University of Nevada, Reno

Western Regional Superpave Center

Program and Research Updates

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Assistant Professor

2014 Nevada Transportation Conference

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Pavements/Materials Engineering Program
Western Region Superpave Center

Personnel

- Peter E. Sebaaly, Ph.D., P.E.
  Professor, Director of WRSC
- Elie Y. Hajj, Ph.D.
  Assistant Professor
- Mena Souliman, Ph.D.
  Post-doctoral Scholar
- Murugaiyah Piratheeban, MSCE
  Research Scientist, Lab Manager
- Students
  15 Research Graduates;
  5 Undergraduates

Facility

- WRSC occupies parts of the 1st & 2nd floors of HREL building.
- Fully ***accredited & certified Lab by AMRL.***
- Current capabilities:
  - *aggregates*
  - *asphalt binders*
  - *asphalt mixtures*
  - *Portland cement concrete*
  - *Large-scale pavement testing (flexible and rigid pavements)*

Main Areas of Research Topics

Selected Research Studies

1. Implementation of AASHTO MEPDG for Flexible Pavements in Nevada (NDOT).
2. Long-Term Performance of CIR in Nevada (NDOT).
3. Development of Percent within Limit Specifications (PWL) for Nevada (NDOT).
4. Cost-Effectiveness and Optimum Application of Slurry Seal (Washoe RTC).
5. Quantifying the Influence of Geosynthetics on Pavement Performance (NCHRP).

Updates on the Implementation of AASHTO MEPDG for Flexible Pavements in Nevada

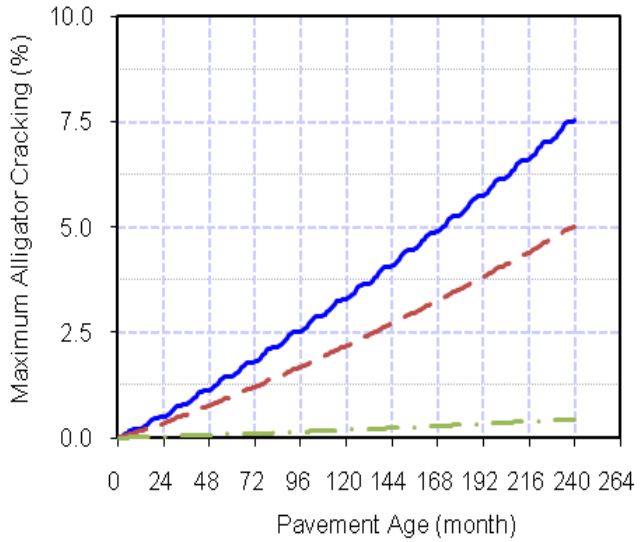
(Sponsor: Nevada DOT)

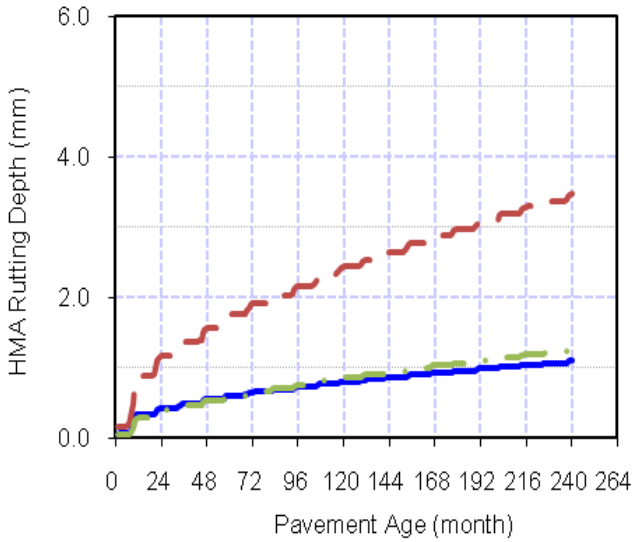
Motivation

- Why M-E Design?
  - Greater emphasis on performance
  - Increased emphasis on rehabilitation strategies
  - Variations in Climate
  - Increased Traffic
  - Budgetary constraints
  - Nonstandard Materials
  - Darwin (AASHTO 93) no longer supported

Pavement ME Design for Flexible Pavements

- Prediction of following distresses with time:
  - Rutting
  - Fatigue cracking
  - Transverse cracking
  - Roughness (IRI)



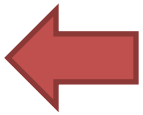


Why Local Calibration for Nevada?

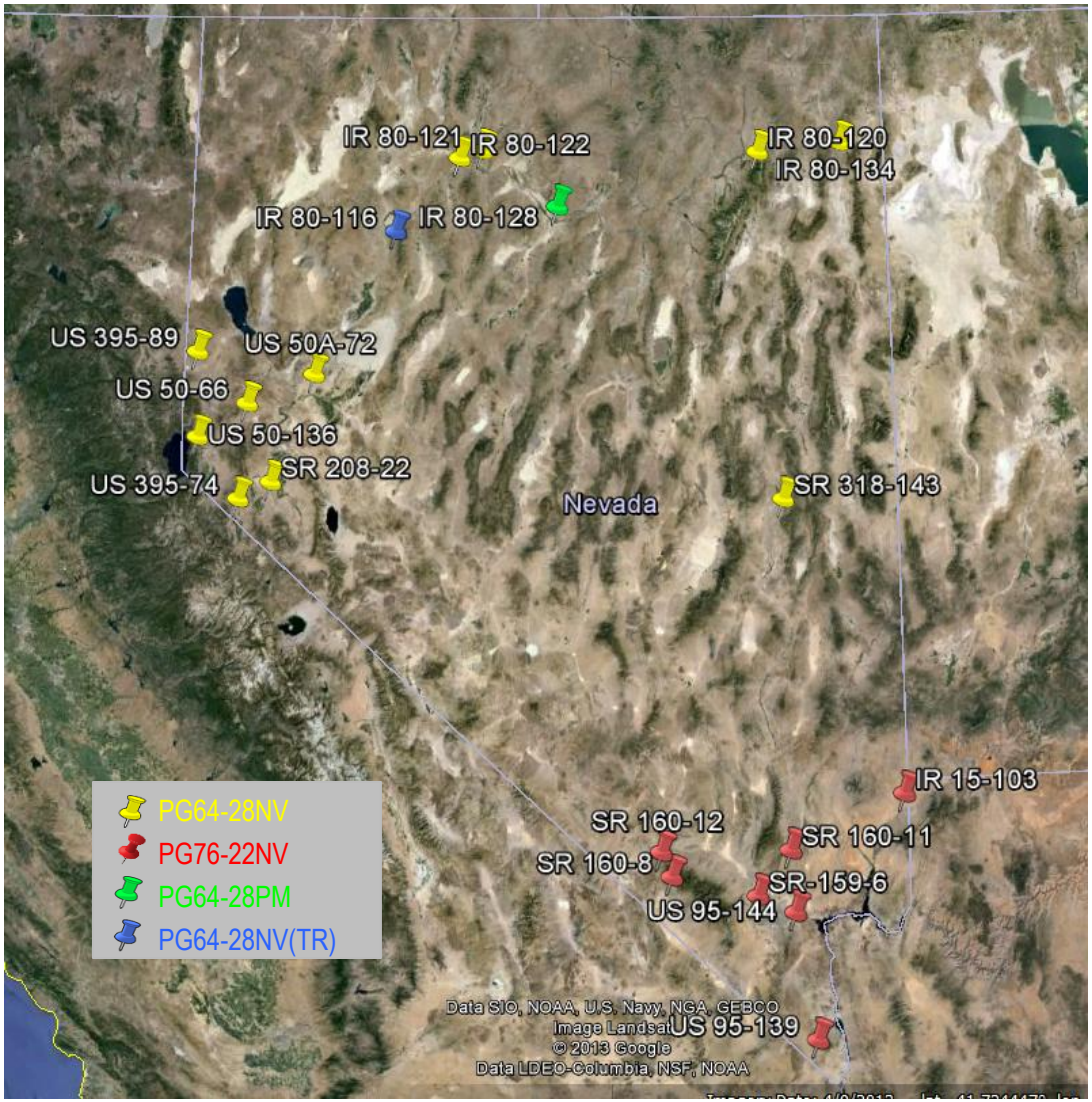
- Nevada's use of polymer-modified asphalt binder.
- Nationally calibrated performance models are calibrated based on neat asphalt binder only.
- Using the national models will show an early failure compared to the true performance of PM binders.
- This may result in unnecessarily thick sections.



Implementation Plan

1. Sample asphalt mixtures from field projects.
2. Develop materials database.
3. Identify existing climatic weather data.
4. Identify existing traffic data.
5. Convert NDOT PMS distress data.
6. **Calibrate to Nevada's Conditions.** 
7. Validate the calibrated models.
8. Conduct trainings

Map of Sampled Contracts (2005-2010)



Candidate Sections for Calibrations

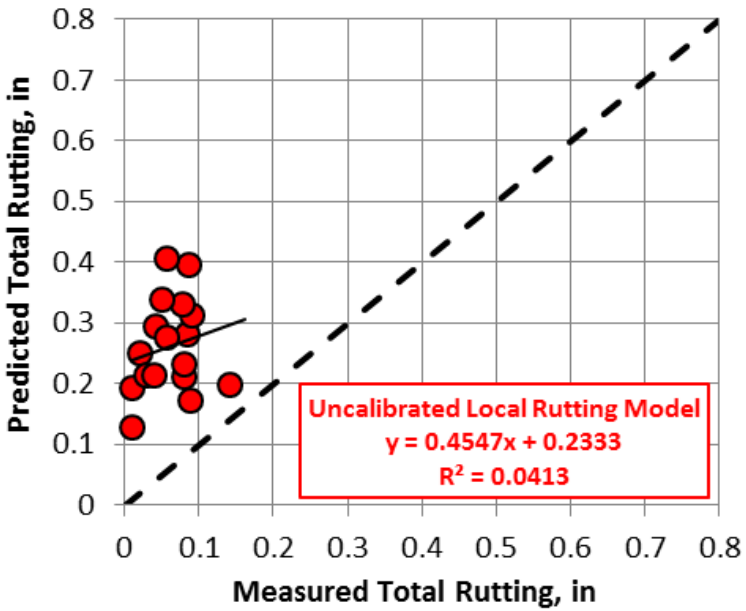
Fatigue Sections											
	Sections		Traffic AADTT	Sampled	Non Sampled	Age(years)	Sampled	Non Sampled	Fatigue (%)	Sampled	Non Sampled
	Non Sampled	Sampled									
PG64-28NV	5	0	Low <1000	0	1	0 to 3	0	1	3 to 10	0	3
			Intermediate 1000-5000	0	1	3 to 6	0	1	10 to 30	0	0
			High >5000	0	3	6 and up	0	3	over 30	0	2
PG76-22NV	13	2	Low <1000	0	6	0 to 3	0	0	3 to 10	1	8
			Intermediate 1000-5000	2	7	3 to 6	2	3	10 to 30	1	3
			High >5000	0	0	6 and up	0	10	over 30	0	1

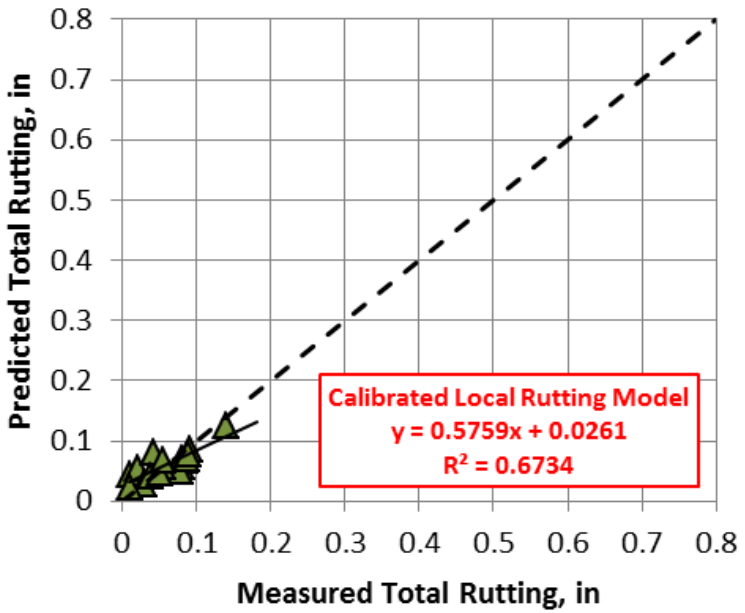
Rutting Sections											
	Sections		Traffic AADTT	Sampled	Non Sampled	Age(years)	Sampled	Non Sampled	Rutting Rating(in)	Sampled	Non Sampled
	Non Sampled	Sampled									
PG64-28NV	11	10	Low <1000	3	4	0 to 3	6	1	0.5 to 1	9	7
			Intermediate 1000-5000	7	4	3 to 6	4	5	0.1 to 0.15	1	2
			High >5000	0	3	over 6	0	5	0.15 and up	0	2
PG76-22NV	15	5	Low <1000	0	6	0 to 3	0	0	0.5 to 1	5	1
			Intermediate 1000-5000	3	7	3 to 6	4	5	0.1 to 0.15	1	14
			High >5000	2	2	6 and up	1	10	0.15 and up	0	0

IRI Sections											
	Sections		Traffic AADTT	Sampled	Non Sampled	Age(years)	Sampled	Non Sampled	IRI Rating (in/mile)	Sampled	Non Sampled
	Non Sampled	Sampled									
PG64-28NV	6	4	Low <1000	1	4	0 to 3	2	0	70 to 90	3	4
			Intermediate 1000-5000	3	2	3 to 6	2	2	90 to 120	1	2
			High >5000	0	0	6 and up	0	4	120 and up	0	0
PG76-22NV	12	5	Low <1000	0	4	0 to 3	0	0	70 to 90	2	8
			Intermediate 1000-5000	3	6	3 to 6	4	4	90 to 120	3	2
			High >5000	2	2	6 and up	1	8	120 and up	0	2

Preliminary Calibration for Rutting Model

- Based on 7 pavement sections tested for rutting in the Repeated Load Triaxial.





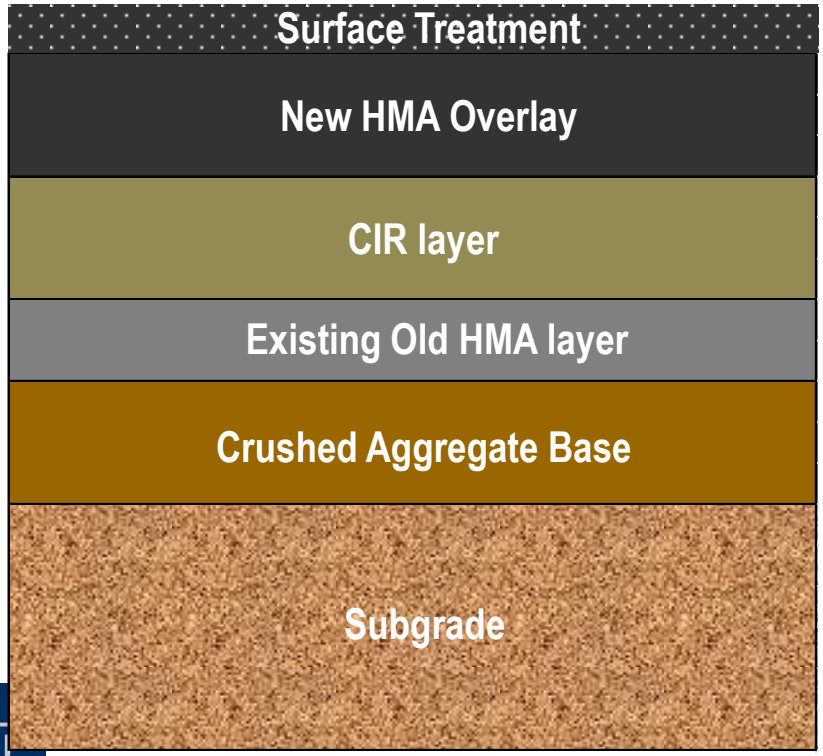
Long-Term Performance of CIR Technique in Nevada

(Sponsor: Nevada DOT)

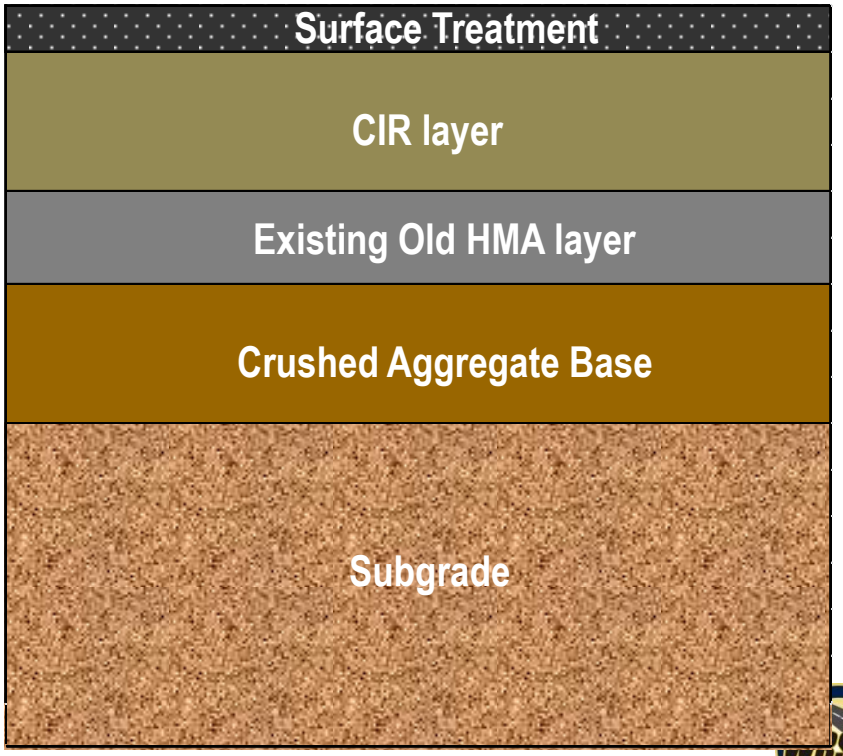
Cold In-Place Recycling in Nevada

- NDOT has used CIR over 1,500 centerline miles of roads over the past two decades (~25% of total system in NV).

High Volume Roads



Low Volume Roads



Cold In-Place Recycling in Nevada

- NDOT has long been using CMS-2s for CIR projects and recently started using Reflex and PASS emulsion.
- NDOT has observed some differences in the performance of CIR roads throughout Nevada.
- Need to assess the long-term performance of CIR roads in Nevada.

Cold In-Place Recycling in Nevada

- Total of 66 CIR projects were evaluated
  - Construction date 2001-2009.
- Factors Considered:

CIR Rehab Type	- With Asphalt Overlay - With Surface Treatment
Emulsion Type	- CMS-2s - Reflex - PASS
Geographic Location	- District - County
Traffic Level	- ESALs
Pre-CIR Pavement Condition	- Pavement Distresses

Cold In-Place Recycling in Nevada

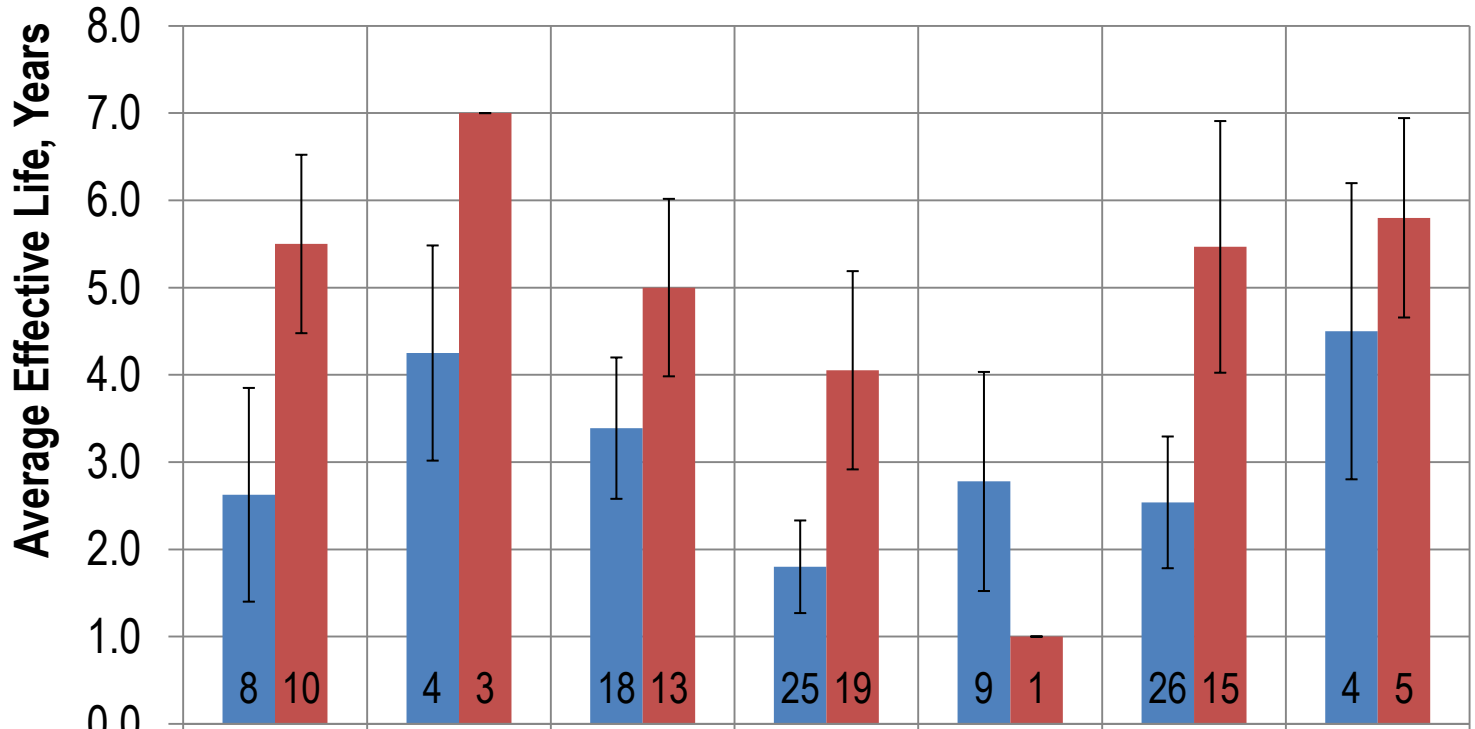
- **CIR + HMA Overlay + Surface Treatment**
  - CIR with CMS-2S Emulsion (37 Projects)
  - CIR with Reflex™ Emulsion (2 Projects)
  - CIR with PASS Emulsion (2 Projects)

- **CIR + Surface Treatment**
  - CIR with CMS-2S Emulsion (9 Projects)
  - CIR with Reflex™ Emulsion (15 Projects)
  - CIR with PASS Emulsion (2 Projects)

Average Effective Life for All Projects Combined

Effective Life Definition

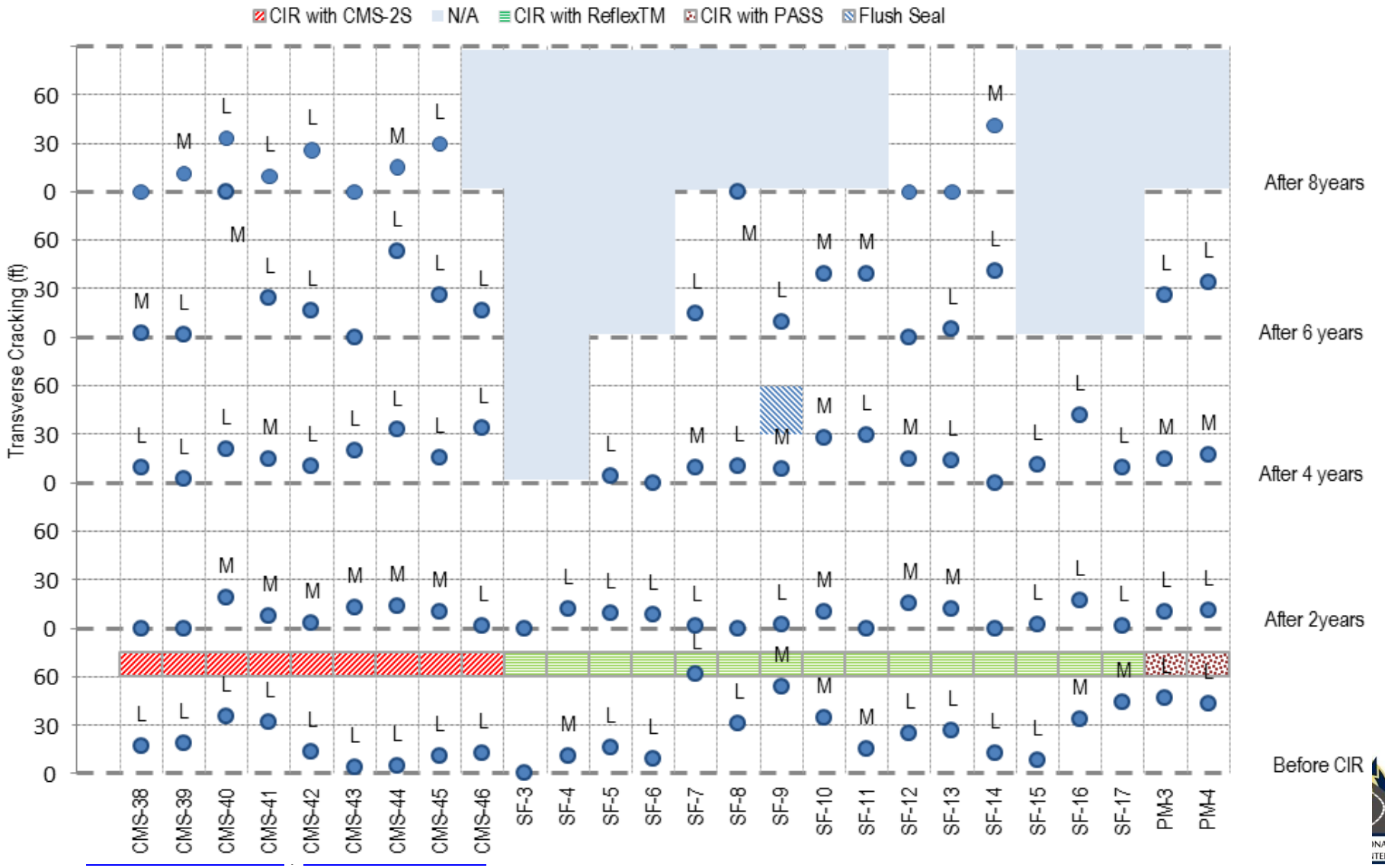
Number of years pavement serves without a particular type of distress is defined as the effective life of the pavement for that distress.



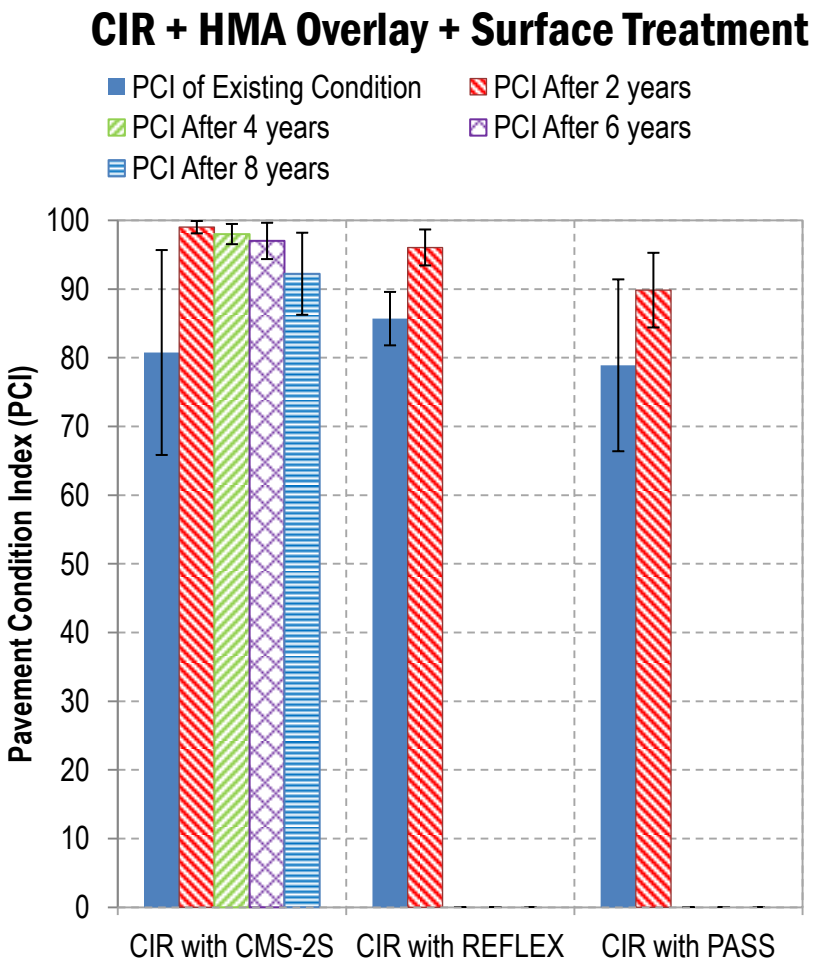
	Fatigue Type A	Fatigue Type B	NWP	Trans	Rut	Roughness	Block A
CIR+Surface Treatment	2.6	4.3	3.4	1.8	2.8	2.5	4.5
CIR+HMA Overlay+Surface Treatment	5.5	7.0	5.0	4.1	1.0	5.5	5.8

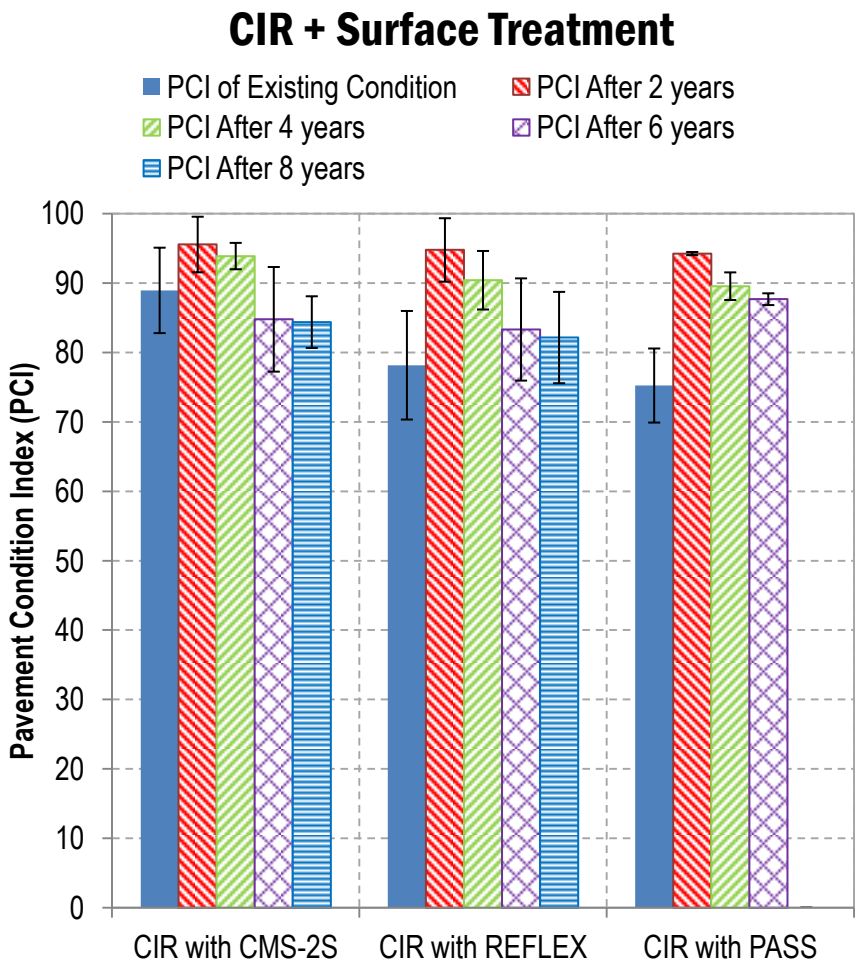
Only one project!

Pavement Performance Charts
Example: CIR + Surface Treatment



Pavement Condition Index (PCI)
According to ASTM D6433





Findings and Conclusions

- Transverse cracking & longitudinal cracking were the major type of distresses.
- CIR pavements with HMA overlay significantly reduced rutting and roughness while the other method fairly reduced it.
- Factors found insignificant on the performance of CIR pavements:
  - Variation in environmental conditions
  - CIR layer thickness between 2 and 3 inches
  - Various surface treatments
- Thickness of the overlay was crucial for the performance of CIR on high volume roads.
- CIR + HMA Overlay + Surface Treatment on high volume roads performed better than CIR + Surface Treatment on low volume roads.
- *CIR with HMA overlay:* Within the first two years, the Reflex and PASS emulsions showed slightly lower performance as compared to the CMS-2S emulsion.
- *CIR with surface treatment:* all three types of emulsions (CMS-2S, Reflex, and PASS) showed similar performances.

Pavement Construction: Percent Within Limit Specifications

(Sponsor: Nevada DOT)

Develop PWL System for NDOT
(PWL = the percent of a lot falling within set specification limits)

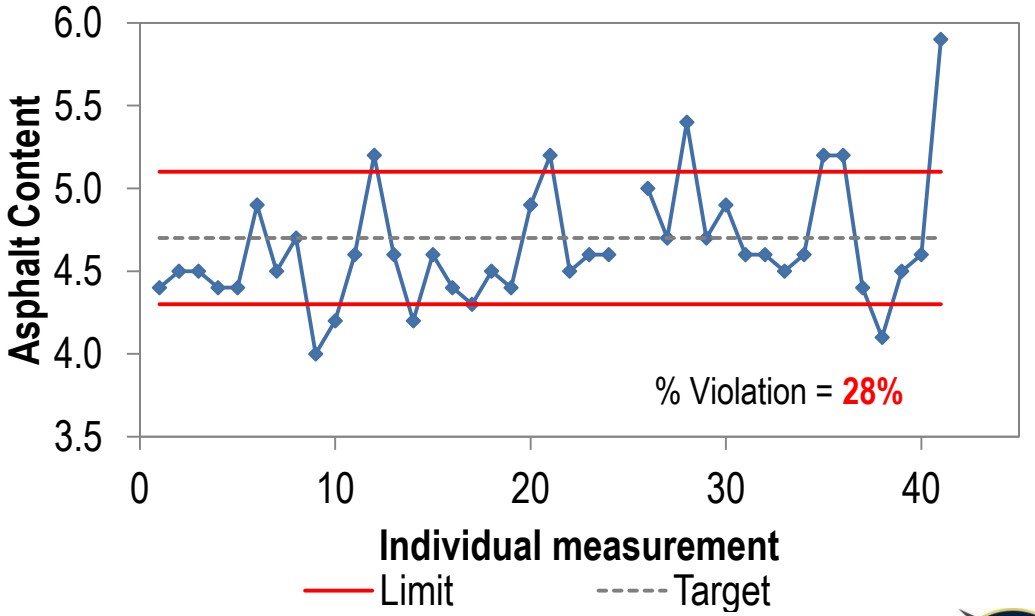
Proposed Specs:

PWL process considers both the actual value of the measured property and its associated variability

Versus

Current Specs:

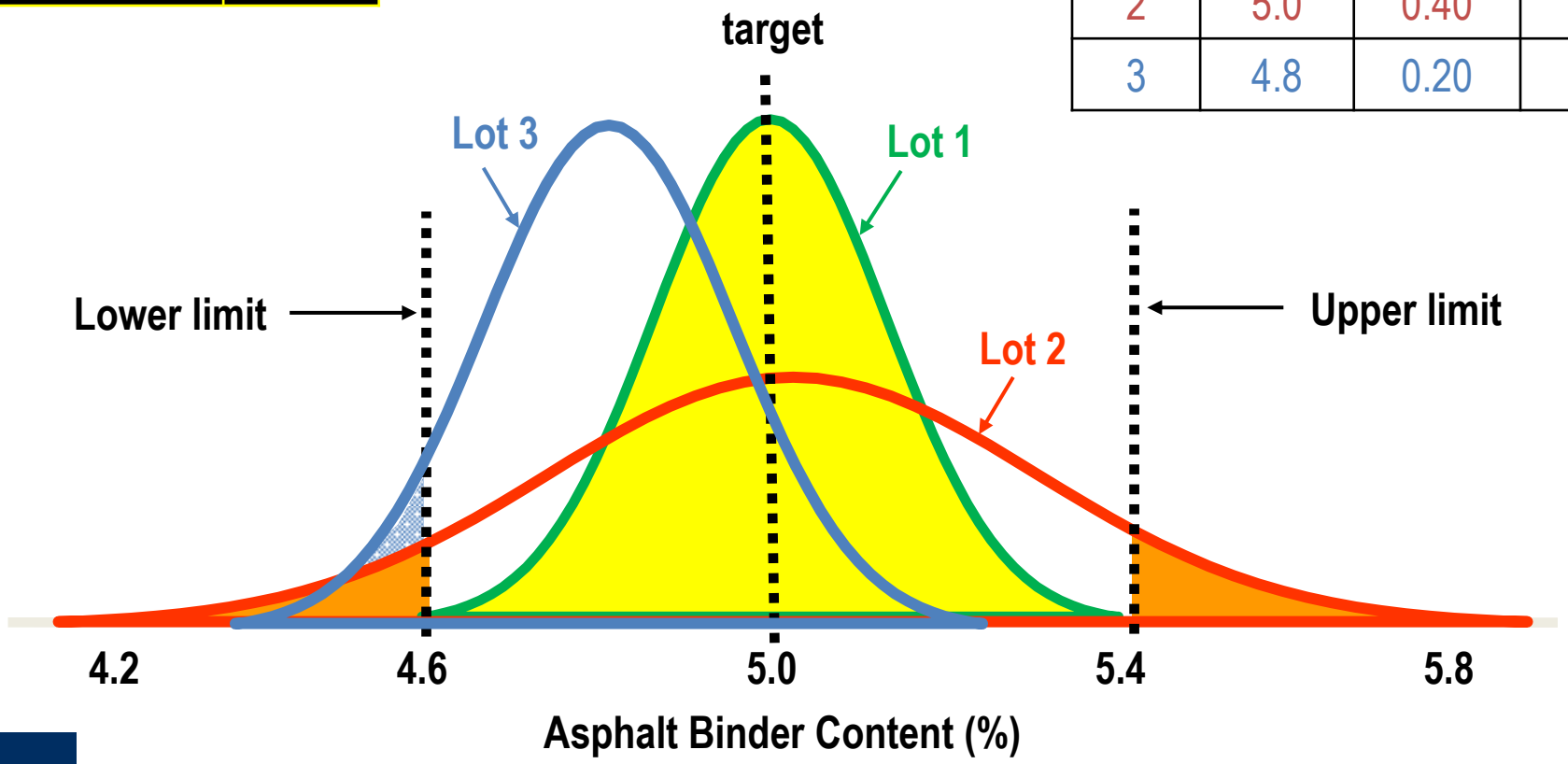
Pass/No pass specifications



Develop PWL System for NDOT Example

Target Value	5.0
Limits	± 0.4

Lot	Mean	STD	PWL
1	5.0	0.20	100
2	5.0	0.40	67
3	4.8	0.20	84



Research Phases

- ***Phase I – Review of Existing PWL Specification Systems***
  - Literature review
  - General framework for the development of the PWL system was recommended for Phase II
- ***Phase II – Develop the PWL Specification System***
  - PWL system was developed including several materials and mixtures properties to identify the PWLs for all sublots and lots of HMA mixtures
  - Weight factors are identified for each of the mixtures properties leading to the development of a single PWL for each lot within a construction project
- ***Phase III – Implement the Specifications***
  - Implement the developed PWL system on several NDOT projects
  - Use the data to fine tune the system as needed

Weight Factors, Overall PWL, & Pay Factors

- Weight factors determined based on the findings from the NDOT study on "Impact of Construction Variability on Pavement Performance."
  - Gradation: **25%**
  - Asphalt Binder Content: **33%**
  - Compaction (i.e., Mat Density): **42%**

  } *Performance-Related Weight Factors*

$$PWL_{Overall} = 0.25\,PWL_{Gradation} + 0.33\,PWL_{AC} + 0.42\,PWL_{Compaction}$$

$$PF = 55 + (0.5 \times PWL_{overall})$$

A 100% pay will be provided to the contractor at a PWL of 90%.

Maximum PF will be at 105%.

Develop PWL System for NDOT
Proposed Implementation Plan

Year 2014	Apply PWL system on pilot projects.	Pay factors will not be implemented.
Year 2015	The 100% pay will be provided at an overall PWL of 70.	The maximum pay factor is fixed at 100%.
Year 2016	The 100% pay will be provided at an overall PWL of 80.	The maximum pay factor is fixed at 100%.
Year 2017	The 100% pay will be provided at an overall PWL of 90.	The maximum pay factor is fixed at 105%.

Cost-Effectiveness and Optimum Application of Slurry Seal

(Sponsor: Washoe County RTC)

Effectiveness of Slurry Seal

Problem Statement and Objective

- Time of application is left to the Project Engineer judgment and practice:

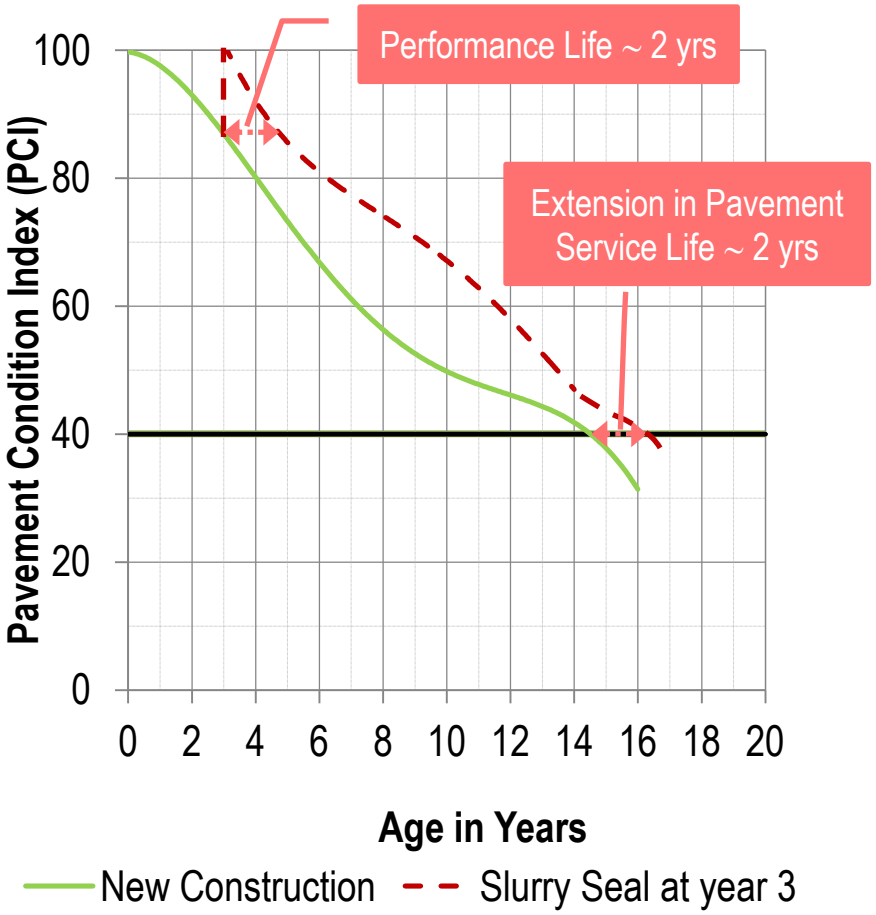
- Identify the optimal timing for the application of slurry seal on asphalt pavements in the Truckee Meadows Region.
  - Phase I: *Single application* of slurry seal.
  - Phase II: *Two sequential application* of slurry seal.

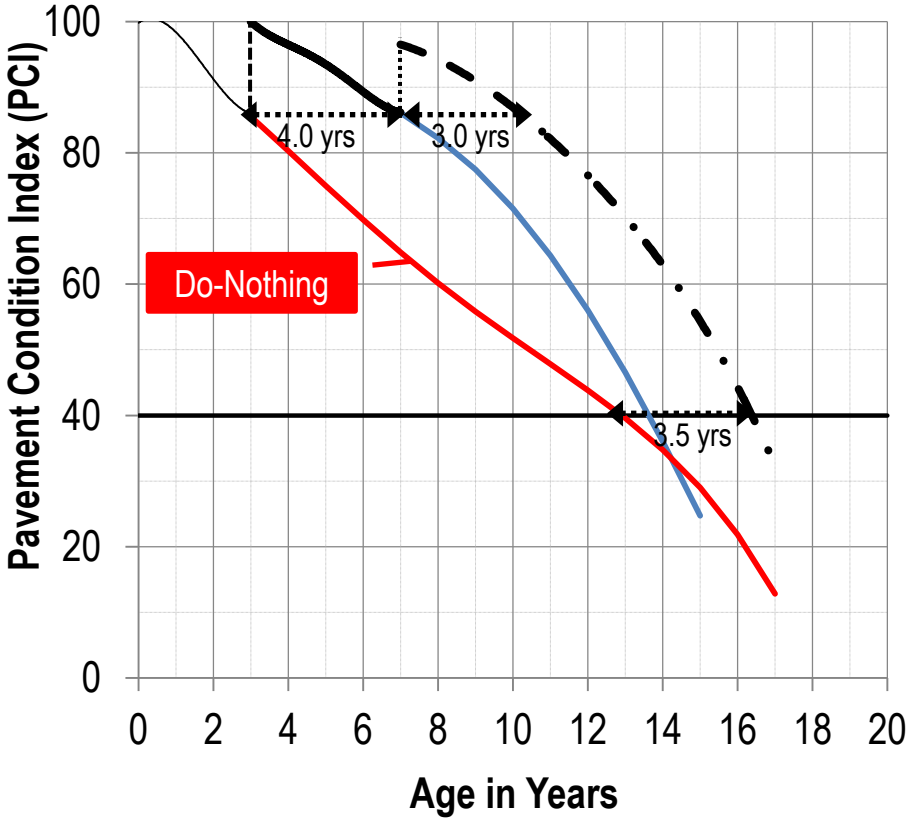
Effectiveness of Slurry Seal

Research Plan

- Flexible Pavements: New vs. Overlay Construction.
- Road Class: Arterial, Collector, Residential.
- Performance measured in terms of PCI (0-100).
  - Do-Nothing: SS was not applied to the pavement.
  - Phase I: Single Application
    - SS applied immediately after construction (referred to as 0).
    - SS applied at either: 1, 3, 5, 7, or 9 years after construction.
  - Phase II: Two sequential Application
    - First SS at either 0, 1, 3 or 5 years / Second SS at either 7 or 9 years.

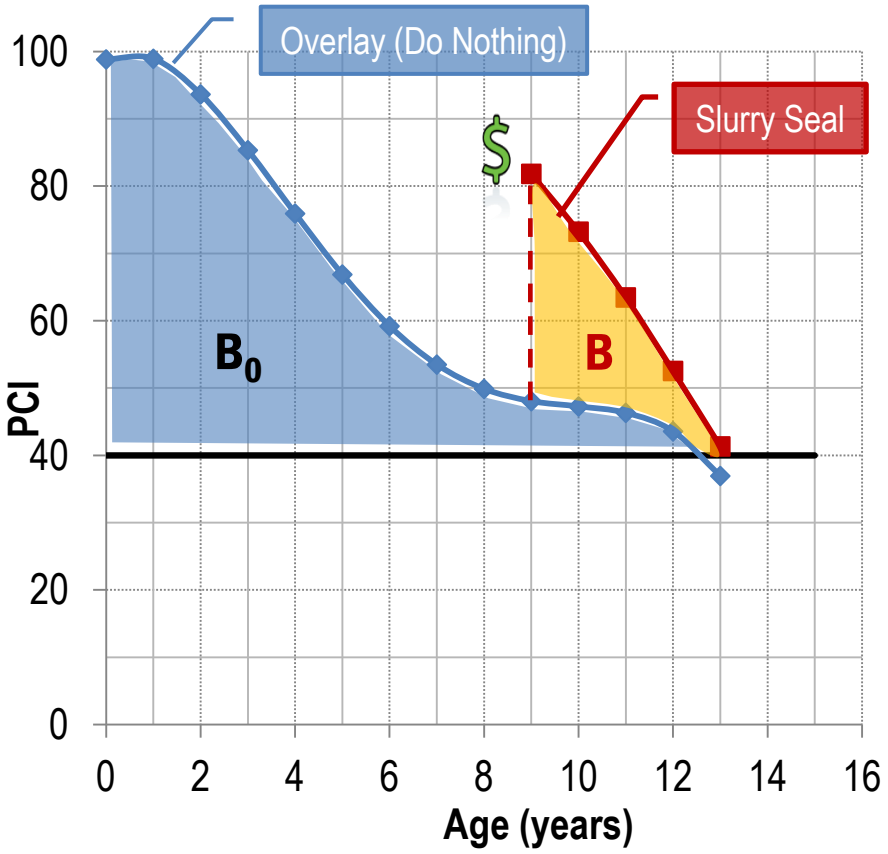
Slurry Seal Applications (Example)



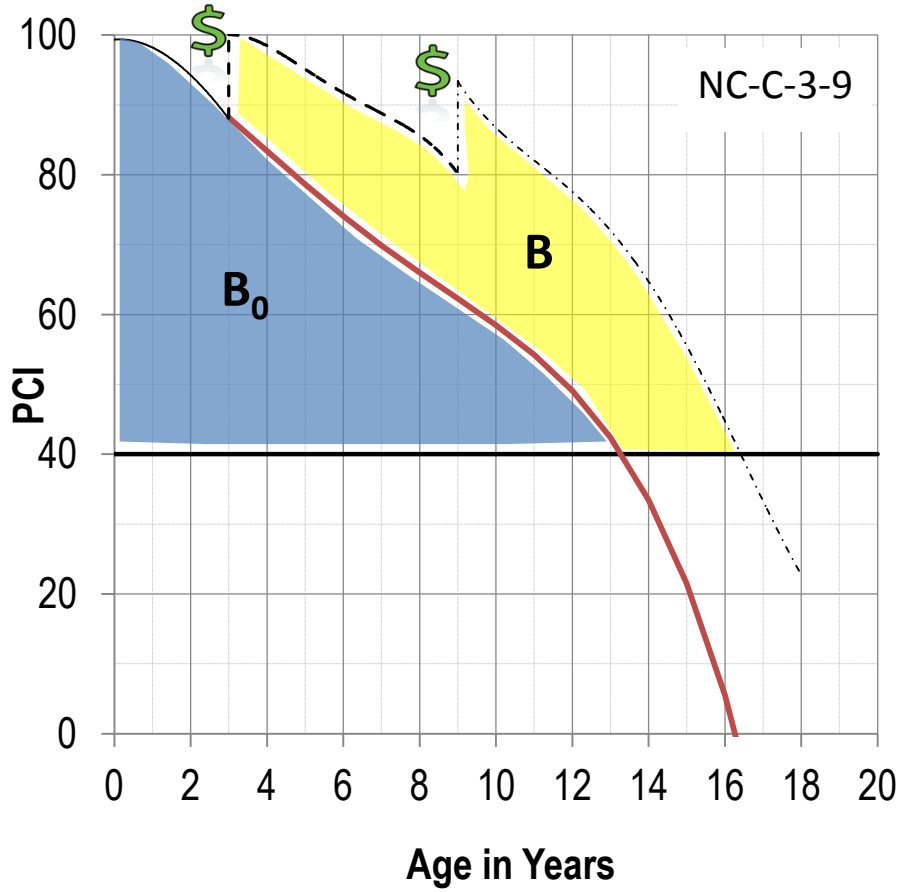


Phase I: Single Application of Slurry Seal

SS Effectiveness



Relative Benefit = $100 \times B / B_0$

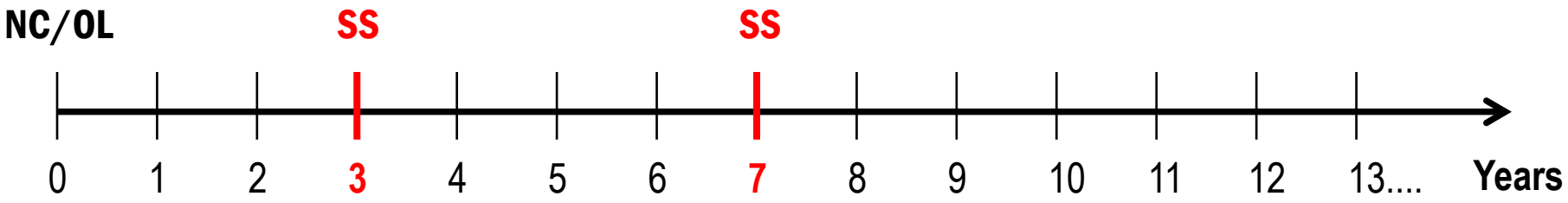


Benefit Cost Ratio = B / C

Effectiveness of Slurry Seal

Summary of Findings

- Application of SS **immediately or one year after** construction is **not effective**.
- In general, the *pavement service life* ***was not*** *extended by application of the* ***single slurry seal***.
- Optimum timing for sequential application:



→ Pavement service life extended by **2.0~4.0 years**

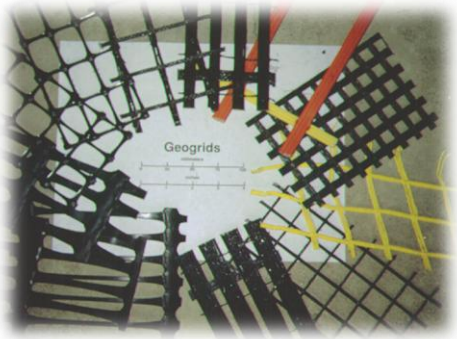
Optimum Timing for Slurry Seal Application

Overall Recommendations

Construction Type	Recommended Threshold PCI Values	
	1st Slurry Seal Application	2nd Slurry Seal Application
New	87-90	86
Overlay	85-87	77

01-50: Quantifying the Influence of Geosynthetics on Pavement Performance

(Sponsor: National Cooperative Highway Research Program)

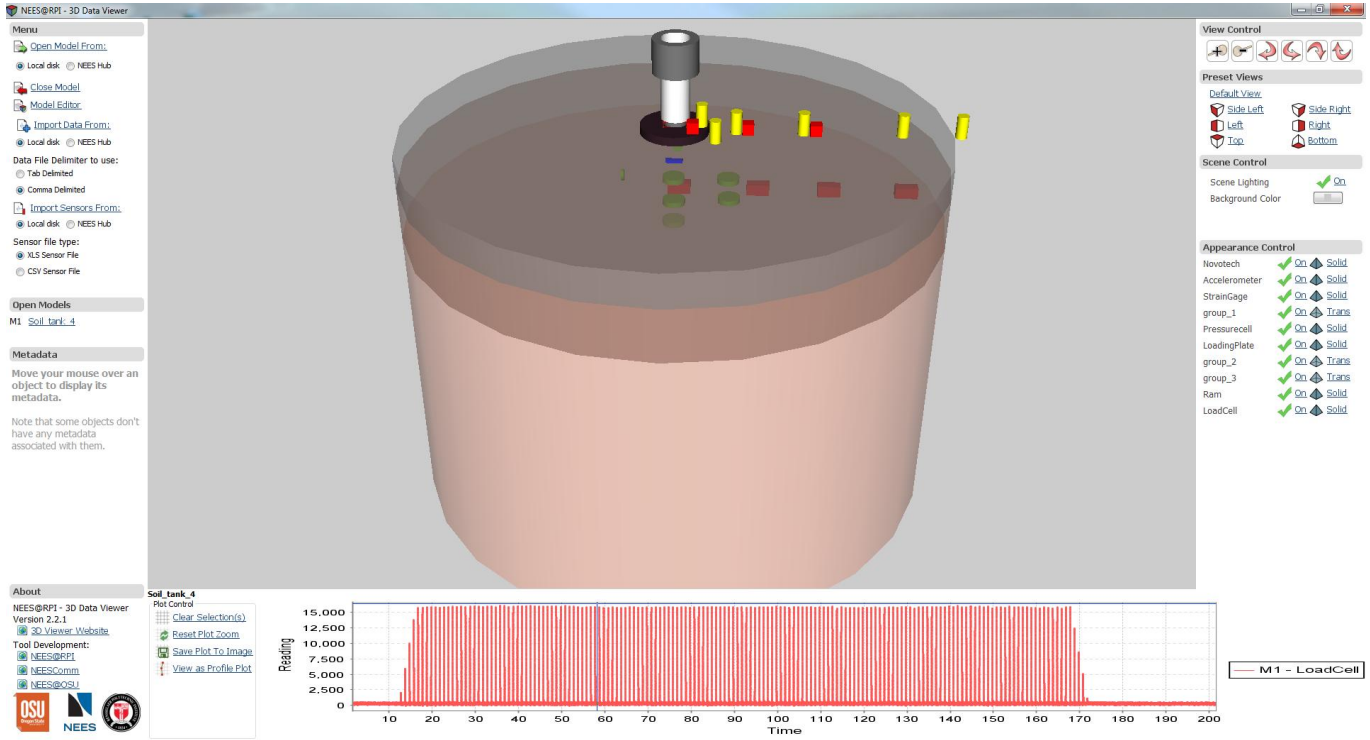


NCHRP 01-50: Research Objective

- To develop a methodology for quantifying the *influence of geosynthetics* on pavement performance for use in pavement design & analysis.
  - Be consistent with the MEPDG framework to facilitate incorporation into the MEPDG
  - Be concerned with using geosynthetics in unbound base/subbase layers for flexible & rigid pavements

NCHRP 01-50:
Large Scale Experiment for Flexible and Rigid Pavements

1. Assess vertical pressure distributions above/below geosynthetic layer;
2. Assess tensile stress/strain distribution within geosynthetic;
3. Assess deformed shape of geosynthetic;
4. Assess confinement of materials provided by geosynthetic;
5. Assess slippage condition at the geosynthetic/unbound material interface.



NCHRP 01-50: Subgrade Preparation and Placement

Subgrade Compaction

Completed Subgrade Placement

NCHRP 01-50: Base Instrumentation

Subgrade Pressure Cell

Excavated Base Area for Instrumentation

NCHRP 01-50: Surface Instrumentation

Surface LVDT's and Accelerometers

Loading Actuator and Plate

Thank You!

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