Pavement Preservation

Jimmy N. Kendrick
Bergkamp Pavement Preservation Solutions

Introduction

- Pavement Preservation is a term that is used quite often but what does it mean? This presentation will provide a clear /concise discussion of the Why, What and How of Pavement Preservation for Asphalt Pavements.
- Topics
  - What is your Road Network Worth?
  - Definitions of Pavement Preservation
  - Using Equivalent Annual Costs to Analyze Your Plan
  - Case Study – Fairfield, Connecticut
  - Advantages and Disadvantages of Various Pavement Preservation Techniques

What is your Road Network Worth in USD ($)

- Sample City –
  - Population (2012) = 386,552
  - Road Network (City Estimate 2015) =
    - 5,000 Lane Miles of Pavement
    - 35,200,000 Square Yards (S.Y.) at 12 ft. wide.

- Assumptions:
  - 8” Pavement Depth
  - Cost of In-Place Asphalt Pavement = $ 28.60 per S.Y.
    - Based on actual 2017 Bid Tabs for Subdivision Paving
  - No costs are included for removal, base stabilization, traffic control, etc.

What is your Road Network Worth in USD ($)

- The Total Replacement Value of the Pavement in the sample city Road Network is over **1 Billion Dollars**
  - - $ 1,006,720,000 to be exact.

- More Data from 2017 Pavement Maintenance and Rehab Budget = $ 5.8 million.
  - Paved Lane Miles in Satisfactory or Better Condition
    - 2013 = 47.7%
    - 2017 = 44.7%
  - Remaining Service Life in Lane Mile Years = 49,500
    - 49,500 years / 5,000 Lane Miles = 9.9 Average
  - How is sample city doing?
  - What are their options?

Option 1

- **Worst First**
  - Rehab worst 1% of S.Y. every year
    - 35,200,000 S.Y. X 1% = 352,000 S.Y. X $ 22.00 (FDR / 3” HMA) = $ 7,744,000. Current budget is $ 5,800,000.
  - Remaining 34,848,000 S.Y. gets one more year older. Remaining Service Life in Lane Mile Years drops from 49,500 to 44,946.
  - Paved Lane Miles in Satisfactory or Better Condition Drops another few percentage points to around 42%.
  - Where will they be in 10 years?

Option 2

- **Preservation**
  - Spend 70% of budget on keeping *good* roads in *good* condition
    - $ 5,800,000 X 70% = $ 4,060,000 / $ 3.50 per S.Y. Average PP Cost. = 1,160,000 S.Y of Pavement that will remain at or above satisfactory condition.
    - Average life extension of Preservation treatments is 7 years
    - Remaining Service Life in Lane Mile Years still drops but not as quickly - from 49,500 to 47,435.
  - In 10 years, the city will have preserved 12,391,000 S.Y. of Pavement or 35% of the network.
  - S.Y. in satisfactory condition will stay somewhat constant.
  - The city is still losing ground but at a much slower rate.

Definitions of Pavement Preservation (PP)

- The long definition of Pavement Preservation is:
- "Programs and activities employing a network level, long-term strategy that enhances pavement performance by using an integrated, cost-effective set of practices that extend pavement life, improve safety and improve motorist satisfaction while saving public tax dollars".

  - The treatment must:
    - Address pavements while they are still in good condition
    - Reduce aging
    - Extend Pavement Life
    - Restore Serviceability

Definitions of Pavement Preservation (PP)

- Think about the sample city example as we dissect the definition.
  - Network Level
    - All Pavements
  - Long-Term Strategy
    - Budgeted Expense
  - Integrated
    - Department Wide
  - Cost-Effective
    - Right Treatment, Right Road, Right Time
  - Meet Road User Expectations


www.fbbd.com

Treatments

- Preservation Treatments in the U.S. generally include:

Agencies have 2 Major Problems

1. **Not enough $**
2. **Not optimizing $**

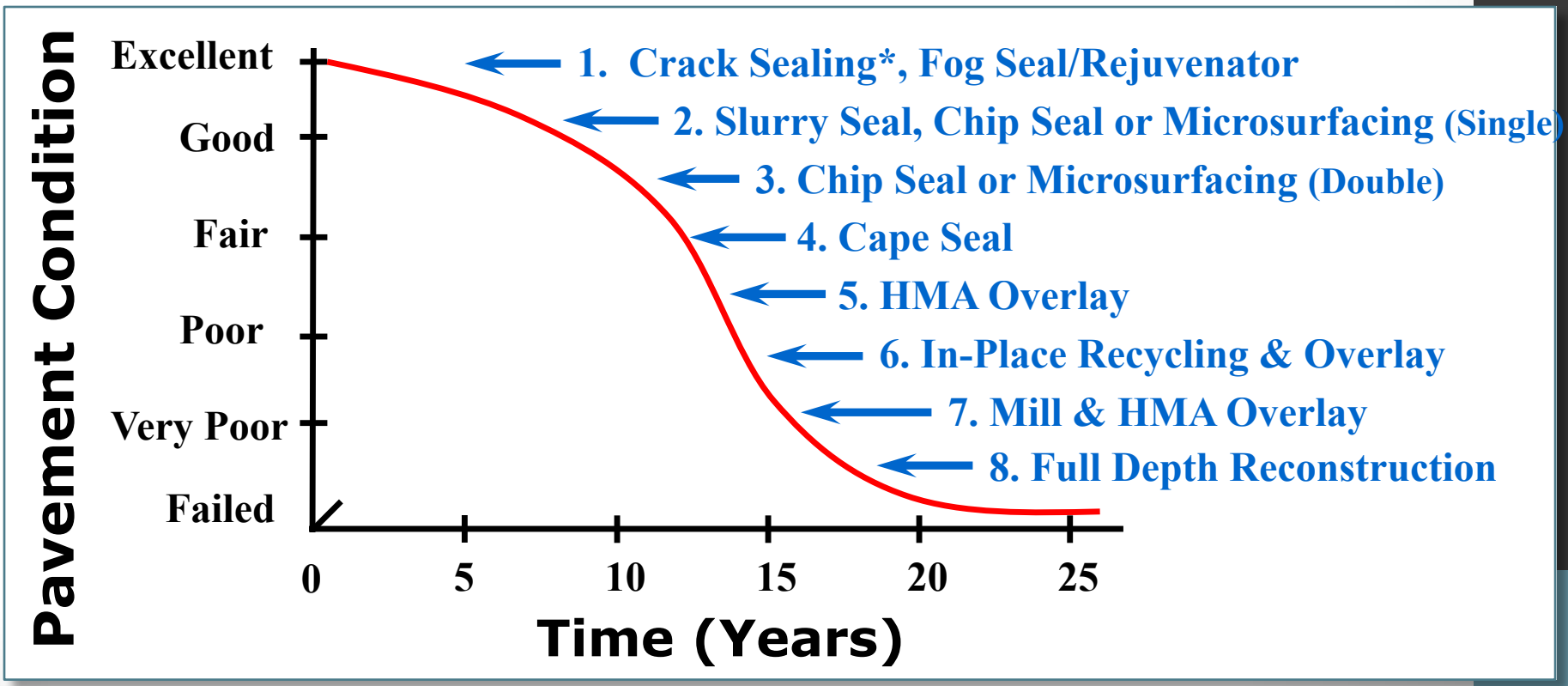
Management Concepts to Optimize Limited Funding

- EAC – Equivalent Annual Costs
- RSL – Remaining Service Life

Asphalt Deterioration Curve

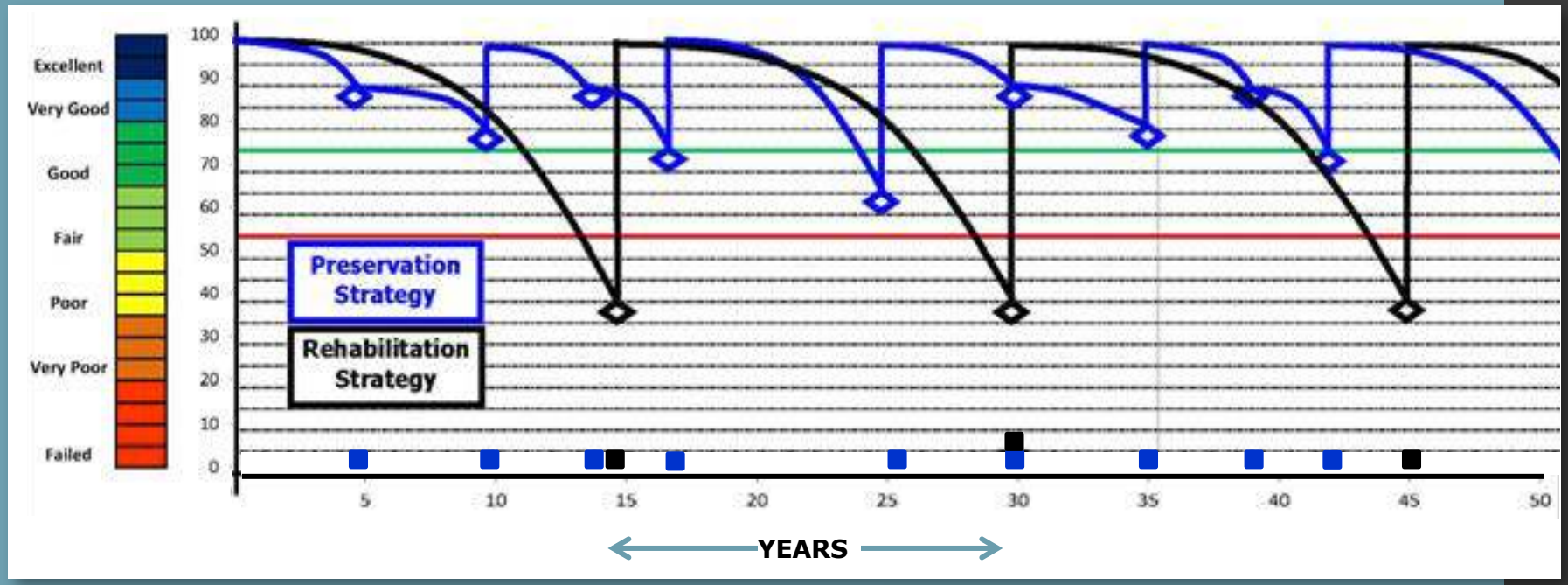
(An Unfortunate Fact of Life)

Applying the Right Treatment, to the Right Road, at the Right Time…



with other

Progressive Pavement Management Preservation vs. Rehabilitation



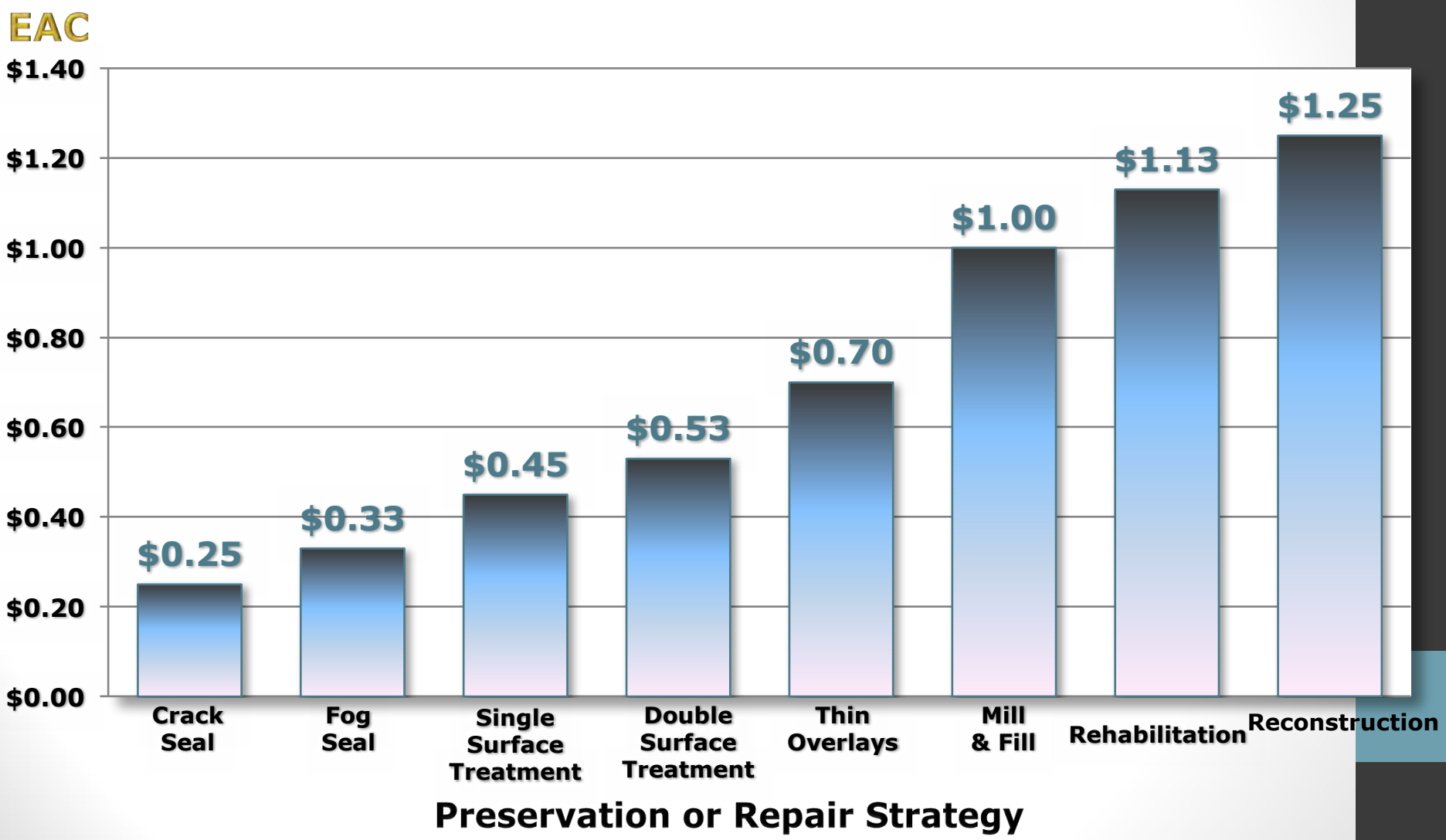
PRESERVATION STRATEGY:

Years 5, 14, 30 & 39: Crack sealing
Years 10 & 35: Microsurfacing (Double)
Years 17 & 42: Cape Seal
Year 25: Mill & Pave
TOTAL COST/SY OVER 50 YEARS = $36.00

REHABILITATION STRATEGY:

Year 15: FDR plus 4" Hot Mix Overlay
Year 30: FDR plus 4" Hot Mix Overlay
Year 45: FDR plus 4" Hot Mix Overlay
TOTAL COST/SY OVER 50 YEARS = $60.00

EAC by Strategy ($/SY/Year)



EAC Example

Roadway Network = 100 centerline miles
Average Paved Width = 26 feet
Total Paved Area = 1,525,000 SY

	Preservation Approach (Chip Seal)	"Worst First" Approach (Rehab)
Network Area	1,525,000 SY	1,525,000 SY
Avg. EAC	**X** $ 0.45/SY/Year	**X** $ 1.13/SY/Year
Required Annual Budget	**$ 686,250**	**$1,723,250**

Save Money…Keep Good Roads Good!

NHDOT – Pavement Management Section 2011 / 2012 Equivalent Annual Costs

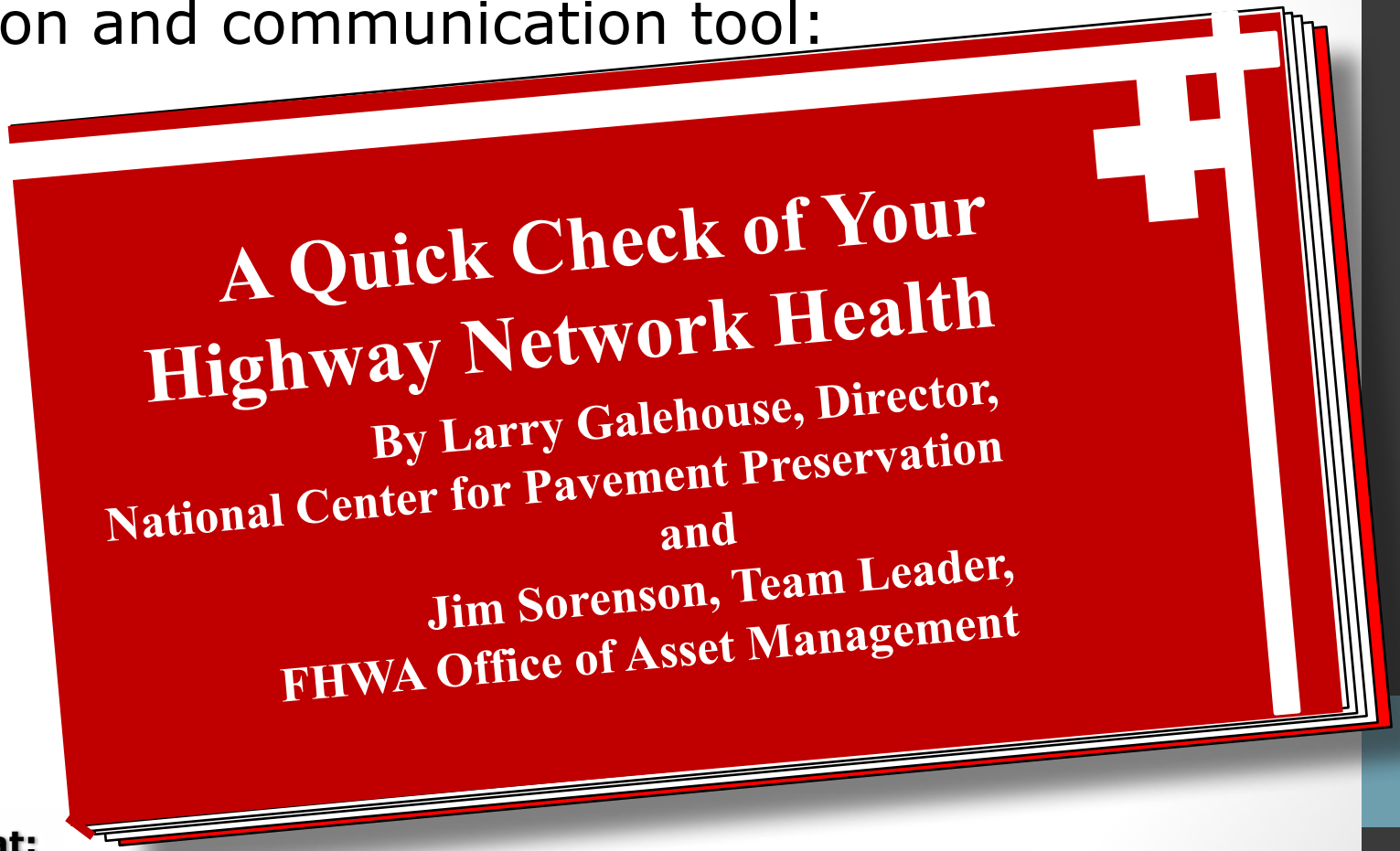
Treatment Alternative	2011/2012 Approx. Costs ($/lane-mile)	2011/2012 Approx. Costs ($/SY)	Estimated Service Life (years)	Equivalent Annual Cost ($/SY/year)
Micro or 4.75mm HMA	$ 22,810	$ 3.24	6	$ 0.54
Double Chip Seal	$ 28,301	$ 4.02	7	$ 0.57
3/4" Paver Shim	$ 25,281	$ 3.59	6	$ 0.60
1" HBP Overlay	$ 33,708	$ 4.79	8	$ 0.60
Chip Seal	$ 21,120	$ 3.00	5	$ 0.60
15% AR Chip Seal	$ 35,482	$ 5.04	8	$ 0.63
Nova Chip (PPST)	$ 44,352	$ 6.30	10	$ 0.63
1-1/2" HBP Overlay	$ 50,561	$ 7.18	10	$ 0.72
1-1/2" ARGG Overlay	$ 70,786	$ 10.05	13	$ 0.77
1-1/2" HBP Inlay	$ 67,457	$ 9.58	10	$ 0.96
FDR with 4" HBP	$ 147,502	$ 20.95	15	$ 1.40
2" TW Inlay with 1-1/2" FW Overlay	$ 134,872	$ 19.16	13	$ 1.47
4" CIP with 3" HBP Overlay	$ 156,035	$ 22.16	15	$ 1.48

Notes:

1. Costs per lane lane mile based on 12-foot lane width.
2. Costs shown here include a 20% multiplier to account for fixed costs.

Remaining Service Life

Simple (*but effective*) planning, education and communication tool:



Available at:
http://www.fhwa.dot.gov/pavement/pub_details.cfm?id=478

A Quick Check of Your Highway Network Health

<u>Remaining Service Life</u> <u>(RSL)</u> **<u>Concept</u>**

- Every road segment has a Remaining Service Life
- 200 lane-miles with NO REPAIRS or MAINTENANCE in a given year, will lose 200 **<u>lane-mile-years</u>** of Remaining Service Life
- Annual work plans should match condition goals ("outcome based budgeting")

For Each Treatment Used:

Added Network Service Life =

Miles of Treatment X **Service Life of Treatment** = **Mile - Years**

Pavement Network Evaluation Worksheet

Total Network Lane Miles = _____

Reconstruction					
Project	Design Life	Lane Miles	Lane Mile Years	Lane Mile Cost	Total Cost
FDR		X	=		
		Total	=	Total	=

Rehabilitation					
Project	Design Life	Lane Miles	Lane Mile Years	Lane Mile Cost	Total Cost
CIPR		X	=		
Mill & Fill		X	=		
		Total	=	Total	=

Pavement Preservation					
Project	Design Life	Lane Miles	Lane Mile Years	Lane Mile Cost	Total Cost
UTBO		X	=		
Microsurfacing		X	=		
Chip Seal		X	=		
Fog Seal		X	=		
Crack Seal		X	=		
		Total	=	Total	=

Publication No. FHWA-IF-07-006

Manchester, NH 2015

New Service Life

Based on 405 Network Miles

• Crack Sealing	=	75.0 Mile-Years
• Fog Seal	=	4.5 Mile-Years
• 1.5" HMA Overlay	=	73.6 Mile-Years
• 2" Mill & Fill	=	144.0 Mile-Years
• 4" Mill & Fill	=	67.5 Mile-Years
• 4" HMA Reconstruction	=	16.2 Mile-Years
New Service Life Added	**=**	**380.8 Mile-Years**
Pavement Life Lost	**=**	**(405) Mile Years**
2015 Program Shortfall	**=**	**24.2 Mile-Years**

Optimizing Limited Roadway Funding

- "Worst-First" is unaffordable
- Deferring maintenance does **<u>NOT</u>** save $$$
- A balanced approach is best
- Use EAC and RSL concepts to better manage your network

Case Study – Fairfield Connecticut

Park Avenue

January 12, 2016

Bridgeport, CT

2004: ***2”*** **Mill & Fill**

Fairfield, CT

2004: ***2”*** **Mill & Fill**

2010: **Crack Sealing & Microsurfacing**

Pavement Preservation Saves Money!

Preservation Success Story

- Fairfield, Connecticut – Population 60,850
- Preservation Champion for New England
- Why?
  - Fearless Innovators
    - Not afraid to try new processes
  - Committed to Pavement Preservation
    - Applied over 11 different PP treatments in 2016
  - Astute Asset Managers
    - Uses Equivalent Annual Costs (EAC) to keep Good Roads Good
  - Regional Leaders
    - City Leaders Share their Story Throughout New England
  - Outstanding Communicators
    - Politicians and Citizens Understand and Support the Program

Network Life Extension Thru Pavement Preservation

- Fairfield owns 288.3 miles of pavement.
  - Every year their network loses 288.3 Mile-Years.
- Estimated Life Extension, in years, of various treatments.
  - Crack Treatments = 2 years
  - Chip Seal = 5 years
  - Micro surfacing = 7 years
  - Cape Seal = 10 years
  - 1.5” Mill and fill = 10 years
  - Reclaim Base with 3.5” HMA = 20 years

Analysis of Network Life Extension - 2016.

Treatment	Est. Life Extension	2016 Miles Completed	New Mile-Years Added
Crack Treatment	2	21.11	42.22
Chip Seal	6	12.42	74.52
Micro Surfacing	7	19.5	136.5
HIR	7	0.3	2.1
Asphalt Leveling	6	6.6	39.6
1.5 “ Mill and Fill	10	1.02	10.2
Cape Seal	9	2.15	19.35
Totals		63.1 (21.8%)	324.49
Annual Loss			(288.3)
2016 Surplus			36.19

Network Life Extension – 4 year Avg.

Year	Mile-Years Added	Mile-Years Lost	% Treated	Gain / Loss
2013	260.62	288.3	13.5%	-27.68
2014	251.27	288.3	15.1%	-37.03
2015	244.04	288.3	15.9%	-44.26
2016	324.49	288.3	21.8%	36.19
Average	270.10	288.3	16.6%	

Treatments

- Preservation Treatments in the U.S. generally include:

Crack Seal

- Specialized materials are placed into or above cracks to prevent the intrusion of water.

Chip Seal

- A pavement surface treatment that combines one or more layers of asphalt with one or more layers of fine aggregate.

- Types of Seals
  - Chip Seal
  - DBST (Double Bituminous Surface Treatment)
  - Scrub Seal
  - Cape Seal

Chip Seal

- Provides the opportunity to maintain roads at a lower cost.
- 1/4 the cost of conventional asphalt overlay
- Provides an effective moisture barrier for the underlying pavement against water intrusion by sealing cracks in the pavement.
- Chip Seals are used on low ADT typically less than 2500 vehicles per day.
- They enhance safety by providing good skid resistance.
- Chip seals are designed to last 5 to 7 years.

Chip Seal Equipment

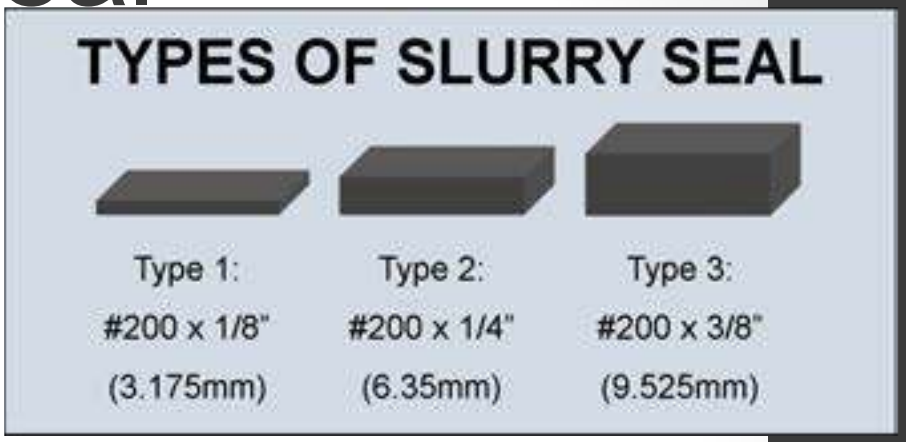
Chip Seal Equipment

Scrub Seal

What is Slurry Seal?

- A slurry seal is a homogenous mixture of emulsified asphalt, water, well-graded fine aggregate and mineral filler that has a creamy fluid-like appearance when applied. Slurry seals are used to fill existing pavement surface defects as either a preparatory treatment for other maintenance treatments or as a wearing course.

Types of Slurry Seal



- Type I (Fine)
  - Finest aggregate gradation
  - Thin covering to the exisitng pavement
  - Low traffic areas
- Type II (General)
  - Maximum Aggregate size 0.25 inches.
  - Treats existing pavements that exhibit moderate to severe raveling due to aging
  - Used to improve skid resistance
- Type III (Coarse)
  - Treats severe surface defects
  - Due to aggregate size can be used to fill slight depressions to prevent water ponding

Micro Surfacing

- Pioneered in the late 1960's and early 1970's in Germany
- Introduced in the United States in the 1980's
- Originally designed to fill ruts in the autobahns
- Suitable for all traffic levels

Micro Surfacing Cont.

- It is a mixture of POLYMER MODIFIED emulsified asphalt, mineral aggregates, water, and additives, proportioned, mixed and uniformly spread over a properly prepared surface.

- Can be used on pavements suffering from:
  - Loss of skid resistance
  - Oxidation
  - Raveling
  - Surface Permeability
  - Rut Damage
  - Cures Chemically
  - Should be traffic ready within one hour
  - Can be placed in multiple stone thickness

Difference between Micro and Slurry

- Slurry Seal
  - Cures by evaporation
  - Place one stone thick
  - Cannot do leveling with slurry
  - Polymer modified slurries are similar to micro
- Micro Surface
  - Always Polymer Modified
  - Can be placed in multiple stone thickness
  - Used for rut fill and leveling

Why use Micro?

- Sacrificial protective layer
  - 6 to 8 year life on sound pavement
  - +8% Polymer Modified Asphalt (Residual)
  - NCAT proven ability to protect surface from moisture penetration

- Tough Skid Resistance
  - +3% Polymer Modified
  - 100% Crushed aggregate
  - Macro and Micro texture provide excellent skid numbers through the life of the product

Why use Micro Cont.

- Transverse Leveling
  - Rut Filling
    - Up to 1 ½” ruts can be filled by ½ width rut filling course
  - Leveling Course
    - Up to 1/2” rutting can be filled by a full width leveling course
  - Surface Course
    - Up to ¼” rutting can be taken care of by the surface course
- Leveling and Rut fill should be followed up by a surface course

Why use Micro Cont.

- Compatible with other preservation treatments
  - Crack Treatments
  - Chip and Scrub Seals
    - Cape Seal
  - Micro Milling
  - Level up under thin HMA overlay

Micro Candidate

Micro Candidate

Micro Candidate

Micro Candidate

Hot In Place Recycling

- On site in place method that rehabilitates deteriorated pavements and minimizes the use of new materials
- Low Cost Maintenance strategy
- Effectively re use existing Materials

Hot Mix Asphalt

- This is the designation given to asphalt mixtures that are heated and poured at temperatures between 300 and 350 degrees Fahrenheit.
- Most commonly used type of asphalt in the united states for highways interstates and roads due to it’s
  - Flexibility
  - Weather resistance
  - Ability to repel water

Hot Mix Asphalt

- HMA is classified into three categories
  - Dense graded mixes
  - Stone matrix asphalt
  - Open grade mixes

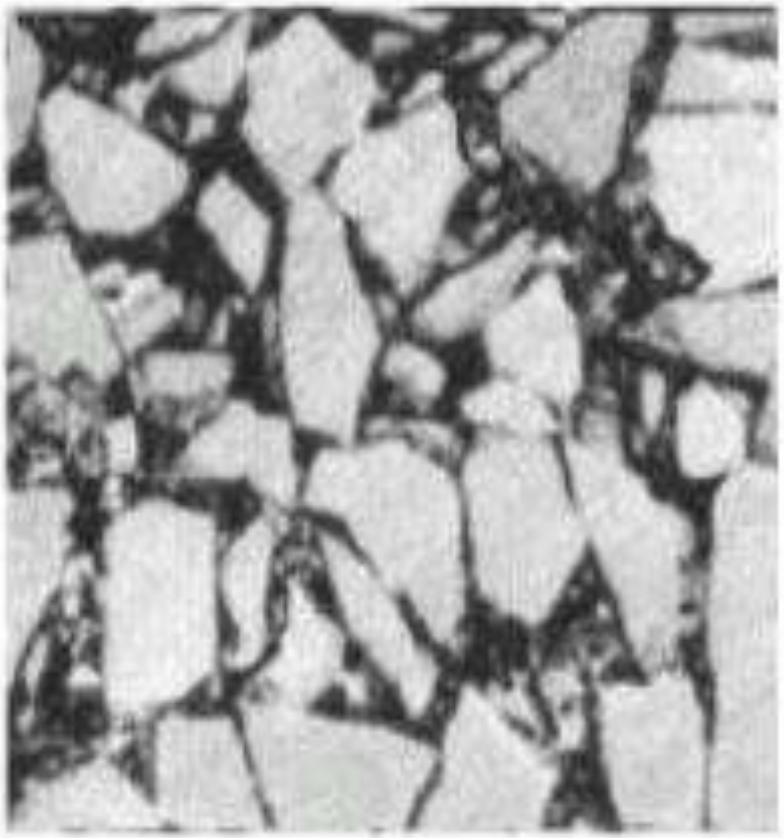
Dense Graded Mix

- Categorized according to the size of the aggregates used, and fall into two sub categories:
  - Fine graded
  - Coarse graded
- Fine graded dense grade mixes contain higher levels of sand small stone.
- Coarse graded contains lager stone

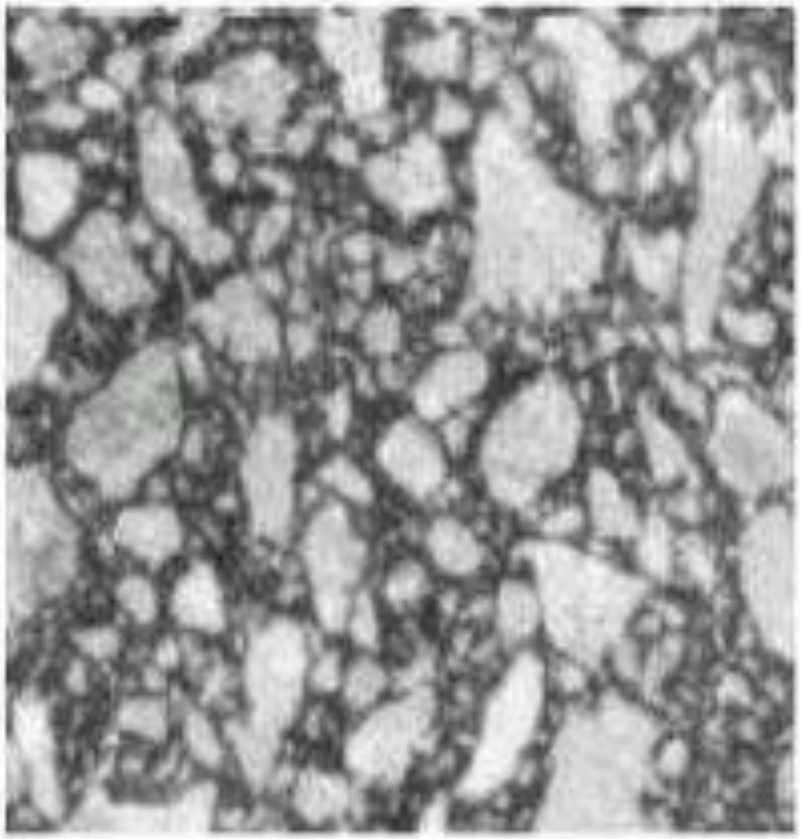
Stone Matrix Asphalt

- Developed in Germany in 1960s
- SMA has high coarse aggregate content that interlocks to form a stone skeleton that resists permanent deformation.
- The Stone Skeleton is filled with a mastic of bitumen and filler to which fibers are added to provide adequate stability of bitumen and to prevent drainage of binder during transport and placement.

Stone Matrix Asphalt



(a) Stone mastic asphalt



(b) Dense graded asphalt

Stone Matrix Asphalt

- Advantages
- SMA provides a textured, durable, and rut resistant wearing course.
- The surface texture characteristics of SMA are similar to Open graded asphalt (OGA) so that the noise generated by traffic is lower than that on DGA but equal to or slightly higher than OGA.
- SMA can be produced and compacted with the same plant and equipment available for normal hot mix, using the above procedure modifications.
- SMA may be used at intersections and other high traffic stress situations where OGA is unsuitable.
- SMA surfacing may provide reduced reflection cracking from underlying cracked pavements due to the flexible mastic.
- The durability of SMA should be equal, or greater than, DGA and significantly greater than OGA.

Open Graded Friction Course

- Open graded friction courses (OGFCs) are a type of pavement that have been built across the United States since the 1950's. These asphalt mixes contain a small portion of fine aggregate, creating a pavement with a relatively large percentage of air voids. They are primarily composed of single size coarse aggregate, and generally have a high asphalt content.

Open Graded Friction Course

Open Graded Friction Course

Open Graded Friction Courses

Advantages	Disadvantages[6]
• Reduced risk of hydroplaning • Improved drainage • Improved visibility • Coarse surface for improved friction values • Improved ride numbers • Reduced noise • Improved driver safety!	• Reduced durability • Raveling/Debonding of OGFC layer • Stripping in OGFC and/or underlying layers • Difficult snow and ice removal

Conclusions

- Road Networks are Valuable Assets
- Managers must view the Network as a Whole
- Managers must know the Health of their Network
- Worst First is an expensive path to the destruction of the Network
- A Pavement Preservation Strategy based on “Right Treatment, Right Road, Right Time” saves money and adds years to the life of the network.

Thank You
Question/Comments

Jimmy N. Kendrick
Bergkamp Pavement Preservations Solutions
Director of Contractor Sales
601-408-4330
jimmyk@bergkampinc.com