Comparative Analysis of Emulsion and Hot Asphalt Cement Chip Seal Performance

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Project Facts

☺☺ TxDOT Atlanta District
- 342 projects
- All built since 1996
- Same seal coat contractor
- Same TxDOT Area Office did design/ construction administration
- Same aggregate
- Same asphalt supplier
- 165 used CRS-2P no precoat
- 177 used AC15-5TR with precoat
Emulsion Binder Usage in Texas

Use of Emulsion as Binder

- CRS-2H
- HFRS-2P
- HFRS
- CRS-2
- CRS-2P

No. of Districts
Chip Seal Strategies

- **Two schools of thought in Texas**
  - Seal as many miles of road as budget will permit: use less expensive system
  - Make every sealed mile as good as possible: use system with best performance.
- **Perception is that AC15-5TR yields a better performance.**
- **Atlanta District policy to use AC15-5TR on higher volume roads and CRS-2P on lower volume roads.**
# Project Data Points

- Type of binder
- Type of aggregate
- Specifications for emulsion and asphalt cement
- Average rate shot in the main lanes
- Specifications for aggregate
- Year of installation
- Contract requirements
- Contract amount
- Amount of material used
- Location of project
- Length in feet and miles
- Area of main lanes shot
- Area of intersections & miscellaneous locations shot
- Average daily traffic
- Visible pavement distresses
PMIS Database Data Points

<table>
<thead>
<tr>
<th>Type of underlying pavement</th>
<th>% Flushing</th>
</tr>
</thead>
<tbody>
<tr>
<td>% deep and shallow rutting</td>
<td>Average 18 kip wheel loads</td>
</tr>
<tr>
<td>Patching percent</td>
<td>Average annual maintenance cost</td>
</tr>
<tr>
<td>% Base failure</td>
<td>Date of last surface</td>
</tr>
<tr>
<td>% Block cracking</td>
<td>Distress score</td>
</tr>
<tr>
<td>% Alligator cracking</td>
<td>Ride score</td>
</tr>
<tr>
<td>% Longitudinal cracking</td>
<td>Surface index</td>
</tr>
<tr>
<td>% Transverse cracking</td>
<td>Skid number</td>
</tr>
<tr>
<td>% Raveling (Shelling)</td>
<td>Pavement condition score</td>
</tr>
</tbody>
</table>
Flushing (Bleeding)
Shelling (Raveling)
Satisfactory Pavement
Project Performance Metrics

- **27 Discreet Metrics**
  - Average High Flushing Score,
  - Average Low Flushing Score, and
  - Project Average Flushing Score,
  - Average Cost of Binder,
  - Average Cost of Aggregate,
  - Average Number of Square Yards on Main Lane, Etc.

- **Weighted Average Metrics**
  - Square yard weighted average of the pavement condition score
  - Square yard weighted average of the skid number
Project Performance Metrics

- **Cost Index Number Metrics**
  - Measure “bang for the buck.”
  - Combines engineering property with cost property.

- **Pavement Condition Cost Index**
  - Compare binders ability to maintain pavement condition at an acceptable price

- **Skid Number Cost Index**
  - Compare binders ability to maintain friction course at an acceptable price
The Pavement Condition Cost Index (PCCI) is defined as:

\[ PCCI_i = \frac{Tc_i}{Ave\ PC_i} \]

where:
- \( PCCI_i \) is the Pavement Condition Cost Index of Project “i”
- \( Tc_i \) is the Total Cost of Project “i”
- \( Ave\ PC_i \) is the Average Pavement Condition Score of Project “i”

Additionally, the Pavement Condition Cost Index Binder “B” (PCCI_B) is calculated as:

\[ PCCI_B = \frac{\sum PCCI_i}{TP_B} \]

where:
- \( TP_B \) is the Total number of projects using Binder “B”
Skid Number Cost Index

\[ \text{SNCI}_i = \frac{\text{TC}_i}{\text{Ave SN}_i} \quad \text{SNCI}_B = \frac{\sum \text{SNCI}_i}{\text{TP}_B} \]

- \( \text{SNCI}_i \) = Skid Number Cost Index of Project “i”
- \( \text{Ave SN}_i \) = Average Skid Number Score of Project “i”
- \( \text{TC}_i \) = Total Cost of Project “i”
- \( \text{SNCI}_B \) = Skid Number Cost Index Binder “B”
- \( \text{TP}_B \) = Total number of projects using Binder “B”
### Underlying Pavement Condition in Study Area

<table>
<thead>
<tr>
<th>Binder</th>
<th>Ave DIS</th>
<th>Ave RD</th>
<th>Ave Rut SH</th>
<th>Ave Rut DP</th>
<th>Ave Rut Sum</th>
<th>Ave Pat</th>
</tr>
</thead>
<tbody>
<tr>
<td>CRS-2P</td>
<td>95.85</td>
<td>3.57</td>
<td>6.09</td>
<td>1.23</td>
<td>6.66</td>
<td>0.94</td>
</tr>
<tr>
<td>AC15-5TR</td>
<td>99.48</td>
<td>3.53</td>
<td>4.80</td>
<td>0.65</td>
<td>4.83</td>
<td>1.81</td>
</tr>
</tbody>
</table>

Emulsions used on roads with more rutting and lower distress scores.
Raveling (Shelling) and Flushing (Bleeding) in Study Area

<table>
<thead>
<tr>
<th>Binder</th>
<th>Ave RAV hi</th>
<th>Ave RAV lo</th>
<th>Ave RAV</th>
<th>Ave FL hi</th>
<th>Ave FL lo</th>
<th>Ave FL</th>
</tr>
</thead>
<tbody>
<tr>
<td>CRS-2P</td>
<td>0.24</td>
<td>0.00</td>
<td>0.12</td>
<td>1.05</td>
<td>0.18</td>
<td>0.61</td>
</tr>
<tr>
<td>AC15-5TR</td>
<td>0.14</td>
<td>0.00</td>
<td>0.07</td>
<td>0.88</td>
<td>0.13</td>
<td>0.51</td>
</tr>
</tbody>
</table>

Rated as: none = 0; low = 1; medium = 2; high = 4

Shows both binders are effective & Atlanta District is getting good performance from their seals.
### Pavement Condition Analysis

#### Pavement Condition Comparison

PCCI = $/Ave Unit of PC

<table>
<thead>
<tr>
<th>Binder</th>
<th>Ave Hi PC</th>
<th>Ave Lo PC</th>
<th>Ave PC</th>
<th>Wt PC mi</th>
<th>Wt PC sy</th>
<th>PCCI</th>
</tr>
</thead>
<tbody>
<tr>
<td>CRS-2P</td>
<td>98</td>
<td>76</td>
<td>87</td>
<td>86</td>
<td>86</td>
<td>949</td>
</tr>
<tr>
<td>AC15-5TR</td>
<td>98</td>
<td>78</td>
<td>88</td>
<td>86</td>
<td>88</td>
<td>1,281</td>
</tr>
</tbody>
</table>

- CRS-2P & AC15-5TR roughly equal performance
- CRS-2P more cost effective
Pavement Condition Cost Index Comparison by Project Year

Pavement Condition Cost Index by Year

PCCI

CRS-2P
AC15-5TR

Project year

**Skid Number Analysis**

**Skid Number Comparison**

**SNCI = $/Ave Unit of SN**

<table>
<thead>
<tr>
<th>Binder</th>
<th>Ave Hi SN</th>
<th>Ave Lo SN</th>
<th>Ave SN</th>
<th>Wt SN mi</th>
<th>Wt SN sy</th>
<th>SNCI</th>
</tr>
</thead>
<tbody>
<tr>
<td>CRS-2P</td>
<td>63</td>
<td>44</td>
<td>54</td>
<td>54</td>
<td>54</td>
<td>1640</td>
</tr>
<tr>
<td>AC15-5TR</td>
<td>60</td>
<td>34</td>
<td>47</td>
<td>47</td>
<td>45</td>
<td>2607</td>
</tr>
</tbody>
</table>

- CRS-2P better skid performance
- CRS-2P more cost effective
**Skid Number Cost Index Comparison by Project Year**

![Skid Number Cost Index by Year](image)

- **Graph Legend:**
  - CRS-2P
  - AC15-5TR
Conclusions

- Emulsion chip seals performed as well as the hot AC seals even though they were applied to roads with poorer underlying condition.
- Emulsion chip seals are more cost effective.