Roller Operations 101: A Basic Overview...

Dale Starr
Volvo Construction Equipment

Industry giants

“Mr. Compaction”
Chuck Deahl

“Paving Preacher”
Tom Skinner

Paving=art; compaction=science
Compaction – primary forces

- Compression using steel-wheeled static rollers
- Manipulation using pneumatic tired or oscillatory rollers
- Impact and Vibration using vibratory rollers

Static rolling & steel wheel rollers

Manipulation and oscillation
Impact and vibration

History of macadam road building

144-year asphalt paving history
Three roller train

Project specifications

Prescriptive or performance specifications?

COLORADO Department of Transportation; 2019 STANDARD SPECIFICATIONS BOOK; DIVISION 400 - PAVEMENTS

"401.17 Compaction. The hot mix asphalt shall be compacted by rolling. Both steel wheel and pneumatic tire rollers will be required. The number, weight, and type of rollers furnished shall be sufficient to obtain the required density while the mixture is in a workable condition. Compaction shall begin immediately after the mixture is placed and be continuous until the required density is obtained.

All other materials shall be removed with the finish rolling. Use of vibratory rollers with the vibrator on will not be permitted during surface course final rolling and will not be permitted on any rolling on bridge decks covered with waterproofing membranes.

SMA shall be compacted to a density of 95 to 97 percent of the daily theoretical maximum specific gravity, determined according to CP 51. All other HMA shall be compacted to a density of 92 to 96 percent of the daily theoretical maximum specific gravity, determined according to CP 51. The longitudinal joints shall be compacted to a target density of 92 percent of the theoretical maximum specific gravity. The tolerance shall be ±4 percent."
Air Void Content AVC or density?
Which do agencies really need and want? What is the difference?

Prescriptive specifications
How can paving contractors increase bonuses, maximize incentives, limit disincentives/penalties?

Performance specifications
How can paving contractors increase bonuses, maximize incentives, limit disincentives/penalties?
‘Best practices’ laydown & rolling

Balance paving speed with capability of roller train to keep up with optimum paving speed

NCHRP Research Report 856 ©2017

Typical paver speed between 20 - 40 feet per minute; most respondents indicated that slower speed would be advantageous to optimize density

NCHRP Research Report 856 ©2017

Tonnage placed per day most commonly < 3,000 tons
Laydown thickness - paver output

3000 tons per day during 8 hours actual paving = 375 tons per hour

Pavement 12 ft (~3.66 m) wide; laydown thickness 3 in (~76 mm)

Paver travels 1,724 ft to lay 375 tons

Modern 3 roller train

Roller train needs to keep up with paver at optimum paving speed for productivity

Follow ‘best practices’ in rolling

Most common breakdown roller - DDV
Intermediate rolling relatively even distribution between DDV and PTR
Most common finish roller – DDS
Decision about roller(s) is contractor responsibility, driven by ability to achieve proper percent density
Breakdown rolling phase

Breakdown rolling achieves initial density (reduction in air void content); typically done using double drum vibratory compactors.

Intermediate rolling phase

Intermediate rolling adds density (reduces air voids) plus reduces permeability of layer; usually done using pneumatic compactors.

Intermediate rolling technology

Alternative to pneumatics to add density (reduce air voids) plus reduce permeability of layer accomplished using oscillatory compactors.
Finish rolling phase

- Drive with compression roll toward paver
- Gradual steering & turns
- Remove roller marks already in pavement
- Reverse direction smoothly
- Smooth starts and stops
- Rolls moist, not wet

Finish rolling technology

Oscillatory compactors are alternative to steel wheel tandems to remove surface marks plus increase final density

Why roller train is changing

- Need for higher pavement bearing capacity & rutting resistance
- Need for higher density at joints & unsupported edges
- Need for more uniform density across pavement
‘Best practices’ in rolling

Temperature: one of most important considerations during laydown and during compaction

Time Allowed for Compaction – TAC critical for all paving mixes

Operating techniques

Reduce operator fatigue to increase productivity
Reduce rolling passes to increase productivity
Increase density, especially at joints
Reduce maintenance and operating costs

Breakdown - work safe, be efficient
Keep safely back from paver

Don’t roll up too close for safety

Operating is more than driving

Roller ‘train’ can consist of multiple compactors in breakdown mode
Each compactor can make multiple passes based on panel width
Uniform density results can provide incentive or disincentive to contractor
Breakdown rolling patterns

How many passes side-by-side?

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<td>168</td>
<td>174</td>
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Drum width (effective width) number of side-by-side passes to fully cover panel width (including overlap and overhang of edges):

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‘Best practices’ in rolling

Add compaction equipment to match optimum paving speed

Vibratory compactor: 3000 VPM frequency five pass pattern, 300 feet per minute average rolling speed...cannot keep pace with paver moving at average speed 60 feet per minute.
Match amplitude to application

Adjust amplitude for each lift

Lower amplitude selections used for thinner lifts, or materials easier to compact, like WMA.

Higher amplitude selections used for thicker lifts, or materials more difficult to compact, like SMA.

Match amplitude to application

Higher force for base courses
Lower force for thin overlays.
Match amplitude to application

Adjust frequency (amplitude)

Frequency change – high or low with dual amplitudes
Higher frequency in low amplitude
Lower frequency in high amplitude
Vibration frequency trend

First vibratory rollers for HMA – frequency limited to 2000 vpm (~33 Hz)

Newest vibratory rollers for HMA - frequency up to 4800 vpm (80 Hz)

Influences of vibration frequency

Smoothness based on drum impact spacing (directly tied to vibration frequency and rolling speed with vibration)

Production based on rolling speed with vibration (ability to keep up with paving train)

What about smoothness?

Smoothness directly tied to vibratory drum impact spacing and rolling speed with vibration
Uniform rolling speed... how fast?

For optimum smoothness:
- Drums less than 35 inches in diameter: 14 impacts per foot
- Drums 35 to 50 inches in diameter: 12 impacts per foot
- Drums 50 to 55 inches in diameter: 10 impacts per foot
- Drums 55 to 60 inches in diameter: 8 impacts per foot

Uniform rolling speed... how fast?

<table>
<thead>
<tr>
<th>Vibrations / minute</th>
<th>Impacts/foot</th>
<th>Speed (mph)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2500</td>
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<td>3000</td>
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<td>4.54</td>
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Maintain consistent rolling speed
Rolling speed... too fast!

IRI - International Roughness Index

Make first pass with vibration
Use automatic vibration controls

Protect unsupported edges

End passes in staggered arcs
Arc to center or supported edge

Reverse smoothly to limit shoving

How many coverages?
How much time is available?

Pay attention to TAC

Watch out for segregation
Avoid excessive drum wetting

As much as 60°F loss in surface temperature recorded by thermal imaging.

Intermediate roll - manipulate

Pneumatic compactors

"401.17 Compaction. The hot mix asphalt shall be compacted by rolling. Both steel wheel and pneumatic tire rollers will be required."

"Factors to be considered include (3) Size, speed, and tire pressure of rubber tire rollers."
Ground contact pressure

Dependent upon:
- Ballasted weight
- Number of tires
- Tire size, ply rating, inflation pressure

Uniform pressure plus overlap

Watch out for tire marks
Intermediate roll with oscillation

Oscillation benefits:
- Drum never bounces
- No drum impact force
- Manipulation reduces voids
- Safe to use on bridges, near buildings, longitudinal joints
- Effective on cooler mixes, either HMA or WMA

Where to use oscillation

“Make or Break” temperature zone

<table>
<thead>
<tr>
<th>Near graded</th>
<th>Target density zone</th>
</tr>
</thead>
<tbody>
<tr>
<td>Breakdown</td>
<td>77-80% behind paver</td>
</tr>
<tr>
<td>Intermediate</td>
<td>88-92%</td>
</tr>
<tr>
<td>Finish</td>
<td>92-97%</td>
</tr>
</tbody>
</table>
Intermediate roll with oscillation

Oscillation limitations:
Deep lifts hard to compact
Drum wear can be rapid (early replacement not uncommon)
Fixed frequency and fixed amplitude are typical (generally not adjustable)

Finish roll to remove marks

Stop or stand at an angle
Uniformity density for PWL/PWT

Roll joints for maximum density

Where is the joint?
Use of an edge compactor

Overlap adjacent passes

Protect unsupported edges
Compaction of supported joint

Method allows material at joint to be confined prior to rolling. Both sides are confined, so full force and weight of roller compresses mix down into joint to achieve highest density.

Good joint performance

Important to fill the joint fully with mix to get high density for best joint performance. Sufficient material at joint results in tight joint, but with some crushing of aggregate at surface.

Good joint appearance
How do we improve?

Improve talent – step-by-step

Communicate regularly, with purpose
Increase responsibility and independence
Plan for success... and for succession
Reduce distractions and interferences
Reward initiative and high performance
Train and cross-train to improve competence

Toolbox Talks; Training Aids Series

- TAS-32 Truck Exchange
- TAS-33 Longitudinal Joint Construction
- TAS-34 Forces of Compaction
- TAS-35 Rolling Procedures
- TAS-36 MTV Exchange
Someone forgot to read TAS-32!

Someone forgot to read TAS-33!

Agency and contractor objectives
Common objectives...the A-B-Cs...

Always pay attention to ‘THE JOB AT HAND’; avoid distractions
Be sure to work safe and work smart; watch out for one another
Concentrate on density and smoothness
Don’t forget the importance of production
Educate the work force; never ignore the importance of training
Follow the rules; ‘Slow and steady’ wins the bonus
Guarantee incentives and avoid disincentives using ‘Best Practices’

Humanity rules...

Never forget...At the end of each shift, everyone deserves to return home to family and friends...
Have a prosperous and safe paving season!

Thank you very much!

SEE YOU AT:

CONEXPO – CON/AGG 2020
• March 10-14, 2020
• Las Vegas, NV
• 140+ education sessions
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Dale Starry
Volvo Construction Equipment

Thank You

Session Evaluations/PDH's
• Complete session feedback in mobile app, your comments appreciated.
• Professional Development Hours logged in session feedback.

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• World of Asphalt 2021
  • March 16-18, 2021
  • Atlanta, GA
  • 120+ education sessions