Establishing & Maintaining Efficient Rolling Patterns

Presented by: Todd Mansell, Sakai America
Why do we want to be efficient?

TO MAXIMIZE PROFIT

TO IMPROVE QUALITY

Profit ————> Quality

Quality ————> Profit
Why do we want to be efficient?

Percentages of Total Pay Factor

- **Compaction**
  - 40%

- **Binder Content**
  - 30%

- **Materials**
  - 30%
Compaction bonus – do the math

- 40% of 5% of the total bid price for HMA = $0.40 \times 0.05 = 0.02$ or 2% of the total bid price for HMA

- Your project has 30,000 tons of HMA

- You bid $70/ton in-place

- $70 \times 30,000 \times 0.02 = $42,000 bonus
Two approaches to efficiency:

1. “Ideal way” - we can have whatever we need or want

2. The “real world” way - we do the best we can with what we have
How do we become more efficient at asphalt compaction?

- Understand the factors affecting compaction
- Understand compaction equipment
- Know how to develop a rolling pattern
- Understand what to do when your rolling pattern isn’t working
Factors Affecting Compaction

- Mix Properties
- Environmental Conditions
- Construction Factors
Mix Properties

Aggregate
Asphalt binder
Temperature
Air voids

FRACUTURED OR CRUSHED FACES ARE BEST!
• Hot AC acts as a lubricant

• Cold AC binds the mix together
Compaction is all about...

Temperature

Temperature

Temperature
Environmental Conditions
Construction Factors

- Lift thickness
- Base conditions
- Roller speed
- Type of rollers
- Rolling pattern
Lift thickness

• Thick lifts are tough to get compaction

• Thin lifts are tough to get compaction

• Ideal is about 3:1 to 4:1

\[
\frac{\text{Lift thickness}}{\text{Max Agg size}}
\]
Check the base
Repairs - base and sub-base

- **Asphalt Concrete (A.C.)**
- **Base**
  - Consists of decomposed granite or rock and sand
- **Sub-Base**
  - Optional, depends upon stability & composition of native soil
- **Native Soil**
Clean & tack before paving
Wait for tack to break!
What affects roller speed?

1. Paver speed

2. Rate of mix delivery to the job
   - Plant schedule, trucking, moisture in aggregate, etc...

3. Mix behind the paver
   - Temperature of HMA delivered to the paver
   - Mix characteristics - Stiff or Tender?
   - Segregation of the mix
     - Temperature differentials
     - Aggregate - highly crushed or 'round rock'

4. Compaction
   - Type of compaction equipment
   - Number of roller passes
   - Roller settings

Rolling Pattern
1. Paver speed

- Should be continuous, smooth operation

- Number and speed of rollers must be balanced with paver speed
2. Rate of mix delivery to the job

- Must be balanced with plant load out capacity

- Paver speed must be balanced with rate of mix delivery
3. Mix behind the paver

- Segregation can severely affect compaction
  - Aggregate, temperature differentials

- Segregation isn't always visible
  - quarry
  - hot plant
  - loading & unloading trucks
  - transferring mix to the paver
  - paver operation & setup
Segregation
Temperature Differentials
4. Compaction

- Must be balanced with paver speed
- Must meet or exceed compaction specs
- Must meet or exceed smoothness specs
NAPA Publication IS-120

“Balancing Production Rates in HMA Operations”

www.hotmix.org
Mix Delivery Production Rate Calculation Form:

Date: 12/8/06  Project No. __________
Project: PERFECT WORLD PAVING

Trial No. 1

(A) HMA scheduled to be placed today (tons)  1800
(B) Hours of paving scheduled (hrs)  6 hrs.
(C) Rate of mix needed (tph)  [A + B] 300 tph
(D) Rate of mix available from HMA facility (tph)  300 tph (w/silos)

E Average truck capacity (net tons)  22
(F) Total truck trips needed (trips)  [A + E] 82

Truck cycle (minutes)
(G) Prep/Wait  3
(H) Load Time  2
(I) Ticket & Tarp  2
(J) Haul to Job  32
(K) Wait on Site  1
(L) Dump/Clean-Up  25
(M) Return Haul

(N) Total Cycle (minutes)  [add G through M] 70 min.
(O) Truck cycle (hours)  [N + 60] 1.2

(P) Number of trips per trucks (round down)  [B ÷ O] 5
(Q) Number of trucks needed (round up)  [F ÷ P] 17

Check calculation:

Is \( \frac{Q}{x} \times \frac{P}{y} \geq \frac{F}{z} \)?

\( \frac{17}{x} \times \frac{5}{y} = \frac{85}{z} \geq \frac{82}{z} \)

Yes \( \rightarrow \) okay

If "NO" check calculation or add additional truck and recheck.

\( \frac{\_\_\_\_}{x} \times \frac{\_\_\_\_}{y} = \frac{\_\_\_\_}{z} \geq \_\_\_\_ \times \_\_\_\_ \)
Paving Production Rate Calculation Form:

Date: 12/8/06  Project No.  
Project: PERFECT WORLD TRUCKING

<table>
<thead>
<tr>
<th>Trial No.</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>(A) HMA scheduled to be placed today (tons)</td>
<td>1800</td>
<td></td>
</tr>
<tr>
<td>(B) Hours of paving scheduled (hours)</td>
<td>6</td>
<td></td>
</tr>
<tr>
<td>(C) Mix delivery rate (tph)</td>
<td>[A + B] 300</td>
<td></td>
</tr>
<tr>
<td>(D) Paving width (feet)</td>
<td>12</td>
<td></td>
</tr>
<tr>
<td>(E) Paving thickness (inches)</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>(F) Paving thickness (feet)</td>
<td>[E + 12] 0.25</td>
<td></td>
</tr>
<tr>
<td>(G) Reference density (pcf)</td>
<td>155 pcf</td>
<td></td>
</tr>
</tbody>
</table>

Specification limits for density:
(H) Minimum (%) | 96 % |   |
(I) Maximum (%) | 100 % |   |
(J) Target density (% of reference) | 98 % |   |

Check Calculation:

<table>
<thead>
<tr>
<th>Is</th>
<th>H</th>
<th>J</th>
<th>I</th>
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(K) Target density (pcf) | ([J x G] + 100) 152 |   |

(L) Average paver rate (feet/minute) | [C x 33.33" + D + F + K] 2.2 |   |

(M) Paver efficiency factor (recommend 0.75 to 0.85) | 0.75 |   |

(N) Actual paver speed (feet/minute) | [L + M] 30 Fpm |   |

\[33.33 = \text{conversion factor (tons/hour to pounds/minute)}\]

\[1 \text{ ton} \times \left(\frac{1 \text{ hour}}{60 \text{ min}}\right) \times \left(\frac{2000 \text{ lb}}{1 \text{ ton}}\right) = 33.33\]
Roller Production Rate Calculation Form

Date: 12/8/06  Project No. ____________________________
Project: Perfect World Rollers

Recommended Breakdown Rolling Speeds:
Static: 2 to 3 1/2 mph; Pneumatic: 2 to 3 1/2 mph
176 fpm (2.0 mph); 220 fpm (2.5 mph); 264 fpm (3.0 mph); 308 fpm (3.5 mph); 352 fpm (4.0 mph)
For Vibratory Rollers: Actual speed for vibratory rollers can be based on the roller's operating frequency
and an impact spacing of 10-12 impacts/ft.
Actual speed = VPM \[\frac{300}{12} \times \frac{100}{80} = 34\] mph

Trial No. _______

(A) Roller speed (feet/minute) see recommendation above
Note: To convert from mph to fpm/minute (mph x 88 = fpm)

(B) Effective roller speed (fpm)
\[0.90 \times A\] 270

(C) Actual roller drum width (feet)
7 ft

(D) Effective roller drum width (feet)
\[C - 0.5\] 6.5 ft
Note: Effective width based on 6 inch overlap

(E) Paving width (feet)
12

(F) Number of passes to cover mat width once (passes)
\[E + D\] 2
(round up to whole number)

(G) No. of repeat coverages to achieve density
(from test strip)
2

(H) Total number of passes
\[F \times G\] 4

(I) Adjusted total passes [if F is even number, enter (F + 1),
if F is odd number, enter (F), i.e., if F = 2, enter 3 on this line]
5

(J) Roller efficiency (recommended 0.75 to 0.85)
0.75

(K) Effective roller production rate (fpm)
\[B \times J + I\] 40 fpm

Compare: Paving Rate to Rolling Rate—OK?
\[\Delta \frac{40}{30} fpm > \frac{50}{30} fpm \text{ (OK)}\]

NATIONAL ASPHALT PAVEMENT ASSOCIATION • IS 120
Communication & Team Work !!
Team Work!!

- Trucking
- Paver Speed
- Rollers
- Hot Plant
How do we maximize HMA compaction efficiency?

By hitting our target density and smoothness with the minimum number of rollers and roller passes.
Definition: Rolling Pattern

“A rolling pattern is the number, type, and sequence of rollers used in a specific, repetitive pattern that will meet or exceed the density and smoothness specifications for the project.”
## Rolling pattern example...

<table>
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<th>%TMD</th>
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<th>Coverage</th>
<th>Settings</th>
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<tr>
<td></td>
<td>88-90%</td>
<td>300-260°F</td>
<td>3</td>
<td>Low A, High F</td>
<td>Low A, static</td>
</tr>
<tr>
<td></td>
<td>90-92%</td>
<td>260-200°F</td>
<td>2</td>
<td>90 psi</td>
<td></td>
</tr>
<tr>
<td></td>
<td>92-93%</td>
<td>200-160°F</td>
<td>2 (1 vibe, 1 static)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

- 150 feet
- 200 feet
- 200 feet
To establish a rolling pattern, you MUST know...

1. Time available for compaction
2. Types of rollers
3. Amplitude & frequency settings
4. Pneumatic tire roller settings
5. Number of roller passes
6. Length of the roller pass
7. Sequence and timing of roller passes
1. Time Available for Compaction

Temperature

Temperature

Temperature
Time Available for Compaction

- Compaction of the mix must be accomplished while the mix is still HOT.
Temperature is Critical

300 - 260 Breakdown rolling
260 - 220 Intermediate rolling
240 - 190 possible "tender zone"
220 - 160 Finish rolling
160 - Stop rolling

Keep steel drums off the mix!!!
One of the biggest problems in Minnesota's bituminous pavements is a lack of in-place density due to late season paving practices. When bituminous materials are placed in cool weather, they are difficult to compact properly because the asphalt stiffens too rapidly.

A computer tool (PaveCool) has been developed to assist contractors, inspectors, and engineers to make rapid decisions regarding cool-weather paving. The user enters the time of day, the date, and the latitude and longitude of the paving job. Next, the type of mixture is entered along with the type of surface being paved.

- The surface mixture, air temperature, wind speed, lift thickness, and mixture delivery temperature are then entered. The final input is the amount of cloud cover.
- A heat flow model is used to compute the temperature drop in the mat and the time it takes for the asphalt mix to cool from its delivery temperature to 175°F (80°C).
- If the user feels that there is an inadequate amount of time available to compact the mixture, options can be explored to extend the time. For instance, increasing the lift thickness or mix temperature will increase the window of time for effective compaction of the pavement.
- Version 2.4 enables the user to specify starting and stopping compaction temperatures according to agency or manufacturer specifications.

**PaveCool Reports (Adobe Reader required)**

(right-click and select “Save Target As...” to save on your computer)

**PaveCool Final Report (1 MB)**

# PaveCool 2.4 - Simulation Results

**Input File:** PaveCool.pct

**Project:** US Hwy 45 Nefks - Columbus, MS

<table>
<thead>
<tr>
<th>Project Date &amp; Time</th>
<th>Start Rolling*</th>
<th>Stop Rolling*</th>
</tr>
</thead>
<tbody>
<tr>
<td>03/09/10 11:55 AM</td>
<td>2 min. (248 °F)</td>
<td>20 min. (175 °F)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>HMA Mix Type</th>
<th>Binder Grade</th>
<th>Thickness (in)</th>
<th>Delivery Temp. (°F)</th>
</tr>
</thead>
<tbody>
<tr>
<td>S-5 64-10</td>
<td>SKY</td>
<td>2.00</td>
<td>125</td>
</tr>
</tbody>
</table>

- **Air Temp.**
  - **Wind Speed:** 40 mph
  - **Sky:** Clear & Dry
  - **Latitude:** 34.0° North

- **Existing Surface**
  - **Moisture:** N/A
  - **State:** N/A
  - **Surface Temp.:** 50.0 °F

---

**Simulation Time:** 03/09/10 12:11 PM

---

**Cooling Curve**

- **HMA Temperature, °F**
  - **Cooling Curve**
  - **Start Temp./Time**
  - **Stop Temp./Time**

**Time, minutes**

- **HMA Temperature, °F**
  - 0 to 120 minutes
How to increase the time available for compaction

- Increase HMA temperature behind the paver
  - Increase plant production temperature
  - Tarp loads
  - Keep short windrows
  - Not too many trucks sitting

- Increase the thickness of the HMA layer
- Place one lift instead of two if possible
- Breakdown with a pneumatic tire roller
- Breakdown in echelon with two double drums
Stay close behind the paver but...THINK SAFETY!!
What if we’re in the middle of shift and the mix is too cool?

1. Call the plant to see what they can do
2. Reduce paver speed
3. Add more rollers
4. Plan for the next day
   • Specify a load out temp when you order mix
   • Check your trucking operation
To establish a rolling pattern, you MUST know...

1. Time available for compaction
2. Types of rollers
3. Amplitude & frequency settings
4. Pneumatic tire roller settings
5. Number of roller passes
6. Length of the roller pass
7. Sequence and timing of roller passes
2. Types of rollers

- Static steel drum
- Vibratory steel drum
- Pneumatic
- Vibratory pneumatic
Static Steel Drum (tandem) Rollers

- Not efficient for highway work
- Less uniform compaction
- 30/70 weight distribution
Vibratory Steel Drum Rollers

- Used in all positions
- Amplitude & Frequency
- Static or vibratory

Build density top to bottom
Pneumatic Rollers

- Most common in intermediate rolling
- Knead the mix
- Tight surface

Builds density from the bottom up
Pneumatic rollers knead mix

Before

After
Eliminate the Bridging Effect

- Steel drums bridge
- Kneading will significantly improve bonding of mixes placed over a rough surface.
Vibratory pneumatic roller

• Has adjustable amplitude settings instead of ballast weight
• Compacts simultaneously from the bottom up and the top down
To establish a rolling pattern, you MUST know...

1. Time available for compaction
2. Types of rollers
3. Amplitude & frequency settings
4. Pneumatic tire roller settings
5. Number of roller passes
6. Length of the roller pass
7. Sequence and timing of roller passes
3. Amplitude & Frequency Settings

Eccentric Mass

Frequency

Amplitude

Centrifugal Force
Vibratory steel drum roller settings

**Frequency**

Settings up to 4,200 vpm on the market today.

**Amplitude Settings**

Most machines have various amplitude settings to choose from. Vibration can also be turned off - static mode.
Amplitude

- Amplitude controls the energy transferred to the mat “compactive effort”
Frequency

- Frequency and Roller Speed control the number of impacts per foot between the steel drum and the mat.
10 to 12 impacts per foot

Good walking speed
Frequency too low or rolling too fast...
How fast can my roller go?

\[
\frac{4,000 \text{ vibrations}}{10 \text{ impacts per foot}} = 400 \text{ feet per minute}
\]

\[
400 \times 0.80 = 320 \text{ fpm}
\]
If I need to make 5 passes...

\[
\frac{320 \text{ feet}}{5 \text{ passes}} = 64 \frac{\text{feet}}{\text{minute}}
\]
So, how fast should the paver go?

64 feet per minute!!!
To establish a rolling pattern, you MUST know...

1. Time available for compaction
2. Types of rollers
3. Amplitude & frequency settings
4. Pneumatic tire roller settings
5. Number of roller passes
6. Length of the roller pass
7. Sequence and timing of roller passes
4. Pneumatic roller variables

- Adjust tire pressures based on mat thickness
- Ballast weight – usually sand or water
- Vibratory pneumatic has no ballast, but has various amplitude settings
Density built from the bottom up

High Pressure

Low Pressure

Depth of penetration of tires into the mix
Vibratory pneumatic tire roller

Various amplitude settings

Dynamic kneading action
To establish a rolling pattern, you **MUST** know...

1. Time available for compaction
2. Types of rollers
3. Amplitude & frequency settings
4. Pneumatic tire roller settings
5. Number of roller passes
6. Length of the roller pass
7. Sequence and timing of roller passes
5. Number of roller passes

• Determine number of passes with the help of your Quality Control team

• Take density readings after each roller pass

• Determine target density values for each roller

• Trial and error to get most efficient roller pattern
Number of roller passes

Establishing the rolling pattern
### Number of roller passes

<table>
<thead>
<tr>
<th></th>
<th>Breakdown</th>
<th>Intermediate</th>
<th>Finish</th>
</tr>
</thead>
<tbody>
<tr>
<td>Settings</td>
<td>12-ton DDV</td>
<td>14-ton tire</td>
<td>8-ton DDV</td>
</tr>
<tr>
<td>1&lt;sup&gt;st&lt;/sup&gt; Pass</td>
<td>High A, High F</td>
<td></td>
<td>1 vibe, low A, high F, 1 static</td>
</tr>
<tr>
<td>Temp</td>
<td>275</td>
<td>250</td>
<td>200</td>
</tr>
<tr>
<td>Density</td>
<td>88%</td>
<td>92%</td>
<td>93.7% (vibe)</td>
</tr>
<tr>
<td>2&lt;sup&gt;nd&lt;/sup&gt; Pass</td>
<td>Temp 260</td>
<td>245</td>
<td>193</td>
</tr>
<tr>
<td>Density</td>
<td>90%</td>
<td>93%</td>
<td>93.8% (static)</td>
</tr>
<tr>
<td>3&lt;sup&gt;rd&lt;/sup&gt; Pass</td>
<td>Temp 252</td>
<td>230</td>
<td></td>
</tr>
<tr>
<td>Density</td>
<td>91%</td>
<td>93.5%</td>
<td></td>
</tr>
<tr>
<td>4&lt;sup&gt;th&lt;/sup&gt; Pass</td>
<td>Temp</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Density</td>
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2. Types of rollers
3. Amplitude & frequency settings
4. Pneumatic tire roller settings
5. Number of roller passes
6. Length of the roller pass
7. Sequence and timing of roller passes
6. Length of roller pass
Length of the Roller Pass

Speed = \frac{Distance}{Time}

Roller speed based on frequency

Time available for compaction

Solve the equation for distance which is the length of the roller pass.
Length of the Roller Pass (cont’d)

Distance = Speed x Time

Roller speed = 320 fpm @ 4,000 vpm

Time = 3 minutes before tender zone (from PaveCool™)

Distance = 320 x 3 = 960 ft
Length of the Roller Pass (cont’d)

QC tells us we need a 5-pass pattern
Roller distance = 960 ft in 3 minutes
960 / 5 = 192 feet
Length of roller pass = 192 feet
Put it all together!

1. Types of rollers
2. Amplitude & Frequency
3. Pneumatic tire roller settings
4. Time Available for Compaction
5. Number of roller passes
Rolling Patterns

- Take density measurements to establish a rolling pattern
- Established patterns will vary as environmental changes occur throughout the day
- Changes in the mix can affect rolling pattern
To establish a rolling pattern, you MUST know...

1. Time available for compaction
2. Types of rollers
3. Amplitude & frequency settings
4. Pneumatic tire roller settings
5. Number of roller passes
6. Length of the roller pass
7. Sequence and timing of roller passes
## 7. Sequence and timing

<table>
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</tr>
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<td>300-260°F</td>
<td>3</td>
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</tr>
<tr>
<td>260-200°F</td>
<td>2</td>
<td>90 psi</td>
</tr>
<tr>
<td>200-160°F</td>
<td>2</td>
<td>Low A, static</td>
</tr>
</tbody>
</table>

- %TMD: Percentage of Total Material Density
- Temp: Temperature range
- Coverage: Number of passes
- Settings: Roll of A and F

<table>
<thead>
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<th>Approximate Density</th>
<th>%TMD</th>
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<td></td>
<td>90-92%</td>
<td></td>
<td>92-93%</td>
<td></td>
</tr>
<tr>
<td>150 feet</td>
<td></td>
<td>200 feet</td>
<td></td>
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- 150 feet
- 200 feet
- 2 (1 vibe, 1 static)
Example of Roller Train

• Three rollers behind the paver
  - Breakdown – double drum steel (84”)
  - Intermediate – pneumatic tire (77”)
  - Finish – double drum steel (84”)

• Paving 12’ wide on a two-lane highway

• Mix temperature is 300°F behind the screed
All mixes are not the same

- Dense-graded (stiff or tender)
- Open-graded mixes
- Rubberized mixes
- Polymer-modified mixes
- SMA mixes
- Superpave mixes
- Hveem mixes
- Marshall mixes
Compaction of Stiff & Tender Mixes

- Stiff Mixes
- Tender Mixes
- Warm Mix
- Other Mix Types
Stiff Mixes

- Low asphalt binder content
- High percentage of crushed aggregate - both coarse and fine
- High amount of mineral filler or fines passing the No. 200 sieve
- Superpave, SMA
Echelon breakdown
Compaction is all about...

Temperature

Temperature

Temperature
Pneumatic Breakdown on Stiff Mixes

Only two rollers needed
After 6 passes and go...
Pneumatic breakdown
Compacting tender mixes

- First, understand what causes mixes to be tender; then you can try to manage it at the source.
- How to compact if you’re “caught” with a tender mix.
Tender Mixes
Compaction in the Tender Zone

2 Basic Approaches

1. Use pneumatic tire roller in the tender zone

2. Get density before mix cools to the tender zone
Temperature Zone Example for Tender Mixes

- Above the Tender zone:
  320 - 240 °F

- Tender zone:
  240 - 190 °F

- Below the Tender zone:
  190 - 150 °F

The exact temperature ranges depend on the mix characteristics.
Or this is what will happen...
Use a pneumatic in the tender zone
## 1. Pneumatic in the tender zone

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<td>2</td>
<td>80 psi</td>
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<td>190-150°F</td>
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</tr>
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</table>

- The exact temperature zones depend on the characteristics of the mix.

- Tender Zone
- 160 feet
- 200 feet
- 250 feet
2. Get density before the mix cools to the tender zone

- Breakdown with two double drum vibratory rollers in echelon

- This means you must know where the tender zone is!!
Density before the tender zone
Breakdown in Echelon
Efficient rolling patterns

1. Pneumatic breakdown for stiff mixes
2. Rolling in echelon
3. Roller drum width selection
4. Rolling the longitudinal joint
1. Pneumatic Breakdown: Cutting Cost by Reducing Rollers

Pneumatic breakdown roller

Conventional Roller Train
Use only two rollers
2. Rolling in Echelon

• Use two rollers in echelon as close behind the paver as possible

• Take advantage of TEMPERATURE

• Rollers can make more passes before the mix cools

• Can be done without a finish roller
Echelon over 12 ft wide mat
Breakdown in Echelon
Intermediate in Echelon
# Compaction Temperatures

<table>
<thead>
<tr>
<th>Mix Type</th>
<th>Breakdown</th>
<th>Intermediate</th>
<th>Finish</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dense mix</td>
<td>325°F - 260°F</td>
<td>260°F - 200°F</td>
<td>200°F - 160°F</td>
</tr>
<tr>
<td>Open Grade</td>
<td>225°F - 200°F</td>
<td><em>Typically, no intermediate roller.</em></td>
<td></td>
</tr>
<tr>
<td>Rubber mixes</td>
<td>330°F - 280°F</td>
<td>280°F - 260°F</td>
<td>260°F - 200°F</td>
</tr>
<tr>
<td>ATPB</td>
<td>250°F - 225°F</td>
<td><em>Typically, only one roller is used.</em></td>
<td>225°F - 200°F</td>
</tr>
</tbody>
</table>

Compaction for each stage of rolling should be complete when the temperature reaches the lower limit. This table is a general guideline. Know your specifications.
3. Roller drum width

- Select the optimum drum width for the job to get coverage before the mix cools
- Fewer passes = higher production, lower operating costs, better quality
84" x 2 passes

Roller A

Roller B

6" Overhang

6" Overlap

12' wide mat

6" Overhang
79” x 2 passes

Roller A

Roller B

6” Overhang

1” Overlap

12’ wide mat

6” Overhang
84" & 79" x 2 passes

Roller A

Roller B

6" Overhang

3.5" Overlap

6" Overhang

12' wide mat
67” x 3 passes

Roller A
Roller A and/or B
Roller B

6” Overhang
13” Overlap
13” Overlap
6” Overhang

12’ wide mat
Rolling Pattern 84” only
One roller covering 2 lanes

Parallel Pattern

4 - 5 roller passes over each point of the pavement
Rolling Pattern 84” only
One roller covering 2 lanes

Cross Pattern

4 - 5 roller passes over each point of the pavement
Rolling Pattern 84” only
2 same make & model rollers covering 2 lanes

Parallel Pattern

5 roller passes over each point of the pavement
Rolling Pattern 84” only
2 different rollers covering 2 lanes

Cross Pattern

5 roller passes over each point of the pavement
Rolling Pattern 67” – 79”

2 same make & model rollers covering 3 lanes

Parallel Pattern

4 or 5 roller passes over each point of the pavement
Rolling Pattern 67” - 79”
2 different rollers covering 3 lanes

4 or 5 roller passes over each point of the pavement
Roller Train 84” only

Covering 2 lanes for Tender Mixes with pneumatic tire roller in the intermediate position

Paver

6” inside the unsupported edge

6” Overhang
Double Drum Vibratory Roller (84”)
Pneumatic Tire Roller

6” Overhang
Steel Wheel Roller (84”)

Arrows indicate the direction of movement.
Roller Train 84” only

Covering 2 lanes for Stiff Mixes with pneumatic tire roller in the breakdown position
Roller Train 84” only

Covering 2 Lanes for Tender Mixes with 3 double drum vibratory rollers

Double Drum Vibratory Rollers (84”) in Echelon

Steel Wheel Roller (84”) *May not be needed.
Roller Train 67” - 79”

Covering 3 Lanes for Tender Mixes with 3 double drum vibratory rollers
Efficiency costs nothing:
It just takes planning!

A 7-pass pattern versus a 5-pass pattern costs 17-ft per minute of production.
4. Rolling the longitudinal joint

Roll from the hot side
Why is it tough to get density?

- Mix temps are lower at edge of mat
- Getting non-segregated mix to the edge of the screed
- Getting enough mix to the edge
- Roll down and bridging of roller drums
What does it take to get density?

Temperature

Temperature

Temperature
Temperature at the joints
Not enough mix...
Paving in echelon – hot joints
Two rolling situations on the longitudinal joint

1. Rolling the unsupported edge

2. Rolling the supported edge
Placing the unsupported edge
Overhang the unsupported edge
Don't run inside the unsupported edge

Steel Drum

The mix tends to widen out

Lane 1

Cracks
Inside the unsupported edge will crack
Movement of the mix at the unsupported edge

Steel Drum

Density of the unsupported edge will be lower.

Lane 1
Stay about 12” in from the unsupported edge with the rubber tire roller.
Do not run the rubber tire roller directly on the unsupported edge.
NEVER run any roller directly on the unsupported edge.
Placing the supported edge
Two different types of overlap

- **Overlap 1**: The thickness of the uncompacted mix

- **Overlap 2**: The amount of overlap of the mix from lane 2 over the top of lane 1.
Fluff Factor

1¼” after compaction
Overlap

Good overlap

Too much overlap

J.A. Scherocman
Good overlap

Too much overlap
Nice joint
Rolling from cold side is very inefficient
Disadvantages of rolling from the cold side

- When rolling from the cold side, bumps are picked up by the roller drum (ie. rocks) and transferred across the mat
- Mat is losing temperature
- Can not vibrate
- Slower production or more rollers needed or lower quality
Rolling from the cold side
Roll from hot side with 6” overhang
Rolling from the hot side
The results...
Rolling off the joint – first pass
Which side was paved first?

The amount of mix needed at the joint

Hot mix pushed over lane 2

Lane 1  Lane 2
Do not rake flat!

The amount of mix needed at the joint

Hot mix pushed over lane 2

Lane 1

Lane 2
Bridging drum - low density
Bump the joint
Bumping the joint

E. Ray Brown
Steel drum rollers can crush aggregate along the joint.
Pneumatics force mix to the joint
Straddle the joint
Barely see the joint & density is great!
Tools you have

- Time available for Compaction - PaveCool™
- Calculate roller speed (10 to 12 ipf) - Set the paver speed to match !!
- Calculate the length of roller pass
- Different roller trains to consider - Stiff mixes - echelon, pneumatic breakdown - Tender mixes - echelon, no steel, pneumatic
- Compaction Troubleshooting guide
Efficiency costs nothing:
Roll from the hot side

A 7-pass pattern versus a 5-pass pattern costs 17-ft per minute of production.

Put the end gates down on the paver, match the joint with the proper horizontal overlap and fluff factor
What to watch for in the field

1. Mix temperature behind the paver
2. Roller speed
3. Distance of rollers behind the paver
4. Amplitude and frequency settings
5. Consistent rolling pattern
SUMMARY of STEPS

1. Identify mix type and lift thickness
2. Determine the TAC (use PaveCool™)
3. Select equipment (drum width)
4. Determine # roller passes (test strip)
5. Calculate roller speed (ipf)
6. Calculate length of roller passes
7. Fine-tune your rolling pattern on the job
8. Try different roller patterns!!
A Rolling Pattern...

<table>
<thead>
<tr>
<th>%TMD</th>
<th>Approximate Density</th>
<th>Coverage</th>
<th>Temp</th>
<th>Settings</th>
<th>Settings</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>88-90%</td>
<td>3</td>
<td>300-260˚F</td>
<td>Low A, High F</td>
<td>Low A, High F</td>
</tr>
<tr>
<td></td>
<td>90-92%</td>
<td>2</td>
<td>260-200˚F</td>
<td>90 psi</td>
<td>90 psi</td>
</tr>
<tr>
<td></td>
<td>92-93%</td>
<td></td>
<td>200-160˚F</td>
<td>Low A, static</td>
<td>Low A, static</td>
</tr>
</tbody>
</table>

- 150 feet
- 200 feet
- 200 feet

Coverages:
- Low A, static 90 psi
- Low A, High F

Settings:
- 3 vibe, 1 static
Compaction is all about... Temperature Temperature Temperature
To MAINTAIN a rolling pattern, you must...

1. Control paver speed
2. Know the rolling pattern
3. Understand “Time Available for Compaction”
4. Work as a team and communicate!!
Thank you!
Asphalt Compaction Troubleshooting

*Is the mix temperature behind the paver hot enough? > 280°F

No

Are the rollers close to the paver?

No

Is the mix exhibiting tender behavior under the roller(s)?

No

Move them into hot zone.

Yes

Keep the steel drum rollers OFF the mix until the tender behavior stops or they will tear up the mat. You can use a rubber tire in tender zone without doing any damage.

Verify that the nuke gauge lift thickness setting is less than the actual lift thickness being placed.

Verify that the roller settings of amplitude, frequency and speed are correct per test strip.

Check with the lab or plant to see if oil content and/or gradation changes have occurred.

Verify the nuke gauge calibration with the mix and lift thickness.

Typically low amplitude for lifts less than 2” thick. High amplitude for lifts > 3” thick.

If changes have occurred, assess the impact of these changes on compaction. Call the QC Manager if necessary.

Record the following

- Mix temp behind paver
- Number & type of rollers
- Roller settings (freq/amplitude)
- Pattern (# coverages)
- Air temperature
- Base temperature
- Asphalt lift thickness
- Mix type
- Average percent compaction
- Roller operators’ names

*Know the recommended compaction temperature for the mix design being used. Know the Time Available for Compaction.*