U.S. Department
of Transportation
Federal Highway Administration

NATIONAL HIGHWAY INSTITUTE

Based on:
NHI Course No. 131032

Hot-Mix Asphalt Construction

Prepared By:

JOINT AASHTO FHWA INDUSTRY TRAINING COMMITTEE ON ASPHALT
"Partners in Performance"

Applied Pavement Technology, Inc.
1755 E. Plumb Lane, Suite 111
Reno, Nevada 89502

Adjusted by

STATE OF WEST VIRGINIA DEPARTMENT OF TRANSPORTATION

Asphalt Pavement Association OF WEST VIRGINIA

West Virginia University
Asphalt Technology Program

Latest Revision: November 2015

Day	Start time	Module	Title	
1	7:30		REGISTRATION	
	8:00	1	Course Introduction	Zaniewski
	8:30	2	Project Organization and Communication	Zaniewski
	9:00	3	Surface Preparation	Bucklew
	10:00		Break	
	10:15	4	Asphalt Delivery	Bucklew
	11:45		Lunch	
	1:00	5	Asphalt Placement	Bucklew
	2:30		Break	
	2:45	5	HMA Placement	Bucklew
	4:00	6	Joint Construction	Bucklew
	5:00		Conclude day 1	
2	8:00		Day 1 review and questions	Zaniewski
	8:30	7	Troubleshooting No. 1	Zaniewski
	9:30	7	Compaction	Zaniewski
	10:15		Break	
	10:30	8	Compaction (Continued	Zaniewski
	11:45		Lunch	
	1:00	8	Compaction (Continued)	Zaniewski
	2:30		Break	
	2:45	9	WVDOH Inspector Duties/Site Manager	Hamrick
	5:00		Free time	

Day	Start time	Module	Title	
3	8:00		Troubleshooting No. 2	Zaniewski
	8:30	10	Quality Control/Quality Assurance	Zaniewski
	10:00		Break	
	10:15	11	Asphalt Density Measurement	Fowler
	11:45		Lunch	
	1:00		Asphalt Density Measurement *(continued)*	Fowler
	2:30		Break	
	2:45		Asphalt Density Measurement *(continued)*	Fowler
	3:45		Control strips and New 401 (PWL)	Campbell Crane
	5:00		Go study	
4	7:30		Register for exam	Fowler
	8:00		Asphalt Field Tech Exam	
			Nuclear gauge practical following test (optional)	
	12:00		Lunch	
	1:00	12	Radiation safety *continued* (optional)	
	4:00		Radiation safety exam	

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1-1

Introductions and Class Poll

- Employer?
- Experience with HMA/WMA?
  - Inspection
  - Supervision
  - Paving crew
  - Roller operator
- No experience?

1-2

Presentation Format

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

1-3

Module 1

Course Introduction

1-4

Need for the Course

- **Training for individuals assigned to asphalt paving projects**
  - New certification program for asphalt field inspectors
  - Include compaction measurement Asphalt Concrete
  - WVDOH believes this course is needed
  - More cost effective use of tax dollars spent on asphalt pavements

1-5

Overall Course Objectives

1. **Recognize the roles & responsibilities of each person on the construction job**
2. **Describe the purpose of project documents and cooperative communication on the job**
3. **List the steps involved in preparing bases and existing surfaces for HMA overlays**

1-6

Overall Course Objectives

4. **Define a proper HMA delivery process to the job site**
5. **Explain the effect of the various components of a HMA paving machine on the finished mat**

1-7

Overall Course Objectives

6. **Describe how to make a good longitudinal or transverse joint**
7. **Describe what effect the compaction process has on the finished pavement**
8. **Identify QA techniques that apply to HMA construction**
9. **Describe the WVDOH QA/QC process**

1-8

WVDOH QA/QC process

- Subjects
  - Compaction,
  - Density testing,
  - Smoothness
- New Module
  - nuclear gauge,
  - gauge comparisons
  - random locations for lot-by-lot testing
  - rollerpass method

1-9

Local Issues

- **Typical design**
- **Contractors/material suppliers**
- **Hauling**
- **Laydown**
- **Compaction**
- **Other?**

WV specific information

1-10

Course Schedule (Day 1)

Module	Title
1	**Course Introduction**
2	**Project Organization and Communication**
3	**Surface Preparation**
4	**Asphalt Mix Delivery**
5	**Asphalt Mix Placement**
6	**Joint Construction**

1-11

Course Schedule (Day 2)

Module	Title
7	**Troubleshooting No. 1**
8	**Compaction**
9	**Density Control Strips**
10	**WVDOH Inspector Duties**

1-12

Course Schedule (Day 3)

Module	Title
9	**Troubleshooting No. 2**
10	**Quality Control/ Quality Assurance**
11	**Asphalt Density Measurement**
12	**Hands-on Nuclear Gauge Training**

1-13

Course Schedule (Day 4)

Title
Written Exam
Optional Asphalt Compaction Practical Exam
Optional Nuclear Gauge Safety Training

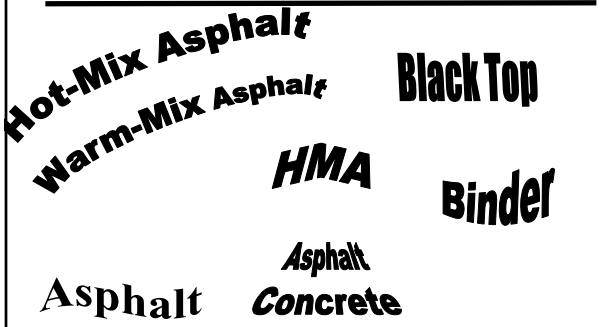
1-14

Course Reference Materials

Participant's Workbook
Hot-Mix Asphalt Paving Handbook 2000
WVDOH Materials
- **MP 401.05.20,**
- **Compaction Worksheets 401 & 407,**
- **QC/QA using nuclear density gauge**
- **IDR**

1-15

Terminology



1-16

The "Team"

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

1-17

Teamwork and Cooperation

1-18

Any Questions?

1-19

West Virginia University
Asphalt Technology Program

Module 2

Project Organization and Communication

2-1

Learning Objectives

1. State the objectives of project organization
2. Define the purpose of the pre-construction conference
3. Describe what should happen at a pre-paving conference

2-2

Learning Objectives

4. List the 4 components of project documents
5. Identify what information the project records should contain
   a) DOH –Daily Work Report
   b) Contractor – Daily diary?

2-3

Communication

2-4

Safety

On-Going Communication

- Weekly updates
- Major events
- Reporting requirements for WV
  - Daily Work Report
  - Compaction Forms
  - System requirements

2-6

Project Documents

	Hierarchy
• Special Provisions	1
• Plans	2
• Supplemental Specifications	3
• Standard Specifications	4
• *Purchase Orders???*	

2-7

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

2-8

Project Documents

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

2-9

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

2-10

Project Records

- Reports
- Pay Estimates
- Traffic Control Plan
- Change Orders
- Force Accounts
- As-Built Plans
- Environmental Documents

Daily Work Report

2-11

Detailed Report Forms

Daily Work Report
Tack Coat
Control Strip
Compaction Forms

2-12

Question

2-13

HMA Construction Program

Module 3

Surface Preparation

3- 1

Learning Objectives

1. Identify the objectives of surface preparation
2. Explain importance of smoothness and measurement techniques
3. Describe proper techniques for preparing subsurface layers for new pavement
4. Describe proper techniques for HMA surface preparation (prior to overlay)

3- 2

Learning Objectives

5. Describe proper *materials and construction* (M&C) techniques for patching
6. Describe proper techniques for placing leveling courses
7. Describe proper surface milling techniques
8. Identify typical surface preparation techniques for concrete pavements

3- 3

What is the primary objective of surface preparation?

Produce surface conditions that are conducive to maximizing the performance of the new HMA surface (or overlay).

3- 4

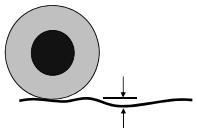
What do we have to improve to achieve the primary objective?

1. Strength and uniformity of supporting layers
2. Distress condition of existing surface
3. Bond between the HMA and the underlying layer
4. Smoothness
5. All of this for DENSITY!!

3- 5

Pavement Smoothness

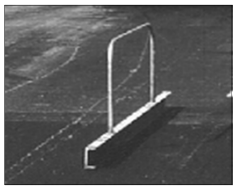
- Important because of its effect on:
  - Ride quality
  - Pavement deterioration
- Construction requirement (specification)
- Value depends upon cumulative profile variations



3- 6

Smoothness Measurement Equipment

Straight Edge



- WV 401.7.2
  - Machine evaluation
    - Inertial Profilometer
  - Other cases
  - 10 ft straight edge
  - Max Deviations
    - Base ¼ in
    - Surface 3/16 in

3- 7

Smoothness Measurement Equipment

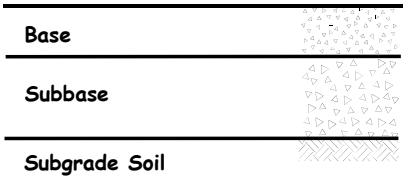
High-Speed Profilometer

3- 8

Preparation of the Subsurface Layers for a New Pavement

3- 9

What materials and construction factors do we strive to control?



3- 10

Is this subgrade ready?

3- 11

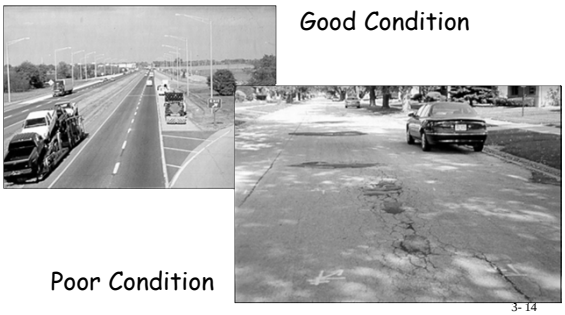
Proof Rolling

3- 12

Re-Work Weak Areas

3- 13

Preparation of an Existing Pavement Surface



Good Condition

Poor Condition

3- 14

Selection of treatments

- Overlay
- Patch and level
- Scratch coat
- Base repairs
- Designer
- Resurfacing coordinator

3- 15

Pavement Surface Repairs Must

- Address the distress mechanism (as well as symptom)
- Employ proper materials and construction procedures
- The plans and specification should define the contractor's responsibility for surface repairs.

3- 16

Is this old patch okay?

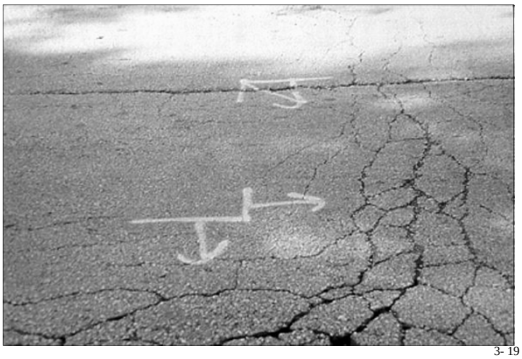
3- 17

Patch Construction

1. Mark patch boundaries
2. Cut boundaries
3. Remove HMA and weak materials
4. Repair foundation
5. Apply tack coat
6. Place HMA patch material
7. Compact the patch

3- 18

Mark Patch Boundaries



3- 19

What's wrong with these?

3- 20

Cut Boundaries

Small Patch

Medium to Large Patch

Remove HMA & Weak Materials

Back Hoe

Small Milling Machine

3- 22

Address drainage problems

3- 23

Repair Foundation
(Replace Base Material)

3- 24

Repair Foundation
(Base Compaction)

3- 25

Apply Tack Coat

Spray Application

Patch Area
After Tack

3- 26

Place HMA Patch Material

3- 27

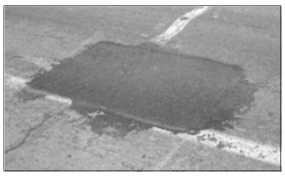
Patch Compaction

Small
Patches

Medium to Large
Patches

3- 28

HMA Patch Examples



Good

Poor

3- 29

Surface Preparation of Existing PCC Pavements

3- 30

Two Primary Categories

PCC Slab Repairs (CPR)	Fractured Slab Techniques
• Joint Resealing	• Crack and Seat
• Partial-Depth	• Break and Seat
• Full-Depth	• Rubblization
• Slab Replacement	

See NHI's *PCC Pavement Evaluation and Rehabilitation* Training Course (No. 131062)

3- 31

PCC Slab Repairs

Partial-Depth Repair

Designer or Resurfacing Coordinator

Full-Depth Repair

3- 32

Rubblization

Resonant Frequency Pavement Breaker

Multiple Drop Hammer

3- 33

Potential Problem with Crack Sealing

3- 34

Improving the Template

- Milling
- Patch and Level
- Scratch Course

3- 35

Patch and Level

- WVDOH
  - General: Patching and Leveling is to be placed at various locations throughout the project to remove irregularities in the existing pavement
    - Dips
    - Raise outside edge
    - Uniform template
  - Not specified as a continuous layer

3- 36

Scratch Course

- WVDOH
  - General: Scratch course shall be specified when deviations in the existing pavement are less than 1 inch in depth.
    - Full lane width
    - Not a constant thickness
    - Equipment drags on high spots and fills low spots
  - Can be placed over entire pavement or limits specified by engineer.

3- 37

Surface Leveling Course

3- 38

Manually Placed Leveling Course

3- 39

What caused these problems?

3- 40

Surface Milling and Micromilling

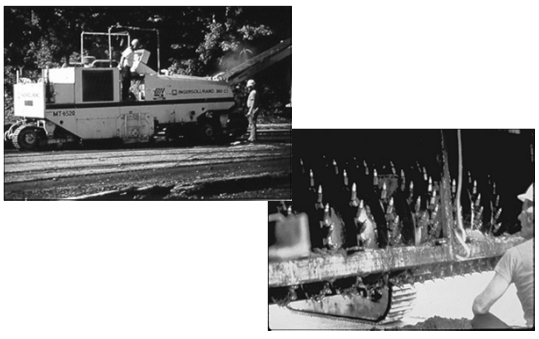
3- 41

Uses for Surface Milling

- Surface distress removal
- Achieve desired profile
  - Allows smoother placement of overlay
- Maintain curb reveal
- Improve bond

3- 42

Milling Equipment



3- 43

Micromilling

- Finer texture than standard milling
- Special provision
  - Remove less material
  - Template correction
  - Existing surfaces with minimal distress
  - Used with thin preservation treatments (High Performance Thin Overlay)

3- 44

Surface Cleaning

3- 45

Apply Tack Coat

Typical Application

Does this look okay?

3- 46

Tack Coat Examples

Proper Coverage

Anything wrong here?

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

AUTHORIZATION NO:	PROJECT NO:	ATTACHMENT TO IDR:
LINE NO:	ITEM NO:	DATE:
PLAN ID:		
CONTRACTOR AND SIGNATURE OF CONTRACTOR REP:		
TICKET NO:	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, all footnotes from Table 406.11 apply.

APPLICATION RATE CHECKS

A	B	C	D	E	F	G	H	I	J
Time	Start Station	End Station	Length (ft) C-B	Width (ft)	Area (yd²) (Dist)*9	Initial Reading (gal)	Final Reading (gal)	Amount Applied (gal) G-H	Rate (gal/yd²) I/F

COMMENTS: _____

INSPECTOR: _____

FORM 3-2 EXISTING SURFACE PREPARATION CHECKLIST

Existing surface check list

Date: _____

Project #: _____ Project: _____

Location of area: Station _____ to _____; Offset _____; Other _____

(HMA Base; HMA Binder, HMA Surface [new or old], PCC Surface)

Item	Deficiencies	Corrections	Agency OK	Contractor OK
Visual Survey				
Permanent Repairs				
Final Cleaning				
Tack Coat				

Good Practice!!!

REMARKS: _____

Traffic Control Concerns

3- 50

Module 4

HMA Delivery

HMA Construction Program

4-1

Learning Objectives

1. State the objective of HMA delivery
2. Discuss key issues related to haul trucks
3. Describe proper truck operation (loading and unloading) techniques
4. Describe the two types of segregation
5. Identify the 4 production rates needing coordination

4-2

HMA Delivery

- What is the objective?

- Truck drivers are a key component,… Make them a part of the team!

4-3

Key Issues Related to Haul Trucks

- Types and characteristics of haul trucks
- Methods of heat insulation
- Cleaning
- Truck maintenance

4-4

West Virginia Best Management Practices

- WVDOT/ Public Service Requirements
  - Oil drip
  - Dirt
  - Tires
  - Back-up alarm
  - Release agent (no diesel)

4-5

Three Basic Types of Haul Trucks

- End dump
- Belly (bottom) dump
- Horizontal discharge

4-6

End Dump Trucks

Standard

Semi-trailer

Standard End Dump Truck

- Capacity: 12-20 tons
- 3 to 6 axles
- Advantage: Maneuverability
- Disadvantage: Limited capacity

4-8

Specification 401.9.7 Trucks for Transporting Mixture

- Truck
  - Good repair –
    - No delays in transporting
    - No "large" oil leaks
  - Insulated
  - Covered
    - Limit air infiltration
    - Water tight
    - Above mix
    - Over sides
  - Hole for measuring temperature
- Release agent
  - Any commercial produce, subject to DOH approval
  - Thin coat
    - Soapy water
    - Mixture <10% lubricating oil
    - Polymer modified binder
      - Agent recommended by supplier
  - Remove excess prior to loading
  - NO DIESEL, KEORSENE OR SIMILAR SOLVENT

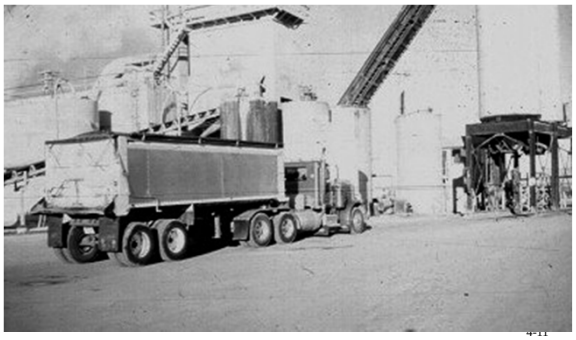
4-9

Tarp for (Some) Protection Against Heat Loss and Inclement Weather

Are there any potential problems with this tarp configuration?

4-10

Side Insulation



4-11

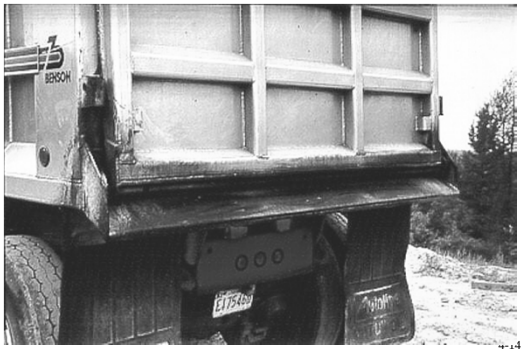
Keep Truck Bed Clean

4-12

Use Only Approved Release Agents

4-13

Keep Outside of Bed Clean Too



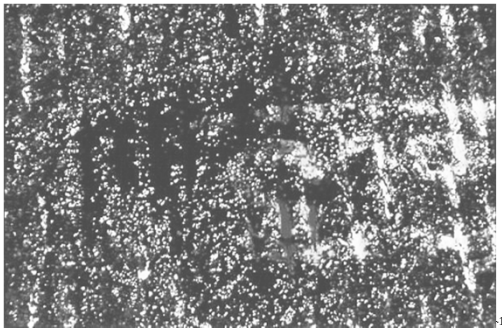
4-14

Haul Vehicle Maintenance

- Engine
- Drive Train
- Hydraulic System
- Brakes
- Lights

4-15

What problem does this hydraulic fluid leak create?



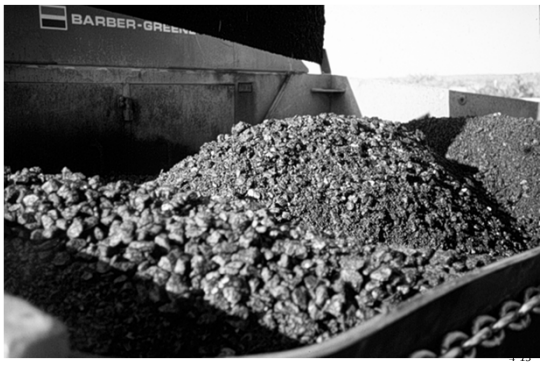
4-16

Acceptable Truck Bed?

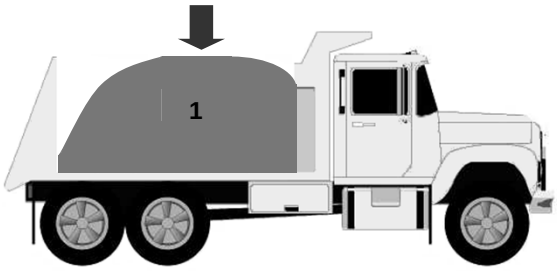
Truck Loading Practices

4-18

Must Avoid Segregation!



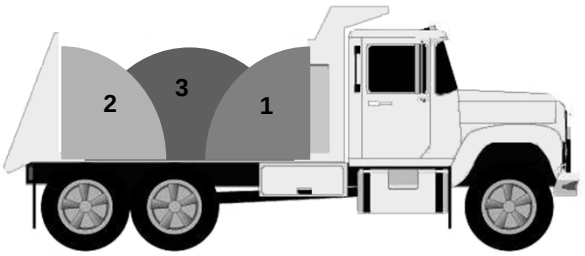
Bad Loading Practice



Not recommended for segregation-prone mixes!

4-20

Correct Sequence for Typical End Dump Trucks in WV



4-21

Other Loading Practices to Avoid

- Topping off
- Overloading

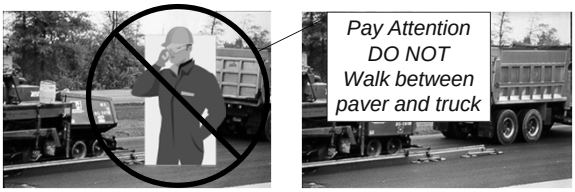
4-22

General Recommendations

- Trucks should wait in designated areas and avoid tracking of tack coat
- Coordinate truck schedule to assure timely arrivals with minimum wait time
- Maintain good communications with plant operators and truck drivers
- Collect weigh tickets upon arrival to site

4-23

End Dump Truck Operation



Positioning in front of paver

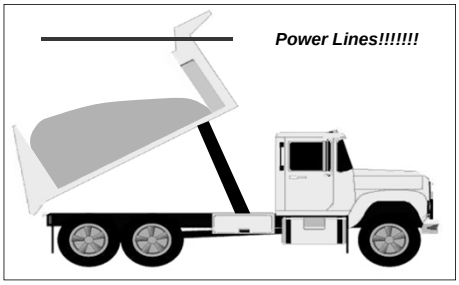
4-24

End Dump Truck Operation

First contact with paver,… avoid bump!

4-25

End Dump Truck Operation



Raise bed, but keep tailgate closed until mix slides against it

4-26

End Dump Truck Operation

Open gate and continue to raise bed

4-27

End Dump Truck Operation

Empty mix in one smooth, continuous discharge

WV Practice??

What are baffles for?

4-28

End Dump Truck Operation

Lower bed before pulling away

4-29

End Dump Truck Operation

Move out and make room

4-30

End Dump Truck Operation

Proceed to the designated clean-up area

4-31

End Dump Truck Operation

End Dump Truck Operation

What happened here?

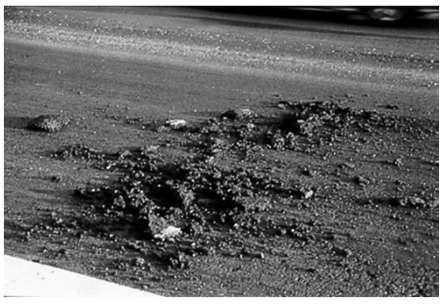
4-33

End Dump Truck Operation

Problem with pulling away with bed up

4-34

End Dump Truck Operation



What probably caused this?

4-35

End Dump Truck Operation

Why can't this be paved over?

4-36

Types of Segregation

- Coarse/Fine Aggregate
- Thermal

4-37

Aggregate Segregation

- Problem – Mix segregation results in non-uniform gradation and density, interconnected air voids, and poor mix performance
- Typical sources:
  - Mix loading
  - Mix unloading
  - Paver operation

4-38

Minimize Aggregate Segregation by:

- Better mix gradations
- Improved loading, unloading and paving practices
- Special equipment – Material Transfer Vehicle (MTV)

4-39

Material Transfer Vehicle

WV Contractor option unless required in the plan notes

Truck dumps into MTV (rather than paver)

4-40

Material Transfer Vehicle

MTV conveys mix into surge bin inserted into paver hopper

4-41

Thermal Segregation

- Problem – Non-uniform temperature distribution makes it difficult to achieve uniform compaction and maximum HMA performance
- Typical sources:
  - Time duration between loading and paving
  - Processes that increase mix exposure to non-uniform cooling

4-42

Thermal Segregation Can Be Reduced by:

- Minimizing time between truck loading and placement
- Use of truck insulation
- Proper paving techniques
- Special equipment – Material Transfer Vehicle (MTV)

4-43

Thermal Segregation As Depicted by Infrared Photos

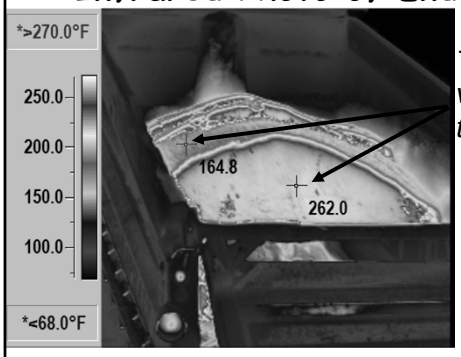
1. End dump truck directly into paver
2. Blaw-Knox MC-30 MTV
   a) With mixing
   b) Without mixing
3. Cedarapids MS-3 MTV
4. Roadtec Shuttle Buggy
5. Belly dump truck with windrow elevator

Photos Courtesy of Washington State DOT

1. End Dump Directly Into Paver

4-45

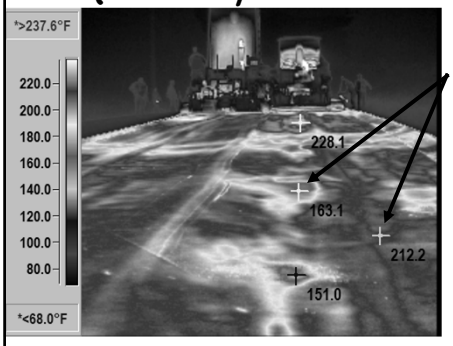
Infrared Photo of End Dump



Temperature variation in truck bed

4-46

Infrared Photo (End Dump Mix Behind Paver)



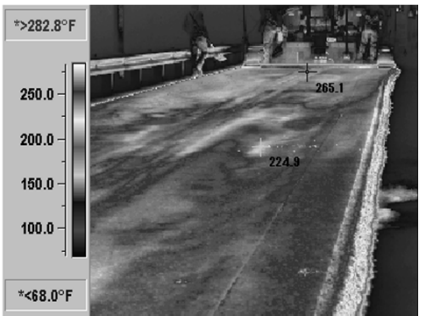
Temperature variation in mat

4-47

2. Blaw-Knox MC-30 MTV

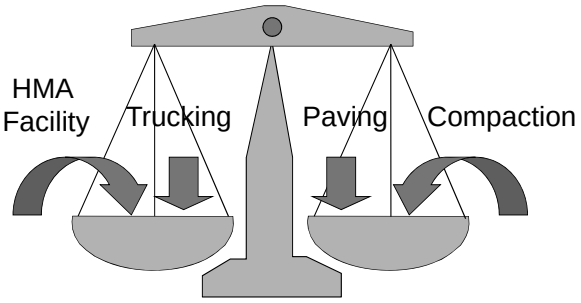
4-48

Infrared Photo (Blaw Knox MTV with Mixing)



4-49

Balancing Production



4-50

Extenuating Circumstances

What kind of situations have you experienced?

4-51

West Virginia University
Asphalt Technology Program

Module 5

HMA Placement

5- 1

Learning Objectives

- State the Objectives of HMA Placement
- Identify Components and Function – Tractor and Screed Unit
- Describe Operational Principles of Screed
- Describe Grade and Slope Control Systems
  - Types
  - Functions
  - Capabilities

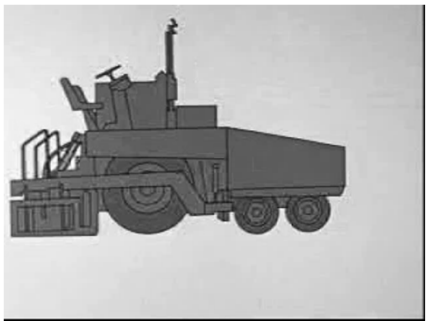
5-2

Learning Objectives

- Recognize Yield-Thickness-Smoothness Relationship
- Describe Proper Operating Techniques
- WVDOH Documents
  - MP 401.03.50 – *requirement for QC Plan*
  - Specification 401.10 – *Paving Operations*

5-3

Proper Auger Loading

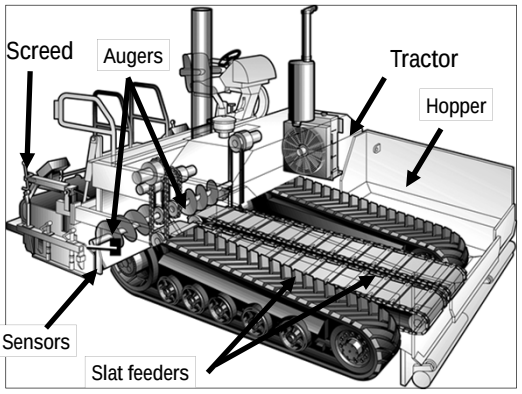


5-4

Tractor Unit

- Drive Systems
- Push Rollers and Truck Hitches
- Hopper
- Slat Conveyer
- Conveyer Flow Gates
- Augers
- Materials Feed System
- Tow Points

5-5



Courtesy of Caterpillar Paving Products

5-6

Tractor Unit

Courtesy of Caterpillar Paving Products

5-7

Track Drive

Courtesy of Caterpillar Paving Products

5-8

Truck Hitch

Not used in WV.
Truck can take control of paver

5-9

Push Rollers With Truck Hitch

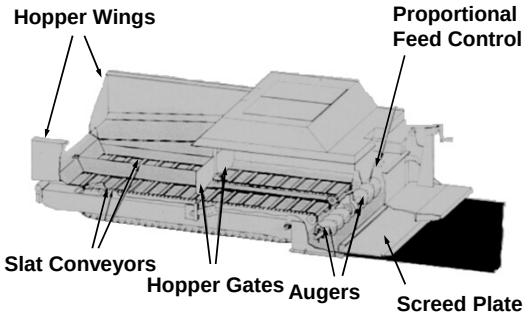
Keep Clean
Careful with Tack!!

5-10

Truck Should Not Bear On Paver

5-11

Material Flow

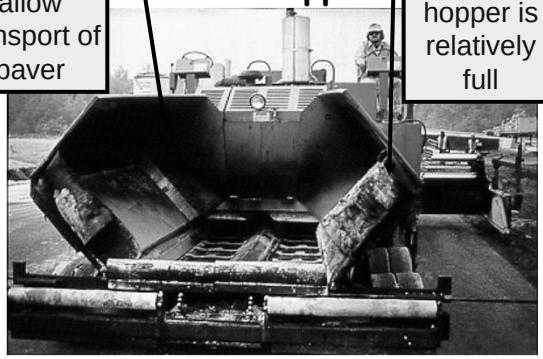


5-12

Paver Hopper

Wings allow transport of paver

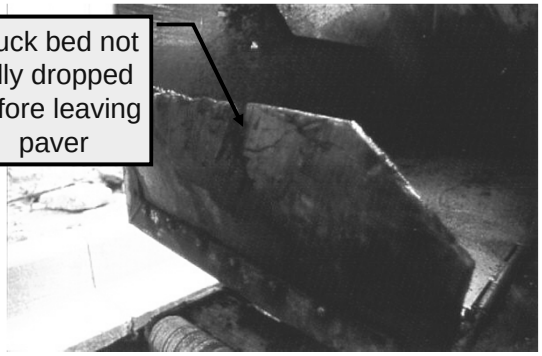
Fold when hopper is relatively full



5-13

Repair Worn Flashing

Truck bed not fully dropped before leaving paver

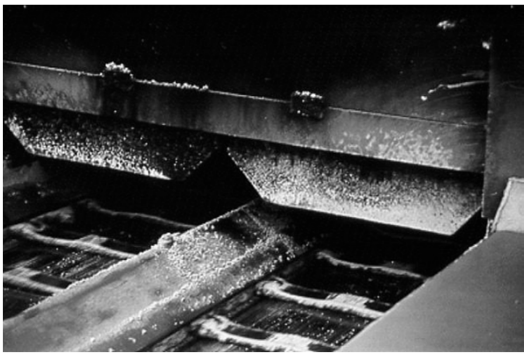


5-14

Slat Conveyors

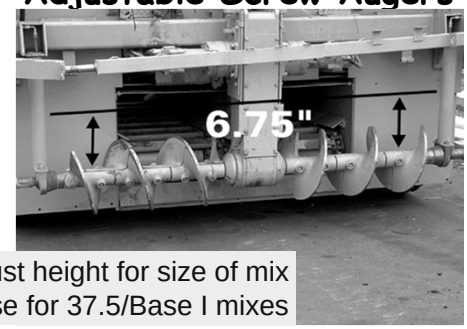
5-15

Flow Gates



5-16

Adjustable Screw Augers

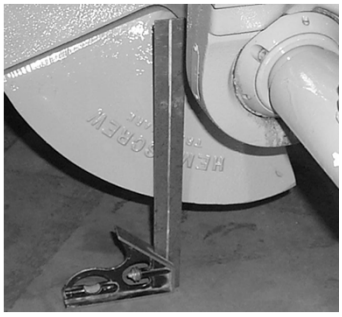


Adjust height for size of mix
Raise for 37.5/Base I mixes

Courtesy of Caterpillar Paving Products

5-17

Adjustable Screw Augers



- **Auger height affects mat texture**
- **Auger height 2” above mat is right for most mixes**
- **Fine tune according to mix**

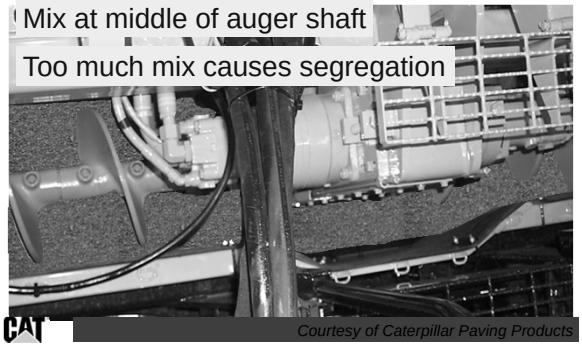
Courtesy of Caterpillar Paving Products

5-18

Proper Head of Material

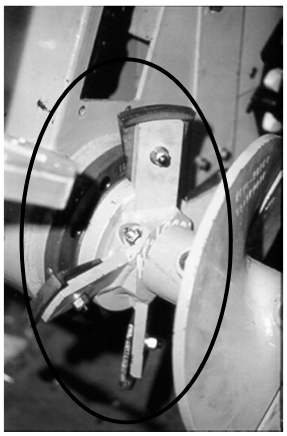
Mix at middle of auger shaft

Too much mix causes segregation



Courtesy of Caterpillar Paving Products

5-19



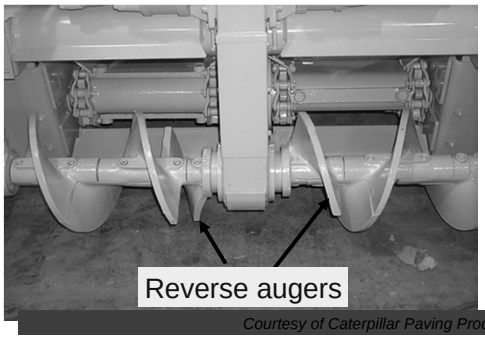
Kick Back Paddles

“Tuck” mix under gear box

Prevents segregation at center of paver

5-20

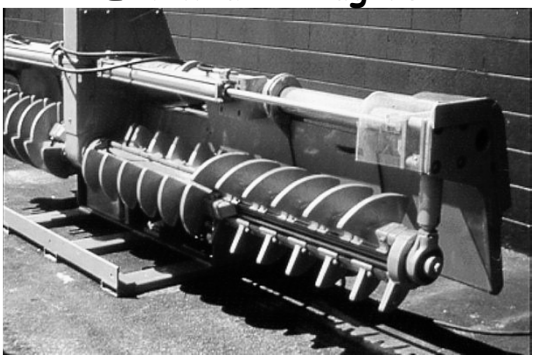
Kick Back Flights



Courtesy of Caterpillar Paving Products

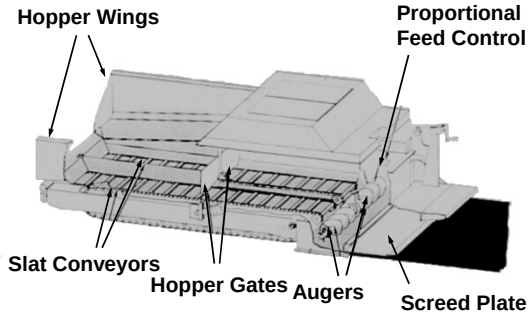
5-21

Extendable Augers



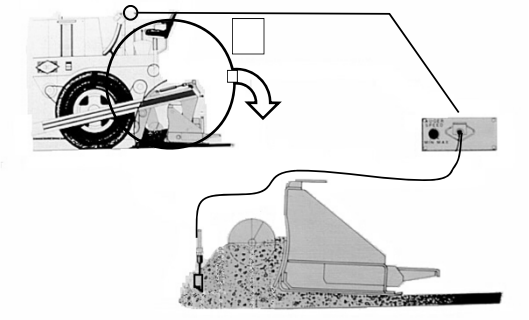
5-22

Material Flow



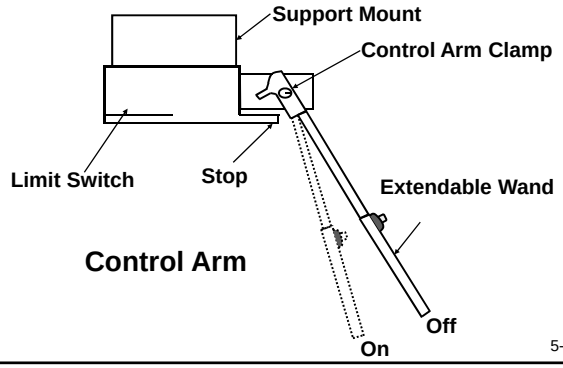
5-23

Feed Control Sensors



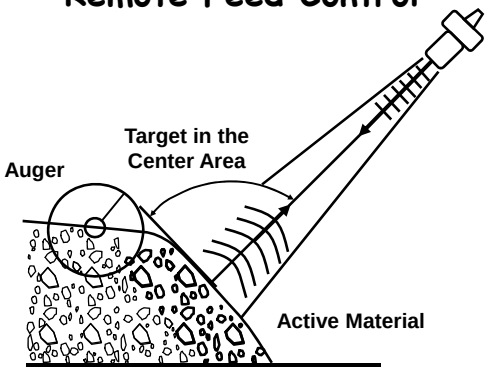
5-24

Mechanical Feed Control Sensors



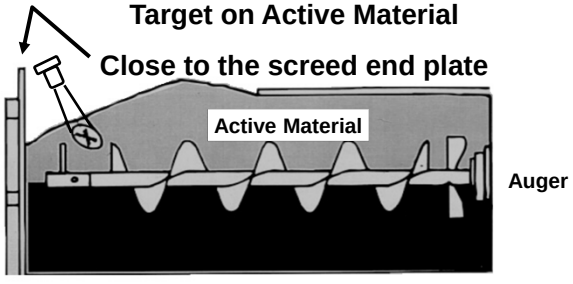
5-25

Remote Feed Control



5-26

Feed Control Sensor

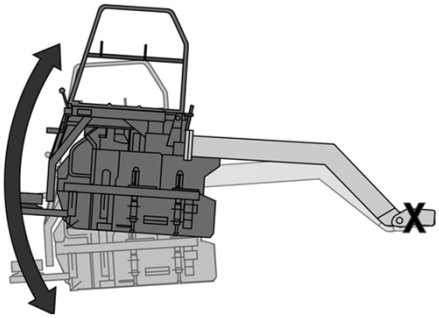


5-27

Screed End Plate

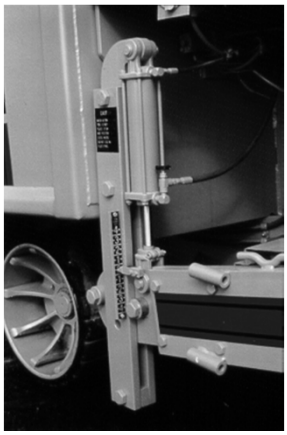
5-28

Tow Point



Courtesy of Caterpillar Paving Products

5-29



Tow Point

Used with automatic controls

5-30

Screed Unit

- Screed plate
- Strike-off
- Crown control
- Extensions and end plates
- Thickness Control Screws
- Screed Arm
- Pre-Compaction System
- Heating Systems
- Maintenance

5-31

Screed Unit

Courtesy of Blaw-Knox Ingersoll Rand Paving Products

5-32

Screed Plate

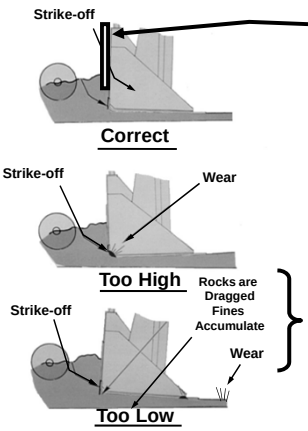
The screed plate is a high wear item.

Maintenance!!!

5-33

Screed Plate

5-34



Prestrike off plate used on some pavers

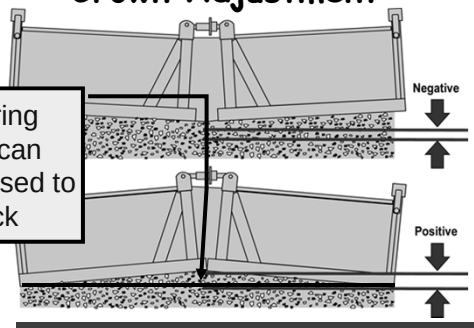
Strike-off Plate Adjustment

Inspection of surface during paving

5-35

Screed Plate Crown Adjustment

A string line can be used to check

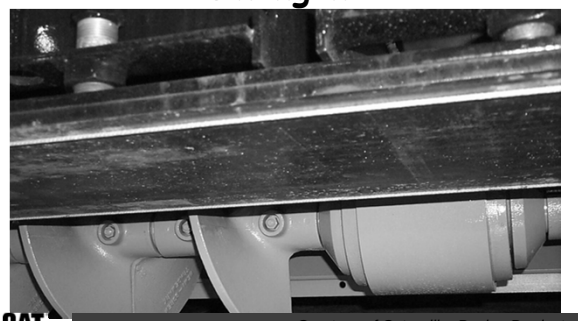


CAT

Courtesy of Caterpillar Paving Products

5-36

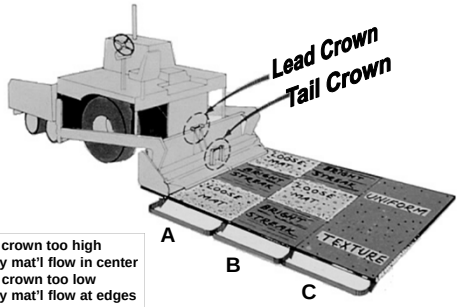
Checking Screed Crown with Stringline



CAT *Courtesy of Caterpillar Paving Products*

5-37

Crown Adjustment



A - Lead crown too high
Heavy mat'l flow in center
B - Lead crown too low
Heavy mat'l flow at edges
C - Uniform mat texture and material flow from correct crown adjustment

5-38

Loose Mat	Bright Streak	Uniform Texture
Bright Streak	Loose Mat	
Loose Mat	Bright Streak	

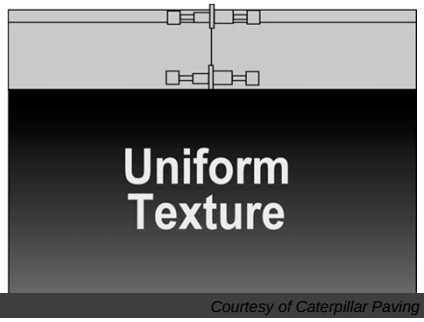
Lead crown too high, heavy material flow in center

Lead crown too low, heavy material flow at edges

Uniform mat texture and material flow from correct crown adjustment

5-39

Lead Crown - ~1/8 in Greater Than Tail Crown



CAT *Courtesy of Caterpillar Paving Products*

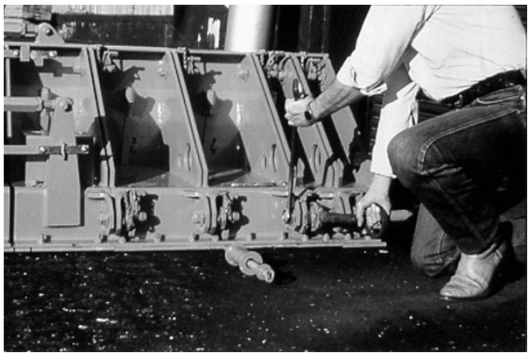
5-40

Hydraulic Screed Extension

Courtesy of Caterpillar Paving Products

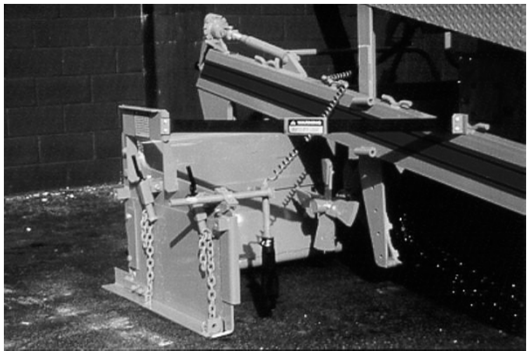
5-41

Mechanical Screed Extension



5-42

Screed End Plate

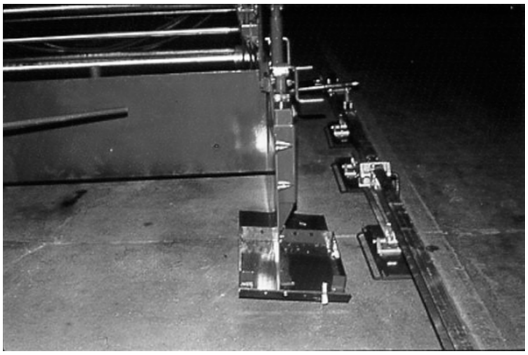


5-43

Longitudinal Joint Forming

5-44

Cut-off Shoes



5-45

Thickness Adjustments

CAT

Courtesy of Caterpillar Paving Products

5-46

Thickness Control Screws

Blaw-Knox

Courtesy of Blaw-Knox Ingersoll Rand Paving Products

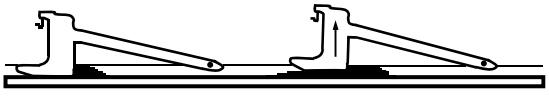
Changes the angle of the screed

5-47

Hand Crank Effects

Hand cranks turned to thicken

Tow point unchanged

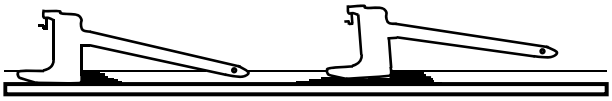


5-48

Tow Point Effects

Hand cranks unchanged

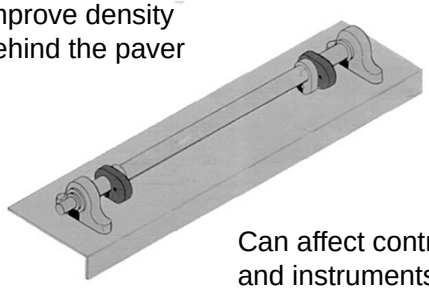
Tow point raised



5-49

Screed Vibrators

Improve density behind the paver



Can affect controls and instruments

5-50

Screed Heaters

Diesel System

Electric System

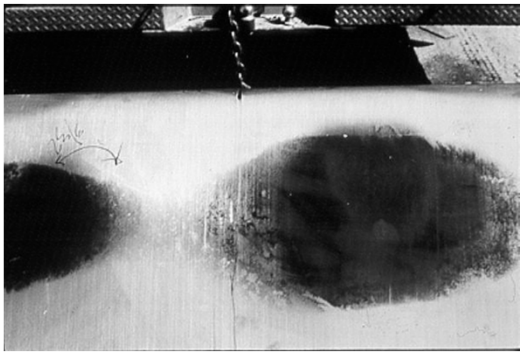
Screed heaters cannot be used to raise the heat of the mix.

heat a cold screed to about 300°F prior to the start of paving.

Blaw-Knox *Courtesy of Blaw-Knox Ingersoll Rand Paving Products*

5-51

Damaged Screed Plate



5-52

Operational Principles of the Screed

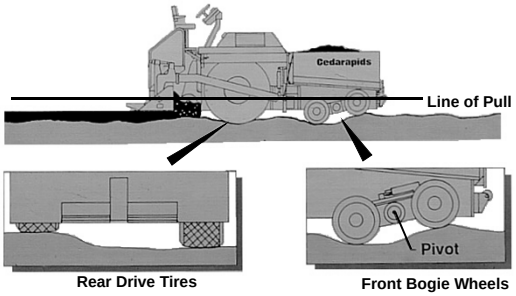
- Self-leveling Concepts
- Screed Response versus Distance
- Forces Acting on a Screed

5-53

Screed Adjustment

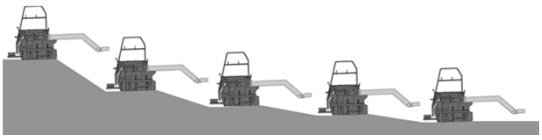
5-54

Self Leveling - Rubber Tired Paver



5-55

Screed Reaction Time

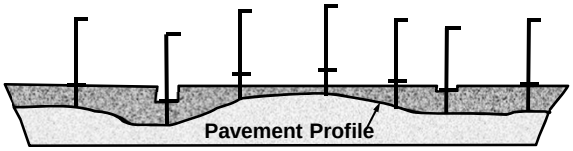


- Screed reacts to change in angle of attack over 5 tow arm lengths
- 65% of change occurs in the first tow arm length
- 35% of change occurs in the last 4 tow arm lengths

CAT *Courtesy of Caterpillar Paving Products*

5-56

Sticking the Mat?



Direction of Paving →

What is the correct thickness?

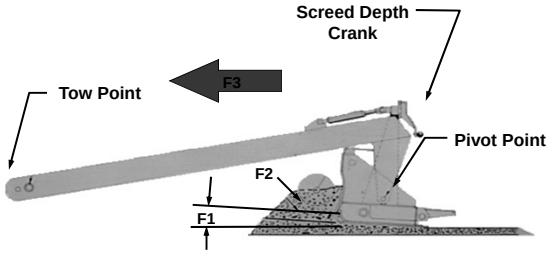
5-57

Main Forces Acting on Screed

1. **Speed of Paver**
2. **Head of Material**
3. **Angle of Attack**
4. **Other Forces**
   - **Pre-compaction**
   - **Screed Weight**

5-58

Screed Forces



Let the PAVER do its job!!!!

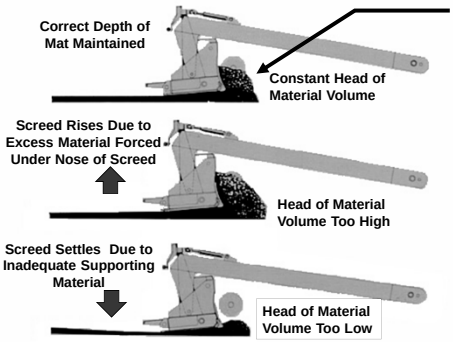
5-59

Mix Effect on Paving

- **Coarser mixtures**
- **Modified asphalts**

5-60

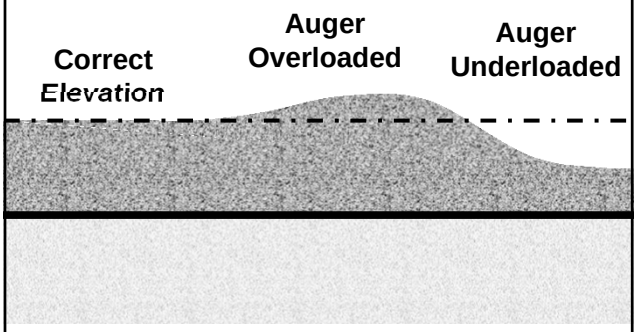
Head of Material



Key issue for Smoothness. The "system" must work together
Trucks
Hoppers
Slats
Constant head of material!!!

5-61

Head of Material Effects



5-62

Stopping the Paver?

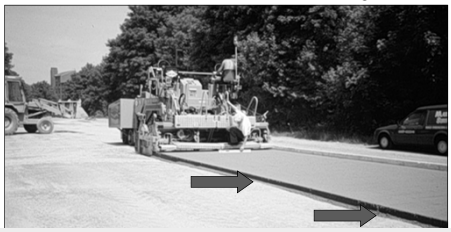
5-63

Screed Control Systems

- **Who's Responsible for Changes?**
- **Sticking the Mat**
- **Manual Controls**
- **Automatic Controls**

5-64

Manual vs. Automatic Adjustments

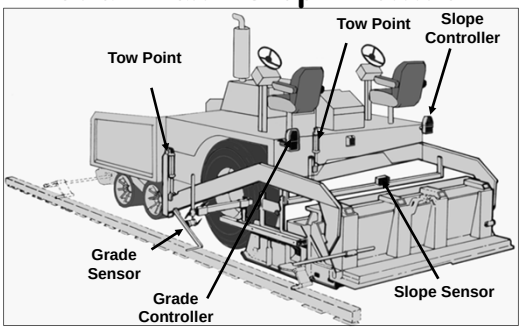


The more the operator tries to assist the self-leveling action of the screed, the **rougher** the new surface will be.

Blaw-Knox *Courtesy of Blaw-Knox Ingersoll Rand Paving Products*

5-65

Grade and Slope Control



Blaw-Knox *Courtesy of Blaw-Knox Ingersoll Rand Paving Products*

5-66

Types of Grade Reference

- **Stringline**
- **Mobile reference**
- **Joint matching shoe**
- **Sonic sensor**
- **Laser**

5-67

Stringline

5-68

Bridge Ski

5-69

Floating Beam

5-70

Contact-less Beam with Four Ultra Sonic Sensors

Blaw-Knox *Courtesy of Blaw-Knox Ingersoll Rand Paving Products*

5-71

Joint Matching Shoe

5-72

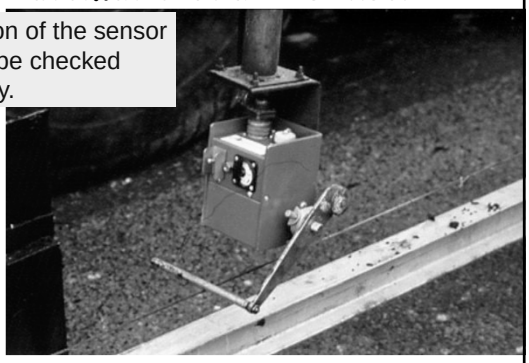
Joint Matching with a Non-contact Grade Sensor

Blaw-Knox. *Courtesy of Blaw-Knox Ingersoll Rand Paving Products*

5-73

Automatic Grade Sensor

operation of the sensor should be checked regularly.



5-74

Yield-Thickness-Smoothness

- **Base Condition**
- **Minimum Thickness**
- **Yield**
- **Smoothness**
- **Controlling Yield versus Thickness or Smoothness**

You can't control yield and thickness or smoothness. Establish beforehand which will be the controlling factor!!!!!

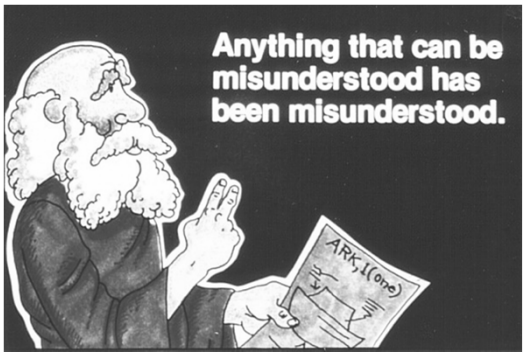
5-75

Types of Paving

- **Planning Pulls**
- **Mainline Paving**
- **Shoulder Paving**
- **Variable Width Paving**
- **Transitions**
- **Temporary Paving**
- **Echelon Paving**
- **Night Paving**

5-76

Paving Widths



5-77

Good Joint Location?

5-78

Mainline Paving

5-79

Shoulder Slope Paving

5-80

Variable Width Paving

5-81

Echelon Paving

5-82

Night Paving

5-83

Night Paving

- Becoming more common
- Requires more attention
- Issues:
  - Visibility
  - Cooler Temperatures
  - New Crews
  - Lighting
  - Safety!!!

5-84

Night Paving-Safety Issues

•Changes in Driving Habits

•Drunk drivers

5-85

Night Paving-Construction Issues

•Operator Awareness
•Equipment Maintenance
•Additional care during testing
•Impacts of limited lighting

5-86

Night Paving-Other Issues?

5-87

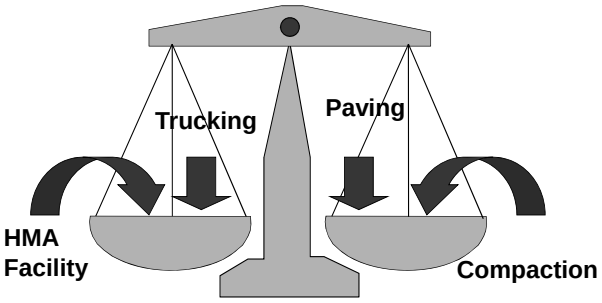
Operating Techniques

- **Warming up machine and screed**
- **Positioning on Joint**
- **Nulling the Screed**
- **Initial Settings**
- **Charging Hopper, Tunnels, Screed**
- **Pulling off Joint**
- **Re-checking Settings**
- **Speed of Paver**
- **Checking Yield**
- **Truck Exchanges**
- **Folding Hopper Wings**
- **HMA Level in Hopper**
- **Auger Operation**
- **Flow Gate Position**
- **Raking and Luting**
- **Concluding Paving**

Traffic Control

5-88

Balancing Production



5-89

PAVING PRODUCTION CALCULATION FORM:

Date:_____ Project #: _____

Project:_____

Tonnes scheduled to be placed today (T-MIX): _____ tonnes

Methods are available for computing the balance between:
- paver production
- roller production
- plant production
- number of trucks required

Actual Paver Production Rate (P-RATE):

= MIX RATE (tph) x 1,000 kg / 1 tonne x 1 hr / 60 min ÷ WIDTH (m) ÷ THICK(m) ÷ DENSITY(kg/

= _____ x 1,000 ÷ 60 ÷ _____ ÷ _____ ÷ _____

P-RATE = _____ meters/min

Paving Efficiency Factor (EFF1): _____ (recommended: 0.75 - 0.85)

Actual Paver Speed (PAVER):

5-90

Operating Techniques

- Warming up machine and screed
- Positioning on Joint
- Nulling the Screed
- Initial Settings
- Charging Hopper, Tunnels, Screed
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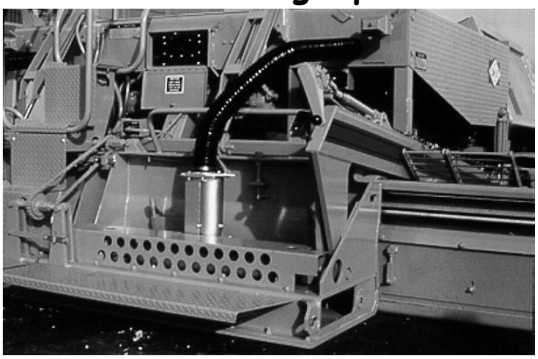
- Re-checking Settings
- Speed of Paver
- Checking Yield
- Truck Exchanges
- Folding Hopper Wings
- HMA Level in Hopper
- Auger Operation
- Flow Gate Position
- Raking and Luting
- Concluding Paving

5-91

Warming Up



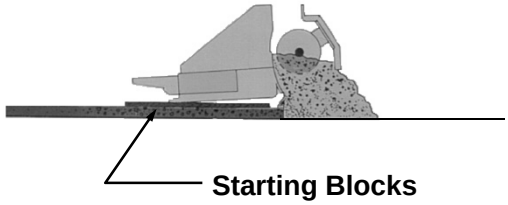
5-92

Operating Techniques

- Warming up machine and screed
- Positioning on Joint
- Nulling the Screed
- Initial Settings
- Charging Hopper, Tunnels, Screed
- Pulling off Joint
- Re-checking Settings
- Speed of Paver
- Checking Yield
- Truck Exchanges
- Folding Hopper Wings
- HMA Level in Hopper
- Auger Operation
- Flow Gate Position
- Raking and Luting
- Concluding Paving

5-93

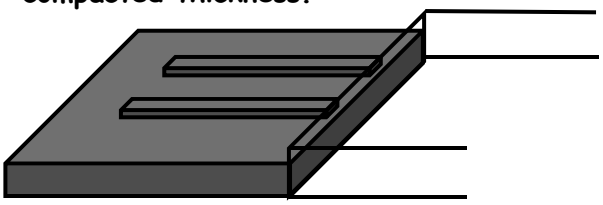
Screed in Position



Starting Blocks

5-94

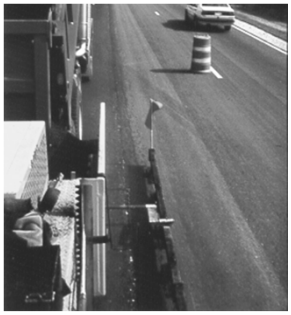
A good rule of thumb is to raise the screed 20% to 25% more than the compacted thickness.

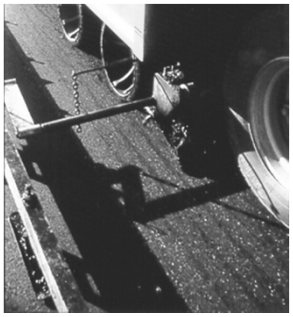


5-95

Steering Guide

Varies by operator SKILL!!!!





5-96

Operating Techniques

- Warming up machine and screed
- Positioning on Joint
- Nulling the Screed
- Initial Settings
- Charging Hopper, Tunnels, Screed
- Pulling off Joint
- Re-checking Settings
- Speed of Paver
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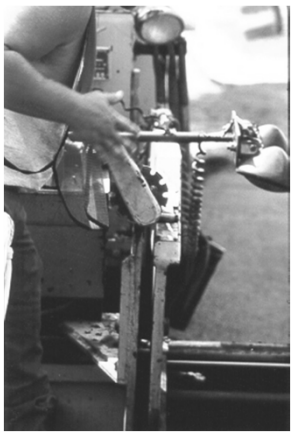
- Truck Exchanges
- Folding Hopper Wings
- HMA Level in Hopper
- Auger Operation
- Flow Gate Position
- Raking and Luting
- Concluding Paving

5-97



Null Screed

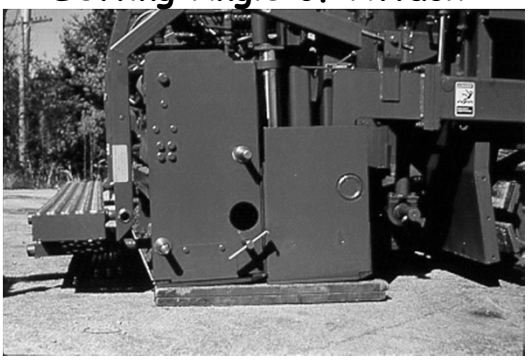
5-98

Operating Techniques

- Warming up machine and screed
- Positioning on Joint
- Nulling the Screed
- Initial Settings
- Charging Hopper, Tunnels, Screed
- Pulling off Joint
- Re-checking Settings
- Speed of Paver
- Checking Yield
- Truck Exchanges
- Folding Hopper Wings
- HMA Level in Hopper
- Auger Operation
- Flow Gate Position
- Raking and Luting
- Concluding Paving

5-99

Setting Angle of Attack



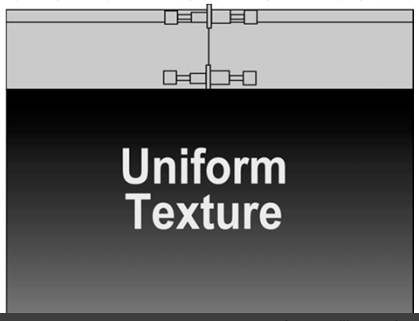
5-100

Misaligned Screed Extension

Courtesy of Blaw-Knox Ingersoll Rand Paving Products

5-101

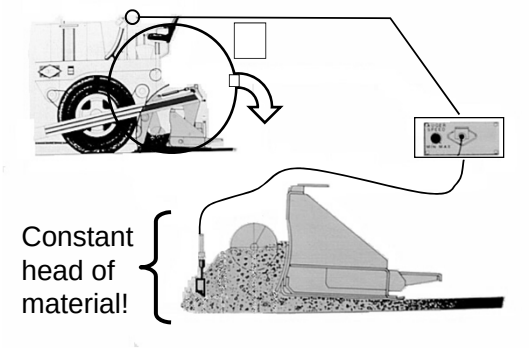
Lead Crown - ~1/8 in Greater Than Tail Crown



Courtesy of Caterpillar Paving Products

5-102

Check and Adjust Sensors



5-103

Operating Techniques

- Warming up machine and screed
- Positioning on Joint
- Nulling the Screed
- Initial Settings
- Charging Hopper, Tunnels, Screed
- Pulling off Joint
- Re-checking Settings
- Speed of Paver
- Checking Yield
- Truck Exchanges
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- HMA Level in Hopper
- Auger Operation
- Flow Gate Position
- Raking and Luting
- Concluding Paving

5-104

Smoothness

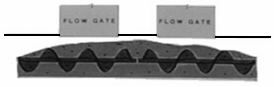
Stop 1 foot short of paver!!

5-105

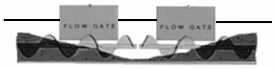
Loading Augers

5-106

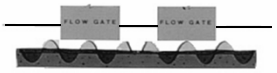
Adjust Flow Gates



Gates too HIGH - augers overloaded



Gates too LOW - insufficient material supply



Correct adjustment - uniform material volume/flow

5-107

Operating Techniques

- Warming up machine and screed
- Positioning on Joint
- Nulling the Screed
- Initial Settings
- Charging Hopper, Tunnels, Screed
- Pulling off Joint
- Re-checking Settings
- Speed of Paver
- Checking Yield
- Truck Exchanges
- Folding Hopper Wings
- HMA Level in Hopper
- Auger Operation
- Flow Gate Position
- Raking and Luting
- Concluding Paving

5-108

Start Up

5-109

Operating Techniques

- Warming up machine and screed
- Positioning on Joint
- Nulling the Screed
- Initial Settings
- Charging Hopper, Tunnels, Screed
- Pulling off Joint
- Re-checking Settings
- Speed of Paver
- Checking Yield
- Truck Exchanges
- Folding Hopper Wings
- HMA Level in Hopper
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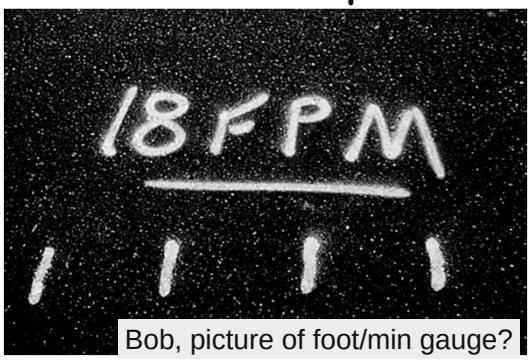
- Raking and Luting
- Concluding Paving

5-110

Check Paver Speed



Bob, picture of foot/min gauge?

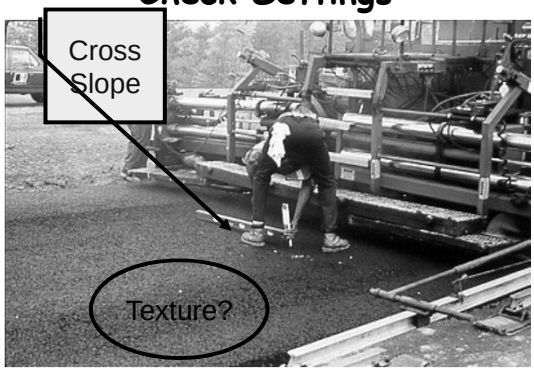
5-111

Re-Check Settings

- Is thickness okay?
- Is cross slope okay?
- Is mat texture okay?

5-112

Check Settings



5-113

Check Head of Material

5-114

Check Yield Periodically

You can't control yield and thickness or smoothness.

Adjusting for yield or thickness will reduce smoothness!!!!

5- 115

Operating Techniques

- Warming up machine and screed
- Positioning on Joint
- Nulling the Screed
- Initial Settings
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- Pulling off Joint
- Re-checking Settings
- Speed of Paver
- Checking Yield
- Truck Exchanges
- Folding Hopper Wings
- HMA Level in Hopper
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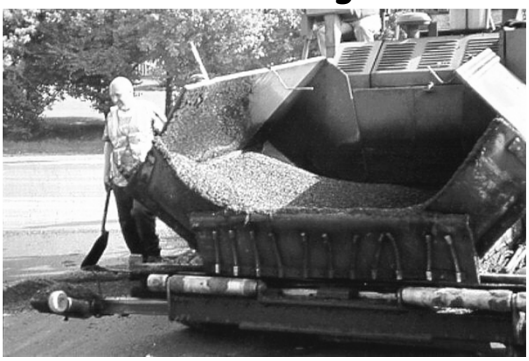
- Flow Gate Position
- Raking and Luting
- Concluding Paving

5-116

Truck Exchanges

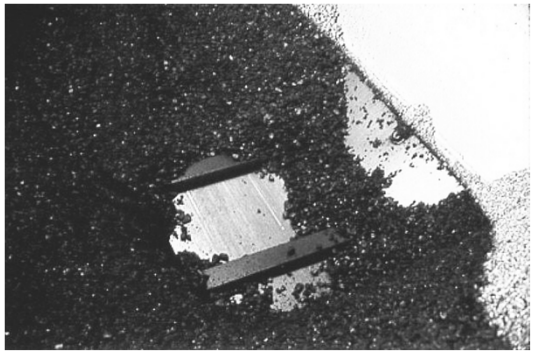
5-117

Fold the Wings?



5-118

Don't Let This Happen!



5-119

Next Truck Not Ready?

5-120

Operating Techniques

- Warming up machine and screed
- Positioning on Joint
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- Initial Settings
- Charging Hopper, Tunnels, Screed
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- Re-checking Settings
- Speed of Paver
- Checking Yield
- Truck Exchanges
- Folding Hopper Wings
- HMA Level in Hopper
- Auger Operation
- Flow Gate Position
- Raking and Luting
- Concluding Paving

5-121

Constant Head of Material

5-122

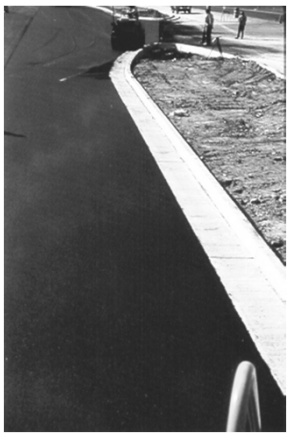
Operating Techniques

- Warming up machine and screed
- Positioning on Joint
- Nulling the Screed
- Initial Settings
- Charging Hopper, Tunnels, Screed
- Pulling off Joint
- Re-checking Settings
- Speed of Paver
- Checking Yield
- Truck Exchanges
- Folding Hopper Wings
- HMA Level in Hopper
- Auger Operation
- Flow Gate Position
- Raking and Luting
- Concluding Paving

5-123

Minimal Luting

5-124



Minimal Luting

5-125

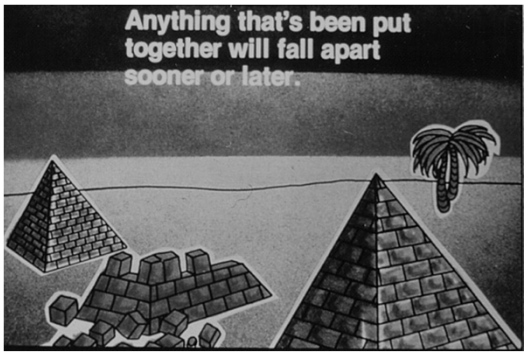
Lute when necessary…

5-126

Operating Techniques

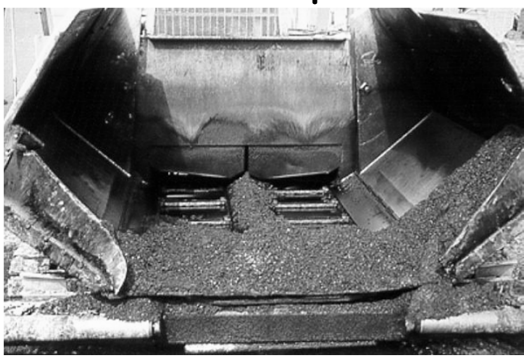
- Warming up machine and screed
- Positioning on Joint
- Nulling the Screed
- Initial Settings
- Charging Hopper, Tunnels, Screed
- Pulling off Joint
- Re-checking Settings
- Speed of Paver
- Checking Yield
- Truck Exchanges
- Folding Hopper Wings
- HMA Level in Hopper
- Auger Operation
- Flow Gate Position
- Raking and Luting
- Concluding Paving

5-127



5-128

Cleanup



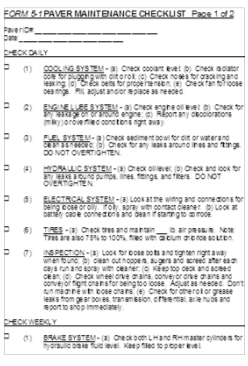
5-129

Paver Maintenance

- Washing down
- Wear check
- Storage of electrical equipment
- Checklists

5-130

Maintenance Checklist



FORM 5-1 PAVER MAINTENANCE CHECKLIST Page 1 of 2

Paver ID# _____
Date _____

CHECK DAILY

☐ (1) COOLING SYSTEM - (a) Check coolant level. (b) Check radiator core for plugging with dirt or rust. (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 on or around engine. (c) Report any discolorations (milky) or overfilled conditions right away.

☐ (3) FUEL SYSTEM - (a) Check sediment bowl for dirt or water and DRAIN EVERYDAY. (b) Check for any leaks around lines and fittings. DO NOT OVERTIGHTEN.

☐ (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 dirty. If dirty, spray with contact cleaner. (b) Look at battery cable connections and clean if starting to corrode.

☐ (6) TIRES - (a) Check tires and maintain ___ lb. air pressure. Note: Tires are also 75% to 100% filled with Calcium chloride solution.

☐ (7) INSPECTION - (a) Look for loose bolts and tighten right away when found. (b) Clean out hoppers, augers and screed after each day's run and spray with cleaner. (c) Keep top deck and screed clean. (d) Check wheel drive chains, conveyor drive chains and conveyor flight chains for being too loose. Adjust as needed. Don't run machine with loose chains. (e) 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 both LH and RH master cylinders for hydraulic brake fluid level. Keep filled to proper level.

DAILY LUBRICATION

☐ (1) Vibrator shaft bearings and U-Joints on vibrator shafts. DO NOT FLUSH GREASE.
☐ (2) Auger shafts flange bearings. (twice daily)
☐ (3) Rear conveyor flight shaft bearings.
☐ (4) Front conveyor flight shaft bearings. SEE OPERATORS MANUAL
☐ (5) Jack shafts and slat sprockets.
☐ (6) Screed arm mover pivot pin.

WEEKLY LUBRICATION

☐ (1) Screed Crank
☐ (2) Clutch Throwout Bearing
☐ (3) Clutch Lever Shaft
☐ (4) Brake Pedals
☐ (5) Slope Pivots and King Pin Bearings. SEE OPERATORS MANUAL
☐ (6) Slope Wheel Bearings
☐ (7) Drive Wheel Bearings
☐ (8) Main Drive Shaft

OIL & GREASE & FILTER CHANGES

☐ (1) ENGINE - Change oil and filter every 150 hrs. For oil, see engine manual.
☐ (2) HYDRAULIC SYSTEM - Change oil (dirty), and change filter 3 times assesson.
☐ (3) CRANKCASES - Oil both every 150 hrs. Dry the cleaners 3 times a year.
☐ (4) Fuel Separator - Filter change 3 times a year.
☐ (5) PUMP DRIVE BOX - TRANSFER BOX, DIFFERENTIAL, LH & RH CONVEYOR DRIVE BOXES - Change gear lube yearly; use SAW140 gear oil.

☐ (1) Drive chain. Adjust 19 mm slack one side.
☐ (2) Conveyor Drive Chains. Larger units 12B-1TB mm from grouts. Smaller units 7B-12mm from frame.

OTHER THINGS THAT NEED SPECIAL ATTENTION AND HANDLING

☐ (1) Grade and Slope Boxes and Cables
☐ (2) Screed Extensions
☐ (3) Belts
☐ (4) Don't tamper with the governors or speed adjusting screws.

Courtesy of Blaw-Knox

REMARKS _____

Completed by _____

5-131

Operating Techniques

- Warming up machine and screed
- Positioning on Joint
- Nulling the Screed
- Initial Settings
- Charging Hopper, Tunnels, Screed
- Pulling off Joint
- Re-checking Settings
- Speed of Paver
- Checking Yield
- Truck Exchanges
- Folding Hopper Wings
- HMA Level in Hopper
- Auger Operation
- Flow Gate Position
- Raking and Luting
- Concluding Paving

Traffic Control

5-132

Traffic Control

5-133

MUTCD?

5-134

Review:

1. **What is the objective of HMA placement?**
2. **List 3 tractor components and their function**
3. **List 3 screed components and their function**

5- 135

Review :

4. **Describe the operational principles of the screed**
5. **List and describe 2 types of grade and slope control systems**
6. **How are yield-thickness-smoothness related?**

5- 136

Review:

7. **Name 2 important paver maintenance items**
8. **List 2 good paver operating techniques**

5- 137

HMA Construction Program

Module 6

Joint Construction

6-1

Learning Objectives

- State the objective of joint construction
- Describe the two types of joints
- Describe transverse joint construction methods
- Describe longitudinal joint construction methods
- Identify proper joint raking/luting techniques

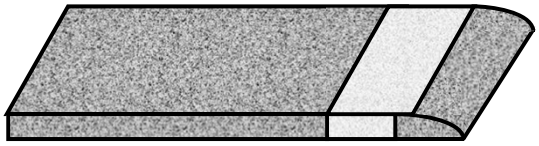
6-2

Transverse Joint

6-3

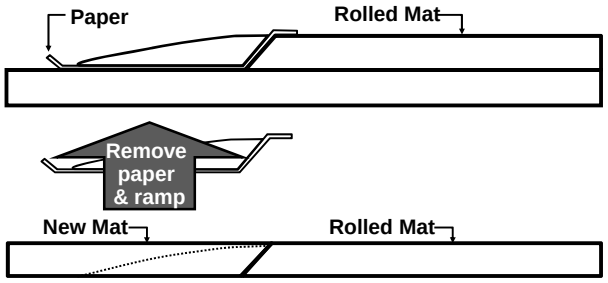
Blaw-Knox *Courtesy of Blaw-Knox Ingersoll Rand Paving Products*

Butt Joint



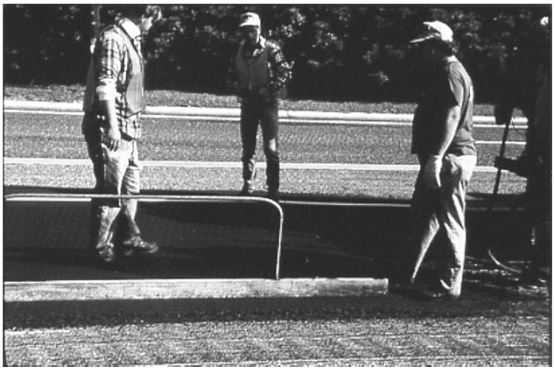
6-4

Papered Transverse Joint



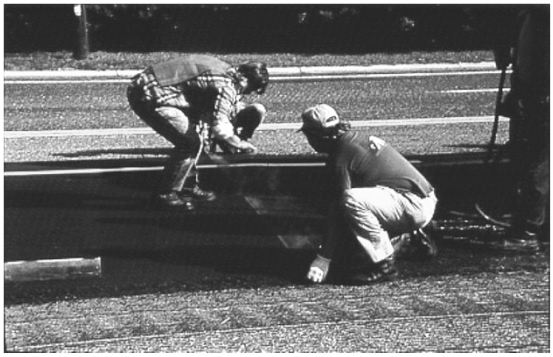
6-5

Feathered Joint Without Paper



6-6

Straightedge Transition Location



6-7

Remove Downstream Material

6-8

Small Milling Machine

6-9

Clean Surface

6-10

Good Tack Method?

6-11

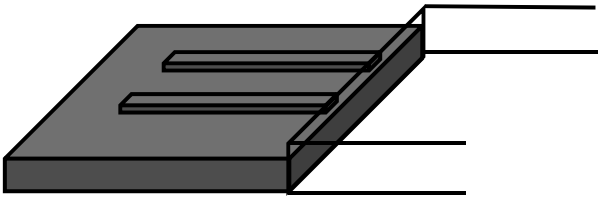
Good Transverse Joint Tack Method

- Use hand wand to apply material
- If pour pot is used
  - Use broom or mop to place material on vertical face
- Ensure uniform coverage of vertical face
- Minimum “puddles”

6-12

Rolldown

Remember to raise the screed 20 to 25% more than the compacted thickness.



Boards account for reduction in thickness during compaction

6-13

Starting Off

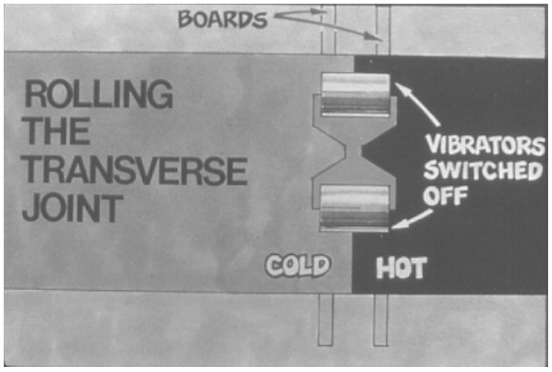
6-14

Minimize Luting

6-15

Smoothness Check

6-16



6-17

Transverse Joint Rolling

6-18

Space Restrictions

6-19

Check for Smoothness

6-20

Sealing Transverse Joint

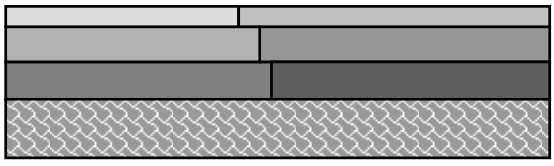
6-21

Longitudinal Joint Construction

6-22

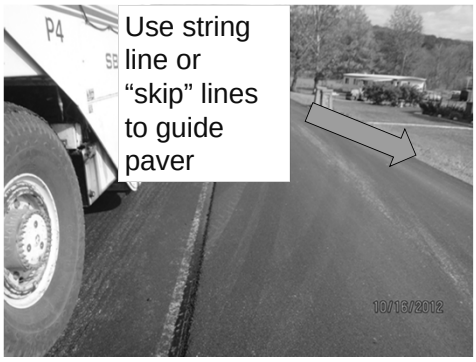
Start with a plan

Staggered Paving Joints (min 6")



6-23

Start with a good edge to pave against



6-24

Keep end gates on the paver down

6-25

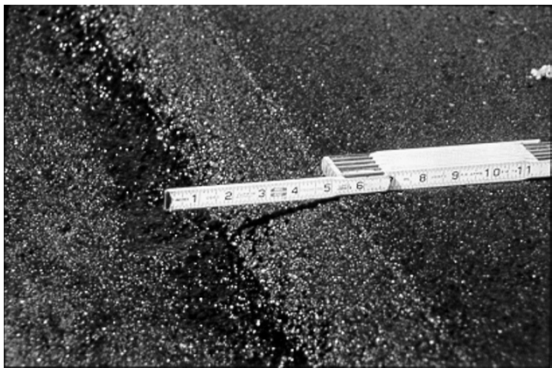
This Avoids Lane-Edge Joint

6-26

Tapered Joint

6-27

Wedge Joint

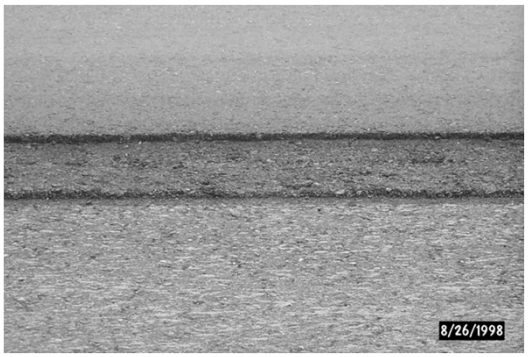


6-28

Rolling Wedge Joint

6-29

Notched Wedge Joint



6-30

Courtesy of Wisconsin DOT

Rolling Notched Wedge Joint

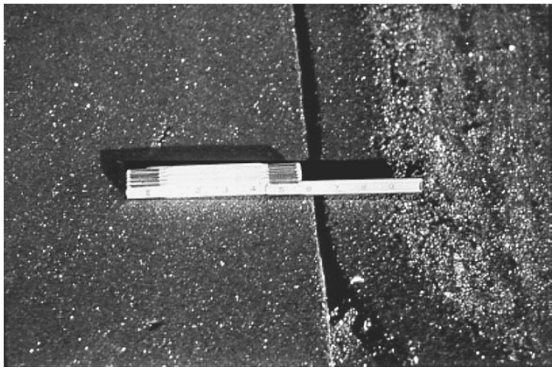
6-31

Courtesy of Wisconsin DOT

Wedge Joint Construction

6-32

Cut Back Edge



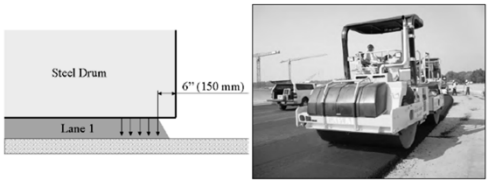
6-33

Proper Rolling Technique for Unsupported Edge

6-34

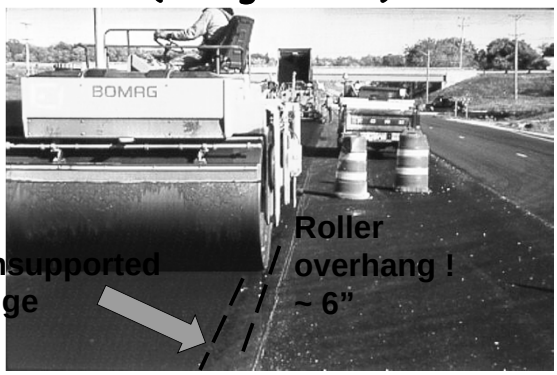
Compaction of the unsupported edge

- The drum should be extended over the unsupported edge of the lane by approx. 6".



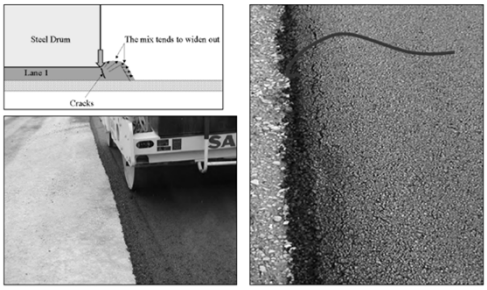
6-35

Rolling Unconfined Edge (Wedge Joint)



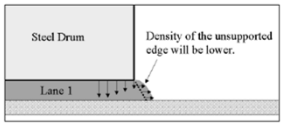
6-36

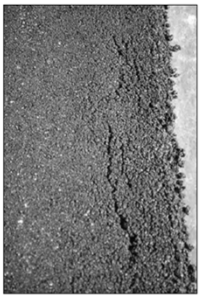
Do not run the steel drum inside the unsupported edge



6-37

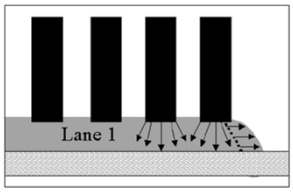
Do not run the steel drum directly on the unsupported edge





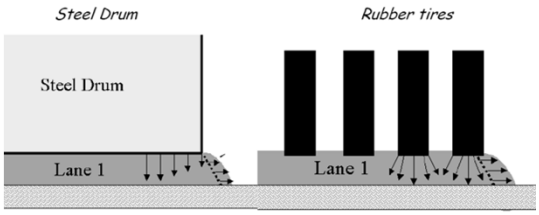
6-38

Do not run the rubber tire roller directly on the unsupported edge



6-39

<u>NEVER</u> run any roller directly on the unsupported edge

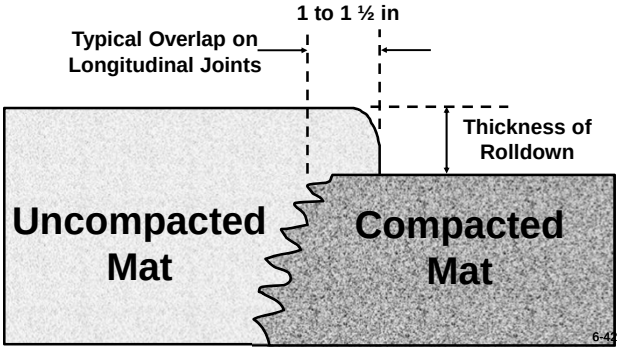


6-40

Proper Rolling Technique for Hot Side

6-41

Joint Overlap

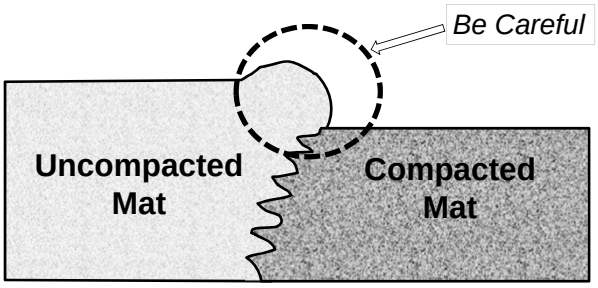


6-42

Hot Joint

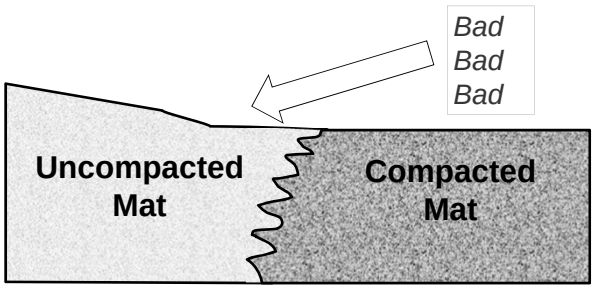
6-43

Mix "Bumped Back" to Joint

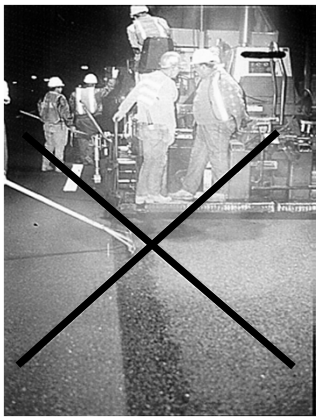


6-44

Mix "Bumped Back" Past Joint



6-45



Incorrect Luting

6-46

Joint Without Luting

6-47

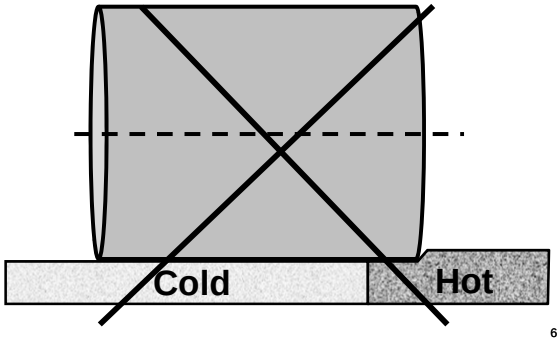
Roller first pass Hot side

6-48

Modified Pinch Technique

6-49

Improper Joint Rolling



6-50

Poor Longitidunal Joint Performance is not Uncommon

6-51

What Is Wrong Here?

6-52

Rolling from the Hot Side

6-53

Summary of Best Practices

First lane

- Use string line or skip lines to guide paver
- Keep side gates down
- Hang roller 6” past mat

Second Lane

- Tack joint
- Hang paver 1” to 1.5” past joint
- Carefully lute and only if needed
- Hold roller 6” from joint on first pass
- Later pass compact “pinch” material

6-54

Questions?

6-55

Questions:

1. **Give 2 reasons to explain low density in a longitudinal joint**
2. **What are 2 types of transverse joint construction methods?**
3. **Name 3 types of longitudinal joints**

56

HMA Construction Program

Module 7
Troubleshooting # 1

7-1

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

7-2

Objective of Effective Troubleshooting?

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

7-3

How to Troubleshoot

- Step One:

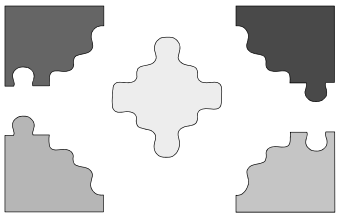
  Stop, step back, look at the big picture

7-4

How to Troubleshoot

- Step Two:

  Break the problem down into pieces



7-5

How to Troubleshoot

- Step Three:

  Eliminate the obvious factors first

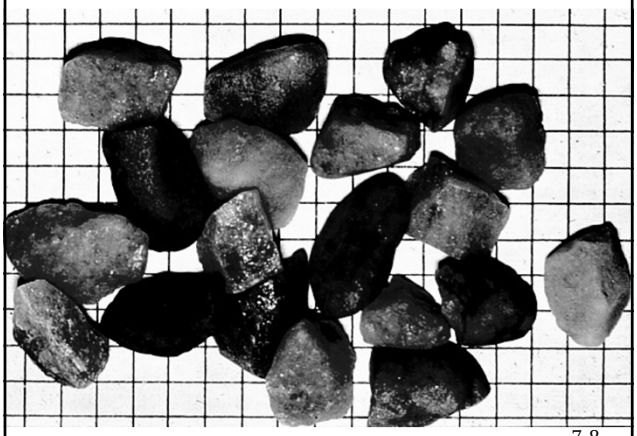
7-6

How to Troubleshoot

- Step Four:

  Analyze each element in full detail

7-7



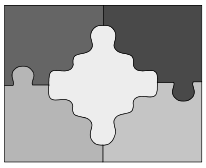
7-8

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

7-9

How to Troubleshoot

- Step Six:

  Recommendation based on facts

7-10

How to Troubleshoot

- Step Seven:

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

7-11

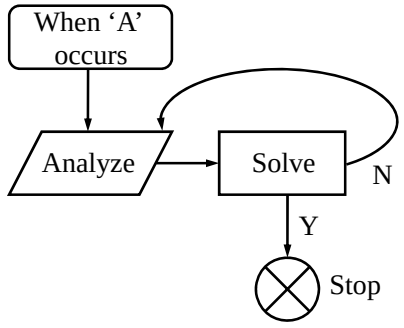
How to Troubleshoot

- Step Eight:

  Take notes every step of the way

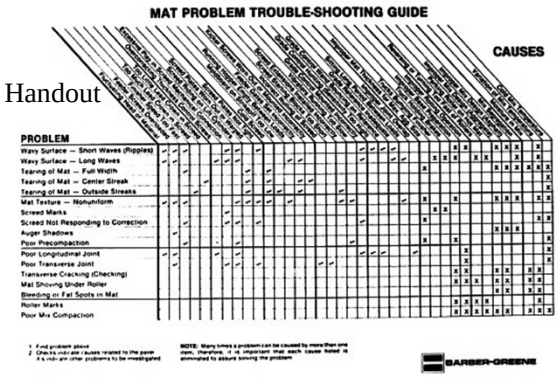
7-12

Troubleshooting Charts

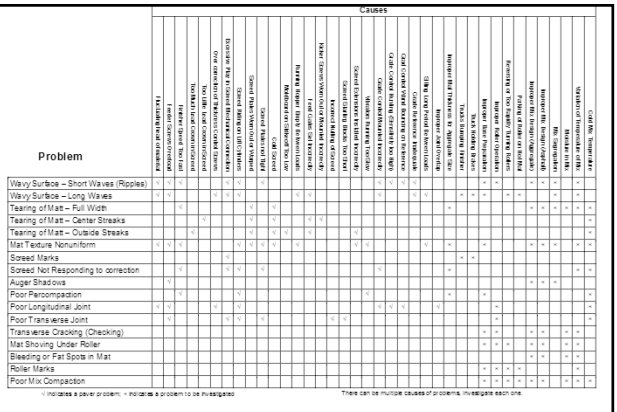


7-13

Handout



7-14

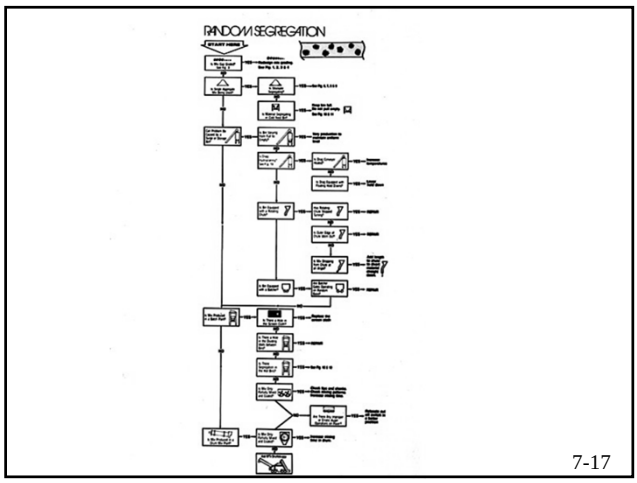


7-15

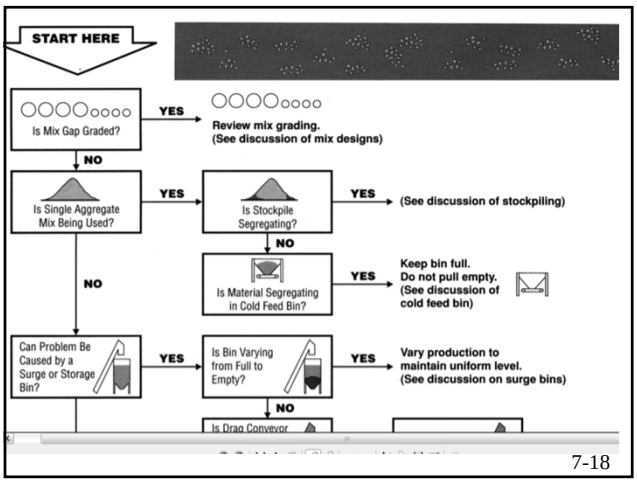
Segregation Troubleshooting

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

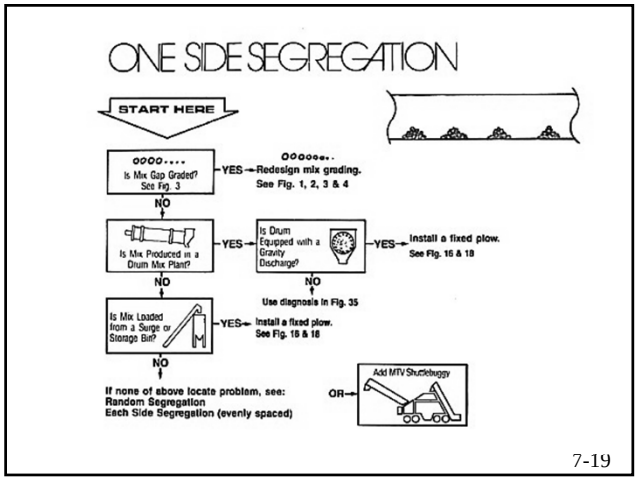
7-16



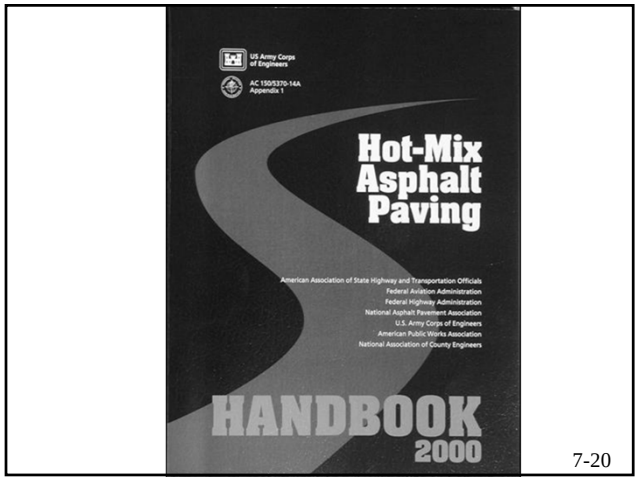
7-17



7-18



7-19



7-20

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

7-21

HMA Construction Program

Module 8 – Compaction

8-1

Learning Objectives

1. State the objective of compaction
2. Describe five engineering properties related to compaction
3. Identify material and mix properties affecting compaction
4. Describe the types of compaction equipment

8-2

Learning Objectives

5. Describe the considerations in the selection of compaction equipment
6. Pick the right roller for the job
7. Identify compaction variables
8. Identify the main components of compaction equipment maintenance

8-3

Learning Objectives

9. Calculate roller productivity
10. Describe proper compaction operating procedures

8-4

Definitions

- Density
- Compaction
- Pass
- Coverage

8-5

Importance of Compaction

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

8-6

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.

Topics

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

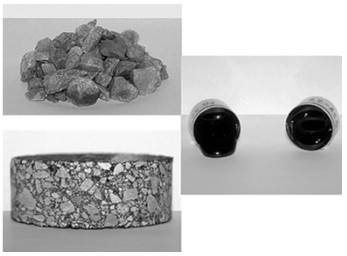
8-8

Factors Affecting Compaction

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

8-9

Properties of the Materials



- Aggregate
- Asphalt Binder
- Mix Properties

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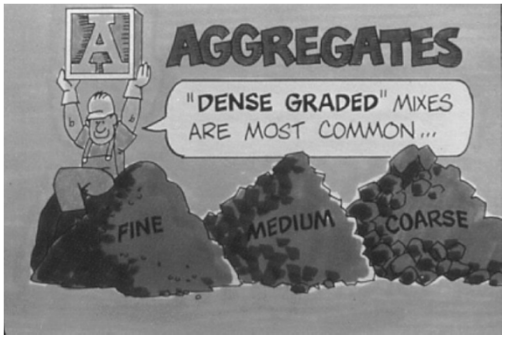
Courtesy of Caterpillar Paving Products

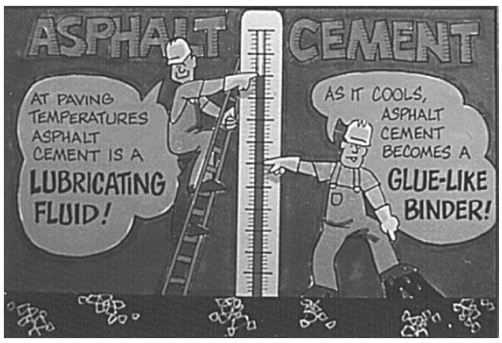
10



8-11

Aggregate Carries the Load

8-12



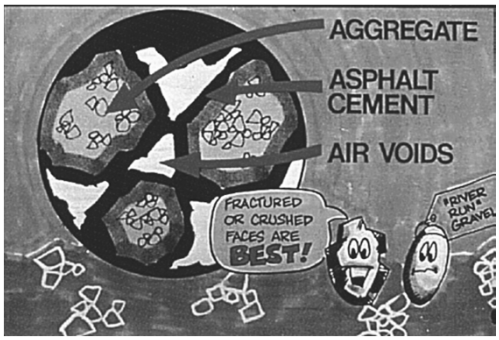
8-13

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

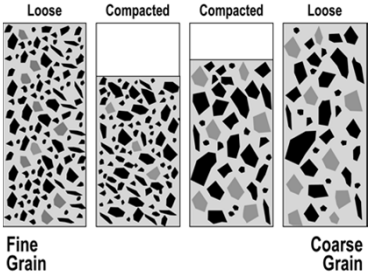
8-14

HMA



8-15

Mix Properties



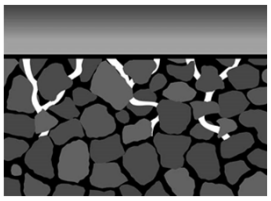
- Compaction rates vary by mix design
- Adjust thickness to match desired compacted mat thickness

CAT

Courtesy of Caterpillar Paving Products

8-16

Mat after Compaction



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

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17

Topics

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

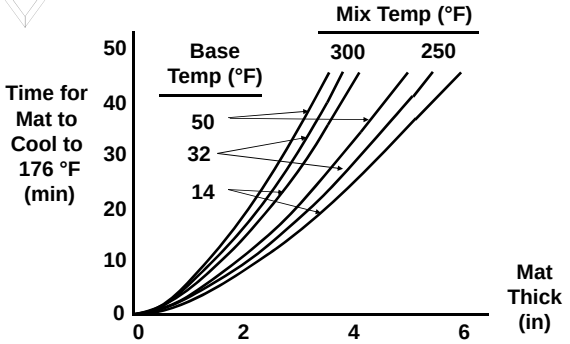
8-18

Rate of Cooling Variables

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

8-19

Mat Temperature Loss



8-20

New Tool – PaveCool

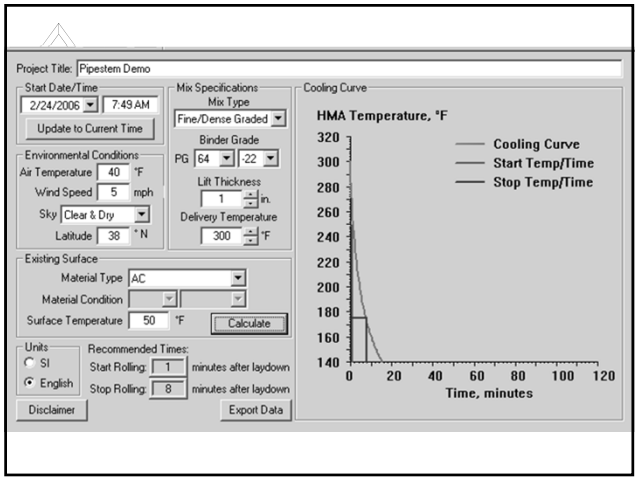
- Actual calculation of pavement cooling times based on job site conditions
- Available FREE

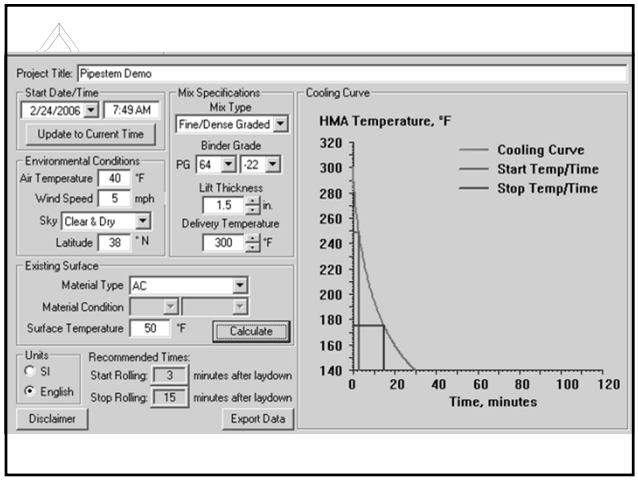
htpp://www.mnroad.dot.us/research/MnRoad_Project/restools/cooltool.asp

8-21

Heat = Compaction

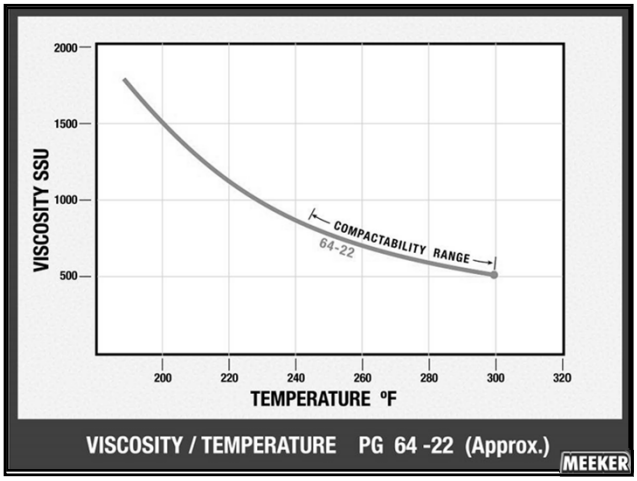
- Minimum temperature to achieve final density is 175 F (165 F sometimes)
- In general, an increase of mat thickness by 50% will result in almost twice as much time for compaction
- HMA delivered at 300 F, Air Temp = 40 F, and Surface Temp = 50 F, Clear and Dry, Wind = 5 mph
  - 1.0" cools to 175F in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

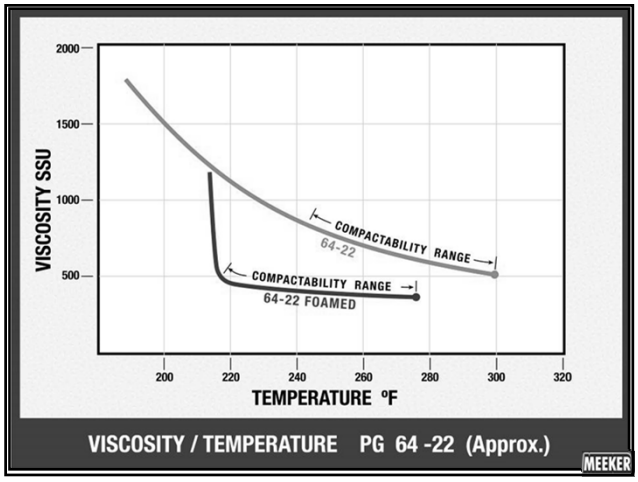




Warm Mix

- We use foaming by water injection – fine mist injected into the liquid to foam it prior to mixing with the aggregates.
- Same minimum temperature requirements to achieve final density is 175 F (165 F sometimes)
- Cooling curve is similar, viscosity curve changes
  - Can affect handwork
  - Patching applications?





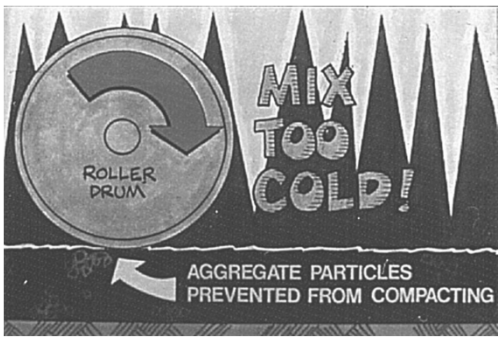
Warm Mix Video

8-28

Major Factors Affecting Rolling Time

FACTORS	allows MORE time	allows LESS time
Mat Thickness	THICK	THIN
Mix Temperature	HIGH	LOW
Base Temperature	HIGH	LOW

8-29



8-30

8-31

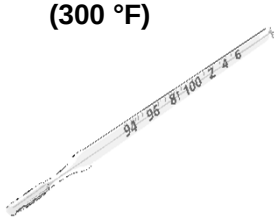
- Take Regular Mat Temperature Readings

- *Temperature control is critical*

Typical Compaction Temperature Range

80 °C - 150 °C
(175 °F) (300 °F)

What are Yours?



8-33

Laydown Site Conditions

- Lift thickness versus aggregate size
  - *Marshall ~2.5x maximum aggregate size*
  - *Superpave ~3x nominal maximum agg. size**
  - Check with design directive for specifics
- Lift thickness uniformity
  - Patch and Leveling
  - Scratch
  - Wedges and other unique conditions

8-34

Laydown Site Conditions

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

8-35

Topics

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

8-36

Types of Rollers

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

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Courtesy of Caterpillar Paving Products

How Do Rollers Compact?

By applying their load
over a given area!

(Contact Pressure)

Static Steel Wheel Roller

- Contact Pressure
- Operation

Static Steel Wheel Roller

Pounds Per Linear Inch (lb/in)

- Example:
  - A 12 ton roller with two, 4.3 feet wide drums.
  - In this case, 60% of the mass is on the drive drum and 40% is on the guide drum.
  - Calculate the lb/in

8-41

Pounds Per Linear Inch (lb/in)

- Example Solution:

  1 ton = 2,000 lb 1 foot = 12 in

  12 ton = 24000 lb

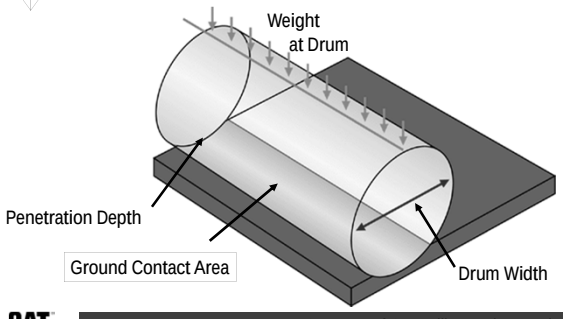
  4.3 ft = 51.6 in

  60% x 24,000 lb / 51.6 in = 279 lb/in

  40% x 24,000 lb / 51.6 in = 186 lb/in

8-42

Contact Pressure



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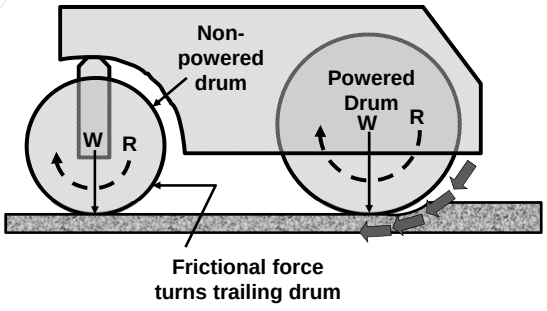
8-43

Travel



8-44

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**

8-45

Pneumatic Tired Rollers

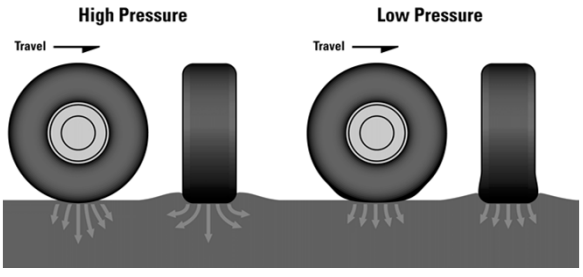
- Wheel load
- Tire design
- Inflation pressure
- Contact area

8-46

Pneumatic

8-47

Tire Inflation Pressure Versus Ground Contact Pressure



CAT

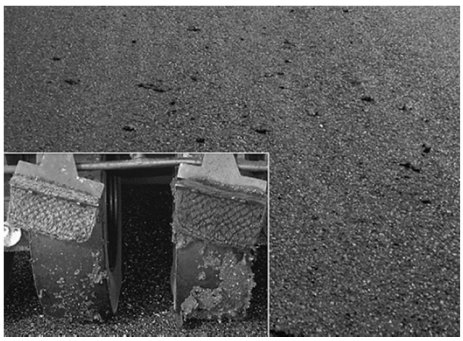
Courtesy of Caterpillar Paving Products

8-48

Skirted Pneumatic Roller

8-49

Tire Pick Up



8-50

Pneumatic Roller Operation

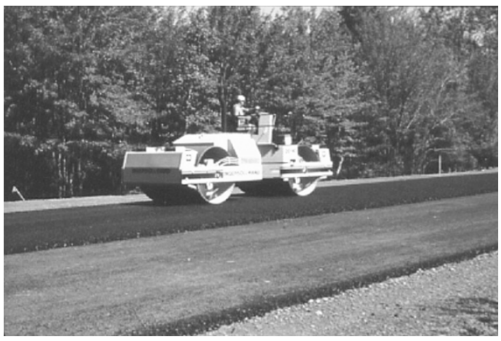
8-51

Vibratory Rollers

- Amplitude
- Frequency
- Impact Spacing
- Operation

8-52

Single Articulated Frame



8-53

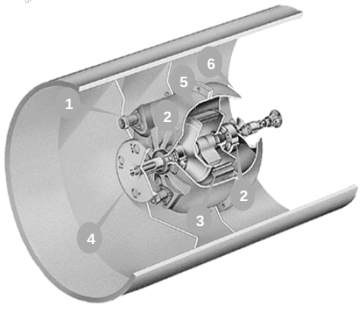
Double Articulated Frame

8-54

Vibratory Roller

8-55

Eccentric Weight System

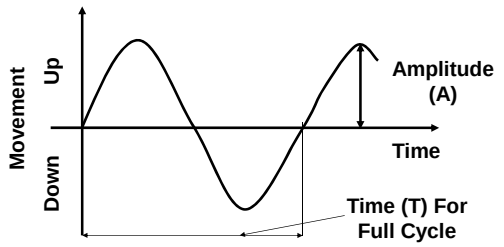


1. Oil level sight gauge
2. Eccentric weight shaft bearings
3. Three-position counterweight
4. Amplitude selection wheel
5. Fixed eccentric weight
6. Pod-style housing

CAT

Courtesy of Caterpillar Paving Products

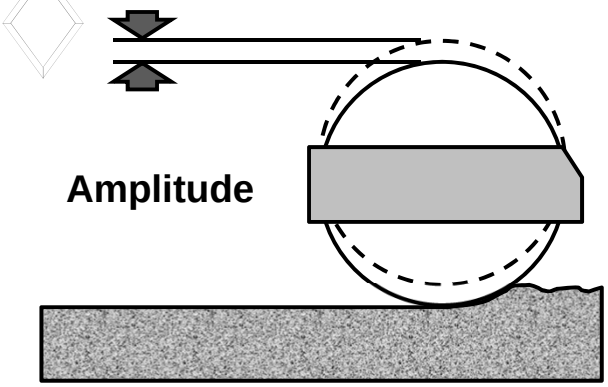
8-56



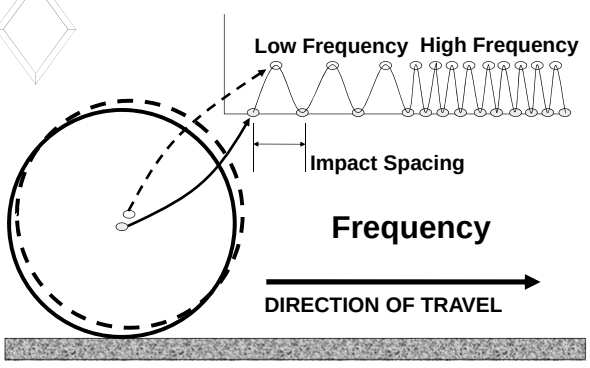
Frequency, f = the number of hertz (cycles/s)--a single cycle is one full rotation of the eccentric weight. Frequency = 1/T

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

8-57



8-58



8-59

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

8-60

Improper Impact Spacing

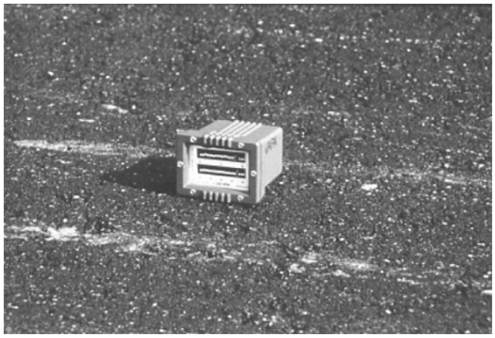
8-61

PROPER Impact Spacing

- **10 – 12 impacts per foot**

8-62

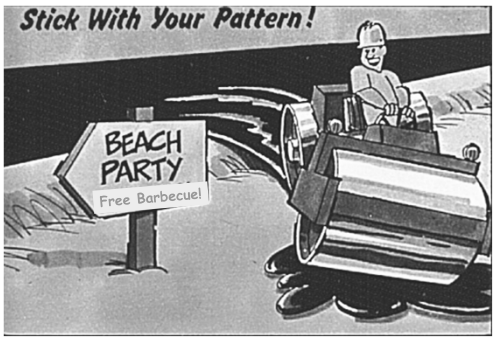
Reed Tachometer



8-63

Vibratory Roller Operation

8-64



8-65

Topics

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

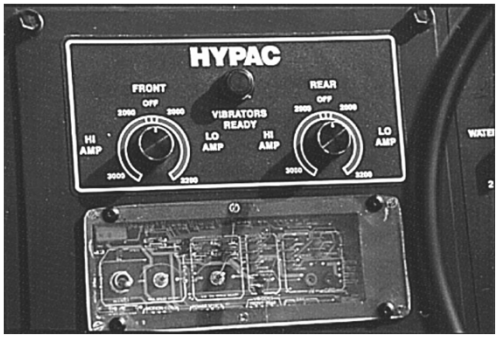
8-66

Roller Operator Controls

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

8-67

Roller Controls



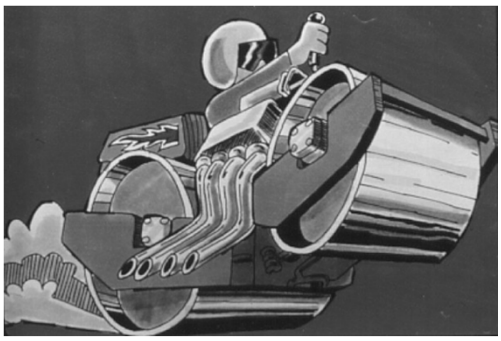
8-68

Compaction Variables

- Roller Speed (Dwell Time)
- Number of Coverages
- Rolling Zone
- Rolling Pattern

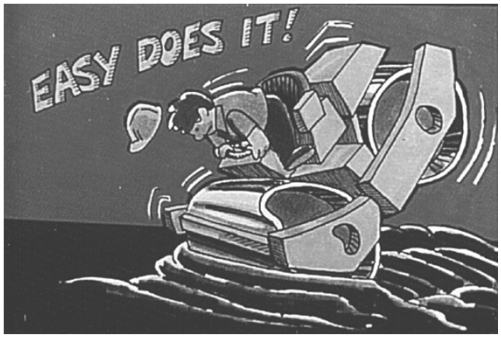
8-69

Speed



8-70

Stopping



8-71

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**	**-------**

8-72

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 ?

8-73

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)*

Breakdown Rolling

- Determine the rolling zone by:
  - Experience
  - Estimating

8-75

Intermediate Rolling

8-76

Finish Rolling

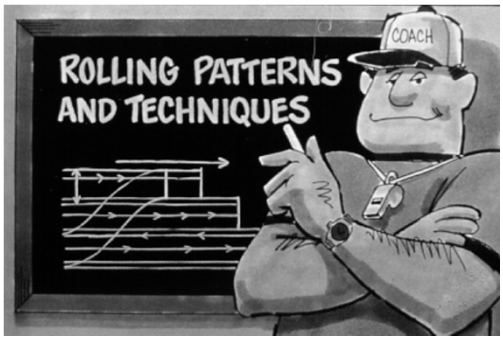
Courtesy of Caterpillar Paving Products

8-77

Topics

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

8-78



8-79

Operating Techniques

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

8-80

Test Strip Construction

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

8-81

Establishing Roller Pattern

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

8-82

Roller Widths

CAT

Courtesy of Caterpillar Paving Products

8-83

Paving Widths

8-84

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

8-85

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

8-86

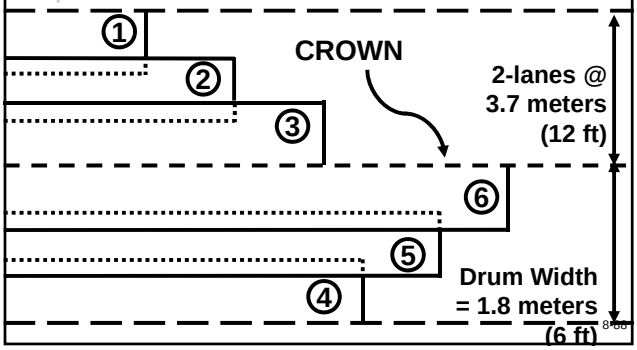
Roller Types by Application

Finish Rolling

Static (tons)	Pneumatic (Wheel Size)	Vibratory (tons)
8 to 10.5	15 in rim	6 to 8
8 to 12	20 in rim	10 to 11
10 to 14		> 12.5

8-87

One Roller Coverage



8-88

How Many Repeat Coverages to Assure Density?

8-89

Checking Density

8-90

As you watch the following videos think about:

- Your experience
- Previous training
- Information from this workshop

8-91

Establishing Roller Pattern

8-92

Establishing Roller Pattern

8-93

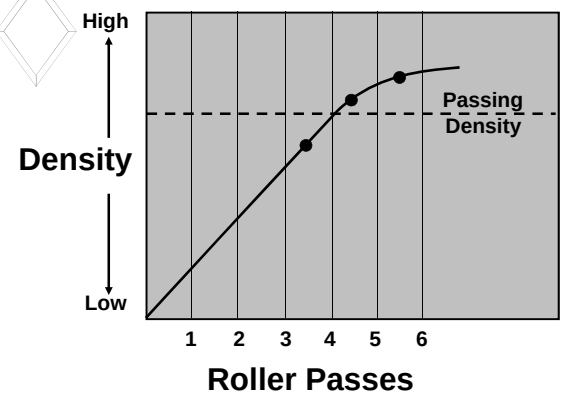
Establishing Roller Pattern

8-94

What do you think about the videos?

- Your experience
- Previous training
- Information from this workshop

8-95



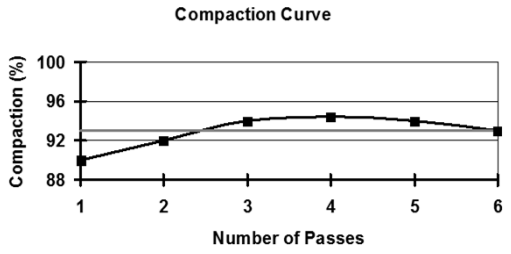
8-96

How many passes typical to achieve density?

- 4-6

8-97

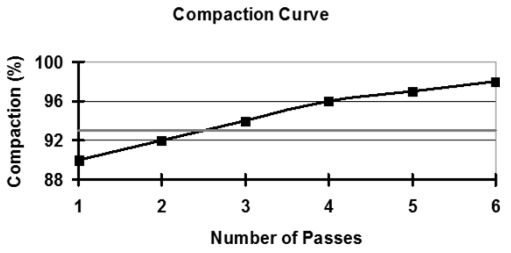
Roller Pattern Problem #1



Decreasing Temperature

8-98

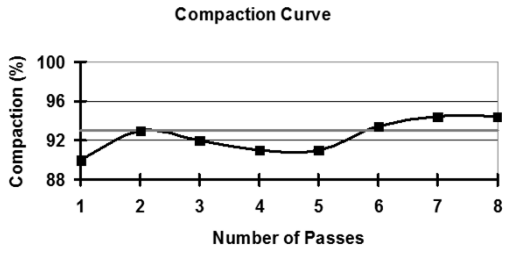
Roller Pattern Problem #2



Decreasing Temperature

8-99

Roller Pattern Problem #3



Decreasing Temperature

8-100

Temperature Gauges

8-101

Interior Temperature

8-102

Improper Gauge Usage

8-103

Coring

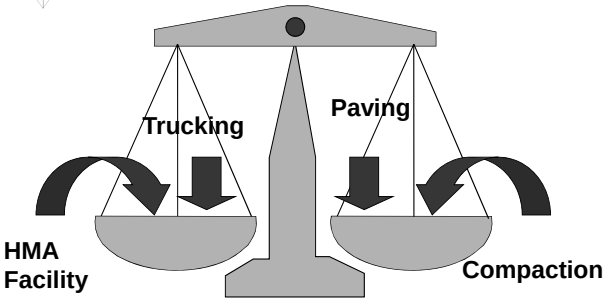
8-104

Topics

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

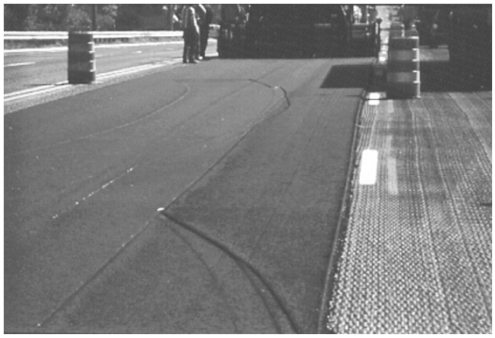
8-105

Balancing Production



8-106

Rolling Zone



8-107

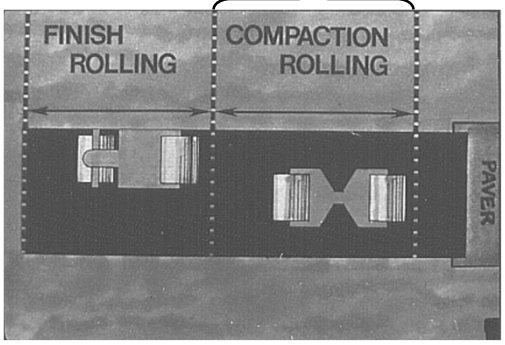
Calculating Your Rolling Zone

- Effective roller speed/(number of passes per coverage) = Effective Compaction Rate
- Effective Compaction (C-Rate) Production Rate equals 28 ft per minute.
- TAC from Environmental Variables chart equals 10 minutes for 2 in thick mat with mix temperature of 250 ^{o}F and base temperature of 50 ^{o}F.
- Rolling zone
- C-Rate times TAC =

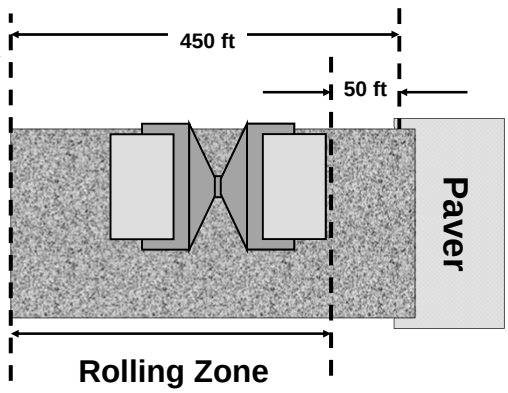
  28 fpm X 10 minutes = 280 ft

8-108

Rolling Zones



8-109



8-110

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							7.0	fpm
OK?							2.0	fpm
Truck Ca							84	inches
Total Trip							6	inches
Prep/Wa							50	feet
Load Tin							2	
Ticket/Ta							3	
Haul Tim							7	
Wait @ J							83	%
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

8-111

Topics

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

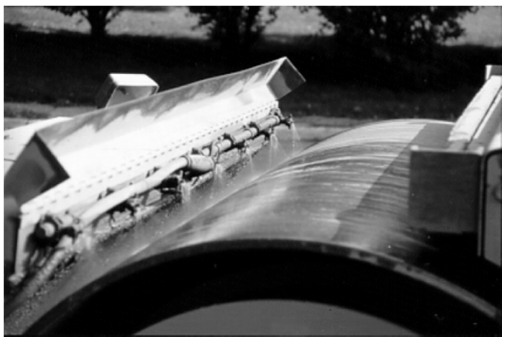
8-112

Roller Maintenance

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

8-113

Water Spray Bar



8-114

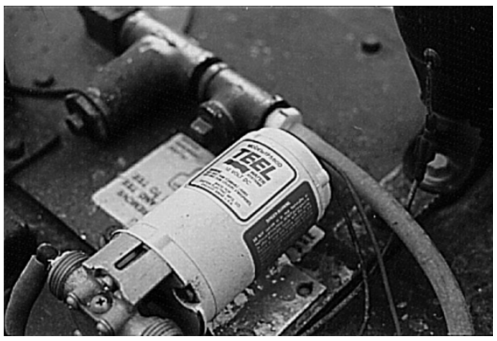
Pads

8-115

Poor Maintenance

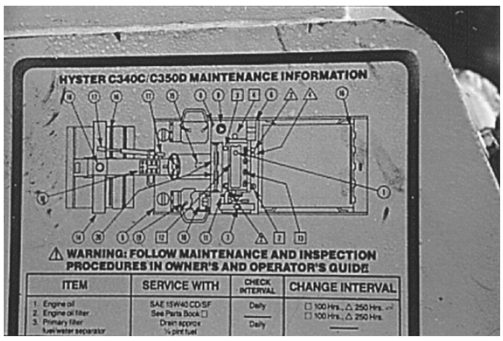
8-116

Water Pump



8-117

Maintenance Chart



8-118

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

8-119

Concluding Operations

8-120

Opening to Traffic

8-121

INSPECTOR'S DUTIES - ASPHALT PAVING

NHI Course #131032

Modified by WVDOT/DOH, APAWV, and WVU ATP

Work Includes…

- **Resurfacing Projects**
  - State Funded
  - Federal Funded
- **New Projects**
  - New Roads
  - Bridge Approaches
  - Road Widening
  - Intersection Improvements

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

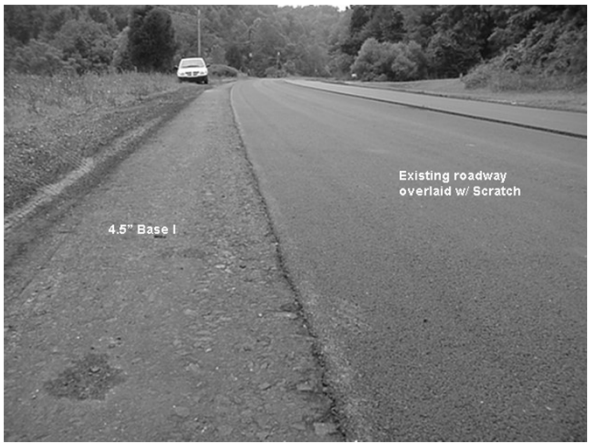
Inspector duties vary depending on the funding program

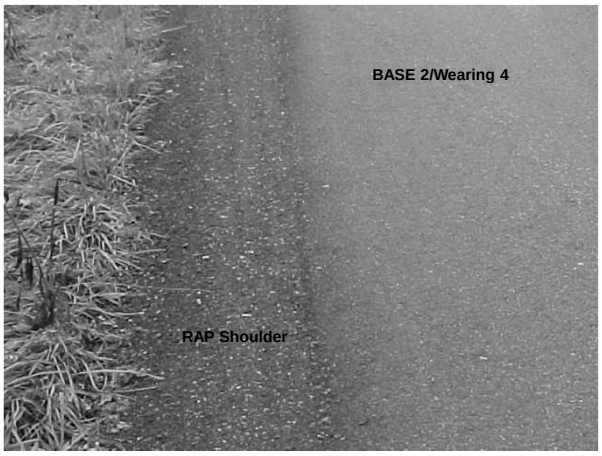
Basic HMA Applications

- **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.





Marshall versus Superpave

- Superpave is an acronym for ***Su***perior ***Per***forming Asphalt ***Pave***ment
- *Newer* method of mix design
- Marshall uses the proctor type of specimen preparation whereas Superpave uses a gyratory compactor

Marshall versus Superpave

- Performance Grade (PG) binders are grouped and selected based on climate
  - PG 64-22 indicates a binder suitable for a climate that does not exceed a seven day maximum surface temperature of 64 C or a coldest minimum surface temperature of -22C.
- Superpave has much more stringent requirements
  - aggregate properties (angularity)
  - production tolerances

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

Activities Prior to Construction…

- Construction Layout
  - Staking the project
  - Mark Heel-ins
  - On larger projects this is usually included in contract

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

- 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

- 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
    - Air Voids
  - All mix designs are "Verified" at the beginning of each season

T400
03-00

WEST VIRGINIA DIVISION OF HIGHWAYS
PLANT MIX FORMULA FOR HOT-MIX ASPHALT

Report Number:	1365839	Date Accepted:	May 10, 2005
HMA Type:	Wearing-1 Skid	HMA Code:	13967
Producer:	West Virginia Paving	Plant Location:	Dunbar, WV
Designed By:	Wayne Ingram	Design Lab:	Southern WV Asphalt, Ingleside, WV
Plant Type:	Drum	Plant Make:	Bituma-Gencor
Plant Code:	W074C	Traffic Type:	Heavy

MIX COMPOSITION

Coarse Aggregate Source		Code	Fine Agg. / Mineral Filler Source		Code
CA_1	Mulzer Stone, Charlestown, In.	M027E	FA_1	Mulzer Stone, Cape Sandy, In.	M289A
CA_2			FA_2	Shelly Materials, Apple Grove, Oh.	R0130
CA_3			FA_3	Bag House Fines	I0000

	CA_1	CA_2	CA_3	FA_1	FA_2	FA_3
Agg. Type	#8 Limestone			Limestone	Natural	BHF
Agg. Code	1135			1116	1115	1115
% Total Agg.	40			25	33	2

% RAP Total Agg.:		Blended Binder G*/sin delta if > 25% RAP:			
% Binder In RAP Design:		Binder Type:	PG 64-22	Binder Code:	1093
Binder Source:	Middleport Terminal, Kanauga, Oh.			Binder SourceCode:	M001A

Sieve Fraction									Voids filled with Asphalt*VFA*(%)	Fines to Asphalt Ratio
Sieve Size	Target	Allowable Min.	Allowable Max.	Sieve Size	Target	Allowable Min.	Allowable Max.		76	0.9
2" (50 mm)				#4 (4.75 mm)	63		80	Temperature Range Completed Mixture (°F)		
1.5" (37.5mm)				#8 (2.36 mm)	39	33	45			
1" (25 mm)				#16(1.18 mm)	27			Desirable Mean Temp.	Temp. Range Min.	Max.
3/4" (19 mm)				#30 (600 µm)	19					
1/2" (12.5 mm)	100	100	100	#50 (300 µm)	11					
3/8" (9.5 mm)	95	85	100	#200(75 µm)	5.5	2.0	9.0	311	286	336

PLANT MIX FORMULA VALUES

Plant Mix Formula Targets			Plant Mix Formula Tolerances	
Specific gravity stone bulk (Gsb): 2.595	Design Property	Accepted Target	Minimum	Maximum
	Asphalt (%)	6.2	5.8	6.6
Maximum Density (kg/m³)	Air Voids (%)	4.0	2.5	5.5
	VMA (%)	16.3	15.3	17.3
	Stability (N)	9797	8000	NA
2410	Flow (0.25mm)	10	8	14

Remarks:

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

Contractor's Requirements

- Contractor should have an overall paving plan including…
  - Production Rate
  - Haul Distance
  - Number of Trucks
  - What does WMA affect here?
- Must be able to maintain a constant "Head of Material"
- Properly staffed paving crew
  - Paving operator
  - Screed person
  - Broom
  - Compaction
  - Laborers

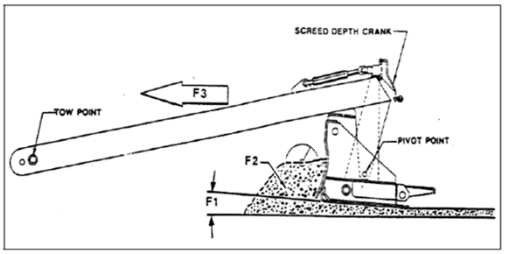


Figure 7-3. Free Floating Screed

The three primary variable factors (Figure 7-3) which influence the vertical position of the free-floating screed are:

1) Factor F-1 – Angle of Attack

2) Factor F-2 – Head of Material

3) Factor F-3 – Paving Speed

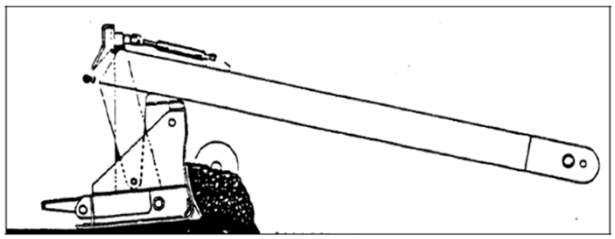


Figure 7-5. Correct Head of Material

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 control strip and gauge correction factors properly??????
  - *Field Sampling Requirements for New 401-PWL*
  - Good technician understands the limitations of the JMF and has a general understanding of the nature of the specific mix

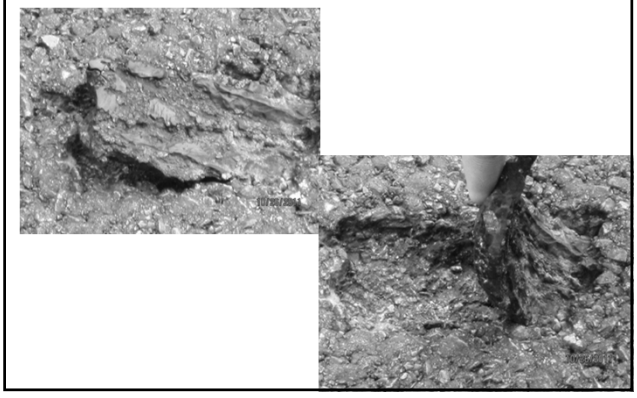
Inspector's Daily Duties…

- 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?

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!!!

Inspector's Daily Duties…

- Is compaction being done properly and density readings are acceptable
- Application rates at approximately 2500' intervals
- Placement of temporary tape and temporary markings as needed/required

What is the Proper Rate for Tack?

- New Tack Coat Specification (2010)
  - 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?

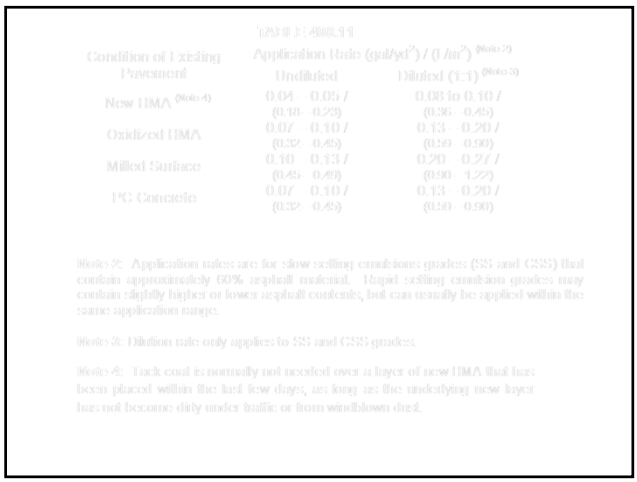


Table 408.11

Condition of Existing Pavement	Application Rate (gal/yd²) / (l /m²) [Note 2]	
	Undiluted	Diluted (1:1) [Note 3]
New HMA [Note 4]	0.04 – 0.05 / (0.18 – 0.23)	0.08 to 0.10 / (0.36 – 0.45)
Oxidized HMA	0.07 – 0.10 / (0.32 – 0.45)	0.13 – 0.20 / (0.60 – 0.90)
Milled Surface	0.10 – 0.13 / (0.45 – 0.59)	0.20 – 0.27 / (0.90 – 1.22)
PC Concrete	0.07 – 0.10 / (0.32 – 0.45)	0.13 – 0.20 / (0.60 – 0.90)

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

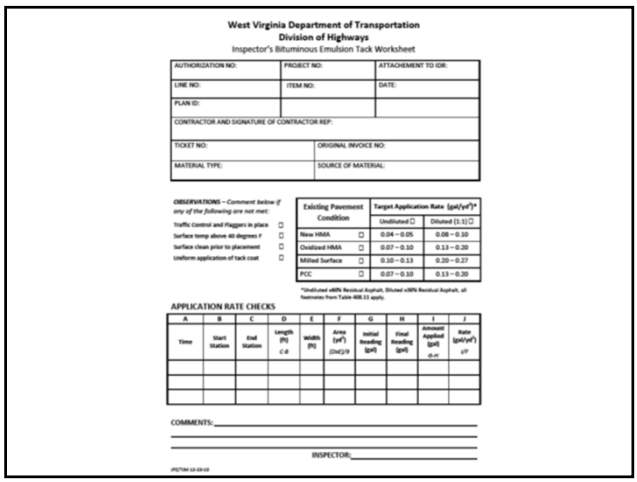
- Existing roadway is very old, dried, cracked, etc. – “Oxidized” from Table 408.11
- Prior to tack placement, dial gauge reads 450 gallons. Tack has been diluted in tank.
- Tack is placed from Sta. 0+00 to Sta. 10+00. Dial gauge reads 275 gallons after tack placement.
- Road width is an average of 12’.

Example Tack Calculation

- Calculate the tack used
  - 450 gal – 275 gal = 175 gal
- Calculate the area of placement
  - (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/yd²***
- Rate is within required range for dilution!
- What is the actual residual tack quantity on the road?

Residual Tack Calculation

- Diluted at 1:1
- (0.13 gal/yd^2 ÷ 2) x 0.60 = ***0.04 gal/yd²***



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

AUTHORIZATION NO:	PROJECT NO:	ATTACHMENT TO ID#:
LINE NO:	ITEM NO:	DATE:
PLAN ID:		
CONTRACTOR AND SIGNATURE OF CONTRACTOR REP:		
TICKET NO:	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, all footnotes from Table 408.11 apply.

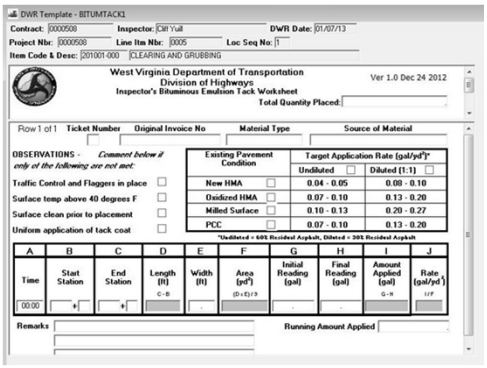
APPLICATION RATE CHECKS

A	B	C	D	E	F	G	H	I	J
Time	Start Station	End Station	Length (ft) C-B	Width (ft)	Area (yd²) (Dxe)/9	Initial Reading (gal)	Final Reading (gal)	Amount Applied (gal) G-H	Rate (gal/yd²) I/F

COMMENTS: _____

INSPECTOR: _____

Site Manager-Tack Worksheet

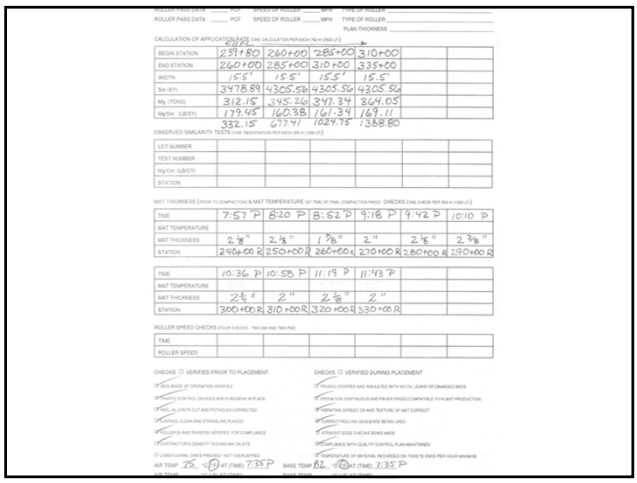


Approximate Rate and Lift Thickness

- 110 PSY = 1.0” Compacted (Stone or Gravel)
- 165 PSY = 1.5” Compacted
- 220 PSY = 2.0” Compacted

Why do we use 110 PSY for an inch?

- Specs require 92%-96% of the Theoretical Maximum Density (Target Density)
- 2010 range for HMA (S or G) mixes – Marshall 147.7 to 159.9 pcf, SP 151.8 to 160.5 pcf for TMD (mixes from Millville came in at 165.7 pcf)
- Assume 154 pcf
  - Compact to 96% = 147.84 pcf
  - 1 cubic foot has 12 *slices* an inch thick that weigh 12.32 pounds
  - 9 of these slices result in one square yard of material that weighs ***110.88 pounds***
- For 165.7 pcf , ***119.3 pounds***



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))

EBFL →

BEGIN STATION	239+80	260+00	285+00	310+00	
END STATION	260+00	285+00	310+00	335+00	
WIDTH	15.5'	15.5'	15.5'	15.5'	
Sm (SY)	3478.89	4305.56	4305.56	4305.56	
Mg (TONS)	312.15	345.26	347.34	364.05	
Mg/Sm (LB/SY)	179.45	160.38	161.34	169.11	
	332.15	677.41	1024.75	1388.80	

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 P

TIME	7:57 P	8:20 P	8:52 P	9:18 P	9:42
MAT TEMPERATURE					

Compaction Penalty

- 401.13.3 Basis of Payment of the Standard Specs and Current 401 Special Provision for Joint Density dated July 16, 2012
- Must refer to the lot evaluations and DWR (***Application Rate***)
- Each lot is generally 1000' long per pull
- If lot overlaps to different application rates, determine the weighted average

Compaction Penalty

- From the QA Lot Evaluation
  - Lot A4 EBFL, Sta. 280+00 to 290+00
  - Lot A5 EBFL, Sta. 290+00 to 300+00.
- Application Rate for Lot A4 is the average of the two corresponding application rates on the DWR worksheet (160.86 psy).
- Application Rate for A5 is 161.34 psy.

Compaction Penalty

- Use the paving length, width, and rate to calculate the tonnage for the lot.
- Lot A4: [(15.5x1000)/9]x(160.86/2000) =138.52 Tons
- Lot A5: 138.93 Tons

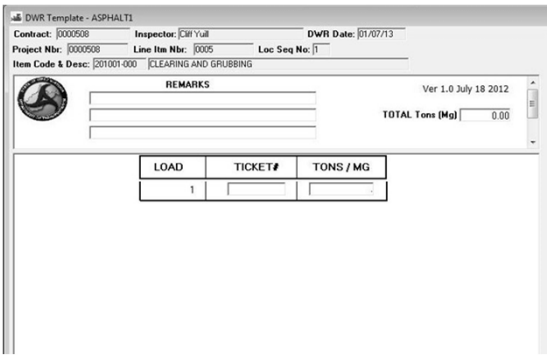
Compaction Penalty

- Final lot densities should be expressed to the nearest whole percent (See MP 401.05.20)
- Assume Lot A4 has the following:
  - Mat Density is 91
  - Joint Density is 88
- Adjustments for lots with both mat and joint testing:
  - Mat Density adjustment is -2%
  - Joint Density adjustment is -10%

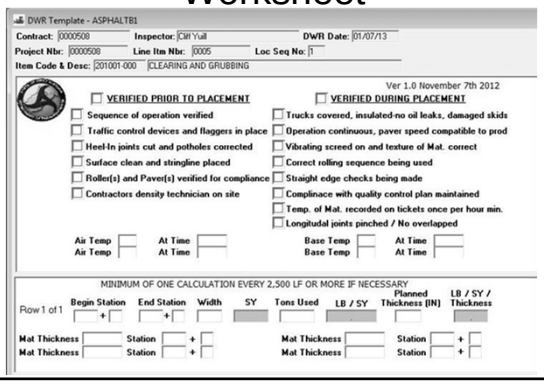
Compaction Penalty

- Adjustment = (unit price) x (quantity) x (mat adjustment + joint adjustment)
- If unit price is $100.00 per ton:
  - ($100) x (138.52) x (-0.02 + -0.10)
  - Penalty = $1,662.24
- Please note…there is incentive money for mat density at 95-96 and joint density 92-96.

Site Manager-Asphalt Worksheet



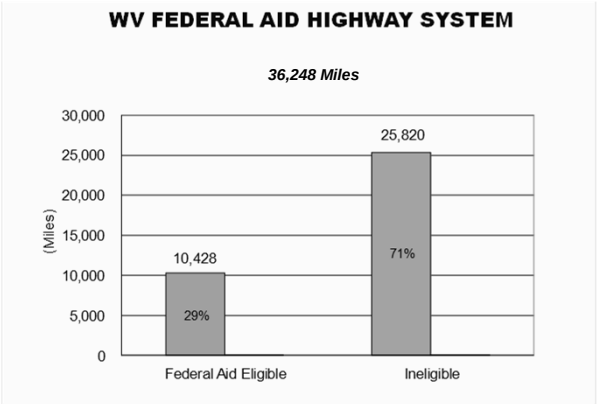
Site Manager-Asphalt Worksheet



FUNDING!!!!!!!

West Virginia 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
  - 35,882 miles
  - Approx 24,000 miles are paved
- Total Federal Aid System Including Turnpike and Fed Aid non-state
  - 36,248 miles



West Virginia ranks second to last in the country in capital investment per state-maintained mile!!!!

(2005)

National Average - $23,967

WV Average - $7,594

Reference Manuals

- Construction Manual
- USACE – *Hot-Mix Asphalt Paving Handbook*
- Asphalt Institute MS 22 – *Construction of Hot-Mix Asphalt Pavements*
- NCAT – *Hot-Mix Asphalt Materials, Mixture Design and Construction*
- Asphalt Institute MS 4 – The Asphalt Handbook
- WVDOT Factbook 2012

?

Next - Site Manager Discussion

HMA Construction Program

Module 10

Quality Control/ Quality Assurance

10-1

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

10-2

Quality Trends in Construction

- Customer-driven quality initiatives
- ISO 9000-based quality systems
- Project-focused quality efforts
- Focus on customer satisfaction
- The definition of “quality”
- Senior leadership involvement

10-3

What does QC/QA mean?

10-4

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 constructor!

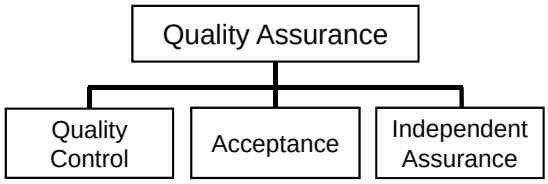
10-5

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 are typically conducted at less *frequency* and with greater *randomization* than the producer's process
- QA is the responsibility of the buyer!

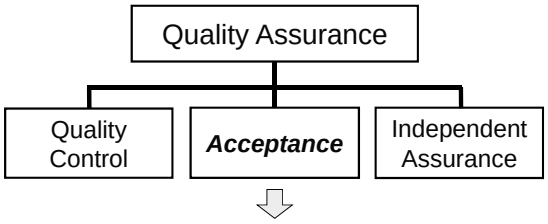
10-6

Elements of QA



10-7

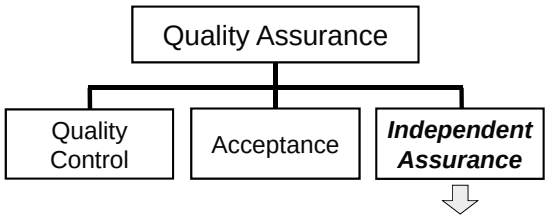
Elements of QA



"all the factors that comprise the buyer/owner's determination of the quality of the product as specified in the contract requirements"

10-8

Elements of QA



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

10-9

QA in Various Settings

Buyer/ Owner	Product	QC Process	Accept-ance	Indep. Assurance
Individ-ual	New Car	?	?	?
Individ-ual	Fast Food	?	?	?
Public Agency	Road-way	?	?	?

10-10

Specifications

- Types
- Relationship to performance
- Risk considerations

Types of Specifications

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

10-12

Method Specifications

- Most common (historically)
- 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 or 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

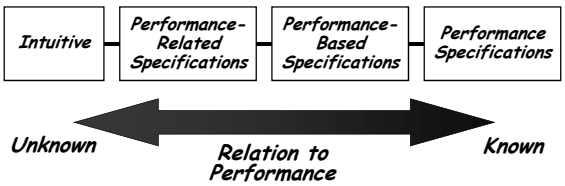
QC/QA Specifications

- 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

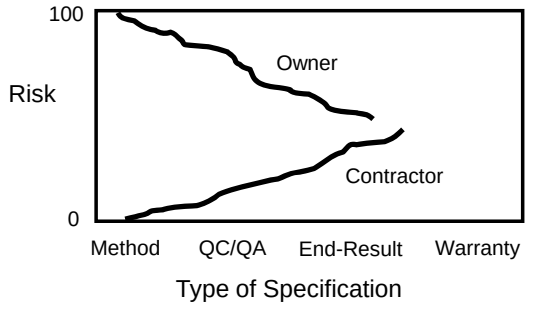
Performance Specifications

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

Relationship to Performance



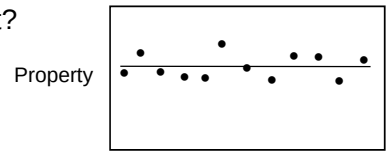
Risk Considerations



10-20

M&C Variability

- What is it?



- Importance
- Properties affected
- Standard measures
- Sources

Importance of Variability

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

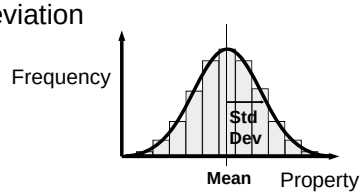
Key Properties Affected by Construction Variability

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

10-23

Standard Measures of Variability

- Range
- Standard deviation



- Coefficient of variation

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

10-25

Reduce Sampling and Testing Variability

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

Use of Statistical Analysis for Quality Control

10-27

Control Charts

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

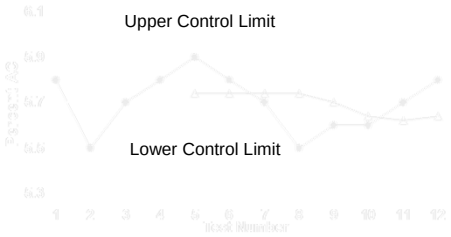
10-28

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

10-29

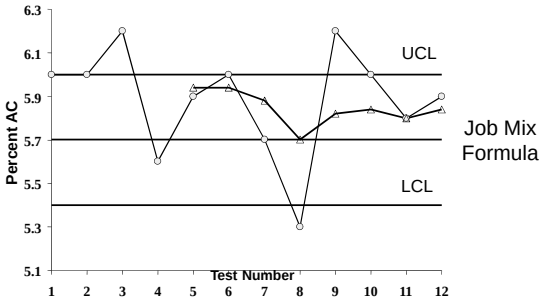
Good Process Control



Δ Running Average • Individual Test Results

10-30

Poor Process Control



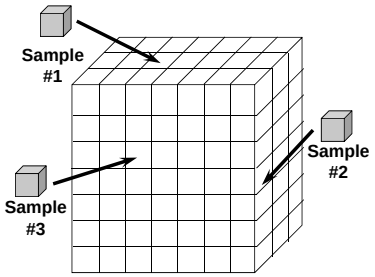
10-31

Use of Statistical Analysis for Quality Assurance

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

10-32

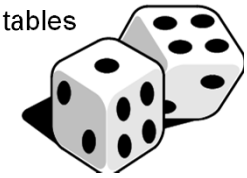
Sampling



10-33

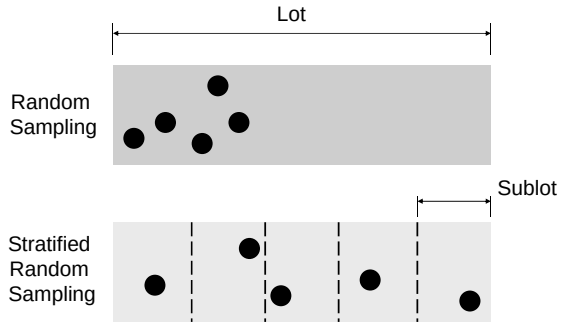
Random Sampling

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



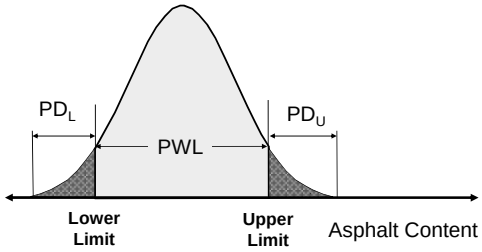
10-34

Lots and Sublots

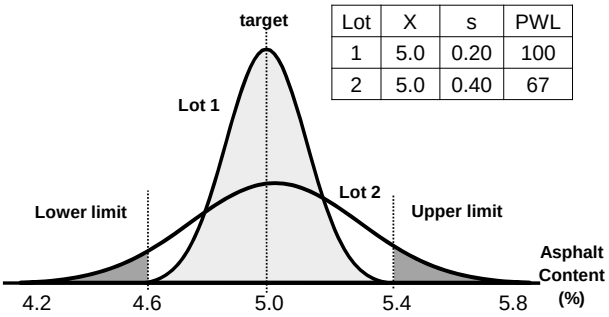


10-35

PWL and PD Concept

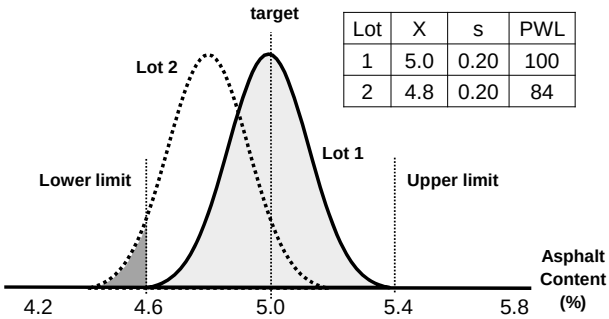


Percent Within Limits



Lot	X	s	PWL
1	5.0	0.20	100
2	5.0	0.40	67

Percent Within Limits



Lot	X	s	PWL
1	5.0	0.20	100
2	4.8	0.20	84

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 PF (both penalty and bonus)
  - PFs are typically determined for different factors and then combined
  - Max and limits on PF are established
- Not common to consider contractor's QC process

10-39

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)

10-40

Mechanics of PWL

$$PWL = 100 - (PD_U + PD_L)$$

Where:

PD_U = Percent Defective (upper), obtained from PD table for calculated QI_U and given n

PD_L = Percent Defective (lower), obtained from PD table for calculated QI_L and given n

n = number of test results

10-41

Pay Factors

Pay Factor (%) = 55 + 0.5*PWL

Current AASHTO Recommendation:

PWL = 90 (10% Defective)

yields a PF = 100%

10-42

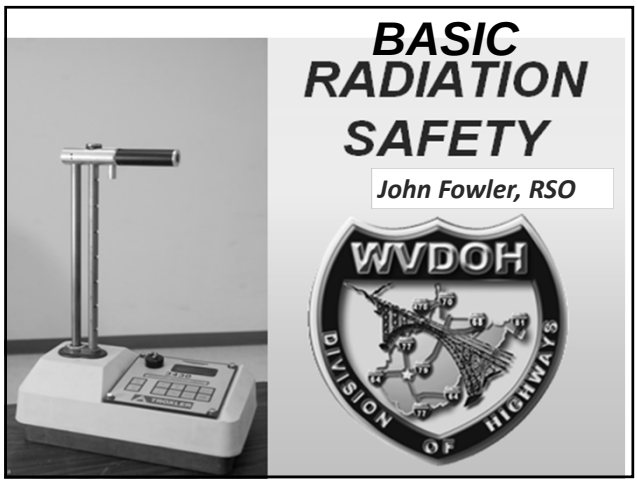
Summary

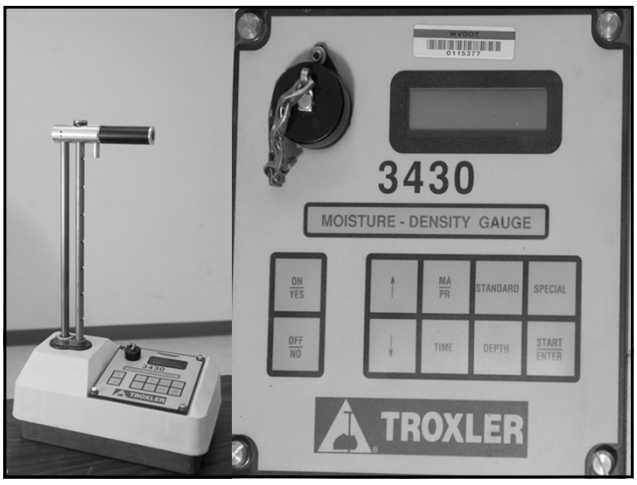
1. Differentiate between quality control (QC) and quality assurance (QA)
2. Different types of specifications (relate to performance and risk)
3. Sources of variability within HMA construction process (emphasis on M&C variability)
4. Statistical analysis for QC (control charts) and QA (sampling to payment)

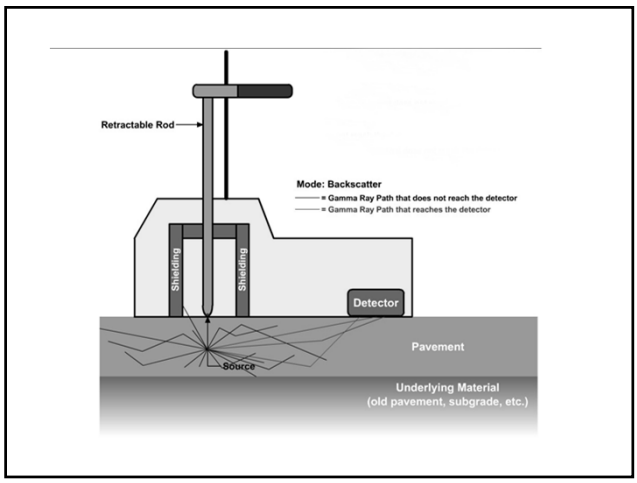
10-43

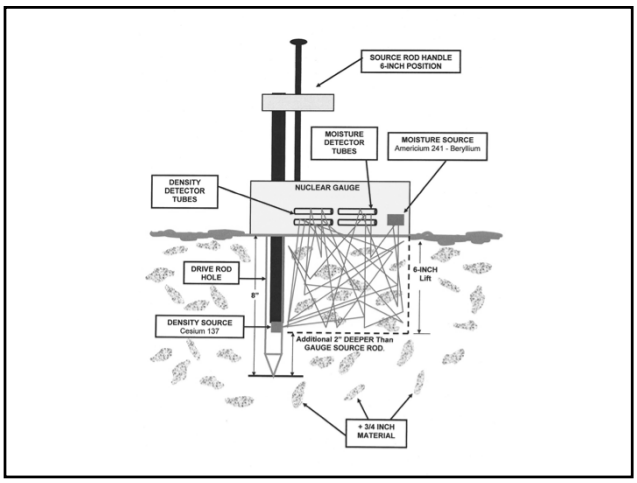
Questions?

10-44


BASIC
RADIATION
SAFETY
John Fowler, RSO
WVDOH
DIVISION OF HIGHWAYS


3430
MOISTURE - DENSITY GAUGE
ON YES
OFF NO
MA PR
STANDARD
SPECIAL
TIME
DEPTH
START ENTER
TROXLER


Retractable Rod
Mode: Backscatter
= Gamma Ray Path that does not reach the detector
= Gamma Ray Path that reaches the detector
Shielding
Shielding
Detector
Pavement
Source
Underlying Material
(old pavement, subgrade, etc.)


SOURCE ROD HANDLE
6-INCH POSITION
MOISTURE DETECTOR TUBES
MOISTURE SOURCE
Americium 241 - Beryllium
DENSITY DETECTOR TUBES
NUCLEAR GAUGE
DRIVE ROD HOLE
8"
6-INCH
Lift
DENSITY SOURCE
Cesium 137
Additional 2" DEEPER Than
GAUGE SOURCE ROD.
+ 3/4 INCH
MATERIAL

Why have a Radiation Safety Program?

ANSWER: To maintain exposures to:

ALARA

Acronym for ***A**s **L**ow **A**s **R**easonably **A**chievable*. This means making every reasonable effort to maintain exposures to radiation as far below the dose limits in this part as is practical. This is the goal of all radiation safety programs.

How to Achieve "ALARA"

TIME

DISTANCE

and

SHIELDING

Time:

The most direct way to reduce radiation dose is to reduce the time spent working with or in the vicinity of radiation sources. If the exposure time is cut in half, the dose will be reduced by the same fraction.

Distance:

Distance is one of the most effective means to reduce dose thanks to basic principles of geometry. When the working distance from a point radiation source is increased by a factor of two, the dose received from that source will be reduced by a factor of four. This is referred to as the inverse square law, i.e., the radiation intensity from a point source decreases with the square of the distance from the source.

Shielding:

Shielding is any material used to reduce the intensity of radiation by absorbing or weakening the radiation coming from the source. Nuclear gauges have a significant amount of shielding already built in to protect the operator.

HAZMAT

(Hazardous Materials Training)

The U.S. DOT regulations 49 CFR 172, Subpart H requires every Hazmat employer to train, test, certify and maintain records for each Hazmat employee. Hazmat training applies to anyone who transports or prepares for transport radioactive materials. Refresher training is required every three years.

Hazmat Employee

- Loads, unloads, or handles hazardous materials.
- Tests, reconditions, repairs, packages for transportation etc.
- Prepares hazardous materials for transportation.
- Is responsible for safety of transporting hazardous materials.

Hazmat Employer

- Uses hazmat employees.
- Transports hazmat materials in commerce.
- Causes hazmat materials to be transported.
- Represents, marks etc. containers, drums, or packaging as qualified for use in the transportation of hazardous materials.

Training

•General awareness.

• Function Specific.

• Safety training concerning emergency response.

Training Requirements

•Shall ensure that each employee is trained.

• May not perform a function unless trained.

• Training may be provided by employer or other public or private sources.

•Must receive training every THREE YEARS.

• Must keep a RECORD of the training.

POSTINGS

Main Building and Gauge Storage Area

- ❖ NRC 3 Notice to Employees
- ❖ Regulatory Guide 8-13
- ❖ NRC Part 21
- ❖ Operating and Emergency Procedure Appendix H
- ❖ Gauge Daily Shipping Logs (storage area only)
- ❖ Gauge Utilization Logs (storage area only)

GAUGE "DAILY" SHIPPING LOG

Troxler Model 3430, SERIAL #_____

UN3332, Radioactive material, Type A Package, Special Form
Cs-137, 0.30 GBq (8 mCi)
Am-241, 1.48 GBq (40 mCi)

Shipment Dates	Shipment Dates	Shipment Dates	Shipment Dates

GAUGE UTILIZATION LOG

Troxler Model 3430, SERIAL #_____

UN3332, Radioactive material, Type A Package, Special Form
Cs-137, 0.30 GBq (8 mCi)
Am-241, 1.48 GBq (40 mCi)

Date Removed from Storage	Removed By (User Name)	Job Site Use Location	Date Returned to Storage	Returned By (User Name)

Handling, Storage and Operation of Nuclear Gauges

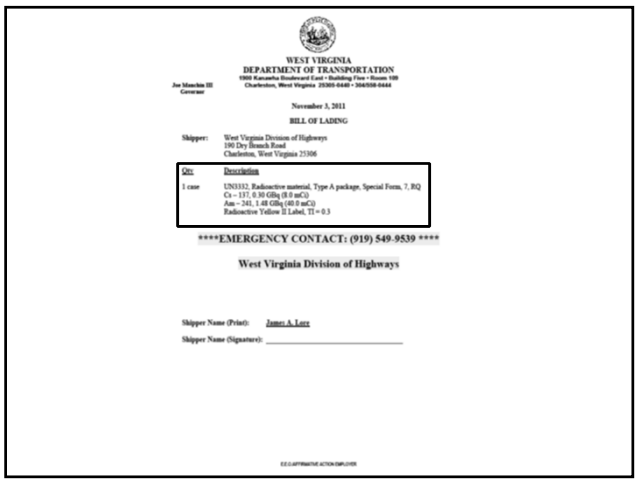
Never Handle, Store or Operate a Gauge in the

RAIN

Transportation of Nuclear Gauges

Shipping Papers (Must List)

- Shipper and consignee
- Special form
- Class 7
- UN3332
- Sealed source
- Type A package
- Radioactive Yellow II
- Transport index



WEST VIRGINIA
DEPARTMENT OF TRANSPORTATION
1900 Kanawha Boulevard East • Building Five • Room 100
Charleston, West Virginia 25305-0440 • 304/558-0444

Joe Manchin III
Governor

November 3, 2011

BILL OF LADING

Shipper: West Virginia Division of Highways
190 Dry Branch Road
Charleston, West Virginia 25306

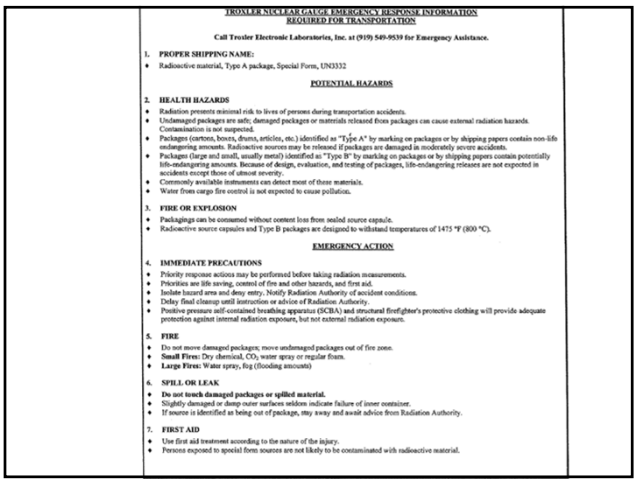
Qty	Description
1 case	UN3332, Radioactive material, Type A package, Special Form, 7, RQ Cs – 137, 0.30 GBq (8.0 mCi) Am – 241, 1.48 GBq (40.0 mCi) Radioactive Yellow II Label, TI = 0.3

****EMERGENCY CONTACT: (919) 549-9539 ****

West Virginia Division of Highways

Shipper Name (Print): James A. Lore

Shipper Name (Signature): _____



TROXLER NUCLEAR GAUGE EMERGENCY RESPONSE INFORMATION
REQUIRED FOR TRANSPORTATION

Call Troxler Electronic Laboratories, Inc. at (919) 549-9539 for Emergency Assistance.

1. PROPER SHIPPING NAME:
- Radioactive material, Type A package, Special Form, UN3332

POTENTIAL HAZARDS

2. HEALTH HAZARDS
- Radiation presents minimal risk to lives of persons during transportation accidents.
- Undamaged packages are safe; damaged packages or materials released from packages can cause external radiation hazards. Contamination is not suspected.
- Packages (cartons, boxes, drums, articles, etc.) identified as "Type A" by marking on packages or by shipping papers contain non-life endangering amounts. Radioactive sources may be released if packages are damaged in moderately severe accidents.
- Packages (large and small, usually metal) identified as "Type B" by marking on packages or by shipping papers contain potentially life-endangering amounts. Because of design, evaluation, and testing of packages, life-endangering releases are not expected in accidents except those of utmost severity.
- Commonly available instruments can detect most of these materials.
- Water from cargo fire control is not expected to cause pollution.

3. FIRE OR EXPLOSION
- Packagings can be consumed without content loss from sealed source capsule.
- Radioactive source capsules and Type B packages are designed to withstand temperatures of 1475 °F (800 °C).

EMERGENCY ACTION

4. IMMEDIATE PRECAUTIONS
- Priority response actions may be performed before taking radiation measurements.
- Priorities are life saving, control of fire and other hazards, and first aid.
- Isolate hazard area and deny entry. Notify Radiation Authority of accident conditions.
- Delay final cleanup until instruction or advice of Radiation Authority.
- Positive pressure self-contained breathing apparatus (SCBA) and structural firefighter's protective clothing will provide adequate protection against internal radiation exposure, but not external radiation exposure.

5. FIRE
- Do not move damaged packages; move undamaged packages out of fire zone.
- **Small Fires:** Dry chemical, CO_2 water spray or regular foam.
- **Large Fires:** Water spray, fog (flooding amounts)

6. SPILL OR LEAK
- **Do not touch damaged packages or spilled material.**
- Slightly damaged or dump outer surfaces seldom indicate failure of inner container.
- If source is identified as being out of package, stay away and await advice from Radiation Authority.

7. FIRST AID
- Use first aid treatment according to the nature of the injury.
- Persons exposed to special form sources are not likely to be contaminated with radioactive material.

Location of Shipping Papers

•A driver of a motor vehicle containing hazardous material and each carrier using such a vehicle, shall ensure that the shipping papers are readily available to and recognizable by authorities in the event of an accident or inspection.

•The driver shall clearly distinguish the shipping papers from all other papers of any kind by distinctively tabbing or by having them appear first.

Location of Shipping Papers

•When the driver is at the vehicle controls, the shipping papers shall be within his immediate reach while restrained by the lap belt. The papers shall be readily visible to a person entering the driver's compartment or in a holder which is mounted to the inside of the door on the driver's side of the vehicle.

•When the driver is not at the vehicle's controls, the shipping papers shall be in a holder which is mounted to the inside of the door on the driver's side of the vehicle or on the driver's seat in the vehicle.

Transportation of Nuclear Gauges

VERY IMPORTANT
When you are NOT transporting a gauge, DO NOT LEAVE shipping papers in the vehicle!!!!

Transportation of Nuclear Gauges

- While restrained by the lap belt, the shipping papers must be within reach of the driver.
- NO need to placard vehicle.
- Driver must have HAZMAT (Hazardous Materials Training) required every THREE YEARS

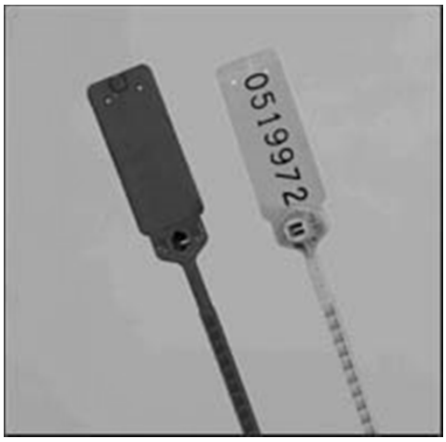
Transportation of Nuclear Gauges

- Gauge must be locked in the shipping case
- Place the gauge as far from the driver and passengers as possible.
- Block and secure the shipping case inside the vehicle.
- Chain or cable case to vehicle.
- When leaving vehicle keep doors locked.
- There must be a minimum of 2 levels (physical barriers) of security.

SECURITY SEALS

Each Type A package must incorporate a feature, such as a seal, that is not readily breakable, and that, while intact, is evidence that the package has not been opened. The seal is required when transporting a gauge to or from a work site, as well as when shipping a gauge via common carrier. [§173.412]

Note: A padlock on the outside of the shipping case is not considered to be a tamper-evident seal by the US DOT.



Emergency Procedures When A Gauge Is Damaged.

- Do not move the gauge.
- Keep people away.
- Rope off the area (approximately 50 feet).
- Assess the damage to the gauge.
- Contact your Radiation Safety Officer.

Emergency Procedures When A Gauge Is Damaged.

- Must avoid contamination.
- Must contact NRC within 24 hours.
- Can do a leak test if the source rod does not appear to be damaged.
- As a minimum, the NRC will want a leak test taken and analyzed plus a report describing the incident and any corrective measures that might be appropriate.

LEAK TEST Demonstration

LEAK TEST

Why is Leak Tests Performed on a Regular basis?

TO DETERMINE IF THE RADIOACTIVE SOURCE IS LEAKING OUT OF THE SOURCE CONTAINER

LEAK TEST PROCEDURE

NOTE: DO NOT REMOVE PATCH FROM FOLDER (Folder is the paper that provides the information the cloth patch is attached to).

LEAK TEST PROCEDURE

Record the SAMPLE DATE on the front of the folder containing the cloth patch.

Match the Serial Number on the front of the folder to the Gauge you are wiping. Open the folder exposing the cloth patch. ***DO NOT USE WETTING SOLUTION.*** Using your fingers or tongs, wipe the areas of the gauge that are nearest to the source(s). Refer to the manual for the recommended wipe locations.

Close the folder with the cloth patch and place the folder inside the zip-lock plastic bag so that the information is visible.

Dosimetry

TLD Badges and Film Badges are used to detect radiation at levels that can be harmful to humans.

About TLD Badges and Film Badges

They emit light in amounts proportional to the radiation received. Thermoluminescent dosimeters (TLDs) are made from one more fluoride chips that measure cumulative exposure to ionizing radiation. Like film badges, they are worn for periods of approximately three months and are then processed to determine the dosage of radiation detected.

Dosimetry

TLD Badges and Film Badges

1. Should only be worn when working with the gauge and by the person it is assigned to.
2. Never store it with or around the gauge.
    - When stored KEEP in a COOL DARK AREA!!!
    - NOT on your DASHBOARD.

TLD's

TLD badges are similar to film badges, but can measure smaller amounts of radiation. TLDs work by measuring the amount of visible light emitted from a crystal in the detector during exposure to ionizing radiation. The exposure of the crystal detector results in ionization, thus producing or trapping electrons in an excited state of the crystal. The dose of radiation exposure is proportional to the number of traps that are created. The TLD is then sent to a lab and heated to depopulate the trap, thus releasing light. With both TLD and film badges, the amount of light released measures the radiation dosage.

Film

Film badges are-radiation sensitive films that are used to measure and record radiation exposure levels at higher levels. These plastic badges contain a small piece of photographic film to record exposure to gamma rays, X-rays, and beta particles. Film badges create permanent records that are able to distinguish between different energies of photons and dosages of different types of radiation. Although film badges are very accurate for exposures over one-hundred millirem, they can't measure exposures of gamma rays less than 20 millirem with great accuracy. Other disadvantages of film badges are that they must be developed and read by a processor, which can be time consuming. In addition, heat exposure can affect the film.

Summary

Employees who handle radioactive materials must learn how to use TLD badges and film badges. Although these products can provide important information about personal radiation exposure, they do not provide safety through radiation shielding. Radiation safety can be monitored by consistently wearing TLD and film badges, and in accordance with all manufacturer specifications.

Storage of Nuclear Gauge

- Lock the source handle.
- Gauge should be locked in the shipping case.
- Storage areas should be in a secure area.
- Control access and RADIATION LEVELS
- Place the gauges in the center of the storage area.
- Monitor radiation levels (on the outside perimeter)
- When a Nuclear Gauge is left UNATTENDED it must be SECURELY LOCKED IN A PROTECTED AREA

Storage of Nuclear Gauge

- There must be a minimum of 2 levels (physical barriers) of security.

Temporary storage in vehicles.

- Secure shipping case to the vehicle.
- Lock the vehicle.
- Remove the keys.
- Park in a secure area.
- Cover the shipping case.
- There must be a minimum of 2 levels (physical barriers) of security.

Gauge Comparison

Comparison of Nuclear Density Gauges In Accordance with Guidelines Contained in **MP 401.05.20**

Blank Form

West Virginia Division of Highways
Comparison of Nuclear Density Gauges
In Accordance With Guidelines Contained In MP 401.05.20

Contractor:		Standard Block # (used for comparison):	
District:		Date:	

Contractor's Gauge #:		WVDOH Gauge #:	
MFG Density Standard Count:		MFG Density Standard Count:	
Density Standard Count:		Density Standard Count:	
Within 2% (Y/N):		Within 2% (Y/N):	

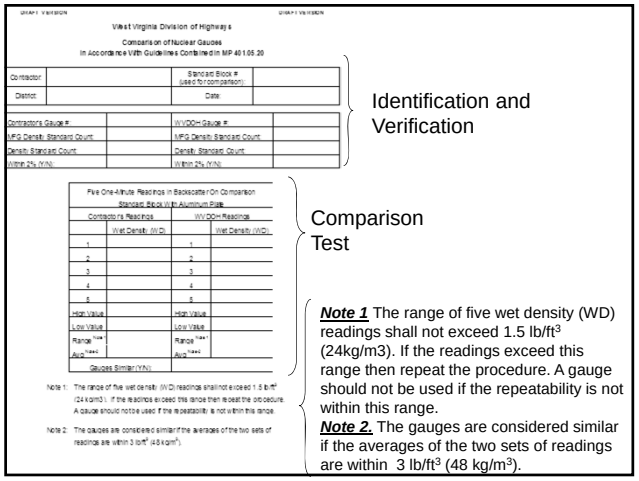
Five One-Minute Readings In Backscatter On Comparison Standard Block With Aluminum Plate

Contractor's Readings		WVDOH Readings	
	Wet Density (WD)		Wet Density (WD)
1		1	
2		2	
3		3	
4		4	
5		5	
High Value		High Value	
Low Value		Low Value	
Range Note 1		Range Note 1	
Avg Note 2		Avg Note 2	
Gauges Similar (Y/N):			

Note 1: The range of five wet density (WD) readings shall not exceed 1.5 lb/ft³ (24 kg/m3). If the readings exceed this range then repeat the procedure. A gauge should not be used if the repeatability is not within this range.

Note 2: The gauges are considered similar if the averages of the two sets of readings are within 3 lb/ft³ (48 kg/m³).

District Technician: _____



West Virginia Division of Highways
Comparison of Nuclear Gauges
In Accordance With Guidelines Contained In MP 401.05.20

Contractor:		Standard Block # (used for comparison):	
District:		Date:	

Contractor's Gauge #:		WVDOH Gauge #:	
MFG Density Standard Count:		MFG Density Standard Count:	
Density Standard Count:		Density Standard Count:	
Within 2% (Y/N):		Within 2% (Y/N):	

Five One-Minute Readings In Backscatter On Comparison Standard Block With Aluminum Plate

Contractor's Readings		WVDOH Readings	
	Wet Density (WD)		Wet Density (WD)
1		1	
2		2	
3		3	
4		4	
5		5	
High Value		High Value	
Low Value		Low Value	
Range Note 1		Range Note 1	
Avg Note 2		Avg Note 2	
Gauges Similar (Y/N):			

Note 1: The range of five wet density (WD) readings shall not exceed 1.5 lb/ft³ (24 kg/m3). If the readings exceed this range then repeat the procedure. A gauge should not be used if the repeatability is not within this range.

Note 2: The gauges are considered similar if the averages of the two sets of readings are within 3 lb/ft³ (48 kg/m³).

Identification and Verification

Comparison Test

Note 1 The range of five wet density (WD) readings shall not exceed 1.5 lb/ft^3 (24kg/m3). If the readings exceed this range then repeat the procedure. A gauge should not be used if the repeatability is not within this range.

Note 2. The gauges are considered similar if the averages of the two sets of readings are within 3 lb/ft^3 (48 kg/m^3).

DRAFT VERSION DRAFT VERSION

Standardization is required every 4 hours!

West Virginia Division of Highways
Comparison of Nuclear Gauges
In Accordance With Guidelines Contained In MP 401.05.20

Contractor:	Master Paving	Standard Block # (used for comparison):	25338
District:	11	Date:	12/25/06

Contractor's Gauge #:	25498	WVDOH Gauge #:	
MFG Density Standard Count:	2732	MFG Density Standard Count:	
Density Standard Count:	2772	Density Standard Count:	
Within 2% (Y/N):	YES	Within 2% (Y/N):	

Record Identification Information
Record Gauge Number, Manufacture Standard Count, Density Standard Count
Is Gauge working correctly? ±2%

2732
X2%
54.6

Round
54.6 ⇒ 55

Range
2732-55= 2677
2732+55=2787

Compare to measurement
Gauge function verified?
Repeat for the other gauge

DRAFT VERSION

DRAFT VERSION

Do NOT move the calibration block!!!

West Virginia Division of Highways

Comparison of Nuclear Gauges

In Accordance With Guidelines Contained In MP 401.05.20

Contractor:	Master Paving	Standard Block # (used for comparison):	25338
District:	11	Date:	12/25/06

Contractor's Gauge #:	25498	WVDOH Gauge #:	25338
MFG Density Standard Count:	2732	MFG Density Standard Count:	2686
Density Standard Count:	2772	Density Standard Count:	2635
Within 2% (Y/N):	YES	Within 2% (Y/N):	YES

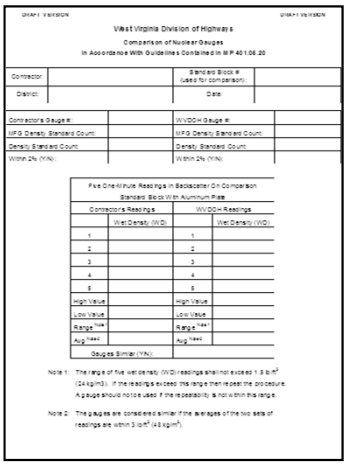
Repeat for the other gauge

$$\frac{2686}{53.7}\ \underline{X2\%}$$

Round 53.7 ⇒ 54

Range
2686 -54 = 2632
2686 +54 =2740

Gauge function verified?



Identification and Verification

Comparison Test

Five One-Minute Readings In Backscatter On Comparison Standard Block With Aluminum Plate			
Contractor's Readings		WVDOH Readings	
	Wet Density (WD)		Wet Density (WD)
1	1876	1	1891
2	1866	2	1875
3	1884	3	1886
4	1865	4	1893
5	1874	5	1887
High Value	1884	High Value	1893
Low Value	1865	Low Value	1875
Range Note 1	19	Range Note 1	18
Avg Note-2	1873	Avg Note-2	1886
Gauges Similar (Y/N):		13 → YES	

RECORD 5 WET DENSITY READINGS

Identify highest reading

Identify lowest reading

Determine range

1893-1875 = 18

Check range

$\leq$24 kg/m^3

Compute average

1891
1875
1886
1893
+1887
9432

9432/5=1886

Repeat for other gauge

Compare range of averages

1886 - 1873 = 13

$\leq$48 kg/m^3

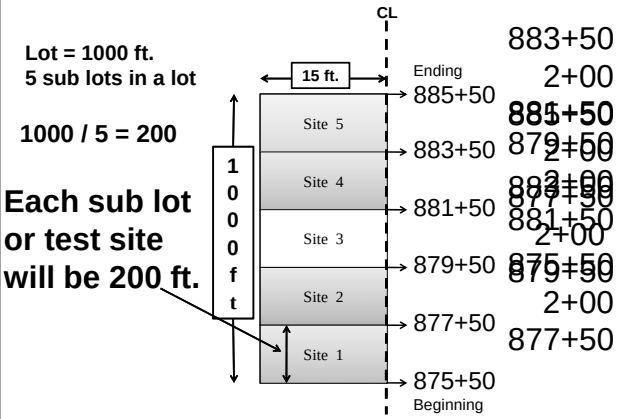
LOT BY LOT TESTING

- 1000 Foot Lot

Lot = 1000 ft.
5 sub lots in a lot

1000 / 5 = 200

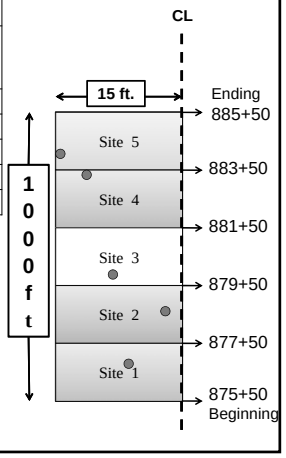
Each sub lot or test site will be 200 ft.



	Random Numbers		Location	
	Length	Width	Distance	Offset Left CL
1	0.683	0.441	876+87	7 ft.
2	0.493	0.155	878+49	2 ft.
3	0.059	0.502	879+62	8 ft.
4	0.996	0.729	883+49	11 ft.
5	0.240	0.972	883+98	15 ft.

Site 2
Width
0.155 x 15 = 2.3 ⇒ 2

883+98



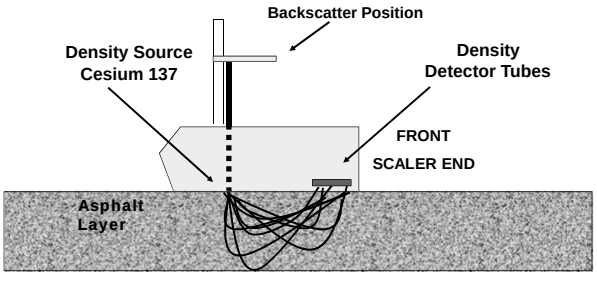
WVDOH

DENSITY EVALUATION

Objectives

- Nuclear Gauge Density Measurements
- Gauge Comparisons
- Lot by Lot - Random Locations
  - Contractor Quality Control
  - DOH Quality Assurance/Acceptance
- Roller pass method

Nuclear Gauge



Practical Issues

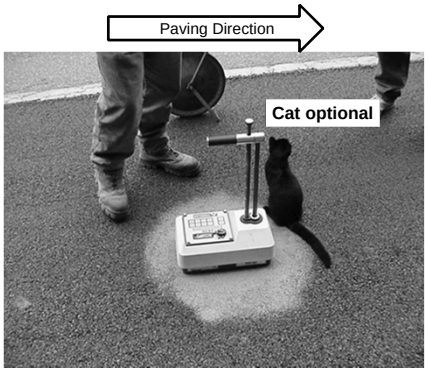
- Do not operate NEAR
  - Large metal objects
    - Equipment
    - Culverts
  - Power lines
  - Other gauges (minimum of 30 feet)

Need good contact between Gauge and Surface

Fill Voids
(Dry Mortar Sand)

Remove Excess

Gauge in position



OPTIONAL CAT AROUND GAUGE TOO LONG

TESTING TIP

- This tip will prevent:
  1. ASPHALT BUILD-UP from accumulating on the BOTTOM of the SOURCE ROD.
  2. Will help keep the SOURCE ROD STORAGE AREA and SLIDING BLOCK CLEAN

Depress trigger on handle and bring handle down slightly.

Take finger off the trigger and use only the palm of your hand to place the rod in the BACKSCATTER POSITION.

This is a preventive measure to insure that the rod is not accidentally driven into the asphalt.

Control Panel

ON YES	↑	MA PR	STD	SPECIAL
OFF NO	↓	TIME	DEPTH	START ENTER

•MP 401.05.20 provides a method for performing Quality Control and Acceptance Testing.

•The Standard Specifications 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. The tests are not used for acceptance.

•The Contractor is responsible for quality control even when acceptance tests are not required, for example Roller Pass

FIVE randomly located One Minute WET DENSITY tests shall be conducted on each lot according to MP 712.21.26.

• *Lot size* = 1000 feet maximum of paving lane.

•*Sublot* = 200 feet (5 equal sublots per lot).
1 test per sublot.

Contractor Quality Control

Contractor tests 1000 foot LOT

Lot divided into 5 equal length SUBLOTS (200 ft. each)

Identify random location for each SUBLOT

	Random Numbers		Location	
	Length	Width	Distance	Offset (left)
1	0.324	0.284	9+55	3
2	0.794	0.850	12+49	10
3	0.403	0.629	13+71	8
4	0.902	0.850	16+70	10
5	0.569	0.997	18+04	12

Site 1
Length
0.324x200
64.8 ⇒ 65
8+90
0+65
9+55

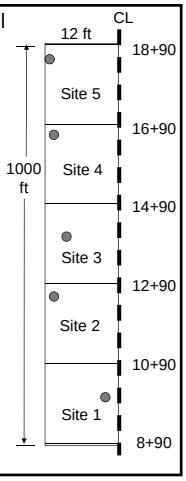
Width
0.284x12
3.4 ⇒ 3

Measure density

Compute average – criteria 92 to 96% of Maximum Specific Gravity

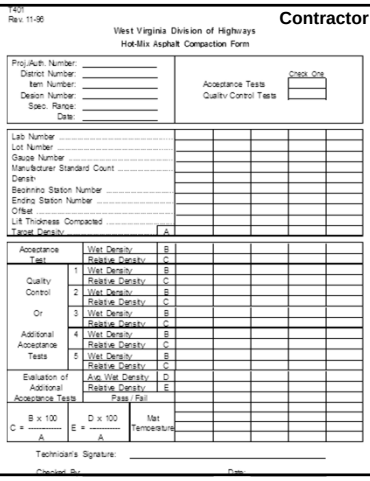
Contractor determines if additional rolling is needed

WVDOH performs acceptance test



T 401

Contractor Quality Control



T401
Rev. 11-96

West Virginia Division of Highways
Hot-Mix Asphalt Compaction Form

Proj./Auth. Number:
District Number:
Item Number:
Design Number:
Spec. Range:
Date:

Acceptance Tests / Quality Control Tests — Check One

Lab Number
Lot Number
Gauge Number
Manufacturer Standard Count
Density
Beginning Station Number
Ending Station Number
Offset
Lift Thickness Compacted
Target Density — A

Acceptance Test — Wet Density B / Relative Density C

Quality Control 1 — Wet Density B / Relative Density C
Quality Control 2 — Wet Density B / Relative Density C
Or
Quality Control 3 — Wet Density B / Relative Density C
Additional Acceptance Tests 4 — Wet Density B / Relative Density C
Additional Acceptance Tests 5 — Wet Density B / Relative Density C

Evaluation of Additional Acceptance Tests — Avg. Wet Density D / Relative Density E — Pass / Fail

B x 100 / A = C = ----------
D x 100 / A = E = ----------
Mat Temperature

Technician's Signature:

Checked By: Date:

T 401

Contractor Quality Control

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West Virginia Division of Highways
Hot-Mix Asphalt Compaction Form

Proj./Auth. Number:
District Number:
Item Number:
Design Number:
Spec. Range:
Date:

Acceptance Tests / Quality Control Tests — Check One: X

Lab Number						
Lot Number		A-1	A-2			
Gauge Number		25498	25498			
Manufacturer Standard Count		2732	2732			
Density		2770	2770			
Beginning Station Number		8+90	18+90			
Ending Station Number		18+90	28+90			
Offset		Lt/CL	Lt/CL			
Lift Thickness Compacted		2	2			
Target Density	A	**2500**	**2500**			

T 401

Contractor Quality Control

Target Density		A	2500	2500				
Acceptance Test		Wet Density	B					
		Relative Density	C					
Quality Control	1	Wet Density	B	2281	2268			
		Relative Density	C	91	91			
	2	Wet Density	B	2318	2307			
		Relative Density	C	93	92			
Or	3	Wet Density	B	2311	2330			
		Relative Density	C	92	93			
Additional Acceptance Tests	4	Wet Density	B	2338	2341			
		Relative Density	C	94	94			
	5	Wet Density	B	2341	2323			
		Relative Density	C	94	93			
Evaluation of Additional Acceptance Tests		Avg. Wet Density	D	2318	2314			
		Relative Density	E	93	93			
		Pass / Fail		PASS	PASS			
B x 100 / A = C = ----------	D x 100 / A = E = ----------	Mat Temperature						

Average
2281
2318
2311
2338
+2341
11589

11589/5 =2317.8

Round 2318

Technician's Signature:

Checked By: Date:

Lot passes, WVDOH performs acceptance test

Quality Assurance
Acceptance Testing

- Acceptance tests will be performed by the Division.
- *Lot size* - 1000 feet maximum of paving lane (Same area as the Contractor tested for quality control).

•A randomly located One Minute WET DENSITY test shall be conducted on each lot according to MP 712.21.26.

• If the WET DENSITY is outside the range (92% to 96%), an additional five tests shall be conducted for the lot and the average of these five tests used to judge acceptance.

WVDOH Quality Assurance

Select one random location within **1000 LOT**

	Random Numbers		Location	
	Length	Width	Distance	Offset (Left)
1	0.601	0.552	14+91	7

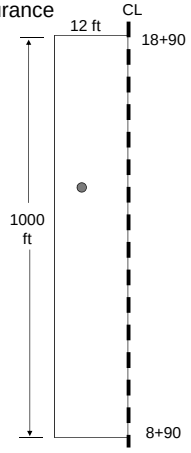
Length
0.601 x 1000 = 601
8 + 90
6 + 01
14 + 91

Width
0.552 x 12 = 6.6 ⇒ 7

Measure density

Acceptance test **PASSES** specification = accept and Continue to next LOT.

Acceptance test **FAILS** specification = Divide Lot into 5 equal SUBLOTS and establish a random test location in each.



T 401

WVDOH Quality Assurance

T401
Rev. 11-96

West Virginia Division of Highways
Hot-Mix Asphalt Compaction Form

Proj./Auth. Number:
District Number:
Item Number:
Design Number:
Spec. Range:
Date:

Acceptance Tests / Quality Control Tests — Check One: X

Lab Number		D11H3897				
Lot Number		A-1				
Gauge Number		25338				
Manufacturer Standard Count		2686				
Densith		2640				
Beginning Station Number		8+90				
Ending Station Number		18+90				
Offset		Lt/CL				
Lift Thickness Compacted		2				
Target Density	A	**2500**				

T 401

WVDOH Quality Assurance

Lift Thickness Compacted				2			
Target Density		A	2500	2500	2500	2500	2500
Acceptance Test	Wet Density	B	2346				
	Relative Density	C	94				
Quality Control 1	Wet Density	B					
	Relative Density	C					
Quality Control 2	Wet Density	B					
	Relative Density	C					
Or 3	Wet Density	B					
	Relative Density	C					
Additional Acceptance Tests 4	Wet Density	B					
	Relative Density	C					
5	Wet Density	B					
	Relative Density	C					
Evaluation of Additional Acceptance Tests	Avg. Wet Density	D					
	Relative Density	E					
	Pass / Fail		PASS				
B x 100 / A = C	D x 100 / A = E	Mat Temperature					

Technician's Signature: _____

Checked By: _____ Date: _____

LOT PASSES ***CONTINUE TO NEXT LOT***

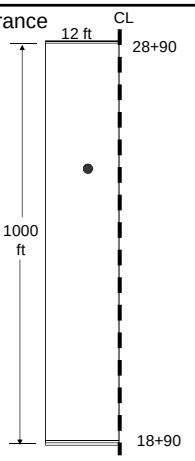
WVDOH Quality Assurance

Next Lot

	Random Numbers		Location	
	Length	Width	Distance	Offset (Left)
1	0.701	0.405	25+91	5

Length
0.701 x 1000 = 701
18 + 90
7 + 01
25 + 91

Width
0.405 x 12 = 4.9 ⇒ 5



Measure density

Acceptance test **PASSES** specification = accept and Continue to next LOT

Acceptance test **FAILS** specification = Divide Lot into 5 equal SUBLOTS and establish a random test location in each

T 401 WVDOH Quality Assurance

T401
Rev. 11-96

West Virginia Division of Highways
Hot-Mix Asphalt Compaction Form

Proj./Auth. Number:
District Number:
Item Number:
Design Number:
Spec. Range:
Date:

Acceptance Tests / Quality Control Tests — Check One: X

Lab Number		D11H3897	D11H3898			
Lot Number		A-1	A-2			
Gauge Number		25338	25338			
Manufacturer Standard Count		2686	2686			
Density		2640	2640			
Beginning Station Number		8+90	18+90			
Ending Station Number		18+90	28+90			
Offset		Lt/CL	Lt/CL			
Lift Thickness Compacted		2	2			
Target Density	A	**2500**	**2500**			

T 401 WVDOH Quality Assurance

Lift Thickness Compacted / Target Density			A	2500	2500	2500	2500	2500
Acceptance Test		Wet Density	B	2346	2268			
		Relative Density	C	94	91			
Quality Control	1	Wet Density	B					
		Relative Density	C					
	2	Wet Density	B					
		Relative Density	C					
Or	3	Wet Density	B					
		Relative Density	C					
Additional Acceptance Tests	4	Wet Density	B					
		Relative Density	C					
	5	Wet Density	B					
		Relative Density	C					
Evaluation of Additional Acceptance Tests		Avg. Wet Density	D					
		Relative Density	E					
		Pass / Fail		PASS	FAIL			
B x 100 / A = C	D x 100 / A = E	Mat Temperature						

Technician's Signature: _____

Checked By: _____ Date: _____

LOT FAILS, *WVDOH PERFORMS ADDITIONAL ACCEPTANCE TEST*

WVDOH Additional Quality Assurance Tests

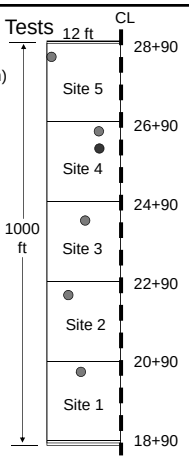
Lot divided into 5 equal length SUBLOTS (200 foot each)

Identify random location for each SUBLOT

	Random Numbers		Location	
	Length	Width	Distance	Offset
1	0.991	0.560	20+88	7
2	0.842	0.732	22+58	9
3	0.732	0.495	24+36	6
4	0.983	0.409	26+87	5
5	0.808	0.987	28+52	12

Measure density

Compute average – criteria 92 to 96% of Maximum Specific Gravity



T 401

WVDOH Quality Assurance

Lift Thickness Compacted								
Target Density			A	2500	2500			
Acceptance Test		Wet Density	B	2346	2268			
		Relative Density	C	94	91			
Quality Control	1	Wet Density	B		2344			
		Relative Density	C					
	2	Wet Density	B		2306			
		Relative Density	C					
Or	3	Wet Density	B		2319			
		Relative Density	C					
Additional Acceptance Tests	4	Wet Density	B		2331			
		Relative Density	C					
	5	Wet Density	B		2354			
		Relative Density	C					
Evaluation of Additional Acceptance Tests		Avg. Wet Density	D		2331			
		Relative Density	E		93			
		Pass / Fail		PASS	PASS			
B x 100 / A = C	D x 100 / A = E	Mat Temperature						

Only new tests are used in average

Technician's Signature: _____

Checked By: _____ Date: _____

LOT PASSES

QUESTION ????

How many test were ran on this LOT?

ANSWER

11

5 Contractor Quality Control

6 DOH Quality Assurance

Acceptance by Roller Pass

- This method is used for thin lifts as outlined by the Standard Specifications.
- Perform testing as outlined in **MP 401.05.20.**

Roller Pass Method

- 100 foot TEST SECTION
- Divide into TWO equal SUBLOTS (50 foot each)
- Determine TWO random numbers
  - Length
  - Width
- Compute location for TWO tests

Roller Pass

Select 100 foot **TEST SECTION**
Divide into TWO equal **SUBLOTS** (50 foot each)
Identify random location for each **SUBLOT**

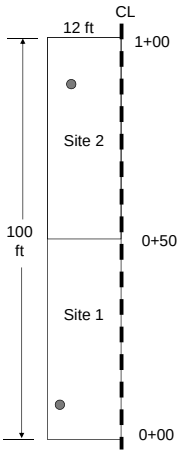
	Random Numbers		Location	
	Length	Width	Distance	Offset (Left)
1	0.338	0.917	17	11
2	0.629	0.631	81	8

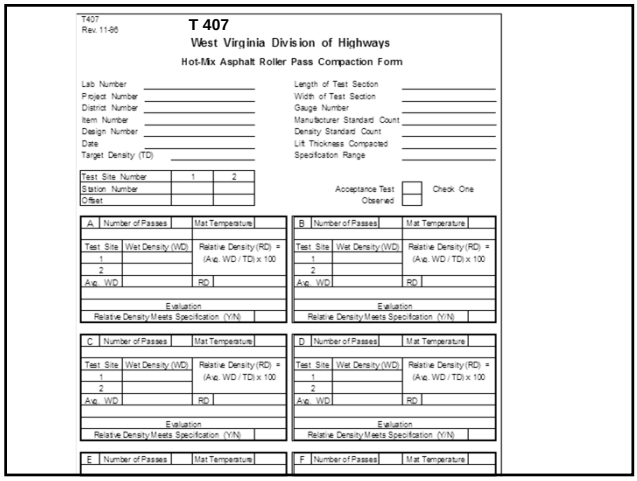
Measure density

Use form T 407

Site 1

Length	**Width**
0.338 x 50	0.917 x 12
16.9 ⇒ 17	11.0 ⇒ 11
0+00	
0+17	
0+17	





T407
Rev. 11-96

T 407

West Virginia Division of Highways

Hot-Mix Asphalt Roller Pass Compaction Form

Lab Number
Project Number
District Number
Item Number
Design Number
Date
Target Density (TD)

Length of Test Section
Width of Test Section
Gauge Number
Manufacturer Standard Count
Density Standard Count
Lift Thickness Compacted
Specification Range

Test Site Number	1	2
Station Number		
Offset		

Acceptance Test Observed ☐ Check One

A	Number of Passes		Mat Temperature	
Test Site	Wet Density (WD)		Relative Density (RD) = (Avg. WD / TD) x 100	
1				
2				
Avg. WD			RD	
Evaluation				
Relative Density Meets Specification (Y/N)				

B	Number of Passes		Mat Temperature	
Test Site	Wet Density (WD)		Relative Density (RD) = (Avg. WD / TD) x 100	
1				
2				
Avg. WD			RD	
Evaluation				
Relative Density Meets Specification (Y/N)				

C	Number of Passes		Mat Temperature	
Test Site	Wet Density (WD)		Relative Density (RD) = (Avg. WD / TD) x 100	
1				
2				
Avg. WD			RD	
Evaluation				
Relative Density Meets Specification (Y/N)				

D	Number of Passes		Mat Temperature	
Test Site	Wet Density (WD)		Relative Density (RD) = (Avg. WD / TD) x 100	
1				
2				
Avg. WD			RD	
Evaluation				
Relative Density Meets Specification (Y/N)				

E	Number of Passes		Mat Temperature	

F	Number of Passes		Mat Temperature	

T 407

T407
Rev. 11-96

West Virginia Division of Highways

Hot-Mix Asphalt Roller Pass Compaction Form

Lab Number	90210	Length of Test Section	100
Project Number	FHP00231467	Width of Test Section	12
District Number	4	Gauge Number	25498
Item Number	4001	Manufacturer Standard Count	2732
Design Number	CJ471	Density Standard Count	2700
Date	12/25/07	Lift Thickness Compacted	1.5
Target Density (TD)	2500	Specification Range	92-96%

Test Site Number	1	2
Station Number	0+17	0+81
Offset	11LtCL	8 LtCL

Acceptance Test Observed [X] Check One

T 407

Data collection Record up to six density measurements.

A	Number of Passes	3	Mat Temperature	254
Test Site	Wet Density (WD)		Relative Density (RD) = (Avg. WD / TD) x 100	
1	2244			
2	2264			
Avg. WD	2254	RD	90%	
Evaluation				
Relative Density Meets Specification (Y/N)			N	

T 407

Number of Passes

Mat Temperature ºF

WET Density Measurement

Average WET Density = (2244 +2264)/2 = 2254

Relative Density = (2254/2500)x100 = 90%

Passes criteria 92 to 96 percent

No

A	Number of Passes	3	Mat Temperature	254
Test Site	Wet Density (WD)		Relative Density (RD) = (Avg. WD / TD) x 100	
1	2244			
2	2264			
Avg. WD	2254	RD	90	
Evaluation				
Relative Density Meets Specification (Y/N)			N	

B	Number of Passes	5	Mat Temperature	244
Test Site	Wet Density (WD)		Relative Density (RD) = (Avg. WD / TD) x 100	
1	2312			
2	2316			
Avg. WD	2314	RD	93	
Evaluation			Success	
Relative Density Meets Specification (Y/N)			Y	

T 407

C	Number of Passes		Mat Temperature	
Test Site	Wet Density (WD)		Relative Density (RD) = (Avg. WD / TD) x 100	
1				
2				
Avg. WD		RD		
Evaluation				
Relative Density Meets Specification (Y/N)				

D	Number of Passes		Mat Temperature	
Test Site	Wet Density (WD)		Relative Density (RD) = (Avg. WD / TD) x 100	
1				
2				
Avg. WD		RD		
Evaluation				
Relative Density Meets Specification (Y/N)				

E	Number of Passes		Mat Temperature	
Test Site	Wet Density (WD)		Relative Density (RD) = (Avg. WD / TD) x 100	
1				
2				
Avg. WD		RD		
Evaluation				
Relative Density Meets Specification (Y/N)				

F	Number of Passes		Mat Temperature	
Test Site	Wet Density (WD)		Relative Density (RD) = (Avg. WD / TD) x 100	
1				
2				
Avg. WD		RD		
Evaluation				
Relative Density Meets Specification (Y/N)				

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 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.

WVDOH
Control Strip Density Testing
MP 401.05.20

CAWV/WVDOH
Asphalt Field Technician Course
2014

Objectives

- Nuclear Gauge Density Measurements
- Lot by Lot - Random Locations
  - Contractor QC
  - DOH QA
- Establish a Control Strip
- Gauge Comparisons
- DOH Core Verification
- Establish Gauge Correction Factor

Nuclear Gauges

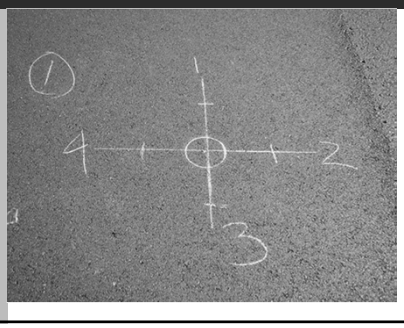
Execution of Control Strip for correction factors does not eliminate the need for best practices, proper handling and maintenance of nuclear gauges

Location of Control Strip

Location – Location - Location

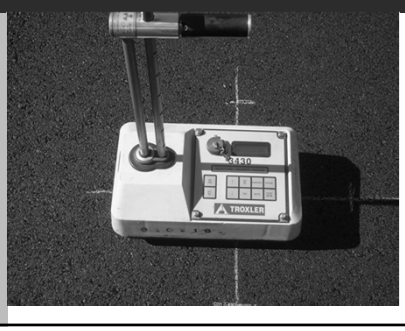
- Width of Paving Lane
- Was 300 ft. in Length, now 240 ft.
- At least 200 ft into paving operation
- Does not displace any lot by lot testing
- 8 test locations

Gauge Positioning Locations



Actual Testing

Actual Gauge Placement



Re-Run Tests

Cores

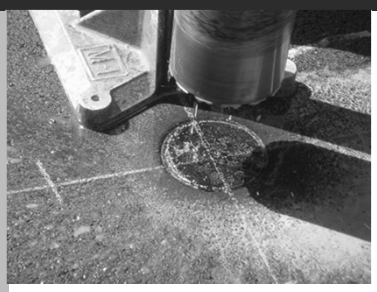
Coring from Testing Location

Test Locations Cooled

Core Locations

Cores from Test Site

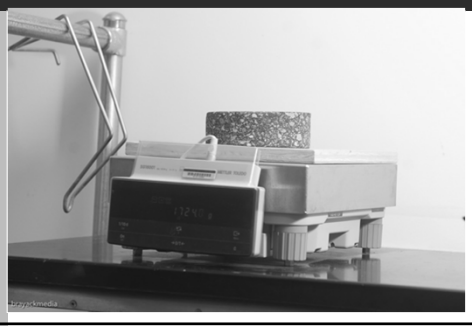
Actual Core – Test Site



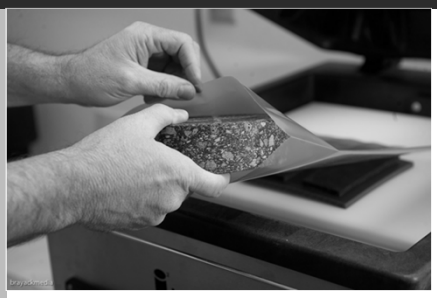
Removal of Core

Cores – Full Layer

Dry Weight (SSD)



CoreLok (Vacuum)



CoreLok – place in chamber

CoreLok – vacuum sealing

CoreLok – prepared specimen

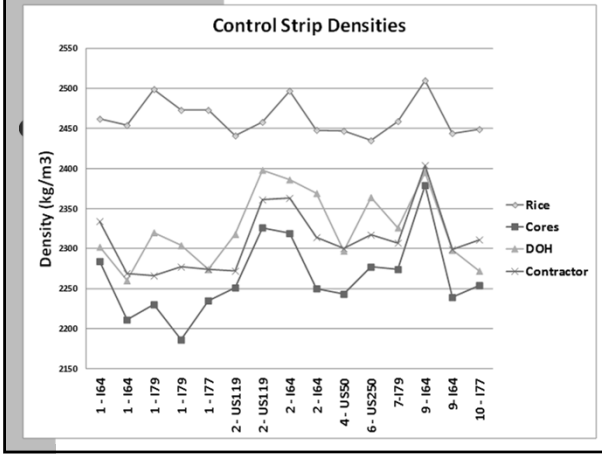
CoreLok – weight in water

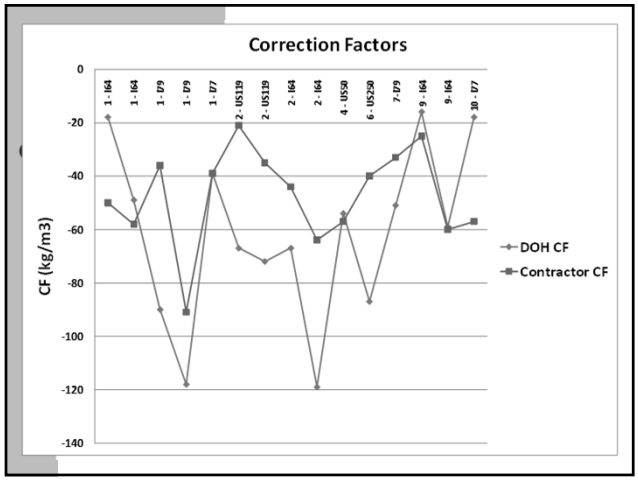
CoreLok – cut open

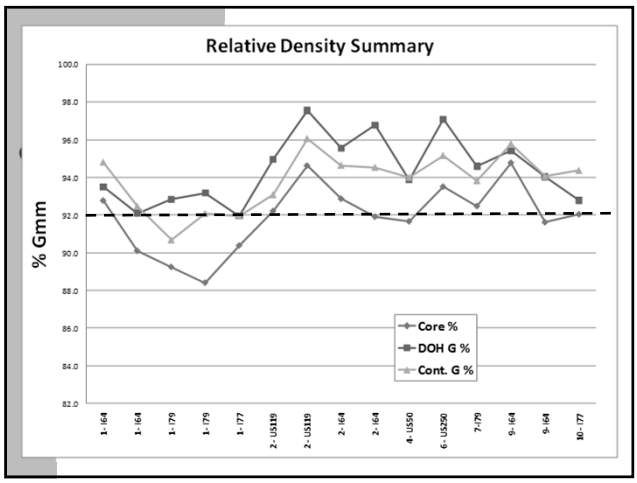
CoreDry – dry weight in 15 min

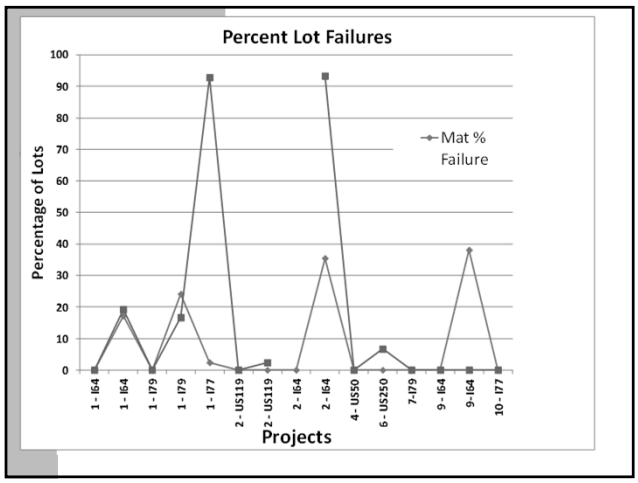
Data Summary-2010

- 7 Districts
- 15 individual control strips
- All mill and fill
- Some with 19 mm and 9.5 mm
- Some only 9.5 mm
- One with 12.5 mm
- One with Warm Mix









Correction Factor Range 2010

RICE AVG	*2463*

Core AVG	*2264*
% COMP	*91.9*

	DOH GAUGES		CONT GAUGES	
CF AVG	*-62*	CF AVG	*-47*
CF STD	*33*	CF STD	*18*
% CF	-2.5	% CF	-1.9
% STD CF	1.3	% STD CF	0.7
AVG READ	2326	AVG READ	2311
% COMP	*94.4*	% COMP	*93.8*
Range %	*93.1-95.7*	Range %	*93.1-94.5*

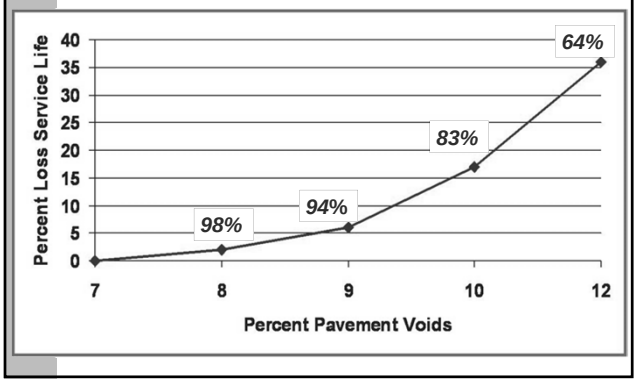
Data Summary-2011

- Control Strips with Thin Lift
- 9 individual control strips in 5 Districts
- All mill and fill except I-81 was new construction
- *Multiple* Contractor and Owner Gauges
- *One* Thin Lift
- *Did some verification testing*

Correction Factor Range 2011

		DOH GAUGES		CONT GAUGES		TL GAUGE	
RICE AVG	*2470*	CF AVG	*-81*	CF AVG	*-43*	CF AVG	*5*
		CF STD	*36*	CF STD	*36*	CF STD	*36*
Core AVG	*2236*	% CF	(3.3)	% CF	(1.7)	% CF	0.2
% COMP	*90.5*	% STD CF	1.5	% STD CF	1.5	% STD CF	1.5
		AVG READ	2317	AVG READ	2279	AVG READ	2231
		% COMP	*93.8*	% COMP	*92.3*	% COMP	*90.3*
		RANGE %	*92.3-95.3*	RANGE %	*90.8-93.8*	RANGE %	*88.8-91.8*

Percent Service Life – WA DOT



Conclusions and Recommendations

- Need to continue use of control strips
- Need to develop a CF for each gauge, each mix, each lift
- Continue 8 core locations in control strip, 6 after discards
- Exercise care when obtaining cores and when sawing to separate layers

Conclusions and Recommendations

- Keep cores flat in a cooler with some ice
- Offset strip approx. 200' from start or longer-changing conditions (equipment, mix volumetrics, etc.) - new control strip may also be an option
- Control Strips do not eliminate the need for proper gauge maintenance, etc. (Checklist)
  - Calibrated
  - *Is gauge charged and ready*?

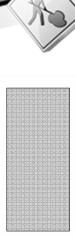
Conclusions and Recommendations

- Use of Thin Lift vs. Traditional Gauge
  - Consideration for projects without the control strip
- CoreLok vs. SSD

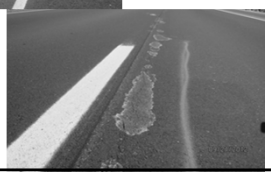
Questions

NEW 401 SPECIAL PROVISION (PWL)

HOT-MIX ASPHALT BASE, WEARING AND PATCHING AND LEVELING COURSES-MAY 2013



WHY? - POOR QUALITY PAVEMENTS INEFFECTIVE SPECIFICATIONS



WHY? "THERE IS A CAUSE"

WVDOH Management

- **"Make things better"**
- **"Prevent poor quality"**
- **"Protect our investment"**
- **"Protect the tax payer"**
- **"Produce and construct asphalt better"**

HOW?

- **We looked at the things (Specifications) within our control and tried to change them to give clearer expectations to the Contractors to provide better pavements.**
- **Provide specifications and requirements that better assure a cost effective quality product.**

THREE NEW SPECIFICATIONS

- **Section 401 – Hot-mix Asphalt**
- **Section 109 – Measurement and Payment**
- **Section 402 – Skid Pavements**

EIGHT NEW *MATERIAL PROCEDURES*

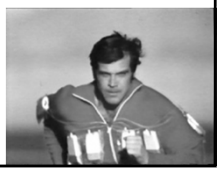
- **MP 401.02.31 QC & Acceptance**
- **MP 401.07.20 Sampling Loose Asphaltic Pavement Mixtures**
- **MP 401.07.21 Sampling Compacted Asphalt**
- **MP 401.07.22 Thickness of Asphalt Concrete Using Cores**
- **MP 401.07.23 Bond Strength**
- **MP 401.07.24 Pavement Macrotexture**
- **MP 401.07.25 Evaluation of HMA Pavements**
- **MP 401.13.50 Determination of PWL**

KEY TERM -PERCENT WITHIN LIMITS

- ***Evaluates a group of samples that have been randomly sampled from a defined amount of production, and uses the sample mean (average) and the sample standard deviation to calculate the percentage of that amount that is statistically within the overall specification limits.***

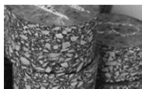
SIGNIFICANT CHANGES WE HAD TO REBUILD IT

- **Quality Measures**
  - **Density (Both Mat and Joint)**
  - **Asphalt Mixes**
  - **Determination of PWL**
- **Start Evaluating Bond Strength**
- **Field Distresses**
- **Payment by Square Yard**
- **Measuring for Thickness**

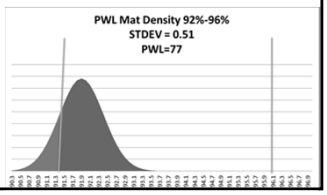


SIGNIFICANT CHANGES
DENSITY

- Mats and Joints – We are checking both.
- Core the finished pavement

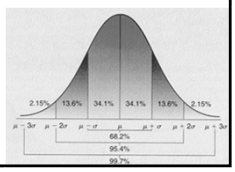


- Daily target
- Statistical Evaluation
  - The targets and methods (PWL) are different.

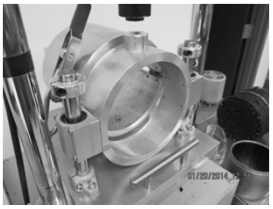


SIGNIFICANT CHANGES

- Asphalt Mixes
  - Sampling Location now Behind Paver
  - "Loose Mix" sample
- Increased Number of Samples
  - (from DOH Perspective)
- %AC and Gradation
- Statistical Evaluation
  The targets and methods (PWL) are different.



SIGNIFICANT CHANGES
BOND STRENGTH



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

GUIDE TO DETERMINING INTERFACE BOND SHEAR STRENGTH OF MULTI-LAYERED ASPHALT PAVEMENT SPECIMENS

1. PURPOSE

1.1 To establish an approved method for determining the interface bond shear strength between layers of asphalt concrete pavement in cored samples taken from the roadway.

2. SCOPE

2.1 This test method covers the determination of the interface bond shear strength between layers of asphalt concrete pavement in cored samples of both Marshall and Superpave mixes.

2.2 This test method is applicable for cores obtained from both newly constructed and previously existing asphalt concrete pavements. It could also be used to determine the interface bond strength between asphalt concrete and Portland cement concrete.

2.2 This test is applicable on six-inch diameter cores that are not less than two inches thick.

3. REFERENCED DOCUMENTS

3.1 AASHTO Standards:
- T 166, Standard Practice for Sampling Hot-Mix Asphalt Paving Mixtures
- T 245, Standard Method of Test for Resistance to Plastic Flow of Bituminous

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 evaluating pavement that is proposed 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 section 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.

SIGNIFICANT CHANGES SQUARE YARDS

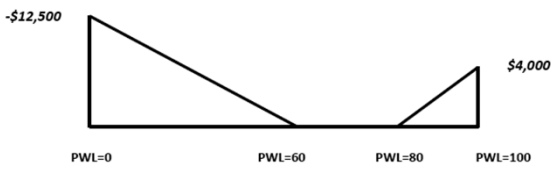
- **Payment by the SY instead of Ton**
- **Specified lift thickness**
- **Measure cores for thickness**

SIGNIFICANT CHANGES

- **Values for each mat lot are used to determine *PWL-No pass/fail-No more moving average***
  - **Mat density - (91.5% to 97.0%)**
  - **Asphalt content - (target +/- 0.4)**
  - **Gradation #200 – (target +/- 2.0)**
- **Joint cores are used to calculate PWL**
  - **Target 89.0%**
- **Lot payment**
  - **0.5D+0.25AC+0.25G x SY Unit Price**
  - **Payment for each component can reach 102%**
  - **Thickness is a separate deduct**

SIGNIFICANT CHANGES

- **Joints have separate incentive/disincentive**



SIGNIFICANT CHANGES *BEFORE CONSTRUCTION*

- **The documents require the Contractor to supply prepared mix to the Division for the development of Ignition Oven correction factors**
- **The documents require the DOH and Contractor to have a *Pre-paving Meeting to discuss and agree upon a paving sequence in order to lay out lots in the field for sampling***
  - ***Production lots are 2500 tons***
  - ***This is converted to a theoretical yield to develop sampling lots along the paving mat***
  - ***Constructed joints have 10,000' lots***

SIGNIFICANT CHANGES *BEFORE CONSTRUCTION*

- **Within each mat lot, there are five sublots**
- **Within each mat sublot**
  - **One random loose mix sample**
  - **One random density core sample**
  - **One random bond strength core (evaluation)**
- **Both mat cores will be measured for thickness prior to density or bond strength testing, 10 measurements per lot**
- **Loose mix evaluated for AC and Gradation (#200)**
- **Joint lots have five sublots, one core per sublot**

SPECIFIED 2013 AND 2014 PROJECTS

- **2013 Project List**
  - **D1 - I64 Wertz Ave. to Yeager Bridge**
  - D3 - I77 Saulsbury to Mineral Wells - *Shadow*
  - **D4 – 2 total (I-68 Hazelton, US 50 Davisson Run to Clarksburg)**
  - **D7 – I79 Servia to Frametown**
  - D9 – I64 Kate's Mountain - *Shadow*
- **2014 Project List**
  - **D1 I79 N Elkview I/C – CO 53 OP**
  - **D2 I64 Kenova to Krouts Creek and I64 - Krouts Creek to Wayne/Cabell Line (Combined-One Project)**
  - **D4 I79 Jane Lew to Harrison Co.**
  - **D5 I81 Both Directions MP 24 to 26 (?)**
  - **D6 I70 EB-WB (This is a holdover from 2013)**
  - **D9 I64 Alta to Richlands Road**

EXAMPLE PAY SCENARIO

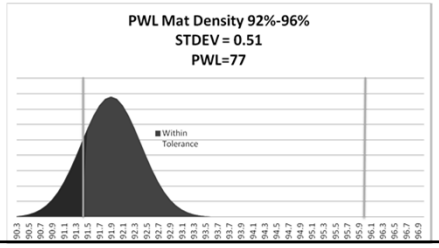
- **Interstate Paving Project**
  - **Pave one lot (2500 tons) along 12' lane. At 1.5 inch design thickness, equates to 22,727 ft or about 4.3 miles.**
  - **Assume bid price at $110 per ton *($275,000)***
- **We sample the following:**
  - **5 cores for mat density (measure for thickness also)**
  - **5 cores for bond strength (measure for thickness also)**
  - **5 loose samples behind paver (AC and gradation)**
  - **10 cores for joint density (10,00 per lot)**

EXAMPLE (CONTINUED)

- **Mat Density**
  - **5 Cores - 91.1, 91.7, 92.1, 92.2, 92.4**
- **AC and gradation of #200 sieve**
  - ***AC - 7.1, 7.2, 6.9, 6.9, 6.8 (Target was 6.5 ± 0.4)***
  - **Gradation – 6.7, 6.3, 5.6, 5.7, 5.6 *(Target was 6.4 ± 2.0)***
- **Thickness**
  - **10 measurements – Average thickness is 1.41 inches**
- **Joint Density**
  - **5 cores – 88.3, 89.6, 88.5, 89.2, 89.5**
  - **5 cores – 89.0, 90.0, 89.0, 89.2, 89.5**

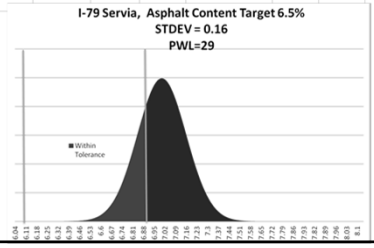
Lower Limit			Upper Limit		
91.1	P_l =		91.1	P_u =	
91.7			91.7		
92.2			92.2		
92.1	77		92.1	100	
92.4			92.4		
Average	91.9		Average	91.9	
St. Dev.	0.51		St. Dev.	0.51	
Lower Lim	91.5		Upper Limit	97	
Ql=	0.784		Qu=	10.000	
Pl=	77		Pu=	100	

PWL = 77
Pay Factor = 93.5%



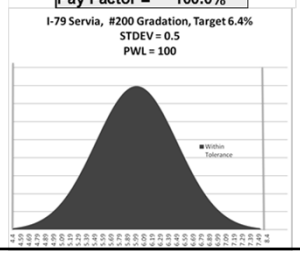
7.1	P_l =		7.1	P_u =	
7.2			7.2		
6.9			6.9		
6.9	100		6.9	29	
6.8			6.8		
Average	7.0		Average	7.0	
St. Dev.	0.16		St. Dev.	0.16	
Lower Limit	6.1		Upper Limit	6.9	
Ql=	5.625		Qu=	-0.625	
Pl=	100		Pu=	29	

PWL = 29
Pay Factor = Defective



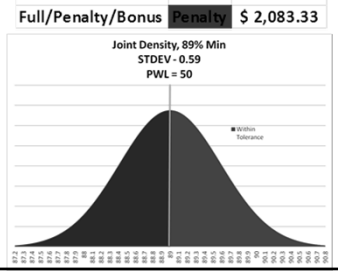
6.7	P_l =		6.7	P_u =	
6.3			6.3		
5.6			5.6		
5.7	100		5.7	100	
5.6			5.6		
Average	6.0		Average	6.0	
St. Dev.	0.50		St. Dev.	0.50	
Lower Lim	4.4		Upper Limi	8.4	
Ql=	3.200		Qu=	4.800	
Pl=	100		Pu=	100	

PWL = 100
Pay Factor = 100.0%



88.3	PWL	
89.6	-	
88.5	50	
89.2		
89.5		
Average	89.0	
St. Dev.	0.59	
Lower Limit	89	
QL=	0.000	
PWL=	50	

Full/Penalty/Bonus **Penalty** **$ 2,083.33**



EXAMPLE – PAY FACTOR

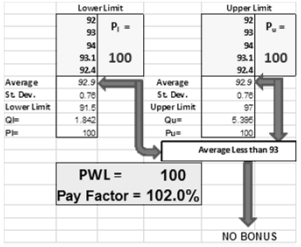
- **Pay Adjustment for MD, AC, and G (Based on $110/ton)**
  - **[(2) Mat Density + AC + Gradation]/400**
  - **[(2 x 93.5%) + (50%) + (100%)]/400**
  - **84.25%** ***(less 15.75%)*** **= *$43,312.50***

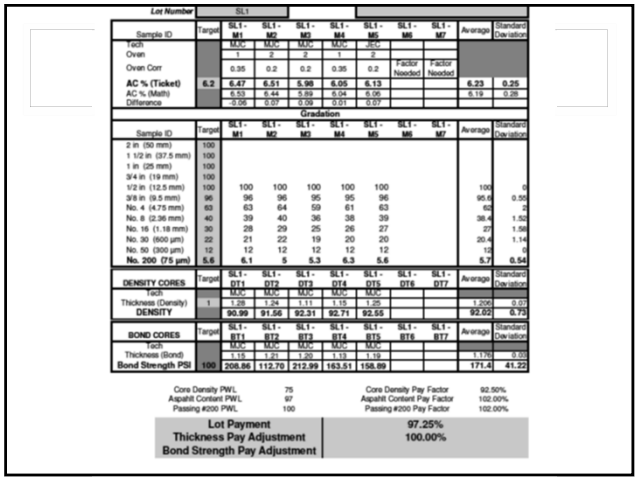
98% under current specs

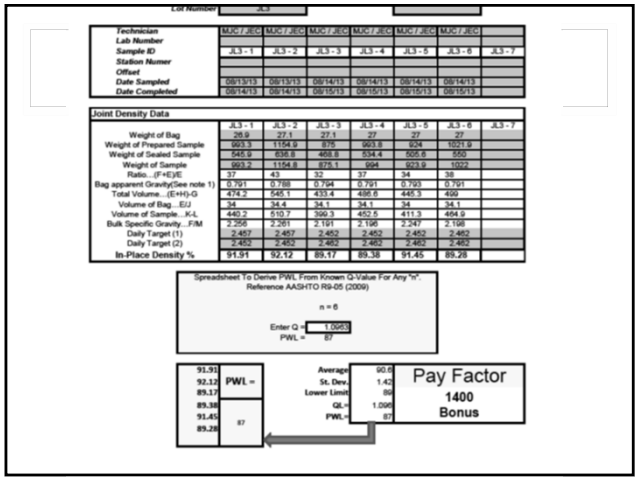
- **Joint Density**
  - **First lot Negative Adjustment = *-$2,083.33***
  - **Second lot = PWL 75, *no adjustment***
- **Total Pay Adjustment so far**
  - ***$45,395.83***

GOOD EXAMPLE MAT DENSITY

- **Mat Density with acceptable numbers**
  - **92.0, 93.0, 94.0, 93.1, 92.4**







Radiation Safety

Jim Lore, RSO

NRC Regulatory Guide 8.13

On Page 4 – 1

Mention in Guide 8.13 is the following NRC Regulations

NRC Regulations Part 19

"Instructions and Reports to Workers, Inspection and Investigations"

NRC Regulations Part 20

"Standards For Protection Against Radiation"

NOTICE TO EMPLOYEES

On Page 5 – 1

APPENDIX H
Operating, Emergency, and Security Procedures

On Page 6 – 1

Radiation
Terms and Definitions

Units of Radiation Dose

❖ ***Rem*** The unit of any of the quantities expressed as dose equivalent. The dose equivalent in rems equal to the absorbed dose in rads multiplied by the quality factor.

❖ ***Millirem*** Equals 1/1000 of a rem.

Units of Radioactivity

❖ ***Curie*** A curie equals 3.7×10^{10} disintegrations per second.

❖ ***Millicurie*** Equals 1/1000 of a curie.

Dose Limits

❖ ***Adults*** **:** 5 rems per year.

❖ ***Minors*** **:** Those under **18** years of age are limited to 10% (one-tenth) of the adult radiation dose limits.

❖***Embryo/ fetus*** **:** 0.5 rems for entire pregnancy.

❖***Occupational Dose:*** Means a dose received by an individual in a restricted area.

❖***External Dose:*** Means the portion of the dose received from radiation sources outside the body.

❖***Member Of The Public:*** Means an individual in a controlled or unrestricted area. An individual is not a member of the public during any period in which the individual receives an occupational dose.

• ***Public Dose***: Means the dose received by a member of the public from exposure to radiation and to radioactive material released by the licensee.

• ***Shallow Dose***: Applies to external exposure of the skin or extremity.

❖ ***Background Radiation:*** Means radiation from cosmic sources, naturally occurring radioactive materials, fallout as it exists in the environment from the testing of nuclear explosive devices.

❖ ***Whole Body Exposure*****:** Means for purposes of external exposure, the head, trunk, arms above the elbow, or legs above the knees.

❖ ***Declared Pregnant Woman***: Means a woman who has voluntarily informed her employer, in writing, of her pregnancy and the estimated date of conception.

❖ ***Restricted Area***: Means an area, access to which is limited by the licensee for the purpose of protecting individuals against undue risks from exposure to radiation and radioactive materials.

❖ ***Controlled Area:*** Means an area outside of a restricted area but inside the site boundary, access to which can be limited by the licensee for any purpose.

❖ ***Unrestricted Area:*** Means an area access to which is neither limited nor controlled by the licensee.

Limits For Individual Members Of The Public

Each licensee shall conduct operations so that:

❖Dose to members of the public does not exceed 0.1 rem (100 millirems) in a year.

❖ Dose in any unrestricted area must not exceed 2 millirems in any one hour.

❖If an individual were continually present in an unrestricted area, the dose from external sources would not exceed 2 millirems in an hour and 0.1 rems (100 millirems) in a year.

Compliance With Dose Limits For Individual Members Of The Public

❖ The licensee shall conduct surveys of radiation levels in unrestricted and controlled areas to demonstrate compliance.

******Demonstration of the Survey Meter******

❖If members of the public have access to controlled areas, the limits for members of the public apply.

POSTINGS
Main Building and Gauge Storage Area

- ❖ NRC 3 Notice to Employees
- ❖ Regulatory Guide 8-13
- ❖ NRC Part 21
- ❖ Operating and Emergency Procedure Appendix H
- ❖ Gauge Dailey Shipping Logs (storage area only)
- ❖ Gauge Utilization Logs (storage area only)

GAUGE "DAILY" SHIPPING LOG

Troxler Model 3430, SERIAL #_____

UN3332, Radioactive material, Type A Package, Special Form
Cs-137, 0.30 GBq (8 mCi)
Am-241, 1.48 GBq (40 mCi)

Shipment Dates	Shipment Dates	Shipment Dates	Shipment Dates

GAUGE UTILIZATION LOG

Troxler Model 3430, SERIAL #_____

UN3332, Radioactive material, Type A Package, Special Form
Cs-137, 0.30 GBq (8 mCi)
Am-241, 1.48 GBq (40 mCi)

Date Removed from Storage	Removed By (User Name)	Job Site Use Location	Date Returned to Storage	Returned By (User Name)

Caution Signs

The symbol shall use the colors magenta, purple, or

black on yellow background.

The symbol is the

3 blade design.

Natural Radiation

Natural Radiation Received per Year

- The total average exposure in the United States from natural radiation is approximately 206 millirems per year.

Watch a Film

“ Radiation Safety: THE BASICS”