Performance of SPS-2 Concrete Pavements

October 16, 2018
Bismark, ND

Kevin Senn, P.E.—NCE
Overview

- National SPS-2 Performance
- National SPS-2 PavementME Predictions
- North Dakota SPS-2 PavementME Predictions
National SPS-2 Performance Roughness

- The initial IRI of SPS-2 sections after placement ranged from 48 to 139 in/mi with a mean of 82 in/mi.
- JPCP constructed on PATB were smoother than sections constructed on LCB or untreated aggregate base.
National SPS-2 Performance Roughness

The bar chart shows the number of test sections for different average changes in IRI per year (in/mi/yr). The data is categorized into:
- < 0
- 0-2
- 2-4
- 4-8
- 8-16
- > 16

The highest number of test sections is in the range of 0-2.
National SPS-2 Performance Faulting

- Widened slab sections show less faulting than conventional width slabs.
- Sections with aggregate base show the highest joint faulting level. Sections with LCB and PATB have the lowest joint faulting.
National SPS-2 Performance Transverse Cracking

- Thinner (203 mm) slabs show more transverse cracks than thicker slabs. Sections with a thinner slab and a widened slab show the highest level of transverse cracking.

- Sections with PATB show the lowest percentage of slabs cracked transversely, while the sections with an LCB show the highest transverse cracking.
Sections with PATB show the lowest total longitudinal cracking levels, while the sections with LCB show the highest longitudinal cracking.
National SPS-2 Performance Lessons Learned (so far)

- In general, LCB provided the worst performance and PATB over DGAB provided the best performance.
- Longitudinal cracking was influenced by base type and slab thickness.
- Widened lanes contributed to lower transverse joint faulting.
National SPS-2 Pavement ME Predictions

Slabs Cracked Transversely

<table>
<thead>
<tr>
<th>Predicted Slabs Cracked</th>
<th>Measured Slabs Cracked</th>
</tr>
</thead>
<tbody>
<tr>
<td>LOW</td>
<td>LOW</td>
</tr>
<tr>
<td>HIGH</td>
<td>HIGH</td>
</tr>
</tbody>
</table>

- I
- II
- III
- IV

LONG TERM Pavement PERFORMANCE
### National SPS-2 PavementME Predictions

<table>
<thead>
<tr>
<th>Type I sections</th>
<th>Type III sections</th>
</tr>
</thead>
<tbody>
<tr>
<td>- Lower traffic loads</td>
<td>- Heavier traffic loads</td>
</tr>
<tr>
<td>- Thicker PCC</td>
<td>- PCC with lower strength and/or more elastic</td>
</tr>
<tr>
<td>- 34% with PATB and 24% with LCB</td>
<td>- No LCB sections</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Type 2 sections</th>
<th>Type IV sections</th>
</tr>
</thead>
<tbody>
<tr>
<td>- 28% with PATB and 47% with LCB</td>
<td>- Most design factors are near the average</td>
</tr>
<tr>
<td>- PCC with higher strength and/or less elastic</td>
<td></td>
</tr>
</tbody>
</table>
# National SPS-2 PavementME Predictions

<table>
<thead>
<tr>
<th>State</th>
<th>Number of Test Sections</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Type I</td>
</tr>
<tr>
<td>Arizona</td>
<td>10</td>
</tr>
<tr>
<td>Arkansas</td>
<td>5</td>
</tr>
<tr>
<td>California</td>
<td>3</td>
</tr>
<tr>
<td>Colorado</td>
<td>9</td>
</tr>
<tr>
<td>Delaware</td>
<td>13</td>
</tr>
<tr>
<td>Iowa</td>
<td>12</td>
</tr>
<tr>
<td>Kansas</td>
<td>9</td>
</tr>
<tr>
<td>Michigan</td>
<td>7</td>
</tr>
<tr>
<td>Nevada</td>
<td>2</td>
</tr>
<tr>
<td>North Carolina</td>
<td>12</td>
</tr>
<tr>
<td>North Dakota</td>
<td>16</td>
</tr>
<tr>
<td>Ohio</td>
<td>5</td>
</tr>
<tr>
<td>Washington</td>
<td>9</td>
</tr>
<tr>
<td>Wisconsin</td>
<td>20</td>
</tr>
<tr>
<td>Slabs Cracked Transverse</td>
<td>Slabs Cracked - Total</td>
</tr>
<tr>
<td>--------------------------</td>
<td>-----------------------</td>
</tr>
<tr>
<td></td>
<td>0</td>
</tr>
<tr>
<td>0</td>
<td>112</td>
</tr>
<tr>
<td>0-20</td>
<td>0</td>
</tr>
<tr>
<td>20-40</td>
<td>0</td>
</tr>
<tr>
<td>40-60</td>
<td>0</td>
</tr>
<tr>
<td>60-80</td>
<td>0</td>
</tr>
<tr>
<td>80-100</td>
<td>0</td>
</tr>
</tbody>
</table>
National SPS-2 PavementME Findings

- Predictions using agency calibration coefficients did not significantly improve upon predictions using default calibration values.
- However, the Root Mean Square Error (RMSE) of Type III predictions reduced by 13.6 (\% of slab cracked) on average.

\[
RMSE = \left[ \frac{1}{N} \sum_{i=1}^{N} (x_m - x_p)^2 \right]^{\frac{1}{2}}
\]

Where:
- \(x_m\) = measured performance
- \(x_p\) = predicted performance
- \(N\) = sample size
National SPS-2 RMSE Distribution – Faulting

Number of Test Sections

RMSE Bins (inch)

0-0.015 (GOOD) 0.015-0.03 (FAIR) 0.03-0.06 (POOR) 0.06-0.19 (VERY POOR)

Default Calibration
Agency Calibration
North Dakota SPS-2
Measured Roughness

IRI (in/mi) vs. Survey Date

- Surface Grinding
- Patching and AC Shoulder Restoration

Survey Date
Jan-93 Jan-95 Jan-97 Jan-99 Jan-01 Jan-03 Jan-05 Jan-07 Jan-09 Jan-11 Jan-13 Jan-15 Jan-17 Jan-19
North Dakota SPS-2
Predicted Roughness
North Dakota SPS-2
Measured Faulting

Survey Date

Faulting (in)

0261
0262
0263
0264
0219
0215
0260, 0213, 0259
Other Sites
North Dakota SPS-2 Predicted Faulting
North Dakota SPS-2
Measured Cracked Slabs

Patching and Slab Replacement on 0217

Patching
North Dakota SPS-2
Predicted Cracked Slabs

![Graph showing predicted cracked slabs from Jan-93 to Jan-19.](image-url)
North Dakota SPS-2 Over-Prediction

- All PavementME predictions showed very little to no distress (less than 1%).
- Therefore, none of the North Dakota SPS-2 test sections performed significantly better than the PavementME prediction.
Example (Arizona) Over-Prediction

Cracked Slabs - Transverse (%)

Year

Arizona 0213

Measured
Predicted with Default Calibrations
Predicted with Local Calibrations
North Dakota SPS-2
No Significant Distress

Similar Sites:
0213, 0214, 0215, 0216, 0218, 0219, 0221, 0222, 0223, 0224, 0259, 0260, 0261, 0262, 0263, and 0264
North Dakota SPS-2 Under-Prediction

Cracked Slabs - Transverse (%)

Year

01/01/85 01/01/90 01/01/95 01/01/00 01/01/05 01/01/10 01/01/15 01/01/20

Measured
Predicted with Default Calibrations

Similar Site:
0220
North Dakota SPS-2 PavementME Findings

- 0217 performed worse than predicted; having 21% of slabs cracked by 2003.
- The cracked slabs were repaired by 2009, but new cracks continued to appear.
- 0219 and 0220 also had about 3% of slabs cracked.
North Dakota SPS-2 PavementME Findings

- 0217, 0218, 0219, 0220 and 0262 have a LCB base type.

<table>
<thead>
<tr>
<th>Pavement Thickness</th>
<th>Low Strength</th>
<th>High Strength</th>
</tr>
</thead>
<tbody>
<tr>
<td>8” PCC</td>
<td>0217 (many cracks)</td>
<td>0218 (no cracks)</td>
</tr>
<tr>
<td>11” PCC</td>
<td>0219 (few cracks)</td>
<td>0220 (few cracks)</td>
</tr>
<tr>
<td></td>
<td>0262 (no cracks)</td>
<td></td>
</tr>
</tbody>
</table>

- All other sections performed well.
SPS-2 Future

- LTPP monitoring
- SPS-2 Pavement Preservation Pooled Fund Study
Thank You

For more information:
https://www.fhwa.dot.gov/research/tfhrc/programs/infrastructure/pavements/ltpp/getdata.cfm
ksenn@ncenet.com

More products and information at:
https://infopave.com