Hot-Mix Asphalt Construction

NATIONAL HIGHWAY INSTITUTE

Federal Highway Administration

NAPA
National Asphalt Pavement Association

JOINT
AASHTO
FHWA
INDUSTRY
TRAINING
COMMITTEE
ON ASPHALT

"Partners in Performance"

Asphalt Pavement Association of West Virginia

West Virginia University
Asphalt Technology Program

Presentation Format

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

Module 1

Course Introduction, Communication, and Project Documents

Need for the Course

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

From the 2017 Standard Specifications

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

Overall Course Objectives

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

Overall Course Objectives

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

Local Issues

- Typical design
  - Superpave? Marshall?
- Contractors/material suppliers
  - Aggregate source? Skid??
- Hauling
- Laydown
- Compaction
- Other?

Course Reference Materials

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

Hot-Mix Asphalt Paving

HANDBOOK 2000

Safety

Communication

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

On-Going Communication

- Daily or Weekly updates
- Major events (traffic change, holidays, etc)
- Reporting requirements for WV

Project Documents

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

Project Documents

__Hierarchy__

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

- *Purchase Orders???*
- *Change Orders*

Project Documents

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

Project Documents

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

Project Documents

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

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West Virginia Challenges

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

The “Team”

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

Teamwork and Cooperation

Questions


It’s important that inspectors understand the how trucking, preparation for paving, and tack coats affect the construction and longevity of asphalt pavements.

Module Outline

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

Preparation for Paving

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

Preparation for Paving

- The most common surfaces overlaid with asphalt include:
  - Subgrade
  - Granular Base Course (Aggregate Base)
  - Existing Asphalt Pavement
  - Existing Portland Cement Concrete Pavement

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New Construction

- Subgrade Preparation
  - The subgrade is the foundation
    - Soil type considered in thickness design
  - Must support
    - Pavement
    - Anticipated traffic
    - Construction equipment
  - Must be properly graded for drainage
    - Transverse and longitudinal grade
    - Smoothness and cross slope
  - Must be uniformly compacted to required density

New Construction

- Aggregate Base Preparation
  - Mix to proper moisture content
  - Best Practice – place using a laydown machine
  - Place in 4—10-inch compacted lifts
  - Stagger longitudinal and transverse joints at least one-foot in each layer
  - Compact base to percentage of Proctor specified
  - Cure after applying prime coat

Prime Coat

Why do we use Prime Coat?

- To seal in the subgrade at the proper moisture content
- To fill the surface voids and protect from the weather
- To stabilize the surface fines
- To promote bonding to the subsequent pavement layer

Prime Penetration

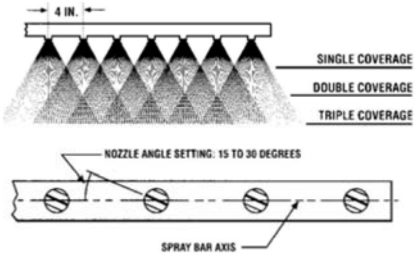
- Emulsion vs. Cutback
  - Cutbacks
    - Penetrate base better
    - Higher shot rate
    - Environmental concerns from solvents
  - Emulsions
    - Lower penetration
    - Can be mixed with base
    - Lower shot rate
    - Greater environmental acceptance

MS-19 Basic Asphalt Emulsion Manual

Typical Requirements

- Weather
  - +60°F (+15°C)
  - No fog or rain
- Application
  - Swept surface
  - Specified application rate
    - 10% maximum variation
  - Minimum of 48 hours drying time

Placement of Prime Coat



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Preparing to Overlay Existing Asphalt

Preparing an existing asphalt surface may be as simple as sweeping (*multiple passes may be necessary*) the existing surface and applying tack coat

Preparing to Overlay Existing HMA

Or it may involve one or more of the following:

- **Patching**
- **Cleaning and filling cracks**
- **Placing a leveling course**
- **Milling the surface**

Failed areas MUST be cleaned, repaired and brought into good structural condition before overlaying.

Asphalt Patching Material

Hot Mix Asphalt (HMA)

- **Makes the longest-lasting patches when correctly constructed**
- **Should be used whenever practical and economical**
- **Use Superpave 3/4" nominal maximum size mix or finer**
- **Use appropriate PG-binder for location**

Maximum and Nominal Maximum Aggregate Size

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

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

Sieve Size	*Percent Passing*	
3/4"		
1/2"	**100**	- MAS
3/8"	**94**	- NMAS
No. 4	**89**	*1st sieve to retain more than a cumulative 10%*
No. 8	**60**	
No. 16	**35**	
No. 30	**23**	
No. 50	**13**	
No. 100	**9**	
No. 200	**6**	
	4.8	

Asphalt Patching Materials

Immediate Use Patching Mix

- Plant-mixed
- SS-1, SS-1h, CSS-1, CSS-1h emulsions may require up to 3% surface moisture on aggregates for successful mixing
- Use well-graded aggregate
- Over-mixing may cause balling up of fine aggregate and premature breaking of emulsion
- 100% coating of coarse particles not always achieved

Asphalt Patching Material

Stockpile Patching Mixes

- Plant-mixed, stockpiled
- Different cutbacks/emulsions used depending on climate and intended duration in stockpile (see Asphalt Institute MS-14, Asphalt Cold Mix, Appendix C)
- Mix workability comes from liquid asphalt with solvent
- Store in clean, well-drained area (preferably under cover)

Asphalt Patching Material

Proprietary Patching Materials

- Purchased by manufacturer
- Special blends of aggregate and binders
- Typically for small work such as core-hole filling, small patches
- Use only for their intended purpose
- Example products to the right

Asphalt Patching Material

Innovative State Highway Mixes

- Mixes developed by state DOT's especially for patching, spalled concrete joints, skin patching, etc.
- Often the best choice since they have been locally developed and have a known performance history

Full Depth and Deep Patching

Definitions:

- **Full depth patching -** the removal and replacement of the entire pavement cross section down to the subgrade or granular base
- **Deep Patching -** the removal and replacement of over 4 inches of asphalt, but not all of the way to the subgrade or granular base

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Full Depth and Deep Patching

Applications:

- **Full depth patching -** applicable to either flexible (asphalt) pavements or rigid (PC Concrete) pavements
- **Deep patching -** when patching with asphalt, deep patching is applicable to flexible pavements only.

Both types of patches are intended to be permanent.

Full Depth and Deep Patching

Step 1:

- Remove the material in the area to be repaired to a depth necessary for reaching firm support
  - This may mean removing some of the subgrade as well.
  - The excavation should extend at least 1-foot into the good pavement surrounding the patch.

Full Depth and Deep Patching

Irregular patch - getting proper compaction is going to be difficult on this one.

Nice straight lines, no distress visible outside the patched area

Full Depth and Deep Patching

Step 1 (continued):

- Patches should be square-edged and rectangular in shape
- Patch should have clean, vertical faces, which can be obtained with a pavement saw
- If the patch width approaches the width of the lane, it would be better to patch the full lane

Full Depth and Deep Patching

Use a medium-sized milling machine when numerous large deep patches are required

Use a small-sized milling machine when numerous small deep patches are required

Full Depth and Deep Patching

Step 2:

- Recompact base or subgrade material
- Apply a tack coat to the vertical faces *after the area has been cleaned*
  - For deep patching, apply a tack coat to the horizontal surface also.

Full Depth and Deep Patching

Step 3:

- Using a dense-graded mix like Superpave, place and spread the HMA in the patch
  - If the patch is more than 6 inches deep, place the patching material in lifts no thicker than 4 inches and compact each lift thoroughly.

Full Depth and Deep Patching

Step 4:

- Compact the patch thoroughly, and flush with the surrounding pavement
  - Use a vibrating plate compactor for small patches
  - Use a roller for patches large enough to accommodate it
  - Make sure that the corners are compacted also

Full Depth and Deep Patching

Step 5:

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

Full Depth and Deep Patching

Step 6:

- Seal joints to prevent water intrusion.

Thin Surface Patching

Definitions

- Thin surface patching - a patch constructed by milling the surface to a depth that ensures removal of all unsound material, then re-filling with a thin lift of HMA.

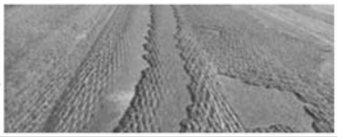
Thin Surface Patching

- Thin surface patches are typically considered to be a temporary fix.
- Use only on pavements that are in relatively good condition other than distresses confined to the surface lift, such as raveling or minor rutting.
- Thin patches over deep cracks or bottom-up cracks will be very short-lived.
- Construct thin surface patches in a manner similar to deep patches

Cold Milling

Cold Milling

- Mill below depth of distress (rutting, surface-initiated cracking)
- Don't leave "scabs" of asphalt
  - Avoid milling to within ½ inch of interface w/granular base
- Consider properties of existing asphalt before milling
  - Increasing value of RAP obtained



Scabs

Advantages of Cold Milling

- Efficiently removes deteriorated pavement.
- Provides opportunity to improve smoothness.
- Provides RAP for recycling operations.
- Provides a highly skid resistant surface.

Cold Milling

- Surface texture produced by milling is a function of:
  - Carbide bit spacing and condition
  - Depth of cut
  - Rotational speed of head
  - Speed of travel

Cold Milling

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

Surface After Milling

Cleaning the Surface

Cleaning the Surface

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

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Preparing to Overlay Existing PCC

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

Above precautions often don't work long-term

Preparing to Overlay Existing PCC

A better way to handle PCC pavement which needs to be overlaid is through one of the following techniques:

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

Cracking/ Breaking and Seating

- References
  - AI MS-17 Manual and AAPTP Report 05-04
- Reduces effective slab length (2-5 feet) by inducing fine vertical transverse cracks in concrete
- Seat broken slabs by rolling
- <u>Crack and Seat</u> applies to jointed plain concrete
  - Very good performance history
- <u>Break and Seat</u> applies to jointed <u>reinforced</u> concrete
  - Must rupture the bond between the reinforcing steel and PCC to be effective
  - Rubblization is preferred due to variable performance history of break/seat (bond not always broken)

Cracking/Breaking and Seating Process

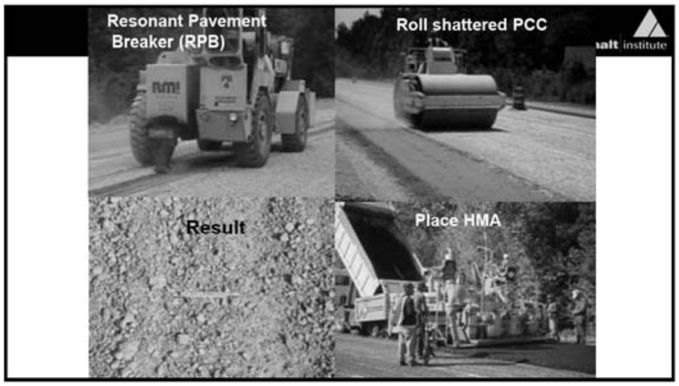
- Remove existing overlay
- Correct drainage problems
- Crack PCC slabs
  - "guillotine" hammer
- Seat cracked PCC
  - 35-50 ton pneumatic roller
- Remove/patch any soft areas identified
- HMA Overlay

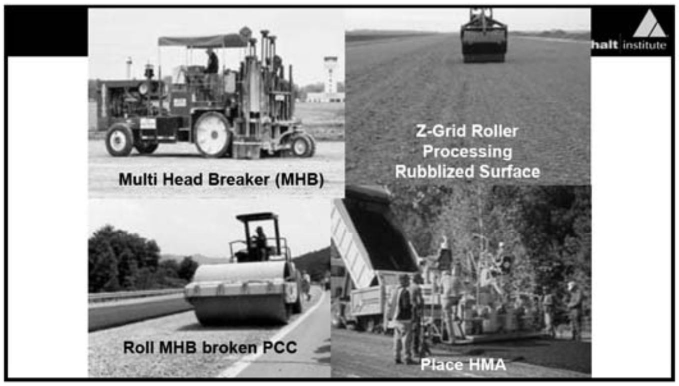
Benefits of Crack/Break and Seat

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

What is Rubblization?

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





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Definition

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

Tack Coat

Why do we use Tack Coat?

- Promotes the bond between old and new pavement layers
  - Vital for structural performance
- Prevents slippage between layers
- Provides an additional moisture barrier,
  - Especially along the transverse and longitudinal vertical surfaces

Tack Coat Definitions

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

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

"Apply the tack coat at a rate of 0.05 gallons/yd^2"

What difference does it make?

If the example spec *intended* 0.05 *gal/yd^2* of residual asphalt:

Undiluted emulsion applied at 0.05 gal/yd^2 using an emulsion with 60% residual asphalt, leaves 0.03 gal/yd^2 on the roadway.

40% less than intended

What difference does it make?

If the example spec *intended* 0.05 *gal/yd^2* of residual asphalt:

Diluted Emulsion using the same emulsion diluted 1:1 with water and applied at ***0.05 gal/yd^2*** leaves *0.015 gal/yd^2* ***on the roadway.***

70% less than intended

What difference does it make?

If the example spec *intended* 0.05 *gal/yd^2* of residual asphalt:

To receive Residual Asphalt at 0.05 gal/yd^2 using an emulsion with 60% residual asphalt, the contractor would need to apply:

0.083 gal/yd^2 ***of*** *Original Emulsion* ***or***
0.167 gal/yd^2 ***of*** *1:1 Diluted Emulsion*

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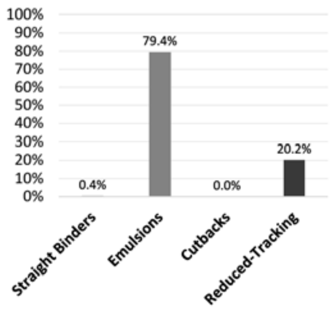
Tack Coat Materials - Mostly Emulsions



Note that reduced-tracking (also called non-tracking) materials are also emulsions

> *"Non-tracking tacks are designed to improve the pavement performance by avoiding the tracking problems associated with traditional tacks. This material is typically manufactured to harden quickly and adhere minimally to tires. When a hot lift of asphalt is subsequently placed over the tack, the hardened tack is reactivated by the heat, and bonds the new overlay with the existing surface." (Seo, 2016)*

Top 5 Emulsions Used

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

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

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

Examples: SS-1hp, CRS-2h, EBL

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Typical Requirements

- **Weather**
  - **+60°F (+15°C)**
  - **No fog or rain**
- **Application**
  - **Swept surface**
  - **Prescribed application rate**
    - **10% maximum variation**
  - **Drying time set by engineer**

Courtesy of stockvault.net

Tack Coat

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

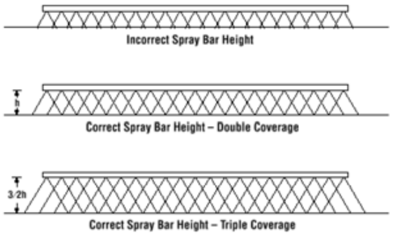
Application Rates?

- What is the Optimal Application Rate?
  - Surface Type
  - Surface Condition
- Recommended Ranges
  - Application rate must be clearly stated in terms of:
    - Residual, Undiluted, or Diluted condition

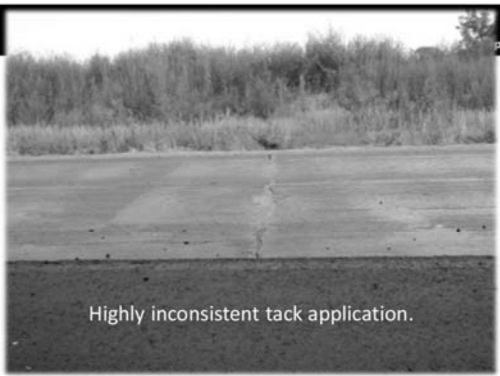
Surface Type	Residual Rate (gsy)	Appx. Bar Rate Undiluted* (gsy)	Appx. Bar Rate Diluted 1:1* (gsy)
New Asphalt	0.02 – 0.05	0.03 – 0.07	0.06 – 0.14
Existing Asphalt	0.04 – 0.07	0.06 – 0.11	0.12 – 0.22
Milled Surface	0.04 – 0.08	0.06 – 0.12	0.12 – 0.24
Portland Cement Concrete	0.03 – 0.05	0.05 – 0.08	0.10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

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

Spray Bar Height and Coverage



Where's the Tack Coat?



Highly inconsistent tack application.

Better, but still streaky.

Nicely tacked.

Nicely tacked.

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Application Calculations

Calculating field application rates

- There are three primary methods of determining field application rates.
  - Determination by volume.
  - Determination by weight or mass.
  - Determination by direct measurement, ASTM D2995

Calculating rates by Volume

- The rate of material applied is calculated by determining the volume of material distributed. Either by:
  - Observation and recordation of an onboard volume meter or gauge.
  - Using a tank stick method where the depth of material is measured in the tank
    - Volume is calculated or by the use of a pre-calibrated stick.

Correcting for temperature

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

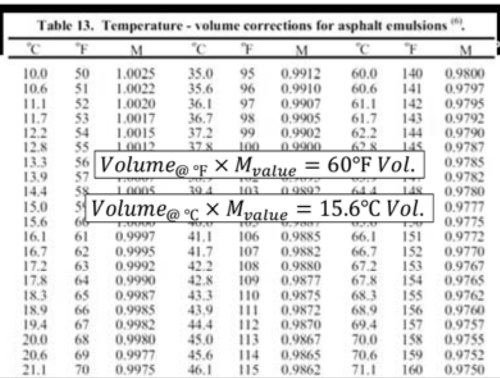


Table 13. Temperature - volume corrections for asphalt emulsions [6].

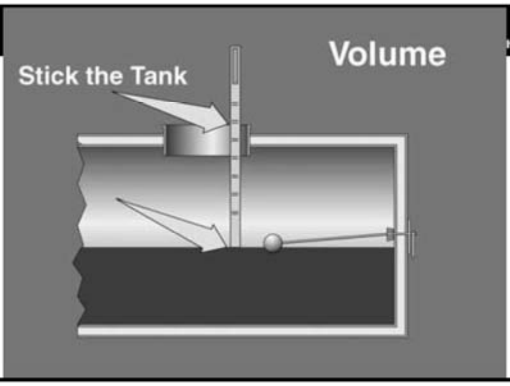
°C	°F	M	°C	°F	M	°C	°F	M
10.0	50	1.0025	35.0	95	0.9912	60.0	140	0.9800
10.6	51	1.0022	35.6	96	0.9910	60.6	141	0.9797
11.1	52	1.0020	36.1	97	0.9907	61.1	142	0.9795
11.7	53	1.0017	36.7	98	0.9905	61.7	143	0.9792
12.2	54	1.0015	37.2	99	0.9902	62.2	144	0.9790
12.8	55	1.0012	37.8	100	0.9900	62.8	145	0.9787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

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

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

Dipstick Method

- Measure Asphalt Volume in Truck
- Record Asphalt Temperature
- Spray Tack Coat Over a Known Area
- Measure Asphalt Volume in Truck
- Correct Volume used for Temperature Variation from 60°F



Before checking your volume by sticking the tank, make sure Distributor is level

$$\frac{9 \times Gallons\ Applied}{\underset{(feet)}{Width} \times \underset{(feet)}{Length}}$$

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

Calculating rates by Volume

- When using a tank volume method for determining the quantity of material distributed, the temperature must be determined and the volume of material corrected to 60°F.
- Lets work an Example Problem

Determining Residual Application Rates

- For the following examples we will assume we are using SS-1h or CSS-1h which have a minimum AASHTO (M140 and M 208 resp.) specified minimum residual asphalt content of 57%.
- Specifying a 60°F 1:1 diluted emulsion.

Exercise: Calculating rates by Volume

Volume at start of Application	1875 gal.
Volume at end of run	1250 gal.
Temperature of material	160°F
Temperature Correction Factor	0.97500
Beginning Station	35+00
Ending Station	56+00
Distributor width	14 Ft.
SS-1h Emulsion is diluted 1:1	

Calculate the residual application rate

Calculating rates by Volume Solution

- **Distance travelled:** 5600ft. – 3500ft. = 2100ft.
- **Area sprayed:** (2100ft. x 14ft.)/9sq.ft./sq.yd. = 3267sq.yd.
- **Hot Gallons sprayed:** 1875 gal-1250 gal = 625 gal. @ 160°F
- **Temp. Correction factor from Chart:** 0.97500
- **60°F gallons:** 625 gal x 0.9750 = 609 gal. @ 60°F

Calculating rates by Volume Solution

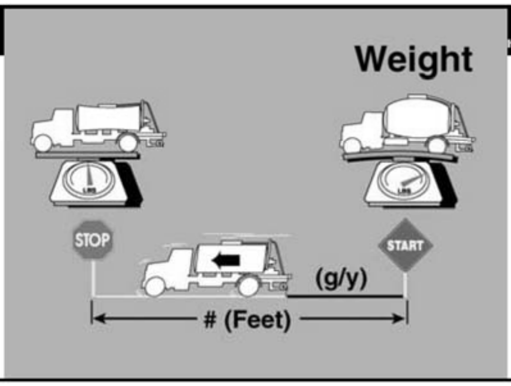
- 609 diluted gallons!
- Diluted 1:1 the actual emulsion is:
  609 gal / 2 = 304.5 undiluted gallons.
- **Final rate:** 304.5 gal/ 3267 sq. yd. = 0.0938 g/sy
- **SS-1h Residual rate:** 0.0938 g/sy x 0.57 = 0.053 g/sy

Comments on Calculating by Volume

- Pros:
  - Quick
  - Simple
  - Accuracy improves with larger areas
- Cons:
  - Volume requires
    - Dip Stick, or
    - Volumeter
  - Dilution rate vital
  - Temperature correction required
  - Inaccurate on small areas

Calculating rates by Weight (Mass)

- Calculating an application rate by weight is the most accurate method.
- Bill of lading from the supplier should contain a 60°F weight per gallon.
- Weight measurements are not affected by temperature.
- However constant weighing after each shot can be complicated.
- Recommend using this method for full load applications, calibration, etc.



Exercise: Calculating rates by Weight (Mass)

- Plans specify CSS-1h (57% residue)
- Tare Weight of empty distributor = 26,000 lbs.
- Loaded weight of distributor (1:1) = 54,000 lbs.
- Bill of lading shows a 60°F density of 8.350 #/gal
- Application width = 15 feet
- Application length = 3 miles

Calculate the residual application rate in lbs/yd^2

Calculating rates by Weight (Mass) Solution

- Step 1: Determine pounds of diluted emulsion applied. Beginning weight – ending weight

54,000# – 26,000# = 28,000#

- Step 2: Account for dilution if present. For our problem, 1:1 dilution of Original Emulsion and Water

∴ 28,000#/2 = 14,000# CSS-1h

- Step 3: Calculate residual asphalt weight. 57% residue in Original Emulsion

14,000# X 0.57 = 7,980#

Calculating rates by Weight (Mass) Solution

- Step 4: Calculate application area. Length X Width

(3 mi. X 5,280 ft./mi.) X 15 ft. = 237,600 ft.^{2}

- Step 5: Convert to square yards.

237,600 ft.^{2} ÷ 9 ft.^{2}/yd.^{2} = 26,400 yd.^{2}

- Step 6: Calculate Residual Asphalt application rate.
  Mass Applied ÷ Area Applied

7,980# ÷ 26,400 yd.^{2} = 0.30 lbs./yd.^{2}

Calculating rates by Weight (Mass) Solution

NOTE: If one wanted to know the residual application in gal./yd.^{2}

- Use 8.350 #/gal from the Bill of Lading.

0.30 #/yd.^{2} ÷ 8.350 #/gal = 0.036 gal./yd.^{2}

Comments on Calculating by Mass

- Pros:
  - Quick
  - Simple
  - Temperature correction not needed
  - Accuracy improves with larger areas
- Cons:
  - Truck scale availability
  - Dilution rate vital
  - Inaccurate on small & irregular areas

**Direct Measurement using
ASTM D2995**

**Standard Practice for
Estimating Application Rate of Bituminous Distributors**

Key Items for Inspectors

- Check truck setup.
  - Spray bar height (~12")
  - Appropriate nozzles
  - Nozzle orientation (15-30°)
  - Check application rate gauge in truck
  - Check application temperature
- Collect samples.
- Know the desired application and residual rates.
- Visually inspect application
- Verify application.
  - Volume
  - Mass
  - ASTM D2995

It's important that inspectors understand the how trucking, preparation for paving, and tack coats affect the construction and longevity of asphalt pavements.

Module Outline

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

Module Outline

- Transportation and delivery
  - Introduction
  - Truck types & requirements
  - Mix delivery concerns
- Preparation for Paving
  - New Construction
  - Overlays
    - Asphalt
    - PC Concrete
- Tack Coats
  - Introduction
  - Materials
  - Application
  - Verification

The Hauling Operation

The hauling operation must provide a steady and consistent flow of asphalt mixture from the plant to the paver.

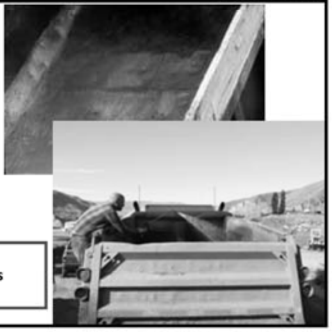
This is accomplished by:

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

The Contractor must anticipate the trucker's activities to properly estimate cycle time.

Truck Bed Requirements—Release Agents

- Tight, clean, smooth metal beds
- Thinly coated with minimum amount of soap solution, lime solution, or any other approved release agent
- Do not allow ponding of these solutions in the truck bed



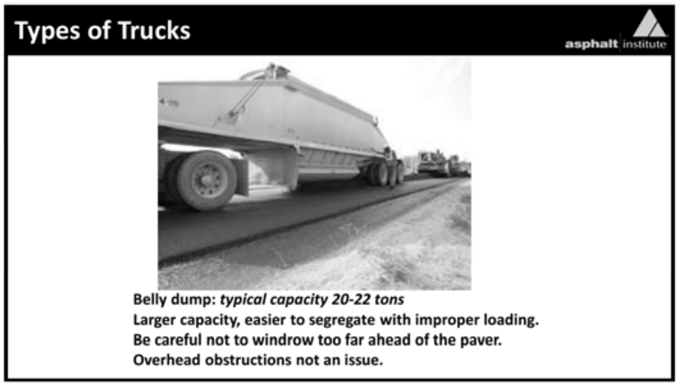
No diesel fuel or other contaminating solvents allowed!

Types of Trucks

End dump: *typical capacity 13-15 tons*
Lower capacity, but shorter wheel base makes it more maneuverable.
Good for jobs in tight spaces.
Watch for overhead obstructions.

Types of Trucks

Semi-trailer, high dump: ***typical capacity 20-22 tons***
Larger capacity, easier to segregate with improper loading.
Watch for overhead obstructions.



Types of Trucks

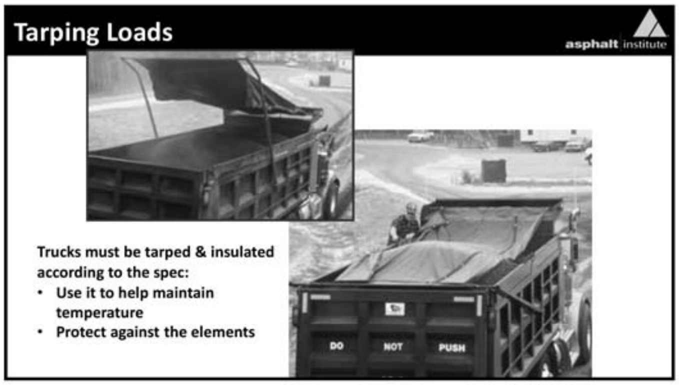
Belly dump: ***typical capacity 20-22 tons***
Larger capacity, easier to segregate with improper loading.
Be careful not to windrow too far ahead of the paver.
Overhead obstructions not an issue.

Types of Trucks

Flow Boy Semi: ***capacity 20-22 tons***
Large capacity, removes concerns about overhead obstructions.
Regulated flow dumps directly into the paver's hopper.

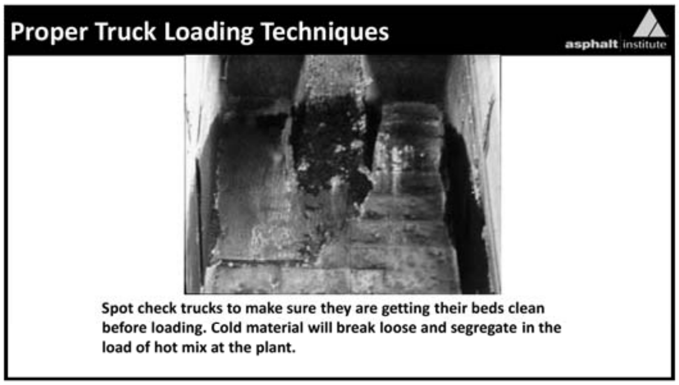
Module Outline

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



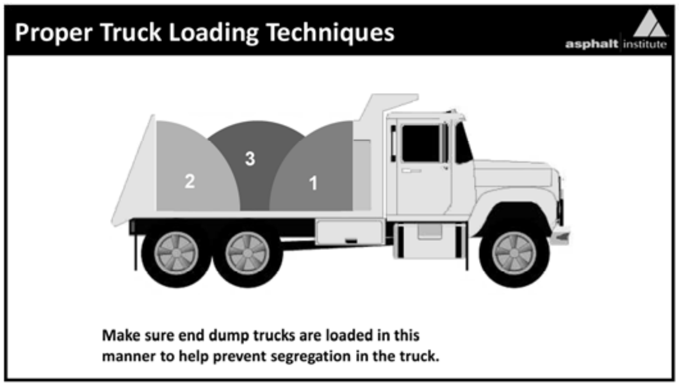
Tarping Loads

Trucks must be tarped & insulated according to the spec:
- **Use it to help maintain temperature**
- **Protect against the elements**



Proper Truck Loading Techniques

Spot check trucks to make sure they are getting their beds clean before loading. Cold material will break loose and segregate in the load of hot mix at the plant.

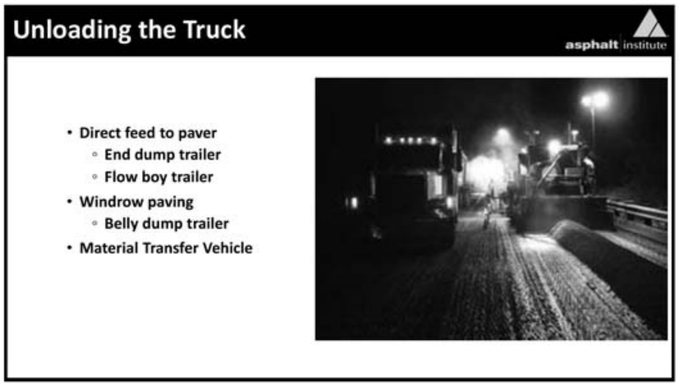


Proper Truck Loading Techniques

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

Proper Truck Loading Techniques

Semi-trailers benefit from more dumps to help prevent segregation.
Don't allow the mix to be dribbled in - ensure quick dumps in a mass.



Unloading the Truck

- Direct feed to paver
  - End dump trailer
  - Flow boy trailer
- Windrow paving
  - Belly dump trailer
- Material Transfer Vehicle

Direct Feed to Paver

- End Dump Trailer
  - Tarps off the load
  - Raise bed to break load
  - Paver engages truck
  - Open gate and continue raising bed so material moves in mass
    - Do not chain (restrict) tailgate opening
    - Not trickled into paver—while paver pushes truck
- Flow Boy Trailer
  - Paver engages truck
  - Transfer material while paver pushes truck

Improperly Backing a Truck

Resulting Deformation

Windrow Paving

- Belly dump trailer
  - Dumpman sets gate opening
  - Produce a straight, consistent windrow
  - Material pick-up machine delivers material to paver
  - Promotes high-volume, continuous paving
  - Segregation harder to prevent

Material Transfer Vehicles

MTVs are intended to
- Help the paving train keep moving continuously
- Expedite truck unloading
- Eliminate truck/paver contact
- Reduce potential for:
  - Physical segregation
  - Thermal segregation

Material Transfer Vehicles (MTVs)

Material Transfer Vehicles

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

One piece of equipment cannot eliminate segregation

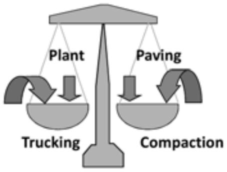
- Use proper release agents
- Good loadout practices
- Proper, tarping, insulation, & hauling
- Proper unloading and dumpman operation
- Pay attention to temperature
- Have enough trucks for a continuous paving operation

Placement

Outline

Placement Best Practices
- Project planning
- Understanding the paver
- Factors affecting the screed
- Screed Adjustments
- Paving process

Project Planning



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

Consistency = Quality

Project Planning

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

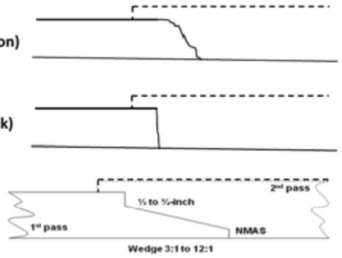
<u>Tracked Pavers</u>
Best for soft surfaces & better traction

Project Planning

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

Project Planning

Types of Longitudinal Joints



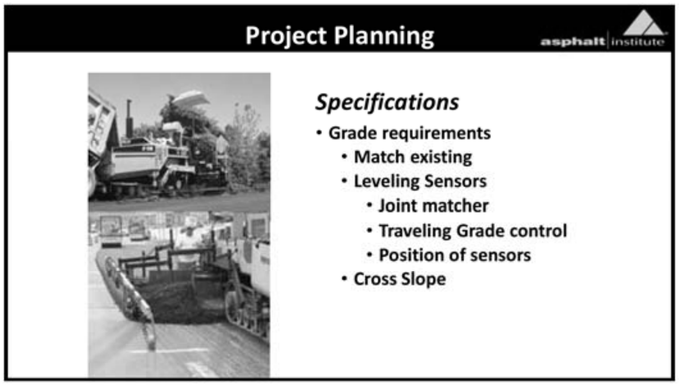
Butt Joint (paver construction)

Butt Joint (milled or cutback)

Notched Wedge Joint

Poor planning – joint in wheelpath

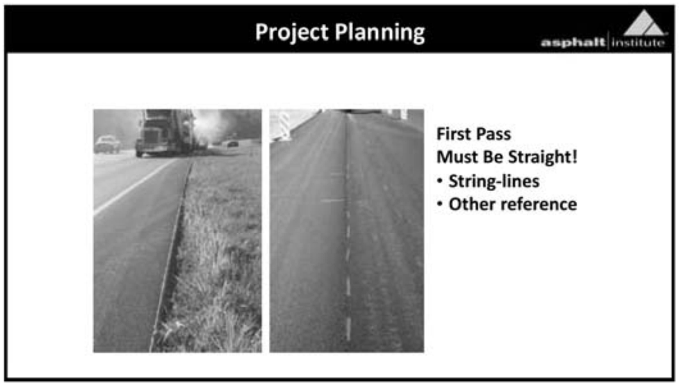
Danny Gierhart photo



Project Planning

Specifications

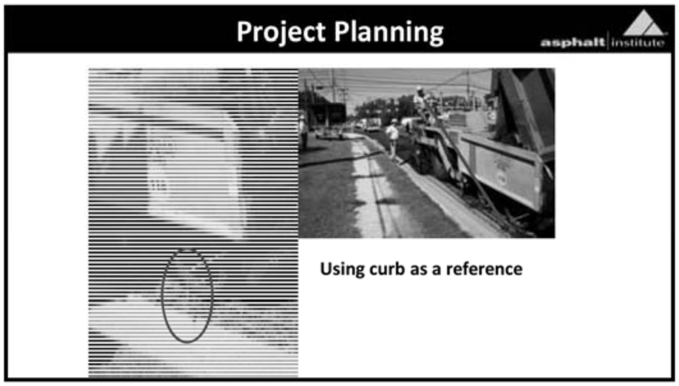
- Grade requirements
  - Match existing
  - Leveling Sensors
    - Joint matcher
    - Traveling Grade control
    - Position of sensors
  - Cross Slope



Project Planning

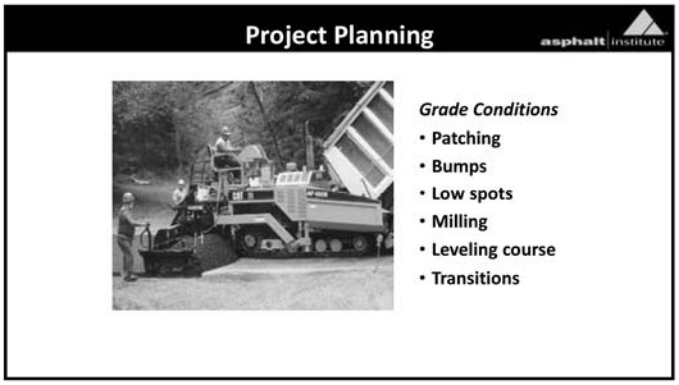
First Pass
Must Be Straight!

- String-lines
- Other reference



Project Planning

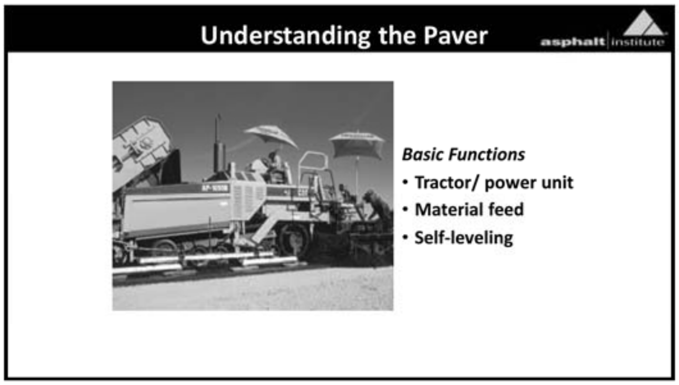
Using curb as a reference



Project Planning

Grade Conditions

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



Understanding the Paver

Basic Functions

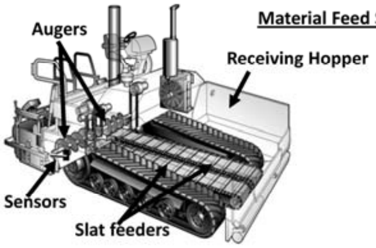
- Tractor/ power unit
- Material feed
- Self-leveling

Understanding the Paver

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

Understanding the Paver

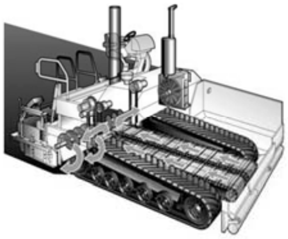
Material Feed System



Understanding the Paver

Material Feed System

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



Visual Inspection of HMA

Problem Indicators

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

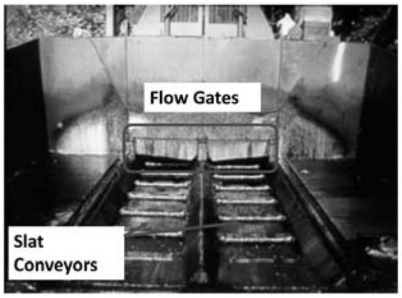
Break the Load

- Move mix in a mass
- Trickling causes segregation

Loading the Hopper

- Avoid spilling in front of the paver
- Truck applies light brake pressure
- Remove prior to advancing
- Adhere to worker safety!

Slat Conveyors and Flow Gates



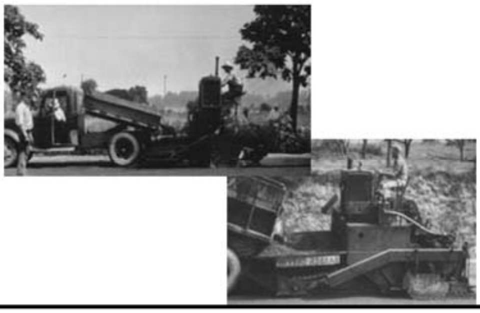
Hopper Management

Conveyor area is exposed and augers are starved!

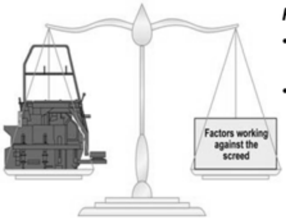
Understanding the Paver

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

Basic Principle Has Not Changed



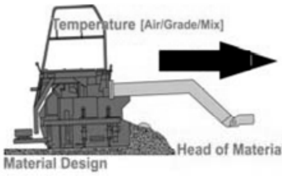
Understanding the Paver



Free-Floating Screed

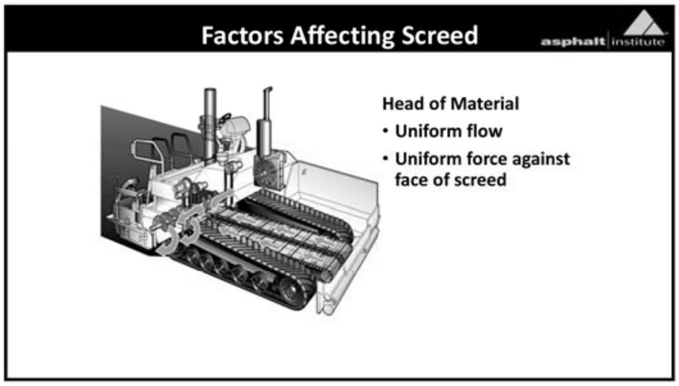
- *Position* determines mat thickness
- Screed *position*
  - Will remain constant
  - *If all factors* remain constant

Understanding the Paver



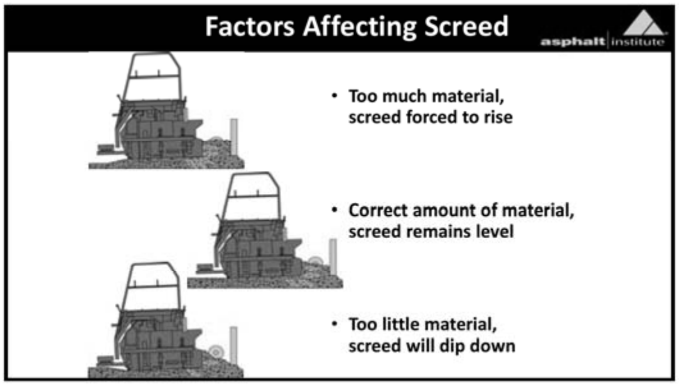
Factors Affecting the Screed

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



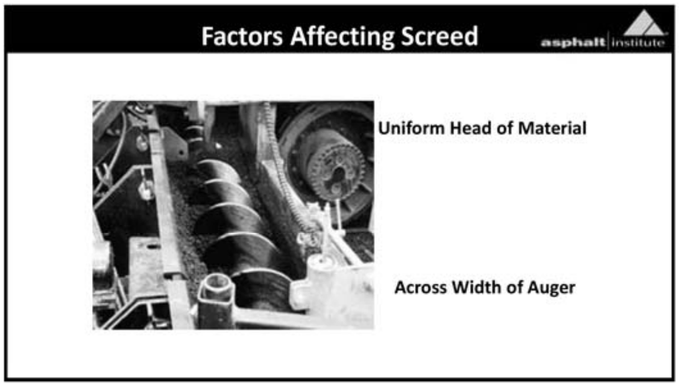
Factors Affecting Screed

Head of Material
- Uniform flow
- Uniform force against face of screed



Factors Affecting Screed

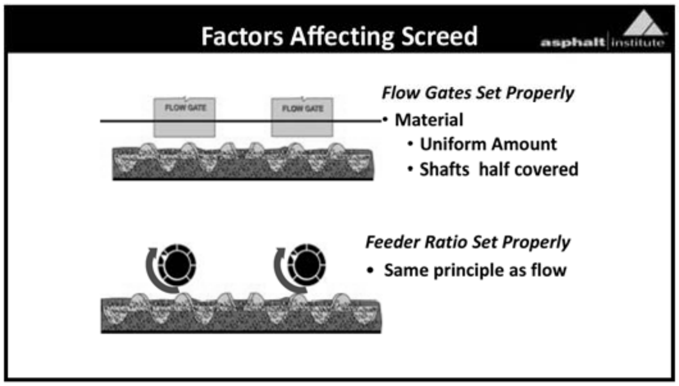
- Too much material, screed forced to rise
- Correct amount of material, screed remains level
- Too little material, screed will dip down



Factors Affecting Screed

Uniform Head of Material

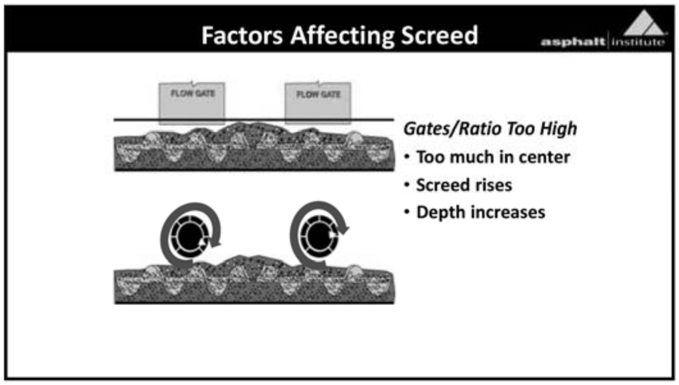
Across Width of Auger



Factors Affecting Screed

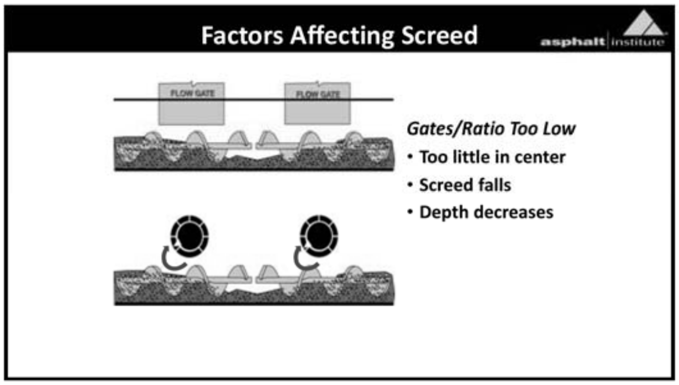
Flow Gates Set Properly
- Material
  - Uniform Amount
  - Shafts half covered

Feeder Ratio Set Properly
- Same principle as flow



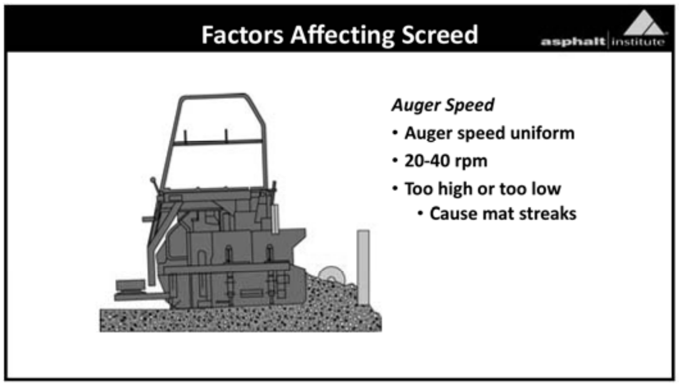
Factors Affecting Screed

Gates/Ratio Too High
- Too much in center
- Screed rises
- Depth increases



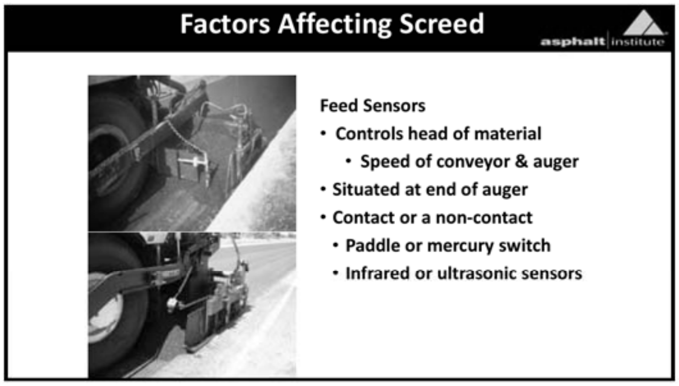
Factors Affecting Screed

Gates/Ratio Too Low
- Too little in center
- Screed falls
- Depth decreases



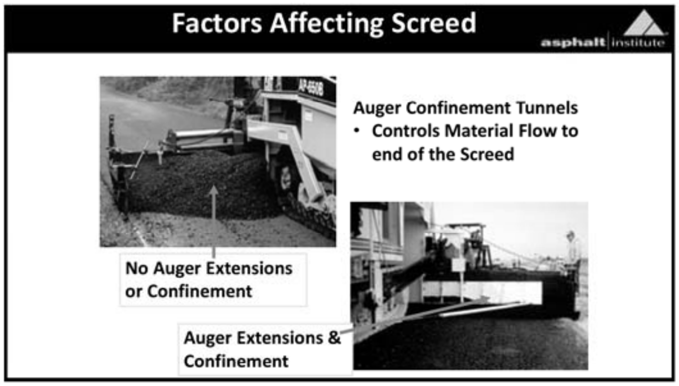
Factors Affecting Screed

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



Factors Affecting Screed

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

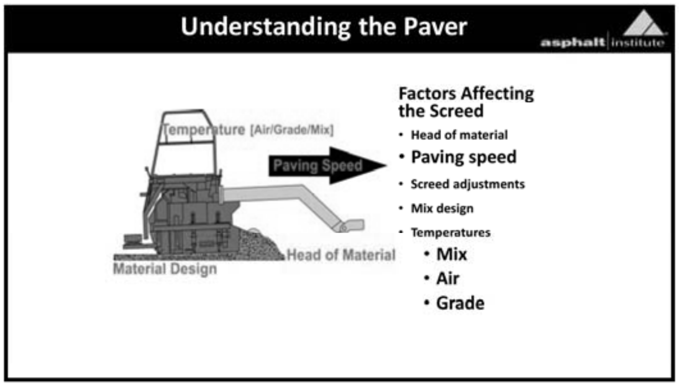


Factors Affecting Screed

Auger Confinement Tunnels
- **Controls Material Flow to end of the Screed**

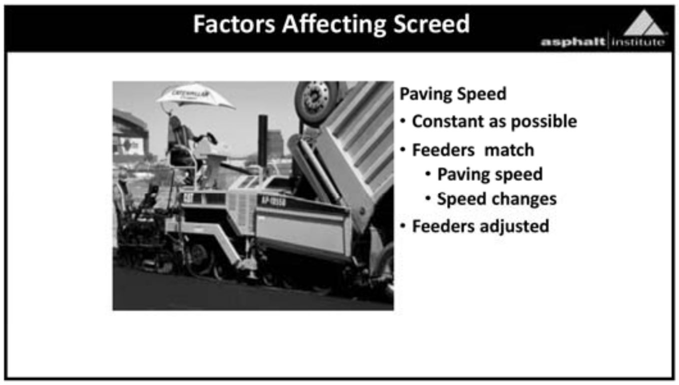
No Auger Extensions or Confinement

Auger Extensions & Confinement



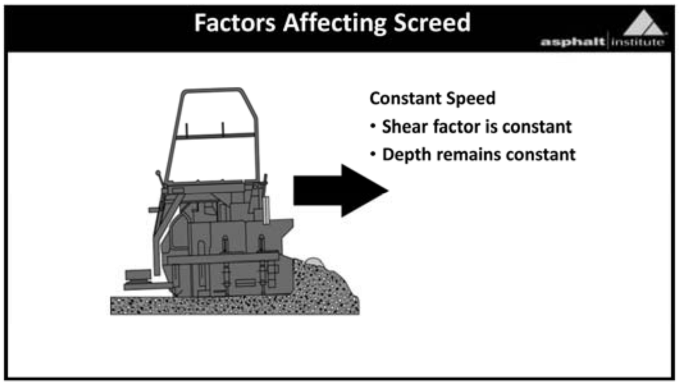
Understanding the Paver

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



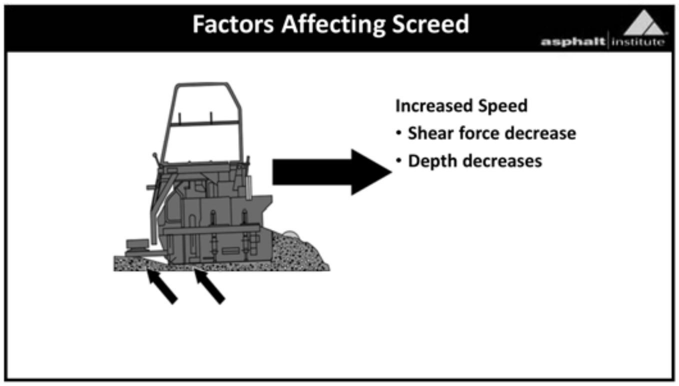
Factors Affecting Screed

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



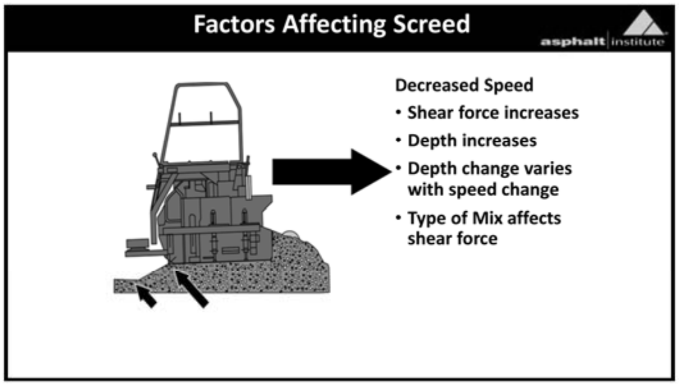
Factors Affecting Screed

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



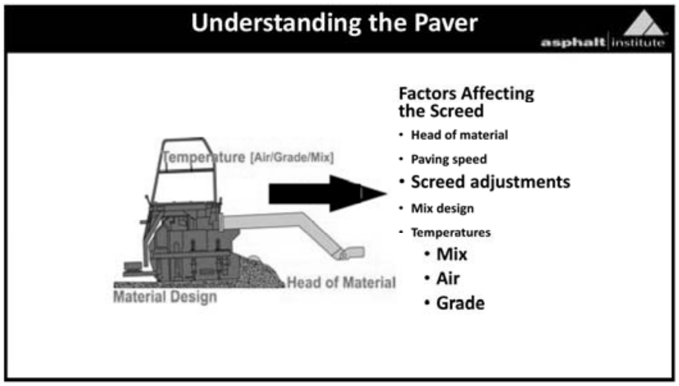
Factors Affecting Screed

Increased Speed
- Shear force decrease
- Depth decreases



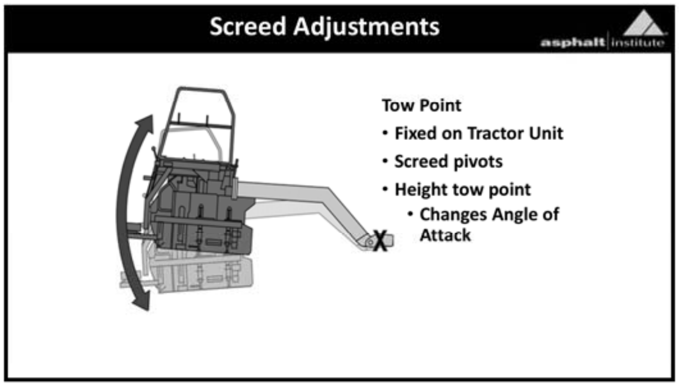
Factors Affecting Screed

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



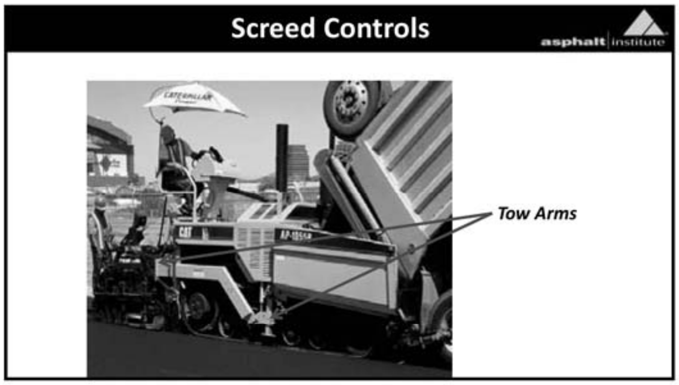
Understanding the Paver

Factors Affecting the Screed
- Head of material
- Paving speed
- Screed adjustments
- Mix design
- Temperatures
  - Mix
  - Air
  - Grade

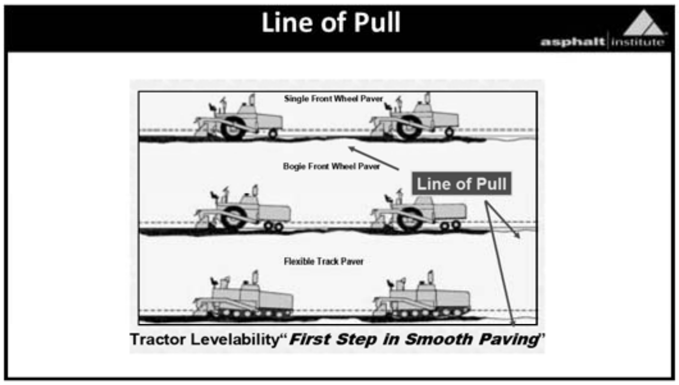


Screed Adjustments

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



Screed Controls

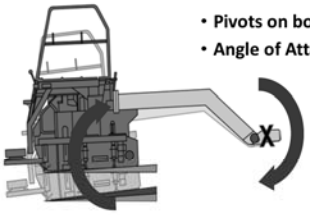


Line of Pull

Tractor Levelability"***First Step in Smooth Paving***"

Developing the Line of Pull

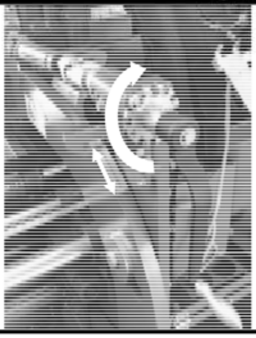
Screed Adjustments



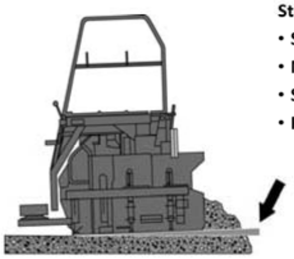
- Pivots on both ends of tow arm
- Angle of Attack

Changing the Angle of Attack

Depth Crank Increases or Decreases Attack Angle

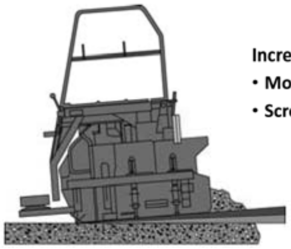


Screed Adjustments



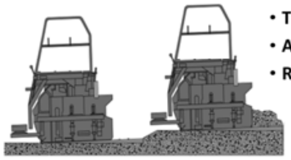
Starting Angle of Attack
- Screed nose & grade
- Nose up attitude
- Screed in equilibrium
- Free Floating

Screed Adjustments

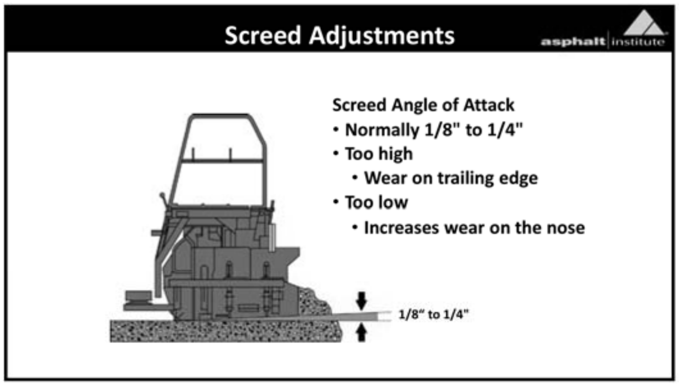


Increase Angle of Attack
- More matl under screed
- Screed rises to new level

Screed Adjustments

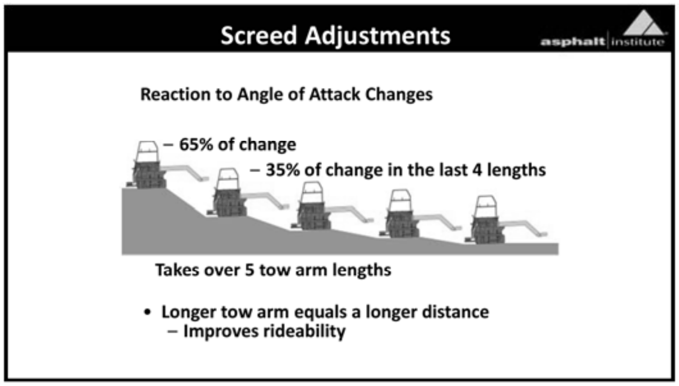


Increased Angle of Attack:
- Screed climbs
- Till forces balance
- Achieves equilibrium
- Returns to original angle



Screed Adjustments

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



Screed Adjustments

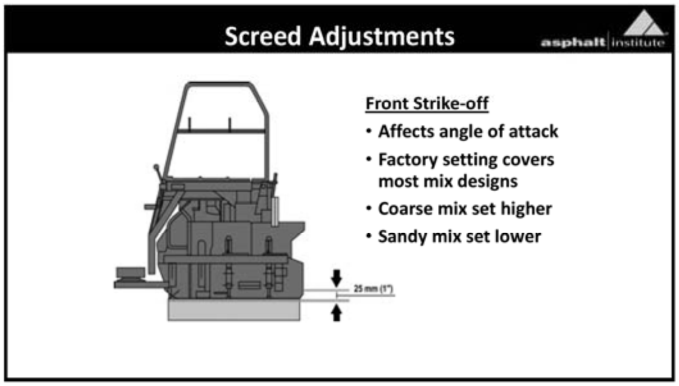
Reaction to Angle of Attack Changes

– 65% of change

– 35% of change in the last 4 lengths

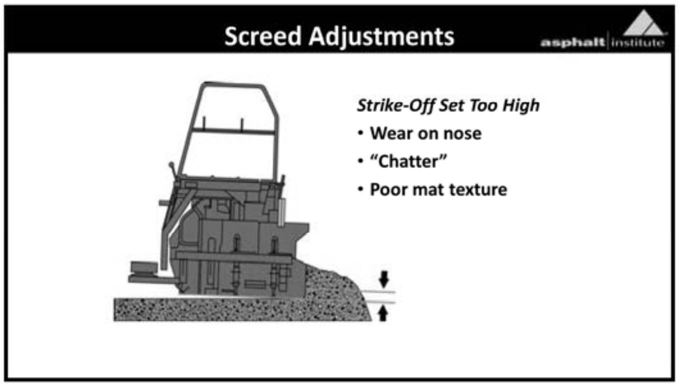
Takes over 5 tow arm lengths

- Longer tow arm equals a longer distance
  - Improves rideability



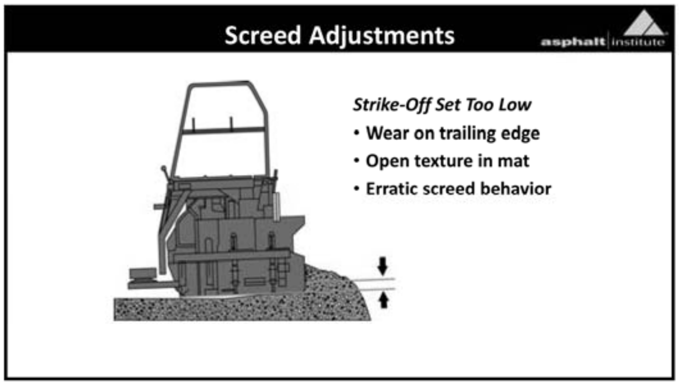
Screed Adjustments

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



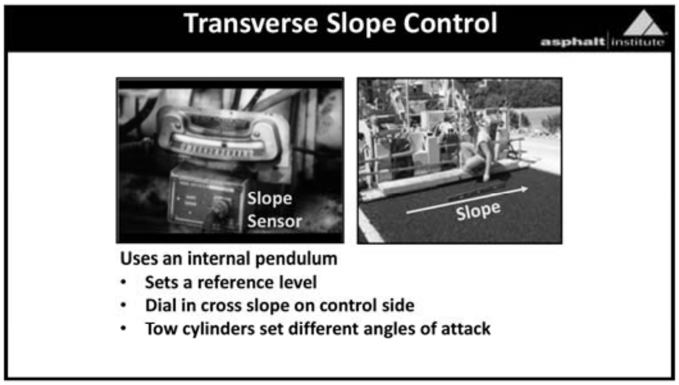
Screed Adjustments

Strike-Off Set Too High
- Wear on nose
- "Chatter"
- Poor mat texture



Screed Adjustments

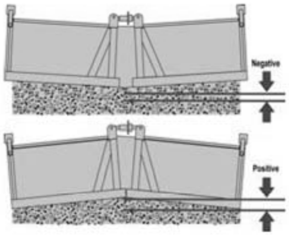
Strike-Off Set Too Low
- Wear on trailing edge
- Open texture in mat
- Erratic screed behavior



Transverse Slope Control

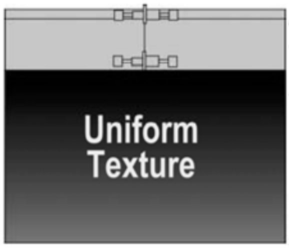
Uses an internal pendulum
- Sets a reference level
- Dial in cross slope on control side
- Tow cylinders set different angles of attack

Screed Adjustments



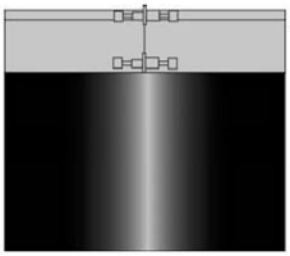
Main Screed Crown
- “Broken”
  - Positive crown
  - Negative crown

Screed Adjustments



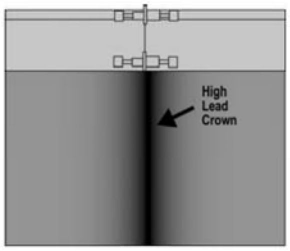
Lead Crown Correct
- Even texture across full width
- Zero crown for most mixes

Screed Adjustments



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

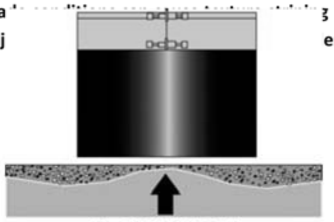
Screed Adjustments



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

Mat Defects

- Gra g
- Adj em



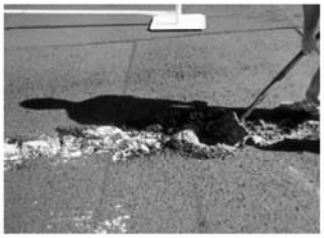
Due to High Point in Grade

Mat Defects

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

Mat Defects

- Grade conditions affect quality



Mat Defects

- Oversized material causes bumps

Mat Defects

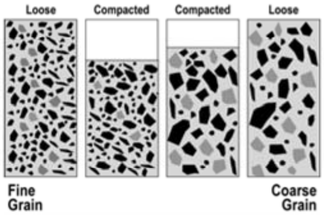
- Mat thickness should be 2 times greater than maximum aggregate size
- Tendency to fracture aggregate
- Lose control of screed

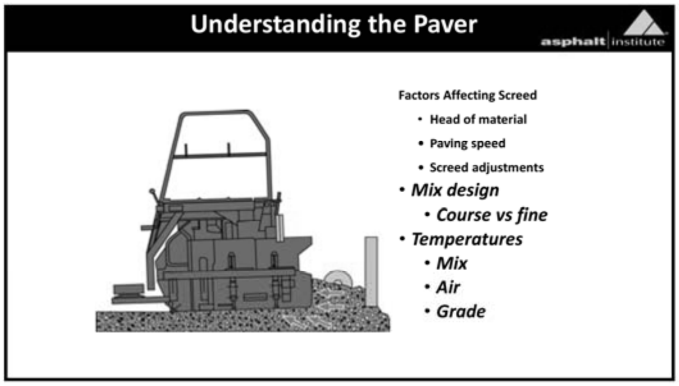
Improperly Backing a Truck

Resulting Deformation

Mat Defects

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

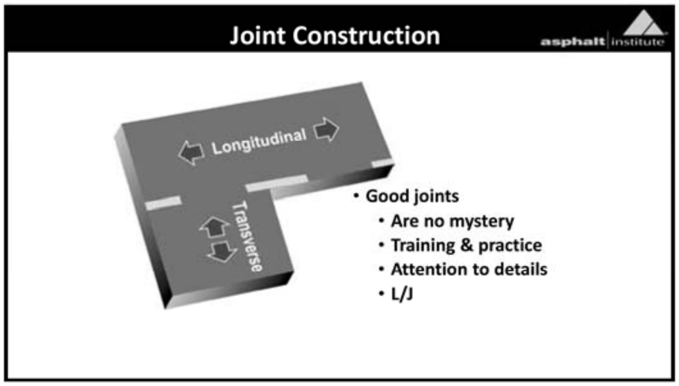




Understanding the Paver

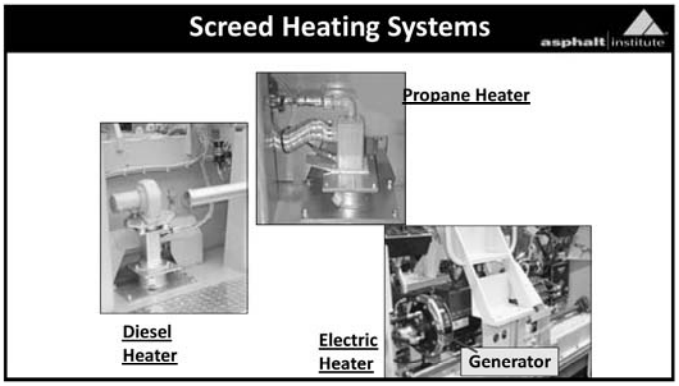
Factors Affecting Screed
- Head of material
- Paving speed
- Screed adjustments

- *Mix design*
  - *Course vs fine*
- *Temperatures*
  - *Mix*
  - *Air*
  - *Grade*



Joint Construction

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



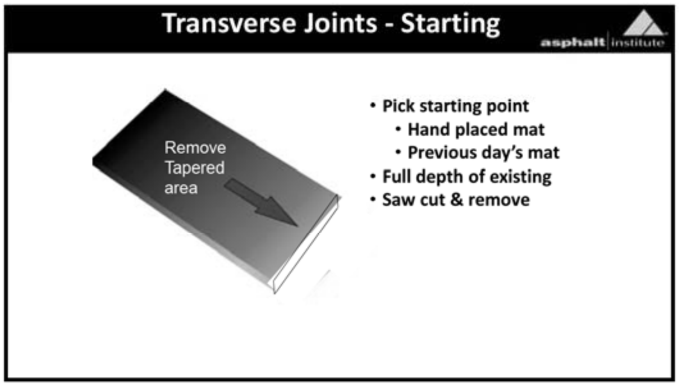
Screed Heating Systems

Propane Heater

Diesel Heater

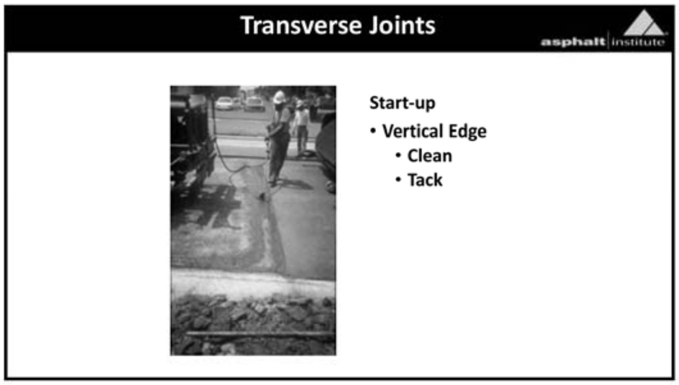
Electric Heater

Generator



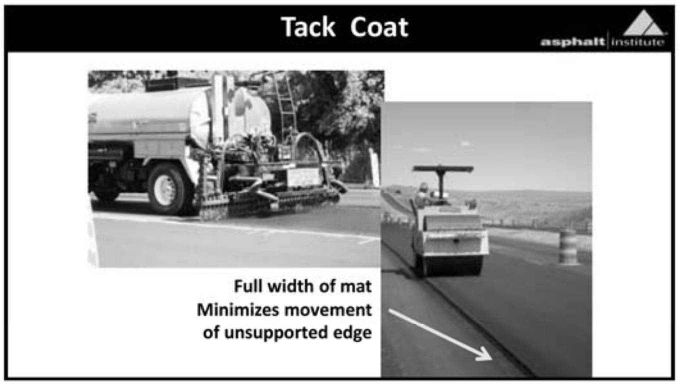
Transverse Joints - Starting

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



Transverse Joints

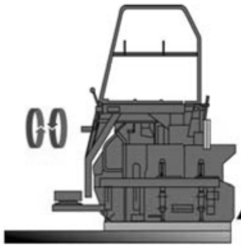
Start-up
- Vertical Edge
  - Clean
  - Tack



Tack Coat

Full width of mat
Minimizes movement
of unsupported edge

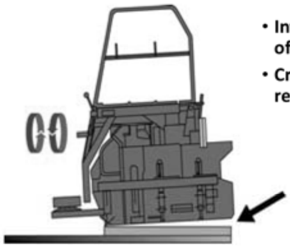
Transverse Joints



- Null screed
  - Zero out angle of Attack

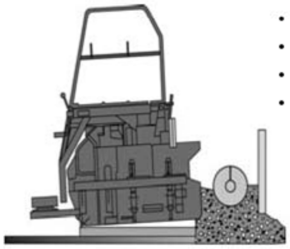
Boards allow for rolldown thickness

Transverse Joints



- Introduce angle of attack
- Crank until resistance is felt

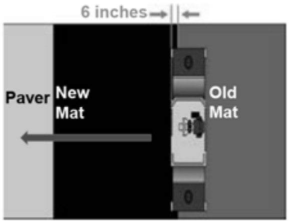
Transverse Joints



- Fill auger half full
- Conveyor manually
- Auger manually
- Shovel if needed

Transverse Joints

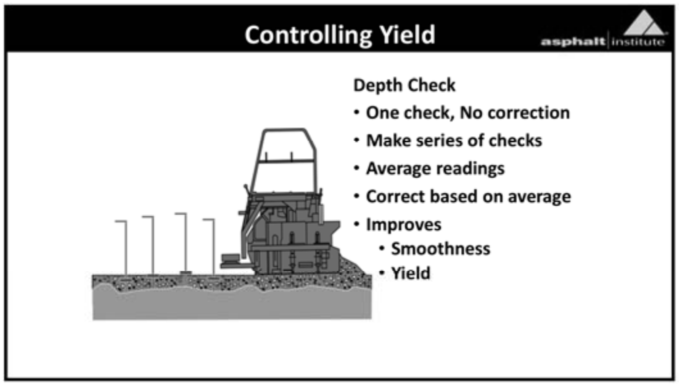
Transverse Joints



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

Transverse Joints

Traffic Safety is always an issue



Controlling Yield

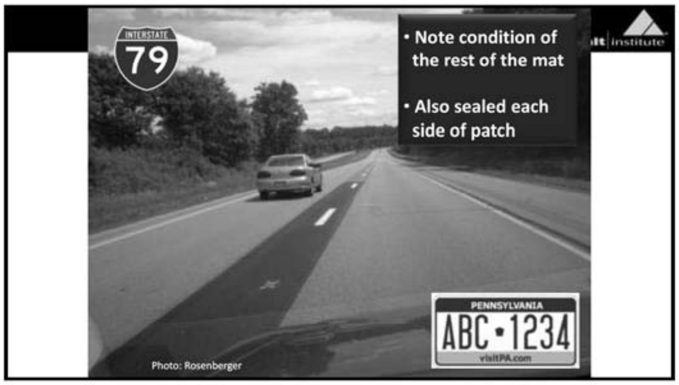
Depth Check
- One check, No correction
- Make series of checks
- Average readings
- Correct based on average
- Improves
  - Smoothness
  - Yield

How To Build a Longitudinal Joint?

Photo: Rosenberger

Photo: Rosenberger

Photo: Rosenberger



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

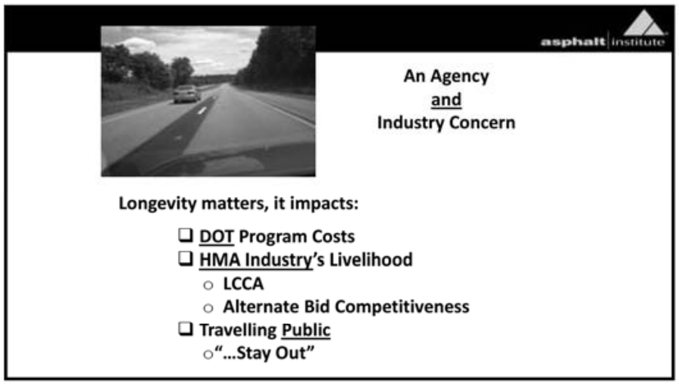
Photo: Rosenberger

Photo: Grass

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

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

How many more years?



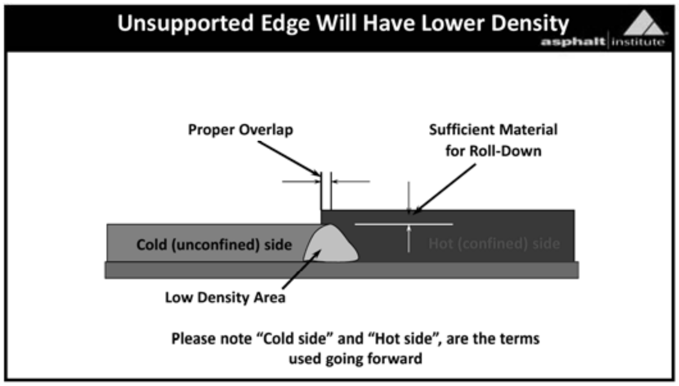
An Agency
<u>and</u>
Industry Concern

Longevity matters, it impacts:

- ☐ <u>DOT</u> Program Costs
- ☐ <u>HMA Industry</u>'s Livelihood
  - ○ LCCA
  - ○ Alternate Bid Competitiveness
- ☐ Travelling <u>Public</u>
  - ○"…Stay Out"

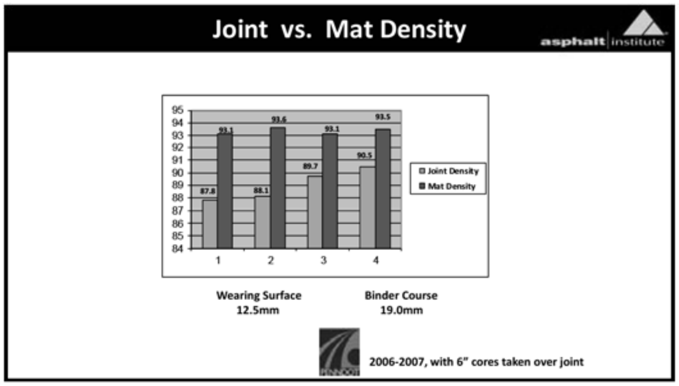
Clarification of Terms

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



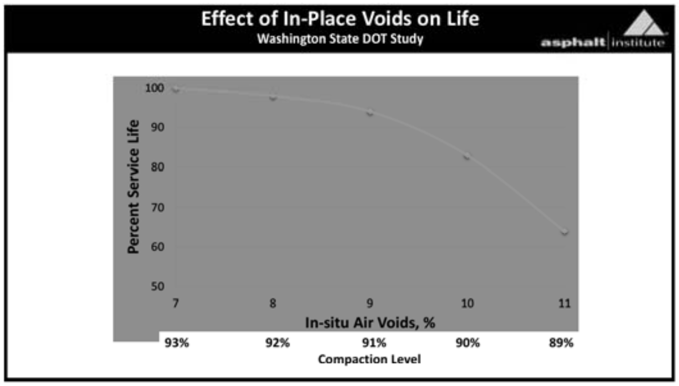
Unsupported Edge Will Have Lower Density

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



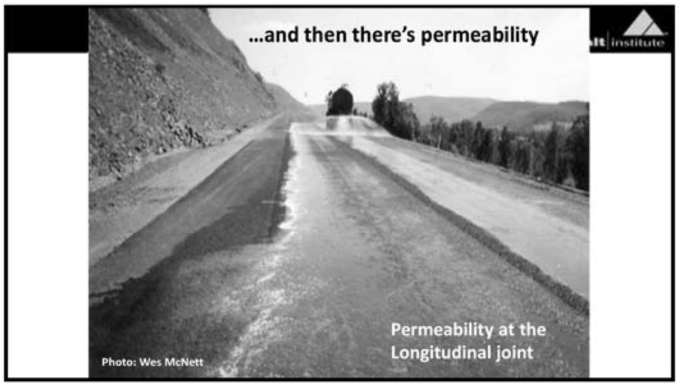
Joint vs. Mat Density

2006-2007, with 6" cores taken over joint



Effect of In-Place Voids on Life

Washington State DOT Study

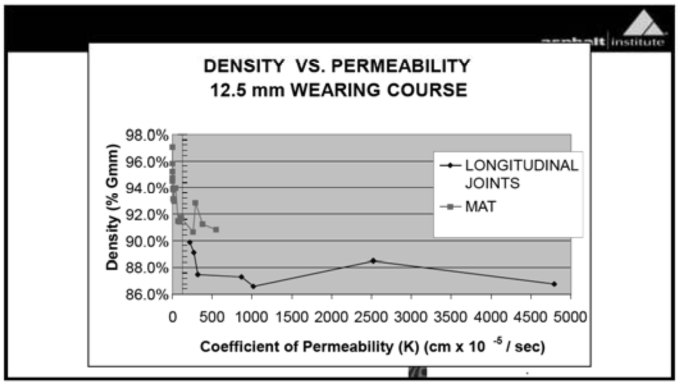


…and then there's permeability

Permeability at the Longitudinal joint

Photo: Wes McNett

Permeability can be Catastrophic



DENSITY VS. PERMEABILITY 12.5 mm WEARING COURSE

Air Voids **≤ 7 or 8%**

Mix generally not permeable

Air Voids **> 10%**

Mix generally permeable

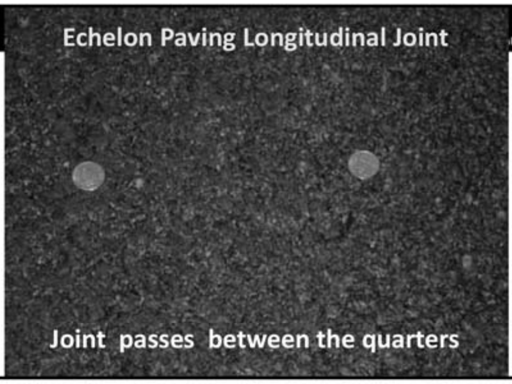
Quality Control and Acceptance of Joint Density

Constructing a Quality Longitudinal Joint

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

The Best Longitudinal Joint: *Echelon Paving*

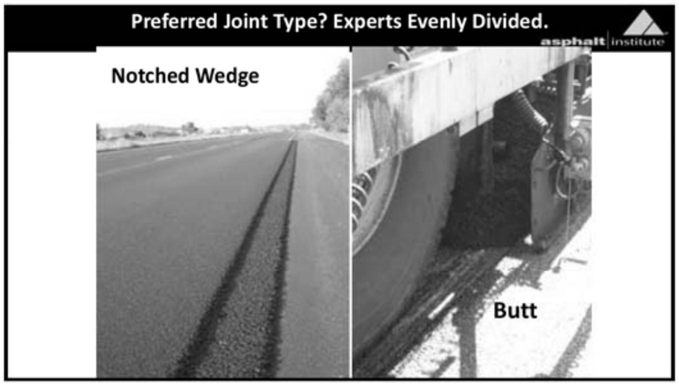
Echelon Paving Longitudinal Joint



Joint passes between the quarters

But, the need to maintain traffic limits the opportunities to pave in echelon

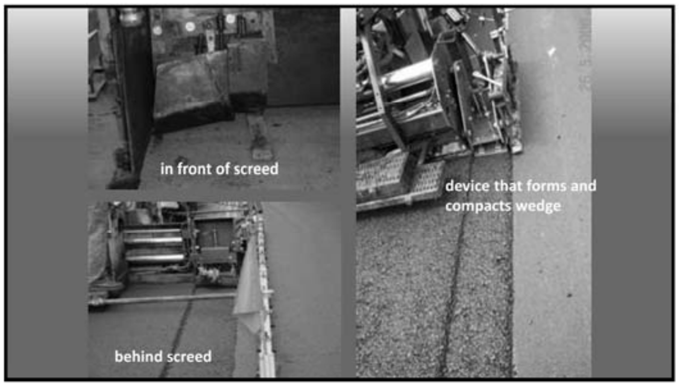
Consequently, most longitudinal joints are built with a cold joint.



Preferred Joint Type? Experts Evenly Divided.

Notched Wedge

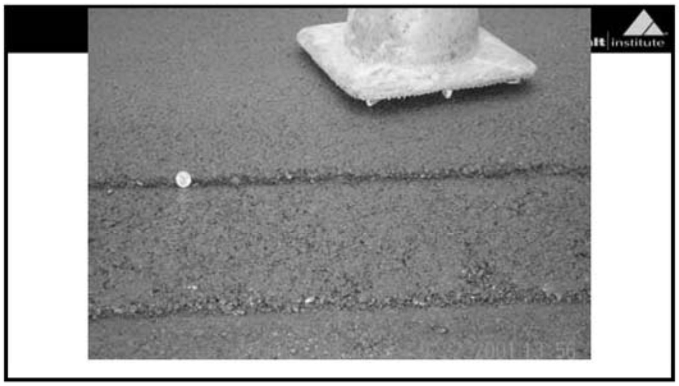
Butt

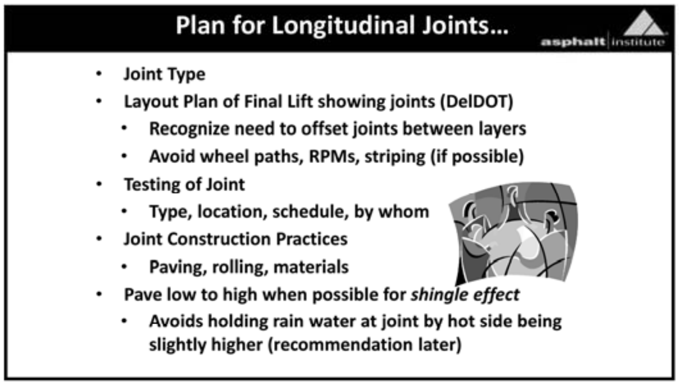


in front of screed

device that forms and compacts wedge

behind screed



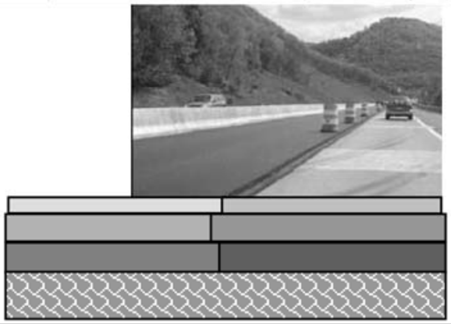


Plan for Longitudinal Joints…

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

Poor planning – joint in wheelpath

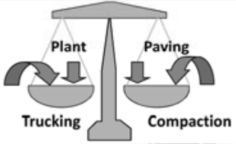
Danny Gierhart photo



DELDOT

DELDOT

GETTING STARTED OFF RIGHT



Dump Person

MTV

Managing Material in the Hopper

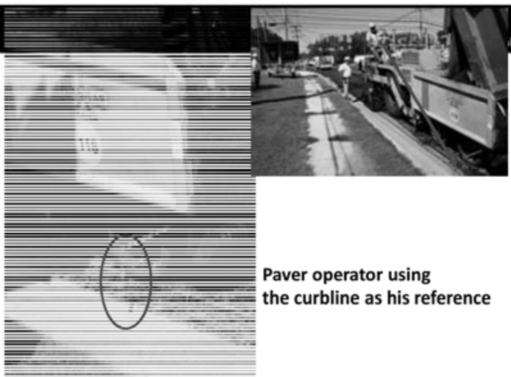
Conveyor area is exposed and augers are starved!

Tack Coat

Full width of mat to minimize movement of unsupported edge

Dump Person

Great Results



Paver operator using the curbline as his reference

with next pass

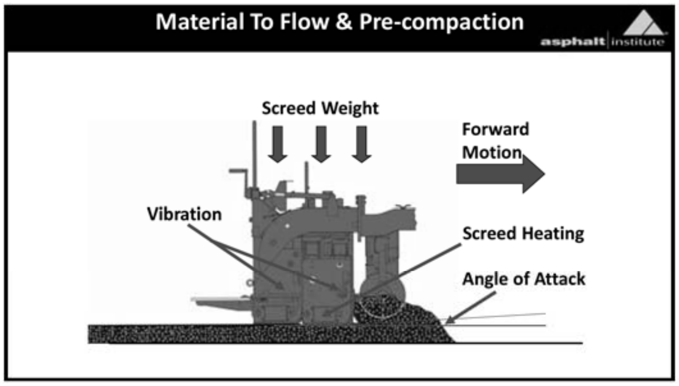
Use Automatic Grade Control (Versus Manual)

Double 55' Ski

Ultrasonic Ski

Contact Ski

Don't Rely on Manual Windmill Johnny



Material To Flow & Pre-compaction

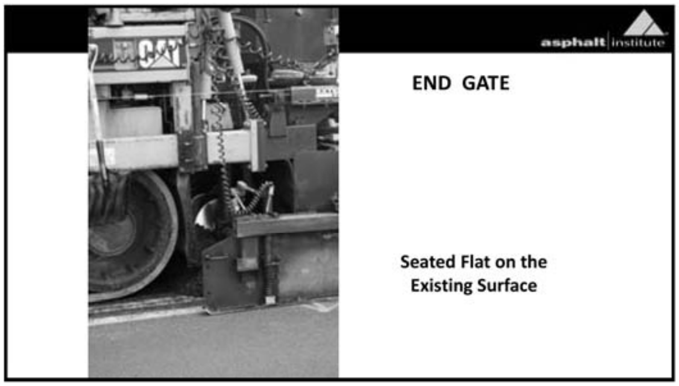
Screed Weight

Forward Motion

Vibration

Screed Heating

Angle of Attack



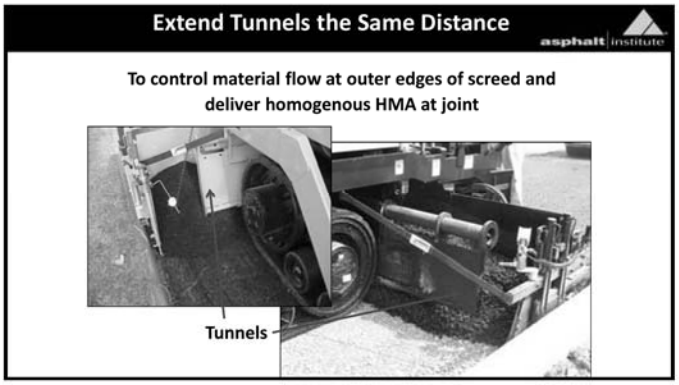
END GATE

Seated Flat on the Existing Surface

Uniform Head of Material

Maintained Across Width of Auger

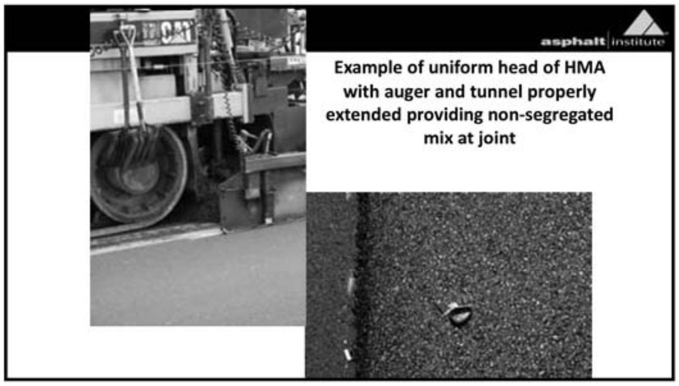
Extend Augers to Within 12-18 inches of End Gate



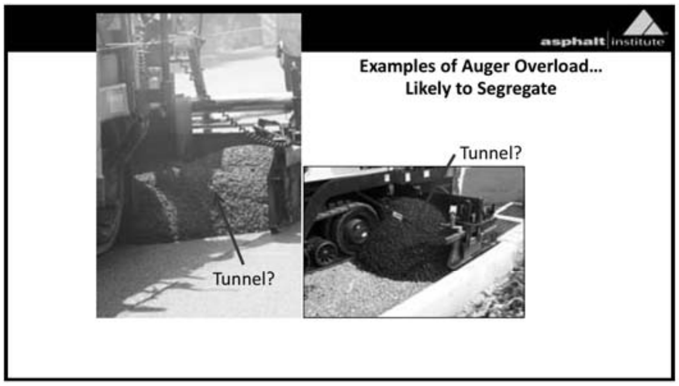
Extend Tunnels the Same Distance

To control material flow at outer edges of screed and deliver homogenous HMA at joint

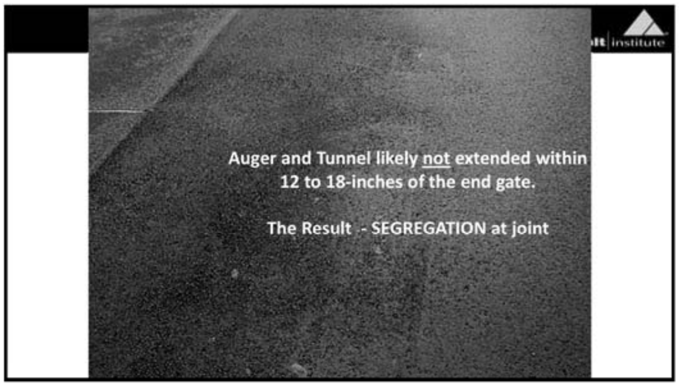
Tunnels



Example of uniform head of HMA with auger and tunnel properly extended providing non-segregated mix at joint



Examples of Auger Overload…
Likely to Segregate



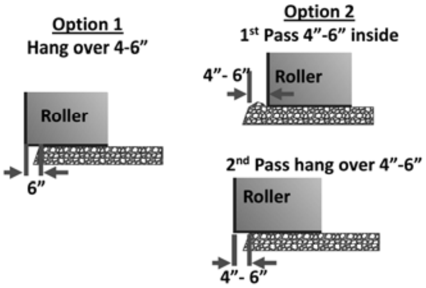
Auger and Tunnel likely <u>not</u> extended within 12 to 18-inches of the end gate.

The Result - SEGREGATION at joint

Critical in cool and cold weather!

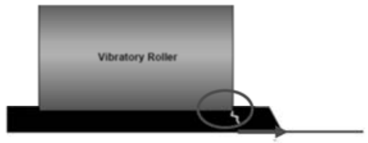
Best Way to Roll a Joint

Rolling Unconfined Side?



Rolling Unsupported Edge

With First Roller Pass



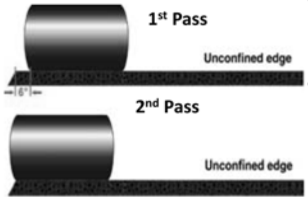
If edge of drum is located just inside the unsupported edge, a stress crack can occur here.

Our Recommendation: Option 1

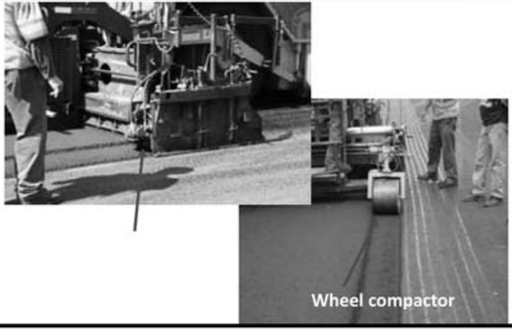
1st Roller Pass Hangs Over 4-6 inches

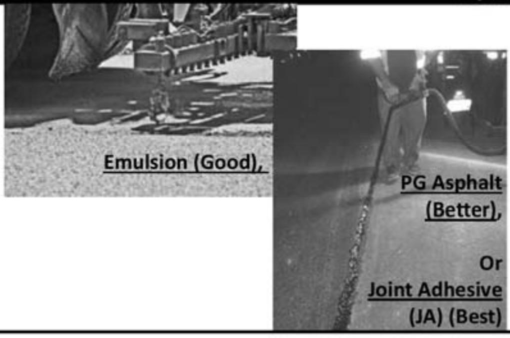
Alternative: Option 2

Stay Back 4-6 inches on 1st pass, then roll 2nd pass w/ slight overhang



- **Concern:**
  - **developing stress crack?**
- **Merit:**
  - **minimize lateral movement?**





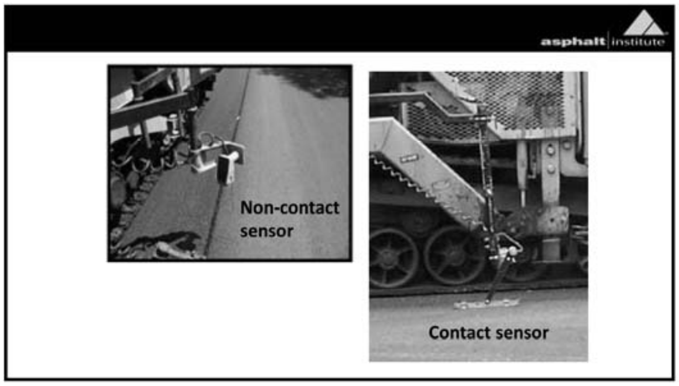
Emulsion (Good),

PG Asphalt (Better),

Or Joint Adhesive (JA) (Best)

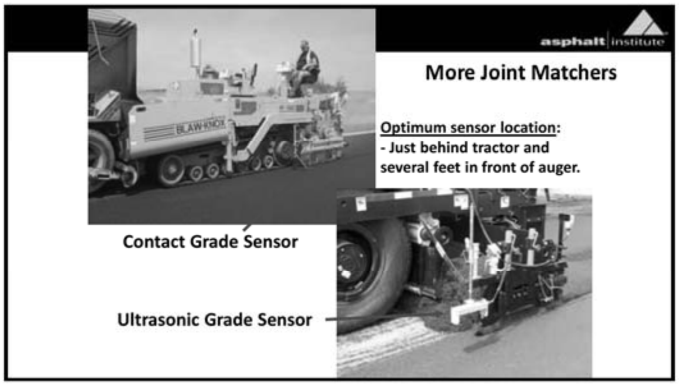
Set Paver Automation to Never Starve the Joint of Material

- **Target final height difference of +0.1" on hot-side versus cold side**
  - **NH spec requires 1/8" higher**
- **Joint Matcher (versus Ski) is best option to ensure placing exact amount of material needed**
- **If hot-side is starved, roller drum will "bridge" onto cold mat and no further densification occurs at joint**



Non-contact sensor

Contact sensor

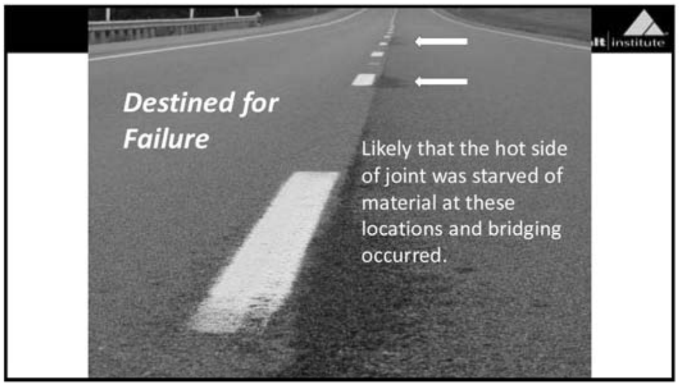


More Joint Matchers

Optimum sensor location:
- Just behind tractor and several feet in front of auger.

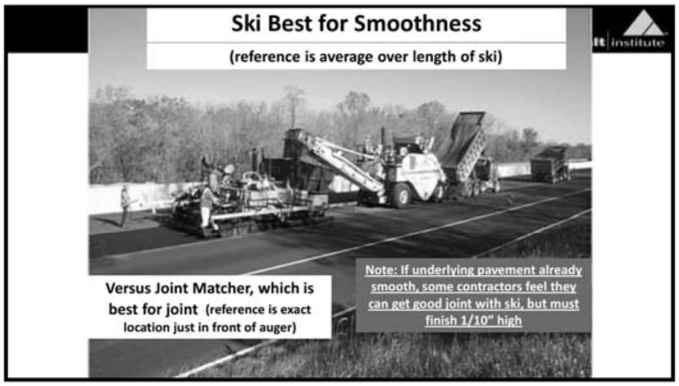
Contact Grade Sensor

Ultrasonic Grade Sensor



Destined for Failure

Likely that the hot side of joint was starved of material at these locations and bridging occurred.

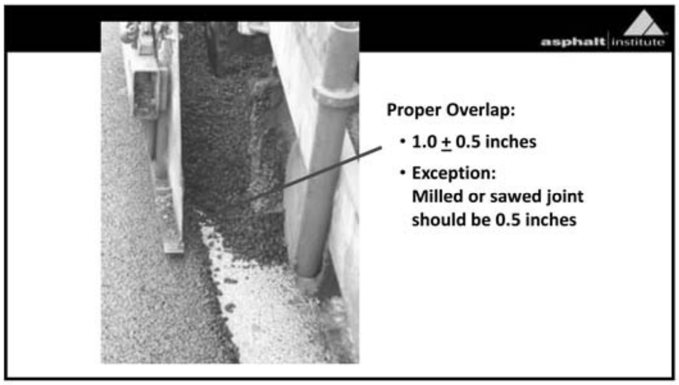


Ski Best for Smoothness

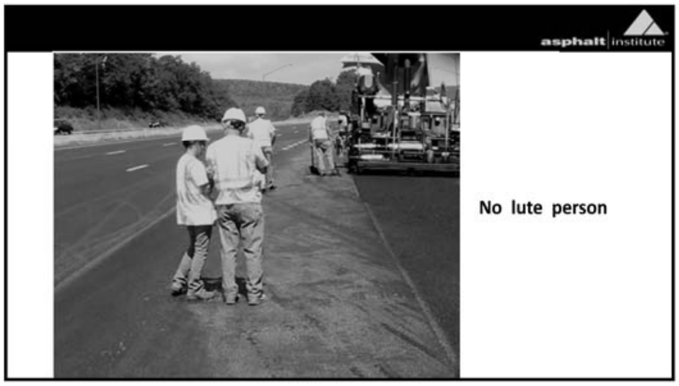
(reference is average over length of ski)

Versus Joint Matcher, which is best for joint (reference is exact location just in front of auger)

Note: If underlying pavement already smooth, some contractors feel they can get good joint with ski, but must finish 1/10" high



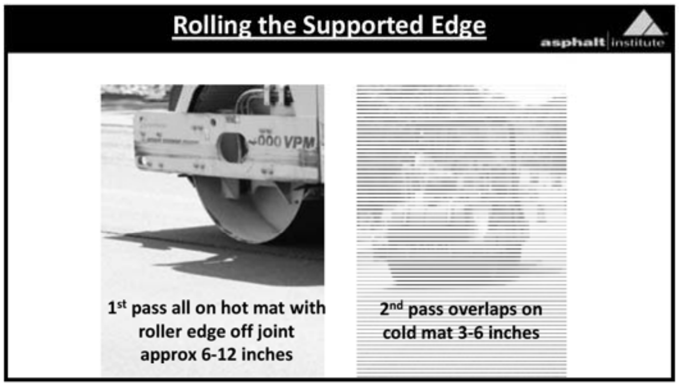
Proper Overlap:
- 1.0 ± 0.5 inches
- Exception:
  Milled or sawed joint should be 0.5 inches



No lute person

This lute person is doing a great job

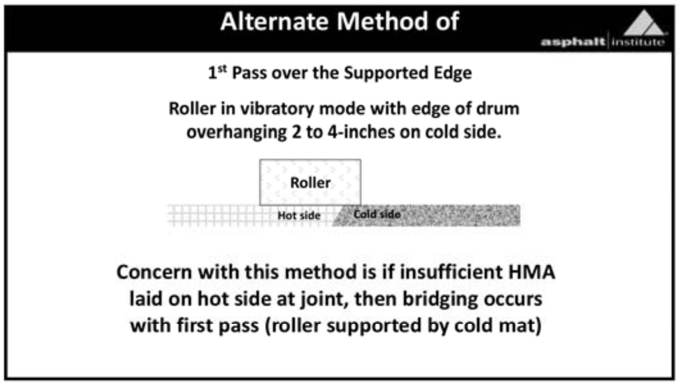
Overlap



Rolling the Supported Edge

1st pass all on hot mat with roller edge off joint approx 6-12 inches

2nd pass overlaps on cold mat 3-6 inches



Alternate Method of

1st Pass over the Supported Edge

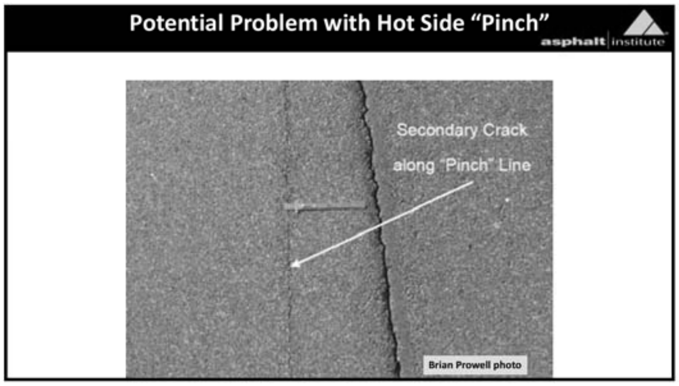
Roller in vibratory mode with edge of drum overhanging 2 to 4-inches on cold side.

Concern with this method is if insufficient HMA laid on hot side at joint, then bridging occurs with first pass (roller supported by cold mat)

Still Must Watch for Stress Cracks

During Site Visit to CO, Staying off 6" on 1st Pass

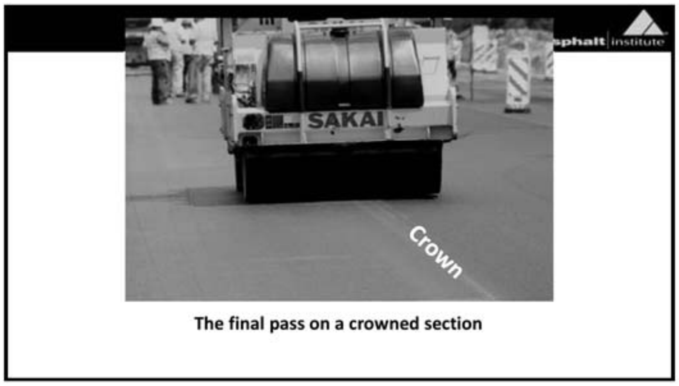
Stress cracks evident at edge of the drum
(while more likely from rolling unsupported edge, can also occur from rolling supported edge)



Potential Problem with Hot Side "Pinch"

Secondary Crack along "Pinch" Line

Brian Prowell photo



Crown

The final pass on a crowned section

GOAL
14 year old surface

I-65 in IN: SR252 to US31
- 12 inches HMA over Rubblized JCP
- Warranty Project

HMA Construction Program

Module 5 – Compaction

Learning Objectives

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

Learning Objectives

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

How to Manage Asphalt Density

FOR Construction PROS.com BY JESSICA LOMBARDO — JANUARY 29, 2019

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

Definitions

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

Definitions

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

---

Importance of Compaction

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

Importance Of Compaction

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

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

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

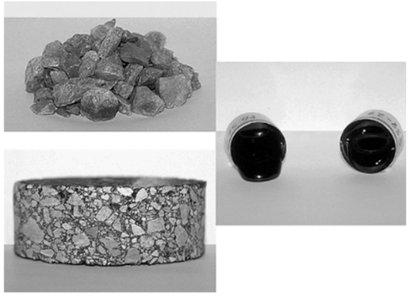
Topics

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

Factors Affecting Compaction

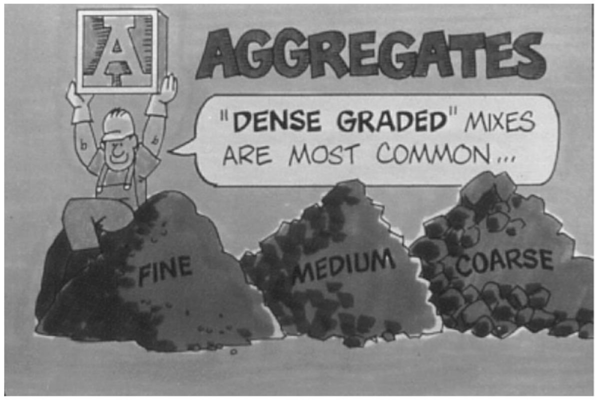
- Properties of the Materials
- Environmental Variables
- Laydown Site Conditions

Properties of the Materials

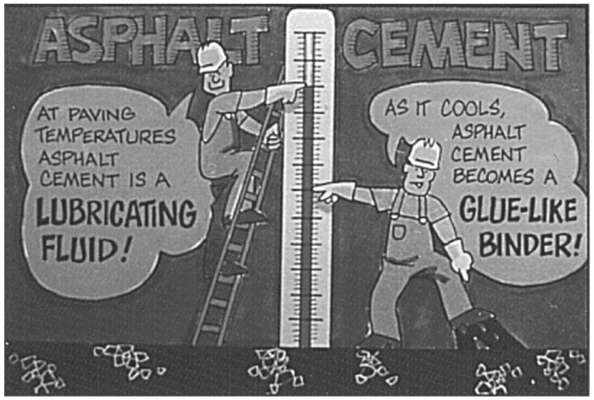


- Aggregate
- Asphalt Binder
- Mix Properties

Courtesy of Caterpillar Paving Products



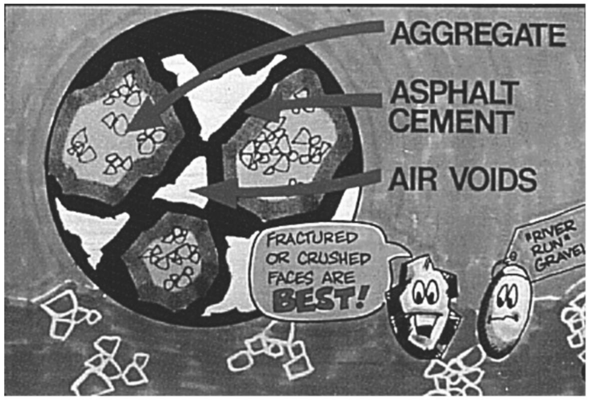
Aggregate Carries the Load



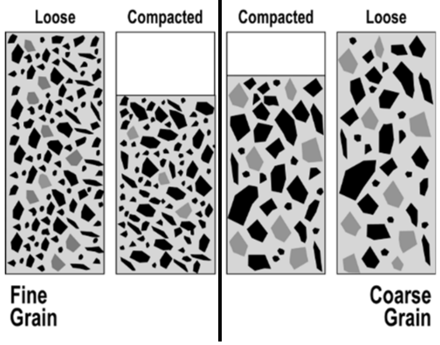
Binder and Compaction

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

HMA



Mix Properties



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

Courtesy of Caterpillar Paving Products

Mat after Compaction

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

Courtesy of Caterpillar Paving Products

Topics

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

Rate of Cooling Variables

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

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

DOH SPEC 401.10.4

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

PaveCool

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

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

Download PaveCool 3.0 (EXE 6 MB)

November 2015 (CD available upon request)

PaveCool for Android

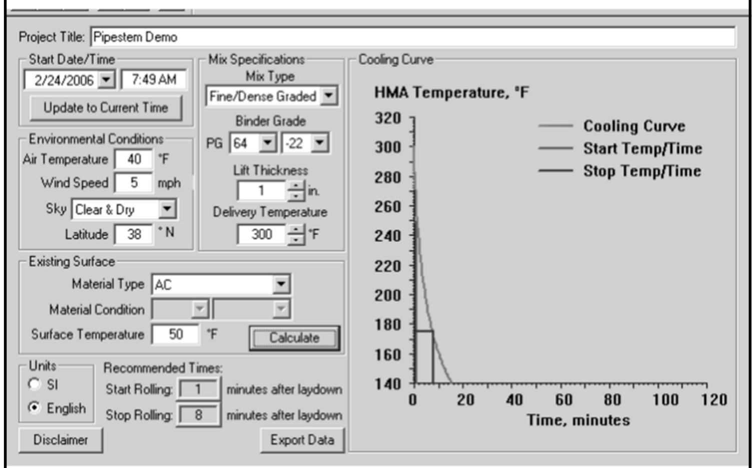
PaveCool for iPhone/iPad

System Requirements

Windows XP, Vista, 7, 8 or 10

20 MB disk space

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



Project Title: Pipestem Demo

Start Date/Time: 2/24/2006 7:49 AM

Mix Specifications

Mix Type: Fine/Dense Graded

Binder Grade: PG 64 -22

Lift Thickness: 1 in.

Delivery Temperature: 300 °F

Environmental Conditions

Air Temperature: 40 °F

Wind Speed: 5 mph

Sky: Clear & Dry

Latitude: 38 °N

Existing Surface

Material Type: AC

Material Condition:

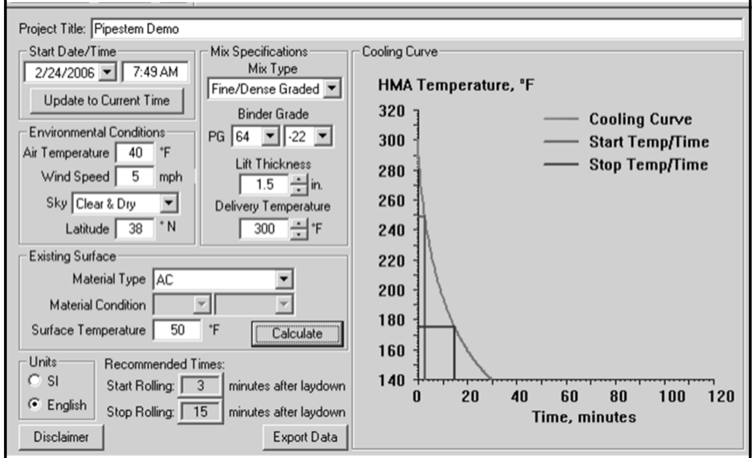
Surface Temperature: 50 °F

Units: ○ SI ● English

Recommended Times:

Start Rolling: 1 minutes after laydown

Stop Rolling: 8 minutes after laydown


Project Title: Pipestem Demo

Start Date/Time: 2/24/2006 7:49 AM

Environmental Conditions
Air Temperature: 40 °F
Wind Speed: 5 mph
Sky: Clear & Dry
Latitude: 38 ° N

Mix Specifications
Mix Type: Fine/Dense Graded
Binder Grade: PG 64 -22
Lift Thickness: 1.5 in.
Delivery Temperature: 300 °F

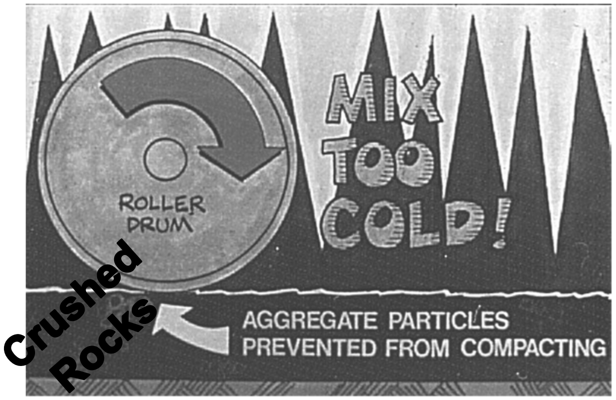
Existing Surface
Material Type: AC
Material Condition:
Surface Temperature: 50 °F

Units
○ SI
● English

Recommended Times:
Start Rolling: 3 minutes after laydown
Stop Rolling: 15 minutes after laydown

Major Factors Affecting Rolling Time

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



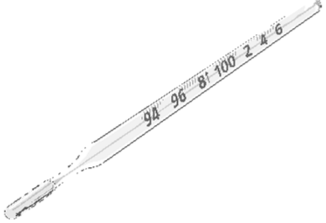
Crushed Rocks

- **Take Regular Mat Temperature Readings**

- ***Temperature control is critical***

Typical Compaction Temperature Range

80 °C	**-**	**150 °C**
(175 °F)		**(~300 °F)**



Laydown Site Conditions

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

Laydown Site Conditions

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

Topics

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

Types of Rollers

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

Courtesy of Caterpillar Paving Products

Oscillating Roller I 79 Flatwoods

How Do Rollers Compact?

By applying their load
over a given area!

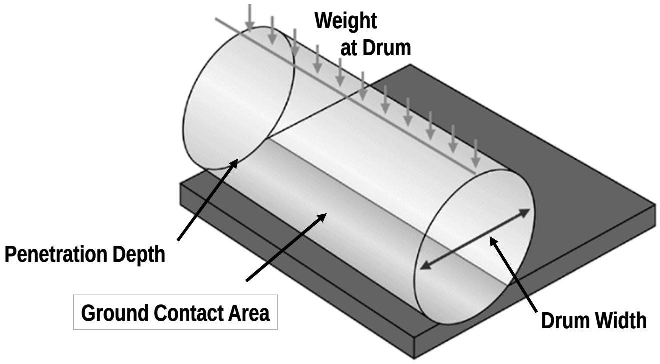
(Contact Pressure)

Static Steel Wheel Roller

- Contact Pressure
- Operation

Static Steel Wheel Roller

Contact Pressure



CAT

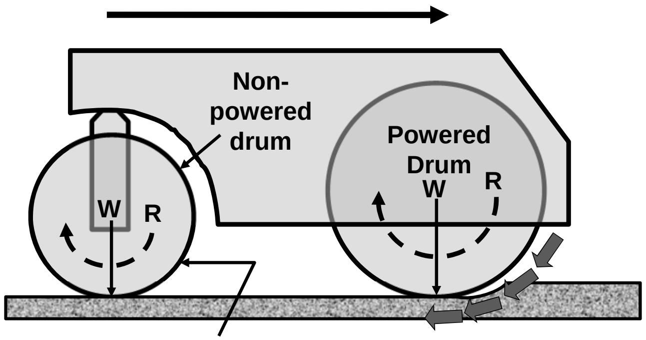
Courtesy of Caterpillar Paving Products

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**

Travel



Non-powered drum

Powered Drum

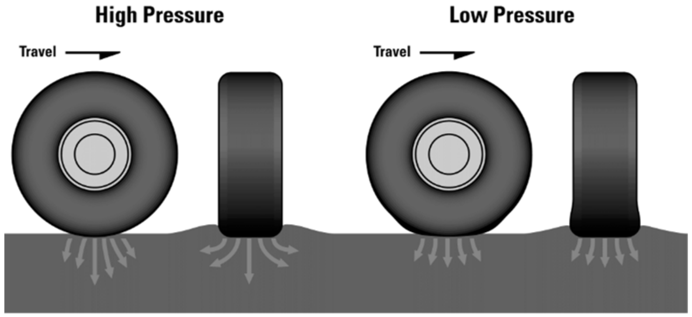
Frictional force turns trailing drum

Pneumatic Tired Rollers

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

Pneumatic

Tire Inflation Pressure Versus Ground Contact Pressure

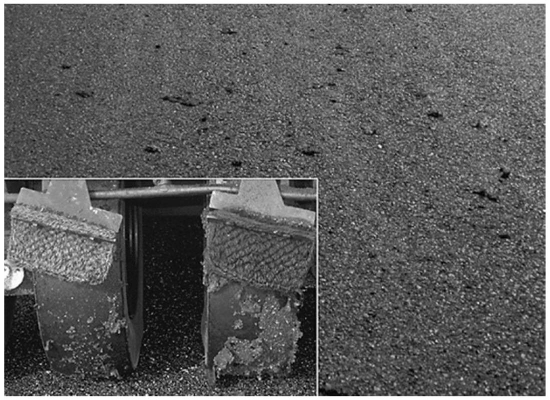


Courtesy of Caterpillar Paving Products

Pneumatic Roller I79 Flatwoods

Insufficient heat in the tires!!!

Tire Pick Up



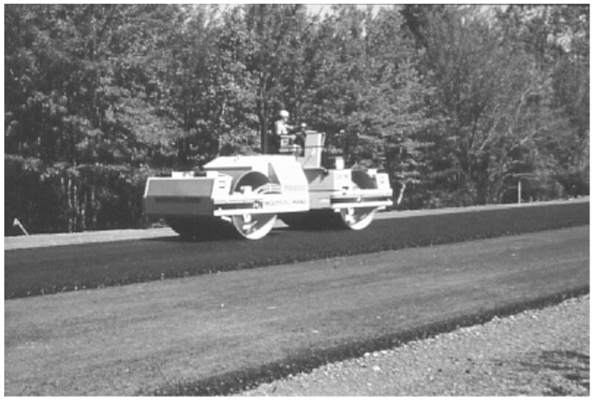
Skirted Pneumatic Roller

Pneumatic Roller Operation

“ideal for uneven courses”

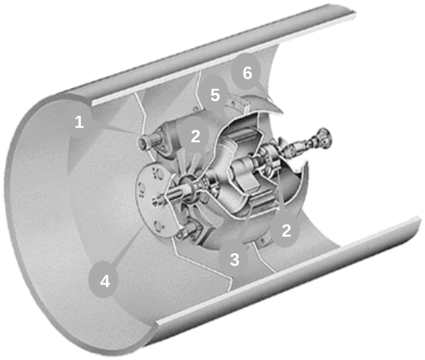
Vibratory Roller

Single Articulated Frame



Double Articulated Frame

Eccentric Weight System

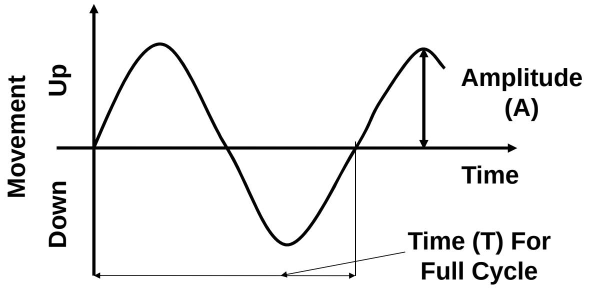


1. Oil level sight gauge
2. Eccentric weight shaft bearings
3. Three-position counterweight
4. Amplitude selection wheel
5. Fixed eccentric weight
6. Pod-style housing

Courtesy of Caterpillar Paving Products

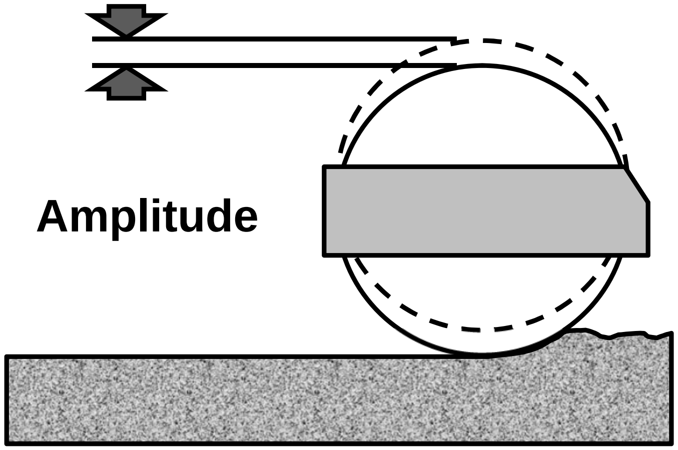
Vibratory Rollers

- Amplitude
- Frequency
- Impact Spacing
- Operation

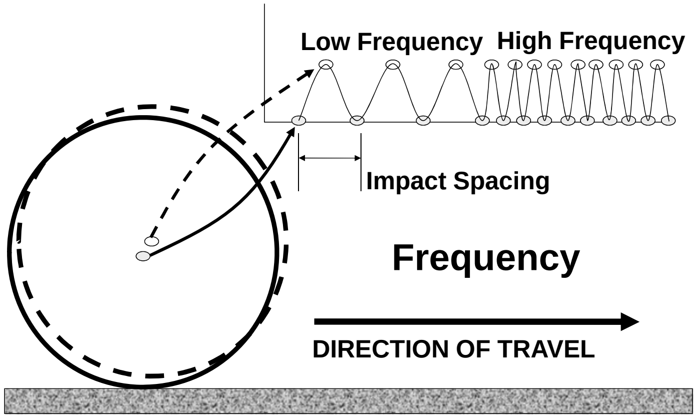


Frequency, f = the number of hertz (cycles/s)--a single cycle is one full rotation of the eccentric weight. Frequency = 1/T

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



Amplitude



Frequency

Typical Data for Vibratory Tandem Rollers

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

Increase due to vibration

Impact Spacing

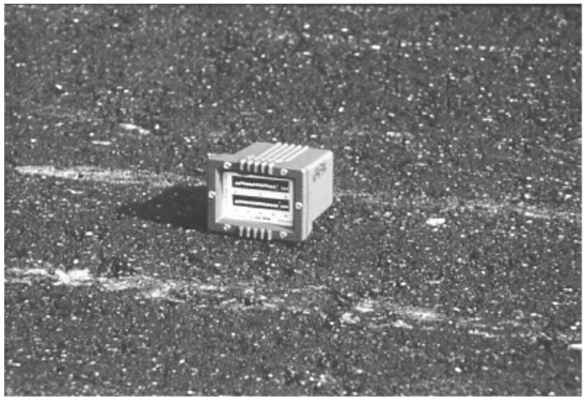
- Ideal is 10-12 impacts per foot

Example

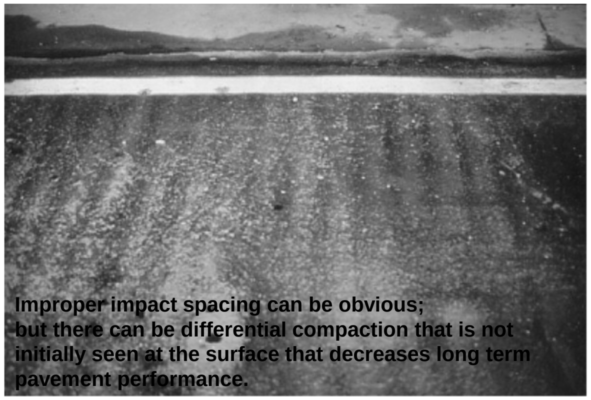
- 2900 Vibrations (impacts) per minute
- 11 impacts/ft
- Determine speed of roller

[redacted]

Reed Tachometer



Improper Impact Spacing


**Improper impact spacing can be obvious;
but there can be differential compaction that is not initially seen at the surface that decreases long term pavement performance.**

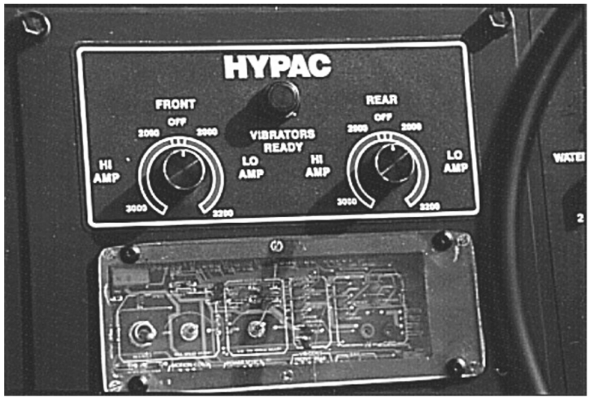
Topics

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

Roller Operator Controls

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

Roller Controls



Compaction Variables

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

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
- Should be completed before the surface temperature of the mix falls below 240^{o} F.
- Operated at the highest possible frequency
- Amplitude setting that is dependent on the thickness of the asphalt concrete

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

Intermediate Rolling

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

Vibratory or pneumatic rollers

Finish Rolling

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

CAT

Courtesy of Caterpillar Paving Products

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

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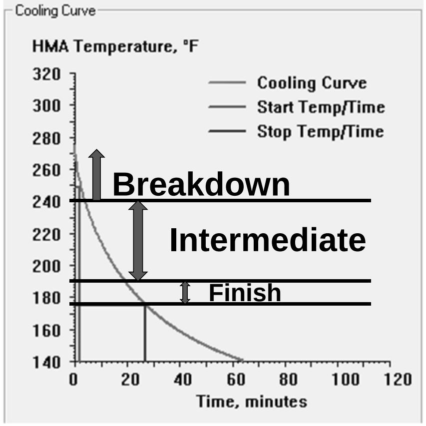
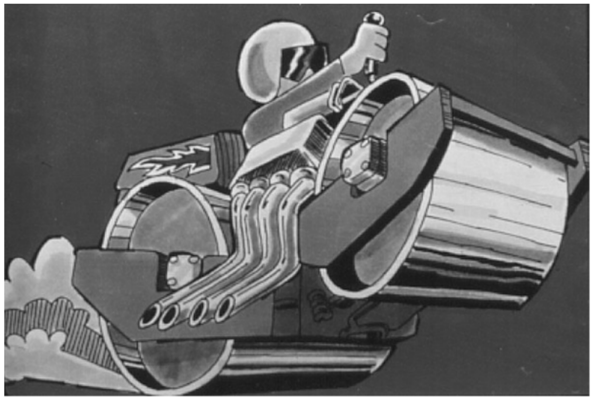
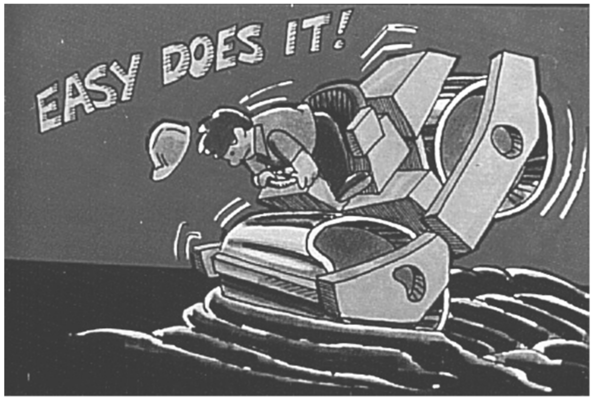
Approximate temperatures for stages of rolling



Speed



Stopping

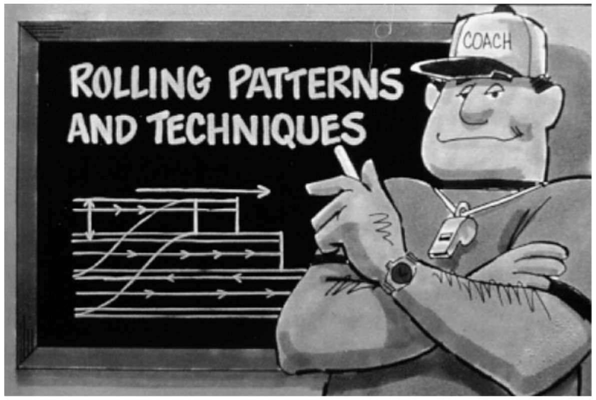


Typical Range of Roller Speeds (mi/hour)

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

Topics

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



Roller Widths

Courtesy of Caterpillar Paving Products

Paving Widths

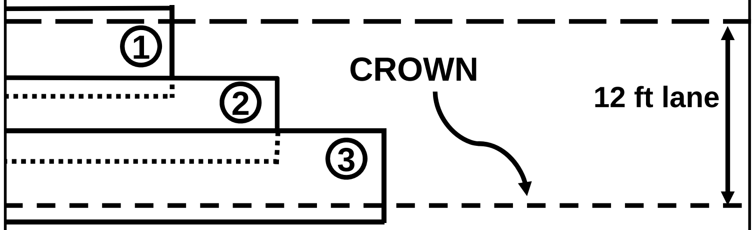
Passes and Coverage

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 ?

One Roller Coverage



3 passes,
1 coverage

Operating Techniques

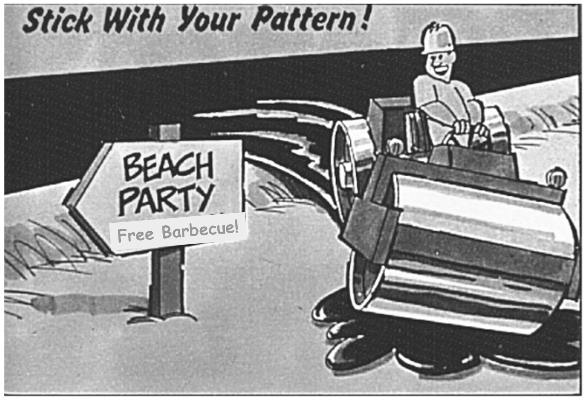
- Test Strip Construction
- Establishing Roller Patterns
- Breakdown Rolling
- Intermediate Rolling
- Finish Rolling
- Re-watering
- Concluding Operations

Test Strip Construction

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

Establishing Roller Pattern

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



Roller Types by Application

Breakdown Rolling

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

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

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

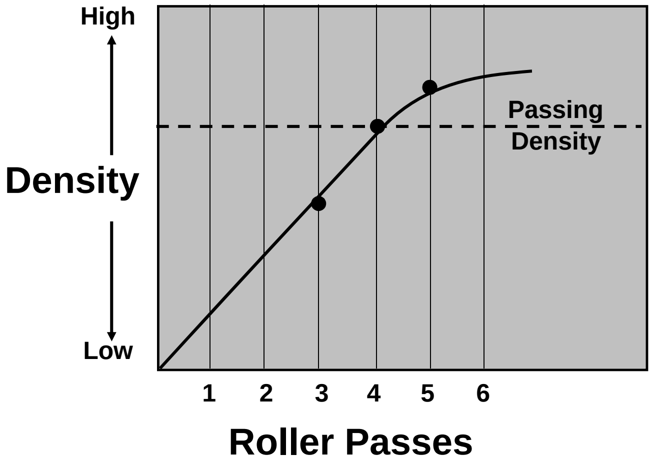
Roller Types by Application

Finish Rolling

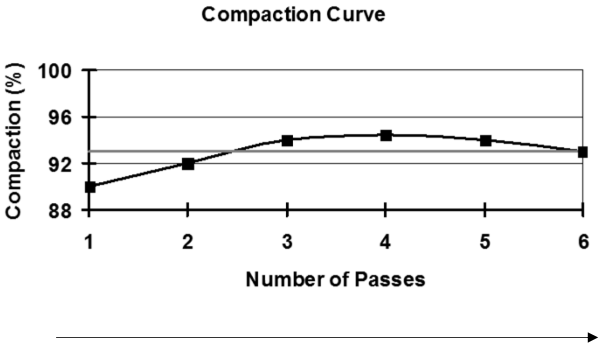
Static (tons)	Vibratory (tons)
	Static Mode
8 to 10.5	6 to 8
8 to 12	10 to 11
10 to 14	> 12.5

How Many Repeat Passes to Assure Density?

Checking Density

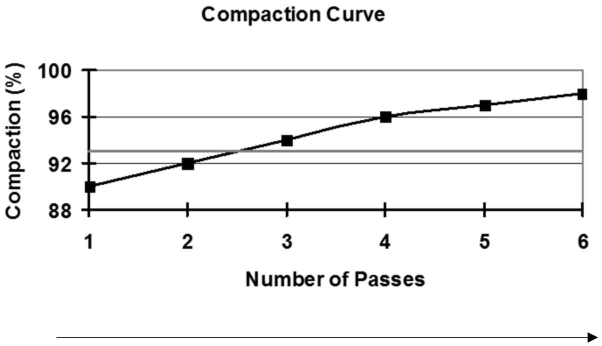


Roller Pattern Problem #1



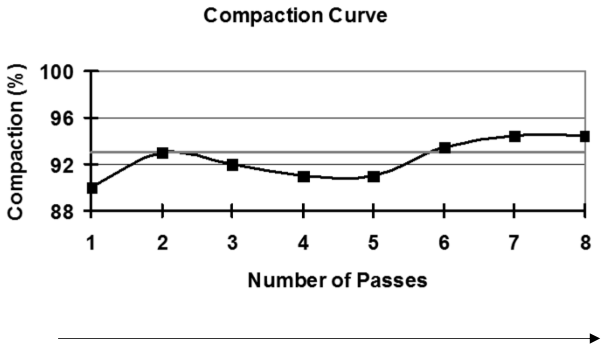
Decreasing Temperature

Roller Pattern Problem #2



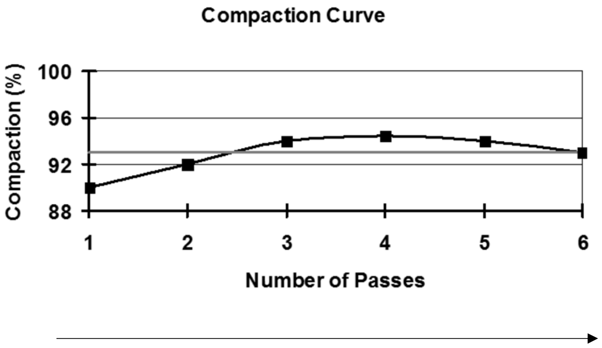
Decreasing Temperature

Roller Pattern Problem #3



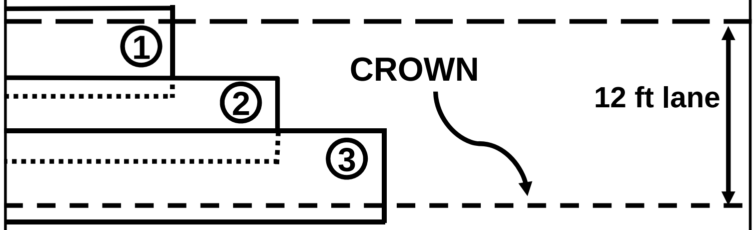
Decreasing Temperature

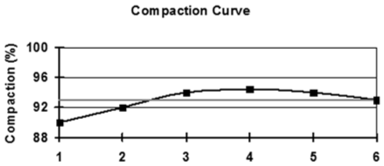
Roller Pattern Problem #1



Decreasing Temperature

One Roller Coverage





3 passes for 1 coverage

4 passes to achieve density

12 trips total

Temperature Gauges

Interior Temperature

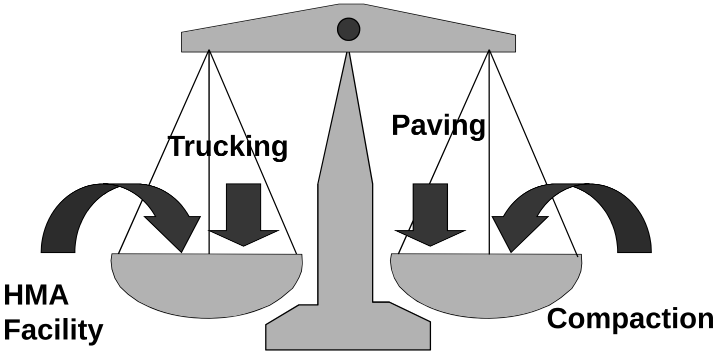
Improper Gauge Usage

Coring

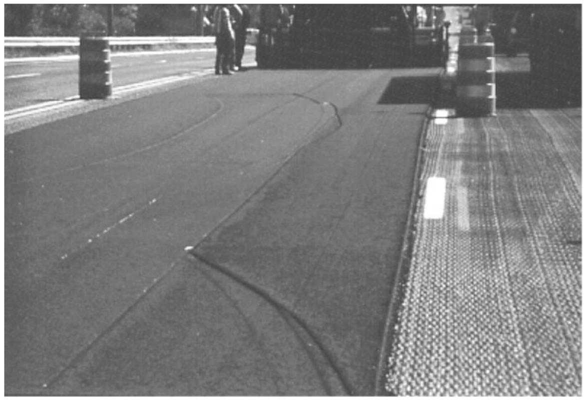
Topics

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

Balancing Production



Rolling Zone



Calculating Your Rolling Zone (Vibratory roller)

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

Calculating Your Rolling Zone

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

Calculating Your Rolling Zone

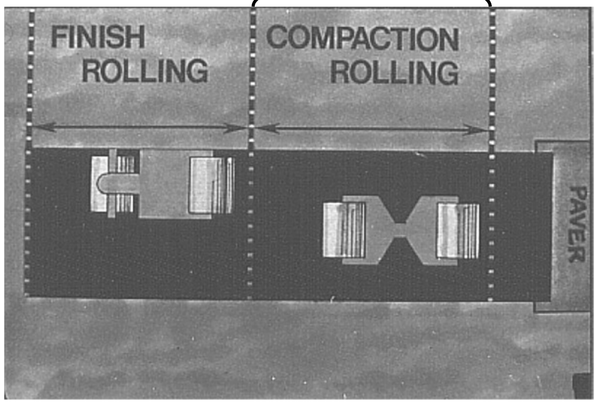
- Roller rate = 14.2 fpm
- Time available for compaction (TAC)
  - From Environmental Variables chart
  - Or PaveCool
  - Example: 10 minutes
    - **2 in thick mat**
    - **mix temperature of 250 ^oF**
    - **base temperature of 50 ^oF.**
- Rolling zone
- Roller rate x TAC = 14.2 fpm X 10 minutes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

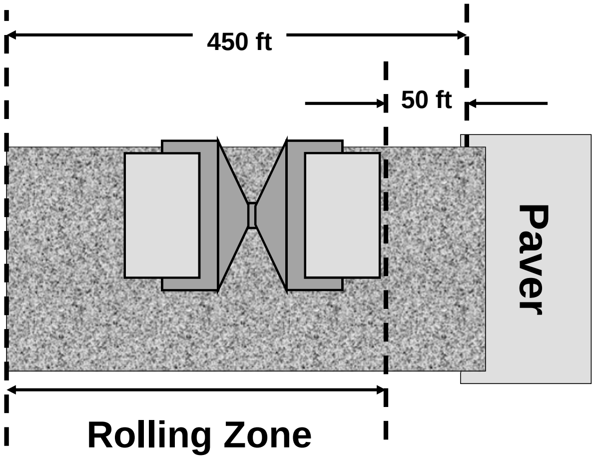
Balancing the paving example

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

Rolling Zones

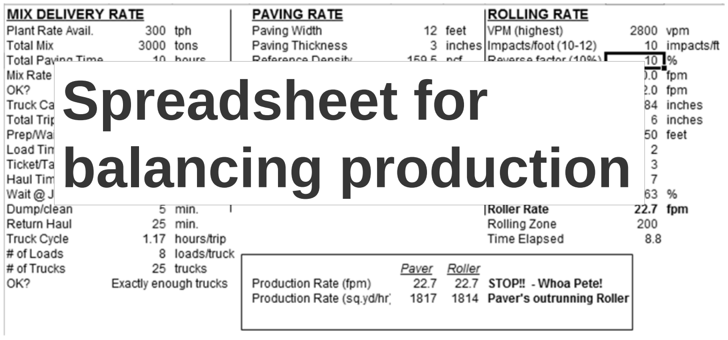
Breakdown + Intermediate





(Conventional HMA)

Roller Production Rate Problem



Spreadsheet for balancing production

MIX DELIVERY RATE		
Plant Rate Avail.	300	tph
Total Mix	3000	tons
Total Paving Time	10	hours
Mix Rate		
OK?		
Truck Ca		
Total Trip		
Prep/Wai		
Load Tim		
Ticket/Ta		
Haul Tim		
Wait @ J		
Dump/clean	5	min.
Return Haul	25	min.
Truck Cycle	1.17	hours/trip
# of Loads	8	loads/truck
# of Trucks	25	trucks
OK?	Exactly enough trucks	

PAVING RATE		
Paving Width	12	feet
Paving Thickness	3	inches
Reference Density	159.5	pcf

ROLLING RATE		
VPM (highest)	2800	vpm
Impacts/foot (10-12)	10	impacts/ft
Reverse factor (10%)	10	%
	0.0	fpm
	2.0	fpm
	84	inches
	6	inches
	50	feet
	2	
	3	
	7	
	63	%
Roller Rate	**22.7**	**fpm**
Rolling Zone	200	
Time Elapsed	8.8	

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

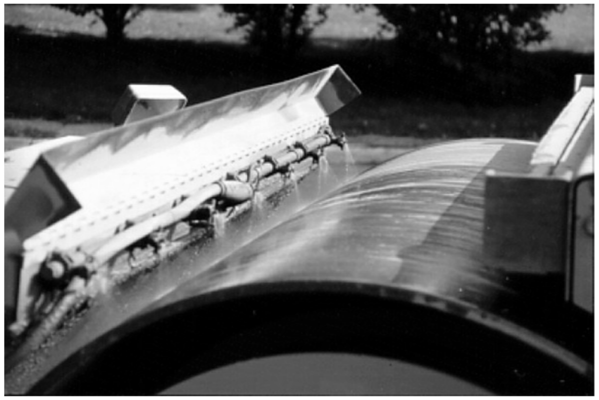
Topics

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

Roller Maintenance

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

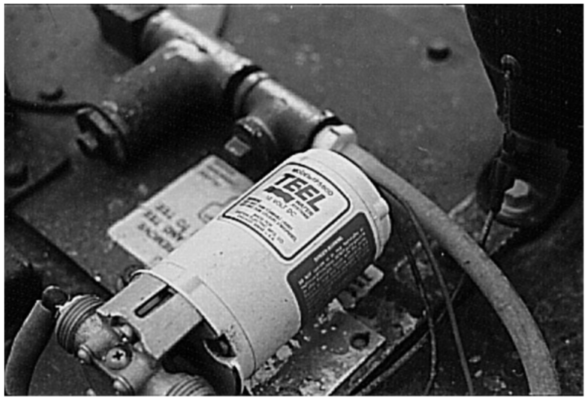
Water Spray Bar



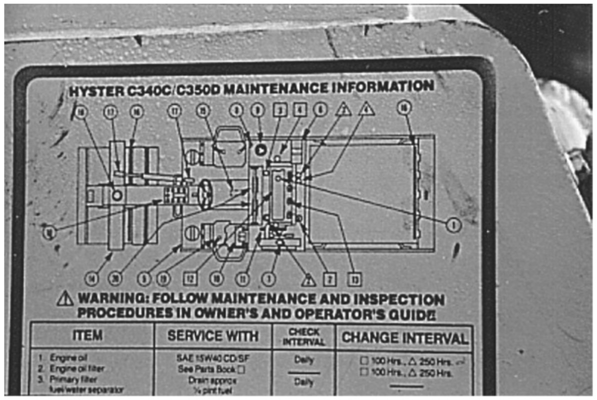
Pads

Poor Maintenance

Water Pump



Maintenance Chart

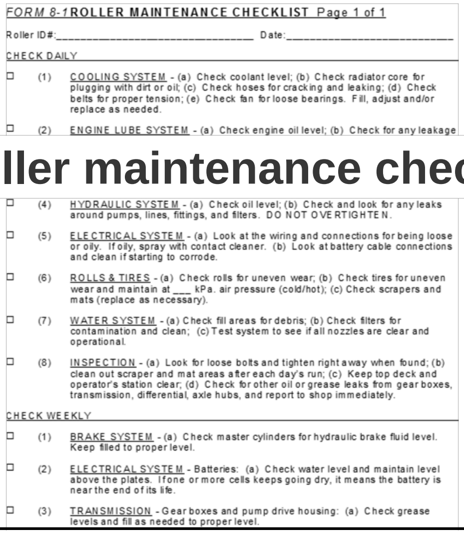


HYSTER C340C/C350D MAINTENANCE INFORMATION

⚠ WARNING: FOLLOW MAINTENANCE AND INSPECTION PROCEDURES IN OWNER'S AND OPERATOR'S GUIDE!

ITEM	SERVICE WITH	CHECK INTERVAL	CHANGE INTERVAL
1. Engine oil	SAE 15W40 CD/SF	Daily	☐ 100 Hrs., △ 250 Hrs.
2. Engine oil filter	See Parts Book ☐	—	☐ 100 Hrs., △ 250 Hrs.
3. Primary filter fuel/water separator	Drain approx ¼ pint fuel	Daily	—

Roller maintenance checklist



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.

Summary notes

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

---

Summary notes cont'd

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

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Summary notes cont'd

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

Summary notes cont'd

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

Summary notes cont'd

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

Finally

> “The single most important thing you can do to a pavement is compact it.”

Opening to Traffic

INSPECTOR'S DUTIES - ASPHALT PAVING

Modified by WVDOT/DOH,
APAWV, and WVU ATP

Work Includes…

- **Resurfacing Projects**
  - State Funded
  - Federal Funded
  - Purchase Order Paving
- **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, route, compaction method

Basic HMA Applications

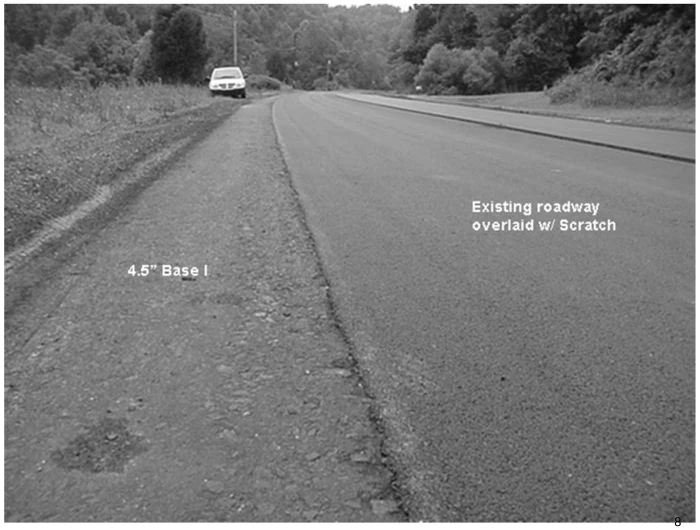
- **Base Course** – stone or HMA course placed above the subgrade or subbase of a road and helps to further distribute the load and improve the overall structure of the pavement section.
  - Marshall Base 1 and 2
  - Superpave Base 37.5, 25 and 19
- **Wearing Course** – a single lift of constant thickness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

Basic HMA Applications

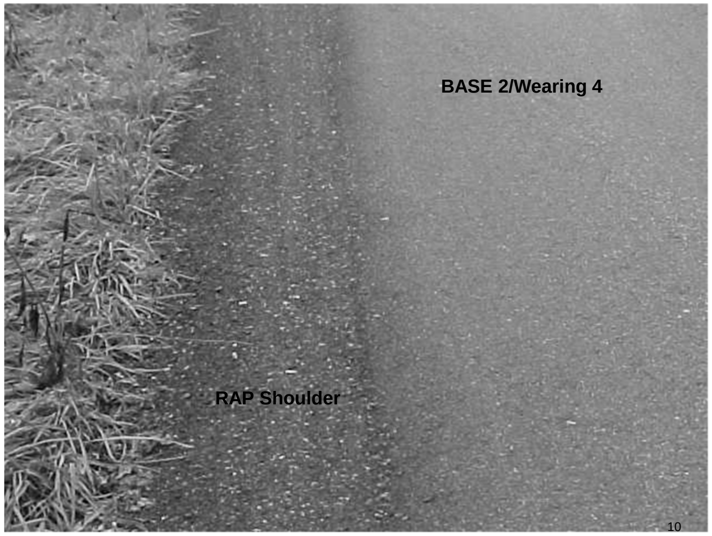
- **Patch & Level (P&L)** – placed at various locations throughout the project to remove irregularities in the existing pavement, such as dips, or to raise the outside edge of pavement to improve the template prior to placing a base or wearing course.
- **Scratch Course** – a leveling course used for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

1.5" Overlay with paved shoulders

1" thin overlay




Existing roadway
overlaid w/ Scratch
4.5" Base I


BASE 2/Wearing 4
RAP Shoulder

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
- Maintenance Finished?
  - – Have all pipes been placed, ditches pulled, mowed, etc
- Verify Quantities In plans with Actual Field Measurements.

Verifying Quantities

- Given road is 1 mile long and has an average width of 28’.
- Convert miles to lineal Ft (1 mile x 5280 ft/mi)
- End Station would be 52+80
- 5280 lf x 28 ft width = 147,840 sq ft.
- 147,840 sq ft / 9= 16,426.67 SY

Approximate Rate and Lift Thickness

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

Verifying Quantities

- 16,426.67 SY x 165 lb/sy / 2000 lb/tn= 1355.20 tn
- How much in each lanes?
- 2 even wearing lanes
- 1355.20 / 2= 677.6 tn each lane.

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
    - Max Density
    - Lab Number
  - All mix designs are "Verified" at the beginning of each season

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
- Properly staffed paving crew
  - Paving operator
  - Screed person
  - Broom
  - Compaction
  - Laborers

Contractor's Requirements

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

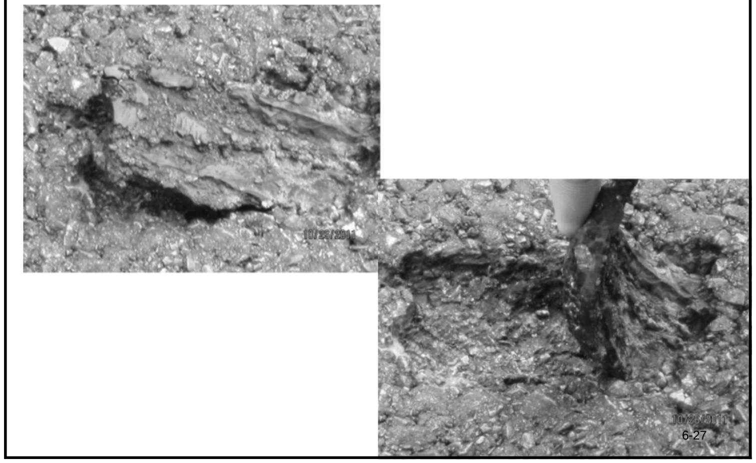
Inspector’s Daily Duties…

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

Inspector Daily Duties…

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

Inspector Daily Duties…

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

Inspector Daily Duties

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

Inspectors Office Duties

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

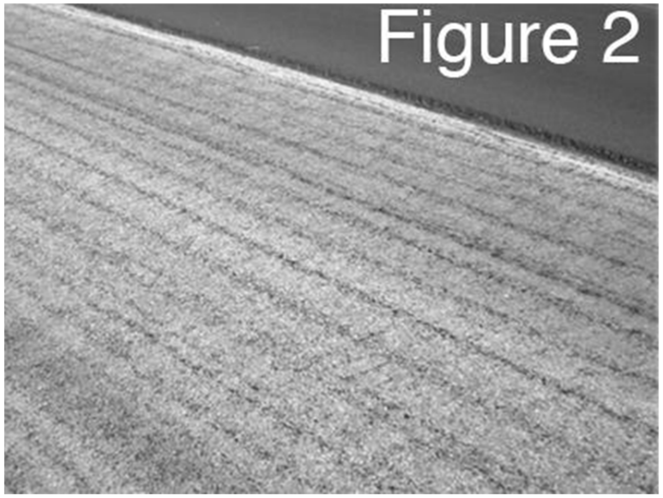
After Project Completion

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

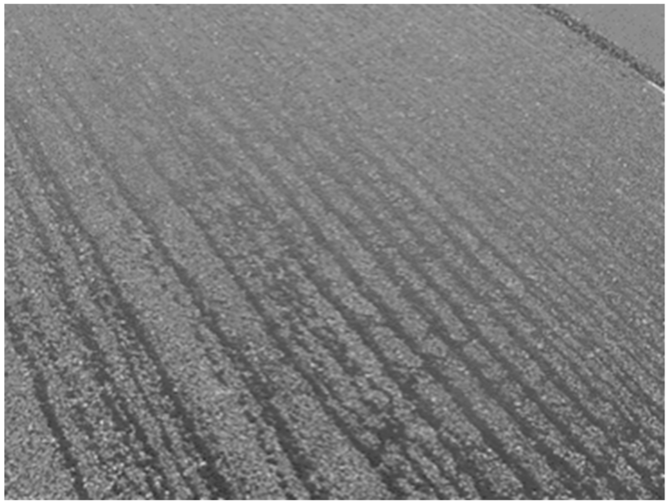
What is the Proper Rate for Tack?

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

Good Tack Application



Poor tack application



Is this a good coat?

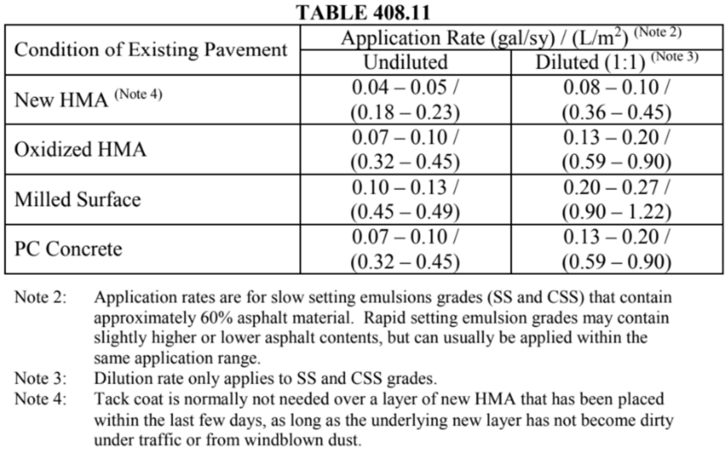


TABLE 408.11

Condition of Existing Pavement	Application Rate (gal/sy) / (L/m^2) (Note 2)	
	Undiluted	Diluted (1:1) (Note 3)
New HMA (Note 4)	0.04 – 0.05 / (0.18 – 0.23)	0.08 – 0.10 / (0.36 – 0.45)
Oxidized HMA	0.07 – 0.10 / (0.32 – 0.45)	0.13 – 0.20 / (0.59 – 0.90)
Milled Surface	0.10 – 0.13 / (0.45 – 0.49)	0.20 – 0.27 / (0.90 – 1.22)
PC Concrete	0.07 – 0.10 / (0.32 – 0.45)	0.13 – 0.20 / (0.59 – 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

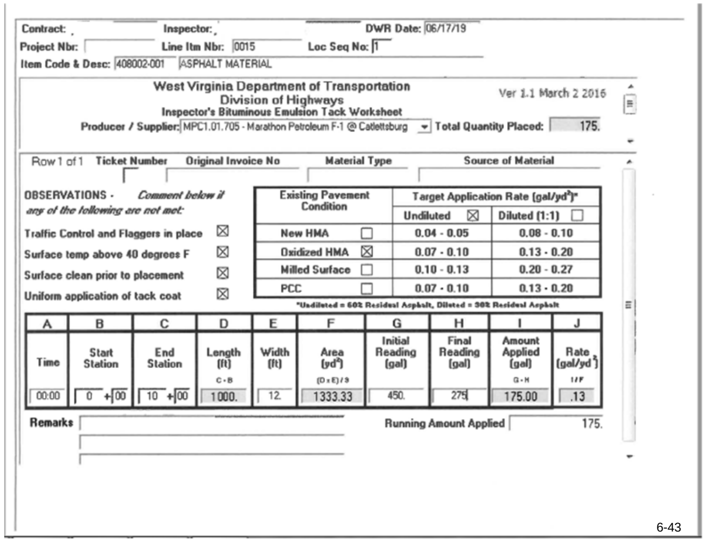
- Existing roadway is very old, dried, cracked, etc. – “Oxidized” from Table 408.11
- Prior to tack placement, dial gauge reads 450 gallons. Tack is not diluted.
- Tack is placed from Sta. 0+00 to Sta. 10+00. Dial gauge reads 275 gallons after tack placement.
- Road width is an average of 12’.

Example Tack Calculation

- 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

- 0.13 gal x 0.60 = ***0.078 (.08) gal/yd²***



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

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

Item Code & Desc: 408002-001 ASPHALT MATERIAL

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

Ver 1.1 March 2 2016

Producer / Supplier: MPC1.01.705 - Marathon Petroleum F-1 @ Catlettsburg

Total Quantity Placed: 175.

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

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

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

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

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

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

Remarks

Running Amount Applied 175.

RPT-ID: RDWRHCON
USER:

West Virginia
Department of Transportation

DATE: 06/06/2019
PAGE: 1 of 5

DAILY WORK REPORT FOR CONTRACT:

DWR Date: 08/11/2018	Contract ID:	Authorized: Yes	Locked: No	Paid: Yes
Inspector ID:	Inspector:			
High Temp: 79	Low Temp: 62	A.M. Condition: CLOUDY	P.M. Condition: PARTLY CLOUDY	
Work Suspended Time: 00:00	Work Resumed Time:00:00	No Work Items Instld: ☐	No Contrs Present: ☐	No Staff Present: ☒

Remarks: Yes

aGENERAL

Contractor Hours
- 6:30 am to 1:30 pm= 7 hrs nlb
6:30 am to 1:30 pm= 7 hrs NLB

WV DOH Hours
6:00 am to 2:00 pm= 7.5 hrs (.25 hr travel, 7.25 hr worked)
- 6:00 am to 2:00 pm= 7.5 hrs (.25 hr travel, 7.25 hr worked)
- 6:00 am to 2:00 pm= 7.5 hrs (.25 hr travel, 7.25 hr worked)

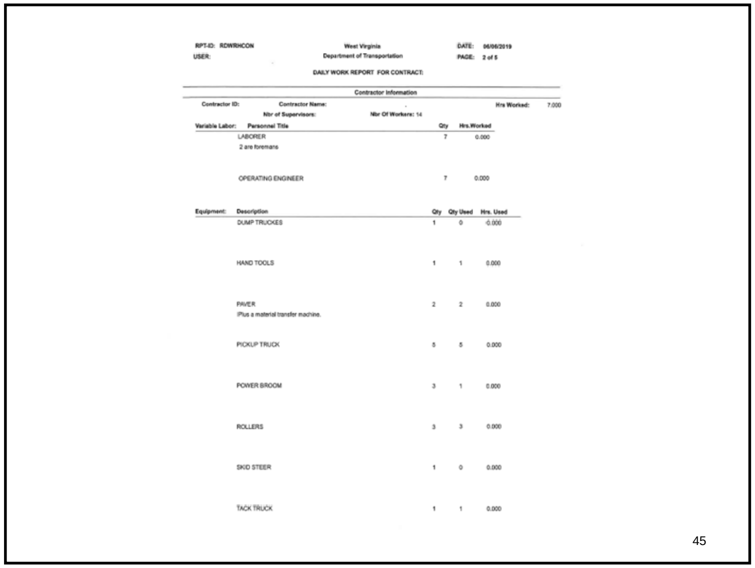
ATTACHMENT 2018 08 11 DWR 0015 Asphalt Tickets

2018 08 11 DWR 0010 Tack Ticket

CONTROLLING ITEM 0015 410007-010 Marshall Skid HMA

This is a non-chargeable day due to it being a weekend but project is in liquidated damages.

MATERIALS 0015 410007-010 Marshall Skid Mix
Lab # C8181836



RPT-ID: RDWRHCON
USER:

West Virginia
Department of Transportation

DATE: 06/06/2019
PAGE: 2 of 5

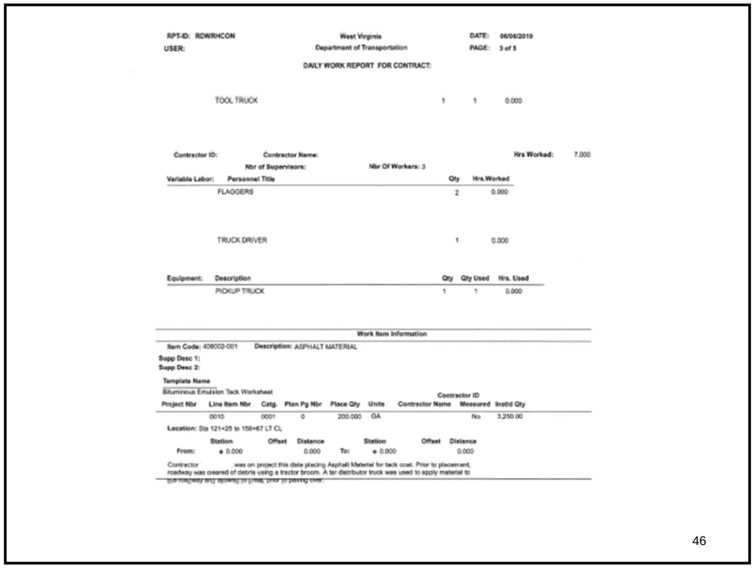
DAILY WORK REPORT FOR CONTRACT:

Contractor Information

Contractor ID: Contractor Name: Hrs Worked: 7.000
Nbr of Supervisors: Nbr Of Workers: 14

Variable Labor:	Personnel Title	Qty	Hrs.Worked
	LABORER 2 are foremans	7	0.000
	OPERATING ENGINEER	7	0.000

Equipment:	Description	Qty	Qty Used	Hrs. Used
	DUMP TRUCKES	1	0	0.000
	HAND TOOLS	1	1	0.000
	PAVER Plus a material transfer machine.	2	2	0.000
	PICKUP TRUCK	5	5	0.000
	POWER BROOM	3	1	0.000
	ROLLERS	3	3	0.000
	SKID STEER	1	0	0.000
	TACK TRUCK	1	1	0.000



RPT-ID: RDWRHCON
USER:

West Virginia
Department of Transportation

DATE: 06/06/2019
PAGE: 3 of 5

DAILY WORK REPORT FOR CONTRACT:

	TOOL TRUCK	1	1	0.000

Contractor ID: Contractor Name: Hrs Worked: 7.000
Nbr of Supervisors: Nbr Of Workers: 3

Variable Labor:	Personnel Title	Qty	Hrs.Worked
	FLAGGERS	2	0.000
	TRUCK DRIVER	1	0.000

Equipment:	Description	Qty	Qty Used	Hrs. Used
	PICKUP TRUCK	1	1	0.000

Work Item Information

Item Code: 408002-001 Description: ASPHALT MATERIAL
Supp Desc 1:
Supp Desc 2:

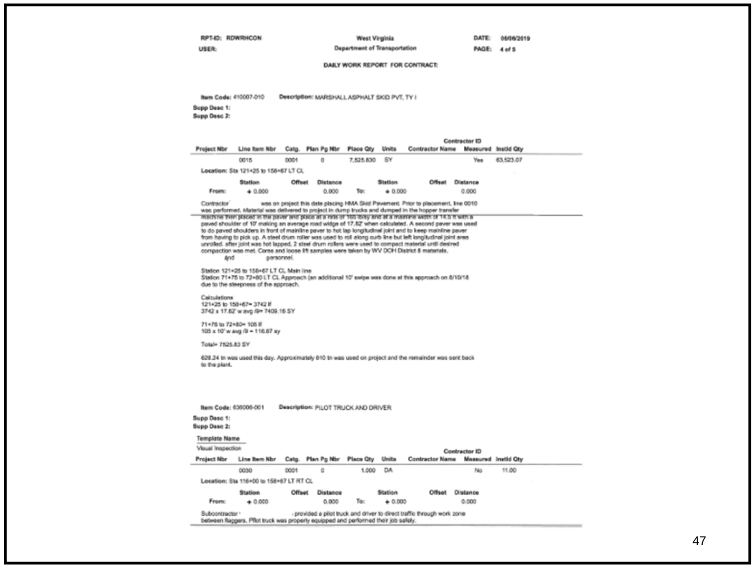
Template Name
Bituminous Emulsion Tack Worksheet

Project Nbr	Line Item Nbr	Catg.	Plan Pg Nbr	Place Qty	Units	Contractor ID Contractor Name	Measured	Instld Qty
	0010	0001	0	200.000	GA		No	3,250.00

Location: Sta 121+25 to 158+67 LT CL

	Station	Offset	Distance		Station	Offset	Distance
From:	+ 0.000		0.000	To:	+ 0.000		0.000

Contractor . was on project this date placing Asphalt Material for tack coat. Prior to placement, roadway was cleared of debris using a tractor broom. A tar distributor truck was used to apply material to the roadway and allowed to break, prior to paving over.



RPT-ID: RDWRHCON
USER:

West Virginia
Department of Transportation

DATE: 06/06/2019
PAGE: 4 of 5

DAILY WORK REPORT FOR CONTRACT:

Item Code: 410007-010 Description: MARSHALL ASPHALT SKID PVT, TY I
Supp Desc 1:
Supp Desc 2:

Project Nbr	Line Item Nbr	Catg.	Plan Pg Nbr	Place Qty	Units	Contractor ID Contractor Name	Measured	Instld Qty
	0015	0001	0	7,525.830	SY		Yes	63,523.07

Location: Sta 121+25 to 158+67 LT CL

	Station	Offset	Distance		Station	Offset	Distance
From:	+ 0.000		0.000	To:	+ 0.000		0.000

Contractor was on project this date placing HMA Skid Pavement. Prior to placement, line 0010 was performed. Material was delivered to project in dump trucks and dumped in the hopper transfer machine then placed in the paver and place at a rate of 165 lb/sy and at a mainline width of 14.5 ft with a paved shoulder of 10' making an average road widge of 17.82' when calculated. A second paver was used to do paved shoulders in front of mainline paver to hot lap longitudinal joint and to keep mainline paver from having to pick up. A steel drum roller was used to roll along curb line but left longitudinal joint area unrolled. after joint was hot lapped, 2 steel drum rollers were used to compact material until desired compaction was met. Cores and loose lift samples were taken by WV DOH District 8 materials, and personnel.

Station 121+25 to 158+67 LT CL Main line
Station 71+75 to 72+80 LT CL Approach (an additional 10' swipe was done at this approach on 8/10/18 due to the steepness of the approach.

Calculations
121+25 to 158+67= 3742 lf
3742 x 17.82' w avg /9= 7409.16 SY

71+75 to 72+80= 105 lf
105 x 10' w avg /9 = 116.67 sy

Total= 7525.83 SY

628.24 tn was used this day. Approximately 610 tn was used on project and the remainder was sent back to the plant.

Item Code: 636006-001 Description: PILOT TRUCK AND DRIVER
Supp Desc 1:
Supp Desc 2:

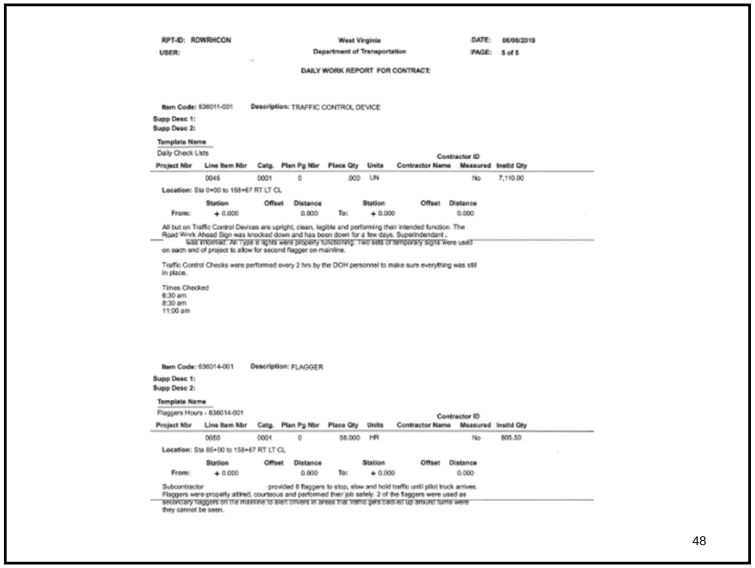
Template Name
Visual Inspection

Project Nbr	Line Item Nbr	Catg.	Plan Pg Nbr	Place Qty	Units	Contractor ID Contractor Name	Measured	Instld Qty
	0030	0001	0	1.000	DA		No	11.00

Location: Sta 116+00 to 158+67 LT RT CL

	Station	Offset	Distance		Station	Offset	Distance
From:	+ 0.000		0.000	To:	+ 0.000		0.000

Subcontractor . provided a pilot truck and driver to direct traffic through work zone between flaggers. Pilot truck was properly equipped and performed their job safely.



RPT-ID: RDWRHCON
USER:

West Virginia
Department of Transportation

DATE: 06/06/2019
PAGE: 5 of 5

DAILY WORK REPORT FOR CONTRACT:

Item Code: 636011-001 Description: TRAFFIC CONTROL DEVICE
Supp Desc 1:
Supp Desc 2:

Template Name
Daily Check Lists

Project Nbr	Line Item Nbr	Catg.	Plan Pg Nbr	Place Qty	Units	Contractor ID Contractor Name	Measured	Instld Qty
	0045	0001	0	.000	UN		No	7,110.00

Location: Sta 0+00 to 158+67 RT LT CL

	Station	Offset	Distance		Station	Offset	Distance
From:	+ 0.000		0.000	To:	+ 0.000		0.000

All but on Traffic Control Devices are upright, clean, legible and performing their intended function. The Road Work Ahead Sign was knocked down and has been down for a few days. Superindendant , was informed. All Type B lights were properly functioning. Two sets of temporary signs were used on each end of project to allow for second flagger on mainline.

Traffic Control Checks were performed every 2 hrs by the DOH personnel to make sure everything was still in place.

Times Checked
6:30 am
8:30 am
11:00 am

Item Code: 636014-001 Description: FLAGGER
Supp Desc 1:
Supp Desc 2:

Template Name
Flaggers Hours - 636014-001

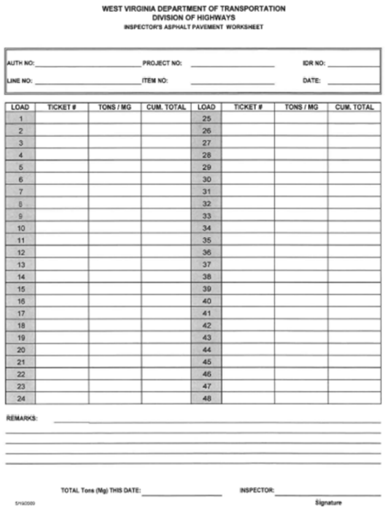
Project Nbr	Line Item Nbr	Catg.	Plan Pg Nbr	Place Qty	Units	Contractor ID Contractor Name	Measured	Instld Qty
	0050	0001	0	56.000	HR		No	805.50

Location: Sta 85+00 to 158+67 RT LT CL

	Station	Offset	Distance		Station	Offset	Distance
From:	+ 0.000		0.000	To:	+ 0.000		0.000

Subcontractor provided 8 flaggers to stop, slow and hold traffic until pilot truck arrives. Flaggers were properly attired, courteous and performed their job safely. 2 of the flaggers were used as secondary flaggers on the mainline to alert drivers in areas that traffic gets backed up around turns were they cannot be seen.

s



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

AUTH NO: ____________ PROJECT NO: ____________ IDR NO: ____________

LINE NO: ____________ ITEM NO: ____________ DATE: ____________

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

REMARKS: ____________

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

5/19/2009 Signature

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

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

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

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

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

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

TIME						
MAT TEMPERATURE						
MAT THICKNESS						
STATION						

TIME						
MAT TEMPERATURE						
MAT THICKNESS						
STATION						

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

TIME						
ROLLER SPEED						

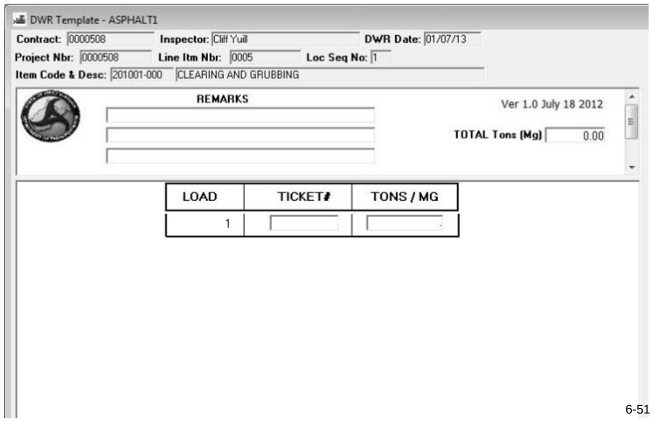
CHECKS ☐ VERIFIED PRIOR TO PLACEMENT CHECKS ☐ VERIFIED DURING PLACEMENT

☐ SEQUENCE OF OPERATION VERIFIED
☐ TRAFFIC CONTROL DEVICES AND FLAGGERS IN PLACE
☐ HEEL-IN JOINTS CUT AND POTHOLES CORRECTED
☐ SURFACE CLEAN AND STRINGLINE PLACED
☐ ROLLER(S) AND PAVER(S) VERIFIED FOR COMPLIANCE
☐ CONTRACTORS DENSITY TECHNICIAN ON SITE
☐ LONGITUDAL JOINTS PINCHED / NO OVERLAPPED

☐ TRUCKS COVERED AND INSULATED WITH NO OIL LEAKS OR DAMAGED SKIDS
☐ OPERATION CONTINUOUS AND PAVER SPEED COMPATIBLE TO PLANT PRODUCTION
☐ VIBRATING SCREED ON AND TEXTURE OF MAT CORRECT
☐ CORRECT ROLLING SEQUENCE BEING USED
☐ STRAIGHT EDGE CHECKS BEING MADE
☐ COMPLINACE WITH QUALITY CONTROL PLAN MAINTAINED
☐ TEMPERATURE OF MATERIAL RECORDED ON TICKETS ONCE PER HOUR MINIMUM

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

Site Manager-Asphalt Worksheet



DWR Template - ASPHALT1

Contract: 0000508 Inspector: Cliff Yuill DWR Date: 01/07/13
Project Nbr: 0000508 Line Itm Nbr: 0005 Loc Seq No: 1
Item Code & Desc: 201001-000 CLEARING AND GRUBBING

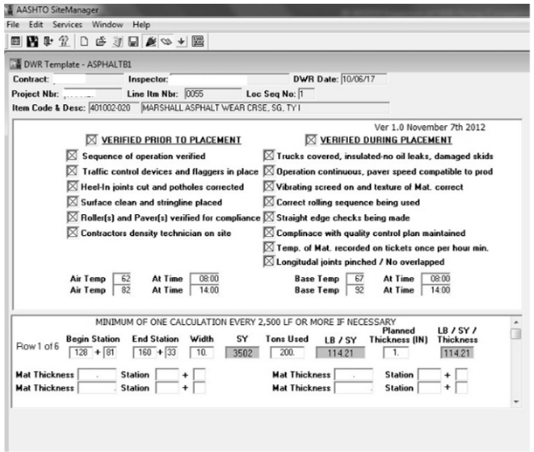
REMARKS

Ver 1.0 July 18 2012

TOTAL Tons (Mg) 0.00

LOAD	TICKET#	TONS / MG
1		

Site Manager Application Rate



DWR Template - ASPHALTB1

Contract: [redacted] Inspector: [redacted] DWR Date: 10/06/17
Project Nbr: [redacted] Line Itm Nbr: 0055 Loc Seq No: 1
Item Code & Desc: 401002-020 MARSHALL ASPHALT WEAR CRSE, SG, TY I

Ver 1.0 November 7th 2012

☒ VERIFIED PRIOR TO PLACEMENT
☒ Sequence of operation verified
☒ Traffic control devices and flaggers in place
☒ Heel-In joints cut and potholes corrected
☒ Surface clean and stringline placed
☒ Roller(s) and Paver(s) verified for compliance
☒ Contractors density technician on site

☒ VERIFIED DURING PLACEMENT
☒ Trucks covered, insulated-no oil leaks, damaged skids
☒ Operation continuous, paver speed compatible to prod
☒ Vibrating screed on and texture of Mat. correct
☒ Correct rolling sequence being used
☒ Straight edge checks being made
☒ Complinace with quality control plan maintained
☒ Temp. of Mat. recorded on tickets once per hour min.
☒ Longitudal joints pinched / No overlapped

Air Temp 62 At Time 08:00 Base Temp 67 At Time 08:00
Air Temp 82 At Time 14:00 Base Temp 92 At Time 14:00

MINIMUM OF ONE CALCULATION EVERY 2,500 LF OR MORE IF NECESSARY

	Begin Station	End Station	Width	SY	Tons Used	LB / SY	Planned Thickness (IN)	LB / SY / Thickness
Row 1 of 6	128 + 81	160 + 33	10.	3502	200.	114.21	1.	114.21

Mat Thickness ______ Station ______ + ______ Mat Thickness ______ Station ______ + ______
Mat Thickness ______ Station ______ + ______ Mat Thickness ______ Station ______ + ______

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

?

Any Questions???

HMA Construction Program

Module 7

Quality Control

Quality Assurance

Learning Objectives

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

What does QC/QA mean?

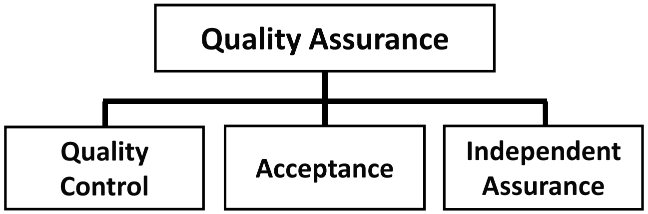
Quality Control

- QC refers to the ***Control*** component of the Production or Construction process
- Also referred to as ***Process Control***
- QC ***Ensures*** the production of uniform materials that meet specification
- QC is achieved through ***Periodic inspection and testing***
- QC is the responsibility of the ***producer or contractor!***

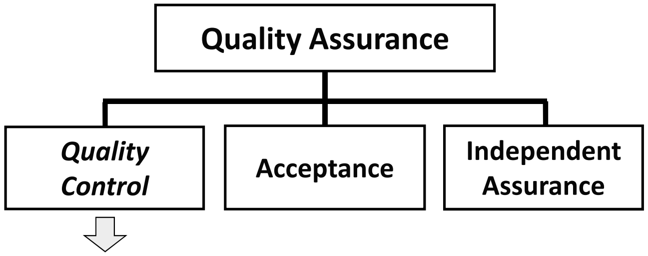
Quality Assurance

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

Elements of QA

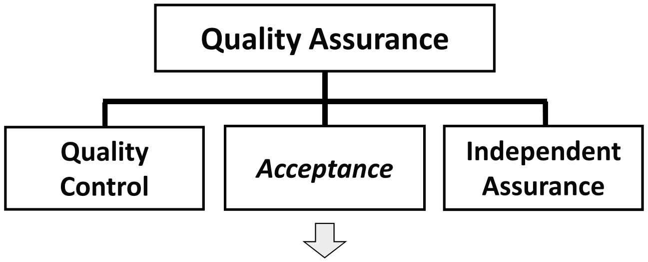


Elements of QA



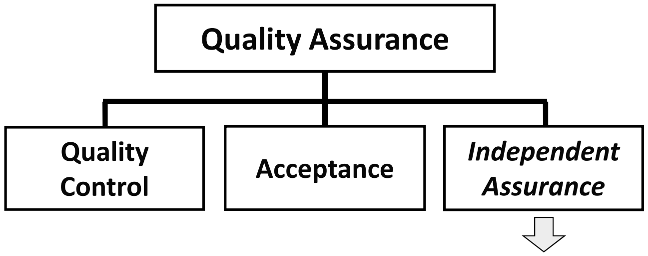
Producer / Contractor provides documentation that the material / end product met specification.

Elements of QA



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

Elements of QA



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

QA in Various Settings

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

Specifications

- **Types**
- **Relationship to performance**
- **Risk considerations**

Types of Specifications

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

Method Specifications

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

Method Specifications

- Problems:
  - Little or no testing

  - Question of quality

  - Uncertainty of performance

End-Result Specifications

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

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

End-Result Specifications

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

QC/QA Specifications

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

Performance Specifications

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

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

Sources of Variability

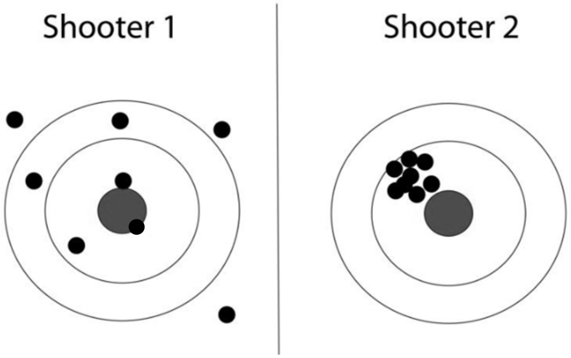
- Materials and construction:
  - Plant (stockpiles, cold feeds, binder addition, additives, mixing, transfer and storage)
  - Hauling (loading, transport, unloading)
  - Paver (operation)
  - Compaction (roller equipment and patterns)
- Sampling and testing….

Reduce Sampling and Testing Variability

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

Use of Statistical Analysis for Quality Control

Who is the better shooter?



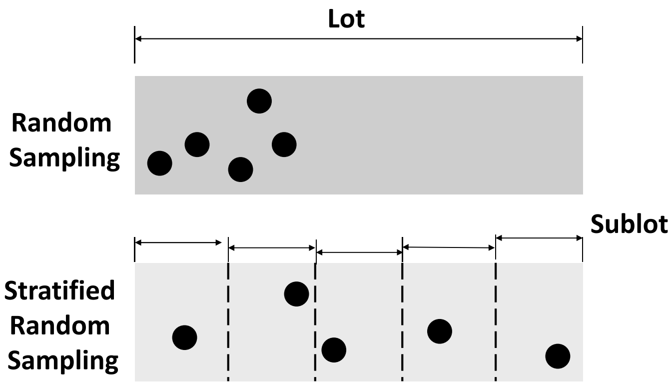
Use of Statistical Analysis for Quality Assurance

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

Random Sampling

- Any portion of the population has equal chance of being selected
- Bias is introduced when judgment is used
- Use random number tables / random number generators (Calculator / Phone)

Lots and Sublots



Pay Adjustment

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

Summary

1. **Differentiate between Quality Control (QC) and Quality Assurance (QA)**
    - **Who does QC? Who does QA?**
2. **Different types of specifications**
    - **Which is better? Most common in WV?**
3. **Sources of variability within HMA construction process**
    - **Materials?   Construction?**

Questions?

WVDOH AF&CT Training

Module 8

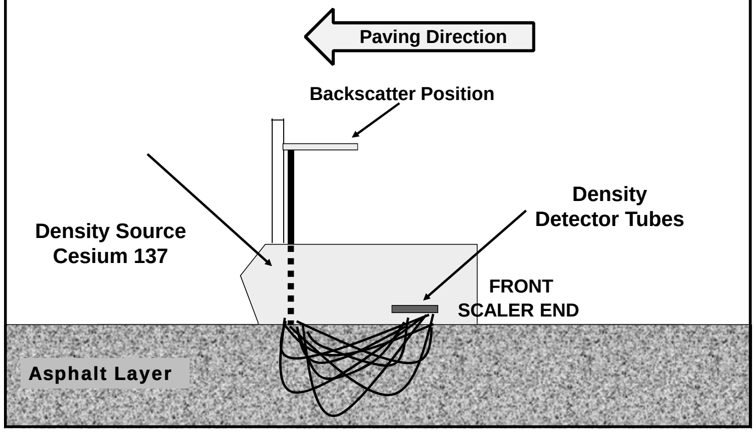
Gauge Compaction
Density Testing

Objectives :

- 401 Compaction Overview
- Gauge Comparisons
- Lot by Lot - Random Locations
  - Contractor Quality Control/Acceptance
  - DOH Quality Assurance/Verification
- Roller Pass Method

- MP 401.05.20
- Section 401 – 2019 Supplemental Specs.

Troxler 3400 Series Nuclear Gauges



Gauge Common Sense

DO NOT OPERATE NEAR :

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

KEEP GAUGE DRY :

- Cover control panel if possible

Gauge Operation

- Good contact between Gauge and Surface

Fill Voids
- Dry Mortar Sand
- Silica Sand

Remove Excess

Gauge in Position

Too Much Exposure To The Gauge

- MP 401.05.20 – Sections **1 - 8** still apply, Sections **9 – 11** are overruled by the Supplemental 401 Specification.
- Specifications Section 401 -

  Provides the requirements for determining how acceptance will be made.

  1. Lot by Lot Testing
  2. Roller Pass Method

Quality Control Testing

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

Acceptance Testing

- Lot By Lot Projects - Under the new 401 Compaction Spec, the Contractor will be doing the Acceptance Testing.
- Roller Pass Projects - The Contractor is still responsible for the testing while being observed by the District.
- **HOWEVER…….**

The PROCESS has Changed!

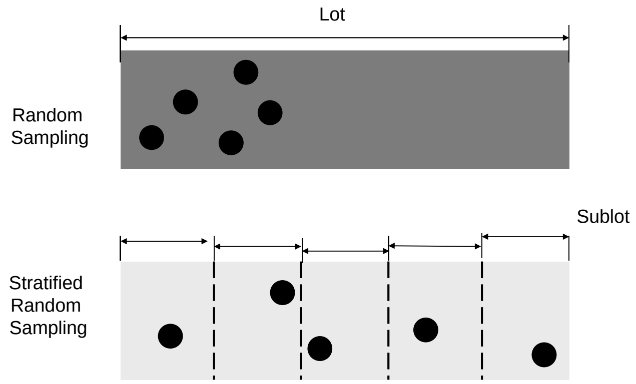
Verification Testing

- Verification tests are performed by the District to validate the Contractor's Acceptance Tests. These results are compared to the Contractor's for statistical similarity.
- If the Verification and Acceptance tests are similar, the Acceptance Tests are evaluated for pay factors.
- **HOWEVER…….**

Verification Testing

- If the Verification and Acceptance tests are not similar, an investigation by the Division will be conducted to determine the reason and the extent of the difference.
- The Division may elect to take additional Verification Tests and evaluate those results for pay factors.

Lots and Sublots



Station Numbers

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

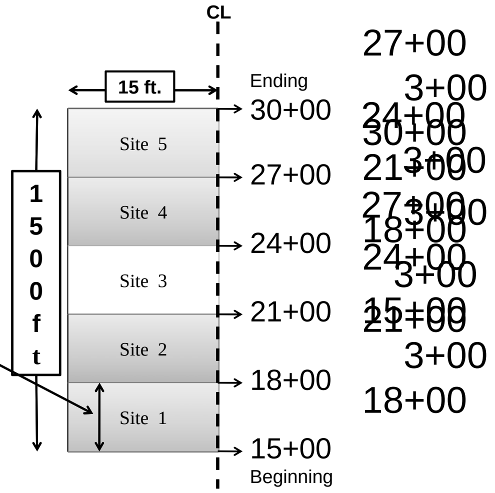
Offsets

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

Lot = 1500 ft.
5 sub lots in a lot

1500 / 5 = 300

Each sub lot or test site will represent 300 ft.



Sublot Exercise

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

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

Site 1

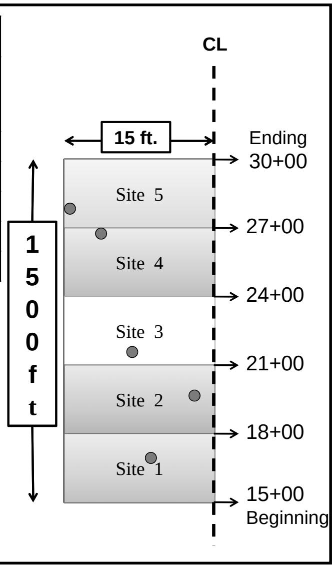
<u>Length</u>

0.683 x 300 =204.9 ⇒ 205

15+00

<u>2+05</u>

17+05



<u>Testing Process</u>

Testing Forms

- **Lot x Lot -- T401**
- **Gauge Comparison -- T428**
- **Roller Pass -- T407**
- **All three are located on DOH "Toolbox" Web Page**

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

<u>Testing Process</u>

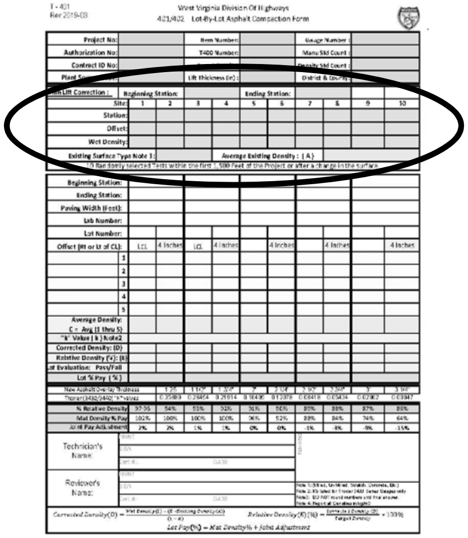
- NEW for 2019 – Thin Lift Correction
- Nuclear Gauges theoretically read 3 ½".
- Most paving is done with thinner lifts.
- The Thin Lift Correction compensates for the existing surface.
- Performed by the Contractor on both Lot By Lot and Roller Pass Projects

Testing Process

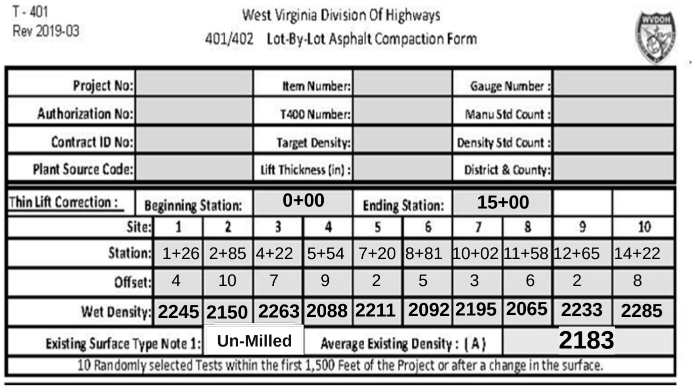
Thin Lift Correction – **Lot By Lot**

- 10 Random Wet Density Tests within the first 1,500 Ft. of paving.
- Average of the 10 Tests is used as the **Existing Density** in the correction equation.
- A new Thin Lift Correction is required any time the existing surface changes.

New T401 Compaction Form



Lot By Lot T401 Form – Thin Lift Correction



T - 401
Rev 2019-03

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

Project No:		Item Number:		Gauge Number :	
Authorization No:		T400 Number:		Manu Std Count :	
Contract ID No:		Target Density:		Density Std Count :	
Plant Source Code:		Lift Thickness (in) :		District & County:	

Thin Lift Correction :	Beginning Station:		0+00		Ending Station:		15+00			
Site:	1	2	3	4	5	6	7	8	9	10
Station:	1+26	2+85	4+22	5+54	7+20	8+81	10+02	11+58	12+65	14+22
Offset:	4	10	7	9	2	5	3	6	2	8
Wet Density:	2245	2150	2263	2088	2211	2092	2195	2065	2233	2285
Existing Surface Type Note 1:		Un-Milled		Average Existing Density : (A)				2183		
10 Randomly selected Tests within the first 1,500 Feet of the Project or after a change in the surface.										

Testing Process

Density Testing – **Lot By Lot**

- **NEW -**

Lot = 1,500 Ft long by the Paving Width
Sublot = 300 Ft long by the Paving Width

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

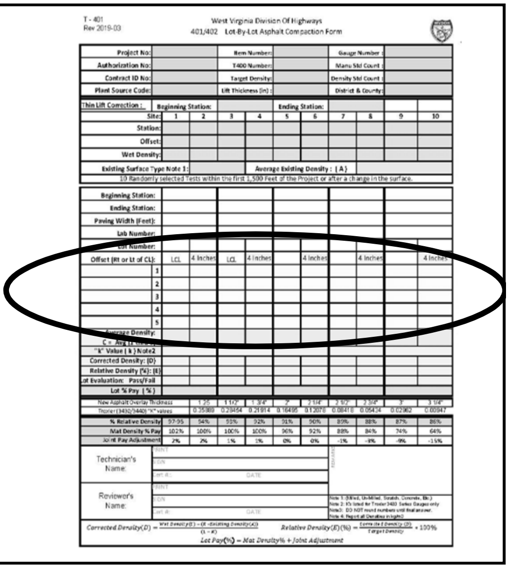
Joint Density Testing on the “Hot” side

Testing Process

Density Testing – **Lot By Lot**

- 5 Random 1 Minute Wet Density Tests per Lot as per MP 712.21.26.
- Average of the 5 Tests is used as the **Average Density** in the correction equation.
- **NEW –** Calculate The **Corrected Density.**

Proposed New T401 Compaction Form



T - 401
Rev 2019-03

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

Project No:		Item Number:		Gauge Number :	
Authorization No:		T400 Number:		Manu Std Count :	
Contract ID No:		Target Density:		Density Std Count :	
Plant Source Code:		Lift Thickness (in) :		District & County:	

Thin Lift Correction : Beginning Station: Ending Station:

Site:	1	2	3	4	5	6	7	8	9	10
Station:										
Offset:										
Wet Density:										

Existing Surface Type Note 1: Average Existing Density : (A)

10 Randomly selected Tests within the first 1,500 Feet of the Project or after a change in the surface.

Beginning Station:										
Ending Station:										
Paving Width (Feet):										
Lab Number:										
Lot Number:										
Offset (Rt or Lt of CL):	LCL	4 Inches	LCL	4 Inches		4 Inches		4 Inches		4 Inches
1										
2										
3										
4										
5										
Average Density: C = Avg (1 thru 5)										
"k" Value (k) Note2										
Corrected Density: (D)										
Relative Density (%): (E)										
Lot Evaluation: Pass/Fail										
Lot % Pay (%)										

New Asphalt Overlay Thickness	1.25	1 1/2"	1 3/4"	2"	2 1/4"	2 1/2"	2 3/4"	3"	3 1/4"
Troxler (3430/3440) "K" values	0.35889	0.28454	0.21914	0.16495	0.12078	0.08418	0.05434	0.02962	0.00947

% Relative Density	97-95	94%	93%	92%	91%	90%	89%	88%	87%	86%
Mat Density % Pay	102%	100%	100%	100%	96%	92%	88%	84%	74%	64%
Joint Pay Adjustment	2%	2%	1%	1%	0%	0%	-1%	-3%	-9%	-15%

Technician's Name: PRINT
SIGN
Cert #: DATE

REMARKS

Reviewer's Name: PRINT
SIGN
Cert #: DATE

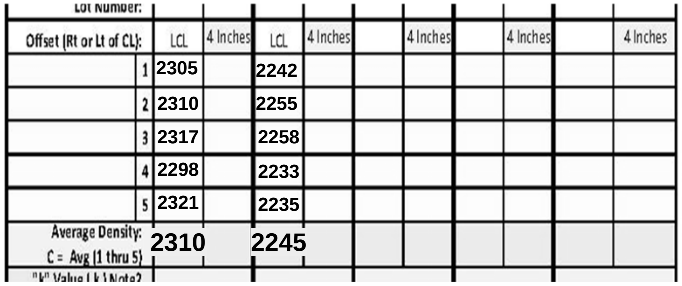
Note 1: (Milled, Un-Milled, Scratch, Concrete, Etc.)
Note 2: K's listed for Troxler 3400 Series Gauges only
Note3: DO NOT round numbers until final answer.
Note 4: Report all Densities in kg/m3

$$\text{Corrected Density}(D) = \frac{\text{Wet Density}(E) - (K \times \text{Existing Density}(A))}{(1-K)} \qquad \text{Relative Density}(E)(\%) = \frac{\text{Corrected Density }(D)}{\text{Target Density}} \times 100\%$$

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

Lot By Lot T401 Form – Density Testing

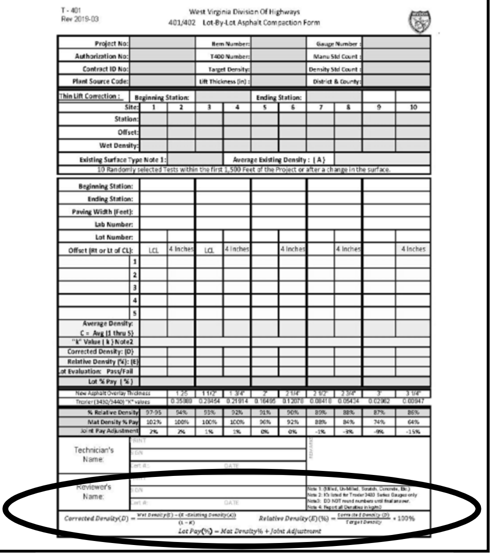
Target Density 2477



Lot Number:										
Offset (Rt or Lt of CL):	LCL	4 Inches	LCL	4 Inches		4 Inches		4 Inches		4 Inches
1	2305		2242							
2	2310		2255							
3	2317		2258							
4	2298		2233							
5	2321		2235							
Average Density: C = Avg (1 thru 5)	2310		2245							
"k" Value (k) Note2										

Average Density in the correction equation.

Proposed New T401 Compaction Form



T - 401
Rev 2019-03

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

Project No: Item Number: Gauge Number :
Authorization No: T400 Number: Manu Std Count :
Contract ID No: Target Density: Density Std Count :
Plant Source Code: Lift Thickness (in) : District & County:

Thin Lift Correction : Beginning Station: Ending Station:
Site: 1 2 3 4 5 6 7 8 9 10
Station:
Offset:
Wet Density:
Existing Surface Type Note 1: Average Existing Density : (A)
10 Randomly selected Tests within the first 1,500 Feet of the Project or after a change in the surface.

Beginning Station:
Ending Station:
Paving Width (Feet):
Lab Number:
Lot Number:
Offset (Rt or Lt of CL): LCL 4 Inches LCL 4 Inches 4 Inches 4 Inches 4 Inches
1
2
3
4
5
Average Density: C = Avg (1 thru 5)
"k" Value (k) Note2
Corrected Density: (D)
Relative Density (%): (E)
Lot Evaluation: Pass/Fail
Lot % Pay (%)

New Asphalt Overlay Thickness 1.25 1 1/2" 1 3/4" 2" 2 1/4" 2 1/2" 2 3/4" 3" 3 1/4"
Troxler (3430/3440) "K" values 0.35889 0.28454 0.21914 0.16495 0.12078 0.08418 0.05434 0.02962 0.00947
% Relative Density 97-95 94% 93% 92% 91% 90% 89% 88% 87% 86%
Mat Density % Pay 102% 100% 100% 100% 96% 92% 88% 84% 74% 64%
Joint Pay Adjustment 2% 2% 1% 1% 0% 0% -1% -3% -9% -15%

Technician's Name: PRINT SIGN Cert #: DATE
REMARKS
Reviewer's Name: PRINT SIGN Cert #: DATE
Note 1: (Milled, Un-Milled, Scratch, Concrete, Etc.)
Note 2: K's listed for Troxler 3400 Series Gauges only
Note3: DO NOT round numbers until final answer.
Note 4: Report all Densities in kg/m3

Corrected Density(D) = (Wet Density(E) – (K × Existing Density(A))) / (1 – K)   Relative Density(E)(%) = Corrected Density (D) / Target Density × 100%
Lot Pay(%) = Mat Density% + Joint Adjustment

Lot By Lot T401 Form – Correction Equation

$$\text{Corrected Density (D)} = \frac{\text{Average Density (C)} - (\text{Average Existing Density (A)} \times \text{k Value})}{1 - \text{k Value}}$$

$$D = \frac{C - (A \times k)}{1 - k}$$

*** DO NOT round any numbers before reaching the final answer.

Lot By Lot T401 Form – Correction Equation

New Asphalt Thickness	3430/3440 Troxler "k" Values	(1 - k)
1 1/2"	0.28454	0.71546
1 3/4"	0.21914	0.78086
2"	0.16495	0.83505
2 1/4"	0.12078	0.87922
2 1/2"	0.08418	0.91582
2 3/4"	0.05434	0.94566
3"	0.02962	0.97038
3 1/4"	0.00947	0.99053

Lot By Lot T401 Form – Correction Equation

1 ½” of Wearing I

$$D = \frac{C - (A \times k)}{1 - k}$$

$$D = \frac{2310 - (2183 \times 0.28454)}{0.71546}$$

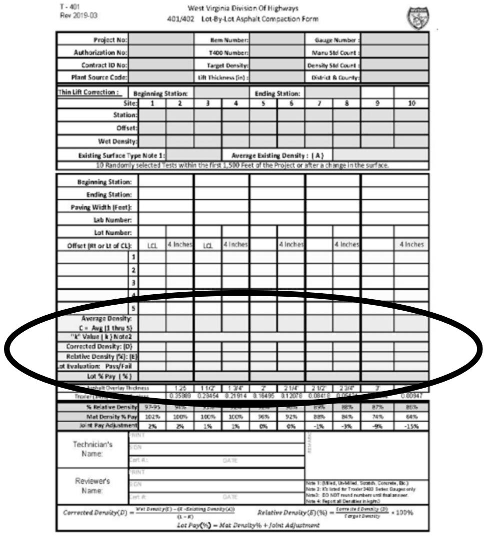
$$D = \frac{2310 - (621.15)}{0.71546}$$

$$D = \frac{1688.85}{0.71546}$$

$$D = 2360.51$$

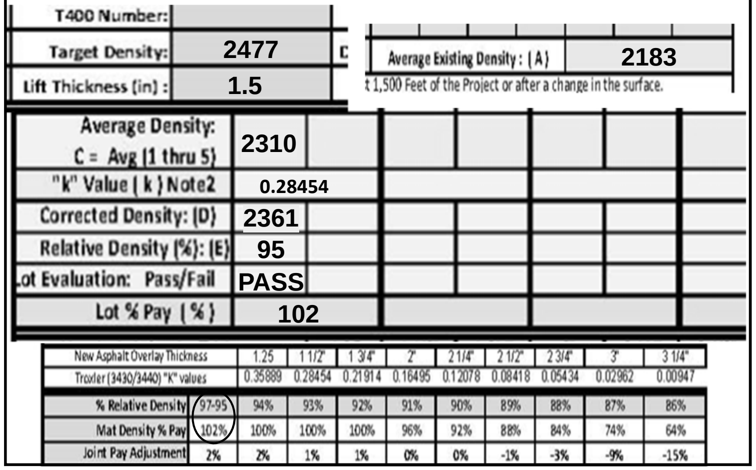
$$D = 2361$$

New T401 Compaction Form



Lot By Lot T401 Form – Density Testing

Evaluate The Lot – No Joint



T400 Number:

Target Density: 2477

Lift Thickness (in) : 1.5

Average Existing Density : (A) 2183

t 1,500 Feet of the Project or after a change in the surface.

Average Density: C = Avg (1 thru 5)	2310
"k" Value (k) Note2	0.28454
Corrected Density: (D)	2361
Relative Density (%): (E)	95
ot Evaluation: Pass/Fail	PASS
Lot % Pay (%)	102

New Asphalt Overlay Thickness		1.25	1 1/2"	1 3/4"	2"	2 1/4"	2 1/2"	2 3/4"	3"	3 1/4"
Troxler (3430/3440) "K" values		0.35889	0.28454	0.21914	0.16495	0.12078	0.08418	0.05434	0.02962	0.00947
% Relative Density	97-95	94%	93%	92%	91%	90%	89%	88%	87%	86%
Mat Density % Pay	102%	100%	100%	100%	96%	92%	88%	84%	74%	64%
Joint Pay Adjustment	2%	2%	1%	1%	0%	0%	-1%	-3%	-9%	-15%

Testing Process

Density Testing – **Joint Testing**

- Done on the "Hot" side when a second travel lane is constructed.
- 5 Random 1 Minute Wet Density Tests per Lot - 4 Inches off of the Joint.
- Average of the 5 Tests is used as the **Average Joint Density** in the correction equation.

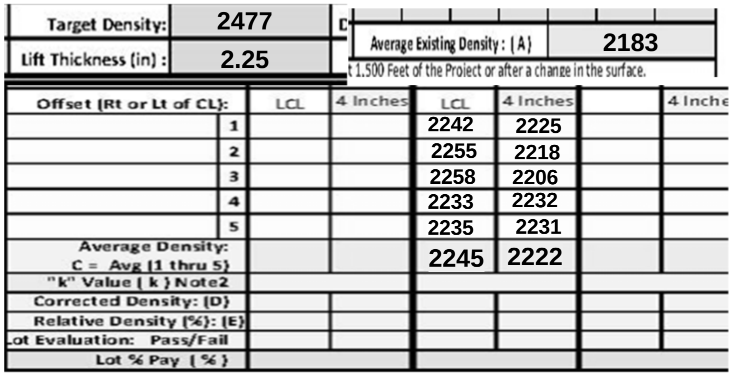
Testing Process

Density Testing – **Joint Testing**

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

Lot By Lot T401 Form – Density Testing

Evaluate The Lot – With Joint



Target Density: 2477

Lift Thickness (in) : 2.25

Average Existing Density : (A) 2183

t 1.500 Feet of the Proiect or after a change in the surface.

Offset (Rt or Lt of CL):		LCL	4 Inches	LCL	4 Inches		4 Inche
	1			2242	2225		
	2			2255	2218		
	3			2258	2206		
	4			2233	2232		
	5			2235	2231		
Average Density: C = Avg (1 thru 5)				2245	2222		
"k" Value (k) Note2							
Corrected Density: (D)							
Relative Density (%): (E)							
ot Evaluation: Pass/Fail							
Lot % Pay (%)							

Lot By Lot T401 Form – Correction Equation

2 1/4” of Wearing 1

MAT

$$D = \frac{C - (A \times k)}{1 - k}$$

$$D = \frac{2245 - (2183 \times 0.12078)}{0.87922}$$

$$D = \frac{2245 - (263.66)}{0.87922}$$

$$D = \frac{1981.34}{0.87922}$$

$$D = 2253.52$$

$$D = 2254$$

Lot By Lot T401 Form – Correction Equation

2 1/4” of Wearing 1

Joint

$$D = \frac{C - (A \times k)}{1 - k}$$

$$D = \frac{2222 - (2183 \times 0.12078)}{0.87922}$$

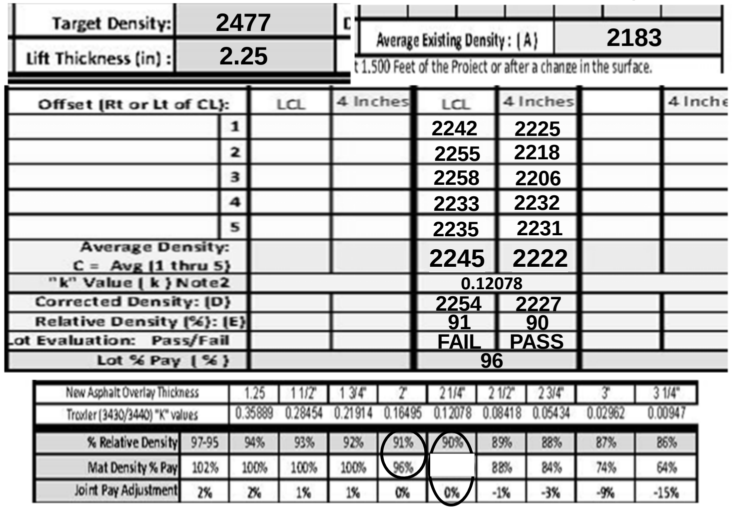
$$D = \frac{2222 - (263.66)}{0.87922}$$

$$D = \frac{1958.34}{0.87922}$$

$$D = 2227.36$$

$$D = 2227$$

Lot By Lot T401 Form – Density Testing



Target Density: 2477

Lift Thickness (in) : 2.25

Average Existing Density : (A) 2183

t 1,500 Feet of the Proiect or after a change in the surface.

Offset (Rt or Lt of CL):		LCL	4 Inches	LCL	4 Inches		4 Inche
	1			2242	2225		
	2			2255	2218		
	3			2258	2206		
	4			2233	2232		
	5			2235	2231		
Average Density: C = Avg (1 thru 5)				2245	2222		
"k" Value (k) Note2				0.12078			
Corrected Density: (D)				2254	2227		
Relative Density (%): (E)				91	90		
ot Evaluation: Pass/Fail				FAIL	PASS		
Lot % Pay (%)				96			

New Asphalt Overlay Thickness		1.25	1 1/2"	1 3/4"	2"	2 1/4"	2 1/2"	2 3/4"	3"	3 1/4"
Troxler (3430/3440) "K" values		0.35889	0.28454	0.21914	0.16495	0.12078	0.08418	0.05434	0.02962	0.00947
% Relative Density	97-95	94%	93%	92%	91%	90%	89%	88%	87%	86%
Mat Density % Pay	102%	100%	100%	100%	96%		88%	84%	74%	64%
Joint Pay Adjustment	2%	2%	1%	1%	0%	0%	-1%	-3%	-9%	-15%

Quality Assurance Verification Testing

- Lot size – 1,500 feet long by paving width (Same area as the Contractor tested for Acceptance).
- A minimum of 2 Verification Lots per Project.

Quality Assurance Verification Testing

- A minimum of 25% Verification Testing per Project. Must always have an even number of Verification Lots:

1 – 8 Acceptance = 2 Verification

9 – 16 Acceptance = 4 Verification

17 – 24 Acceptance = 6 Verification

25 – 32 Acceptance = 8 Verification

Quality Assurance Verification Testing

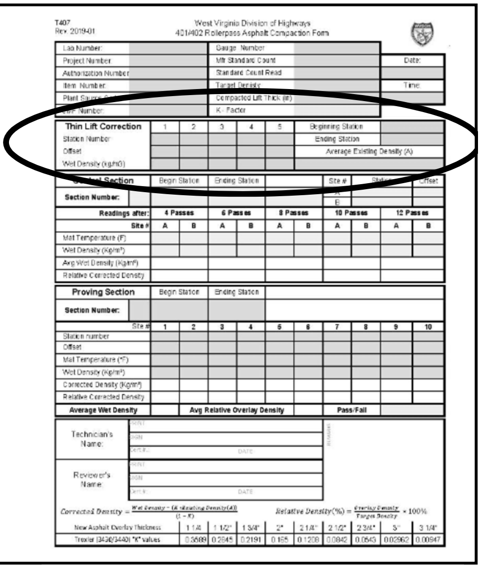
- Thin Lift Correction is not required.
- The Uncorrected wet densities are evaluated for statistical similarity

Testing Process

Thin Lift Correction – **Rollerpass**

- 5 Random Wet Density Tests within the first 400 Ft. of paving beginning 100 Ft. beyond transverse joint
- Average of the 5 Tests is used as the **Existing Density** in the correction equation.
- A new Thin Lift Correction is required any time the existing surface changes.

New T407 Compaction Form



T407
Rev. 2019-01

West Virginia Division of Highways
401/402 Rollerpass Asphalt Compaction Form

Lab Number:		Gauge Number		
Project Number		Mfr Standard Count		Date:
Authorization Number		Standard Count Read		
Item Number:		Target Denisty		Time:
Plant Source		Compacted Lift Thick (in)		
F Number:		K- Factor		

Thin Lift Correction	1	2	3	4	5	Beginning Station	
Station Number						Ending Station	
Offset						Average Existing Density (A)	
Wet Density (kg/m3)							

Section	Begin Station	Ending Station		Site #	Station	Offset
Section Number:				A		
				B		

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

Proving Section	Begin Station	Ending Station	
Section Number:			

Site #	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
Station number										
Offset										
Mat Temperature (°F)										
Wet Density (Kg/m³)										
Corrected Density (Kg/m³)										
Relative Corrected Density										

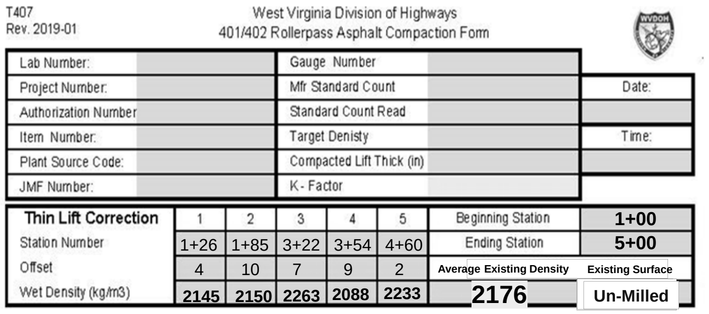
Average Wet Density		**Avg Relative Overlay Density**		**Pass/Fail**	

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

$$Corrected\ Density = \frac{Wet\ Density - (K \times Existing\ Density(A))}{(1 - K)} \qquad Relative\ Density(\%) = \frac{Overlay\ Density}{Target\ Density} \times 100\%$$

New Asphalt Overlay Thickness	1 1/4	1 1/2"	1 3/4"	2"	2 1/4"	2 1/2"	2 3/4"	3"	3 1/4"
Troxler (3430/3440) "K" values	0.3589	0.2845	0.2191	0.165	0.1208	0.0842	0.0543	0.02962	0.00947

Roller Pass T407 Form – Thin Lift Correction



T407
Rev. 2019-01

West Virginia Division of Highways
401/402 Rollerpass Asphalt Compaction Form

Lab Number:		Gauge Number		
Project Number:		Mfr Standard Count		Date:
Authorization Number		Standard Count Read		
Item Number:		Target Denisty		Time:
Plant Source Code:		Compacted Lift Thick (in)		
JMF Number:		K - Factor		

Thin Lift Correction	1	2	3	4	5	Beginning Station	**1+00**
Station Number	1+26	1+85	3+22	3+54	4+60	Ending Station	**5+00**
Offset	4	10	7	9	2	**Average Existing Density**	**Existing Surface**
Wet Density (kg/m3)	**2145**	**2150**	**2263**	**2088**	**2233**	**2176**	**Un-Milled**

Testing Process

Density Testing – **Roller Pass**

- **NEW -**

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

Daily Roller Passes to be established per Project

Roller Pass

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

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

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

Site 1

Length

0.338 x 50

16.9 ⇒ 17

1+00

0+17

1+17

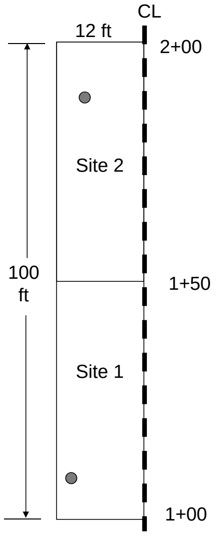
Width

0.917 x 12

11.0 ⇒ 11

Measure density

Use form T 407



Testing Process

Density Testing – **Roller Pass**

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

Testing Process

Control Section – **Roller Pass**

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

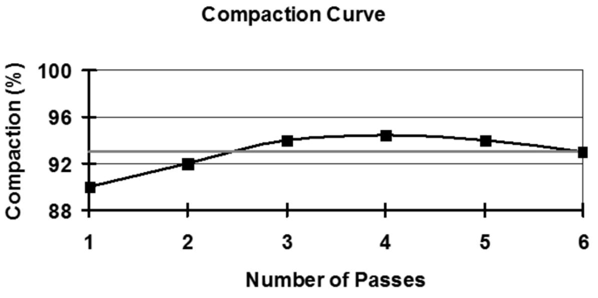
Testing Process

Control Section – **Roller Pass**

Continue process – 2 Passes at a time until one of the following occur :

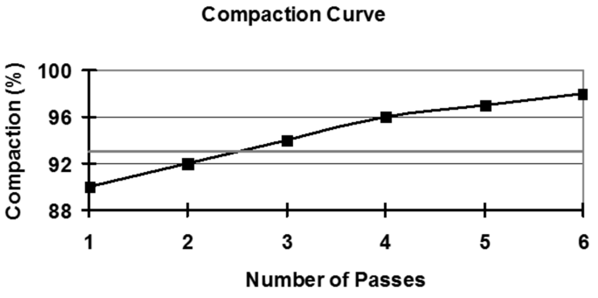
- Less than **5 kg/m³** increase in Average Wet Density.
- One or Both test Locations “Break Over” after achieving 92% Gmm (Corrected)
- The Corrected Relative Density exceeds 97% Gmm

Roller Pattern Problem #1



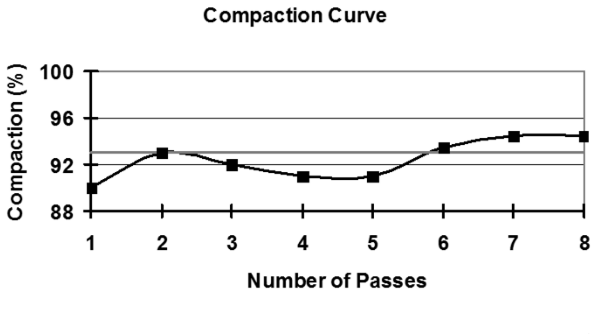
Decreasing Temperature

Roller Pattern Problem #2



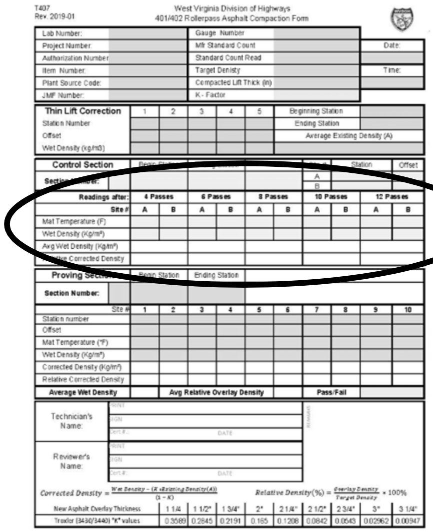
Decreasing Temperature

Roller Pattern Problem #3



Decreasing Temperature

New T407 Compaction Form



T407
Rev. 2019-01

West Virginia Division of Highways
401/402 Rollerpass Asphalt Compaction Form

Lab Number:		Gauge Number		
Project Number:		Mfr Standard Count		Date:
Authorization Number		Standard Count Read		
Item Number:		Target Denisty		Time:
Plant Source Code:		Compacted Lift Thick (in)		
JMF Number:		K - Factor		

Thin Lift Correction	1	2	3	4	5	Beginning Station	
Station Number						Ending Station	
Offset						Average Existing Density (A)	
Wet Density (kg/m3)							

Control Section		Begin Station	Ending Station		Site #	Station	Offset
Section Number:					A		
					B		

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

Proving Section		Begin Station	Ending Station
Section Number:			

Site #	1	2	3	4	5	6	7	8	9	10
Station number										
Offset										
Mat Temperature (°F)										
Wet Density (Kg/m³)										
Corrected Density (Kg/m³)										
Relative Corrected Density										

Average Wet Density		Avg Relative Overlay Density		Pass/Fail	

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

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

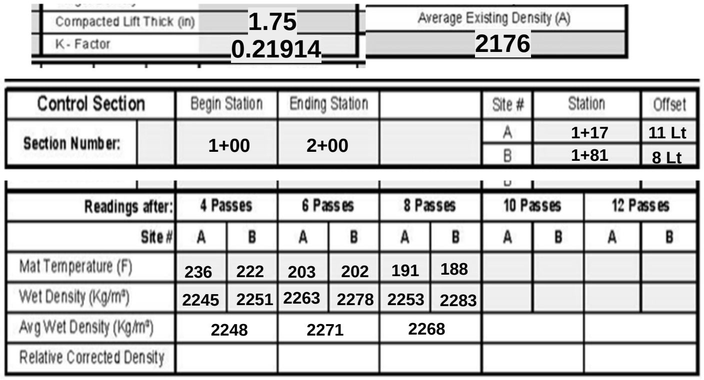
REMARKS

$$Corrected\ Density = \frac{Wet\ Density - (K \times Existing\ Density(A))}{(1 - K)}$$

$$Relative\ Density(\%) = \frac{Overlay\ Density}{Target\ Density} \times 100\%$$

New Asphalt Overlay Thickness	1 1/4	1 1/2"	1 3/4"	2"	2 1/4"	2 1/2"	2 3/4"	3"	3 1/4"
Troxler (3430/3440) "K" values	0.3589	0.2845	0.2191	0.165	0.1208	0.0842	0.0543	0.02962	0.00947

Roller Pass T407 Form – Control Section



Compacted Lift Thick (in)	1.75	Average Existing Density (A)	
K - Factor	0.21914		2176

Control Section		Begin Station	Ending Station		Site #	Station	Offset
Section Number:		1+00	2+00		A	1+17	11 Lt
					B	1+81	8 Lt

Readings after:	4 Passes		6 Passes		8 Passes		10 Passes		12 Passes	
Site #	A	B	A	B	A	B	A	B	A	B
Mat Temperature (F)	236	222	203	202	191	188				
Wet Density (Kg/m³)	2245	2251	2263	2278	2253	2283				
Avg Wet Density (Kg/m³)	2248		2271		2268					
Relative Corrected Density										

Target Density = 2485
1 ¾" of Wearing 1

Rollerpass T407 Form – Correction Equation

1 3/4" of Wearing 1

$$D = \frac{C - (A \times k)}{1 - k}$$

$$D = \frac{2271 - (2176 \times 0.21914)}{0.78086}$$

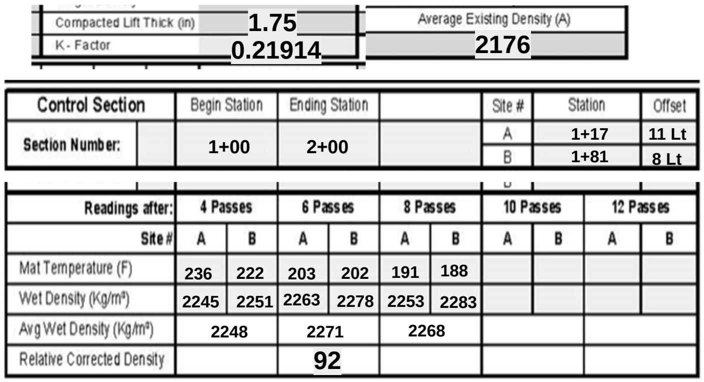
$$D = \frac{2271 - (476.85)}{0.78086}$$

$$D = \frac{1794.15}{0.78086}$$

$$D = 2297.66$$

$$D = 2298$$

Roller Pass T407 Form – Control Section



Compacted Lift Thick (in)	1.75
K- Factor	0.21914

Average Existing Density (A)
2176

Control Section	Begin Station	Ending Station		Site #	Station	Offset
Section Number:	1+00	2+00		A	1+17	11 Lt
				B	1+81	8 Lt

Readings after:	4 Passes		6 Passes		8 Passes		10 Passes		12 Passes	
Site #	A	B	A	B	A	B	A	B	A	B
Mat Temperature (F)	236	222	203	202	191	188				
Wet Density (Kg/m³)	2245	2251	2263	2278	2253	2283				
Avg Wet Density (Kg/m³)	2248		2271		2268					
Relative Corrected Density			92							

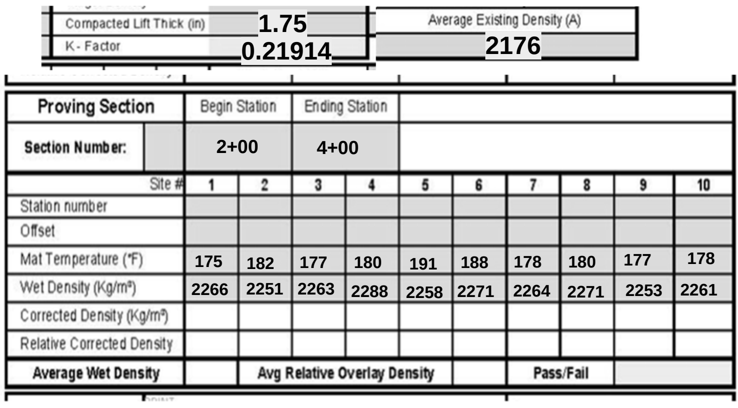
Corrected Wet Density = 2298
Target Density = 2485

Testing Process

Proving Section – **Roller Pass**

- 200 Feet long beginning at the end of the Control Section.
- 10 Random Wet Density Tests
- Corrected Average must be 92% or greater
- Corrected Average must be within 34 Kg/m³ of the Control Section Corrected Density.

Roller Pass T407 Form – Control Section



Compacted Lift Thick (in)	1.75
K- Factor	0.21914

Average Existing Density (A)
2176

Proving Section	Begin Station	Ending Station
Section Number:	2+00	4+00

Site #	1	2	3	4	5	6	7	8	9	10
Station number										
Offset										
Mat Temperature (°F)	175	182	177	180	191	188	178	180	177	178
Wet Density (Kg/m³)	2266	2251	2263	2288	2258	2271	2264	2271	2253	2261
Corrected Density (Kg/m³)										
Relative Corrected Density										
Average Wet Density		**Avg Relative Overlay Density**					**Pass/Fail**			

Average Wet Density = 2265
Target Density = 2485

Rollerpass T407 Form – Correction Equation

1 3/4" of Wearing 1

$$D = \frac{C - (A \times k)}{1 - k}$$

$$D = \frac{2265 - (2176 \times 0.21914)}{0.78086}$$

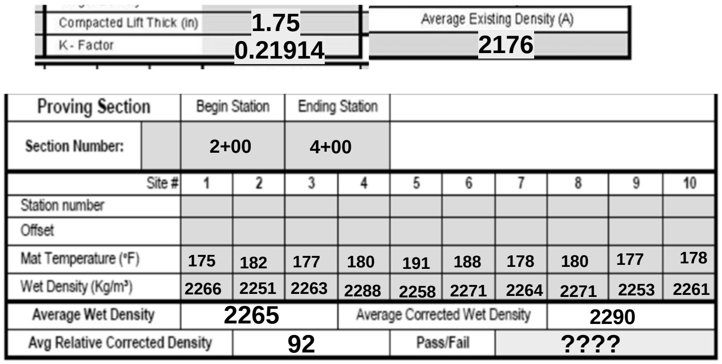
$$D = \frac{2265 - (476.85)}{0.78086}$$

$$D = \frac{1788.15}{0.78086}$$

$$D = 2289.98$$

$$D = 2290$$

Roller Pass T407 Form – Control Section

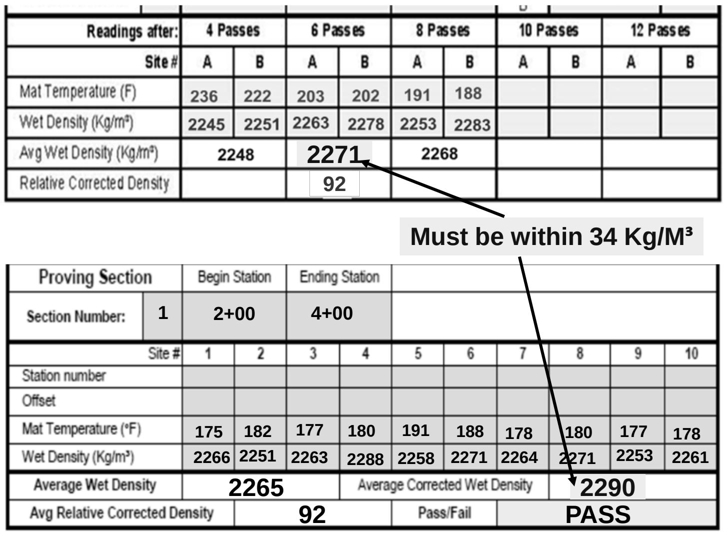


Compacted Lift Thick (in)	1.75
K - Factor	0.21914

Average Existing Density (A)
2176

Proving Section	Begin Station	Ending Station								
Section Number:	2+00	4+00								
Site #	1	2	3	4	5	6	7	8	9	10
Station number										
Offset										
Mat Temperature (°F)	175	182	177	180	191	188	178	180	177	178
Wet Density (Kg/m³)	2266	2251	2263	2288	2258	2271	2264	2271	2253	2261
Average Wet Density	2265		Average Corrected Wet Density				2290			
Avg Relative Corrected Density		92		Pass/Fail		????				

Target Density =   2485

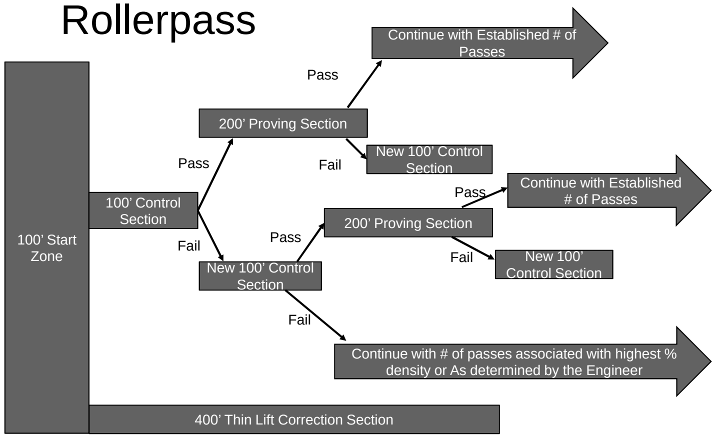


Readings after:	4 Passes		6 Passes		8 Passes		10 Passes		12 Passes	
Site #	A	B	A	B	A	B	A	B	A	B
Mat Temperature (F)	236	222	203	202	191	188				
Wet Density (Kg/m³)	2245	2251	2263	2278	2253	2283				
Avg Wet Density (Kg/m³)	2248		2271		2268					
Relative Corrected Density			92							

Must be within 34 Kg/M³

Proving Section	Begin Station	Ending Station								
Section Number: 1	2+00	4+00								
Site #	1	2	3	4	5	6	7	8	9	10
Station number										
Offset										
Mat Temperature (°F)	175	182	177	180	191	188	178	180	177	178
Wet Density (Kg/m³)	2266	2251	2263	2288	2258	2271	2264	2271	2253	2261
Average Wet Density	2265		Average Corrected Wet Density				2290			
Avg Relative Corrected Density		92		Pass/Fail		PASS				

Rollerpass



100' Start Zone

100' Control Section

Pass

200' Proving Section

Pass

Continue with Established # of Passes

Fail

New 100' Control Section

Fail

New 100' Control Section

Pass

200' Proving Section

Pass

Continue with Established # of Passes

Fail

New 100' Control Section

Fail

Continue with # of passes associated with highest % density or As determined by the Engineer

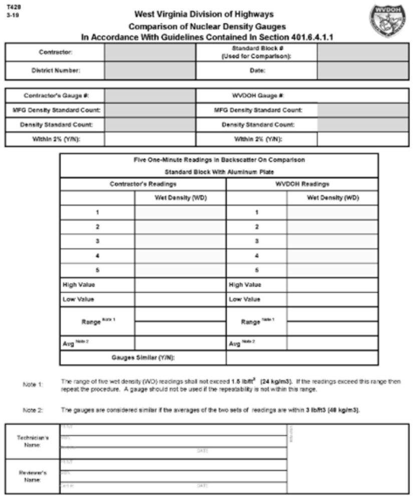
400' Thin Lift Correction Section

Gauge Comparison

Comparison of Nuclear Density Gauges In Accordance with Guidelines Contained in

MP 401.05.20

T-428 Gauge Comparison Form



T428
3-19

West Virginia Division of Highways
Comparison of Nuclear Density Gauges
In Accordance With Guidelines Contained In Section 401.6.4.1.1

Contractor:		Standard Block # (Used for Comparison):	
District Number:		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):			

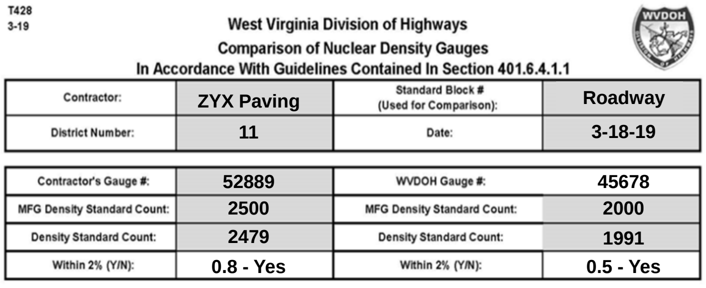
Note 1: The range of five wet density (WD) readings shall not exceed **1.5 lb/ft^3 (24 kg/m3).** If the readings exceed this range then repeat the procedure. A gauge should not be used if the repeatability is not within this range.

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

Technician's Name	
Reviewer's Name	

T-428 Gauge Comparison Form

Part 1 - Identification and Verification



T428
3-19

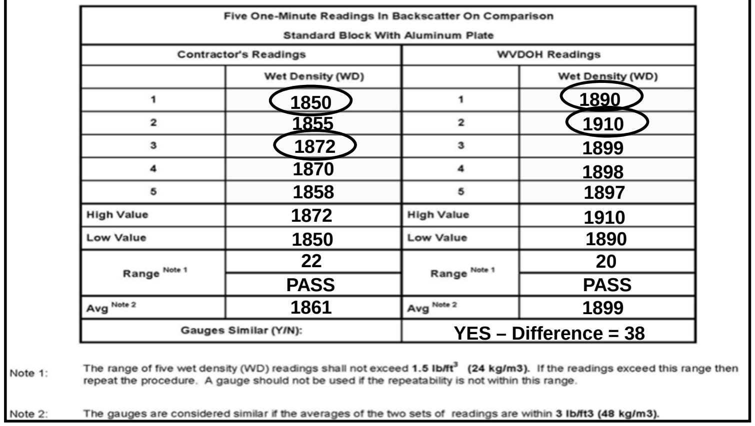
West Virginia Division of Highways
Comparison of Nuclear Density Gauges
In Accordance With Guidelines Contained In Section 401.6.4.1.1

Contractor:	ZYX Paving	Standard Block # (Used for Comparison):	Roadway
District Number:	11	Date:	3-18-19

Contractor's Gauge #:	52889	WVDOH Gauge #:	45678
MFG Density Standard Count:	2500	MFG Density Standard Count:	2000
Density Standard Count:	2479	Density Standard Count:	1991
Within 2% (Y/N):	0.8 - Yes	Within 2% (Y/N):	0.5 - Yes

T-428 Gauge Comparison Form

Part 2 - Repeatability & Similarity



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	1850	1	1890
2	1855	2	1910
3	1872	3	1899
4	1870	4	1898
5	1858	5	1897
High Value	1872	High Value	1910
Low Value	1850	Low Value	1890
Range Note 1	22	Range Note 1	20
	PASS		PASS
Avg Note 2	1861	Avg Note 2	1899
Gauges Similar (Y/N):		YES – Difference = 38	

Note 1: The range of five wet density (WD) readings shall not exceed **1.5 lb/ft^3 (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).**

T-428 Gauge Comparison Form

Part 2 - Repeatability & Similarity

- In the event that the District would not have an Aluminum Standard block available, the gauge comparison may be done on a new - finished asphalt surface.
- Mark gauge location on the pavement and follow the same procedure.

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.

Section 410: Percent Within Limits (PWL)

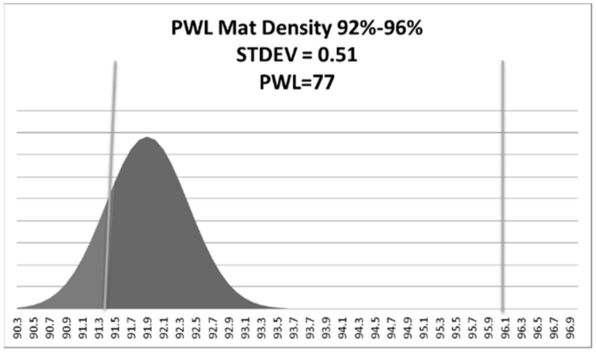
PWL Paving – Overview

- **Method of QA for NHS routes and above**
- **Material samples taken from the roadway**
- **Pay Factors for the things that matter most:**
  - **Asphalt Content**
  - **Gradation**
  - **Mat Density**
  - **Joint Density**
  - **Bond Strength**
  - **Thickness**

PWL Paving – Overview

- **Payment is by the SY, not by the Ton**
  - **Eliminates the need for change orders and over runs**
- **Not just an average or a moving average**
- **PWL is based on average, standard deviation, and limits**
  - **Theoretical percentage of all data that is statistically within the overall specification limits**

PWL Paving – Visual Example



PWL Paving – Key Terms

- **Upper Limit**
- **Lower Limit**
- **Mean**
- **Standard Deviation**
- **Pay Factor**
- **PWL Rating**
- **Mat Lots**
- **Loose Samples**
- **Core Samples**
- **Joint Lots**
- **Shoulder Lots**

PWL Paving – Specifications

- **Section 410 – Asphalt Base and Wearing Courses, Percent within Limits (PWL)**
- Section 109.11 – Square Yard Paving Adjustments

PWL Paving – Material Procedures

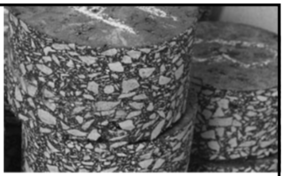
- MP 401.02.31 QC & Acceptance
- **MP 401.07.20 Sampling Loose Asphaltic Pavement Mixtures**
- **MP 401.07.21 Sampling Compacted Asphalt**
- MP 401.07.22 Thickness of Asphalt Concrete Using Cores
- MP 401.07.23 Bond Strength
- MP 401.07.24 Pavement Macrotexture
- **MP 401.07.25 Evaluation of HMA Pavements**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

PWL Paving – Loose Mix Samples

- **Sampling Location**
  - **"Loose Mix" sample behind the paver for Pay**
  - **Still truck samples for plant QC/QA**
- **Samples tested at the District Materials Lab**
  - **24hr turn around on AC Content and Gradation**
  - **Statistical Evaluation**

  - ***https://youtu.be/lTZeDmYojuM***

PWL Paving – Density Analysis



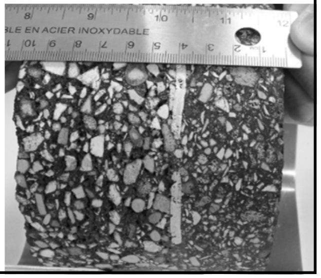
- Mat and Longitudinal Joint Evaluations
- Coring the finished pavement
- No field density testing is required
  - Still a good Practice for QC
  - Can use non-nuclear
- Density tests in the lab
- Statistical Evaluation

PWL Paving – Bond Strength

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

PWL Paving – Thickness

- Specified lift thickness
  - Check with the Density and Bond cores
  - Agree on interface in the field

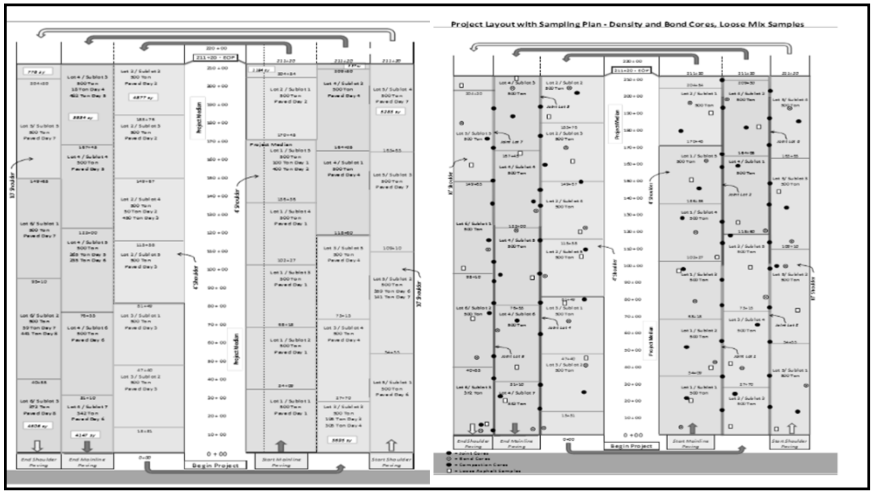


PWL Paving – Field Evaluations – Pavement Distresses

- What happens when something goes wrong
- Means to stop production if segregation, bleeding, etc occurs

PWL Paving – Prior to Construction

- Lot Layout
  - Production lots are 2500 tons
  - Constructed joints have 10,000’ lots
- Pre-paving Meeting
  - Different than pre-construction meeting
  - Agree on paving sequence – Layout Lots in field for sampling
  - Loose mix locations at beginning of day
  - Cores marked after finish roller…notify contractor!
- Oven Correction Factor
  - The Contractor shall supply prepared mix to the Division



PWL Paving – Prior to Construction

- Within each mat lot (2500 tons), there are five sublots (500 tons)
  - can be 3-7
- Within each sublot:
  - One random loose mix sample
  - One random density core sample
  - One random bond strength core
- Both mat cores will be measured for <u>thickness</u> prior to density or bond strength testing, 10 measurements per lot. AVERAGE
- Loose mix evaluated for AC and Gradation (#200)
- Joint lots (10,000ft) have five sublots, one core per sublot

PWL Paving – Example Setup

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

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

PWL Paving – Example Setup

- 3500 ton project, single “extended” lot

Determine	Method	Answer
Area (SY)	**Area (ft) / 9**	
Loose Samples	**One per mat sublot**	
Mat Density Samples	**One per mat sublot**	
Bond Strength Samples	**One per mat sublot**	
Joint Density Samples	**One per JOINT sublot**	
Thickness Samples	**Use Bond Strength & Mat Density Cores**	

PWL Paving – Example Results

- Mat Density (91.5 – 97.0)
  - 7 Cores - 93.00, 93.10, 92.30, 93.00, 93.50, 92.40, 92.60
  - PWL = 100
  - 7 Cores - 93.00, 93.10, 92.30, 93.00, 93.50, 92.40, 89.60
  - PWL = 75
- Consistency!

PWL Paving – Statistical Evaluation

- Statistical Evaluation
  - Final payment is based on the average and Standard deviation
- Each property is given limits
  - Mat density - (91.5% to 97.0%)
  - Asphalt content - (target +/- 0.4)
  - Gradation #200 – (target +/- 2.0)
  - Bond Strength – (100 min) – Separate pay adjustment
  - Joint cores (89.0% min) – Separate pay adjustment
  - Thickness – (>= Design – 0.04in) – Separate pay adjustment

PWL Paving – Pay Adjustment

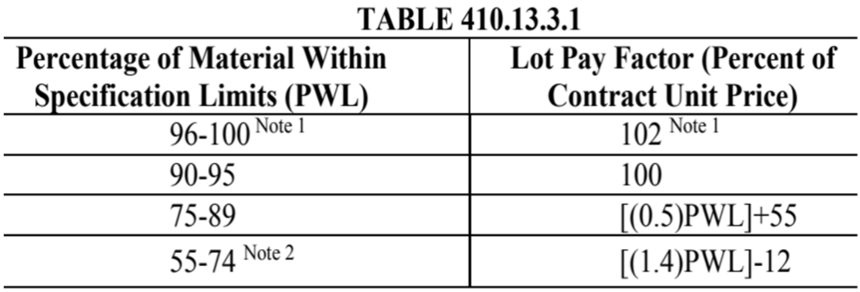


TABLE 410.13.3.1

Percentage of Material Within Specification Limits (PWL)	Lot Pay Factor (Percent of Contract Unit Price)
96-100 Note 1	102 Note 1
90-95	100
75-89	[(0.5)PWL]+55
55-74 Note 2	[(1.4)PWL]-12

PWL Paving – Pay Adjustment

- **Lot Payment**

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

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

PWL Paving – Pay Adjustment

- **Joint Payment**

$$\$\ \boldsymbol{Bonus} = \frac{\boldsymbol{PWL-80}}{\boldsymbol{20}}\ \boldsymbol{x}\ \boldsymbol{4000}$$ **(When ≥ 80)**

$$\$\ \boldsymbol{Penalty} = \frac{\boldsymbol{60-PWL}}{\boldsymbol{60}}\ \boldsymbol{x}\ \boldsymbol{12,500}$$ **(When ≤ 60)**

PWL Paving – Pay Adjustment

- **Thickness Payment**

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

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

PWL Paving – Pay Adjustment Example

- **Determine the pay factors for this example lot**

Property	PWL	Pay Factor
Density	97	
Asphalt Content	90	
Gradation	86	

PWL Paving – Pay Adjustment Example

- Joint PWL is 57. What is the bonus or penalty?

PWL Paving – Pay Adjustment Example

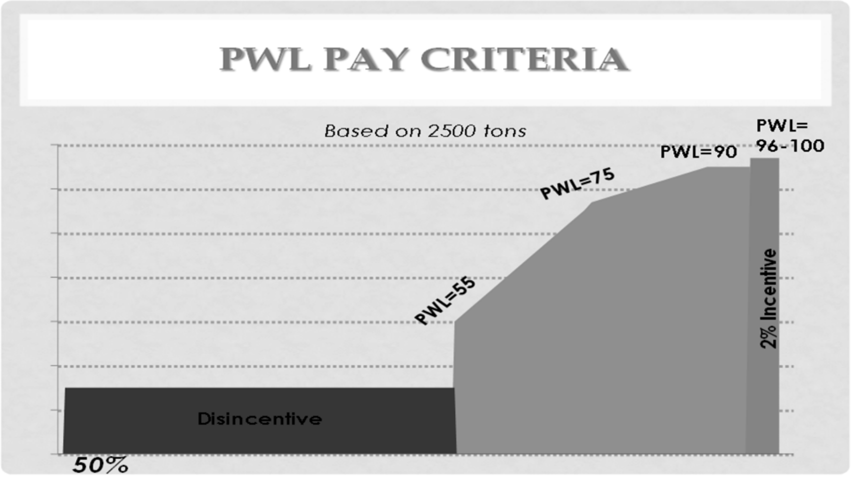
- Thickness target is 2 inches, and average is 1.92 inches. What is the pay adjustment?

$$\% \, \boldsymbol{Adjustment} = \frac{\boxed{}}{\boxed{}} \, \boldsymbol{x} \; \mathbf{100}$$

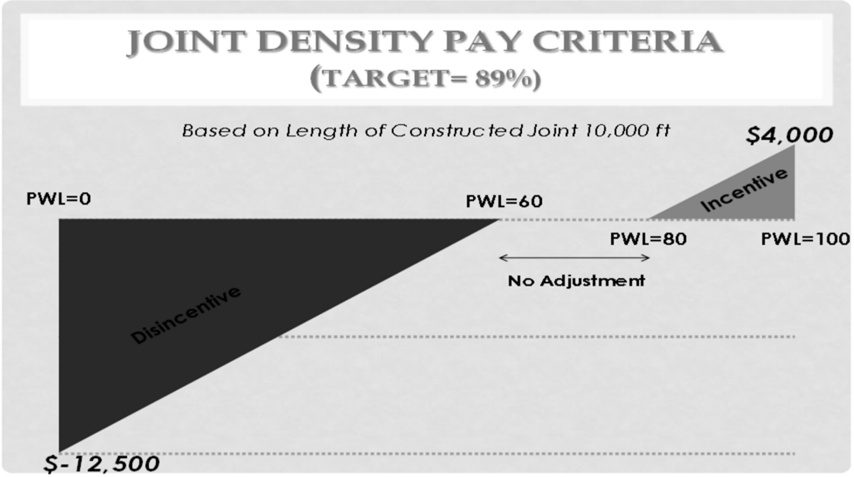
$$\% \, \boldsymbol{Adjustment} = \boxed{}$$

PWL Paving – Construction

- Sampling Plans
    - Check with the DOH about where samples will be during the day
- Sampling: Don’t stop the paver
- Cores
    - Once the finish roller has completed the section, the DOH will mark locations
    - Cores shall be drilled square, with 6” I.D. bit
- Consistency throughout the Lot, low standard deviation

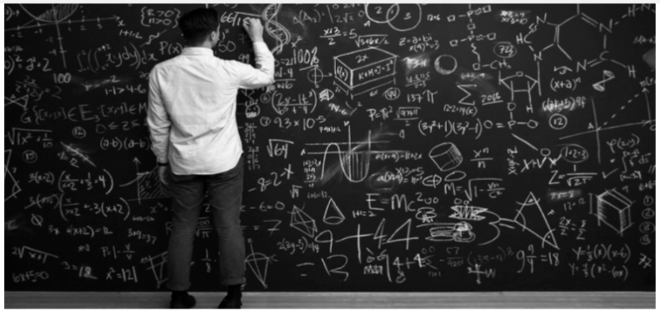


PWL PAY CRITERIA



JOINT DENSITY PAY CRITERIA
(TARGET= 89%)

Time to crunch the Numbers

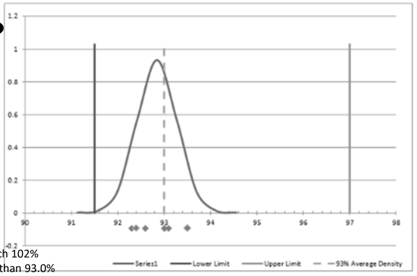


Density Analysis

Number of samples, n:	7
Average	92.8
St. Dev.	0.4277
Lower Limit	91.5
Upper Limit	97

Ql=	3.140	Qu=	9.719
	3.139585		9.719355
	0.000000		0.000000
	0.000000		0.000000
	100.000000		100.000000
	100.000000		100.000000
Pl=	100	Pu=	100

PWL =	**100**
Payment =	**100%**



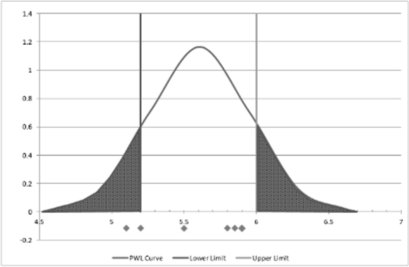
- Payment for each component can reach 102%
  - Density average must be greater than 93.0%

Asphalt Content Analysis

Number of samples, n:	7
Average	5.6
St. Dev.	0.3560
Lower Limit	5.2
Upper Limit	6

Ql=	1.030	Qu=	1.217
	1.029956		1.217220
	0.272916		0.231628
	15.298700		10.708300
	84.701300		89.291700
	85.000000		90.000000
Pl=	85	Pu=	90

PWL =	**75**
Payment =	**93%**

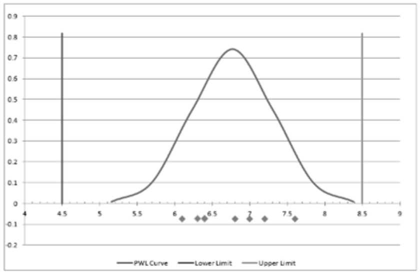


Dust Analysis

Number of samples, n:		7
Average		6.7
St. Dev.		0.5786
Lower Limit		4.5
Upper Limit		8.5

Ql=	3.860	Qu=	3.053
	3.859866		3.053327
	0.000000		0.000000
	0.000000		0.000000
	100.000000		100.000000
	100.000000		100.000000
Pl=	100	Pu=	100

PWL =	**100**
Payment =	**102%**

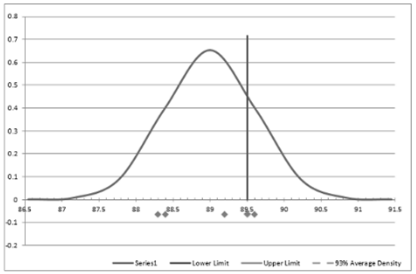


Joint Lot 1

Number of samples, n:		5
Average		89.0
St. Dev.		0.6125
Lower Limit		89.5
Upper Limit		

Ql=	-0.816	Qu=	-145.313
	-0.816363		-145.312662
	0.728180		41.116124
	78.010300		100.000000
	21.989700		0.000000
	22.000000		0.000000
Pl=	22	Pu=	100

PWL =	**22**
Payment =	**-$7,916.67**

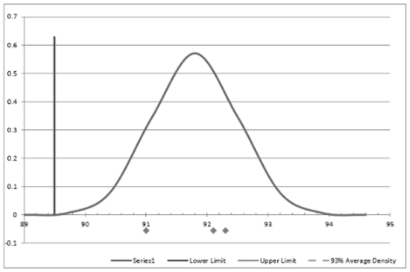


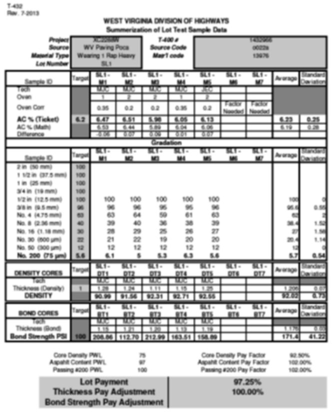
Joint Lot 2

Number of samples, n:		3
Average		91.8
St. Dev.		0.7001
Lower Limit		89.5
Upper Limit		

Ql=	3.285	Qu=	-131.124
	3.285245		-131.124125
	0.000000		57.278412
	0.000000		100.000000
	100.000000		0.000000
	100.000000		0.000000
Pl=	100	Pu=	100

PWL =	**100**
Payment =	**$4,000.00**





T-432
Rev. 7-2013

WEST VIRGINIA DIVISION OF HIGHWAYS
Summerization of Lot Test Sample Data

Project	[illegible]	***T-400 #***	1432966
Source	WV Paving Poca	***Source Code***	[illegible]
Material Type	Wearing 1 Rap Heavy	***Mat'l code***	13976
Lot Number	SL1		

Sample ID	Target	SL1 - M1	SL1 - M2	SL1 - M3	SL1 - M4	SL1 - M5	SL1 - M6	SL1 - M7	Average	Standard Deviation
Tech		MJC	MJC	MJC	MJC	JEC				
Oven		1	2	2	1	2				
Oven Corr		0.35	0.2	0.2	0.35	0.2	Factor Needed	Factor Needed		
AC % (Ticket)	**6.2**	**6.47**	**6.51**	**5.98**	**6.05**	**6.13**			**6.23**	**0.25**
AC % (Math)		6.53	6.44	5.89	6.04	6.06			6.19	0.28
Difference		-0.06	0.07	0.09	0.01	0.07				

Gradation

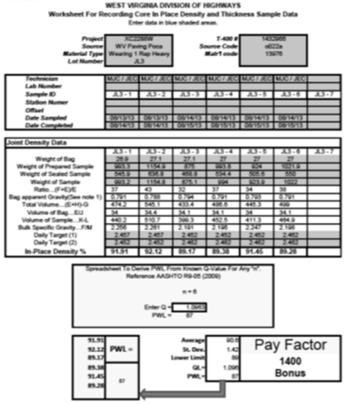
Sample ID	Target	SL1 - M1	SL1 - M2	SL1 - M3	SL1 - M4	SL1 - M5	SL1 - M6	SL1 - M7	Average	Standard Deviation
2 in (50 mm)	100									
1 1/2 in (37.5 mm)	100									
1 in (25 mm)	100									
3/4 in (19 mm)	100									
1/2 in (12.5 mm)	100	100	100	100	100	100			100	0
3/8 in (9.5 mm)	96	96	96	95	95	96			95.6	0.55
No. 4 (4.75 mm)	63	63	64	59	61	63			62	2
No. 8 (2.36 mm)	40	39	40	36	38	39			38.4	1.52
No. 16 (1.18 mm)	30	28	29	25	26	27			27	1.58
No. 30 (600 µm)	22	21	22	19	20	20			20.4	1.14
No. 50 (300 µm)	12	12	12	12	12	12			12	0
No. 200 (75 µm)	**5.6**	**6.1**	**5**	**5.3**	**6.3**	**5.6**			**5.7**	**0.54**

DENSITY CORES	Target	SL1 - DT1	SL1 - DT2	SL1 - DT3	SL1 - DT4	SL1 - DT5	SL1 - DT6	SL1 - DT7	Average	Standard Deviation
Tech		MJC	MJC	MJC	MJC	MJC				
Thickness (Density)	1	1.28	1.24	1.11	1.15	1.25			1.206	0.07
DENSITY		**90.99**	**91.56**	**92.31**	**92.71**	**92.55**			**92.02**	**0.73**

BOND CORES	Target	SL1 - BT1	SL1 - BT2	SL1 - BT3	SL1 - BT4	SL1 - BT5	SL1 - BT6	SL1 - BT7	Average	Standard Deviation
Tech		MJC	MJC	MJC	MJC	MJC				
Thickness (Bond)		1.15	1.21	1.20	1.13	1.19			1.176	0.03
Bond Strength PSI	**100**	**208.86**	**112.70**	**212.99**	**163.51**	**158.89**			**171.4**	**41.22**

Core Density PWL	75	Core Density Pay Factor	92.50%
Asphalt Content PWL	97	Asphalt Content Pay Factor	102.00%
Passing #200 PWL	100	Passing #200 Pay Factor	102.00%

Lot Payment	**97.25%**
Thickness Pay Adjustment	**100.00%**
Bond Strength Pay Adjustment	



WEST VIRGINIA DIVISION OF HIGHWAYS

Worksheet For Recording Core In Place Density and Thickness Sample Data

Enter data in blue shaded areas.

Project XC2288W
Source WV Paving Poca
Material Type Wearing 1 Rap Heavy
Lot Number JL3

T-400 # 1432966
Source Code c022a
Matr'l code 13976

Technician	MJC / JEC	MJC / JEC	MJC / JEC	MJC / JEC	MJC / JEC	MJC / JEC	
Lab Number							
Sample ID	JL3 - 1	JL3 - 2	JL3 - 3	JL3 - 4	JL3 - 5	JL3 - 6	JL3 - 7
Station Numer							
Offset							
Date Sampled	08/13/13	08/13/13	08/14/13	08/14/13	08/14/13	08/14/13	
Date Completed	08/14/13	08/14/13	08/15/13	08/15/13	08/15/13	08/15/13	

Joint Density Data

	JL3 - 1	JL3 - 2	JL3 - 3	JL3 - 4	JL3 - 5	JL3 - 6	JL3 - 7
Weight of Bag	26.9	27.1	27.1	27	27	27	
Weight of Prepared Sample	993.3	1154.9	875	993.8	924	1021.9	
Weight of Sealed Sample	545.9	636.8	468.8	534.4	505.6	550	
Weight of Sample	993.2	1154.8	875.1	994	923.9	1022	
Ratio....(F+E)/E	37	43	32	37	34	38	
Bag apparent Gravity(See note 1)	0.791	0.788	0.794	0.791	0.793	0.791	
Total Volume....(E+H)-G	474.2	545.1	433.4	486.6	445.3	499	
Volume of Bag....E/J	34	34.4	34.1	34.1	34	34.1	
Volume of Sample....K-L	440.2	510.7	399.3	452.5	411.3	464.9	
Bulk Specific Gravity....F/M	2.256	2.261	2.191	2.198	2.247	2.198	
Daily Target (1)	2.457	2.457	2.452	2.452	2.452	2.462	
Daily Target (2)	2.452	2.452	2.462	2.462	2.462	2.462	
In-Place Density %	**91.91**	**92.12**	**89.17**	**89.38**	**91.45**	**89.28**	

Spreadsheet To Derive PWL From Known Q-Value For Any "n".
Reference AASHTO R9-05 (2009)

n = 6

Enter Q = 1.0963
PWL = 87

91.91 92.12 89.17 89.38 91.45 89.28	**PWL =**	87

Average 90.6
St. Dev. 1.42
Lower Limit 89
QL= 1.096
PWL= 87

Pay Factor

1400
Bonus

PWL Paving – Conclusions

- Just remember...

- Best practices
- Consistency

West Virginia University
Asphalt Technology Program

HMA Construction Program

Module 10

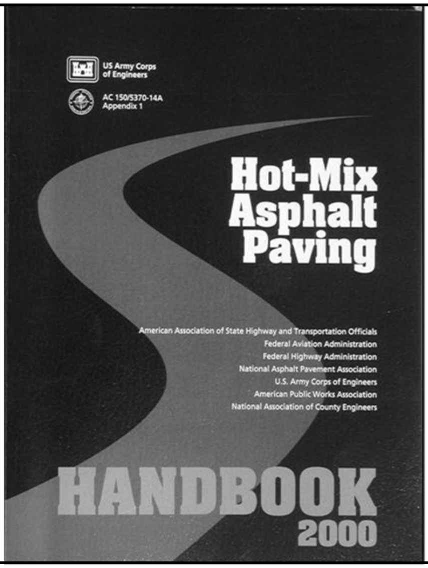
Troubleshooting

Learning Objectives

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

Objective of Effective Troubleshooting?

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



US Army Corps
of Engineers

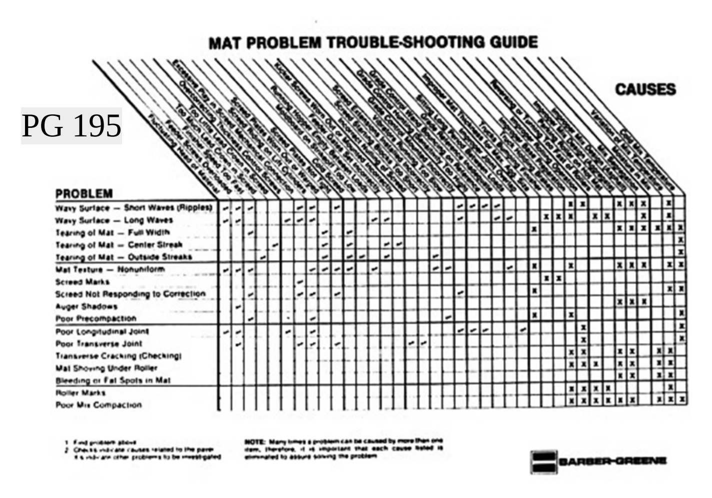
AC 150/5370-14A
Appendix 1

Hot-Mix
Asphalt
Paving

American Association of State Highway and Transportation Officials
Federal Aviation Administration
Federal Highway Administration
National Asphalt Pavement Association
U.S. Army Corps of Engineers
American Public Works Association
National Association of County Engineers

HANDBOOK
2000

PG 195

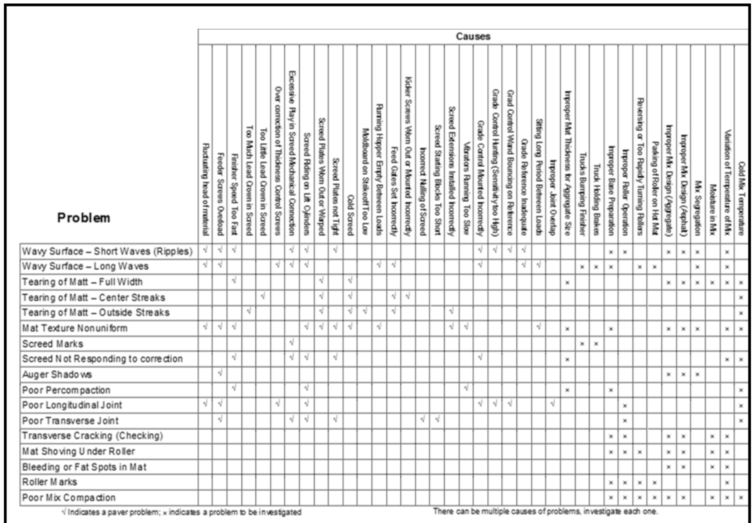


MAT PROBLEM TROUBLE-SHOOTING GUIDE

CAUSES

PROBLEM
Wavy Surface — Short Waves (Ripples)
Wavy Surface — Long Waves
Tearing of Mat — Full Width
Tearing of Mat — Center Streak
Tearing of Mat — Outside Streaks
Mat Texture — Nonuniform
Screed Marks
Screed Not Responding to Correction
Auger Shadows
Poor Precompaction
Poor Longitudinal Joint
Poor Transverse Joint
Transverse Cracking (Checking)
Mat Shoving Under Roller
Bleeding or Fat Spots in Mat
Roller Marks
Poor Mix Compaction

BARBER-GREENE



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

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

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

How to Troubleshoot

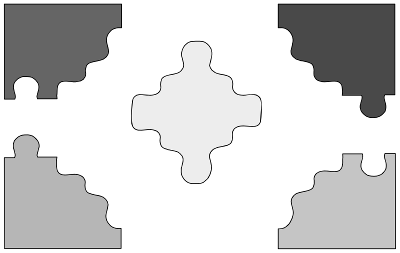
- Step One:

  Stop, step back, look at the big picture

How to Troubleshoot

- Step Two:

  Break the problem down into pieces



How to Troubleshoot

- Step Three:

  Eliminate the obvious factors first

How to Troubleshoot

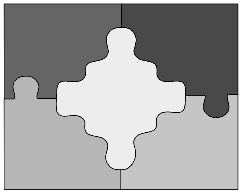
- Step Four:

  Analyze each remaining element in full detail

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

How to Troubleshoot

- Step Six:

  Make recommendations based on facts

How to Troubleshoot

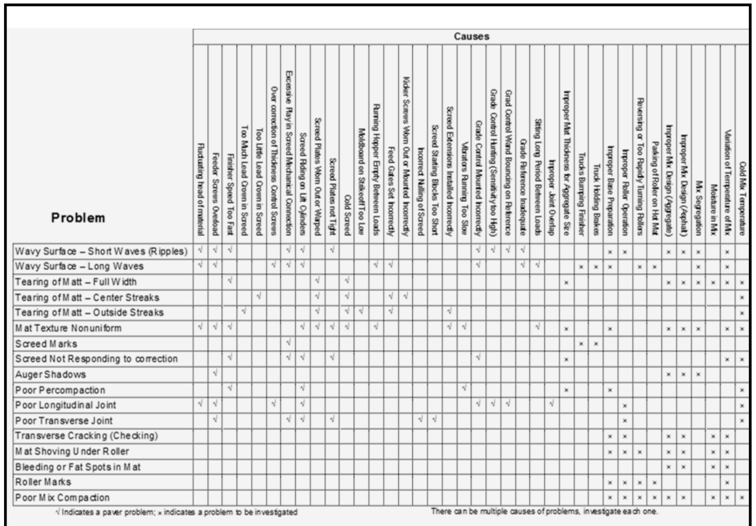
- Step Seven:

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

How to Troubleshoot

- Step Eight:

  Take notes every step of the way



Problem	Causes																																					
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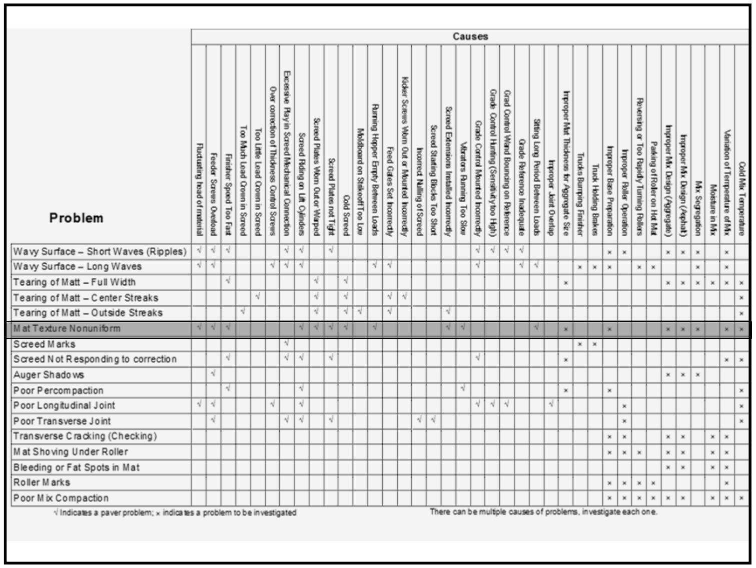
Wavy Surface – Short Waves (Ripples)	√	√	√				√	√		√										√	√	√	√						×	×			×	×	×		×	
Wavy Surface – Long Waves	√	√				√	√	√					√	√						√			√	√			×	×	×		×	×			×		×	
Tearing of Matt – Full Width			√						√		√															×							×	×	×	×	×	×
Tearing of Matt – Center Streaks					√				√		√			√	√																							×
Tearing of Matt – Outside Streaks				√					√		√	√		√				√																				×
Mat Texture Nonuniform	√	√	√					√	√	√	√		√					√	√					√		×			×				×	×	×		×	×
Screed Marks							√																				×	×										
Screed Not Responding to correction			√				√	√		√										√						×											×	×
Auger Shadows		√																															×	×	×			
Poor Percompaction			√					√											√							×			×									×
Poor Longitudinal Joint	√	√				√		√												√	√	√			√					×								×
Poor Transverse Joint		√					√	√		√						√	√													×								×
Transverse Cracking (Checking)																													×	×			×	×		×	×	
Mat Shoving Under Roller																													×	×	×		×	×		×	×	
Bleeding or Fat Spots in Mat																																	×	×		×	×	
Roller Marks																													×	×	×	×					×	
Poor Mix Compaction																													×	×	×	×	×	×		×	×	×

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

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



Problem	Causes																		
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Wavy Surface – Short Waves (Ripples)	√	√	√				√	√		√									
Wavy Surface – Long Waves	√	√				√	√	√					√	√					
Tearing of Matt – Full Width			√						√		√								
Tearing of Matt – Center Streaks					√				√		√			√	√				
Tearing of Matt – Outside Streaks				√					√		√	√		√				√	
Mat Texture Nonuniform	√	√	√					√	√	√	√		√					√	√
Screed Marks							√												
Screed Not Responding to correction			√				√	√		√									
Auger Shadows		√																	
Poor Percompaction			√					√											√
Poor Longitudinal Joint	√	√				√		√											
Poor Transverse Joint		√					√	√		√						√	√		
Transverse Cracking (Checking)																			
Mat Shoving Under Roller																			
Bleeding or Fat Spots in Mat																			
Roller Marks																			
Poor Mix Compaction																			

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

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

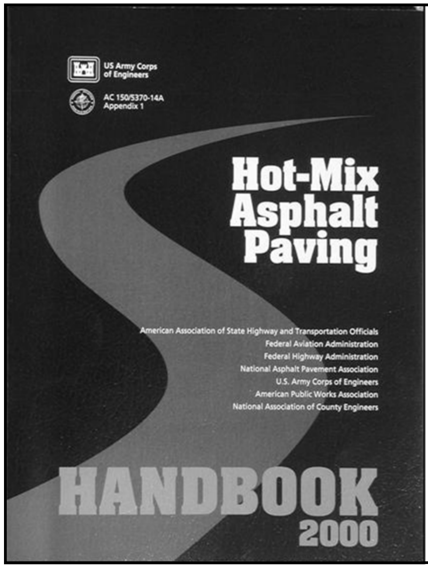
There can be multiple causes of problems, investigate each one.

Segregation Troubleshooting

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

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


US Army Corps of Engineers
AC 150/5370-14A
Appendix 1

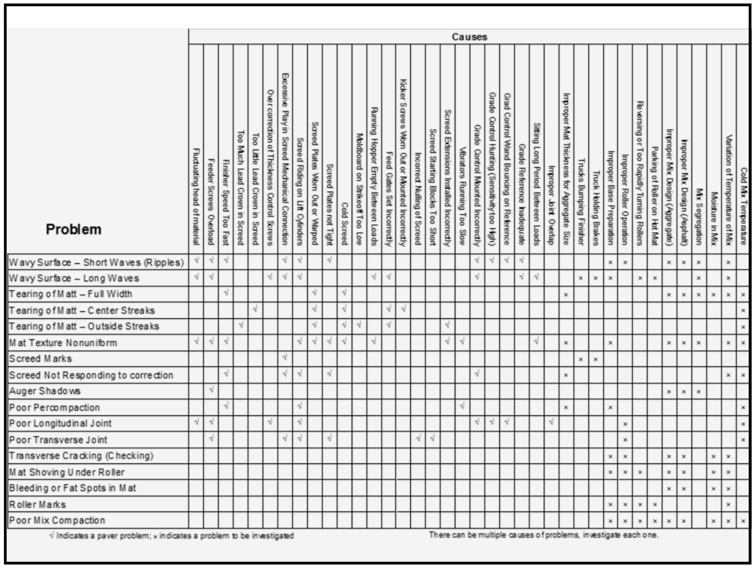
Hot-Mix Asphalt Paving

American Association of State Highway and Transportation Officials
Federal Aviation Administration
Federal Highway Administration
National Asphalt Pavement Association
U.S. Army Corps of Engineers
American Public Works Association
National Association of County Engineers

HANDBOOK
2000

Section 19 -

Mat Problems



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

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

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

Example 1

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

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

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

Example 1

Example 1

- What would cause this?

Handbook Pages 202 – 203

- What can you do right now to correct this?

Handbook Pages 203 - 204

Example 2

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

This is slightly more noticeable at the transverse joints.

The test results from the day before meets the specifications.

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

Example 2

Example 2

- What would cause this?
- Should you Pave today?
- What can you do right now to correct this?

Example 2

Example 2

Example 3

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

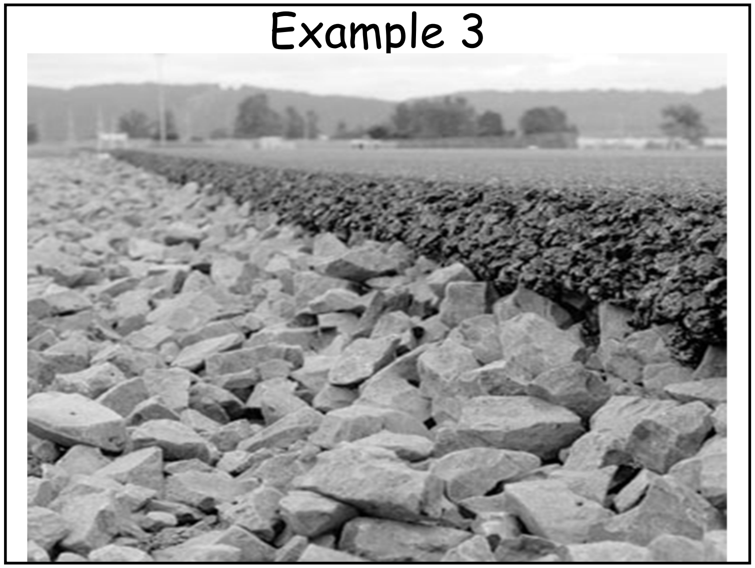
Even with a double drum vibratory and a 10 ton pneumatic roller, you are barely able to achieve the minimum density on the 2 ½" mat.

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

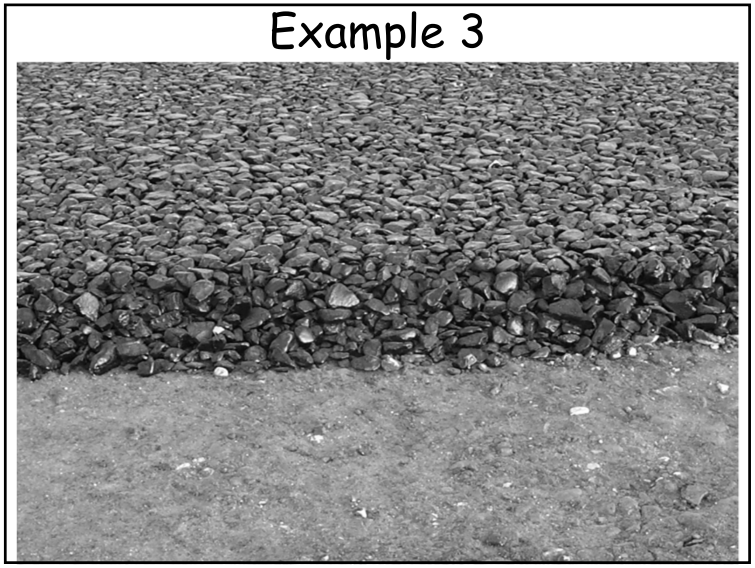
Yes, the test strip did pass, but do you start paving?

Example 3

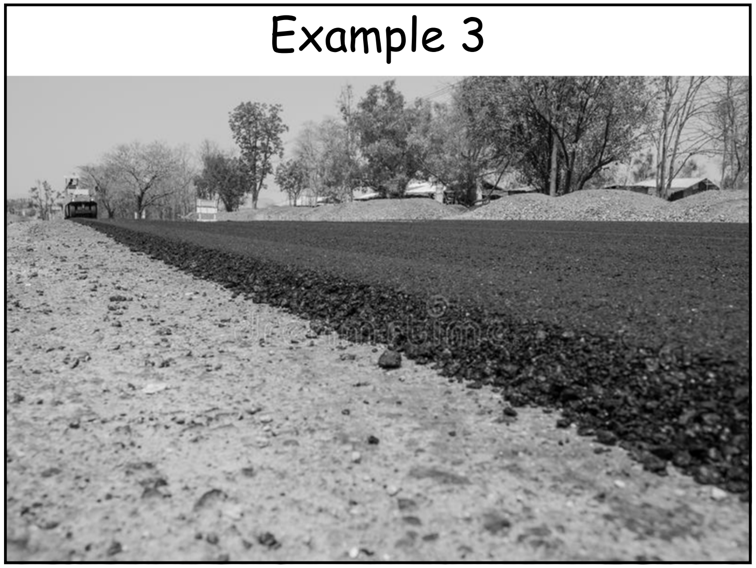
- As a consultant, what do you recommend?
- What all should you check before proceeding?
- What are your options?



Example 3



Example 3



Example 3

Questions??

WEST VIRGINIA DEPARTMENT OF TRANSPORTATION
DIVISION OF HIGHWAYS
CONTRACT ADMINISTRATION DIVISION

MATERIALS PROCEDURE

COMPACTION TESTING OF HOT-MIX ASPHALT PAVEMENTS

1.0 PURPOSE

1.1 The purpose of this procedure is to establish the test methods for quality control testing by the Contractor and verification testing by the Division.

2.0 SCOPE

2.1 This procedure is applicable for all items of hot-mix asphalt pavements requiring compaction testing.

3.0 DEFINITIONS

3.1 Quality Control Testing – Testing conducted by the Contractor to monitor and control the production of their product.

3.2 Verification Testing – Testing conducted by the Division to determine specification compliance.

4.0 APPLICABLE DOCUMENTS

AASHTO R11
MP 712.21.26

5.0 EQUIPMENT

5.1 Nuclear density gauges of the backscatter type.

5.2 One measuring tape of approximately 50 feet (20 meters).

5.3 Lime or other suitable material to mark test sites.

5.4 Dry mortar sand.

5.5 Supply of T401 or T407 data sheets.

6.0 ROUNDING OF DATA

6.1 Test data must be rounded according to AASHTO R11.

6.2 Test data and calculations are rounded to the following nearest significant digit.

Station Number	1 ft (0.1 m)
Offset	1 ft (0.1 m)
Wet Density	0.1 lb/ft^3 (1 kg/m^3)
Target Density	0.1 lb/ft^3 (1 kg/m^3)
Lift Thickness Compacted	0.25 inch (1 mm)
Relative Density	1 %
Average Relative Density	1 %
Average Wet Density	0.1 lb/ft^3 (1 kg/m^3)

7.0 STANDARDIZATION OF NUCLEAR GAUGE

7.1 Warm up the gauge in accordance with the manufacturer’s recommendations.

7.2 Standardization must be performed away from metal and other objects.

7.3 Clean the top of the standard block and the bottom of the gauge with a cloth.

7.4 Make sure the gauge is turned the correct way on the block.

7.5 After making the necessary adjustments on the gauge for standardization, take a four minute count for density.

7.6 Compare the standard count to the manufacturer's standard count. The standard count must be within ± 2% from the manufacturer's standard.

7.7 If the gauge is not within the specified tolerance, repeat the standardization. If the gauge will not standardize after four attempts, there is probably something wrong with the gauge. There may be electronics problems, the gauge needs calibrated, or a stability check needs to be performed. Do not use a gauge for testing if it will not standardize.

7.8 A gauge must be standardized before testing and at least every four hours during testing.

8.0 COMPARISON OF GAUGES

8.1 The gauge used for the Contractor's quality control testing should be compared with the gauge used for the Division's verification testing.

8.2 Standardize both gauges according to 7.1 through 7.8.

8.3 Place the aluminum plate provided by the Division on the standard block used for verification testing. Place the standard block on material weighing a minimum of 110 lb/ft^3 (1762 kg/m^3). The block must not be near metal or other objects during testing and must not be moved. Keep the gauges separated a minimum of 30 feet (9.1 meters) during testing.

8.4 Take 5 one minute wet density readings with each gauge in the backscatter position. The gauges are to be oriented on the block the same as for standardization.

8.5 Record the wet density readings exactly as shown on the gauge. The range of the five readings shall not exceed 1.5 lb/ft^3 (24 kg/m^3). If the readings exceed this range, perform a new set of five readings. A gauge should not be used if the repeatability of the gauge is not within this range.

8.6 Average the five readings for each gauge. The gauges are considered similar if the averages of the readings are within 3 lb/ft^3 (48 kg/m^3).

8.7 The density readings for verification testing will not be adjusted to compensate for any differences in readings between gauges.

9.0 QUALITY CONTROL TESTING

9.1 Record the test data on a T401 form.

9.2 Divide the LOT into five equal sublots.

9.3 Randomly locate a test site within each sublot according to MP 712.21.26.

9.4 Check each test site to determine if there are surface voids. Fill the voids with dry mortar sand. Avoid a build-up of fines on the surface to no more than 0.1 inch (3 mm).

9.5 Take a one minute wet density reading on each test site.

9.6 Perform the calculations on the Division approved form.

9.7 Compare the relative densities to the specification requirements.

9.8 The results of the quality control tests should be used by the Contractor to judge if the LOT will meet specifications when verification tests are performed by the Division. Corrective measures are to be taken to bring the LOT into specifications if the quality control tests indicate that a nonconformance situation exists.

10.0 LOT-BY-LOT DIVISION VERIFICATION TESTING

10.1 Once the Contractor offers a LOT of material to the Division for testing, verification testing will be performed to determine compliance to the specifications.

10.2 Randomly locate a test site within the LOT according to MP 712.21.26.

10.3 Check each test site to determine if there are surface voids. Fill the voids with dry mortar sand. Avoid a build-up of fines on the surface to no more than 0.1 inch (3 mm).

10.4 Take a one minute wet density reading in the backscatter position.

10.5 Perform the calculations on the T401 form.

10.6 Compare the percent relative density to the specification range. If the value is within the range, the LOT is accepted for density.

10.7 When the percent relative density is outside the specification range, divide the LOT into five equal sublots and randomly locate a test site in each sublot according to MP 712.21.26.

10.8 Take a wet density reading at each test site.

10.9 Average the five wet densities.

10.10 Calculate the percent relative density.

10.11 The LOT would be acceptable if the average relative density falls within the specification range. A nonconformance situation exists if the value is outside the range.

11.0 ROLLERPASS COMPACTION PROCEDURE

11.1 When the total new pavement thickness is limited, the specifications may require that compaction testing will be performed in accordance with the following rollerpass procedure.

11.2 At the beginning of the work, a test section shall be constructed with a length of 100 feet (30 meters) and the width of the paving operation except in restricted areas. If the 100 feet (30 meters) length cannot be obtained, then the test section shall be the maximum obtainable length.

11.3 If there is a concern that the existing pavement conditions may cause difficulty in obtaining the specified density requirement then the Division will either monitor or conduct density testing of the existing pavement before the test section is constructed. Five randomly located wet density tests will be conducted within the test section area and the results will be recorded on a T401 form. Additional testing may also be conducted on other sections of the existing pavement if it is considered necessary for later evaluation.

11.4 To determine the number of roller passes for lift thicknesses of less than 1.5 inches (38 mm), immediately after placement start the rolling operation on the test section and continue this process until the mat temperature reaches 175 °F (80 °C). If the mat begins to show signs of distress (such as excessive surface aggregate breakage or mat cracking) before reaching 175 °F (80 °C), then discontinue rolling and record the number of roller passes completed before the stress signs occurred. The mat temperature may be lowered to 165 °F (74 °C) if the contractor can demonstrate through the test section that additional densification can be achieved at this lower temperature without causing any pavement distress.

11.5 If the lift thickness is 1.5 inches (38 mm) or greater, the rolling operation may be stopped at 200 °F (93 °C) to conduct density testing as per Section 11.7. If additional rolling is needed then continue as per Section 11.4. If the air temperature is below 60 °F (16 °C), the rolling operation should not be halted until the mat temperature reaches 175 °F (80 °C) unless the distress signs described in Section 11.4 occur. Project conditions may require the Engineer to determine the proper rolling application for lift thicknesses of 1.5 inches (38 mm) or greater.

11.6 The Division will either conduct or closely monitor all density testing on the test section.

11.7 Divide the test section into two equal sublots and randomly locate a test site within each according to MP 712.21.26. Take a wet density reading on each sublot using the procedure described in Section 10.3 and 10.4. Determine the average wet density obtained from the two sublots and use this average to calculate the relative density of the test section. Record all rollerpass density test data on a T407 form.

11.8 If the relative density of the test section is within 92 – 96 % of the maximum density of the approved mix design, or the maximum density established by the most recent plant mix formula verification, then density has been achieved and the number of roller passes has been established for the remainder of the project.

11.9 If the relative density of the test section is above 96 % the Division will make a visual evaluation of the mat and the mixture to look for any appearance of excessive asphalt or an extremely fine mix which may result in over compaction. A review of any density test results obtained from the existing pavement will be made to determine if the existing pavement density was significantly higher than the target density of the mix. The Division will determine whether additional test sections are needed or that the pavement is compacted to the satisfaction of the Engineer with the established number of roller passes. If it is later determined, through the Contractor’s daily quality control testing, that the mix had an air void content below 2.5% then proper adjustments shall be made to the mix to bring the air voids back into the allowable tolerance limits. The Division may require the Contractor to establish a new test section if such mix adjustments are required.

11.10 If the relative density of the test section is below 92 %, then a new test section shall be established and the Contractor shall make adjustments to his rolling operation in an attempt to achieve a higher density level before the mat temperature reaches 175 °F (80 °C).

11.11 If the density requirement is not met after two consecutive test sections are completed, the Division will determine whether additional test sections are needed or that the pavement is compacted to the satisfaction of the Engineer with the established number of roller passes. To help with this decision, an evaluation will be made of the existing pavement condition and any density test results obtained prior to construction of the test section will be reviewed. If it is later determined, through the Contractor’s daily quality control testing, that the mix had an air void content above 5.5% then proper adjustments shall be made to the mix to bring the air voids back into the allowable tolerance limits. The Division may require the Contractor to establish a new test section if such mix adjustments are required.

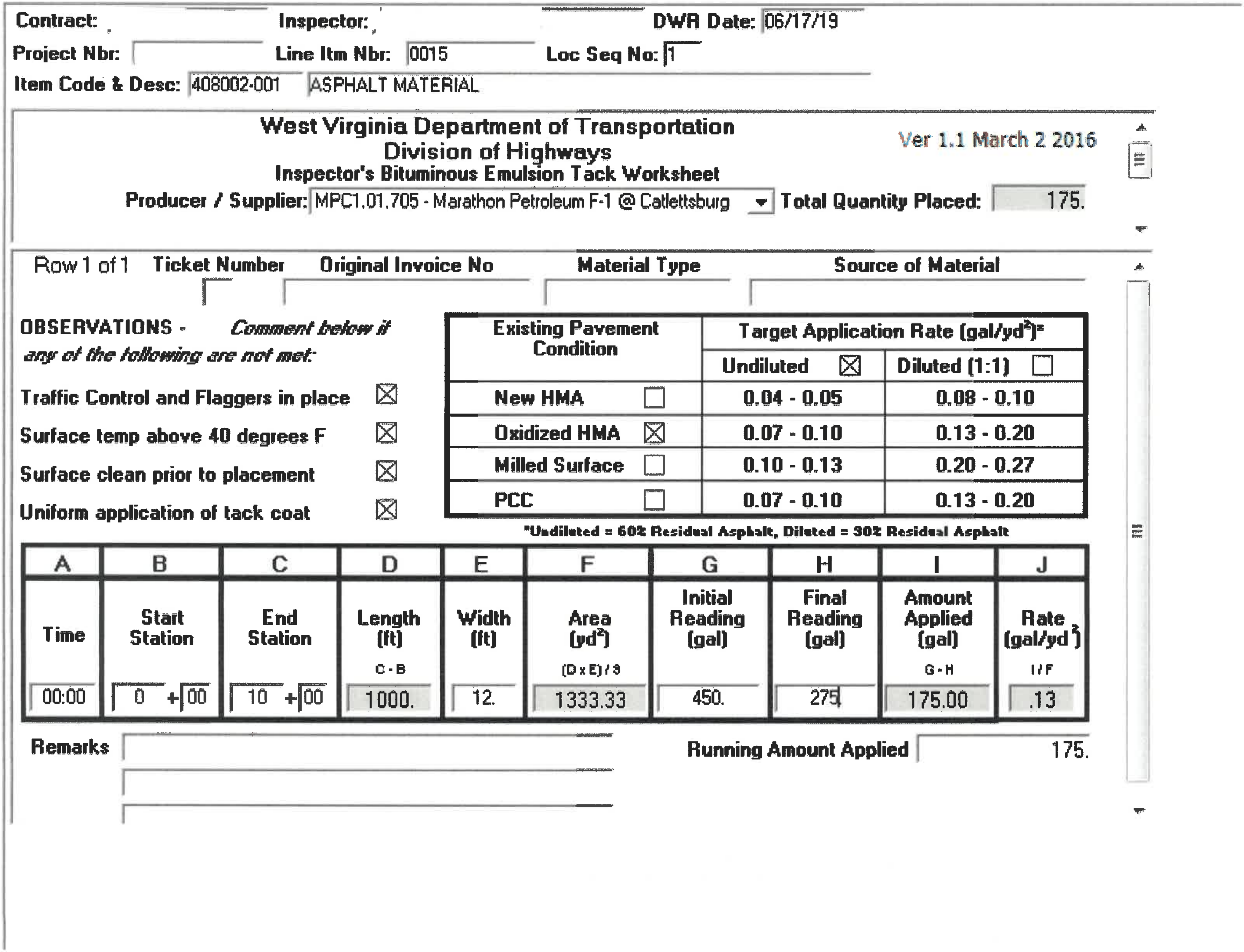
11.12 The established number of roller passes shall continue for the remainder of the project unless the Division determines that weather conditions or changes in the condition of the existing roadway are affecting the rolling operation. Under such circumstances, the Division may request that a new roller pattern be established through a new test section.

11.13 The designated number of roller passes shall continue to be completed before the mat temperature falls below 175 °F (80 °C) unless the conditions of Section 11.4 have been established.

11.14 The Contractor shall designate a person to monitor and document the number of roller passes and the mat temperature through the duration of the project.

Robert K. Tinney

Robert K. Tinney, Director
Contract Administration Division



Contract:

Inspector:

DWR Date: 06/17/19

Project Nbr:

Line Itm Nbr: 0015

Loc Seq No: 1

Item Code & Desc: 408002-001 ASPHALT MATERIAL

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

Ver 1.1 March 2 2016

Producer / Supplier: MPC1.01.705 - Marathon Petroleum F-1 @ Catlettsburg

Total Quantity Placed: 175.

Row 1 of 1

Ticket Number	Original Invoice No	Material Type	Source of Material

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

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

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

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

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

Remarks

Running Amount Applied 175.

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

AUTH NO: ____________________ **PROJECT NO:** ____________________ **IDR NO:** ____________

LINE NO: ____________________ **ITEM NO:** ____________________ **DATE:** ____________

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

REMARKS: ____

____

____

____

____

TOTAL Tons (Mg) THIS DATE: ____________________ **INSPECTOR:** ____________________

5/19/2009

Signature

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

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

PLAN THICKNESS ____________

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

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

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

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

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

TIME						
MAT TEMPERATURE						
MAT THICKNESS						
STATION						

TIME						
MAT TEMPERATURE						
MAT THICKNESS						
STATION						

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

TIME						
ROLLER SPEED						

CHECKS ☐ VERIFIED PRIOR TO PLACEMENT CHECKS ☐ VERIFIED DURING PLACEMENT

☐ SEQUENCE OF OPERATION VERIFIED

☐ TRAFFIC CONTROL DEVICES AND FLAGGERS IN PLACE

☐ HEEL-IN JOINTS CUT AND POTHOLES CORRECTED

☐ SURFACE CLEAN AND STRINGLINE PLACED

☐ ROLLER(S) AND PAVER(S) VERIFIED FOR COMPLIANCE

☐ CONTRACTORS DENSITY TECHNICIAN ON SITE

☐ LONGITUDAL JOINTS PINCHED / NO OVERLAPPED

☐ TRUCKS COVERED AND INSULATED WITH NO OIL LEAKS OR DAMAGED BKDS

☐ OPERATION CONTINUOUS AND PAVER SPEED COMPATIBLE TO PLANT PRODUCTION

☐ VIBRATING SCREED ON AND TEXTURE OF MAT CORRECT

☐ CORRECT ROLLING SEQUENCE BEING USED

☐ STRAIGHT EDGE CHECKS BEING MADE

☐ COMPLINACE WITH QUALITY CONTROL PLAN MAINTAINED

☐ TEMPERATURE OF MATERIAL RECORDED ON TICKETS ONCE PER HOUR MINIMUM

AIR TEMP ______ °C (°F) AT (TIME) ______

AIR TEMP ______ °C (°F) AT (TIME) ______

BASE TEMP ______ °C (°F) AT TIME ______

BASE TEMP ______ °C (°F) AT TIME ______

RPT-ID: RDWRHCON

USER:

West Virginia
Department of Transportation

DATE: 06/06/2019

PAGE: 1 of 5

DAILY WORK REPORT FOR CONTRACT:

DWR Date: 08/11/2018	**Contract ID:**	**Authorized:** Yes	**Locked:** No	**Paid:** Yes
Inspector ID:	**Inspector:**			
High Temp: 79	**Low Temp:** 62	**A.M. Condition:** CLOUDY	**P.M. Condition:** PARTLY CLOUDY	
Work Suspended Time: 00:00	**Work Resumed Time:**00:00	**No Work Items Instld:** ☐	**No Contrs Present:** ☐	**No Staff Present:** ☒

Remarks: Yes

aGENERAL

Contractor Hours
- 6:30 am to 1:30 pm= 7 hrs nlb
6:30 am to 1:30 pm= 7 hrs NLB

WV DOH Hours
6:00 am to 2:00 pm= 7.5 hrs (.25 hr travel, 7.25 hr worked)
- 6:00 am to 2:00 pm= 7.5 hrs (.25 hr travel, 7.25 hr worked)
- 6:00 am to 2:00 pm= 7.5 hrs (.25 hr travel, 7.25 hr worked)

ATTACHMENT

2018 08 11 DWR 0015 Asphalt Tickets

2018 08 11 DWR 0010 Tack Ticket

CONTROLLING ITEM

0015 410007-010 Marshall Skid HMA

This is a non-chargeable day due to it being a weekend but project is in liquidated damages.

MATERIALS

0015 410007-010 Marshall Skid Mix
Lab # C8181836

DAILY WORK REPORT FOR CONTRACT:

Contractor Information

Contractor ID: **Contractor Name:** **Hrs Worked:** 7.000

Nbr of Supervisors: **Nbr Of Workers:** 14

Variable Labor:

Personnel Title	Qty	Hrs.Worked
LABORER 2 are foremans	7	0.000
OPERATING ENGINEER	7	0.000

Equipment:

Description	Qty	Qty Used	Hrs. Used
DUMP TRUCKES	1	0	0.000
HAND TOOLS	1	1	0.000
PAVER Plus a material transfer machine.	2	2	0.000
PICKUP TRUCK	5	5	0.000
POWER BROOM	3	1	0.000
ROLLERS	3	3	0.000
SKID STEER	1	0	0.000
TACK TRUCK	1	1	0.000

TOOL TRUCK	1	1	0.000

Contractor ID: **Contractor Name:** **Hrs Worked:** 7.000

Nbr of Supervisors: **Nbr Of Workers:** 3

Variable Labor: Personnel Title	Qty	Hrs.Worked
FLAGGERS	2	0.000
TRUCK DRIVER	1	0.000

Equipment: Description	Qty	Qty Used	Hrs. Used
PICKUP TRUCK	1	1	0.000

Work Item Information

Item Code: 408002-001 **Description:** ASPHALT MATERIAL

Supp Desc 1:

Supp Desc 2:

Template Name

Bituminous Emulsion Tack Worksheet

Project Nbr	Line Item Nbr	Catg.	Plan Pg Nbr	Place Qty	Units	Contractor ID Contractor Name	Measured	Instld Qty
	0010	0001	0	200.000	GA		No	3,250.00

Location: Sta 121+25 to 158+67 LT CL

	Station	Offset	Distance		Station	Offset	Distance
From:	+ 0.000		0.000	**To:**	+ 0.000		0.000

Contractor , was on project this date placing Asphalt Material for tack coat. Prior to placement, roadway was cleared of debris using a tractor broom. A tar distributor truck was used to apply material to the roadway and allowed to break prior to paving over.

DAILY WORK REPORT FOR CONTRACT:

Item Code: 410007-010 **Description:** MARSHALL ASPHALT SKID PVT, TY I
Supp Desc 1:
Supp Desc 2:

Project Nbr	Line Item Nbr	Catg.	Plan Pg Nbr	Place Qty	Units	Contractor ID Contractor Name	Measured	Instld Qty
	0015	0001	0	7,525.830	SY		Yes	63,523.07

Location: Sta 121+25 to 158+67 LT CL

	Station	Offset	Distance		Station	Offset	Distance
From:	+ 0.000		0.000	**To:**	+ 0.000		0.000

Contractor ' was on project this date placing HMA Skid Pavement. Prior to placement, line 0010 was performed. Material was delivered to project in dump trucks and dumped in the hopper transfer machine then placed in the paver and place at a rate of 165 lb/sy and at a mainline width of 14.5 ft with a paved shoulder of 10' making an average road widge of 17.82' when calculated. A second paver was used to do paved shoulders in front of mainline paver to hot lap longitudinal joint and to keep mainline paver from having to pick up. A steel drum roller was used to roll along curb line but left longitudinal joint area unrolled. after joint was hot lapped, 2 steel drum rollers were used to compact material until desired compaction was met. Cores and loose lift samples were taken by WV DOH District 8 materials, and personnel.

Station 121+25 to 158+67 LT CL Main line
Station 71+75 to 72+80 LT CL Approach (an additional 10' swipe was done at this approach on 8/10/18 due to the steepness of the approach.

Calculations
121+25 to 158+67= 3742 lf
3742 x 17.82' w avg /9= 7409.16 SY

71+75 to 72+80= 105 lf
105 x 10' w avg /9 = 116.67 sy

Total= 7525.83 SY

628.24 tn was used this day. Approximately 610 tn was used on project and the remainder was sent back to the plant.

Item Code: 636006-001 **Description:** PILOT TRUCK AND DRIVER
Supp Desc 1:
Supp Desc 2:

Template Name
Visual Inspection

Project Nbr	Line Item Nbr	Catg.	Plan Pg Nbr	Place Qty	Units	Contractor ID Contractor Name	Measured	Instld Qty
	0030	0001	0	1.000	DA		No	11.00

Location: Sta 116+00 to 158+67 LT RT CL

	Station	Offset	Distance		Station	Offset	Distance
From:	+ 0.000		0.000	**To:**	+ 0.000		0.000

Subcontractor ' provided a pilot truck and driver to direct traffic through work zone between flaggers. Pilot truck was properly equipped and performed their job safely.

Item Code: 636011-001 **Description:** TRAFFIC CONTROL DEVICE

Supp Desc 1:
Supp Desc 2:

Template Name

Daily Check Lists

							Contractor ID	
Project Nbr	**Line Item Nbr**	**Catg.**	**Plan Pg Nbr**	**Place Qty**	**Units**	**Contractor Name**	**Measured**	**Instld Qty**
	0045	0001	0	.000	UN		No	7,110.00

Location: Sta 0+00 to 158+67 RT LT CL

	Station	Offset	Distance		Station	Offset	Distance
From:	+ 0.000		0.000	**To:**	+ 0.000		0.000

All but on Traffic Control Devices are upright, clean, legible and performing their intended function. The Road Work Ahead Sign was knocked down and has been down for a few days. Superindendant was informed. All Type B lights were properly functioning. Two sets of temporary signs were used on each end of project to allow for second flagger on mainline.

Traffic Control Checks were performed every 2 hrs by the DOH personnel to make sure everything was still in place.

Times Checked
6:30 am
8:30 am
11:00 am

Item Code: 636014-001 **Description:** FLAGGER

Supp Desc 1:
Supp Desc 2:

Template Name

Flaggers Hours - 636014-001

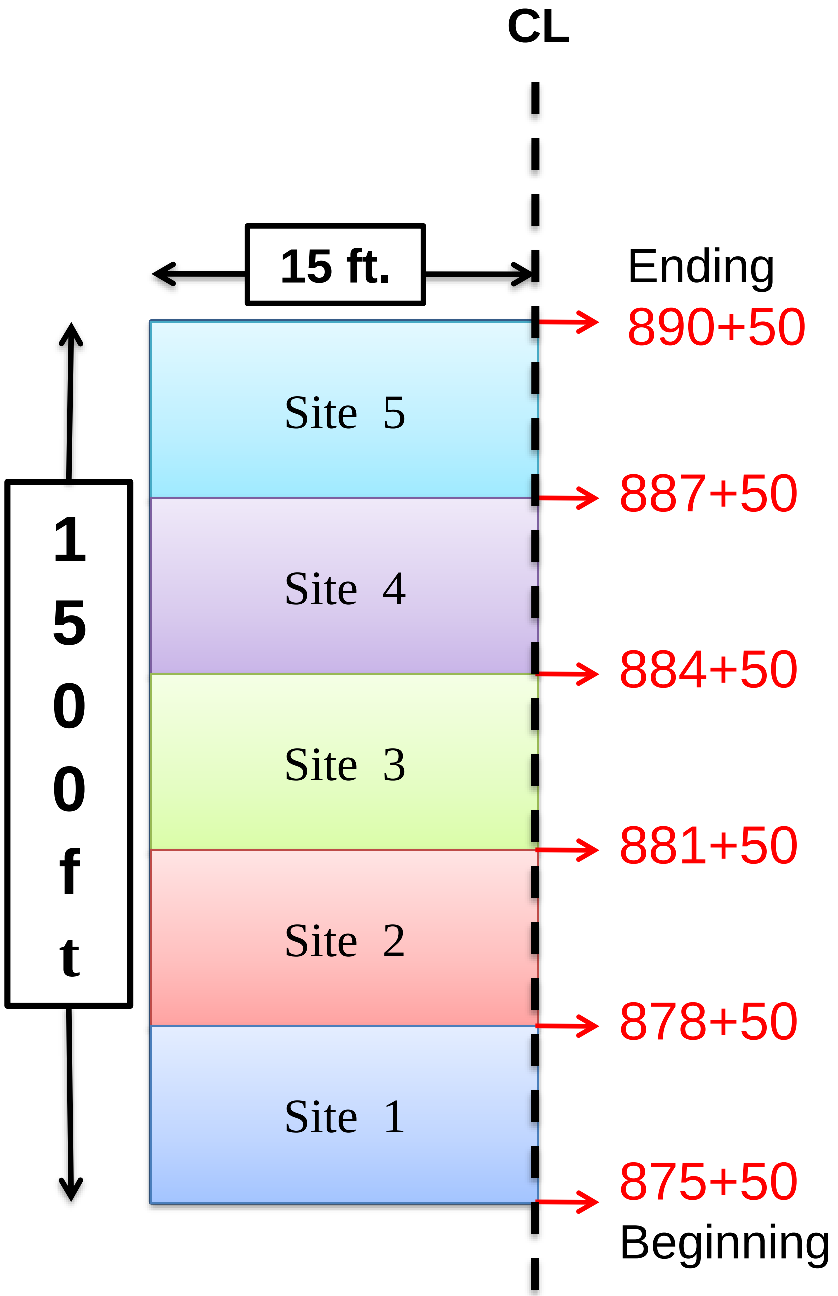
							Contractor ID	
Project Nbr	**Line Item Nbr**	**Catg.**	**Plan Pg Nbr**	**Place Qty**	**Units**	**Contractor Name**	**Measured**	**Instld Qty**
	0050	0001	0	56.000	HR		No	805.50

Location: Sta 85+00 to 158+67 RT LT CL

	Station	Offset	Distance		Station	Offset	Distance
From:	+ 0.000		0.000	**To:**	+ 0.000		0.000

Subcontractor provided 8 flaggers to stop, slow and hold traffic until pilot truck arrives. Flaggers were properly attired, courteous and performed their job safely. 2 of the flaggers were used as secondary flaggers on the mainline to alert drivers in areas that traffic gets backed up around turns were they cannot be seen.

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



T - 401
Rev 2019-03-20

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

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

Thin Lift Correction :	**Beginning Station:**			**Ending Station:**						
Site:	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
Station:										
Offset:										
Wet Density:										
Existing Surface Type Note 1:			**Average Existing Density : (A)**							

10 Randomly selected Tests within the first 1,500 Feet of the Project or after a change in the surface.

Date:										
Beginning Station:										
Ending Station:										
Paving Width (Feet):										
Lab Number:										
Lot Number:	A1	J1	A2	J2						
Offset (Rt or Lt of CL):		4 Inches		4 Inches		4 Inches		4 Inches		4 Inches
1										
2										
3										
4										
5										
Average Density: **C = Avg (1 thru 5)**										
"k" Value (k) Note2										
Corrected Density: (D)										
Relative Density (%): (E)										
ot Evaluation: Pass/Fail										
Lot % Pay (%)										

New Asphalt Overlay Thickness	1.25	1 1/2"	1 3/4"	2"	2 1/4"	2 1/2"	2 3/4"	3"	3 1/4"
Troxler (3430/3440) "K" values	0.35889	0.28454	0.21914	0.16495	0.12078	0.08418	0.05434	0.02962	0.00947

% Relative Density	97-95	94%	93%	92%	91%	90%	89%	88%	87%	86%
Mat Density % Pay	102%	100%	100%	100%	96%	92%	88%	84%	74%	64%
Joint Pay Adjustment	**2%**	**2%**	**1%**	**1%**	**0%**	**0%**	**-1%**	**-3%**	**-9%**	**-15%**

Technician's Name:	PRINT	REMARKS
	SIGN	
	Cert #.: DATE	
Reviewer's Name:	PRINT	
	SIGN	Note 1: (Milled, Un-Milled, Scratch, Concrete, Etc.) Note 2: K's listed for Troxler 3400 Series Gauges only Note3: DO NOT round numbers until final answer. Note 4: Report all Densities in kg/m3
	Cert #: DATE	

$$Corrected\ Density(D) = \frac{Wet\ Density(C) - (K *Existing\ Density(A))}{(1-K)}$$

$$Relative\ Density(E)(\%) = \frac{Corrected\ Density\ (D)}{Target\ Density} * 100\%$$

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

3/19/2019

T - 407
Rev 2019-04-04

West Virginia Division of Highways
401/402 Rollerpass Asphalt Compaction Form

Project Number:		**Item Number:**		**Gauge Number :**	
Contract ID:		**T400 Number:**		**Mfr Std Count :**	
Contract Line Item:		**Target Density:**		**Density Std Count :**	
Plant Source Code:		**Lift Thick (in) :**		**District & County:**	
Lab Number:		**K - Factor** $^{\text{Note2}}$**:**		**Date:**	

Thin Lift Correction	1	2	3	4	5	Existing Surface Type $^{\text{Note 1}}$:	
Station Number						Beginning Station	
Offset (RoC/E)						Ending Station	
Wet Density (kg/m3)						Average Existing Density (A)	

Control Section	Begin Station		Ending Station				Site #	Station		Offset
Section Number:							A			
							B			
Readings after:	**4 Passes**		**6 Passes**		**8 Passes**		**10 Passes**		**12 Passes**	
Site #	**A**	**B**	**A**	**B**	**A**	**B**	**A**	**B**	**A**	**B**
Mat Temperature (F)										
Wet Density (Kg/m³)										
Avg Wet Density (Kg/m³)										
Corrected Density										
Relative Corrected Density										

Proving Section	Begin Station		Ending Station							
Section Number:										
Site #	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
Station number										
Offset										
Mat Temperature (°F)										
Wet Density (Kg/m³)										
Average Wet Density				Average Corrected Wet Density						
Avg Relative Corrected Density					**Pass/Fail**					

Technician's Name:	PRINT	REMARKS
	SIGN	
	Cert #.: DATE	
Reviewer's Name:	PRINT	
	SIGN	Note 1: (Milled, Un-Milled, Scratch, Concrete, Etc.) Note 2: K's listed for Troxler 3400 Series Gauges only Note3: DO NOT round numbers until final answer. Note 4: Report all Densities in kg/m3
	Cert #: DATE	

$$Corrected\ Density = \frac{Wet\ Density - (K * Existing\ Density(A))}{(1-K)} \qquad Relative\ Density(\%) = \frac{Overlay\ Density}{Target\ Density} * 100\%$$

New Asphalt Overlay Thickness	1 1/4	1 1/2"	1 3/4"	2"	2 1/4"	2 1/2"	2 3/4"	3"	3 1/4"
Troxler (3430/3440) "K" values	0.35889	0.28454	0.21914	0.16495	0.12078	0.08418	0.05434	0.02962	0.00947

2019-04-04

PWL Paving – Example Setup

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

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

PWL Paving – Example Setup

- **3500 ton project, single “extended” lot**

Determine	Method	Answer
Area (SY)	**Area (ft) / 9**	
Loose Samples	**One per mat sublot**	
Mat Density Samples	**One per mat sublot**	
Bond Strength Samples	**One per mat sublot**	
Joint Density Samples	**One per JOINT sublot**	
Thickness Samples	**Use Bond Strength & Mat Density Cores**	

PWL Paving – Pay Adjustment Example

- **Determine the pay factors for this example lot**

Property	PWL	Pay Factor
Density	97	
Asphalt Content	90	
Gradation	86	

PWL Paving – Pay Adjustment Example

- **Joint PWL is 57. What is the bonus or penalty?**

PWL Paving – Pay Adjustment Example

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

$$\% \; \boldsymbol{Adjustment} = \frac{\boxed{}}{\boxed{}} \; \boldsymbol{x} \; \mathbf{100}$$

$$\% \; \boldsymbol{Adjustment} = \boxed{}$$

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

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

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