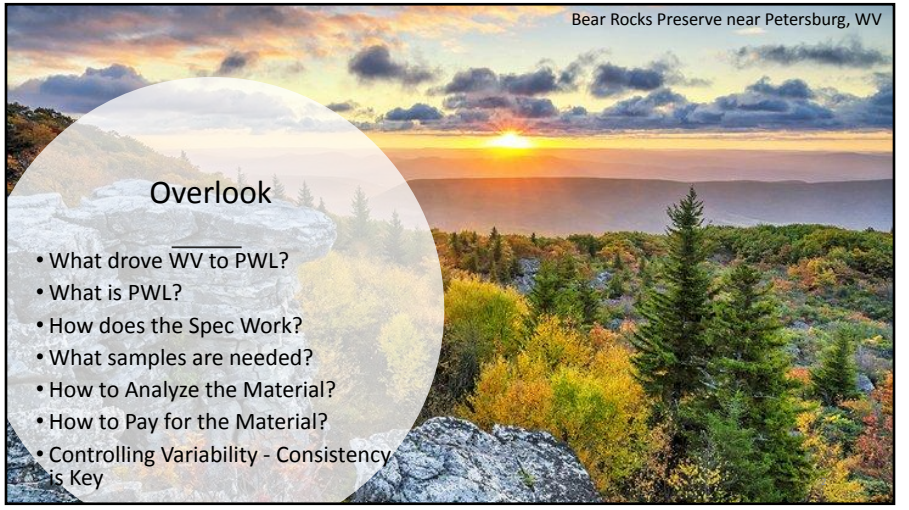


West Virginia's PWL – Section 410

John Crane, P.E.
Asphalt Pavement Association of WV

ASPHALT PAVEMENT ASSOCIATION OF WEST VIRGINIA

SHERMAN1 CAHAL



Overlook

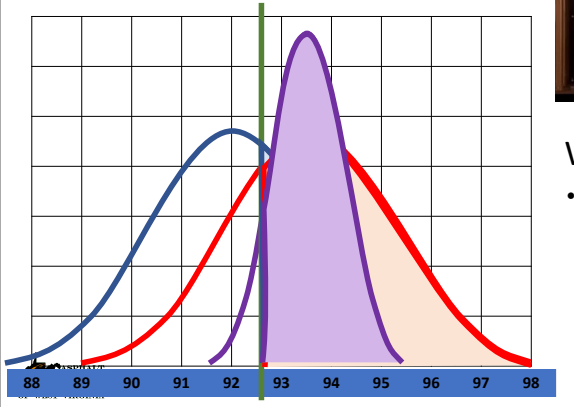
- What drove WV to PWL?
- What is PWL?
- How does the Spec Work?
- What samples are needed?
- How to Analyze the Material?
- How to Pay for the Material?
- Controlling Variability - Consistency is Key

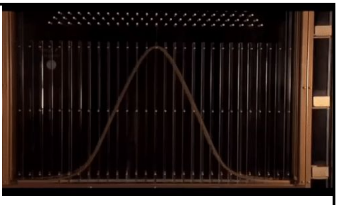
Why West Virginia Changed their specs?

- Poor performing pavements with ineffective specification to combat issues
- FHWA's ~2011 Stewardship Review
  - Improve QA/QC procedures
  - Higher focus on DOH performing Acceptance testing of Materials
- DOH was investigating ways of achieve higher performing, longer lasting roadways
  - F&T testing
  - Standard Deviation Driven
  - Percent within Limitation (PWL)

3

Normal Distribution





What is PWL?

- The statistical method of determining the amount of material that is within the pre-established characteristic boundary(ies)

4

Lets have some fun with statistics!

Why did WV go with PWL?

- Desired a more robust methods to Evaluate Overall Quality
- WVDOH's standard Asphalt QC/QA was based on moving average
  - Straight Average and Moving Average is not the best measure of quality
  - Lacks enforcement to stay on Target
- WVDOH wanted to focus on end results Specification drawing data from the field
  - Materials properties along with Mat and Joint Density
- Promote consistency throughout the project

PWL Paving – WV Overview

- This is the Method of QA for NHS routes and above
- Material samples are taken from the roadway
  - Asphalt Content / Gradation / Mat Density / Joint Density /Bond Strength / Thickness
- PWL statistical analysis
  - Based on average, standard deviation, and specified limits
  - Theoretical percentage of all data that is statistically within the overall specification limits
  - Not just an average or a moving average
- Pay Factors are established
- Payment is by the SY, not by the Ton
  - Eliminates the need for change orders and over runs

What's **required** and What's not Quality Control (QC)

- Plant
  - Volumetric Mixture Control – Air Void, VMA, Asphalt Content, Gradation
    - Per tonnage basis – 1000-ton sublot (750 tons during mixture verification)
  - Samples must satisfy single sample tolerance and moving average tolerance
- Field
  - None*

What's required and What's not? Quality Assurance (QA)

- The WVDOH does all the Acceptance testing
- Field Sampled – 2500-ton Lots w/ 5 sublots
  - Thickness – Cores
  - Density Mat – Cores
  - Bond Strength – Cores
  - Asphalt Content – Loose Mix
  - Gradation(Dust Content) – Loose Mix
- Density Joint – Cores 10,000 FT Lot w/ 5 sublots
- Inspection @ Plant
  - Minimal involvement

Test	Limits
Asphalt Content	JMF ± 0.4%
Gradation (-%200)	JMF ± 2.0%
Density	91.5 – 97.0% G_{mm}
Joint Density	> 89.0% G_{mm}
Bond Strength	> 100 psi
Thickness	Design – 0.04"

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PWL Paving – Loose Mix Samples

- Sampling Location
  - "Loose Mix" sample behind the paver for Pay
  - Still truck samples for plant QC/QA
  - https://www.youtube.com/watch?v=ITZeDmYojuM
  - https://www.youtube.com/watch?v=to8C-iesXkY

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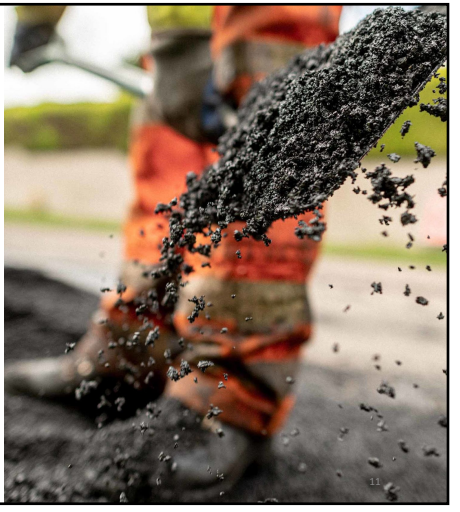
PWL – Asphalt & Dust Content

- All materials arriving on the project are expected to be **quality** and stay **consistent**.
- Importance of Asphalt and Dust
- Asphalt and Gradations tests are performed in the lab
- Statistical Evaluation



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PWL Paving – Core Samples

- Must use a 6-inch Core bit – **Inside Diameter**
- Cores are used to determine
  - In-place Density
  - Bond Strength
  - In-place Thickness
- Care should be taken to ensure the viability of the core
  - Drill as deep as reasonable possible
  - Do not pry or push on the layer to be tested.

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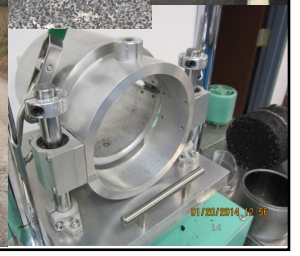
PWL Paving – Density Analysis

- Mat and Longitudinal Joint Evaluations
- Coring the finished pavement
- No field density testing is required
  - Still a good Practice for QC
  - Can use non-nuclear
- Density tests in the lab
- Statistical Evaluation

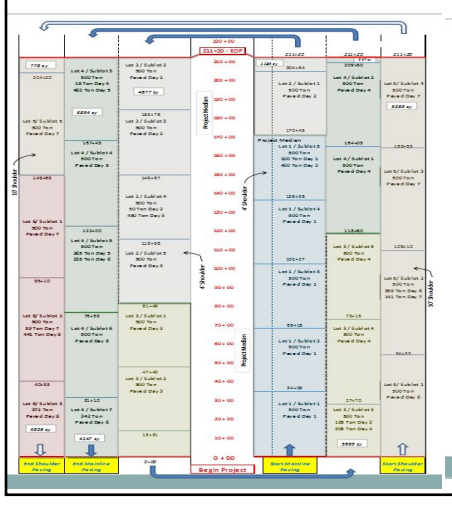
PWL Paving – Bond Strength

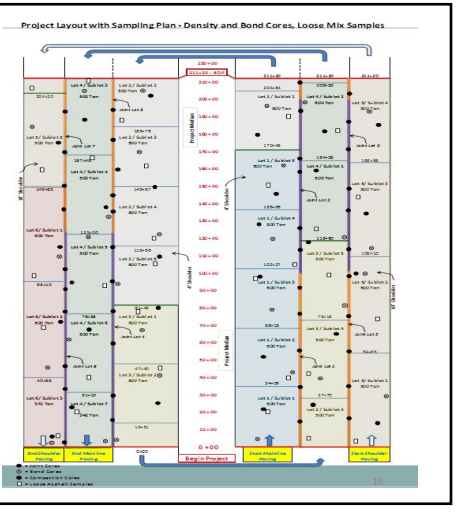


- Poor tack coats and surface prep can lead to premature failures
  - Layer slip / Delamination / Cracking
- Cores are tested in a Shear device
  - Lower limit of 100psi
- Statistical Evaluation

How Do We Know Where to Get These Samples

- Prior to Construction
- Lot Layout
  - Production lots are 2500 tons
  - Constructed joints have 10,000' lots
- Pre-paving Meeting
  - Agree on paving sequence – Layout Lots in field for sampling
  - Loose mix locations at beginning of day
  - Cores marked after finish roller…notify contractor!





PWL Paving – Example Setup

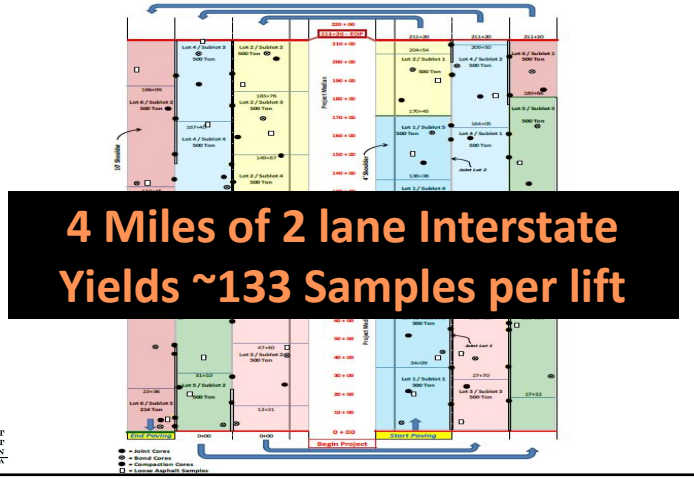
- Two lane, 3.0 mile road, 1.5 inch design thickness, 12 ft lanes. Example mix is 156.7 lb/CF max. How many tons?

Determine	Method	Answer
Thickness (ft)	**Thickness / 12**	
Length (ft)	**Length(mi) x 5280**	
Area (SF)	**Length x Width x Lanes**	
Volume (CF)	**Area x Thickness**	
Field Density	**Max Density x 94%**	
Pounds required	**Field Density x Volume**	
Tons required	**Pounds / 2000**	

PWL Paving – Example Setup

- **3500 ton project, single "extended" lot**
  - **Sublot = 500 ton…. Therefore 3500/500 = 7**

Determine	Method	Answer
Loose Samples	**One per mat sublot**	
Mat Density Samples	**One per mat sublot**	
Bond Strength Samples	**One per mat sublot**	
Length (ft)	**Length(mi) x 5280**	
Joint Density Samples	**One per JOINT sublot**	
Thickness Samples	**Use Bond Strength & Mat Density Cores**	



4 Miles of 2 lane Interstate
Yields ~133 Samples per lift

Significant Changes
Field Evaluations – Pavement Distresses

MP 401.07.25
February, 2013

WEST VIRGINIA DEPARTMENT OF TRANSPORTATION
DIVISION OF HIGHWAYS
MATERIALS CONTROL, SOILS AND TESTING DIVISION

MATERIALS PROCEDURE

GUIDE FOR EVALUATION OF ASPHALT PAVEMENTS WITH SUBSTANDARD PROPERTIES

1. **PURPOSE**

1.1 Provide a consistent approach and checklist for use by construction project personnel when evaluating asphalt pavement with substandard properties and aid in any subsequent decision.

1.2 Identify pavement factors and characteristics most critical to satisfactory performance.

1.3 Validate, if it is appropriate, the removal of the pavement in question.

2. **SCOPE**

2.1 This procedure shall be applicable to all newly placed Marshall and Superpave mix base layers and wearing courses.

2.2 All facets of construction including quality control, quality assurance, and independent assurance sampling and testing, along with construction practices and methods, and observable distresses and defects in the finished mat should be considered when determining any action required to remediate the newly placed asphalt course(s). It is generally necessary to consider all facets when trying to determine the cause of substandard properties and observed distresses, and then decide on remedial aaction that needs to be executed.

3. **REFERENCED DOCUMENTS**

3.1 Special Provision Section 401, Asphaltic Base, Wearing, and Patching and Leveling Courses, original issuance February 2013.

The Fork in the Road (New in 2023)

Interstates and Divided NHS Routes

- PWL Calculations on:
  - Mat Density
  - Joint Density
  - Bond Strength
  - Asphalt Content
  - #200(Dust) Content
- Lot Average
  - Thickness of cores

Two-Lane and Non-divided NHS Route Exceptions

- PWL Calculations on:
  - Asphalt Content
  - #200(Dust) Content
- Lot Average on:
  - Mat Density
  - Joint Density
  - Bond Strength
  - Thickness of Cores

Commonalities:

- Main Lot Payment is always based on Mat Density, Asphalt Content, and Dust Content. With the Total Lot payment calculated the same regardless of how the Payment Factors are generated
  - 50% Mat Density, 25% each Asphalt content and Dust content
- Thickness, Bond Strength and Joint Density are each stand alone adjustments based on their individual equations

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PWL Paving – Pay Adjustment

- **Lot Payment**

$$CP(2PD + PB + PA)/400$$

- **Contract Price, Pay Density, Pay Binder, Pay Aggregate**
- **Payment for each component can reach 102%, but the average density must be greater than 93.0%**

Incentives have been removed from the specification on projects let on of after January 1st, 2023.

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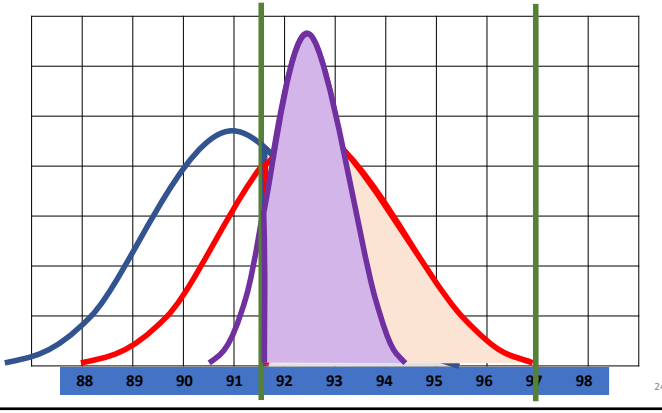
Recap… what does PWL mean?



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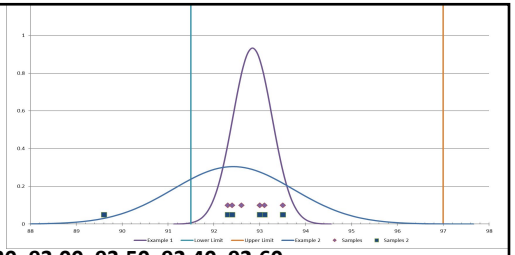
PWL Paving – Example



- Mat Density (91.5 – 97.0)
- Example 1:
  - 7 Cores - 93.00, 93.10, 92.30, 93.00, 93.50, 92.40, 92.60
    - Avg = 92.84 Stdev = .43
  - PWL = 100
- Example 2:
  - 7 Cores - 93.00, 93.10, 92.30, 93.00, 93.50, 92.40, 89.60
    - Avg = 92.42 Stdev = 1.31
  - PWL = 75

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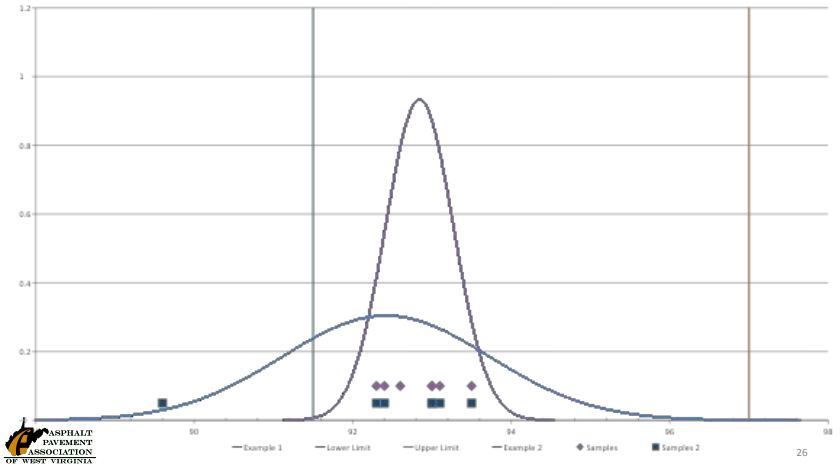

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PWL Paving – Pay Adjustment

Interstates and Divided NHS Routes

TABLE 410.13.3.1

Percentage of Material Within Specification Limits (PWL)	Lot Pay Factor (Percent of Contract Unit Price)
90-100	100
75-89	[(0.5)PWL]+55
55-74 Note 1	[(1.4)PWL]-12

Jobs let prior to January 1st, 2023 are still eligible for an incentives up to 2% for a PWL between 96-100

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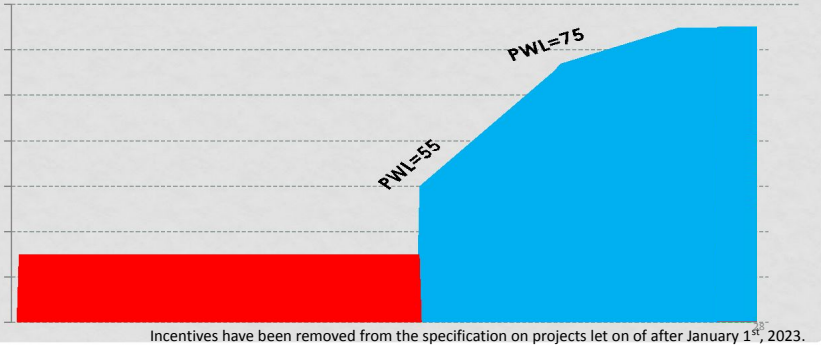
Based on 2500 tons

Interstates and Divided NHS Routes

PWL PAY CRITERIA



Incentives have been removed from the specification on projects let on of after January 1st, 2023.

PWL Paving – Pay Adjustment

- Lot Payment

$$CP(2PD + PB + PA)/400$$

  - Contract Price, Pay Density, Pay Binder, Pay Aggregate
  - Payment for each component can reach 102%, but the average density must be greater than 93.0%

Incentives have been removed from the specification on projects let on of after January 1st, 2023.

Interstates and Divided NHS Routes

PWL Paving – Pay Adjustment Example

- Determine the pay factors for this example lot

Property	PWL	Pay Factor
Density	87	
Asphalt Content	90	
Gradation	86	

- What is the Lot payment
  - $CP(2PD + PB + PA)/400$

TABLE 410.13.3.1

Percentage of Material Within Specification Limits (PWL)	Lot Pay Factor (Percent of Contract Unit Price)
90-100	100
75-89	[(0.5)PWL]+55
55-74 Note 1	[(1.4)PWL]+12

Interstates and Divided NHS Routes

PWL Paving – Pay Adjustment

- Thickness Payment

$$\%\ Adjustment = \frac{t}{T}\ x\ 100$$

- T = Total Plan Thickness
- t = average lot thickness + 0.04

Interstates and Divided NHS Routes

PWL Paving – Pay Adjustment

- Joint Payment
  - When PWL > 60 there is no adjustment

$$Disincentive(\$) = \frac{60-PWL}{60}\ x\ 12,500 \quad \text{(When} \leq 60\text{)}$$

Jobs let prior to January 1st, 2023 are still eligible for up to a $4000 incentives for PWL ≥ 80

$$Incentive(\$) = \frac{PWL-80}{20}\ x\ 4000$$

Interstates and Divided NHS Routes

JOINT DENSITY PAY CRITERIA

(TARGET= 89%)

Incentives have been removed from the specification on projects let on of after January 1st, 2023.

PWL Paving – Pay Adjustment Example

- **Joint Density PWL is 57. What is the Adjustment?**

PWL Paving – Pay Adjustment Example

- **Thickness target is 2 inches, and average is 1.92 inches. What is the pay adjustment?**

$$\%\ Adjustment = \frac{t}{T}\ x\ 100$$

$$\%Adjustment\ Of\ Unit\ Price = \qquad x\ 100$$

$$\%\ Adjustment\ Of\ Unit\ Price =$$

- **Unit price = $10/sqyd**
- **Therefore an <u>Additional Standalone</u> Adjustment for inadequate thickness**
  - **Lot Area*(100-98%)/100*Unit Cost = 42,240*(.02)*$10 = $8448 Penalty**

The Fork in the Road (New in 2023)

Interstates and Divided NHS Routes

- PWL Calculations on:
  - Mat Density
  - Joint Density
  - Bond Strength
  - Asphalt Content
  - #200(Dust) Content
- Lot Average
  - Thickness of cores

Two-Lane and Non-divided NHS Route Exceptions

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  - #200(Dust) Content
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  - Joint Density
  - Bond Strength
  - Thickness of Cores

Commonalities:

- Main Lot Payment is always based on Mat Density, Asphalt Content, and Dust Content. With the Total Lot payment calculated the same regardless of how the Payment Factors are generated
  - 50% Mat Density, 25% each Asphalt content and Dust content
- Thickness, Bond Strength and Joint Density are each stand alone adjustments based on their individual equations

Two Lane Exceptions

- AC, Gradation, and Thickness are still calculated the same as Interstate PWL
- Mat Density, Joint Density, and Bond Strength are calculated based on the lot average

Mat Density PD

TABLE 410.13.7.2

Payment Factors for Pavement Mat Density	
Average Lot Percent Density	**Payment Factor (PD)**
Greater than 98 %	Note 1
91.50% to 98.00%	100
88.00% to 91.49%	= 100 – 4*(91.50% - Percent density)
Less than 88%	= 84 – 10*(88% - Percent density) Note 2

Example 1:

7 Cores - 93.00, 93.10, 92.30, 93.00, 93.50, 92.40, 92.60

Avg = 92.84 Stdev = .43

PWL=100 -> PD = 100

Example 2:

7 Cores - 93.00, 93.10, 92.30, 93.00, 93.50, 92.40, 89.60

Avg = 92.42 Stdev = 1.31

PD = 100

Joint Density Adjustment

TABLE 410.13.7.3

Pay Adjustment for Pavement Joint Density per Linear Foot	
Average Lot Percent Density	Price Adjustment ($ / LF)
Greater than 97 %	Note 3
89.00 % to 97.00%	0
88.00% to 88.99%	-0.20
Less than 88%	= [{0.50*(Percent Density – 88.00)} – 0.20]

Bond Strength Adjustment

TABLE 410.13.7.4

Pay Adjustment for Bond Strength per 2500 Ton Lot	
Average Lot Bond Strength (PSI)	**Price Adjustment ($ / Lot)**
100.00 and Greater	0
75.00 to 99.99	= [{1,000*(PSI - 75.00)} – 25,000]
Less than 75.00	– 25,000

Confused??

PWL boils down to controlling variability

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Let's tie this back to yesterday… Understanding the Variability

- Material Variations
- Testing Variations
- Plant Operations
- Environmental Conditions
- Delivery of Material
- Field Prep
- Paving Operations
- Rolling Operations

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Materials and Testing Variations

- Aggregates
  - Stockpiles Gradation
  - Aggregate Texture
  - Daily if not multiple daily moisture checks
  - Stockpile size
- RAP

Plant Operations

- Material Feed
- Bag house Control
  - Dust Creation
- Liquid and belt Calibration
- Moisture Control
- Temperature Control
- Starts and Stops/Job Switching
  - Material waste
- Inspection – Plant wear

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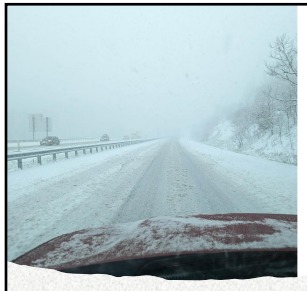
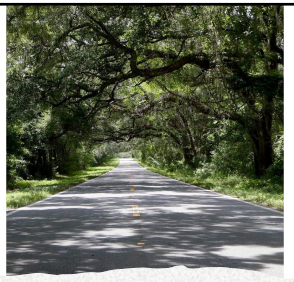
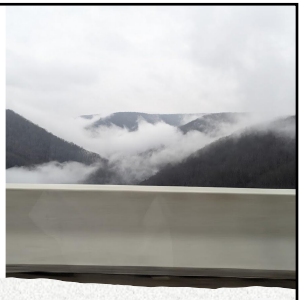


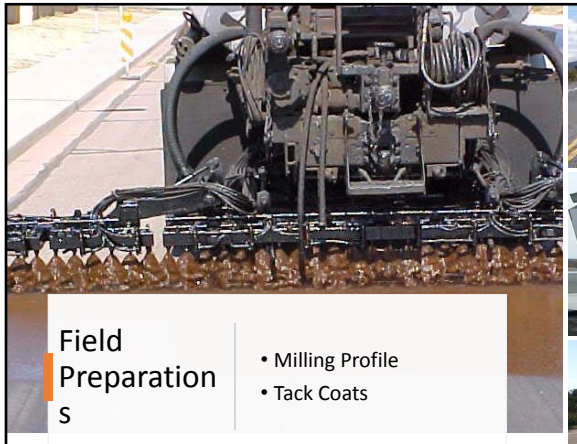

Field Preparations

- Milling Profile
- Tack Coats

Delivery of Material

- Insulated Trucks
- Sound Tarps on Trucks
- Constant Material Delivery
- Haul distance
- Use of an MTV

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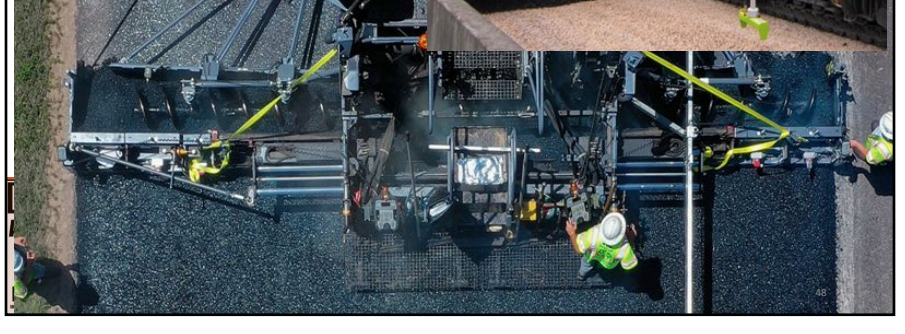
Paving Operations

- Paver Setup
  - Auger Extension
  - Tunnel Extension



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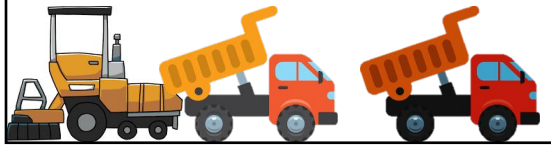
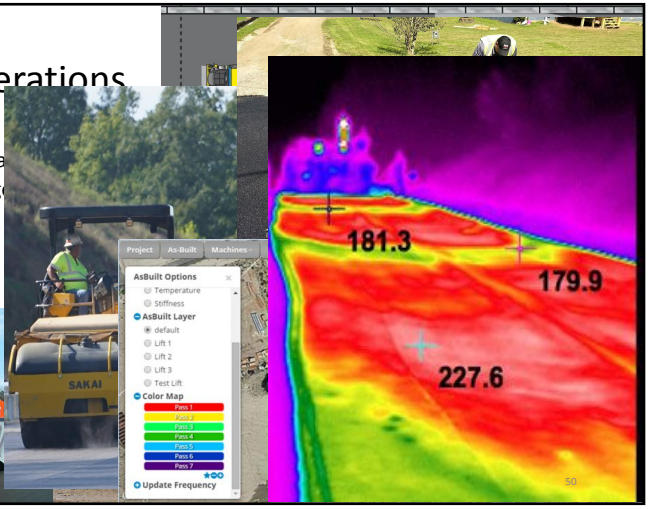
Paving Operations

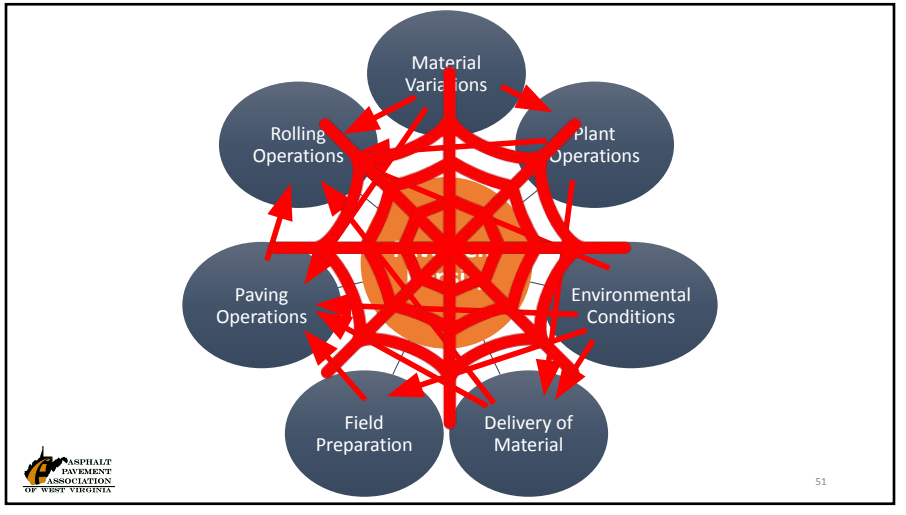
- Constant Paver Speed throughout the day
  - DO NOT STOP
  - Constant Material Delivery
- Thickness of the Lift
  - Consistent Lift = Consistent Compaction



Rolling Operations

- Patterns
  - Establish a roller pa
  - If conditions chang
- Types – Pneumatic,
- Number of Rollers
- Temperatures





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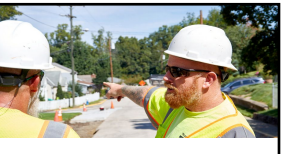
Communication



- Everyone needs to be involved/ Communicate with everyone Involved
  - Plant Personnel – especially your loader operator
  - Lab Tech and field Tech
  - Truckers
  - Roller Operators
  - Paving Operators
- Sample Data needs to be communicated to the project personnel

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WHY YOU SHOULD CARE ABOUT THIS!!!

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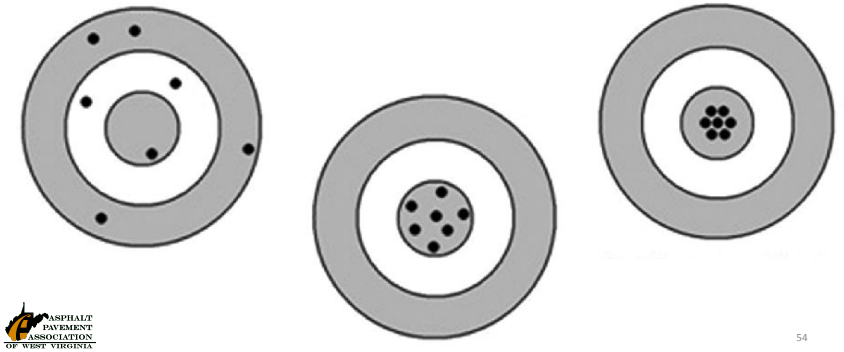
Remember it is all about CONSISTENCY



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Questions?

JCrane@asphaltwv.com
304-988-6623

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HMA Construction Program

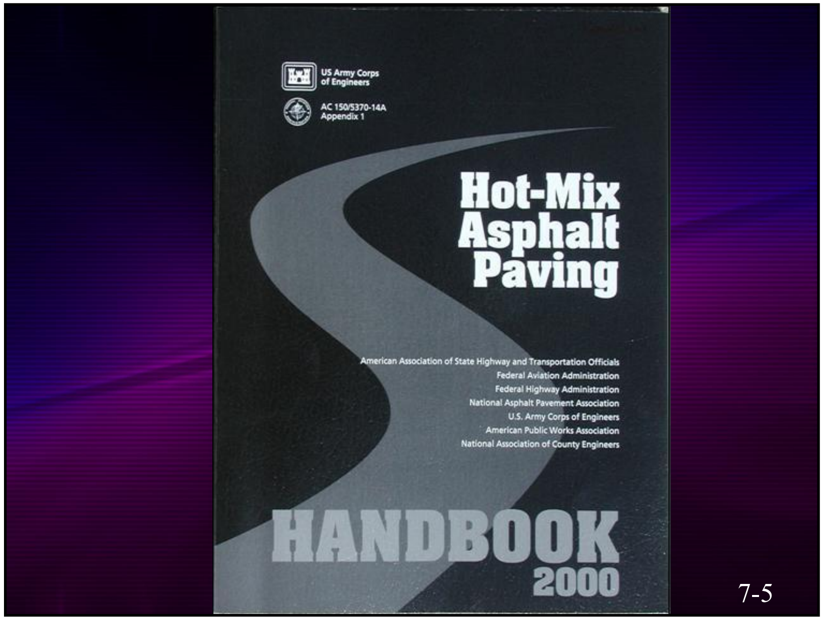
Module 10
Troubleshooting

Learning Objectives

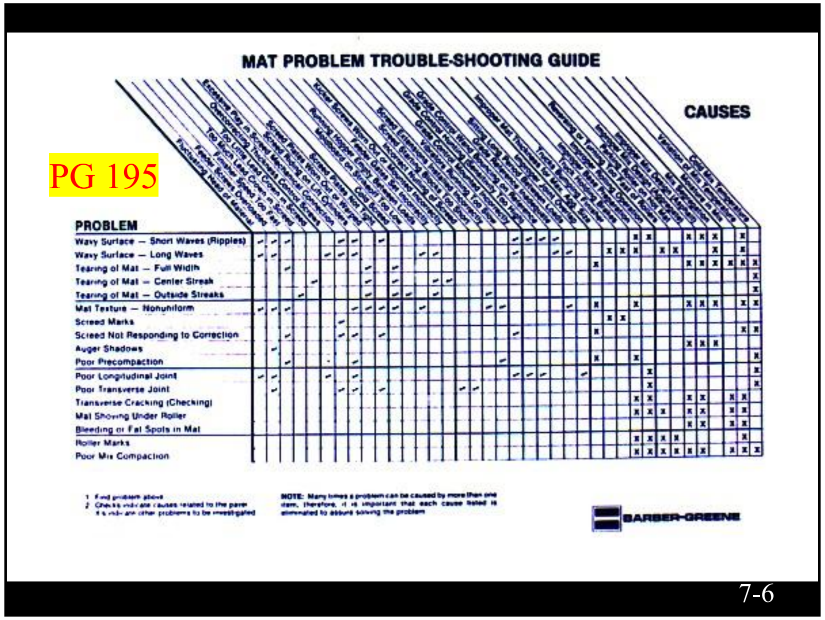
1. State the objective of effective troubleshooting
2. List the steps needed to effectively troubleshoot
3. Analyze situations and recommend action to be taken

Objective of Effective Troubleshooting?

- Isolating the problem so that an appropriate solution can be arrived at quickly and efficiently.



7-5



7-6

Causes

Problem	Fluctuating head of material	Feeder Screws Overload	Finisher Speed Too Fast	Too Much Lead Crown in Screed	Too Little Lead Crown in Screed	Over correction of Thickness Control Screws	Excessive Play in Screed Mechanical Connection	Screed Riding on Lift Cylinders	Screed Plates Worn Out or Warped	Screed Plates not Tight	Cold Screed	Moldboard on Strikeoff Too Low	Running Hopper Empty Between Loads	Feed Gates Set Incorrectly	Kicker Screws Worn Out or Mounted Incorrectly	Incorrect Nulling of Screed	Screed Starting Blocks Too Short	Screed Extensions Installed Incorrectly	Vibrators Running Too Slow
Wavy Surface – Short Waves (Ripples)	√	√	√				√	√		√									
Wavy Surface – Long Waves	√	√				√	√	√					√	√					
Tearing of Matt – Full Width			√						√		√								
Tearing of Matt – Center Streaks					√				√		√			√	√				
Tearing of Matt – Outside Streaks				√					√		√	√		√				√	
Mat Texture Nonuniform	√	√	√					√	√	√	√		√					√	√
Screed Marks							√												
Screed Not Responding to correction			√				√	√		√									
Auger Shadows		√																	
Poor Percompaction			√					√											√
Poor Longitudinal Joint	√	√				√		√											
Poor Transverse Joint		√					√	√		√						√	√		
Transverse Cracking (Checking)																			
Mat Shoving Under Roller																			
Bleeding or Fat Spots in Mat																			
Roller Marks																			
Poor Mix Compaction																			

Problem	Grade Control Mounted Incorrectly	Grade Control Hunting (Sensitivity too High)	Grad Control Wand Bouncing on Reference	Grade Reference Inadequate	Sitting Long Period Between Loads	Improper Joint Overlap	Improper Mat Thickness for Aggregate Size	Trucks Bumping Finisher	Truck Holding Brakes	Improper Base Preparation	Improper Roller Operation	Reversing or Too Rapidly Turning Rollers	Parking of Roller on Hot Mat	Improper Mix Design (Aggregate)	Improper Mix Design (Asphalt)	Mix Segregation	Moisture in Mix	Variation of Temperature of Mix	Cold Mix Temperature
Wavy Surface – Short Waves (Ripples)	√	√	√	√						×	×			×	×	×		×	
Wavy Surface – Long Waves	√			√	√			×	×	×		×	×			×		×	
Tearing of Matt – Full Width							×							×	×	×	×	×	×
Tearing of Matt – Center Streaks																			×
Tearing of Matt – Outside Streaks																			×
Mat Texture Nonuniform					√		×			×				×	×	×		×	×
Screed Marks								×	×										
Screed Not Responding to correction	√						×											×	×
Auger Shadows														×	×	×			
Poor Percompaction							×			×									×
Poor Longitudinal Joint	√	√	√			√					×								×
Poor Transverse Joint											×								×
Transverse Cracking (Checking)										×	×			×	×		×	×	
Mat Shoving Under Roller										×	×	×		×	×		×	×	
Bleeding or Fat Spots in Mat														×	×		×	×	
Roller Marks										×	×	×	×					×	
Poor Mix Compaction										×	×	×	×	×	×		×	×	×

√ Indicates a paver problem; × indicates a problem to be investigated

There can be multiple causes of problems, investigate each one.

7-7

How to Troubleshoot

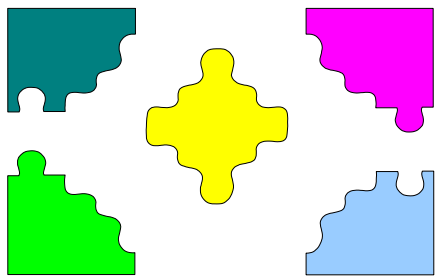
- Step One:

  Stop, step back, look at the big picture

7-8

How to Troubleshoot

- Step Two:
  Break the problem down into pieces



7-9

How to Troubleshoot

- Step Three:
  Eliminate the obvious factors first

7-10

How to Troubleshoot

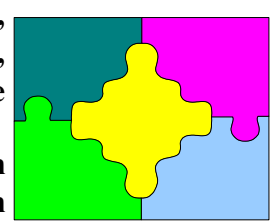
- Step Four:
  Analyze each remaining element in full detail

7-11

How to Troubleshoot

- Step Five:
  Re-combine the pieces of puzzle

Stop,
Step back,
Look at big picture



Break the problem down in pieces

Analyze each element in full detail

Eliminate the obvious factors first

7-12

How to Troubleshoot

- Step Six:

  Make recommendations based on facts

7-13

How to Troubleshoot

- Step Seven:

  Make changes “one at a time;” then analyze results

7-14

How to Troubleshoot

- Step Eight:

  Take notes every step of the way

7-15

How to Troubleshoot

Problem	Causes																																				
	Fluctuating head of material	Feeder Screws Overload	Finisher Speed Too Fast	Too Much Lead Crown in Screed	Too Little Lead Crown in Screed	Over correction of Thickness Control Screws	Excessive Play in Screed Mechanical Connection	Screed Riding on Lift Cylinders	Screed Plates Worn Out or Warped	Screed Plates not Tight	Cold Screed	Moldboard on Strikeoff Too Low	Running Hopper Empty Between Loads	Feed Gates Set Incorrectly	Kicker Screws Worn Out or Mounted Incorrectly	Incorrect Nulling of Screed	Screed Starting Blocks Too Short	Screed Extensions Installed Incorrectly	Vibrators Running Too Slow	Grade Control Mounted Incorrectly	Grade Control Hunting (Sensitivity too High)	Grad Control Wand Bouncing on Reference	Grade Reference Inadequate	Sitting Long Period Between Loads	Improper Joint Overlap	Improper Mat Thickness for Aggregate Size	Trucks Bumping Finisher	Truck Holding Brakes	Improper Base Preparation	Improper Roller Operation	Reversing or Too Rapidly Turning Rollers	Parking of Roller on Hot Mat	Improper Mix Design (Aggregate)	Improper Mix Design (Asphalt)	Mix Segregation	Moisture in Mix	Variation of Temperature of Mix	Cold Mix Temperature
Wavy Surface – Short Waves (Ripples)	√	√	√				√	√		√										√	√	√	√						×	×			×	×	×		×	
Wavy Surface – Long Waves	√	√				√	√	√					√	√						√			√	√			×	×	×		×	×			×		×	
Tearing of Matt – Full Width			√						√		√															×							×	×	×	×	×	×
Tearing of Matt – Center Streaks					√				√		√			√	√																							×
Tearing of Matt – Outside Streaks				√					√		√	√		√				√																				×
Mat Texture Nonuniform	√	√	√					√	√	√	√		√					√	√					√		×			×				×	×	×		×	×
Screed Marks							√																				×	×										
Screed Not Responding to correction			√				√	√		√										√						×											×	×
Auger Shadows		√																															×	×	×			
Poor Percompaction			√					√											√							×			×									×
Poor Longitudinal Joint	√	√				√		√												√	√	√			√					×								×
Poor Transverse Joint		√					√	√		√						√	√													×								×
Transverse Cracking (Checking)																													×	×			×	×		×	×	
Mat Shoving Under Roller																													×	×	×		×	×		×	×	
Bleeding or Fat Spots in Mat																																	×	×		×	×	
Roller Marks																													×	×	×	×					×	
Poor Mix Compaction																													×	×	×	×	×	×		×	×	×

√ Indicates a paver problem; × indicates a problem to be investigated

There can be multiple causes of problems, investigate each one.

7-17

Problem	Causes																																				
	Fluctuating head of material	Feeder Screws Overload	Finisher Speed Too Fast	Too Much Lead Crown in Screed	Too Little Lead Crown in Screed	Over correction of Thickness Control Screws	Excessive Play in Screed Mechanical Connection	Screed Riding on Lift Cylinders	Screed Plates Worn Out or Warped	Screed Plates not Tight	Cold Screed	Moldboard on Strikeoff Too Low	Running Hopper Empty Between Loads	Feed Gates Set Incorrectly	Kicker Screws Worn Out or Mounted Incorrectly	Incorrect Nulling of Screed	Screed Starting Blocks Too Short	Screed Extensions Installed Incorrectly	Vibrators Running Too Slow	Grade Control Mounted Incorrectly	Grade Control Hunting (Sensitivity too High)	Grad Control Wand Bouncing on Reference	Grade Reference Inadequate	Sitting Long Period Between Loads	Improper Joint Overlap	Improper Mat Thickness for Aggregate Size	Trucks Bumping Finisher	Truck Holding Brakes	Improper Base Preparation	Improper Roller Operation	Reversing or Too Rapidly Turning Rollers	Parking of Roller on Hot Mat	Improper Mix Design (Aggregate)	Improper Mix Design (Asphalt)	Mix Segregation	Moisture in Mix	Variation of Temperature of Mix	Cold Mix Temperature
Wavy Surface – Short Waves (Ripples)	√	√	√				√	√		√										√	√	√	√						×	×			×	×	×		×	
Wavy Surface – Long Waves	√	√				√	√	√					√	√						√			√	√			×	×	×		×	×			×		×	
Tearing of Matt – Full Width			√						√		√															×							×	×	×	×	×	×
Tearing of Matt – Center Streaks					√				√		√			√	√																							×
Tearing of Matt – Outside Streaks				√					√		√	√		√				√																				×
Mat Texture Nonuniform	√	√	√					√	√	√	√		√					√	√					√		×			×				×	×	×		×	×
Screed Marks							√																				×	×										
Screed Not Responding to correction			√				√	√		√										√						×											×	×
Auger Shadows		√																															×	×	×			
Poor Percompaction			√					√											√							×			×									×
Poor Longitudinal Joint	√	√				√		√												√	√	√			√					×								×
Poor Transverse Joint		√					√	√		√						√	√													×								×
Transverse Cracking (Checking)																													×	×			×	×		×	×	
Mat Shoving Under Roller																													×	×	×		×	×		×	×	
Bleeding or Fat Spots in Mat																																	×	×		×	×	
Roller Marks																													×	×	×	×					×	
Poor Mix Compaction																													×	×	×	×	×	×		×	×	×

√ Indicates a paver problem; × indicates a problem to be investigated

There can be multiple causes of problems, investigate each one.

7-20

Segregation Troubleshooting

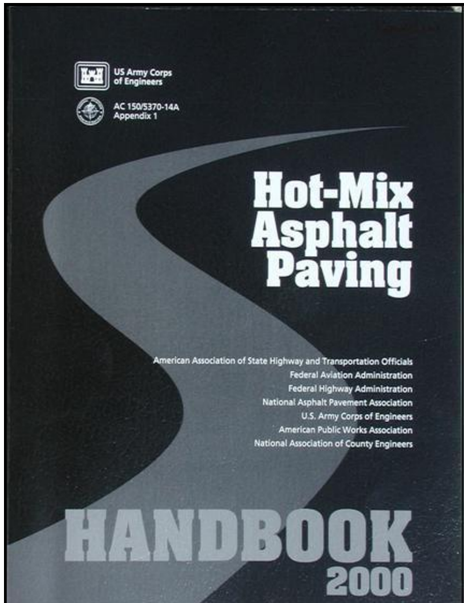
That’s 18 possible causes for non-uniform mat texture!

7-21

How to Troubleshoot

- Stop, step back, look at big picture
  - Break the problem down in pieces
    - Eliminate the obvious factors first
      Analyze each element in full detail
      Re-combine the pieces of puzzle
    - Recommendation based on facts
  - Changes “one at a time;” analyze
- Take notes every step of the way

7-22



Section 19 - Mat Problems

7-23

Problem	Fluctuating head of material	Feeder Screws Overload	Finisher Speed Too Fast	Too Much Lead Crown in Screed	Too Little Lead Crown in Screed	Over correction of Thickness Control Screws	Excessive Play in Screed Mechanical Connection	Screed Riding on Lift Cylinders	Screed Plates Worn Out or Warped	Screed Plates not Tight	Cold Screed	Moldboard on Strikeoff Too Low	Running Hopper Empty Between Loads	Feed Gates Set Incorrectly	Kicker Screws Worn Out or Mounted Incorrectly	Incorrect Nulling of Screed	Screed Starting Blocks Too Short	Screed Extensions Installed Incorrectly	Vibrators Running Too Slow	Grade Control Mounted Incorrectly	Grade Control Hunting (Sensitivity too High)	Grad Control Wand Bouncing on Reference	Grade Reference Inadequate	Sitting Long Period Between Loads	Improper Joint Overlap	Improper Mat Thickness for Aggregate Size	Trucks Bumping Finisher	Truck Holding Brakes	Improper Base Preparation	Improper Roller Operation	Reversing or Too Rapidly Turning Rollers	Parking of Roller on Hot Mat	Improper Mix Design (Aggregate)	Improper Mix Design (Asphalt)	Mix Segregation	Moisture in Mix	Variation of Temperature of Mix	Cold Mix Temperature
	Causes																																					
Wavy Surface – Short Waves (Ripples)	√	√	√				√	√		√										√	√	√	√						×	×			×	×	×		×	
Wavy Surface – Long Waves	√	√				√	√	√					√	√						√			√	√			×	×	×		×	×			×		×	
Tearing of Matt – Full Width			√						√		√															×							×	×	×	×	×	×
Tearing of Matt – Center Streaks					√				√		√			√	√																							×
Tearing of Matt – Outside Streaks				√					√		√	√		√				√																				×
Mat Texture Nonuniform	√	√	√					√	√	√	√		√					√	√					√		×			×				×	×	×		×	×
Screed Marks							√																				×	×										
Screed Not Responding to correction			√				√	√		√										√						×											×	×
Auger Shadows		√																															×	×	×			
Poor Percompaction			√					√											√							×			×									×
Poor Longitudinal Joint	√	√				√		√												√	√	√			√					×								×
Poor Transverse Joint		√					√	√		√						√	√													×								×
Transverse Cracking (Checking)																													×	×			×	×		×	×	
Mat Shoving Under Roller																													×	×	×		×	×		×	×	
Bleeding or Fat Spots in Mat																																	×	×		×	×	
Roller Marks																													×	×	×	×					×	
Poor Mix Compaction																													×	×	×	×	×	×		×	×	×

√ Indicates a paver problem; × indicates a problem to be investigated

There can be multiple causes of problems, investigate each one.

7-24

Example 1

Your paving team has been using a double drum steel wheel roller as the breakdown roller on an 1 ½" of Wearing 1 overlay.

You are experiencing some checking in the mat after the second or third pass.

The mix has been tested at the lab and isn't suspect – Asphalt & Dust contents are good.

Example 1

Example 1

Example 1

- What would cause this?

  Handbook Pages 202 – 203

- What can you do right now to correct this?

  Handbook Pages 203 - 204

Example 2

You are show up on the Project and see random fat spots and bleeding in the wheel paths on a 1” Wearing 1 overlay placed yesterday .

This is slightly more noticeable at the transverse joints.

The test results from the day before meets the specifications.

You are ready to start paving the same mix on the same stretch of road today.

7-29

Example 2

Example 2

Example 2

•What would cause this?

•Should you Pave today?

•What can you do right now to correct this?

7-32

Example 2

Example 3

A test strip of 19 mm Asphalt has been completed on a $2 Million paving Project and you have been comparing roller passes to in-place density – measured with cores.

Even with a double drum vibratory and a 10 ton pneumatic roller, you are barely able to achieve the minimum density on the 2 ½" mat.

The Contractor and Agency are not in agreement of how to proceed.

Yes, the test strip did pass, but do you start paving?

7-34

Example 3

- As a consultant, what do you recommend?
- What all should you check before proceeding?
- What are your options?

7-35

Example 3

Example 3

Example 3

Example 3

Example 4

You are paving a 9.5mm Skid wearing mix on a 2 lane road. As a compaction technician, you are struggling with compaction and notice that the surface is "spongy" at 130º F. You can twist your heel into the surface and make a sizable scar.

What could cause this, and what can you do?

Example 4

Example 4

Example 4

Example 4

Example 4

Example 4

Disclaimer : Photos used within this presentation are for illustrative purposes only, any references to individuals or specific products are unintentional and coincidental. (CDM)

7-47

WVDOH

DENSITY EVALUATION

MCS&T - October 17, 2024

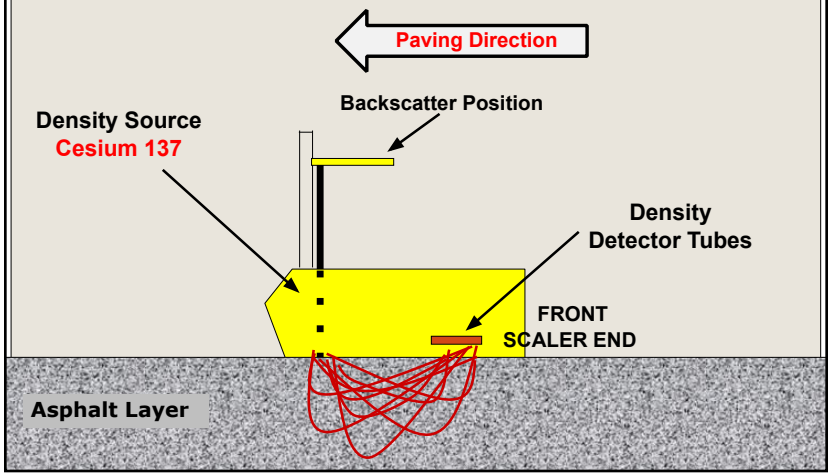
Jamie Rose - Quarry Operations Manager - J.F. Allen Company

Objectives :

- 401 Compaction Overview
- Gauge Comparisons
- Lot by Lot - Random Locations
- Roller Pass Method

- MP 401.05.20 - Deactivated in 2023
- Section 401 – 2023 Spec Book
- Section 401 – Supplemental Specifications

Troxler 3400 Series Nuclear Gauges



Standard Practices

Pre-Operation:

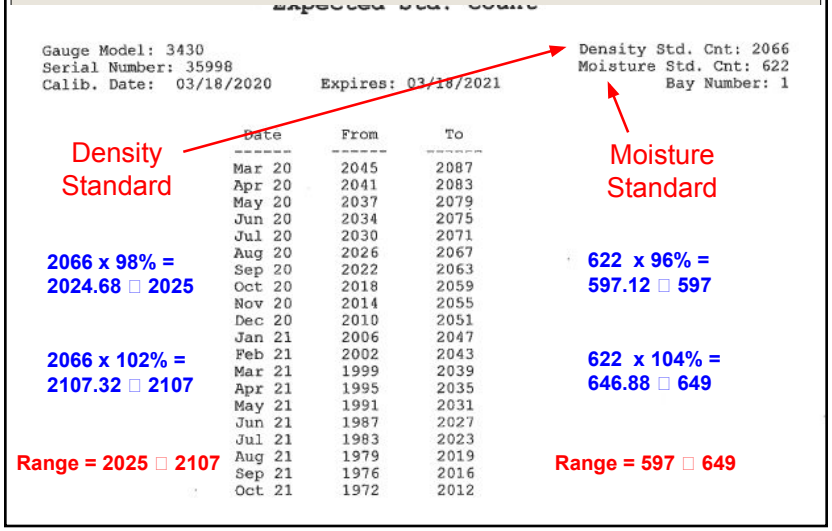
- Has Gauge been Calibrated within the last 24 Months
- Proper Bill Of Lading for Transport
- Is Gauge Properly Charged
- Proper Standard Block in Case
- Gauge and Standard Block Cleaned

Standard Practices

Operation – Standardizing the Gauge:

- Verify that the Standard Block and the bottom of the Gauge are clean.
- Place the Gauge on the Standard Block in the correct direction.
- Make sure Standard Block is sitting on a solid surface away from large metal objects such as equipment and trucks.
- Make sure you don't standardize within 30 feet of another gauge.
- Check to make sure Gauge Standard counts are within limits of the Calibrated Manufacturer's Standard Counts.
- **Density = +/- 2%**
- **Moisture = +/- 4%**

Standard Practices



Standard Practices

Operation – Standardizing the Gauge:

- Check to make sure Gauge Standard counts are within limits of the Calibrated Manufacturer's Standard Counts.
- **Density = +/- 2%**
- **Moisture = +/- 4%**

- **Remember - this Range comes from the Calibration Sheets for the Gauge. The numbers from the Gauge when you Standardize must fall into this Range.**

Standard Practices

Operation – Testing:

- Verify the settings in the Gauge.
  - Proper Units – Kg/m³
  - Asphalt is always a Wet Density Reading
  - Asphalt is always tested in the Backscatter Position
  - Proper target density set in the gauge
  - Tests for DOH must be 1 Minute tests
- Find test location by using Random Numbers.
- Make sure you don't test within 30 feet of another gauge.
- Make sure Gauge is sitting on a solid area away from large metal objects such as equipment and trucks.

Gauge Operation

- Good contact between Gauge and Surface

Fill Voids
- Dry Mortar Sand
- Silica Sand

Remove Excess

Gauge in Position

Too Much Exposure To The Gauge

Gauge Common Sense

DO NOT OPERATE NEAR :

- Large metal objects
  - Equipment
  - Culverts
- Power lines
- Other gauges (minimum of 30 feet)

KEEP GAUGE DRY :

- Cover control panel if possible

Specifications Section 401

Provides the requirements for determining how acceptance will be made.

1. Lot by Lot Testing
2. Roller Pass Method

Quality Control Testing

- Quality control tests are performed to allow the Contractor to control the material. These tests are not used for acceptance.
- The Contractor is responsible for quality control even when acceptance tests are not required, for example, a Roller Pass.

Acceptance Testing

- Lot By Lot Testing - 2023 Spec Book
  - Measured Roadway Width > 16'
  - Total New Thickness >/= 1.5"
  - Total Continuous Paving Length >/= ½ Mile

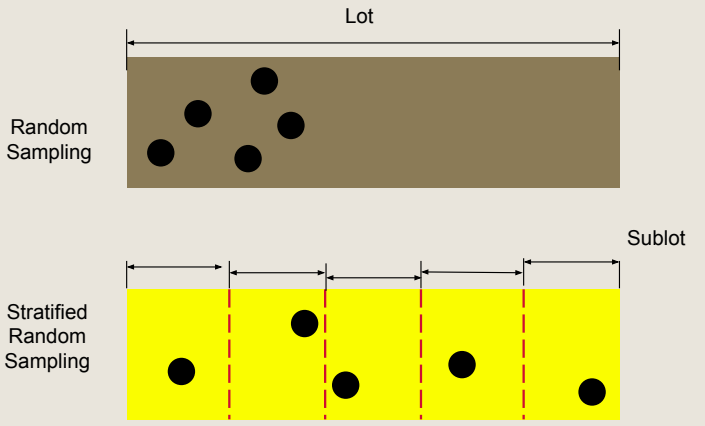
Acceptance Testing

- Lot By Lot Projects -
  - All Projects Bid in 2023 – 2023 Spec Book - DOH does the Acceptance Testing.
  - Projects Let in 2022 or Prior – 2022 Supplemental Specs - Contractor does the Acceptance Testing.
  - Laydown POs – 2017 Spec Book - DOH does the Acceptance Testing – No Joint Testing.

Acceptance Testing

- Roller Pass Projects - The Contractor is responsible for the testing while being observed by the District.
- Roller Pass Method –
  - Laydown POs - MP401.05.20
  - 2022 & Prior Projects – 2022 Supplemental
  - 2023 Projects – 2023 Spec Book

Lots and Sublots



Station Numbers

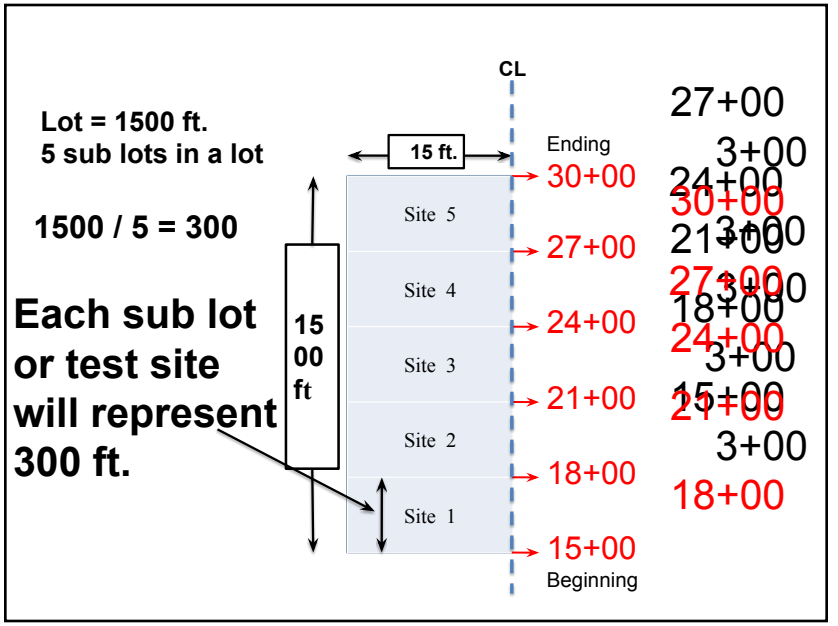
- Common way of tracking longitudinal distance on Projects
- The " + " Sign is simply a place holder – just like the comma in 10,000
- Beginning of Project (BOP) = 0+00
- End of Project (EOP) = 144+25 (Example)
- 144+25 = 14,425 Feet

Offsets

- Common way of tracking left & right distance on Projects
- On Paving Projects, typically measured from the centerline or the center joint
- Never test on the edge of the pavement – pull the gauge 1' in away from the edge
- Offsets for Joint Testing with the gauge are always 4 inches

Sublot Exercise

Handbook – 5 Pages from end



Sublot Exercise

	Random Numbers		Location	
	Length	Width	Distance	Offset Left CL
1	0.683	0.441		
2	0.493	0.155		
3	0.059	0.502		
4	0.996	0.729		
5	0.240	0.972		

	Random Numbers		Location	
	Length	Width	Distance	Offset Left CL
1	0.683	0.441	17+05	7 ft.
2	0.493	0.155	19+48	2 ft.
3	0.059	0.502	21+18	8 ft.
4	0.996	0.729	26+99	11 ft.
5	0.240	0.972	27+72	14 ft.

Site 1

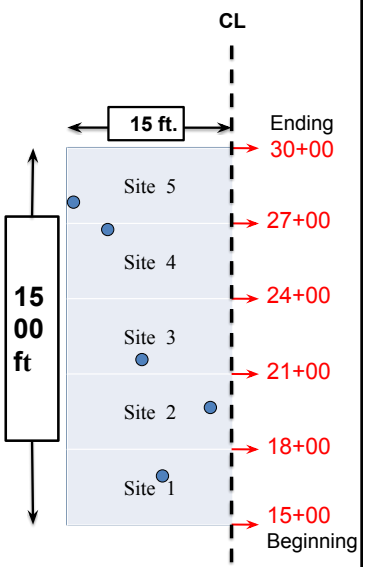
Length

0.683 x 300 =204.9 ⇒ 205

15+00

2+05

17+05



Testing Process

Testing Forms

- **Lot x Lot -- T401**
- **Gauge Comparison -- T401b**
- **Roller Pass -- T407**
- **All three are located on DOH "Toolbox" Web Page**

http://transportation.wv.gov/highways/mcst/Pages/tbox.aspx

Gauge Comparison

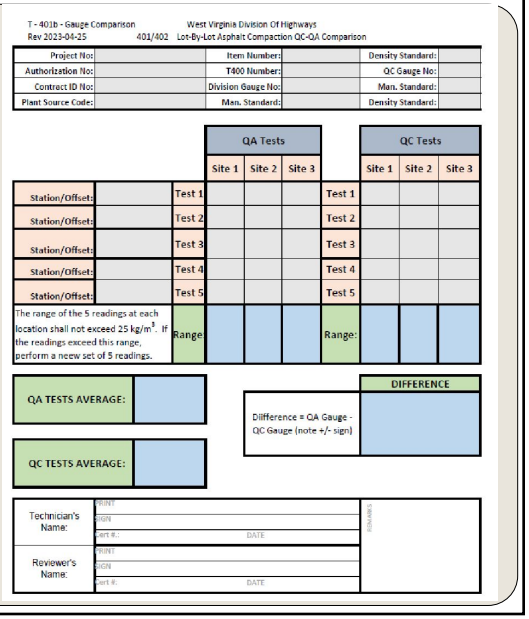
Comparison of Nuclear Density Gauges In Accordance with Guidelines Contained in

Section 401.6.4.1.1

2023 Gauge Verification

1. Randomly locate **3** test sites within the first **500 ft** of paving – starting **100 ft** from the take-off Joint & a minimum of **1 ft** from either edge.
2. Take 5 One-Minute readings in the same spot.
3. For each gauge used – the Range of the 5 readings cannot exceed 25 kg/m³.
4. Once all 3 locations are done average the 15 readings for each gauge to compare differences between gauges.
5. This will be used so the Contractor can determine the Density to achieve on their gauge.

T-401b Gauge Comparison Form



T - 401b - Gauge Comparison — West Virginia Division Of Highways
Rev 2023-04-25 — 401/402 Lot-By-Lot Asphalt Compaction QC-QA Comparison

Project No:		Item Number:		Density Standard:	
Authorization No:		T400 Number:		QC Gauge No:	
Contract ID No:		Division Gauge No:		Man. Standard:	
Plant Source Code:		Man. Standard:		Density Standard:	

		QA Tests				QC Tests		
		Site 1	Site 2	Site 3		Site 1	Site 2	Site 3
Station/Offset:	Test 1				Test 1			
Station/Offset:	Test 2				Test 2			
Station/Offset:	Test 3				Test 3			
Station/Offset:	Test 4				Test 4			
Station/Offset:	Test 5				Test 5			
The range of the 5 readings at each location shall not exceed 25 kg/m³. If the readings exceed this range, perform a new set of 5 readings.	Range:				Range:			

QA TESTS AVERAGE:		DIFFERENCE	
QC TESTS AVERAGE:		Difference = QA Gauge - QC Gauge (note +/- sign)	

Technician's Name:	PRINT SIGN Cert #: DATE	REMARKS
Reviewer's Name:	PRINT SIGN Cert #: DATE	

T-401b Gauge Comparison Form

Part 1 - Identification and Verification

T - 401b - Gauge Comparison — West Virginia Division Of Highways
Rev 2023-04-25 — 401/402 Lot-By-Lot Asphalt Compaction QC-QA Comparison

Project No:	STP-033-2.22	Item Number:	401002-020	Density Standard:	2479
Authorization No:	AB 2575 G	T400 Number:	2018448	QC Gauge No:	45678
Contract ID No:	1122334	Division Gauge No:	52889	Man. Standard:	2000
Plant Source Code:	XYZ.01.400	Man. Standard:	2500	Density Standard:	1991

T-401b Gauge Comparison Form

Part 2 - Repeatability & Similarity

			QA Tests Site 1	QA Tests Site 2	QA Tests Site 3		QC Tests Site 1	QC Tests Site 2	QC Tests Site 3
Station/Offset:	1+33 / 4' R	Test 1	2250			Test 1	2290		
Station/Offset:	2+59 / 8' R	Test 2	2255			Test 2	2310		
Station/Offset:	4+62 / 7' R	Test 3	2272			Test 3	2299		
Station/Offset:		Test 4	2270			Test 4	2298		
Station/Offset:		Test 5	2258			Test 5	2297		
The range of the 5 readings at each location shall not exceed 25 kg/m^3. If the readings exceed this range, perform a neew set of 5 readings.		Range:	22			Range:	20		

QA TESTS AVERAGE:	2261
QC TESTS AVERAGE:	2299

	DIFFERENCE
Diifference = QA Gauge - QC Gauge (note +/- sign)	- 38

Testing Process

Density Testing – **Lot By Lot**

2022 & Prior Projects

Lot = 1,500 Ft long by the Paving Width

Sublot = 300 Ft long by the Paving Width

Acceptance Range = 92% **- 97%**

Joint Density Testing on the "Hot" side

Testing Process

Density Testing – **Lot By Lot**

DOH Laydown POs

Lot = 1,000 Ft long by the Paving Width

Sublot = 200 Ft long by the Paving Width

Acceptance Range = 92% - 96%

Joint Density Testing is not done

Testing Process

Density Testing – **Lot By Lot**

2023 Projects

Lot = 1,000 Ft long by the Paving Width

Sublot = 200 Ft long by the Paving Width

Acceptance Range = 93% - 97%

Joint Density Testing on the "Hot" side

Testing Process

Density Testing – **Joint Testing**

2023 Projects

- Done on the "Hot" side when a second travel lane is constructed.
- 5 Random 1 Minute Wet Density Tests per Lot - 4 Inches off of the Joint.
- Done at the same Station as the Mainline Density Test .

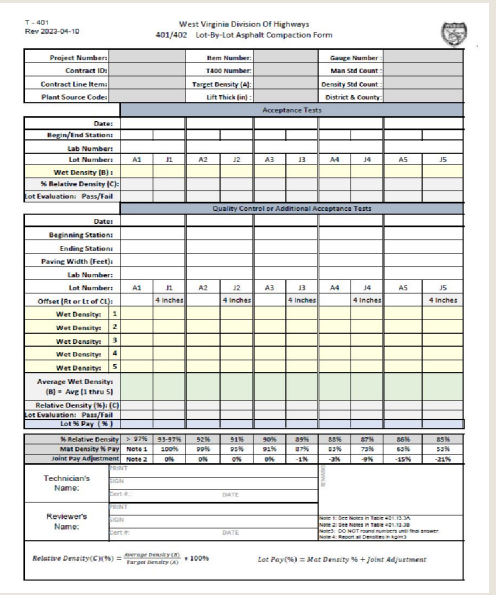
Testing Process

Density Testing – **Joint Testing**

2023 Projects

- Calculate the **Average Density** the same as the Mainline Densities.
- Evaluate the Lot – Pass / Fail -
  Spec Range = 90% - 97%

T401 Compaction Form – April 2023 Revision



T - 401
Rev 2023-04-10

West Virginia Division Of Highways
401/402 Lot-By-Lot Asphalt Compaction Form

Project Number:		Item Number:		Gauge Number	
Contract ID:		T400 Number:		Mast Std Count	
Contract Line Item:		Target Density (A):		Density Std Count	
Plant Source Code:		Lift Thick (in) :		District & County	

Acceptance Tests

Date:										
Begin/End Station:										
Lab Number:										
Lot Number:	A1	J1	A2	J2	A3	J3	A4	J4	A5	J5
Wet Density (B) :										
% Relative Density (C):										
Lot Evaluation: Pass/Fail										

Quality Control or Additional Acceptance Tests

Date:										
Beginning Station:										
Ending Station:										
Paving Width (Feet):										
Lab Number:										
Lot Number:	A1	J1	A2	J2	A3	J3	A4	J4	A5	J5
Offset (Rt or Lt of CL):		4 inches		4 inches		4 inches		4 inches		4 inches
Wet Density: 1										
Wet Density: 2										
Wet Density: 3										
Wet Density: 4										
Wet Density: 5										
Average Wet Density: (B) = Avg (1 thru 5)										
Relative Density (%): (C)										
Lot Evaluation: Pass/Fail										
Lot % Pay (%)										

% Relative Density	> 97%	93-97%	92%	91%	90%	89%	88%	87%	86%	85%
Mat Density % Pay	Note 1	100%	99%	95%	91%	87%	81%	73%	60%	50%
Joint Pay Adjustment	Note 2	0%	0%	0%	0%	-1%	-3%	-9%	-15%	-21%

Technician's Name: PRINT / SIGN / Cert #: / DATE:

Reviewer's Name: PRINT / SIGN / Cert #: / DATE:

Note 1: See Notes in Table 401.10.3A
Note 2: See Notes in Table 401.10.2B
Note3: DO NOT round numbers until final answer
Note 4: Report all Densities in kg/m3

Relative Density(C)(%) = $\frac{\text{Average Density (B)}}{\text{Target Density (A)}} \times 100\%$

Lot Pay(%) = Mat Density % + Joint Adjustment

T - 401
Rev 2023-04-10

West Virginia Division Of Highways
401/402 Lot-By-Lot Asphalt Compaction Form

Project Number:		Item Number:		Gauge Number :	
Contract ID:		T400 Number:		Man Std Count :	
Contract Line Item:		Target Density (A):	2465	Density Std Count :	
Plant Source Code:		Lift Thick (in) :		District & County:	

T401 Compaction Form – April 2023 Revision

	Acceptance Tests									
Date:										
Begin/End Station:										
Lab Number:										
Lot Number:	A1	J1	A2	J2	A3	J3	A4	J4	A5	J5
Wet Density (B) :	2277		2288		2305		2291	2251	2295	2187
% Relative Density (C):	92		93		94		93	91	93	89
Lot Evaluation: Pass/Fail			Pass		Pass		Pass	Pass	Pass	

2465 - Gmm

T401 Compaction Form – April 2023 Revision

	Quality Control or Additional Acceptance Tests									
Date:										
Beginning Station:										
Ending Station:										
Paving Width (Feet):										
Lab Number:										
Lot Number:	A1	J1	A2	J2	A3	J3	A4	J4	A5	J5
Offset (Rt or Lt of CL):		4 inches		4 inches		4 inches		4 inches		4 inches
Wet Density: 1	2266									2129
Wet Density: 2	2307									2134
Wet Density: 3	2286									2201
Wet Density: 4	2276									2176
Wet Density: 5	2288									2144
Average Wet Density: (B) = Avg (1 thru 5)	2285									2157
Relative Density (%): (C)	93									88
Lot Evaluation: Pass/Fail	Pass								Pass	Fail
Lot % Pay (%)	100									97

% Relative Density	> 97%	93-97%	92%	91%	90%	89%	88%	87%	86%	85%
Mat Density % Pay	Note 1	100%	99%	95%	91%	87%	83%	73%	63%	53%
Joint Pay Adjustment	Note 2	0%	0%	0%	0%	-1%	-5%	-9%	-15%	-21%

T401 Compaction Form – April 2023 Revision

Roller Pass

Select 100 foot **CONTROL SECTION – 100 Ft past the Take-off Joint.**

Divide into TWO equal **SUBLOTS** (50 foot each)

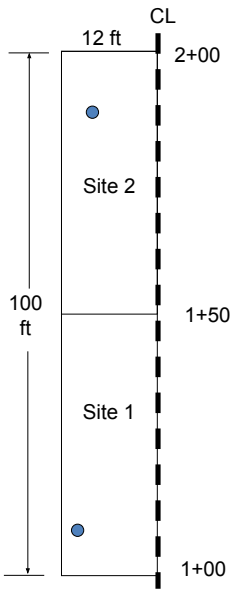
	Random Numbers		Location	
	Length	Width	Distance	Offset (Left)
1	0.338	0.917	1+17	11
2	0.629	0.631	1+81	8

Length
0.338 x 50
16.9 ⇒ 17
1+00
0+17
1+17

Site 1

Width
0.917 x 12
11.0 ⇒ 11

Measure density
Use form T 407



Testing Process (2022 & 2023)

Density Testing – **Roller Pass**

- Control Section - 100 ft to 200 ft from the take-off joint. (100 Feet Long)
- 2 – 50 Ft. sublots with 1 random testing location within.
- Apply 4 Passes, take 1 Minute Test, Mark Gauge Location, record results and temperature - for each location.

Testing Process (2022 & 2023)

Control Section – **Roller Pass**

- Add 2 more Passes – Repeat Test in the **same spot** as the first one, record results and temperature.
- Compare second set average wet density to the first set average wet density.

Testing Process (2022 & 2023)

Control Section – **Roller Pass**

- Continue process – 2 Passes at a time until one of the following occur :
- Less than **5 kg/m³** increase in Average Wet Density.
- One or Both test Locations "Break Over"
- The Relative Density exceeds 97% of the Theoretical . Max Gravity (Gmm)
- The Mat Temperature Reaches 175 Degrees

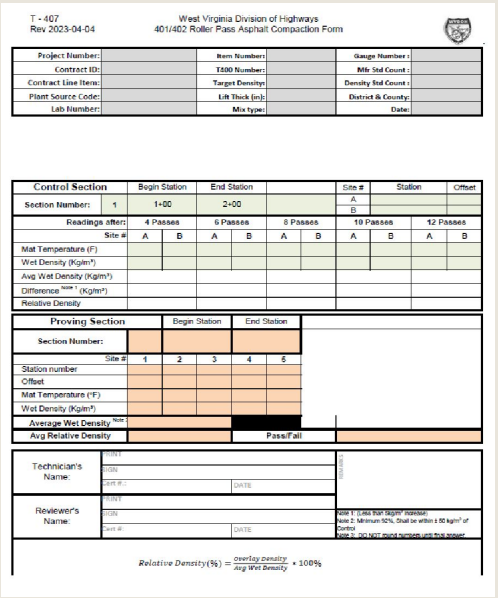
Testing Process (2022 & 2023)

Density Testing – **Roller Pass**

Proving Section – Area after Roller Passes are established to validate it is the correct number.

Daily Roller Passes to be established per Project

Roller Pass T407 Compaction Form - July 2019 Revision



T - 407
Rev 2023-04-04

West Virginia Division of Highways
401/402 Roller Pass Asphalt Compaction Form

Project Number:		Item Number:		Gauge Number :	
Contract ID:		T400 Number:		Mfr Std Count :	
Contract Line Item:		Target Density:		Density Std Count :	
Plant Source Code:		Lift Thick (in):		District & County:	
Lab Number:		Mix type:		Date:	

Control Section		Begin Station		End Station				Site #	Station		Offset
Section Number:	1	1+00		2+00				A			
								B			
Readings after:		4 Passes		6 Passes		8 Passes		10 Passes		12 Passes	
Site #		A	B	A	B	A	B	A	B	A	B
Mat Temperature (F)											
Wet Density (Kg/m³)											
Avg Wet Density (Kg/m³)											
Difference [Note 1] (Kg/m³)											
Relative Density											

Proving Section		Begin Station		End Station	
Section Number:					
Site #	1	2	3	4	5
Station number					
Offset					
Mat Temperature (°F)					
Wet Density (Kg/m³)					
Average Wet Density [Note 2]					
Avg Relative Density				Pass/Fail	

Technician's Name:	PRINT		
	SIGN		
	Cert # :	DATE	
Reviewer's Name:	PRINT		
	SIGN		
	Cert # :	DATE	

Note 1: (Less than 50g/m³ minimum)
Note 2: Minimum 92%. Shall be within ± 50 kg/m³ of Control
Note 3: DO NOT round numbers until final answer

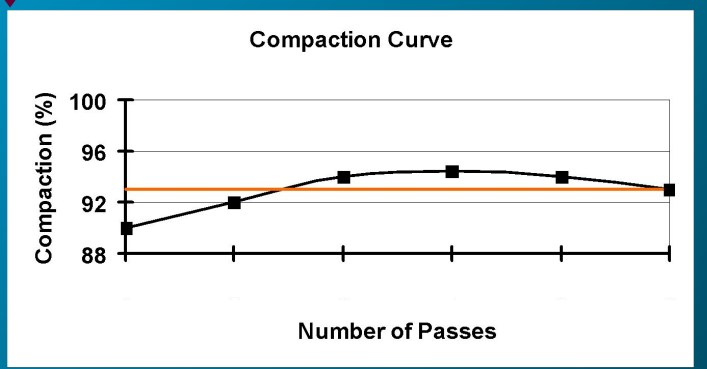
$$Relative\ Density(\%) = \frac{overlay\ density}{Avg\ Wet\ Density} \times 100\%$$

Testing Process (2023)

Proving Section – **Roller Pass**

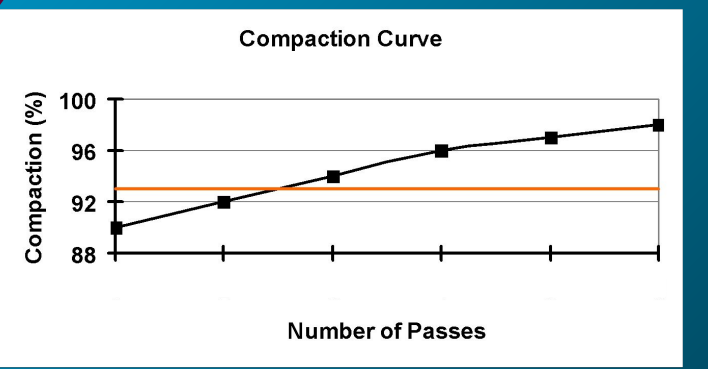
- **1000** Feet long beginning at the end of the Control Section.
- **5** Random Wet Density Tests
- Average Density must be 92% or greater
- Average must be within **50** Kg/m³ of the Control Section Density.

Roller Pattern Problem #1



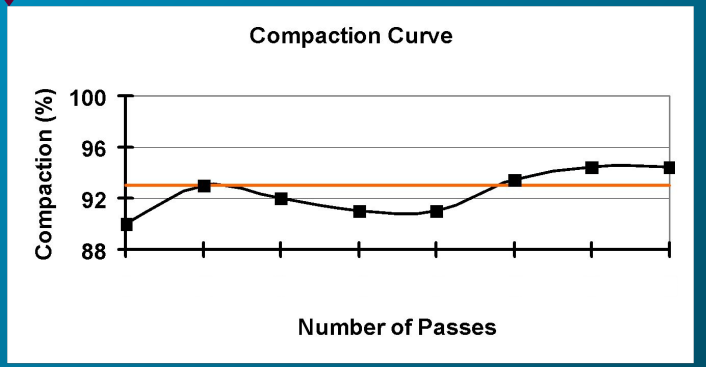
8-47

Roller Pattern Problem #2



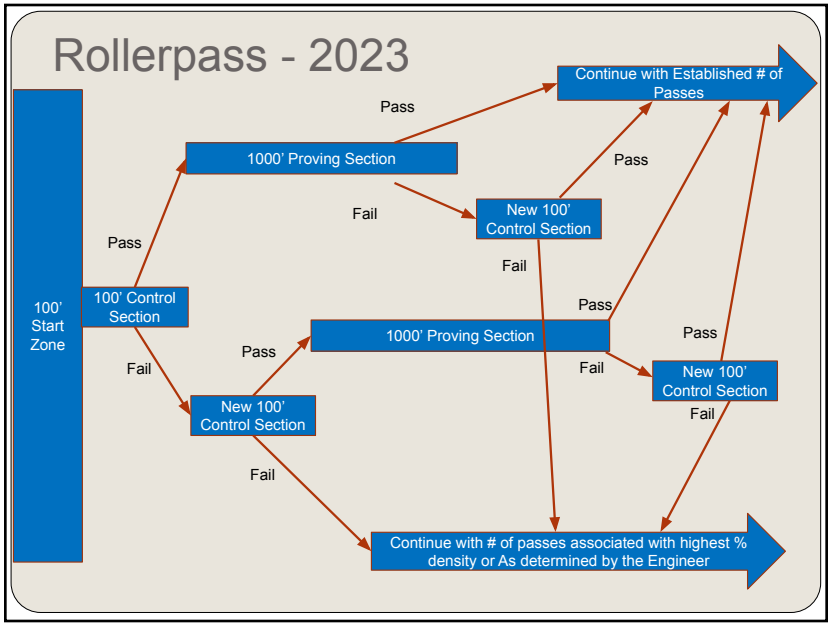
8-48

Roller Pattern Problem #3



Decreasing Temperature

8-49



Nuclear Gauge Testing Summary

1. Use random numbers to locate test sites according to MP 712.21.26.
2. Must have a void free surface, fill voids with dry silica sand or mortar sand. Surface must be smooth and flat.
3. Take a ONE minute WET DENSITY Reading in BACKSCATTER Position.
4. Be careful that your gauge doesn't get damaged by construction equipment etc.
5. Check with District prior to Project to make sure of which testing Specs to use.

Example Tack Calculation

- Existing roadway is very old, dried, cracked, etc. – “Oxidized” from Table 408.11
- Prior to tack placement, dial gauge reads 450 gallons. Tack is diluted.
- Tack is placed from Sta. 0+00 to Sta. 10+00. Dial gauge reads 275 gallons after tack placement.
- Road width is an average of 12’.

Example Tack Calculation

TABLE 408.11

Condition of Existing Pavement	Application Rate (gal/sy) (Note 2)	
	Undiluted	Diluted (1:1) (Note 3)
New HMA (Note 4)	0.04 – 0.05	0.08 – 0.10
Oxidized HMA	0.07 – 0.10	0.13 – 0.20
Milled Surface	0.10 – 0.13	0.20 – 0.27
PC Concrete	0.07 – 0.10	0.13 – 0.20

Note 2: Application rates are for slow setting emulsions grades (SS and CSS) that contain approximately 60% asphalt material. Rapid setting emulsion grades may contain slightly higher or lower asphalt contents, but can usually be applied within the same application range.

Note 3: Dilution rate only applies to SS and CSS grades.

Note 4: Tack coat is normally not needed over a layer of new HMA that has been placed within the last few days, as long as the underlying new layer has not become dirty under traffic or from windblown dust.

408.12-METHOD OF MEASUREMENT:

No materials shall be removed from the Project for any purpose until the operation has been completed and the quantities of materials incorporated into the operations have been determined, except when authorized by the Engineer.

The quantity of "Asphalt Material" for tack coat shall be the number of gallons, prior to dilution, incorporated into the completed work. Any applicable dilution rates, shall be supplied to the Engineer by the Contractor on the material delivery ticket.

Dry sand or stone chips used as a blotter course due to excessive use of tack coat shall be considered incidental to the work.

When items for maintaining traffic are included in the Contract, they will be measured and paid as provided in Section 636.

Example Tack Calculation

- Calculate the tack used

  PAY QTY. = 450 gal – 275 gal = <u>175 GALLONS</u>

- LETS CHECK THE APPLICATION RATE:
  - (12’ x 1000’) ÷ 9 ft^2 per yd^2 = 1333.33 yd^2
- Calculate Rate of Application
  - 175 gal ÷ 1333.33 yd^2 = ***0.13 gal/yd^2***

TABLE 408.11

Condition of Existing Pavement	Application Rate (gal/sy) (Note 2)	
	Undiluted	Diluted (1:1) (Note 3)
New HMA (Note 4)	0.04 – 0.05	0.08 – 0.10
Oxidized HMA	0.07 – 0.10	0.13 – 0.20
Milled Surface	0.10 – 0.13	0.20 – 0.27
PC Concrete	0.07 – 0.10	0.13 – 0.20

Contract: , Inspector: , DWR Date: 06/17/19

Project Nbr: , Line Itm Nbr: 0015 , Loc Seq No: 1

Item Code & Desc: 408002-001 ASPHALT MATERIAL

West Virginia Department of Transportation
Division of Highways
Inspector's Bituminous Emulsion Tack Worksheet

Ver 1.1 March 2 2016

Producer / Supplier: MPC1.01.705 - Marathon Petroleum F-1 @ Catlettsburg , Total Quantity Placed: 175.

Row 1 of 1 | Ticket Number | Original Invoice No | Material Type | Source of Material

OBSERVATIONS - *Comment below if any of the following are not met:*

- Traffic Control and Flaggers in place ☒
- Surface temp above 40 degrees F ☒
- Surface clean prior to placement ☒
- Uniform application of tack coat ☒

Existing Pavement Condition	Target Application Rate (gal/yd²)*	
	Undiluted ☒	Diluted (1:1) ☐
New HMA ☐	0.04 - 0.05	0.08 - 0.10
Oxidized HMA ☒	0.07 - 0.10	0.13 - 0.20
Milled Surface ☐	0.10 - 0.13	0.20 - 0.27
PCC ☐	0.07 - 0.10	0.13 - 0.20

*Undiluted = 60% Residual Asphalt, Diluted = 30% Residual Asphalt

A	B	C	D	E	F	G	H	I	J
Time	Start Station	End Station	Length (ft) C - B	Width (ft)	Area (yd²) (D x E) / 9	Initial Reading (gal)	Final Reading (gal)	Amount Applied (gal) G - H	Rate (gal/yd²) I / F
00:00	0 +00	10 +00	1000.	12.	1333.33	450.	275	175.00	.13

Remarks

Running Amount Applied 175.

EXAMPLE DWR ENTRY

Division of Highways

Daily Work Report

Report v1

Contract:	2023080002, BIG OTTER-FRAMETOWN RD					**Prime Contractor:**	WEST VIRGINIA PAVING, INC.
DWR Date:	9/6/2023	**Day of Week:**	Wednesday	**Inspector:**	James Putnam	**Agency Project Engineer:**	Steven Ruppert
Seq Num:	1	**DWR Status:**	Approved	**Entered By:**	James Putnam	**Agency Delivery Engineer:**	Steven Ruppert
Last Updated Date:	9/14/2023			**Last Updated By:**	Savannah Summers	**Managing Office:**	
Weather:	9			**Low Temp:**	66 **High Temp:** 91	**Rainfall Amount:**	**SECIR Indicator:**
Fed. Proj. Num:	NHPP-0079(091)			**State Proj. Num:**	S308-79-43.37 00		
Work Items:	Yes			**Contractors:**	Yes	**Daily Staff:**	No **Attachment(s):** Yes

Remarks

Type	Remarks
00	PRIME CONTRACTOR TIME WV PAVING NO LUNCH 6:00AM TO 7:00PM = 13 HRS WVDOH PERSONNEL TIME JAMES PUTNAM 5:30AM TO 7:30PM = 13.5 HRS 1 HR TRAVEL 12.5 HRS PROJECT INSPECTION, DOCUMENTATION, ETC WVDOH PERSONNEL TIME DAKOTA RIFFLE 6:30AM TO 7:30PM = 12.5 HRS 1 HR TRAVEL 11.5 HRS PROJECT INSPECTION, ETC
02	2023 09 06 DWR 0025 SUPERPAVE ASPHALT TICKETS TY19 2023 09 06 DWR 0025 SUPERPAVE ASPHALT DELIVERY REPORT TY19
03	LINE # 0025, ITEM 410001-030 SUPERPAVE ASPHALT BASE TY 19

Division of Highways

Daily Work Report

Report v1

Item Postings

Item Description	Item ID	Seq. Num	Cont Ln	Project	Category	Proj Ln	Quantity Posted	Unit	From Station - To Station Location
SUPERPAVE ASPHALT BASE CRSE, TY 19	410001-030	1	0025	2023080002	0001	0025		SY	BIG OTTER FRAMETOWN RD PROJECT

Materials:

Material Name	Installed Quantity	Unit	Source	Work Location
19 mm Asphalt Mix, Superpave		TN		

Contractor: WEST VIRGINIA PAVING, INC.

Comments: PAY FOR THIS ITEM WILL BE MADE AT A LATER DATE ON COMPLETION OF PWL SAMPLE TESTING.

AT THE FOLLOWING LOCATIONS, THE CONTRACTOR USES A TRANSFER MACHINE AND A RUBBER TIRE PAVER TO PLACE ASPHALT BASE FOLLOWED BY 3 STEEL DRUM ROLLERS FOR COMPACTION. TERRADON TECHNICIAN, JUSTIN WHITTINGTON, ON SITE FOR DENSITY. WV PAVING, JAMEY PROPPS ON SITE FOR PWL CORE DRILLING. WVDOH TECHNICIAN DAVID SCHOOLCRAFT ON SITE.

(PAYMENT WILL BE REQUESTED FOR A 12FT LANE)

SB SLOW LANE
2611+75 TO 2596+70 = 1505
EQUALITY
2595+78 TO 2516+35 = 7943

1505 + 7943 = 9448

((9,448 X 12 = 113,376) / 9 = 12,597.333)

NB SLOW LANE
2516+35 TO 2522+80 = 645

((645 X 12 = 7,740) / 9 = 860)

12,597.333 + 860 = 13,457.333 SY

PAY QUANTITY = 0 SY

TRAFFIC CONTROL DEVICE	636011-001	1	0140	2023080002	0001	0140	0	UN	BIG OTTER FRAMETOWN RD PROJECT

Materials:

Material Name	Installed Quantity	Unit	Source	Work Location
Traffic Control Devices	0	EA		

Contractor: HIGHWAY SAFETY, INC.

Comments: ALL TRAFFIC CONTROL DEVICES ARE PROPERLY LOCATED THROUGHOUT THE PROJECT. THE SIGNS ARE CLEAN, LEGIBLE, AND CLEARLY VISIBLE. SPEED TRAILERS AND ARROW BOARDS ARE ALSO UTILIZED IN EACH LANE AS PART OF THE REQUIRED SPECIFICATIONS FOR THE TRAFFIC CONTROL SET UP AS LISTED PER THE PLAN SHEET. REFER TO THE DAILY CHECK LIST FOR ADDITIONAL INFORMATION.

PAY QUANTITY = 0 UN

TRAFFIC DIRECTOR	636014-002	1	0155	2023080002	0001	0155	11.5	HR	BIG OTTER FRAMETOWN RD PROJECT

Materials:

Material Name	Installed Quantity	Unit	Source	Work Location

Contractor: WEST VIRGINIA PAVING, INC.

Comments: CONTRACTOR USES A TRAFFIC DIRECTOR ON THIS DATE FOR THE SAFETY OF THE TRAVELING PUBLIC. PATROL VEHICLE FOLLOWED THE OPERATIONS THROUGHOUT THE PROJECT AS PER THE CONTRACTOR'S REQUEST. THE OFFICER ON DUTY THIS DATE IS BRIAN YOUNG.

HOURS ON SITE 7:00AM TO 6:30PM = 11.5 HRS

PAY QUANTITY = 11.5 HR

ELECTRIC ARROW	636021-001	1	0160	2023080002	0001	0160	2	DA	BIG OTTER FRAMETOWN RD PROJECT

Materials:

Material Name	Installed Quantity	Unit	Source	Work Location

Comments: CONTRACTOR UTILIZES 32 TYPE B WARNING LIGHTS. ALL TYPE B WARNING LIGHTS ARE PLACED PROPERLY. ALL TYPE B LIGHTS ARE ON AND WORKING PROPERLY. AS PER THE PLANS, B LIGHT PAYMENT WILL BE REQUESTED FOR PLACEMENT ON ROAD WORK 2 MILES SIGNS, ROAD WORK 1 MILE SIGNS, AND 55 MPH SIGNS.

ALL B-LIGHTS ARE WORKING THIS DATE

PAY QUANTITY = 32 DA

SHADOW VEHICLE	636028-002	1	0175	2023080002	0001	0175		MO	BIG OTTER FRAMETOWN RD PROJECT

Materials:

Material Name	Installed Quantity	Unit	Source	Work Location

Contractor: WEST VIRGINIA PAVING, INC.

Comments: CONTRACTOR UTILIZES A SHADOW VEHICLE WHILE PERFORMING WORK. I PREVIOUSLY ADVISED WV PAVING TO HAVE THE SHADOW VEHICLE SET UP TO MEET SPECIFICATIONS LISTED IN THE STANDARD DETAILS. THE SHADOW VEHICLE HAS BEEN EQUIPPED WITH FLASHING BEACONS AND A TRUCK MOUNTED ATTENUATOR. SPOKE WITH VERN WALKER, WV PAVING, ABOUT HAVING 2 SHADOW VEHICLES ON THE PROJECT WHEN PROJECT SCHEDULED FOR 1 AS PER THE PLANS. WV PAVING AGREED HAVING PAYMENT FOR THE USE OF 1 UNLESS 2 BECOMES NEEDED. ONLY 1 IS BEING UTILIZED AT THIS TIME.

PUT IN SERVICE ON 07/25/2023. NEXT PAYMENT REQUEST 9/25/2023

PAY QUANTITY = 0 MO

SPEED MONITORING TRAILER	636030-001	1	0180	2023080002	0001	0180		2 DA	BIG OTTER FRAMETOWN RD PROJECT

Materials:

Material Name	Installed Quantity	Unit	Source	Work Location
Traffic Control Devices	0	EA		

Contractor: HIGHWAY SAFETY, INC.

Comments: THERE ARE 2 SPEED MONITORING TRAILERS PLACE ON THIS PROJECT. ONE PLACED ON THE SB SIDE OF THE PROJECT AND ONE ON THE NB SIDE OF

WEST VIRGINIA DEPARTMENT OF TRANSPORTATION
DIVISION OF HIGHWAYS
INSPECTOR'S ASPHALT PAVEMENT WORKSHEET

AUTH NO: _____ PROJECT NO: _____ IDR NO: _____

LINE NO: _____ ITEM NO: _____ DATE: _____

LOAD	TICKET #	TONS / MG	CUM. TOTAL	LOAD	TICKET #	TONS / MG	CUM. TOTAL
1				25			
2				26			
3				27			
4				28			
5				29			
6				30			
7				31			
8				32			
9				33			
10				34			
11				35			
12				36			
13				37			
14				38			
15				39			
16				40			
17				41			
18				42			
19				43			
20				44			
21				45			
22				46			
23				47			
24				48			

REMARKS: _____

TOTAL Tons (Mg) THIS DATE: _____ INSPECTOR: _____

5/19/2009 Signature

ROLLER PASS DATA _____ PCF SPEED OF ROLLER _____ MPH TYPE OF ROLLER _____

ROLLER PASS DATA _____ PCF SPEED OF ROLLER _____ MPH TYPE OF ROLLER _____

PLAN THICKNESS _____

CALCULATION OF APPLICATION RATE (ONE CALCULATION PER EACH 762 m (2500 LF))

BEGIN STATION						
END STATION						
WIDTH						
Sm (SY)						
Mg (TONS)						
Mg/Sm (LB/SY)						

OBSERVED SIMILARITY TESTS (ONE OBSERVATION PER EACH 305 m (1000 LF)

LOT NUMBER						
TEST NUMBER						
Mg/Cm (LB/CY)						
STATION						

MAT THICKNESS (PRIOR TO COMPACTION) & MAT TEMPERATURE (AT TIME OF FINAL COMPACTION PASS) CHECKS (ONE CHECK PER 305 m (1000 LF)

TIME						
MAT TEMPERATURE						
MAT THICKNESS						
STATION						

TIME						
MAT TEMPERATURE						
MAT THICKNESS						
STATION						

ROLLER SPEED CHECKS (FOUR CHECKS - TWO AM AND TWO PM)

TIME						
ROLLER SPEED						

CHECKS ____ VERIFIED PRIOR TO PLACEMENT CHECKS ____ VERIFIED DURING PLACEMENT

- ☐ SEQUENCE OF OPERATION VERIFIED
- ☐ TRAFFIC CONTROL DEVICES AND FLAGGERS IN PLACE
- ☐ HEEL-IN JOINTS CUT AND POTHOLES CORRECTED
- ☐ SURFACE CLEAN AND STRINGLINE PLACED
- ☐ ROLLER(S) AND PAVER(S) VERIFIED FOR COMPLIANCE
- ☐ CONTRACTORS DENSITY TECHNICIAN ON SITE
- ☐ LONGITUDAL JOINTS PINCHED / NO OVERLAPPED
- ☐ TRUCKS COVERED AND INSULATED WITH NO OIL LEAKS OR DAMAGED SIDES
- ☐ OPERATION CONTINUOUS AND PAVER SPEED COMPATIBLE TO PLANT PRODUCTION
- ☐ VIBRATING SCREED ON AND TEXTURE OF MAT CORRECT
- ☐ CORRECT ROLLING SEQUENCE BEING USED
- ☐ STRAIGHT EDGE CHECKS BEING MADE
- ☐ COMPLIANCE WITH QUALITY CONTROL PLAN MAINTAINED
- ☐ TEMPERATURE OF MATERIAL RECORDED ON TICKETS ONCE PER HOUR MINIMUM

AIR TEMP _____ °C (°F) AT (TIME) _____ BASE TEMP _____ °C (°F) AT TIME _____

AIR TEMP _____ °C (°F) AT (TIME) _____ BASE TEMP _____ °C (°F) AT TIME _____

T - 401
Rev 2023-04-10

West Virginia Division Of Highways
401/402 Lot-By-Lot Asphalt Compaction Form

Project Number:		**Item Number:**		**Gauge Number :**	
Contract ID:		**T400 Number:**		**Man Std Count :**	
Contract Line Item:		**Target Density (A):**		**Density Std Count :**	
Plant Source Code:		**Lift Thick (in) :**		**District & County:**	

Acceptance Tests

Date:										
Begin/End Station:										
Lab Number:										
Lot Number:	A1	J1	A2	J2	A3	J3	A4	J4	A5	J5
Wet Density (B) :										
% Relative Density (C):										
Lot Evaluation: Pass/Fail										

Quality Control or Additional Acceptance Tests

Date:										
Beginning Station:										
Ending Station:										
Paving Width (Feet):										
Lab Number:										
Lot Number:	A1	J1	A2	J2	A3	J3	A4	J4	A5	J5
Offset (Rt or Lt of CL):		4 Inches		4 Inches		4 Inches		4 Inches		4 Inches
Wet Density: 1										
Wet Density: 2										
Wet Density: 3										
Wet Density: 4										
Wet Density: 5										
Average Wet Density: (B) = Avg (1 thru 5)										
Relative Density (%): (C)										
Lot Evaluation: Pass/Fail										
Lot % Pay (%)										

% Relative Density	> 97%	93-97%	92%	91%	90%	89%	88%	87%	86%	85%
Mat Density % Pay	**Note 1**	100%	99%	95%	91%	87%	83%	73%	63%	53%
Joint Pay Adjustment	**Note 2**	**0%**	**0%**	**0%**	**0%**	**-1%**	**-3%**	**-9%**	**-15%**	**-21%**

Technician's Name:	PRINT SIGN Cert #.: DATE	REMARKS
Reviewer's Name:	PRINT SIGN Cert #: DATE	Note 1: See Notes in Table 401.13.3A Note 2: See Notes in Table 401.13.3B Note3: DO NOT round numbers until final answer. Note 4: Report all Densities in kg/m3

$$Relative\ Density(C)(\%) = \frac{Average\ Density\ (B)}{Target\ Density\ (A)} * 100\%$$

$$Lot\ Pay(\%) = Mat\ Density\ \% + Joint\ Adjustment$$

West Virginia Division of Highways
401/402 Roller Pass Asphalt Compaction Form

Project Number:		**Item Number:**		**Gauge Number :**	
Contract ID:		**T400 Number:**		**Mfr Std Count :**	
Contract Line Item:		**Target Density:**		**Density Std Count :**	
Plant Source Code:		**Lift Thick (in):**		**District & County:**	
Lab Number:		**Mix type:**		**Date:**	

Control Section		Begin Station	End Station		Site #	Station	Offset
Section Number:	**1**	1+00	2+00		A		
					B		

Readings after:	**4 Passes**		**6 Passes**		**8 Passes**		**10 Passes**		**12 Passes**	
Site #	**A**	**B**	**A**	**B**	**A**	**B**	**A**	**B**	**A**	**B**
Mat Temperature (F)										
Wet Density (Kg/m³)										
Avg Wet Density (Kg/m³)										
Difference Note 1 (Kg/m³)										
Relative Density										

Proving Section		Begin Station	End Station		
Section Number:					
Site #	**1**	**2**	**3**	**4**	**5**
Station number					
Offset					
Mat Temperature (°F)					
Wet Density (Kg/m³)					
Average Wet Density Note 2					
Avg Relative Density			**Pass/Fail**		

Technician's Name:	PRINT	REMARKS
	SIGN	
	Cert #.: DATE	
Reviewer's Name:	PRINT	
	SIGN	
	Cert #: DATE	

Note 1: (Less than 5kg/m^3 increase)
Note 2: Minimum 92%, Shall be within ± 50 kg/m^3 of Control
Note 3: DO NOT round numbers until final answer.

$$Relative\ Density(\%) = \frac{Overlay\ Density}{Avg\ Wet\ Density} * 100\%$$

Problem	Causes																																				
	Fluctuating head of material	Feeder Screws Overload	Finisher Speed Too Fast	Too Much Lead Crown in Screed	Too Little Lead Crown in Screed	Over correction of Thickness Control Screws	Excessive Play in Screed Mechanical Connection	Screed Riding on Lift Cylinders	Screed Plates Worn Out or Warped	Screed Plates not Tight	Cold Screed	Moldboard on Strikeoff Too Low	Running Hopper Empty Between Loads	Feed Gates Set Incorrectly	Kicker Screws Worn Out or Mounted Incorrectly	Incorrect Nulling of Screed	Screed Starting Blocks Too Short	Screed Extensions Installed Incorrectly	Vibrators Running Too Slow	Grade Control Mounted Incorrectly	Grade Control Hunting (Sensitivity too High)	Grad Control Wand Bouncing on Reference	Grade Reference Inadequate	Sitting Long Period Between Loads	Improper Joint Overlap	Improper Mat Thickness for Aggregate Size	Trucks Bumping Finisher	Truck Holding Brakes	Improper Base Preparation	Improper Roller Operation	Reversing or Too Rapidly Turning Rollers	Parking of Roller on Hot Mat	Improper Mix Design (Aggregate)	Improper Mix Design (Asphalt)	Mix Segregation	Moisture in Mix	Variation of Temperature of Mix	Cold Mix Temperature
Wavy Surface – Short Waves (Ripples)	√	√	√				√	√		√										√	√	√	√					×	×					×		
Wavy Surface – Long Waves	√	√				√	√	√					√	√						√			√	√			×	×		×	×			×		
Tearing of Mat – Full Width			√						√		√														×							×	×	×	×	×	×
Tearing of Mat – Center Streaks					√				√		√			√	√																						×
Tearing of Mat – Outside Streaks				√					√		√	√		√				√																			×
Mat Texture Nonuniform	√	√	√					√	√	√	√		√					√	√					√		×			×			×	×	×	×	×	×
Screed Marks							√																				×	×									
Screed Not Responding to correction			√				√	√		√										√						×										×	×
Auger Shadows		√																															×	×	×		
Poor Precompaction			√					√											√							×			×								×
Poor Longitudinal Joint	√	√				√		√												√	√	√			√					×							×
Poor Transverse Joint		√					√	√		√						√	√													×							×
Transverse Cracking (Checking)																												×	×			×	×		×	×	
Mat Shoving Under Roller																												×	×	×		×	×		×	×	
Bleeding or Fat Spots in Mat																																×	×		×	×	
Roller Marks																												×	×	×	×					×	
Poor Mix Compaction																												×	×	×	×	×	×		×	×	×

√ Indicates a paver problem; × indicates a problem to be investigated

There can be multiple causes of problems, investigate each one.