

Determining the Age and Smoothness of Asphalt and Concrete Pavements at the Time of First Rehabilitation using LTPP Program Data

South East States Pavement Conference

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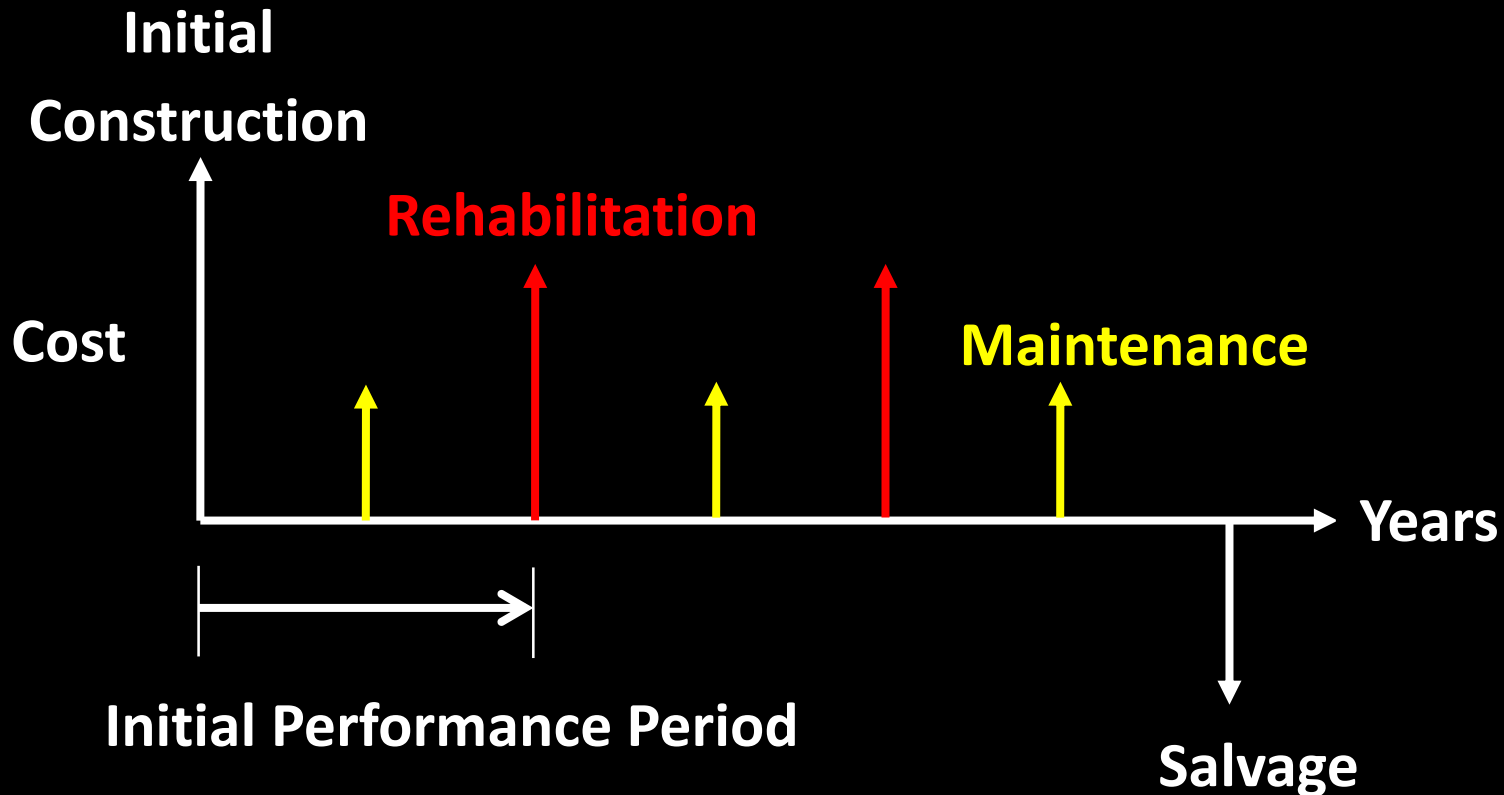
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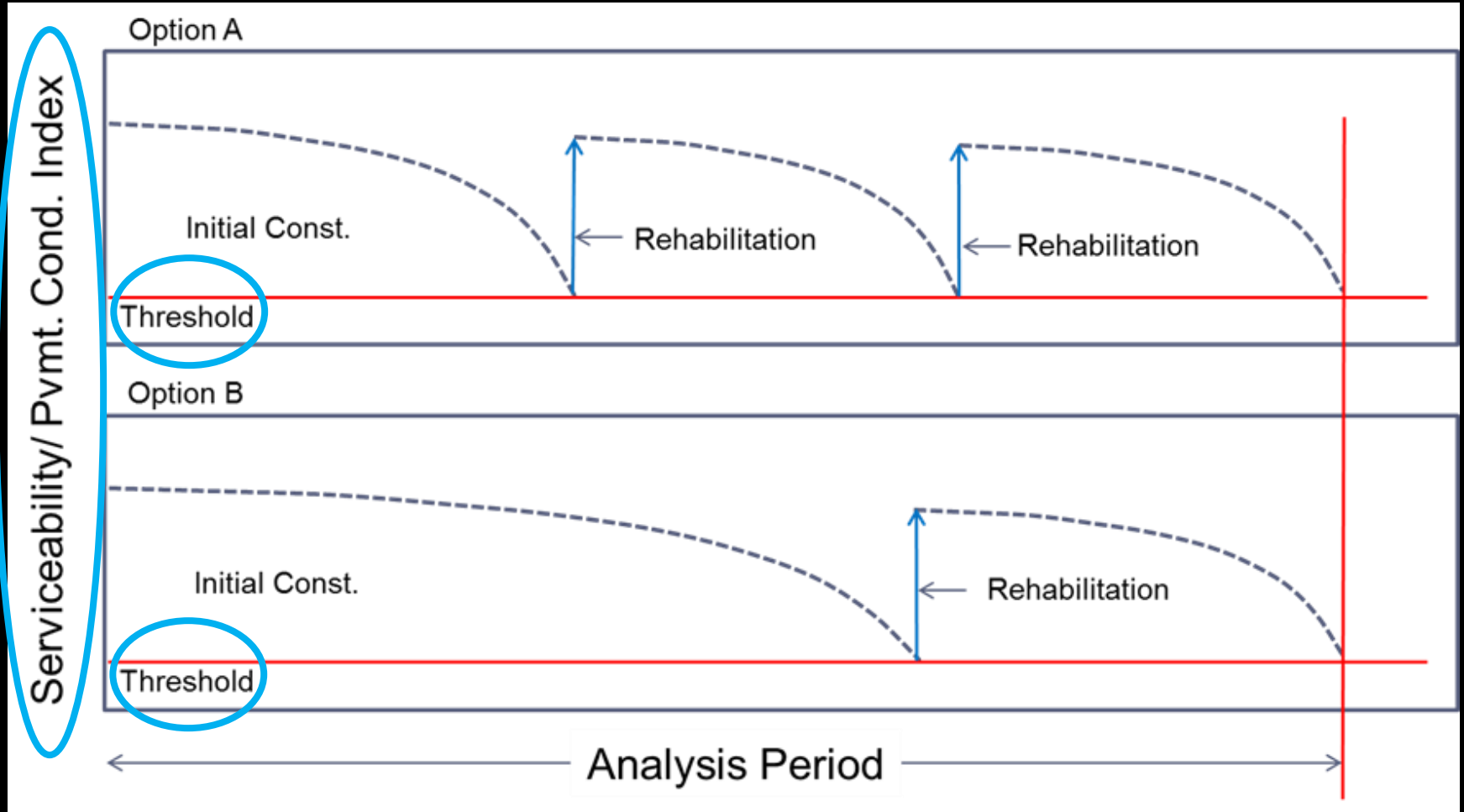


Pavement Type Selection - LCCA



$$NPV = \text{Initial Const. Cost} + \sum_{k=1}^N \text{Future Cost}_k \left[\frac{1}{(1+i)^{n_k}} \right] - \text{Salvage Value} \left[\frac{1}{(1+i)^{n_e}} \right]$$

Performance Periods



Objectives

- Determine **actual initial performance periods** of asphalt and concrete pavements based on historical data
- Determine **IRI** (common measure) at time of **first rehabilitation**

Scope

- Existing literature and previous survey results
- Questionnaire to SHAs
- LTPP data
 - SDR 28

Methodology

- Review previous surveys related to initial performance period in LCCA
- Issue survey to SHAs
 - What rehabilitation activities are considered?
 - How is initial performance period in LCCA determined?
 - How is the timing of the first rehabilitation determined?

Methodology

- Analyze LTPP data
 - Actual timing of first rehabilitation
 - IRI at first rehabilitation
 - Deterioration rate of ride quality
 - Variances due to pavement type and experiment

Previous Surveys of SHAs

- Initial performance period for AC pavement in LCCA
 - Most reporting values between 10 and 15 years
- Initial performance period for PCC pavement in LCCA
 - Most reporting values between 20 and 25 years

Survey of SHAs

- Determination of Initial Performance Periods for LCCA:
 - Procedures varied
 - Based on historical performance/PMS records
 - Based on engineering judgment or consensus
 - Various distresses
 - Pavement design life

Survey of SHAs

- Decision making process for actual timing of first rehabilitation
 - Procedures varied
 - Distress/performance index

Historical Data and Analysis

- LTPP databases
 - Nationwide
 - Largest dataset available
- Challenges:
 - Identifying original construction date
 - Date entered into LTPP \neq date of construction
 - Historical IRI
 - Data quality

LTPP Experiments - GPS

Exp #	Description
1	Asphalt Concrete (AC) on Un-bound Granular Base
2	Asphalt Concrete (AC) on Bound Base
3	Jointed Plain Concrete Pavement (JPCP)
4	Jointed Reinforced Concrete Pavement (JRCP)
5	Continuously Reinforced Concrete Pavement (CRCP)

LTPP Experiments - SPS

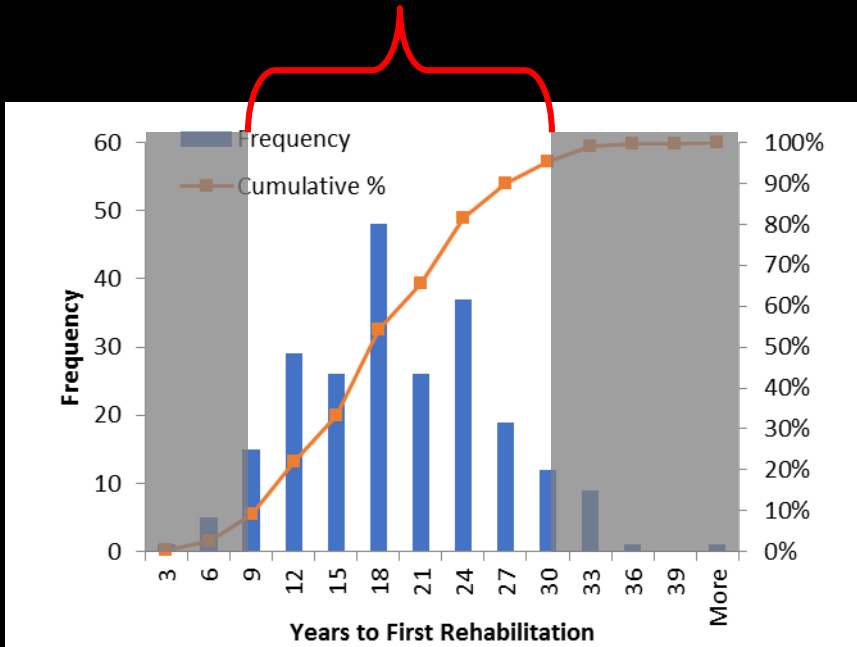
Exp #	Description
5	AC Overlay of AC Pavement
90	Superpave Asphalt Binder Study, AC Overlay on AC
6	Rehabilitation of Jointed PCC Pavement
7	Bonded Concrete Overlay on PCC Pavement
9C	Superpave Asphalt Binder Study, AC Overlay on CRCP
9J	Superpave Asphalt Binder Study, AC Overlay on JCP

Rehabilitation Activities

Code	Rehabilitation Type	Pavement
7	PCC Slab Replacement (sq. yards)	PCC
12	Grinding surface (sq. yards)	PCC
14	Pressure Grout Subsealing (no. of holes)	PCC
16	Asphalt Subsealing (no. of holes)	AC
18	Reconstruction (Removal and Replacement) (sq. yards)	AC/PCC
19	Asphalt Concrete Overlay (sq. yards)	AC/PCC
20	Portland Cement Concrete Overlay (sq. yards)	AC/PCC
43	Hot-Mix Recycled Asphalt Concrete (overlay) (sq. yards)	AC/PCC
44	Cold-Mix Recycled Asphalt Concrete (overlay) (sq. yards)	AC/PCC
45	Heater Scarification, Surface Recycled Asphalt Concrete (sq. yards)	AC
50	Joint Load Transfer Restoration in PCC Pavements (linear feet)	PCC
51	Mill Off AC and Overlay with AC (sq. yards)	AC
52	Mill Off AC and Overlay with PCC (sq. yards)	AC
55	Mill Existing Pavement and Overlay with Hot-Mix Recycled AC.	AC/PCC
56	Mill Existing Pavement and Overlay with Cold-Mix Recycled AC.	AC/PCC

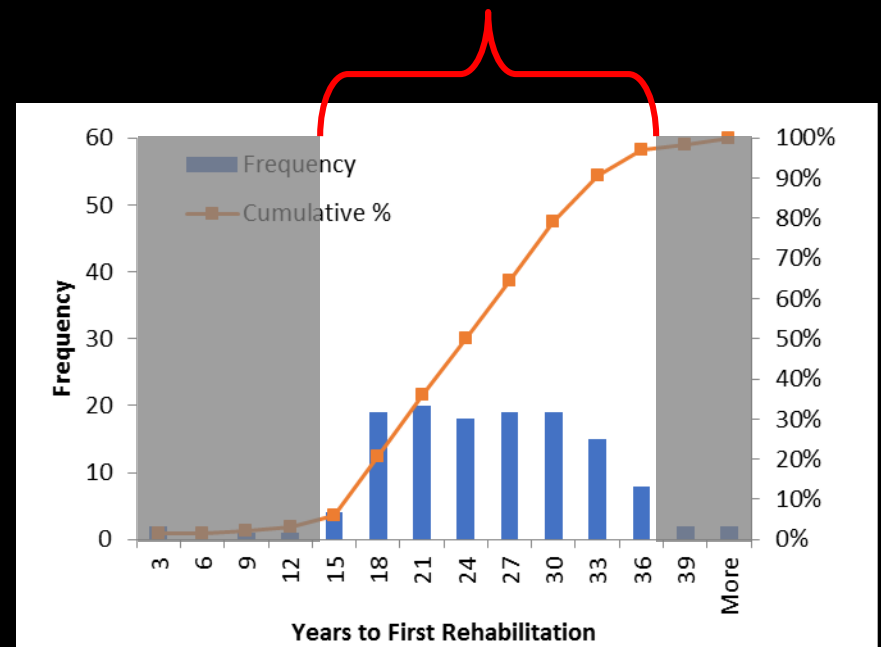
Timing of First Rehabilitation

Middle 90% of Distribution



AC Pavements

Middle 90% of Distribution



PCC Pavements

GPS & SPS Experiments

Time to First Rehab, GPS

Exp No.	Pavement Type	No. of Sects	Age at First Rehabilitation, Years			
			Avg	Min	Max	Std Dev
GPS-1	AC on Granular base	111	17.92	7.09	28.18	5.36
GPS-2	AC on Bound base	76	16.82	7.75	28.93	5.70
GPS-3	JPCP	41	23.40	14.68	34.68	5.98
GPS-4	JRCP	27	23.88	15.07	35.44	5.68
GPS-5	CRCP	28	23.80	14.76	33.69	6.11

Based on the middle 90% of distribution

Time to First Rehab, SPS

Exp No.	Pavement Type	No. of Sites	Age at First Rehabilitation, Years			
			Avg	Min	Max	Std Dev
SPS-5	AC	16	18.90	9.01	25.75	4.74
SPS-9O	AC	3	23.99	16.87	28.16	6.20
SPS-6	PCC	14	24.79	17.19	31.98	5.55
SPS-7	PCC	4	23.23	12.88	34.83	9.20
SPS-9C	CRCP	2	22.29	21.75	22.84	N/A
SPS-9J	JPCC	5	25.88	22.97	30.27	3.51

Based on the middle 90% of distribution

Time to First Rehab, AC vs. PCC

Pavement Type	No.	Time, years			
		Avg	Min	Max	Std Dev
AC	206	17.68	7.09	28.93	5.51
PCC	121	23.84	12.88	35.44	5.79

Based on the middle 90% of distribution. Range for AC: 6.71 – 29.05 years;
range for PCC 12.03 – 35.64.

Last MRI Value before First Rehab

Exp. No.	Pavement Type	No.	Avg MRI (in/mi)	Min MRI (in/mi)	Max MRI (in/mi)	Std. Dev.
GPS-1	AC on Granular base	101	119.10	30.18	359.01	58.86
GPS-2	AC on bound base	65	102.01	49.90	260.35	43.75
GPS-3	JPCP	41	138.85	81.32	260.66	50.26
GPS-4	JRCP	22	130.91	86.02	229.16	32.86
GPS-5	CRCP	27	112.39	48.29	257.88	45.68

Analysis was done only on GPS experiments.

Average MRI

AC Pavements: 112.41 in/mi

PCC Pavements: 128.97 in/mi

MRI Distribution

Pavement Type	IRI Categories (in/mi)**				
	Percent of Total Pavement Sections				
	Very Good < 60	Good 60 – 94	Fair 95 – 119	Poor 120 – 170	Very Poor > 170
AC Pavements	9.6%	34.3%	24.1%	17.5%	14.5%
PCC Pavements*	1.1%	23.3%	26.7%	34.4%	14.4%

*Sum is not 100% due to rounding

**Categories after U.S. Department of Transportation. 1999 Status of the Nation's Highways, Bridges and Transit: Conditions and Performance, Report to Congress. Washington, D.C., 2000.

Deterioration Rate of Ride Quality

- For each pavement section, data fitted with simple linear regression
 - Rates varied
 - Some occurrence of negative rates (i.e. pavement became smoother over time)

Deterioration Rate of Ride Quality

- Filtered for positive rates and meaningful relationship ($R^2 > 50\%$):

Exp. No.	Pavement Type	No.	Mean Rate (in/mi/yr)	Min Rate (in/mi/yr)	Max Rate (in/mi/yr)
GPS-1	AC on Granular base	59	6.76	0.64	24.52
GPS-2	AC on bound base	47	4.67	0.72	14.64
GPS-3	JPCP	24	3.74	0.59	16.71
GPS-4	JRCP	11	3.39	0.74	11.37
GPS-5	CRCP	9	3.73	0.47	7.29

Conclusions

- AC pavement: actual performance period greater than typical values used in LCCA
- PCC pavement: actual performance period similar to typical values used in LCCA

Pavement Type	No.	Mean Age at 1 st Rehab (yrs)	Typical Age in LCCA (yrs)
AC	206	17.7	10 - 15
PCC	121	23.8	20 - 25

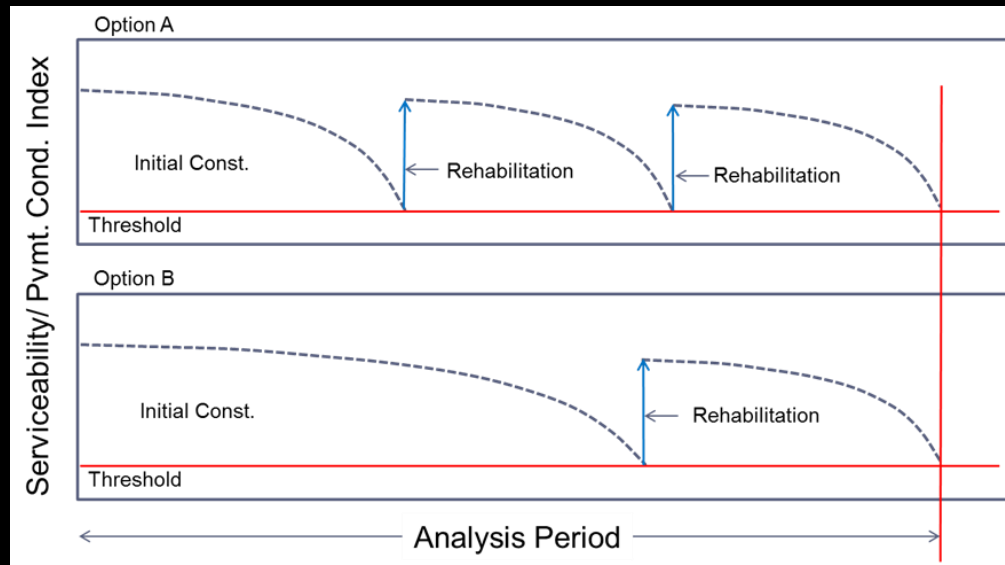
Conclusions

- AC pavements smoother than PCC pavements at time of 1st rehab
- Majority of AC and PCC pavements rehabilitated before 170 in/mi, therefore 170 in/mi is not adequate as trigger for rehabilitation

Pavement Type	No.	Mean MRI prior to 1 st Rehab (in/mi)
AC	166	112.41
PCC	90	128.97

Recommendations

- Currently no performance parameter can equate functional and structural performance among pavement types; therefore, IRI may be considered.
- Threshold value should be re-examined periodically to account for advancements
- $IRI < 170$ in/mile should be used as threshold for first rehabilitation



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Thank You!

Article

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Determining the Age and Smoothness of Asphalt and Concrete Pavements at the Time of First Rehabilitation using Long-Term Pavement Performance Program Data

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REVIEW OF INITIAL SERVICE LIFE DETERMINATION IN LIFE CYCLE COST ANALYSIS (LCCA) PROCEDURES AND IN PRACTICE

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