What Causes Stripping Under Chip Seals
What to Do About It

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Stripping Under Chip Seals
The Issues

• Some streets develop potholes 2 to 3 years after chip seals are applied
• Starts as small blisters
• Grows to $\frac{1}{2}$” to 1” deep potholes the size of pie pans or larger
The Issues

• The wearing course seems to be destroyed
• Seems mainly to happen on curb and gutter streets
Hypotheses

• Observed high variability in density of cores taken from streets with issues

• Then developed theory that high air voids makes mix more prone to stripping then mix with proper density
Task 1
Survey local agencies

- Over 60% reported stripping
- Seems to appear 2 to 4 years after first chip seal is placed
- Seems to happen more often on pavements that are older when they received first chip seal
  - 8+ years old or older
Task 2
Study testing methods

• Lottman Test
• Asphalt Pavement Analyzer
• Modified Iowa Boiling Test
• Lab permeability tester
• Made pucks up at 3 voids level, 7, 10, & 14%
• All testing methods showed that as inplace air voids increase the susceptibility to water damage also increases
TSR vs. Air Voids

![Graph showing the relationship between TSR and Air Voids with a linear trend line and the equation y = -1.5242x + 0.954 and R^2 = 0.999.](image)
Task 3
Field testing

- Valid lab finding
- Develop method to determine if street should be chip sealed
  - Needs to be user friendly
  - Non-destructive
Nuclear Density Tester
Coring and Air Voids Testing
Lab Permeability Testing
Stripping
Task 4
Compare Construction Methods

- Ordinary compaction vs. specified density
  - Most Cities use ordinary compaction
- 2340 mixes vs. 2360 super pave
<table>
<thead>
<tr>
<th></th>
<th>2340 Mixes</th>
<th>2360 Super Pave</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Crushing</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Type 31 No crushing requirement</td>
<td></td>
<td>Level 2 30% + 4</td>
</tr>
<tr>
<td><strong>Volumetric</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Air Voids</td>
<td></td>
<td>Air Voids</td>
</tr>
<tr>
<td>4%</td>
<td></td>
<td>VMA*</td>
</tr>
<tr>
<td></td>
<td></td>
<td>AFT **</td>
</tr>
<tr>
<td>No TSR***</td>
<td></td>
<td>TSR Required</td>
</tr>
<tr>
<td><strong>Compaction</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ordinary Compaction</td>
<td></td>
<td>Max Density</td>
</tr>
<tr>
<td>Modified specified</td>
<td></td>
<td>Higher Requirements</td>
</tr>
</tbody>
</table>
Task 5 Analysis Data

- Good correlation between all test methods used
- Permeability increased greatly around 9% air voids
  - This corresponds with findings from other states
Conclusions & Recommendations

- Stripping is caused by high air voids
- Streets seem to have high degree of variability of density
- MnDOT has similar issues on longitudinal construction joints
  - Air voids from 10 to 16%
  - Chip sealing is not cause of the issues
Effects Chip Seals on Construction Joints

\[ y = -2 \times 10^{-5} x^2 + 0.0224 x - 0.0415 \]
\[ R^2 = 0.9716 \]

\[ y = 0.0005 x^2 + 0.0026 x - 0.0101 \]
\[ R^2 = 0.8187 \]
Conclusions & Recommendations

- On new construction or re-paving
- Recommend switching from ordinary compaction to specified density
- Does not appear to increase cost of paving
- May increase cost of inspection
- Reserve right to pick coring locations
Conclusions & Recommendations

- Existing Streets
- Nuclear density tester will determine variability quickly
- Recommend chip sealing streets with less than 6 lbs. variability
- Chip sealing early in streets life seems to help
Conclusions & Recommendations

• Fog sealing may be an option
  – Seal water out
  – Allow water vapor to escape
Next Steps

• Working of faster curing fog seal emulsions
• Emulsions that will stay black longer
  – Polymer modification
• Fog seal are still effective after they have turned gray
Css-1h Fog Seal Performance

<table>
<thead>
<tr>
<th>Location - Transition (Application Rate - gsy)</th>
<th>Permeability (in/day)</th>
</tr>
</thead>
<tbody>
<tr>
<td>B/W Cells 19-18 (0.10)*</td>
<td></td>
</tr>
<tr>
<td>B/W Cells 18-17 (0.15)</td>
<td></td>
</tr>
<tr>
<td>B/W Cells 17-16 (0.20)</td>
<td></td>
</tr>
</tbody>
</table>

- k Before
- k After
- k, 2 Yrs After

*Kₜ taken as 18-17
Thank You!