TPF-5(291) Development of an SPS-2 Pavement Preservation Experiment

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National Pavement Preservation Conference
NPPC23
Impacts and Benefits from Pavement Preservation

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Michigan State University

AASHTO TSP2 Pavement Preservation

Rocky Mountain West Pavement Preservation Partnership
Southeast Pavement Preservation Partnership
Midwestern Pavement Preservation Partnership
Northeast Pavement Preservation Partnership

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- NCE—Timin Punnackal, Nicole Dufalla, Nick Weitzel

Agenda

- Intro to SPS-2s
- TPF Project History
- Key Activities
- Selected Findings
- Q&A


Arizona SPS-2

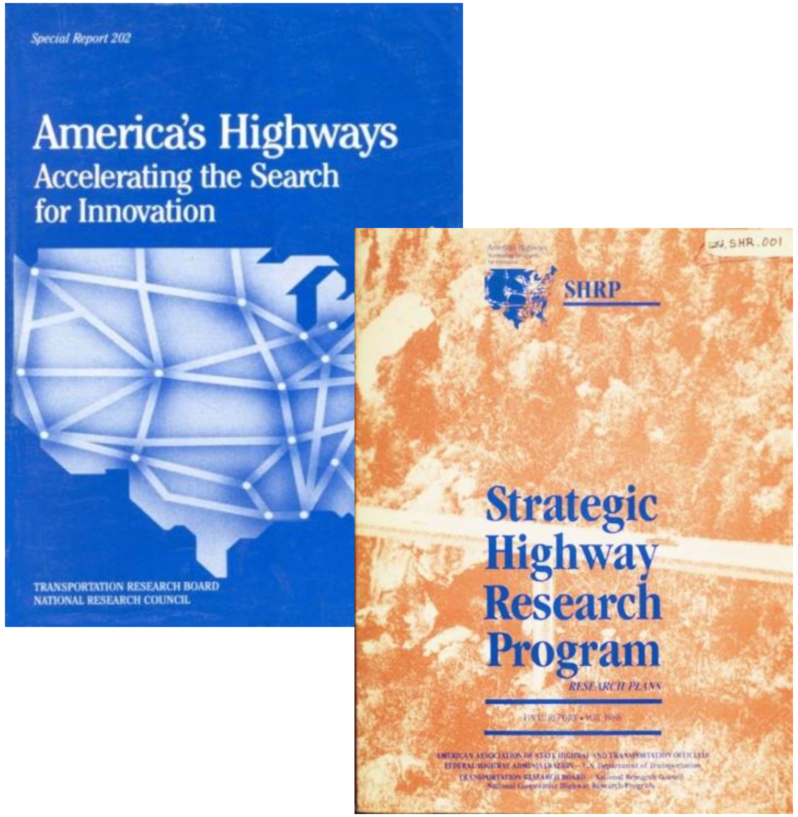
Intro to SPS-2s


California SPS-2

The Long Term Pavement Performance Program (LTPP)

- The LTPP program began in 1987 as part of the Strategic Highway Research Program (SHRP)
- The longest running highway research program in history
- $250+ Million study
- Over 2,500 test sections
  - General Pavement Studies (GPS)
  - Specific Pavement Studies (SPS)

LTPP's Goal



determine **HOW** and **WHY** pavements perform as they do

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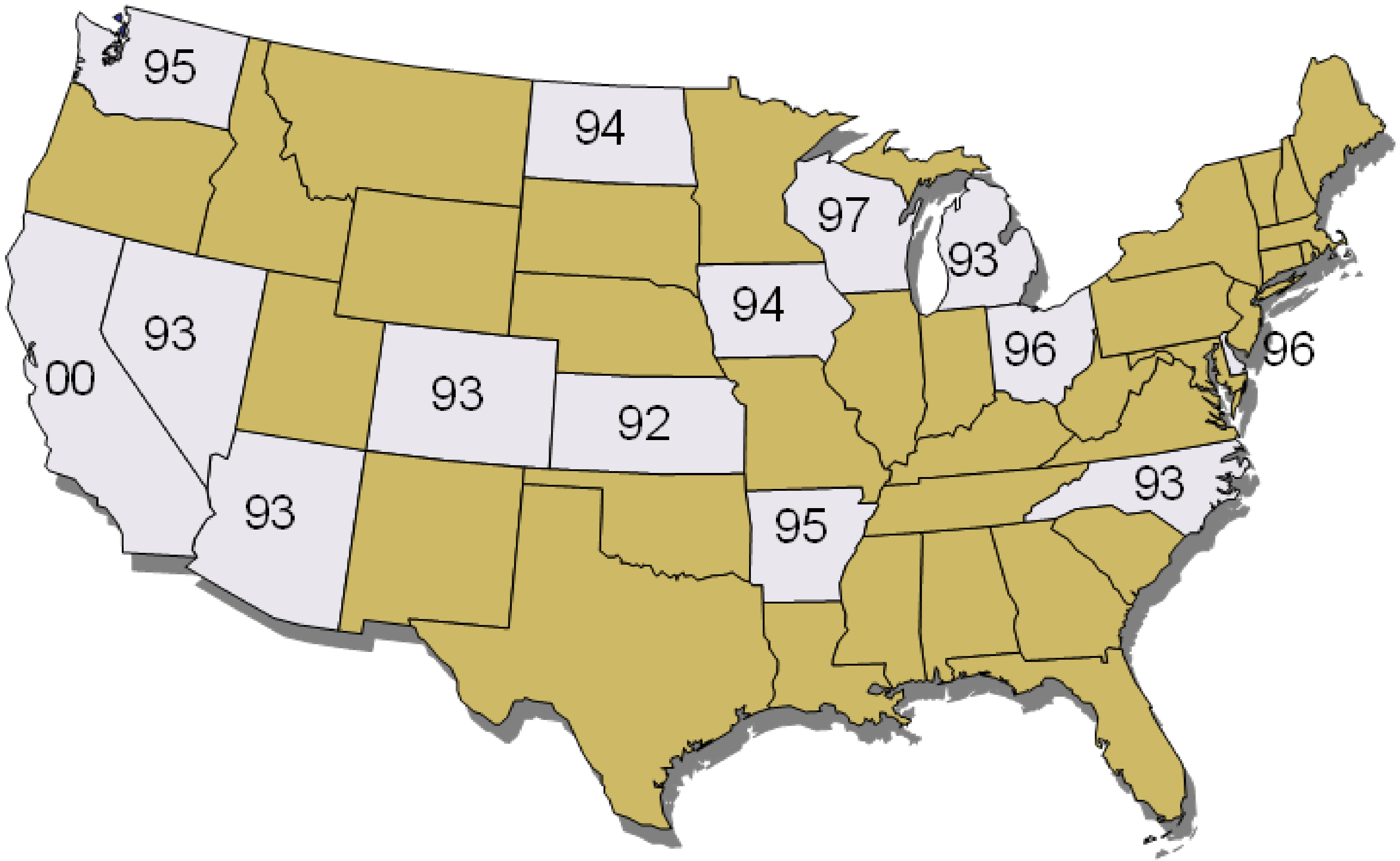
Reasons to Create the SPS-2 Experiment

- "At present, highway agencies lack sufficient information on the influence of concrete strength and pavement drainage on the performance of portland cement concrete (PCC) pavements. "
- "Although these factors appear in the AASHTO Guide for Design of Pavement Structures, they were incorporated into the equations through rational engineering considerations and not as the direct result of a structured field experiment."

SPS-2 Experimental Matrix

						Drainage		
						No		Yes
						Base type		
						AGG	LCB	PATB
Slab thickness, inches	8	Flexural strength, psi	550	Lane width, ft	12	0201	0205	0209
					14	0213	0217	0221
			900		12	0214	0218	0222
					14	0202	0206	0210
	11		550		12	0215	0219	0223
					14	0203	0207	0211
			900		12	0204	0208	0212
					14	0216	0220	0224

SPS-2 Locations



TPF Project History

Background: Project Objective

- The objective of this initial study is to provide a comprehensive assessment of all the SPS-2 test sections, in terms of performance monitoring, materials characterization, traffic and environmental data, and surviving test sections. The intent is to provide sufficient information to determine what can and cannot be studied in a preservation experiment on the SPS-2 test sections.

Background: Project Tasks

- Scope of work evolution over time:
  1. Original work to delivery of Draft Final Report
  2. Comparison of MEPDG predictions to actual performance
  3. SPS-2 Tech Days and additional analyses for Report based on TAC review comments
  4. Additional analyses identified as part of SPS-2 Tech Days and TAC input

Reports Completed

- Development of SPS-2 Pavement Preservation Experiment
- Evaluating the Impact of Design Features on Pavement Performance
- Analysis of Impact of Joint Score and ALR on Pavement Performance
- Updating Previous LTPP Analyses and the SPS-2 Experimental Matrix
- Evaluating the Impact of Non-Experimental Factors on Pavement Performance
- Impact of Changes in Climate, Traffic, Distress, and Maintenance on Deterioration Rate
- Comparison of SPS-8 and SPS-2 Performance
- Diurnal Changes in Roughness
- Service Life Evaluation
- Evaluating the Impact of Mix Design on Performance
- MEPDG Analysis of the PCC-Base Friction Loss
- Evaluation of Transverse Joint Opening Width

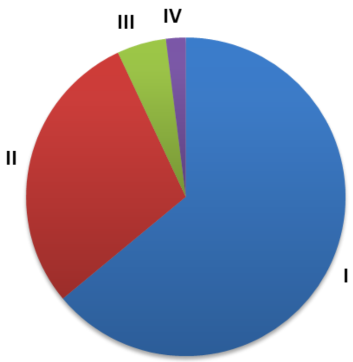
Key Activities

PMED Comparisons

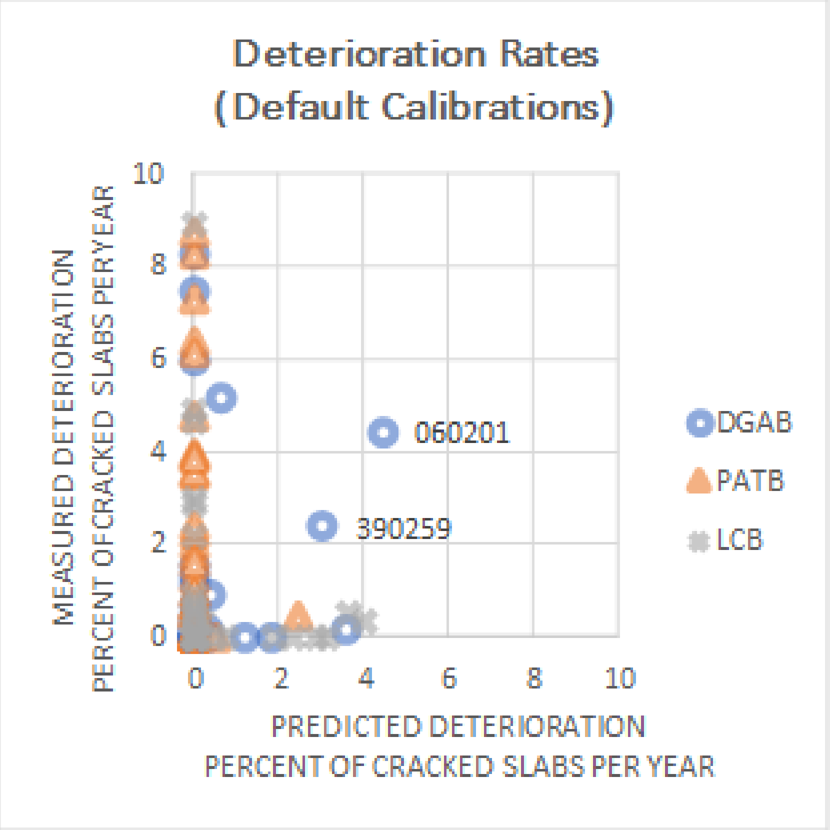
- Developed process to extract SPS-2 data from LTPP Pavement Performance Database as a file of inputs into the AASHTOWare PavementME Design (PMED) software
- Performed runs for all SPS-2 test sections

Deterioration Rates
Actual vs Predicted Performance

- Actual deterioration rates were not found to correlate with predicted deterioration rates.
- More than half SPS-2 test section were measured and predicted to have little to no distress.



Predicted Slabs Cracked	Measured Slabs Cracked	
	LOW	HIGH
LOW	I	II
HIGH	III	IV



SPS-2 Tech Days

- TAC supported engaging in SPS-2 Tech Days where supported by the State Highway Agency
- Nine completed
- Excellent participation
- Typically included classroom presentations/discussions and field visit

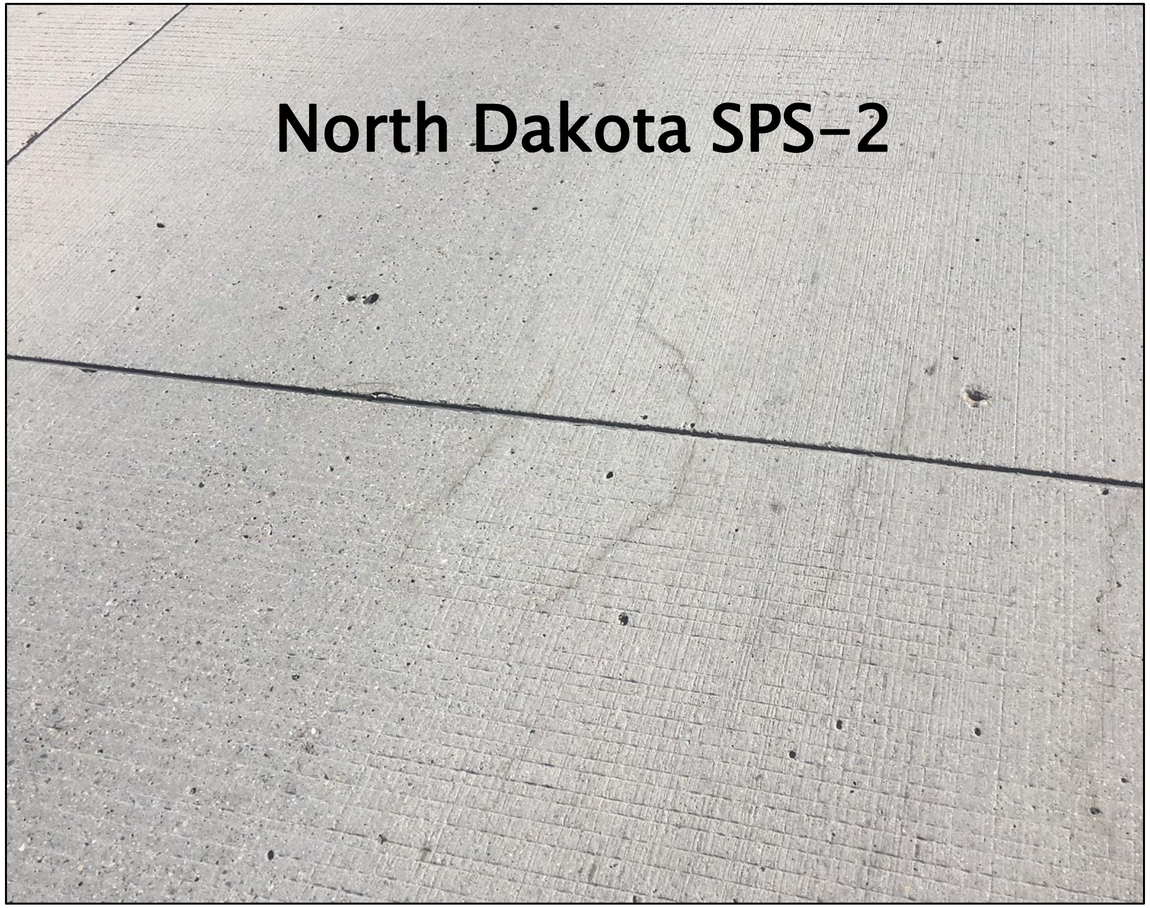
TPF-5(291), SPS-2 TECH DAYS		
State	Date	Location
Arizona	2/21/2018	Phoenix
Colorado	3/23/2018	Denver
Washington	5/2/2018	Ritzville
Iowa	5/30/2018	Pleasant Hill
Kansas	10/2/2018	Abeline
North Dakota	10/16/2018	Biskmark/Fargo
California	3/12/19	Stockton/Delhi
Arkansas	3/19/19	Little Rock
Ohio	5/22/19	Delaware (OH)

SPS-2 Tech Days

Workshop

Field Review

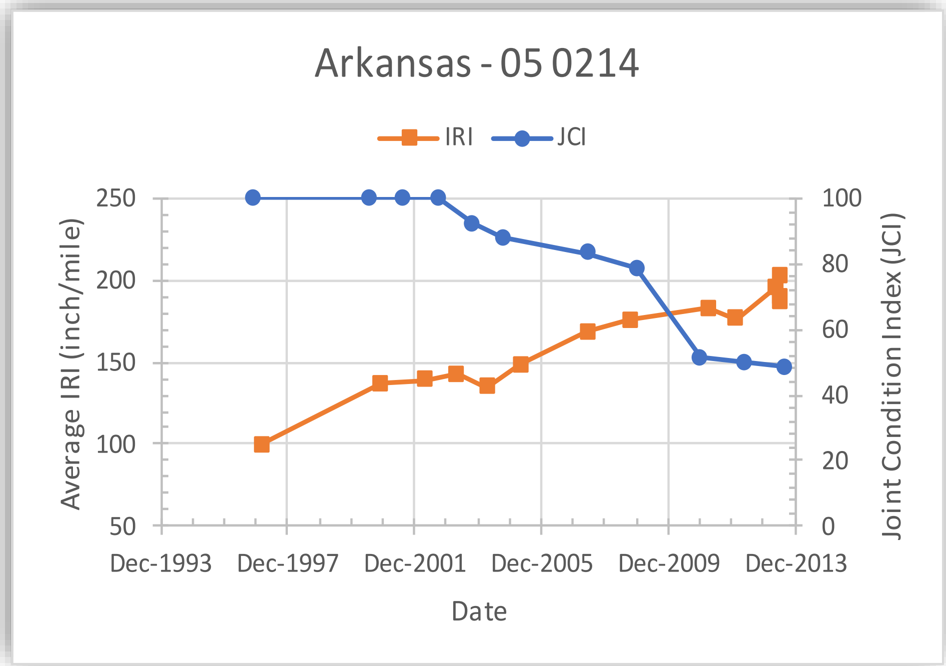
Selected Findings



Joint Seal Condition Analysis

$$JCI = 100 \times \frac{2(count\ of\ low\ severity\ joints) + (count\ of\ medium\ servity\ joints)}{2(total\ number\ of\ joints)}$$

Example



Average Transverse Joint Seal Deterioration Rate by Design Feature

SPS-2 Design Feature	Feature Type	Average JCI/year
PCC Thickness	Thick (11”)	-3.2
	Thin (8”)	-4.5
Base Type	DGAB	-3.3
	LCB	-3.5
	PATB	-4.5
PCC Strength	High	-3.9
	Low	-3.7
Lane Width	12’	-3.6
	14’	-4.1
Drainage	Drainage blanket with longitudinal drains	-3.7
	Longitudinal drains	-2.2
	No subsurface drainage	-4.0

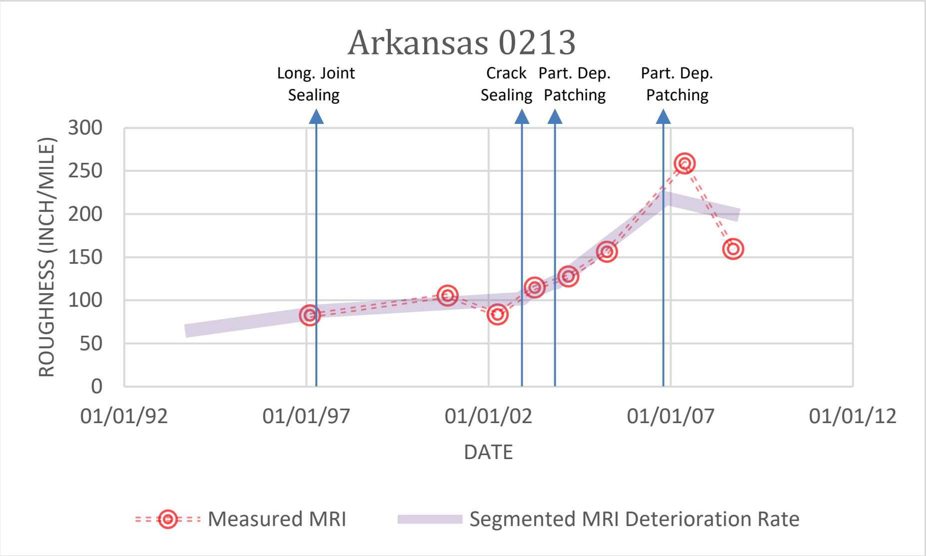
Joint Seal Condition Analysis

- The highest joint seal deterioration rates were found among thin pavement test sections with PATB base
- As joint condition decreases IRI, faulting, and percent of cracked slabs typically increase.
- The inverse relationship between joint condition and cracked slabs is strongest for pavements with:
  - thin high-strength PCC
  - treated bases
  - 12-foot wide slabs
  - subsurface drainage


California SPS-2

Impact of Maintenance on Roughness

- Evaluated how different types of maintenance affected roughness deterioration rate in the short-term
- Process:
  - Segment roughness deterioration rates by maintenance events.
  - Evaluate the change in roughness deterioration before and after maintenance and compare to the overall roughness deterioration rate.



Date	Maintenance Treatment
9/1/1993	*In-Study*
2/5/1997	Lane-Shoulder Longitudinal Joint Sealing
12/12/2002	Crack Sealing
11/15/2003	Partial Depth Patching of PCC Pavement other than at Joint
10/15/2006	Partial Depth Patching of PCC Pavement other than at Joint
11/15/2008	*Out-of-Study*

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Coarseness Factor – Workability Factor

Zone	Description	Low-Strength Mixtures	High-Strength Mixtures
Zone I	Coarse gap-graded aggregate mix that tends to segregate	04 (Arizona) 06 (California) 10 (Delaware) 37 (North Carolina) 39 (Ohio) 53 (Washington)	37 (North Carolina) 39 (Ohio)
Zone II	Well graded mix in sizes between 2-inch and ¾-inch maximum aggregate size	05 (Arkansas) 19 (Iowa) 26 (Michigan) 32 (Nevada) 38 (North Dakota)	05 (Arkansas) 08 (Colorado) 38 (North Dakota)
Zone III	¾-inch minus aggregate mixtures	None	
Zone IV	Excessive fines mixtures – sticky	08 (Colorado) 20 (Kansas) 55 (Wisconsin)	04 (Arizona) 06 (California) 10 (Delaware) 19 (Iowa) 20 (Kansas) 26 (Michigan) 53 (Washington) 55 (Wisconsin)
Zone V	Non-plastic mixtures – rocky		32 (Nevada)

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Design Feature Impact on Performance

SPS-2 Design Feature	Design Feature Type	Pavement Performance Measure Deterioration Over Time								
		Roughness	Faulting	Transverse Cracking	Longitudinal Cracking	Shoulder Dropoff	LTE	Mid-slab Deflection	AREA Value	Joint Condition
PCC Thickness	Thick (11″)	👍	👍	👍	👍	NA	👍	👍	✕	👍
	Thin (8″)	👎	👎	👎	👎	NA	👎	👎	✕	👎
Base Type	DGAB	✕	✕	✕	👍	NA	✕	✕	✕	👍
	PATB	👍	👍	👍	👍	NA	✕	✕	✕	👍
	LCB	👎	👎	👎	👎	NA	✕	✕	✕	👎
PCC Strength	High	✕	👍	👎	👍	NA	👍	✕	✕	✕
	Low	✕	👎	👍	👎	NA	👎	✕	✕	✕
Lane Width	12′	✕	👎	👎	👍	NA	👎	✕	✕	👍
	14′	✕	👍	👍	👎	NA	👍	✕	✕	👎
Drainage	Drainage blanket/ longitudinal drains	👍	✕	👍	👍	NA	✕	✕	✕	👍
	No subsurface drainage	👎	✕	👎	👎	NA	✕	✕	✕	👎
Shoulder Type	AC	👎	NA	NA	✕	👎	✕	NA	NA	NA
	PCC	👍	NA	NA	✕	👍	✕	NA	NA	NA

👍 – relatively positive impact on deterioration rate or performance measure.
👎 – relatively negative impact on deterioration rate or performance measure.
✕ – no clearly observable impact or impact varies significantly from project to project.
NA – impact on performance measure was not applicable to design feature.

Design Feature Impact on Service Life

- Serviceability based on FHWA roughness, faulting, and cracking criteria

Design Factor	Relative Service Life Improvement	
	Regular Traffic	Lower Traffic
Thick pavements	4 years (15-20%)	2 years (10-15%)
PATB base type	2 years (10-15%)	<0.5 years
High-strength PCC	1-2 years (10%)	<0.5 years
Widened lanes	<0.5 years	N/A

Q&A + For More Information

- InfoPave™ https://infopave.fhwa.dot.gov/
- TPF https://www.pooledfund.org/Details/Study/533
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Transportation Pooled Fund - Study Detail

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Thank You!