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Using Density, Permeability, Infiltration, and Absorption to Assess the Quality of HMA Longitudinal Joints
The Problem

Cold Lane

1 - 5% lower than mat density

Hot Lane
The Problem
The Cause?

- Low Density
- Permeability
- Gradation

What should we measure?
Project Site #1
Project Site #2
Notched Wedge Joint Maker (NW)

- Overlap
- Safety Edge
- Aggregate Interlock
Notched Wedge (NW)
CrafCo Joint Adhesive (CF)

- Bond cold and hot side of joint
- Reduce permeability
JOINTBOND® (JB)

- Polymerized emulsion
- Penetrates surface
- Stabilizes joint
Joint Heater (JH)
Joint Heater (JH)
- Same as used for mainline paving operations
Hot Overlap (HO)
Hot Pinch (HP)
Cold Roll (CR)
Test Methods

Nuclear Density

Permeability / Infiltration

Density – T166 / Absorption

Density – T331
Testing Plan

- 2 Projects
  - 500 ft sections for each of 8 methods
  - 3 locations in each section
Distance from Joint

Nuclear Density

Density, %

12C
6C
J
6H
12H

CF CR HO HP JB JH NW TC
Distance from Joint

Core Density - T331

T331 Density, %

- 6C
- J
- 6H
Distance from Joint

Core Absorption

Absorption, %

CF  CR  HO  HP  JB  JH  NW  TC

Symbols:
- 6C
- J
- 6H
Distance from Joint

Field Permeability

$k, \text{ cm/s} \times 10^{-5}$

- CF
- CR
- HO
- HP
- JB
- JH
- NW
- TC

6C
J
6H
Distance from Joint

Infiltration

Infiltration, cm/hr

CF  CR  HO  HP  JB  JH  NW  TC

6C  J  6H
Construction method – significant
Distance from joint – significant
Interaction – significant

- Permeability / Infiltration
  - JB and JH – Low permeability at and away from the joint
  - Others – High permeability at joint, lower values away from the joint
## Discrimination

<table>
<thead>
<tr>
<th>Nuclear Density</th>
<th>T166</th>
<th>T331</th>
<th>Absorption</th>
<th>Permeability</th>
<th>Infiltration</th>
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Density vs. Permeability

SSD
\[ y = 5 \times 10^{20}e^{-0.454x} \]
\[ R^2 = 0.60 \]

VS
\[ y = 4 \times 10^{10}e^{-0.204x} \]
\[ R^2 = 0.44 \]

NG
\[ y = 5 \times 10^{15}e^{-0.326x} \]
\[ R^2 = 0.55 \]
Data Groupings

Nuclear Density vs. Infiltration

- Poor
- Fair
- Good

Infiltration (cm/hr) vs. Nuclear Density (%)

- 4% abs
- 2% abs
Conclusions

- Joint Heater
- Joint Bond
- Notched Wedge  \[ \text{Best Performers} \]
- Rolling Patterns (CR)
- Tack Coat  \[ \text{Not as successful} \]
- Crafco  \[ \text{Unsuccessful} \]
Joint Adhesive

Permeable area near joint

Zone of protection by CF
Conclusions

- Field measures better able to discriminate quality level than absorption or core density
  - Nuclear gauge dependent upon core correction
    - Gauge seating issues
  - Permeability/infiltration not standard QC tests
- All methods were able distinguish proximity to the joint
  - SSD showed strongest relationship to permeability
    - Ability to measure low density?
Recommendations

- Use Density as measure of quality
  - Already used for QC/QA efforts
- Joint Requirements
  - 89 percent minimum density
  - 4 percent maximum absorption
- Allow contractor to make informed decision regarding specific joint construction method
  - Emphasize the importance of good construction techniques
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Thank You