

**Construction of Quality Hot Mix Asphalt Pavements - 1 Day Course** asphalt institute

asphalt ACADEMY

## Placing Hot Mix Asphalt

**Gregory A. Harder, P.E.**  
Asphalt Institute Regional Engineer  
Tully, NY

Training, so necessary. ▲


## Topics to be Covered

asphalt institute

- **Surface Preparation**
- **Hot-Mix Delivery**
- **Paving Equipment**
- **Paving Procedures**

W e ' r e d r i v e n . www.asphaltinstitute.org ▲

## Surface Preparation

asphalt institute

The performance of a hot mix asphalt pavement is strongly related to the condition of the surface on which it is constructed.

W e ' r e d r i v e n . www.asphaltinstitute.org ▲

## Surface Preparation

asphalt institute

- 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

W e ' r e d r i v e n . www.asphaltinstitute.org ▲

## Surface Preparation

asphalt institute

The most common surfaces overlaid with HMA or WMA include:


- **Subgrade**
- **Granular Base Course (Aggregate Base)**
- **Existing Asphalt Pavement**
- **Existing PC Concrete Pavement**

W e ' r e d r i v e n . www.asphaltinstitute.org ▲

## Subgrade Preparation

asphalt institute

- The subgrade is the pavement foundation
- Must support the pavement and anticipated traffic
  - Soil type considered in thickness design
- Must be properly graded to provide drainage
  - Transverse and longitudinal grade
  - Smoothness and cross slope
- Must be uniformly compacted to required density




W e ' r e d r i v e n . www.asphaltinstitute.org ▲

# Placing Hot Mix Asphalt

## Proof Rolling

asphalt institute



- Tire pressure at least 90% of maximum
- At least 6600 lb. per tire
- Roll full width using two complete passes
- If test rolling reveals soft, yielding, or unstable areas, remove
- Replace with approved material
- Test roll corrected area

W e ' r e d r i v e n . www.asphaltinstitute.org

## Prime Coat

asphalt institute


### 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

Training, so necessary. ▲

## Prime Coat

asphalt institute




- Often use MC-30 or MC-70
- Can use emulsion on non-cohesive soils or in areas where cutbacks banned
- Remove loose material from roadway before application
- 0.2 to 0.5 gal/yd<sup>2</sup>
- Blot excess prime with sand
- Broom off excess sand

*Advice - Allow prime coat to cure 24 - 72 hours*

Training, so necessary. ▲

## Aggregate Base Preparation

asphalt institute





- Mix to proper moisture content
- Best Practice - place using a laydown machine
- Place in 4" - 8" compacted lifts
- Stagger longitudinal and transverse joints at least 1' in each succeeding layer
- Compact base to percentage of proctor specified
- Cure before applying Prime Coat

W e ' r e d r i v e n . www.asphaltinstitute.org

## Preparing to Overlay Existing HMA

asphalt institute

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



Training, so necessary. ▲

## Preparing to Overlay Existing HMA

asphalt institute

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.**

W e ' r e d r i v e n . www.asphaltinstitute.org

# Placing Hot Mix Asphalt

## Patching

asphalt institute




- Make sure to get well into the sound pavement when you mark the patch for removal
- Use good straight lines that are cut with vertical faces
- Remove all loose material
- Tack base and all vertical surfaces
- Patches must be strong enough to become a part of the permanent structure or they will be back!


www.asphaltinstitute.org

## Patching

asphalt institute



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



Nice straight lines, no distress visible outside the patched area

## Tack Coat

asphalt institute

### Why do we use Tack Coat?

- To promote the bond between old and new pavement layers.
- To prevent slippage between pavement layers
- To provide an additional moisture barrier, especially when applied along the transverse and longitudinal vertical surfaces



Training, so necessary. ▲

## Tack Coat

asphalt institute

### Definitions:

**Original Emulsion** - A mixture of asphalt, water, and a small amount of emulsifying agent to maintain a uniform blend. An SS-1 emulsion, the product typically used for fog seal and tack coat, contains up to 43% water.


**Diluted Emulsion** - An original emulsion diluted with additional water to reduce the viscosity and allow for easier spraying.

**Residual Asphalt Content** - The amount of asphalt remaining on the pavement surface after all of the water, both in the original emulsion and any additional water, has evaporated.

Training, so necessary. ▲

## Tack Coat

asphalt institute




- SS-1 is typically used, but can use SS-1h, CSS-1, or CSS-1h
- Clean the roadway before applying
- Coat all surfaces which will come into contact with the HMA
- Watch accidental pick-up
- Do not apply in cold or windy weather, or on wet surfaces with free standing water (damp is OK)

Training, so necessary. ▲

## Tack Coat

asphalt institute



- Original emulsion is often diluted at 1:1 ratio to enhance sprayability
- Apply the diluted emulsion at a rate of 0.05 to 0.15 gal/ yd<sup>2</sup>
- The rate may be adjusted based on pavement surface texture (less on smooth, more on rough)
- Make sure the tack breaks before paving

**Advice:** Don't allow the Contractor to tack too far in advance of the paver. Wind can blow dust and debris into the tack, minimizing its effectiveness

Training, so necessary. ▲



# Placing Hot Mix Asphalt

## HMA Placement

asphalt institute

4 IN.

SINGLE COVERAGE

DOUBLE COVERAGE

TRIPLE COVERAGE

NOZZLE ANGLE SETTING: 15 TO 30 DEGREES

SPRAY BAR AXIS

www.asphaltinstitute.org

## Preparing to Overlay Existing PCC

asphalt institute

- 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**

www.asphaltinstitute.org

## Preparing to Overlay Existing PCC

asphalt institute

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

**These techniques reduce the size subject to movement, which makes them easier to permanently seat and stabilize.**

www.asphaltinstitute.org

## Rubblization

asphalt institute

The best method to totally eradicate slab movement is rubblization

www.asphaltinstitute.org

## Hot Mix Delivery

asphalt institute

ROADTEC

Training, so necessary. ▲

## Condition of Haul Trucks

asphalt institute

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

**No diesel fuel or other contaminating solvents allowed!**

Training, so necessary. ▲



# Placing Hot Mix Asphalt

## Condition of Haul Trucks


asphalt institute



Trucks must have a tarp according to the spec - use it to help maintain HMA temperature & protect against the elements

## Types of Haul Trucks

asphalt institute



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

Training, so necessary. ▲

## Types of Haul Trucks

asphalt institute




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

Training, so necessary. ▲

## Types of Haul Trucks

asphalt institute



**Belly dump:** capacity 20-22 tons  
Drops mix in windows for a paver outfitted for pick-up. Be careful not to window too far ahead of the paver.

Training, so necessary. ▲

## Types of Haul Trucks

asphalt institute

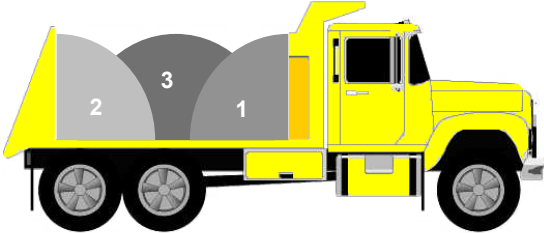


**Flow Boy Semi:** capacity 20-22 tons  
Larger capacity, removes concerns about overhead obstructions  
Regulated flow dumps directly onto the slat conveyors

Training, so necessary. ▲

## Proper Truck Loading Technique

asphalt institute




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

Training, so necessary. ▲

# Placing Hot Mix Asphalt

## Proper Truck Loading Technique

asphalt institute



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

Training, so necessary. ▲

## Material Transfer Vehicle (MTV)

asphalt institute



www.asphaltinstitute.org

## Material Transfer Vehicle (MTV)

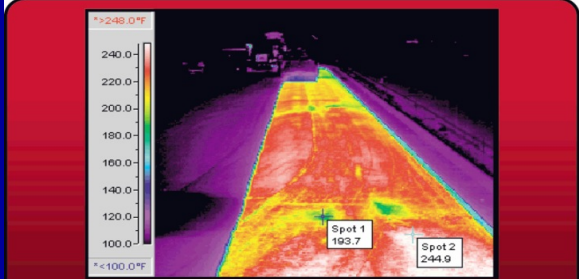
asphalt institute

**MTVs are intended to**

- Help the paving train keep moving continuously
- Reduce potential for physical segregation
- Reduce potential for thermal segregation

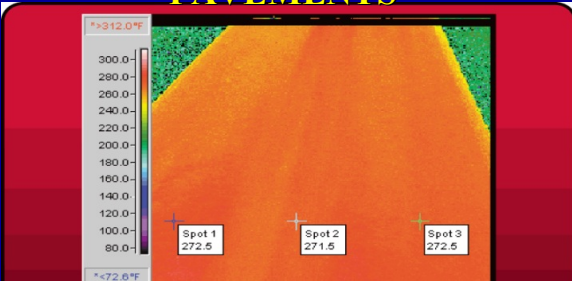
www.asphaltinstitute.org

## PLACING SUPERPAVE PAVEMENTS



TEMPERATURE DIFFERENTIAL - MAT w/PAVER

## PLACING SUPERPAVE PAVEMENTS



MAT USING ROADTEC SHUTTLE BUGGY

## Material Transfer Vehicle (MTV)

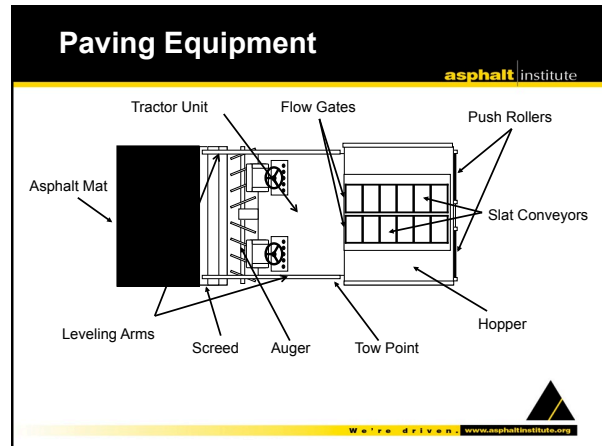
asphalt institute

**One piece of equipment alone cannot eliminate segregation**

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

www.asphaltinstitute.org

# Placing Hot Mix Asphalt



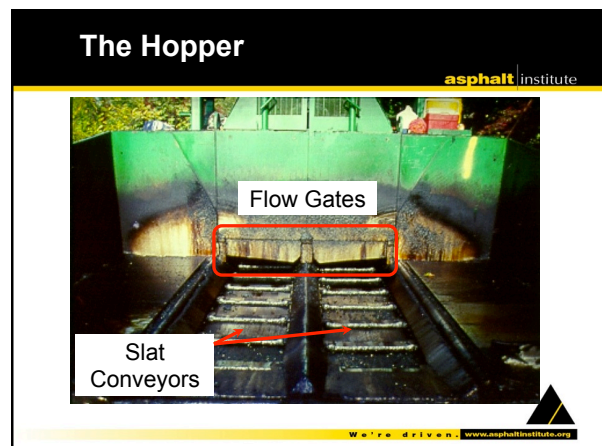
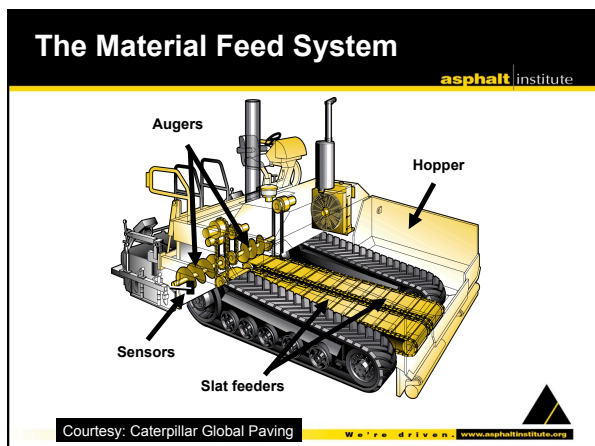
## Equipment - Paver Types

**Wheeled Pavers**  
Easy to operate,  
inexpensive to  
maintain

**Tracked Pavers**  
Best for soft surfaces  
& when conditions  
require better traction

**asphalt** institute

- ## The Tractor Unit
- Provides the power to move the paver, pulls the screed unit, and powers the machinery on the paver
  - Trucks back up close to the paver. The paver is propelled slowly by the tractor unit into the truck, which dumps the HMA directly into the hopper
  - Alternately, trucks dump directly into an MTV, which moves forward at the same speed as the paver, dumping the HMA into the hopper
  - Make sure to check the tire pressure on wheeled pavers
  - Tracks should be snug, but not too tight
  - Low tire pressure or loose tracks can cause excess paver movement, resulting in an uneven pavement surface
  - Don't allow buildup on tires or tracks
- asphalt** institute





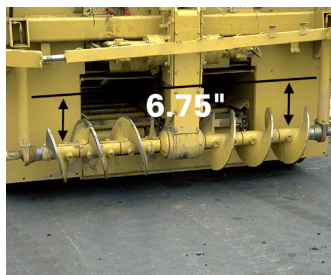
## Some Hoppers Use Augers Instead of Slat Conveyors



## Slat Conveyers and Flow Gates in the Hopper

- Slat conveyors move the material rearward to the flow gates that meter a uniform flow
- Slat conveyors can move independently of paver speed *and* each other to maintain proper head of material in the augers
- Flow gates can be adjusted to allow for more or less mix to the augers
- Coarse particles tend to conglomerate on the wings, especially when truck delivery is inconsistent

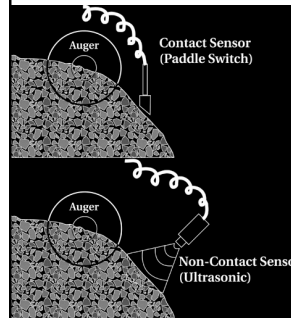
## The Augers



- Adjustable Augers*
- Augers distribute mix in front of screed
  - Adjustable height augers help mat texture
  - Help prevent segregation

Courtesy: Caterpillar Global Paving

## The Augers



- Flow controls maintain the head of material automatically
- Situated in the auger chamber, usually near the end of the auger
- Contact paddle switch or a non-contact infrared or ultrasonic sensors are used

## Protection Against Centerline Segregation



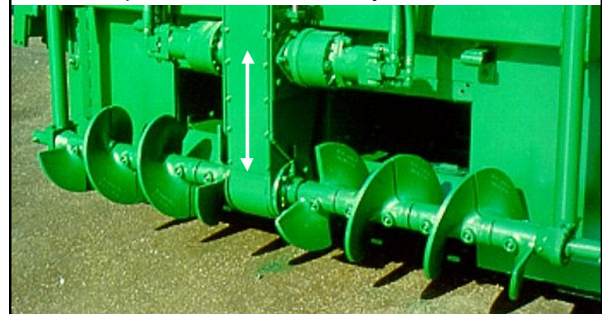
### Kick Back Paddles on Each Auger

Make sure They Are in Place  
Watch Worn Condition

**Paddles are used to ensure enough materials flows behind the gearbox to prevent centerline segregation**

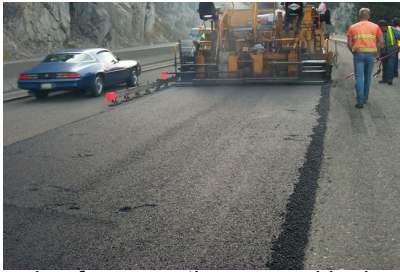
## Protection Against Centerline Segregation

Some pavers may have reverse augers in lieu of kickback paddles - make sure they are not too worn



# Placing Hot Mix Asphalt

## Longitudinal Segregation - Center



Example of segregation caused by inadequate amount of material behind the gearbox

## The Screed Unit

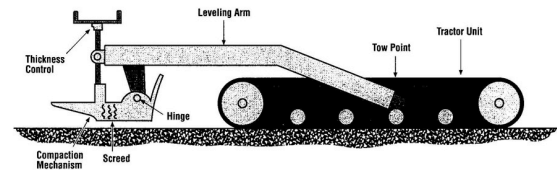


Diagram of Self-Leveling Floating Screed

### Main Components:

- Leveling Arms
- Screed Plate
- Heating Unit
- Tamping bars, vibratory attachment
- Controls

## The Screed Unit

### Has two major functions:

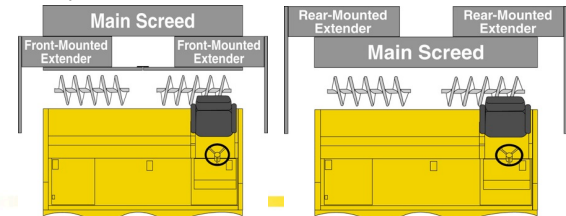
- 1) Strikes off the mix to achieve thickness and smoothness
- 2) Provides the initial compaction of the mix

## The Screed Unit

The screed plate is basically a flat piece of metal which is weighted, vibrated or tamped at high frequency, and heated to produce a smooth, somewhat compacted mat behind the paver.

They can have a fixed or variable width.

They can be widened with extensions.



## The Screed Unit



Check screed for smoothness, signs of wear, cleanliness

## Streaks in Mat




Something is probably stuck on the screed and dragging into the mix

# Placing Hot Mix Asphalt

## Texture Differential

asphalt institute

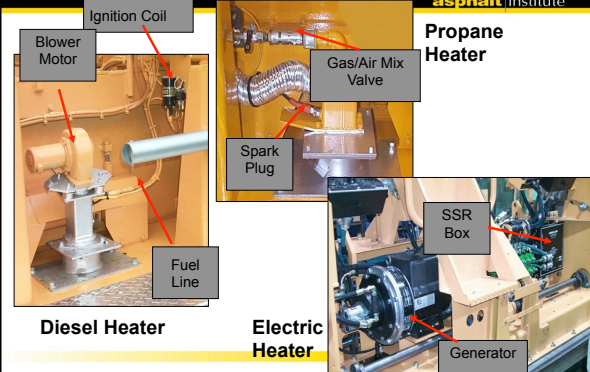


Screed needs adjustment

www.asphaltinstitute.org

## The Screed Must be Heated Initially

asphalt institute

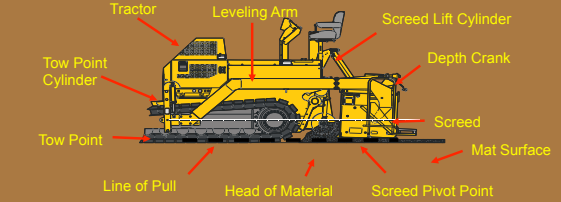


Diesel Heater

Electric Heater

Propane Heater

www.asphaltinstitute.org




Two leveling arms connect the screed to the tractor. They connect to the tractor at the **Tow Point**, and to the screed at the **Pivot Point**. The tow points allow the screed to rise and fall based on paving speed and the amount of material flowing underneath. This self-leveling process allows the screed to compensate for irregularities in the grade or base surface, employing the free-floating principle. The **Tow Point** and **Pivot Point** combine to produce a **LINE OF PULL** parallel to the plane over which the screed travels.

www.asphaltinstitute.org

## The Basic Principle Has Not Changed

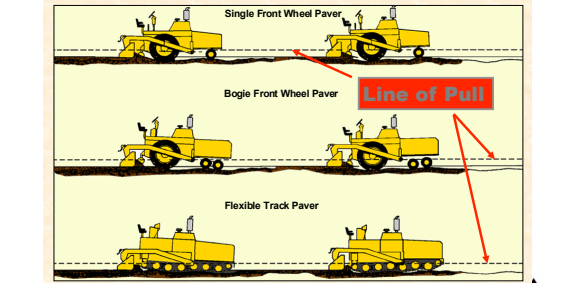
asphalt institute



www.asphaltinstitute.org

## Developing the Line of Pull

asphalt institute

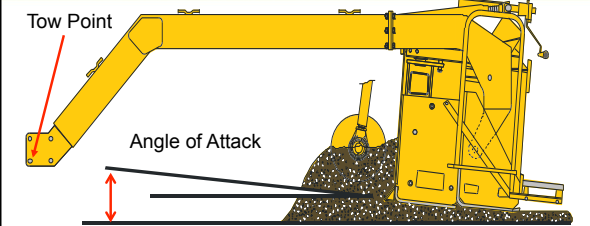


**Tractor Levelability "First Step in Smooth Paving"**

www.asphaltinstitute.org

## Force # 1 - The Angle of Attack

asphalt institute



The **Angle of Attack** is the angle that exists between the bottom of the screed plate and the grade surface. This angle is a primary factor in determining the amount of material that will pass under the screed in a given distance and is a critical element in controlling mat depth.

www.asphaltinstitute.org



# Placing Hot Mix Asphalt

## Changing the Angle of Attack

asphalt institute

Screed Rotates About the Screed Leveling Arm Pivot Point

Turning the Depth Crank Extends or Retracts Depth Screws to Increase or Decrease the Paving Angle of Attack

www.asphaltinstitute.org

## Increasing the Angle of Attack

asphalt institute

Angle of Attack Increases

Mat Depth Increases

When the Angle of Attack is increased, more material passes under the screed. The mat depth will increase until the screed is again moving in a plane that is relatively parallel to the grade surface.

Once the correct mat depth is established and the Head of Material and Paving Speed remain constant, there is very little need for further Angle of Attack adjustments.

www.asphaltinstitute.org

## Reaction Time for Depth Change

asphalt institute

Direction of Paving →

Screed Path

Step Amplitude = 100%

Tow Point Path

0 1L 2L 3L 4L 5L 6L

L = Leveling Arm Length

www.asphaltinstitute.org

## Allow time for changes before making more!

asphalt institute

“Windmill Johnny” - Puts Waves in the Mat!

www.asphaltinstitute.org

## Reaction Time for Depth Change

asphalt institute

The ‘Key’ to Good Angle of Attack Control

Frequent Depth & Slope Checks

www.asphaltinstitute.org

## Force # 2 - Head of Material

asphalt institute

The Head of Material is the mass of paving material that lies directly in front of and spans the entire width of the screed. *Ninety-five to Ninety-eight percent of all mat flaws originate from paving with an improper head of material.*

Line of shear

Angle of Attack

Material Passes under Screed

Head of Material

www.asphaltinstitute.org

# Placing Hot Mix Asphalt

### Head of Material Too High

Mat Depth Increases

Excessive Wear on Augers

---

### Head of Material Too Low

Mat Depth Decreases

Screed could Drag or Crack Rock

### Correct Head of Material

Uniform Mat

HMA Even with the Top of the Auger Shaft  
(Good Starting Position)

Hold Within  $\pm$  One Inch Tolerance

### Force # 3 - Paver Speed

Paving Speed Increases

Mat Depth Decreases

Paving Speed Decreases

Mat Depth Increases

In an ideal paving operation, the paver would operate non-stop throughout the day, because an increase or decrease in paving speed can directly affect the quality of the mat being laid.

A paving operation runs most efficiently when no waiting time is required for trucks to arrive with material, and all starts and stops are made quickly and smoothly.

### Forces # 4 & 5 - Screed Weight and Material Stability

Screed Weight

Material Stability

### Forces # 4 & 5 - Screed Weight and Material Stability

When the Paver Stops For an Extended Length of Time

Trucks Bumping the Paver Can Also Cause Marks

### Screed Controls

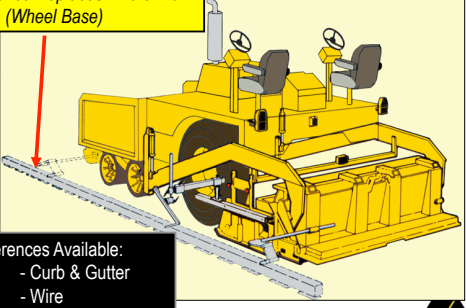
There are three main types of screed controls:

- 1) Mat Thickness
- 2) Crown Formed in the Mat
- 3) Transverse Slope

# Placing Hot Mix Asphalt

## Screed Controls

New Reference Replaces Line of Pull (Wheel Base)



Other References Available:

- Mobile
- Joint
- Laser
- Curb & Gutter
- Wire
- Sonic Averaging

www.asphaltinstitute.org

## Screed Controls - Mobile References

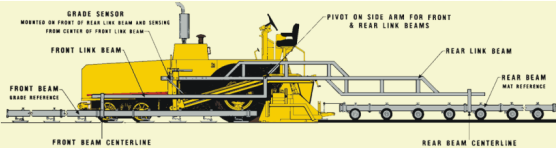



Mobile Reference      Joint Matching Shoe

If the roadway being paved is uneven, the tractor, and therefore the tow point, follows the road profile also.

Grade controls attempt to keep the tow point at a constant elevation, producing a smooth overlay that is thinner in high spots and thicker in low spots.


## Screed Controls - Mobile References

Electronic adjustment to screed height using sensing and reference system

www.asphaltinstitute.org

## Screed Controls - Mobile References



Sonic Averaging Beam

www.asphaltinstitute.org

## Screed Controls - Mobile References



Variable Width Screed - Flat

Variable Width Screed Crowned & Sloped

Screed Crown & Road Width (Road Profile)

www.asphaltinstitute.org

## Screed Controls - Transverse Slope Control

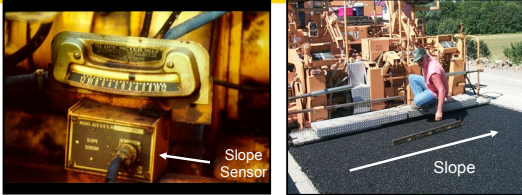
- Typically mounted opposite the longitudinal reference systems
- Used to maintain the proper transverse cross slope
- Places material at a consistent cross-slope regardless of the deviations experienced by the wheel base of the paver

www.asphaltinstitute.org



# Placing Hot Mix Asphalt

## Screed Controls - Transverse Slope Control



Uses Grade as the Established Profile and Accurately Maintains the Slope From One Side of the Mat to the Other.

## The Paving Process



## Let the Paver Drive Up to the Truck



- Trucking can affect mat quality
- Driver backed into paver
- Driver used brakes

Courtesy: Caterpillar Global Paving

## Loading the Hopper



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

## Loading the Hopper



- Avoid spillage of HMA material in front of the paver
- Spilled material should be removed prior to advancing
- Adhere to worker safety !

## Don't Let the Hopper Get Empty



Maintain hopper 25% to 75% full - even when paver is stopped

# Placing Hot Mix Asphalt

## To Dump or Not to Dump - That is the Question

asphalt institute



W e ' r e d r i v e n . www.asphaltinstitute.org

## Augers

asphalt institute

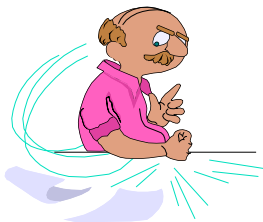
Keep a uniform head of material



W e ' r e d r i v e n . www.asphaltinstitute.org

## Keep the Operation Moving

asphalt institute



One of the essentials for a consistent and high quality hot mix asphalt pavement is to provide for a continuous operation!

W e ' r e d r i v e n . www.asphaltinstitute.org

## CAUTION: AXE-GRINDING AHEAD!



## Balancing Production Rates in HMA Operations

asphalt institute

Does this sound familiar?

- 1) Trucks bunch up at the paver
- 2) Paver speeds up to unload all of the trucks
- 3) Roller is left way behind and fresh mat cools
- 4) Paver unloads all trucks, stops on fresh mat for a long time while waiting for next bunched up group of trucks
- 5) The mix left in the hopper cools, forming hardened globs which periodically break off into freshly-delivered mix
- 6) Rollers (with their binoculars) see paver taking break, drive at break-neck speed so they can park on the fresh mat for a while and enjoy a refreshing cigarette break
- 7) No one understands why density averages 91% - *there must be something wrong with the mix*

W e ' r e d r i v e n . www.asphaltinstitute.org

## Balancing Production Rates in HMA Operations

asphalt institute

Balancing production rates involves four operations:

- 1) Plant
- 2) Hauling
- 3) Paving
- 4) Compaction

Maintaining a balance of these operations can save the Contractor money, but more importantly, will result in a better quality pavement.

W e ' r e d r i v e n . www.asphaltinstitute.org

## The Asphalt Plant's Role

asphalt institute

The asphalt plant's production capability sets caps on all other rates.

The number and size of storage silos affect the ability of the plant to consistently serve the project with mix.

The mix will stay at temperature in a mass in the silo for a reasonable period of time. It is OK for them to fill the night before.

Plant production should decrease after a rain. It will take the aggregate longer to dry.



W e ' r e d r i v e n . www.asphaltinstitute.org

## The Trucker's Role

asphalt institute

Trucking is probably the most difficult operation to maintain a consistent flow.

The Contractor needs to take time to properly train the Truckers and communicate expectations.

- Why is cleaning the bed important?
- Why stop short of the paver rather than backing all the way into it?
- Why is it important to maintain spacing?

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



W e ' r e d r i v e n . www.asphaltinstitute.org

## The Paver's Role

asphalt institute

Paver operators *must* understand their responsibility of running the paver at a uniform rate - it is the linchpin of the entire balancing act..

Consistent paver speed increases smoothness by minimizing depressions caused by parked pavers and rollers.

Consistent paver speed enables uniform density by allowing rollers to maintain uniform speed and coverage.

Consistent paver speed helps truckers maintain uniform spacing and mix delivery.



W e ' r e d r i v e n . www.asphaltinstitute.org

## The Roller's Role

asphalt institute

The final step in of the laydown operation is the compaction process, which is a key element in the final quality and longevity of the pavement.

The key is that the paver should not be allowed to place any more material than the rolling train can compact.

If the paver must run at a faster rate, an additional roller must be employed to achieve the target density.

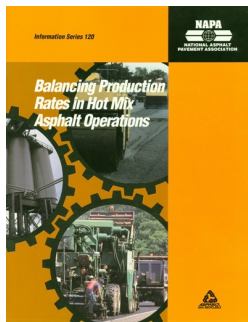
Uniform coverage at a consistent, slow speed will result in a mat with good, uniform density.



W e ' r e d r i v e n . www.asphaltinstitute.org

## Balancing Production Rates in HMA Operations

asphalt institute



NAPA's Information Series 120 Manual contains a lot of in depth information on the topic, including calculations and worksheets.

It was the source for most of the bullet points in the previous slides in this subsection.



W e ' r e d r i v e n . www.asphaltinstitute.org

## QUESTIONS?

asphalt institute

**Good Reference Materials on the Topic:**

**MS-2:** Mix Design Methods



**SP-2:** Superpave Mix Design



**MS-4:** The Asphalt Handbook



**MS-22:** HMA Construction



<http://www.asphaltinstitute.org>



W e ' r e d r i v e n .