

SEAUPG 2002 CONFERENCE




**PERPETUAL
PAVEMENT**
And Selected Short Subjects

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Illinois Asphalt Pavement Assn.
iapa

Marvin Traylor




**A Modern
Life Cycle Cost Analysis**

- Initial Costs
- Out Year Costs
- User Delay Costs




Score Card

	<u>PCC</u>	<u>HMA</u>
Initial Costs		
Out Year Costs		
User Delay Costs		



State	% of Pavements Constructed with Asphalt	State	% of Pavements Constructed with Asphalt
1. Alaska	100%	26. Tennessee	72%
2. Vermont	99%	27. Texas	67%
3. Maine	98%	28. Arkansas	64%
4. Montana	95%	29. South Carolina	63%
5. New Hampshire	94%	30. California	59%
6. New Mexico	93%	31. Oklahoma	55%
7. Arizona	93%	32. Kentucky	52%
8. Florida	92%	33. West Virginia	52%
9. Hawaii	92%	34. Mississippi	50%
10. Idaho	92%	35. South Dakota	49%
11. Nevada	91%	36. Nebraska	42%
12. Utah	91%	37. New Jersey	40%
13. Maryland	91%	38. Minnesota	37%
14. Alabama	90%	39. Connecticut	31%
15. Oregon	90%	40. Ohio	29%
16. Wyoming	89%	41. Wisconsin	28%
17. Massachusetts	88%	42. Louisiana	25%
18. Rhode Island	85%	43. New York	24%
19. Washington	85%	44. Pennsylvania	18%
20. Georgia	84%	45. Michigan	18%
21. Colorado	84%	46. Indiana	17%
22. North Carolina	81%	47. Missouri	12%
23. Kansas	79%	48. Iowa	9%
24. Virginia	78%	49. Illinois ****	3%
25. North Dakota	74%	50. Delaware	1%

Source: The Federal Highway Administration; Highway Statistics 1997; Table HM-31; Page V-18



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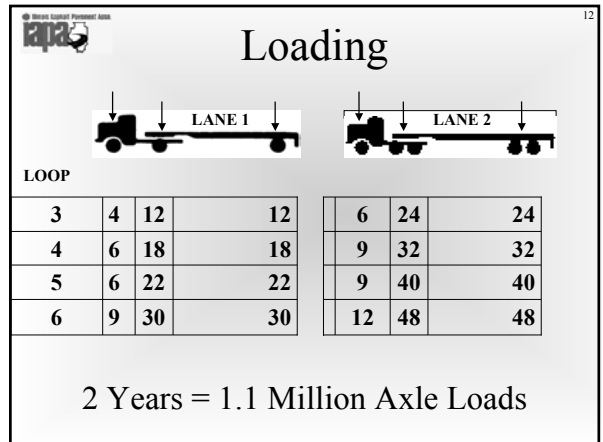
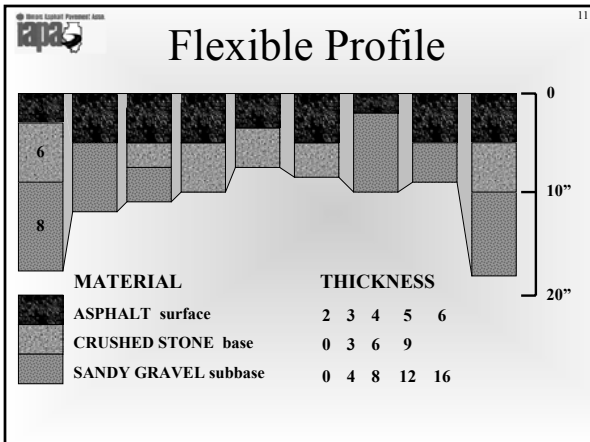
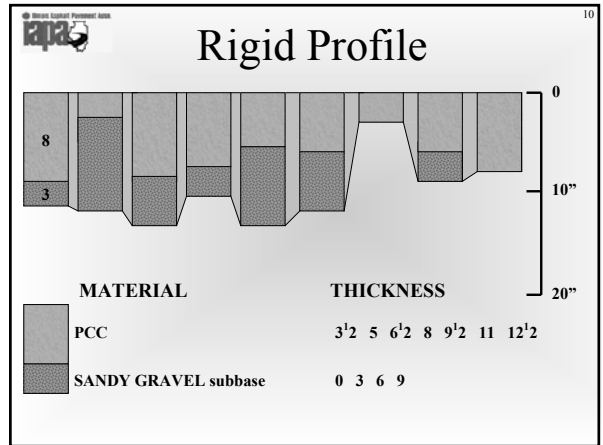
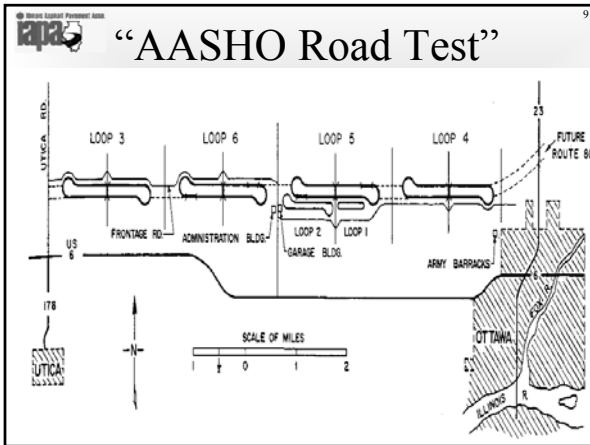
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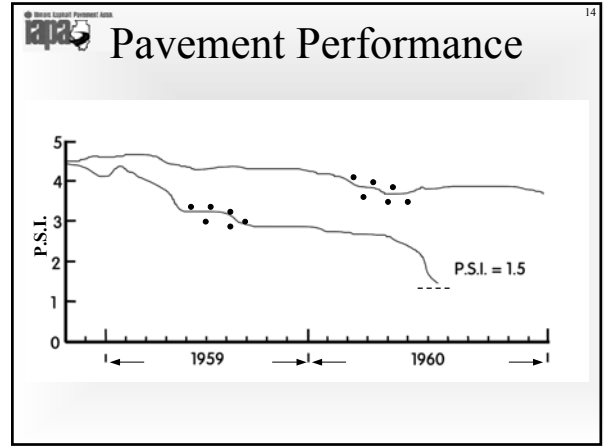
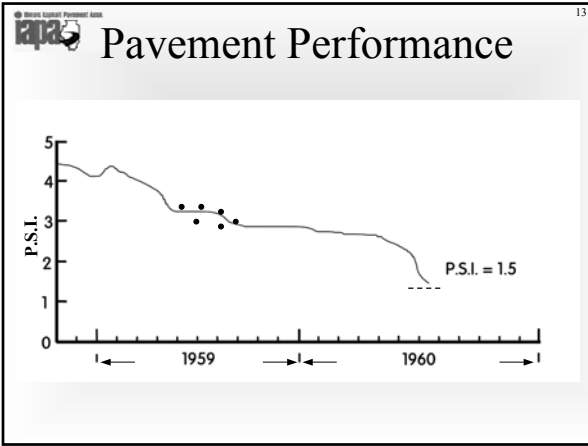
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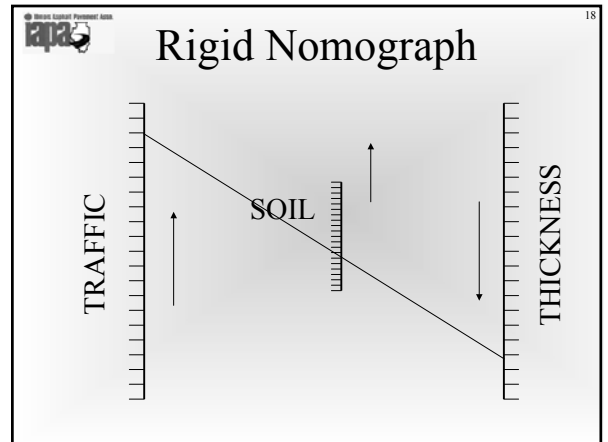
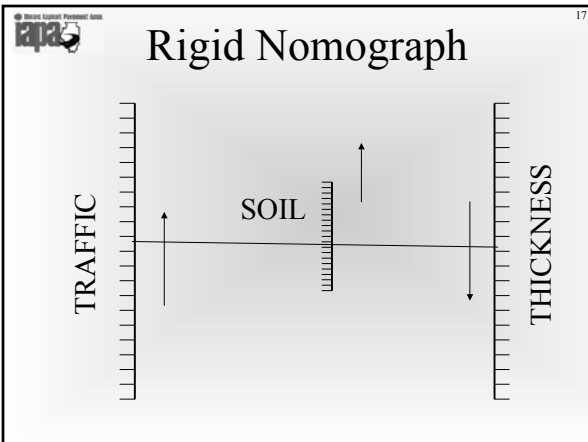
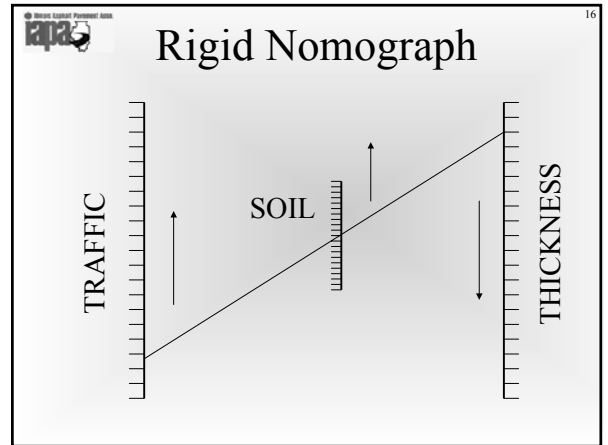
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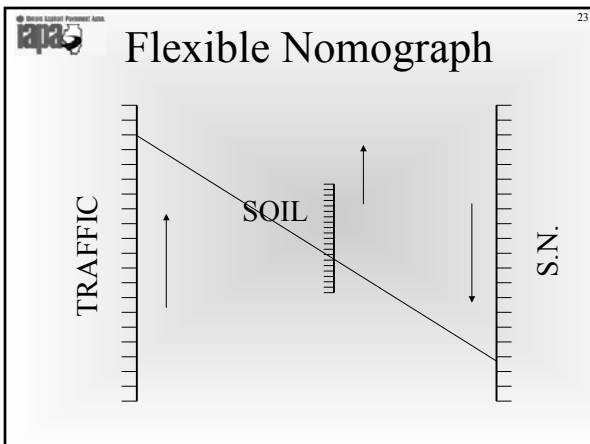
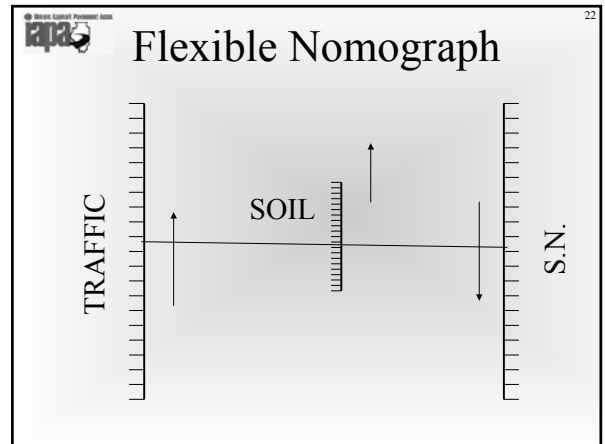
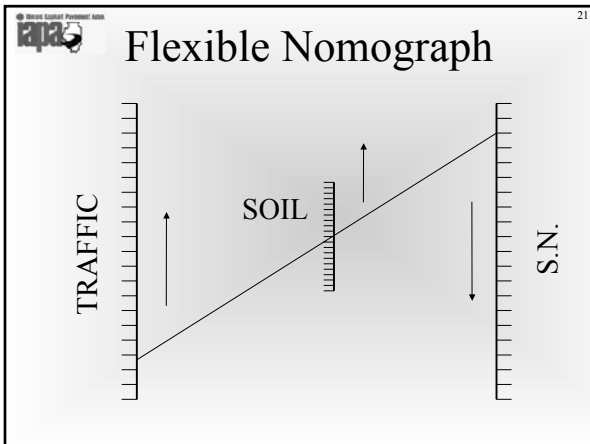
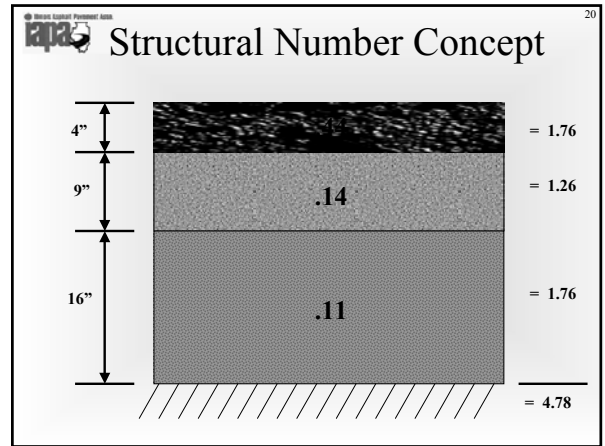
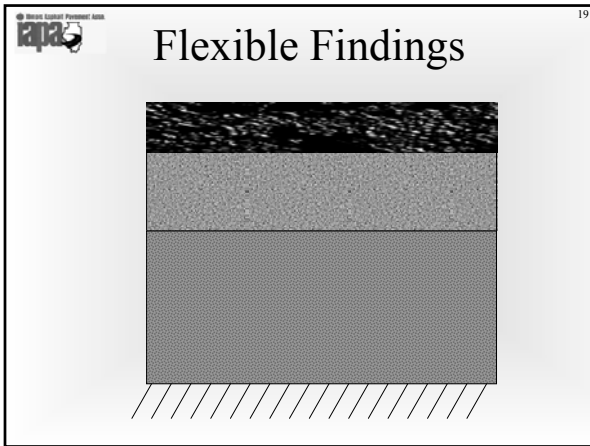
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Rigid Findings

Subbase Necessary to
Prevent Pumping



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- ## AASHO Advances
- Equivalent 18^K Single Axle Loads (ESALs)
 - Thickness Designs for both B & W
 - “Equivalent” Pavements

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AASHO Limitations

- One Set of Materials
- Two Years of Weathering
- 1.1 Million Axles
- No Full Depth
- Totally Empirical

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Mechanistic Design

Mechanistic -

“Concerning the Relationships Between Applied Forces and Material Responses.”

27

Mechanistic Design

Mechanistic -

“Concerning the Relationships Between Applied Forces and Material Responses.”

Basic Premise -

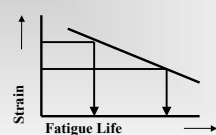
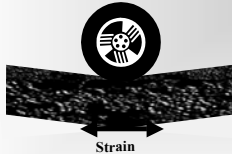
Low Deflections = Long Life

28

Fatigue Theory

High Strain = Short Life

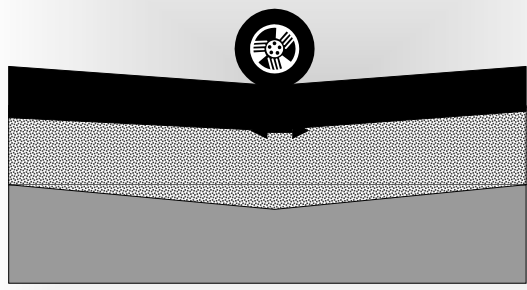
Low Strain = Long Life



The diagram shows a cross-section of a road surface with a tire tread on top. A downward-pointing arrow labeled 'Strain' is positioned below the road surface. To the right, a graph plots 'Strain' on the vertical axis and 'Fatigue Life' on the horizontal axis. A downward-sloping line represents the relationship between the two variables. Two vertical lines drop from the graph to the horizontal axis, indicating that higher strain levels correspond to shorter fatigue life.

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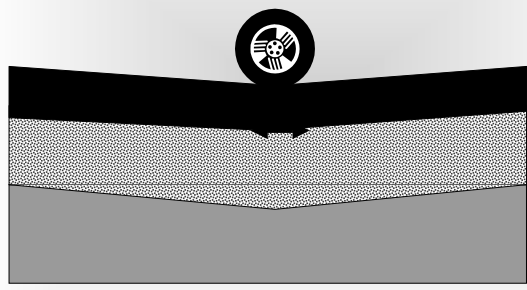
Fatigue Cracking



The diagram shows a cross-section of a road surface with three distinct layers: a top asphalt layer, a middle aggregate base, and a bottom subgrade. A tire tread is shown on top. A crack is visible in the top asphalt layer, extending downwards into the base layer.

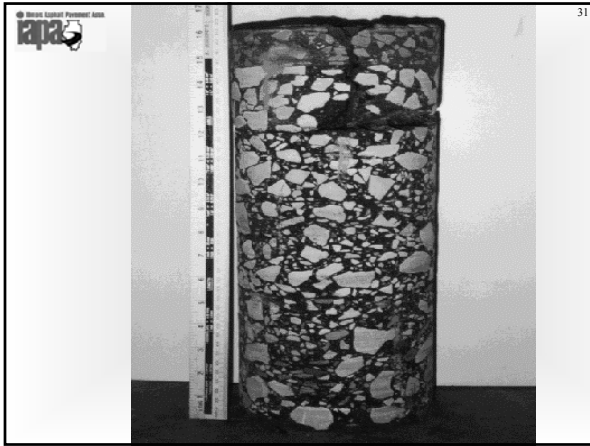
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The diagram shows a cross-section of a road surface with three distinct layers: a top asphalt layer, a middle aggregate base, and a bottom subgrade. A tire tread is shown on top. A crack is visible in the top asphalt layer, extending downwards into the base layer.

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TRL Report 250
Nunn, Brown, Weston
& Nicholls

Design of Long-Life Flexible
Pavements for Heavy Traffic

<http://www.trl.co.uk>

“The deterioration of thick, well constructed, fully flexible pavements is not structural, but occurs at the surface as cracking and rutting.”

Professor Monismith
University of California, Berkeley
1972 AAPT Proceedings

“Moreover, based on recent studies, it was assumed that strains less than 70×10^{-6} would cause no fatigue damage.”

Fatigue Theory for Thick Pavements

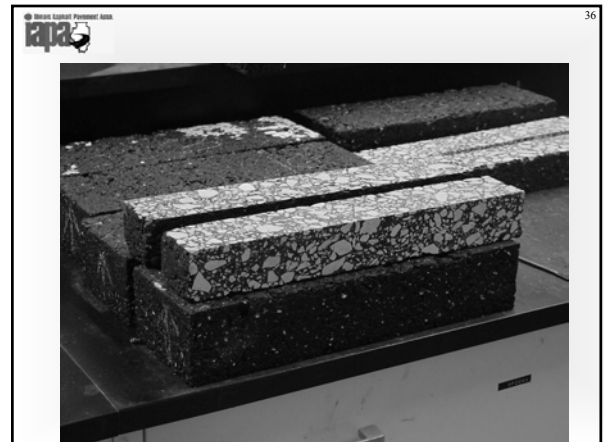
High Strain = Short Life
Low Strain = Unlimited Life

Strain

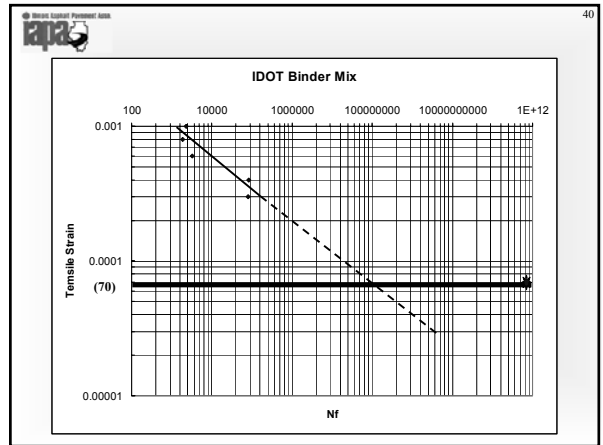
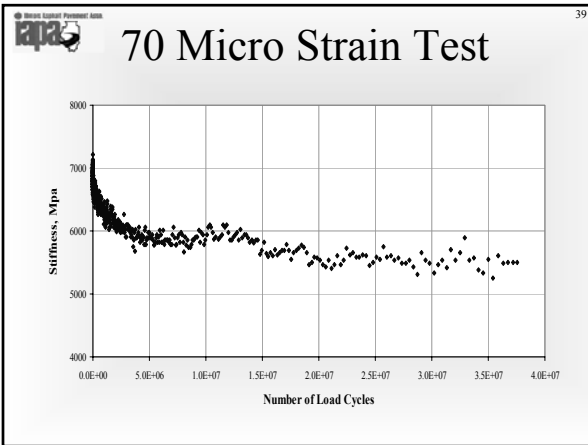
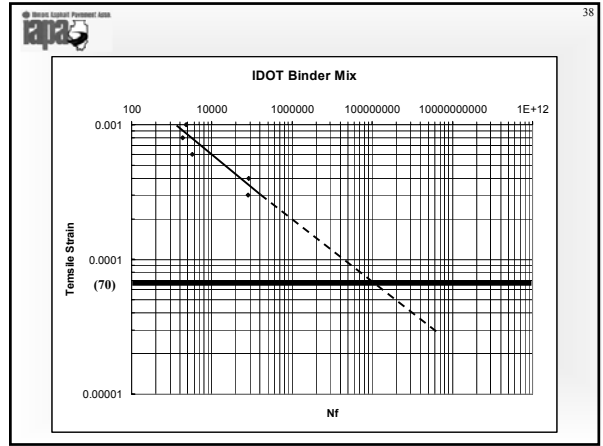
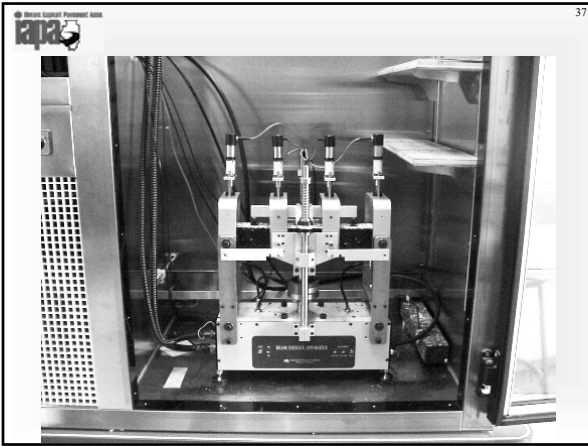
Fatigue Life

70

Unlimited Fatigue Life



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Significance of Fatigue Endurance Limit

“...such a limit would provide a thickness limit for the pavement..Increasing the thickness beyond the limiting thickness... would provide no increased structural resistance to fatigue damage and represent an unneeded expense.”

Prof. Carpenter

Fatigue (20 Year Mechanistic Thickness Design)

TF	Microstrain	Thickness
1	100	10.5
2	80	12.5
3	70	13.5
5	60	15.0
10	50	16.5
15	45	18.0
20	40	19.0
30	35	22.0

TF1 = 200 Trucks/Day

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Fatigue


(20 Year Mechanistic Thickness Design)

TF	Microstrain	Thickness
1	100	10.5
2	80	12.5
3	70	13.5
5	60	15.0
10	50	16.5
15	45	18.0
20	40	19.0
30	35	22.0

TF1 = 200 Trucks/Day

44

Perpetual Pavement



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Advantages

- Thinner Sections
- No Full-Depth Patching
- Rapid/Inexpensive Rehab
- Permanent Elevations

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Dollars & Days

47

Dollars & Days

30 Year Concrete

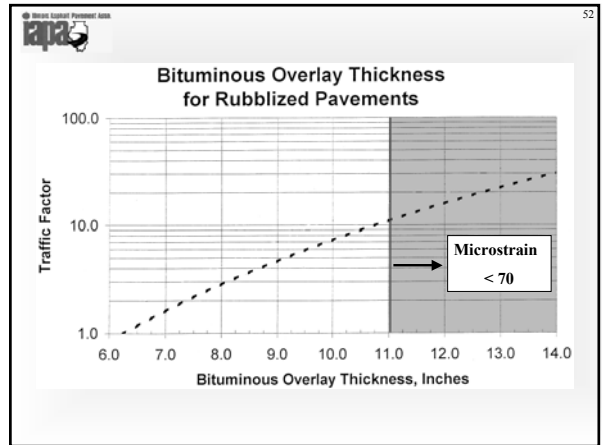
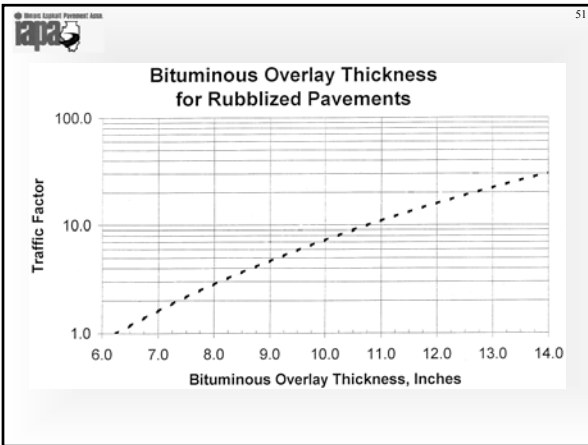
Year	Activity	\$ (millions)	Days
0	New Construction	4.0	60
10			
20			
30	Patch/Overlay	0.4	60
40	Patch/Overlay	0.4	60
50	Reconstruction	4.0	60
60			
70			
80	Patch/Overlay	0.4	60
90	Patch/Overlay	0.4	60
100	Reconstruction	4.0	60
TOTAL		\$13.6	420

48

Dollars & Days

30 Year Concrete				Perpetual Pavement			
Year	Activity	\$ (millions)	Days	Year	Activity	\$ (millions)	Days
0	New Construction	4.0	60	0	New Construction	3.0	30
10				10			
20				20	Mill/Overlay	0.3	15
30	Patch/Overlay	0.4	60	30			
40	Patch/Overlay	0.4	60	40	Mill/Overlay	0.3	15
50	Reconstruction	4.0	60	50			
60				60	Mill/Overlay	0.3	15
70				70			
80	Patch/Overlay	0.4	60	80	Mill/Overlay	0.3	15
90	Patch/Overlay	0.4	60	90			
100	Reconstruction	4.0	60	100	Mill/Overlay	0.3	15
TOTAL				TOTAL			
		\$13.6	420			\$4.8	105

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Dollars & Days*

	Rubblize	20 Yr. PCC	30 Yr. PCC
\$	1.9	3.5	3.9
Days	55	90	105

* All figures for One Mile of 4-Lane Divided Pavement

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Score Card

	PCC	HMA
Initial Costs		
Out Year Costs		
User Delay Costs		


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Initial Costs


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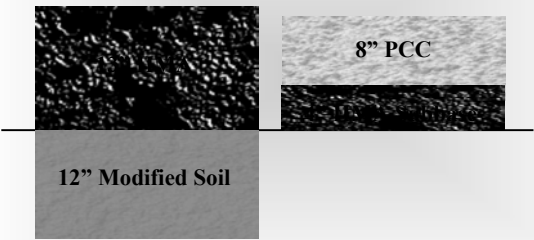
Stanford Avenue
Springfield, Illinois

- 4-Lane Urban Section
- New Alignment
- Length of Project: 4673 feet
- Design Traffic: 28,000 ADT (8% trucks)
- Letting Date - 1999

57




Alternate Pavements



8" PCC

12" Modified Soil


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Engineer's Estimate (Total Project)

<u>WHITE</u>	<u>BLACK</u>
\$2,445,407	\$2,331,134
5% Difference	


59



Actual Bids (Total Project)

	<u>WHITE</u>	<u>BLACK</u>
FREESSEN	\$2,114,322	\$1,599,532
FLATT		\$1,599,992
SANKEY		\$1,772,477
MERRILL		\$1,779,209
CALHOUN	\$2,343,458	
32% Difference		

60



Score Card

	<u>PCC</u>	<u>HMA</u>
Initial Costs		X
Out Year Costs		
User Delay Costs		

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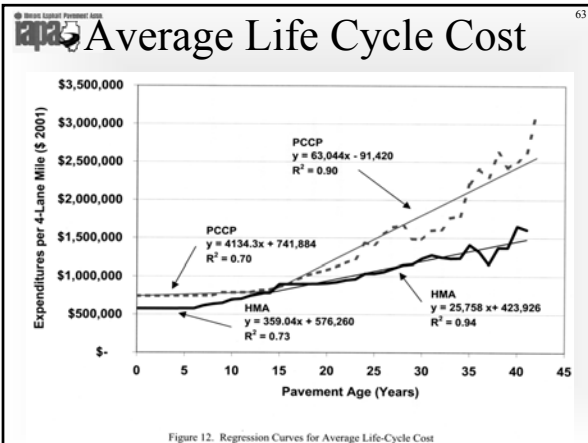


Out Year Costs


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Kansas Interstate Study



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Score Card

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Initial Costs		X
Out Year Costs		X
User Delay Costs		


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User Delay Costs



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Score Card

	<u>PCC</u>	<u>HMA</u>
Initial Costs		X
Out Year Costs		X
User Delay Costs		X

