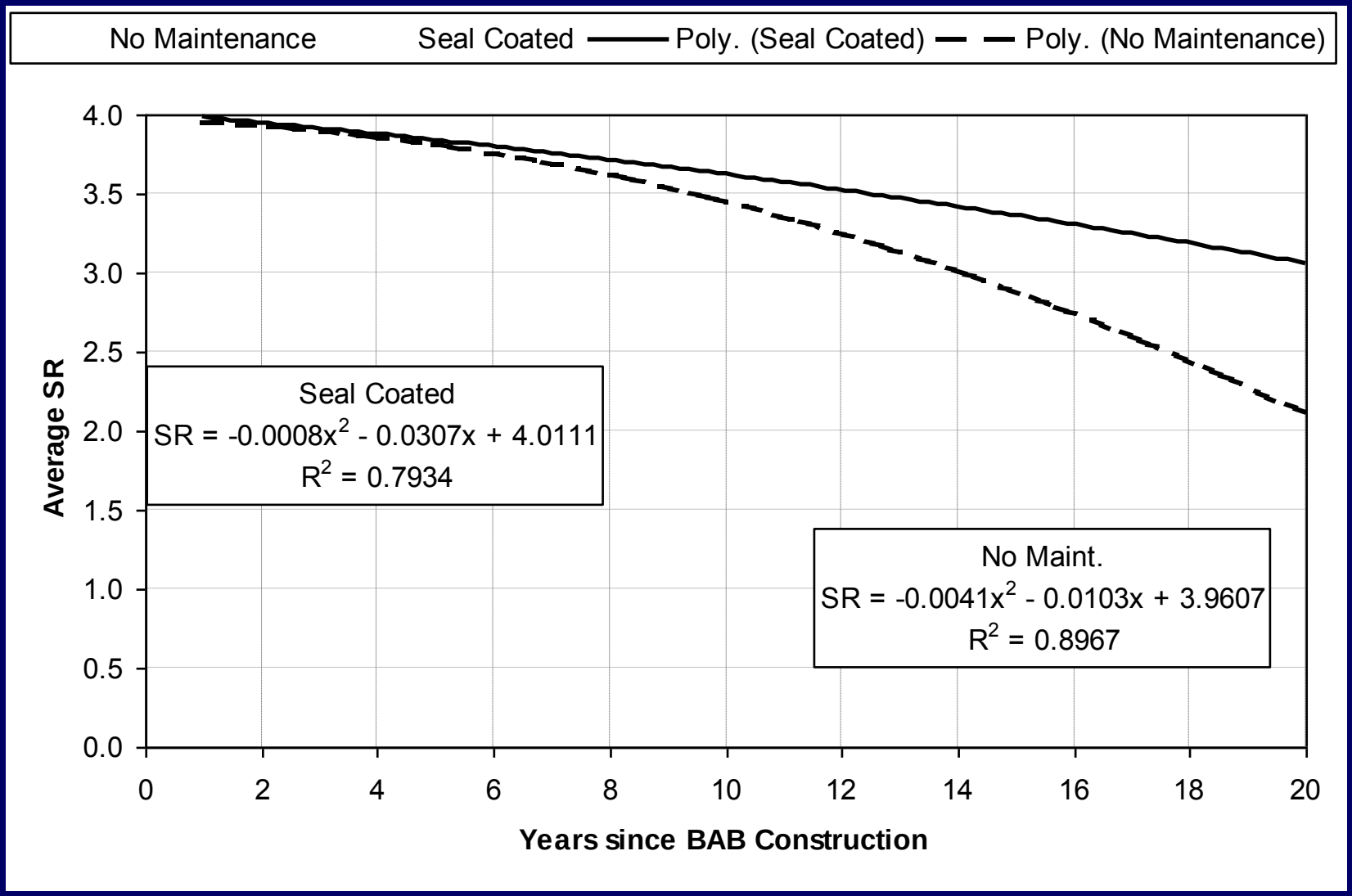
Using Chip Seals & Fog Seals in Pavement Maintenance

Thomas J. Wood
Research Project Supervisor
MnDOT's Office of Materials & Road Research

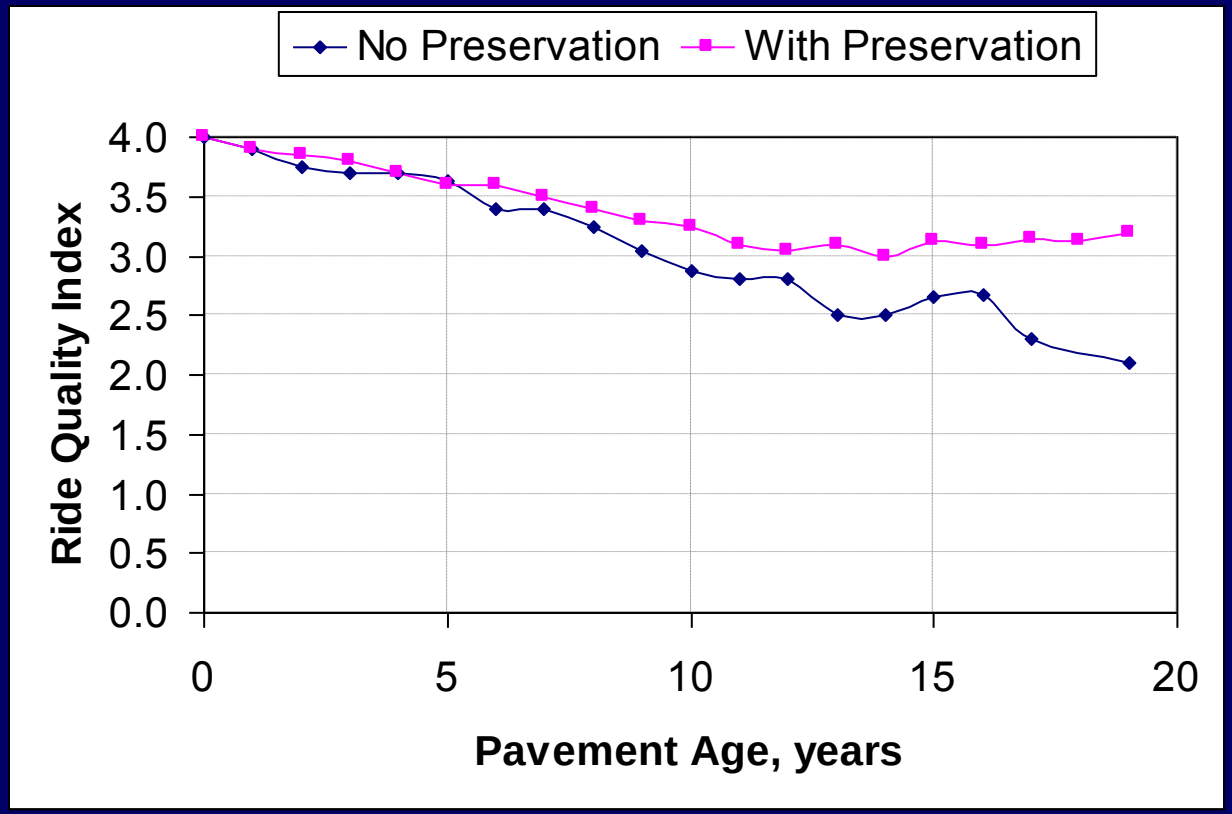
Why do we do Pavement Preservation?

The Answer is?

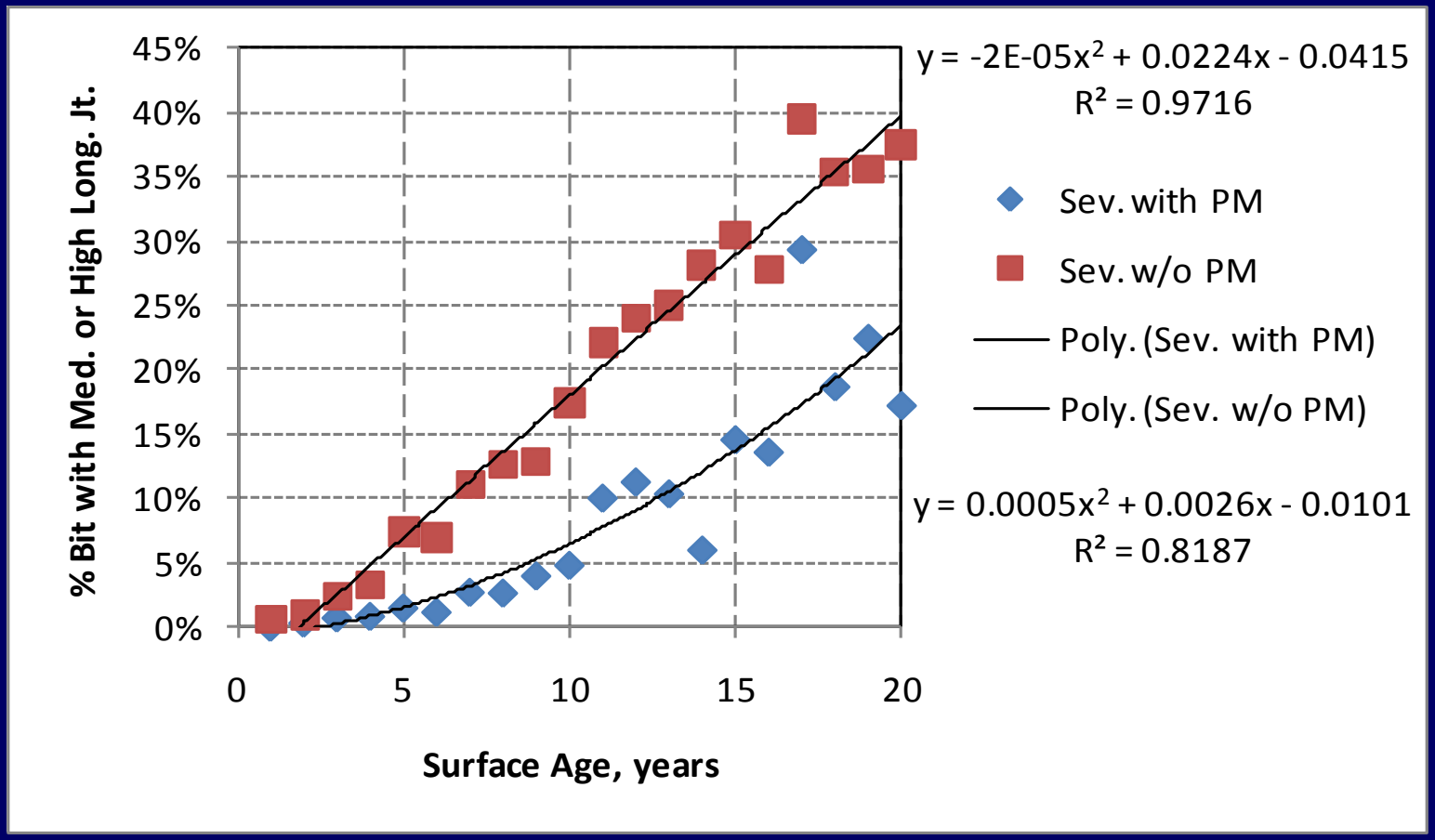
- To keep new pavements new longer!
- Is Pavement Preservation Cost Effective
  - Yes
    - **But depends on properly constructed projects.**
- How do we know it is Cost Effective?
  - Pavement Management Data
    - Mn/DOT experiences
  - Report from Ohio shows 7 years extensions


No Maintenance
Seal Coated
Poly. (Seal Coated)
Poly. (No Maintenance)
Average SR
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
0
2
4
6
8
10
12
14
16
18
20
Years since BAB Construction
Seal Coated
SR = -0.0008x2 - 0.0307x + 4.0111
R2 = 0.7934
No Maint.
SR = -0.0041x2 - 0.0103x + 3.9607
R2 = 0.8967

Ride:


No Preservation
With Preservation
Ride Quality Index
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
0
5
10
15
20
Pavement Age, years

Effects on Construction Joints



Chip Sealing

Chip Sealing

What Is a Chip Seal?

- Bituminous surface treatment
  - Heavy asphalt binder membrane
  - Followed by aggregate chip

Topics!

- Chip Seal Design
- Pay Items
- Aggregate Requirements
- Binders
- Construction Details
- Pavement Markings
- Fog Sealing
- Cul-de-sac
- Recreational Trails
- Parking Lots
- Tips

Seal Coat Design

What does this design method do

1. Gives amount of stone to cover 1 yd^2 a single stone thick
2. Gives starting binder application rate
   - Starting rate should yield 60 to 70% embedment

Press F1 for Program Usage Note

Minnesota Seal Coat Handbook

SEAL COAT DESIGN

ID	Sample	Project	Location	Sampled	Tested	Test ID	Agg ID
12	BA06-124	City of Hasti	Hastings M		5/18/2006	BA06-0124	

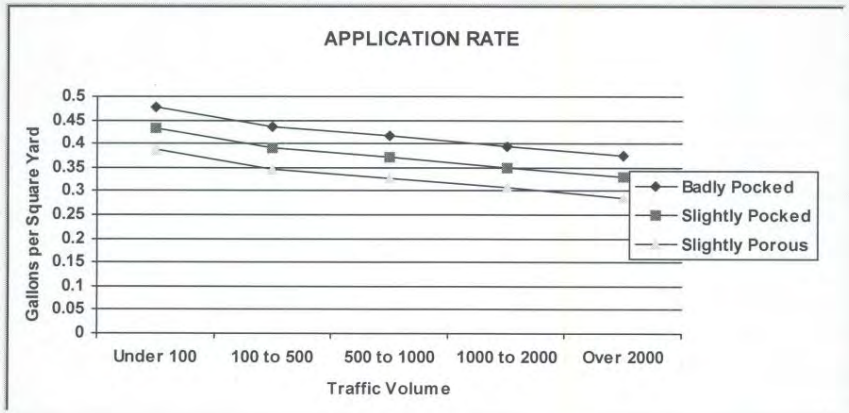
AggType	Dresser T	Binder ID	
Agg Size	FA 2 .5	Binder Type	

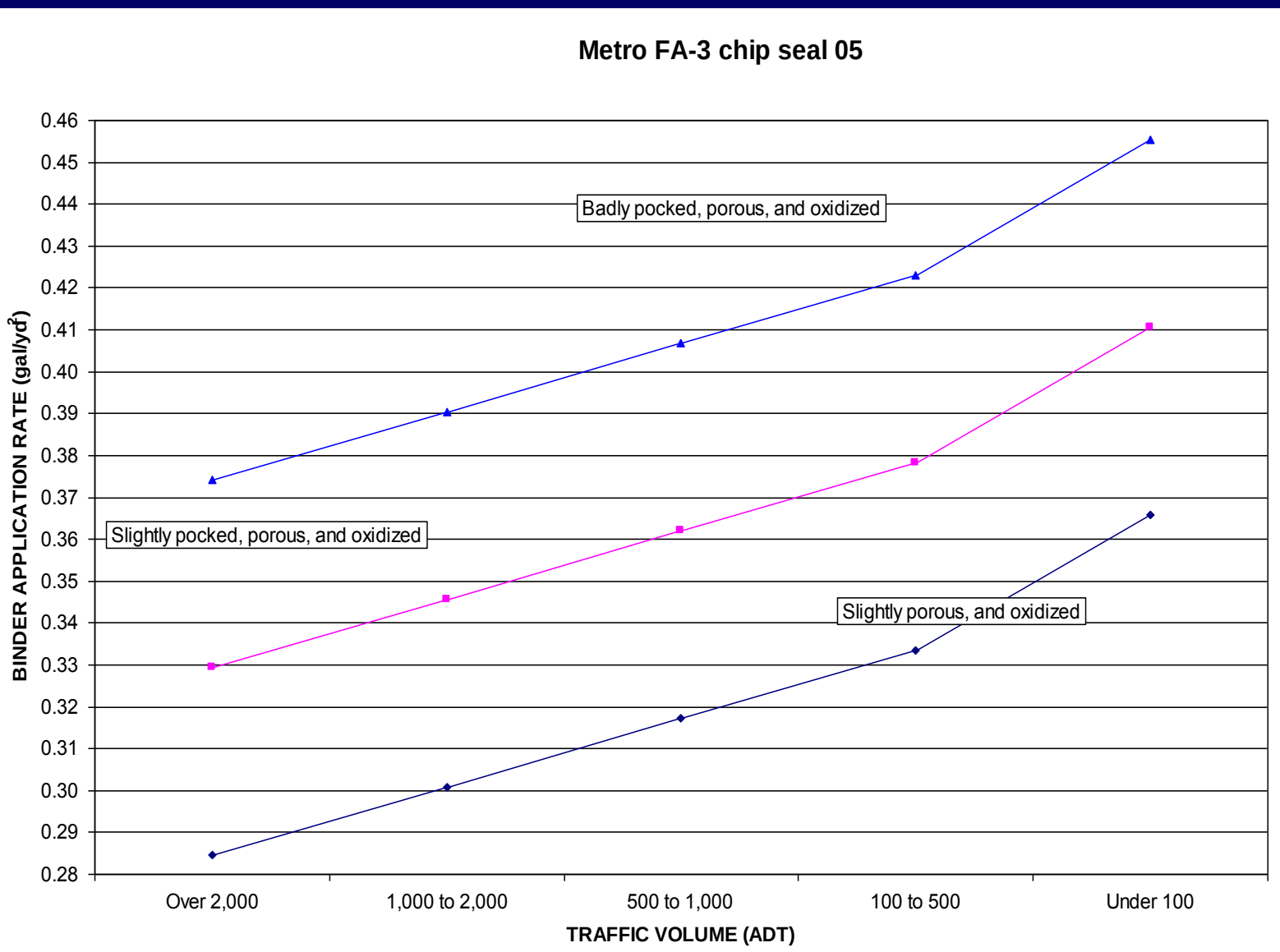
PERCENT					
Passing 1/2	100	Retained 1-3/4	0	Passing 1-3/4	0
Passing 3/8	100	Retained 3/4-1/2	0	Passing 3/4-1/2	0
Passing 1/4	79	Retained 1/2-3/8	0	Passing 1/2-3/8	0
Passing No 4	35	Retained 3/8-1/4	81	Passing 3/8-1/4	19
Passing No 8	1	Retained 1/4-No 4	0	Passing 1/4-No 4	0
Passing No 16	1				
Passing No 50	1				
Passing No 200	0.5				

MEDIAN	0.21	Waste	1.05	Residual Asphalt	0.67
FLAKINES	0.19	Traffic	0.7	COVER	21.80736
ALD	0.18	Surface	0.06	FLAT	0.2768157
Bulk SG	2.945	Aggregate Absorption	0	NOT FLAT	0.3033081
Loose UW	103.4				
VOIDS	0.437334	Absorption Correction	0		

GRAPH VALUES Below (Gal/SY)

Traffic Factor	Badly Pocked	Slightly Pocked	Slightly Porous	Vehicles / Day
0.6	0.3756	0.3308	0.2860	Over 2000
0.65	0.3957	0.3509	0.3061	1000 to 2000
0.7	0.4158	0.371	0.3262	500 to 1000
0.75	0.4359	0.3911	0.3463	100 to 500
0.85	0.4761	0.4313	0.3865	Under 100




Metro FA-3 chip seal 05
BINDER APPLICATION RATE (gal/yd²)
0.46
0.45
0.44
0.43
0.42
0.41
0.40
0.39
0.38
0.37
0.36
0.35
0.34
0.33
0.32
0.31
0.30
0.29
0.28
Badly pocked, porous, and oxidized
Slightly pocked, porous, and oxidized
Slightly porous, and oxidized
Over 2,000
1,000 to 2,000
500 to 1,000
100 to 500
Under 100
TRAFFIC VOLUME (ADT)

Seal Coat Design Summary

- Design for FA-3 (3/8 inch) chip
  - Without design av. 30 lbs./Yd.^{2}
  - Without design av. Binder 0.30 gal./Yd.^{2}
  - With design av. 17 lbs./Yd.^{2}
  - With design av. Binder 0.42 gal./Yd.^{2}
- Available free
  - http://www.dot.state.mn.us/materials/researchsealcoat.html

3 Common Payment Methods

- Volumes
- Area
- Combination Binder & Area

Volumes

- Gallon / Ton of binder
- Tons of aggregate
  - Encouraged over application of aggregate
    - Waste of money
    - Increased chance of vehicle damage
    - Conflict between Agency personnel and Contractor

Area

- Square yard / meter
  - One pay item
  - Easy to measure
  - No over runs
  - Contractor will put minimum amount of binder specified

Binder & Area

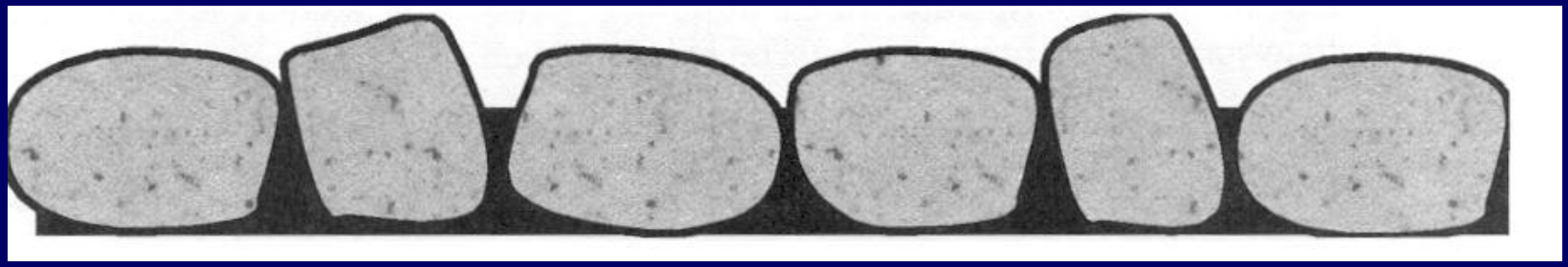
- Binder by gallon or ton
- Rest of chip seal by square yard or meter
  - Encourages proper application of aggregate
  - Eliminates cost over runs
  - Easy inspection
    - Allows inspectors to concentrate on important issues.
    - Reduces conflict between Agency and Contractor

Aggregate Requirements

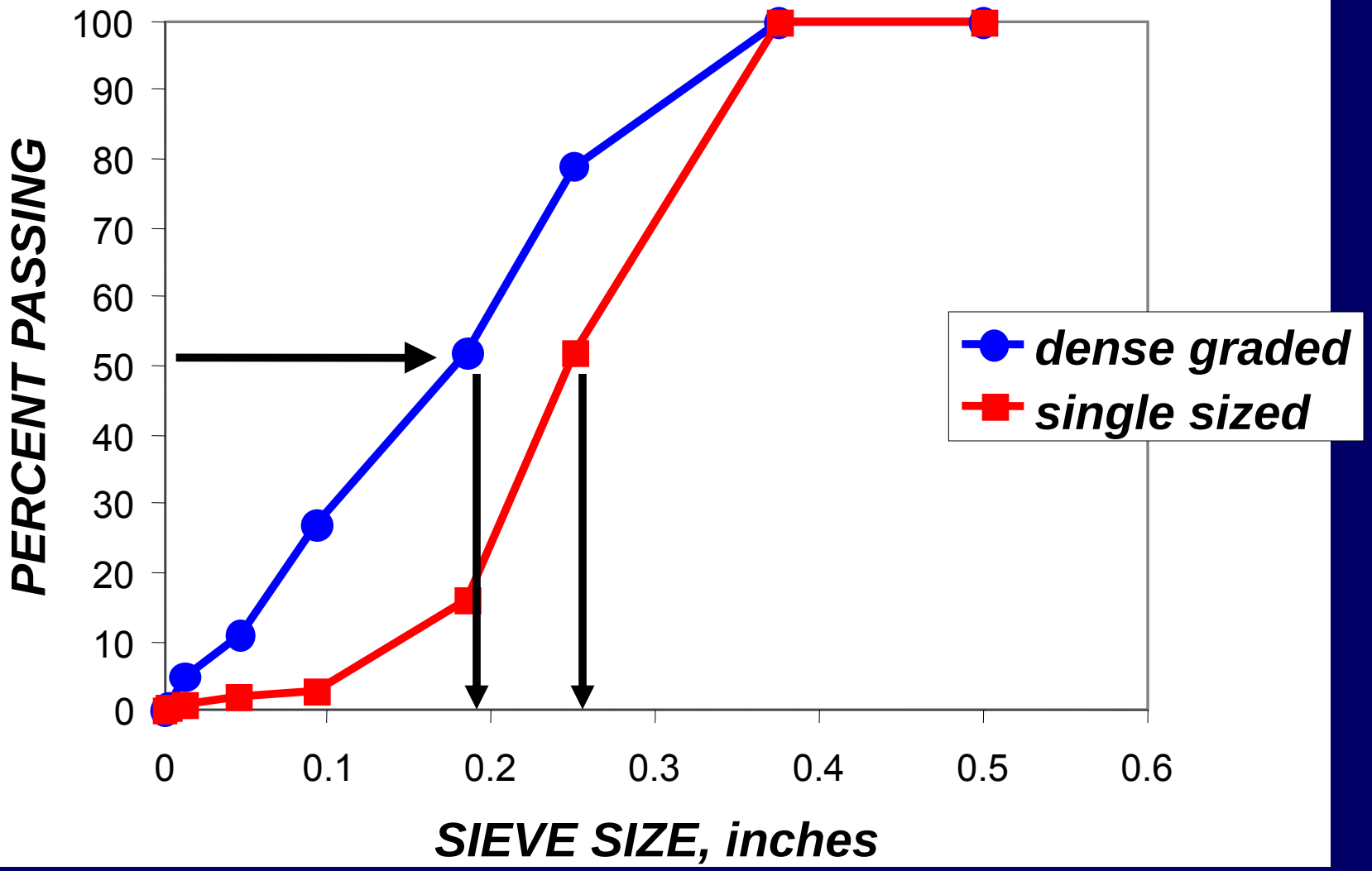
Aggregate Requirements

- Must be clean
  - Clay free aggregate
  - Less then 1% passing #200
- LAR loss % max. 35%
- 80 % one face crushed
- Flakiness Index Max. 25%
  - DFT 508

Dense Graded Vs. Single Size!



Dense Graded vs. Single Sized



Advantages of Single Sized Agg.

- Single sized aggregate
  - More uniform height
  - Weighs less per cubic foot
    - 47% passing the #4 95.7 lbs./ft^3
    - 8% passing the #4 84.5 lbs./ft^3
  - More room for binder
    - Increased Voids

Advantages of Single Sized Agg.

- FA-3 $16.00 ton dense graded
  - 18.5 pounds / yard needed
    - **$0.148**/ yard
- Single size
  - 14.5 pounds / yard needed
    - **$0.116** / yard
- You can pay up to $4.44 a ton more for single sized chip and the total cost per square yard will be the same as dense grade chip.

Binders

- Hot applied
  - Not commonly used in upper Midwest
  - Safety issues
    - Non modified application temperature 280° F +
    - Polymer modified 330° F +
    - Needs clean dry chips
    - Dry roads
- Cut Back
  - Not environmentally acceptable anymore
    - Every 10,000 gallons of cutback place on roadway gives off 1,500 of gasoline or diesel fuel

Emulsions

- CRS-2 cationic rapid set asphalt emulsion
  - NOT polymer modified
  - Has been work horse for MN for years
  - Builds strength over longer time the CRS-2P
    - You can sweep is next morning
    - Can take up to 10 days to develop full strength.
  - Average Residual Asphalt is 67%

Emulsions

- HFMS-2 high float medium set asphalt emulsion
  - Good with dirty aggregate
  - Must let skin over if using clean chips.
  - Supposedly has jell structure.
  - Very slow developing strength
    - Earliest you can sweep is next morning
  - Similar to Medium Set Cutback.
  - Average Residual Asphalt is 67%

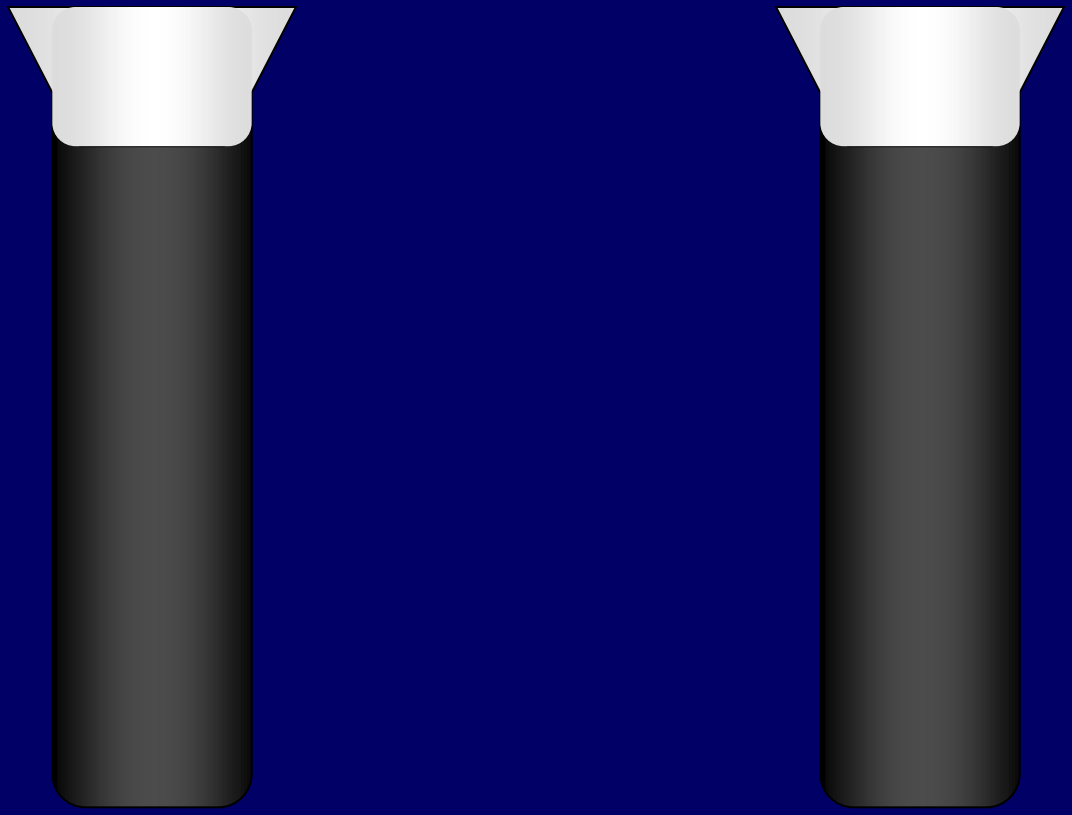
Emulsions

- CRS-2p cationic rapid set polymer modified
  - Develops strength in hours instead of days
  - Can be swept same day
  - Requires use of clean aggregates
  - Must place aggregate within 1 min. of binder placement
  - Eliminates bleeding
    - Higher softening point
      - CRS-2 average softening point 108° F
      - CRS-2p average softening point 128° F
  - Average Residual Asphalt is 70%

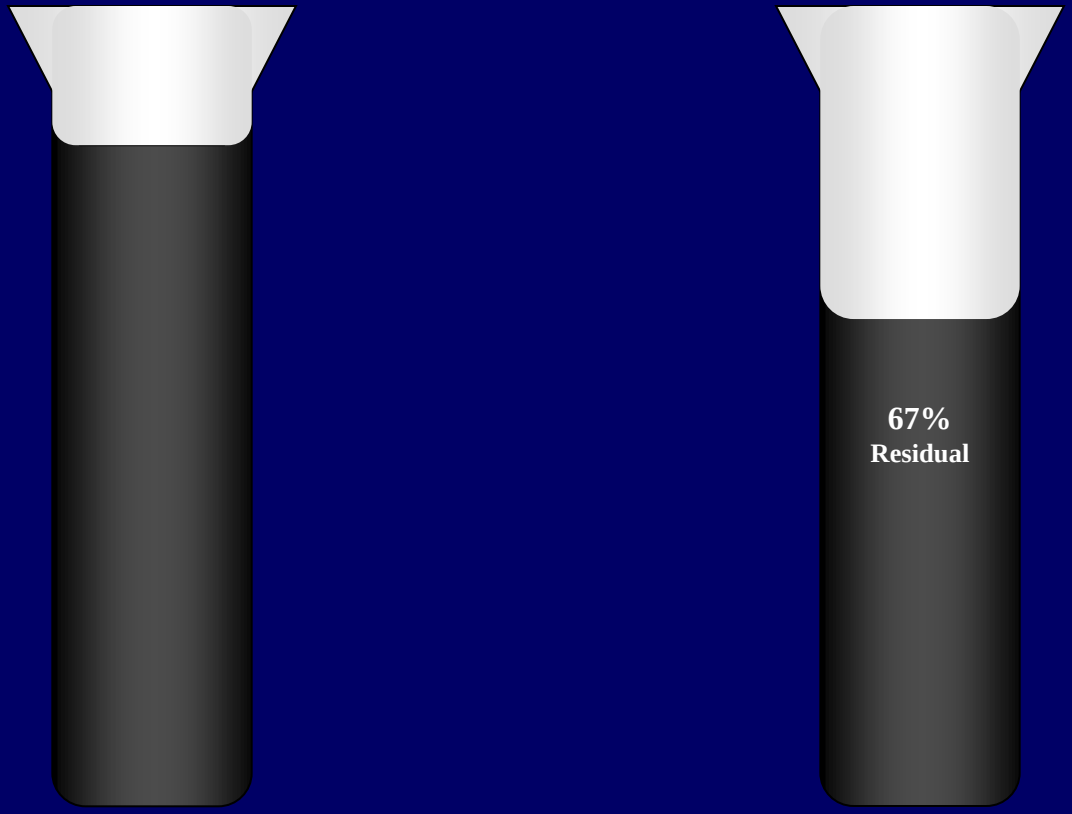
Residual Asphalt

- Hot applied 100%
- Cut back 85%
- Emulsion 67%

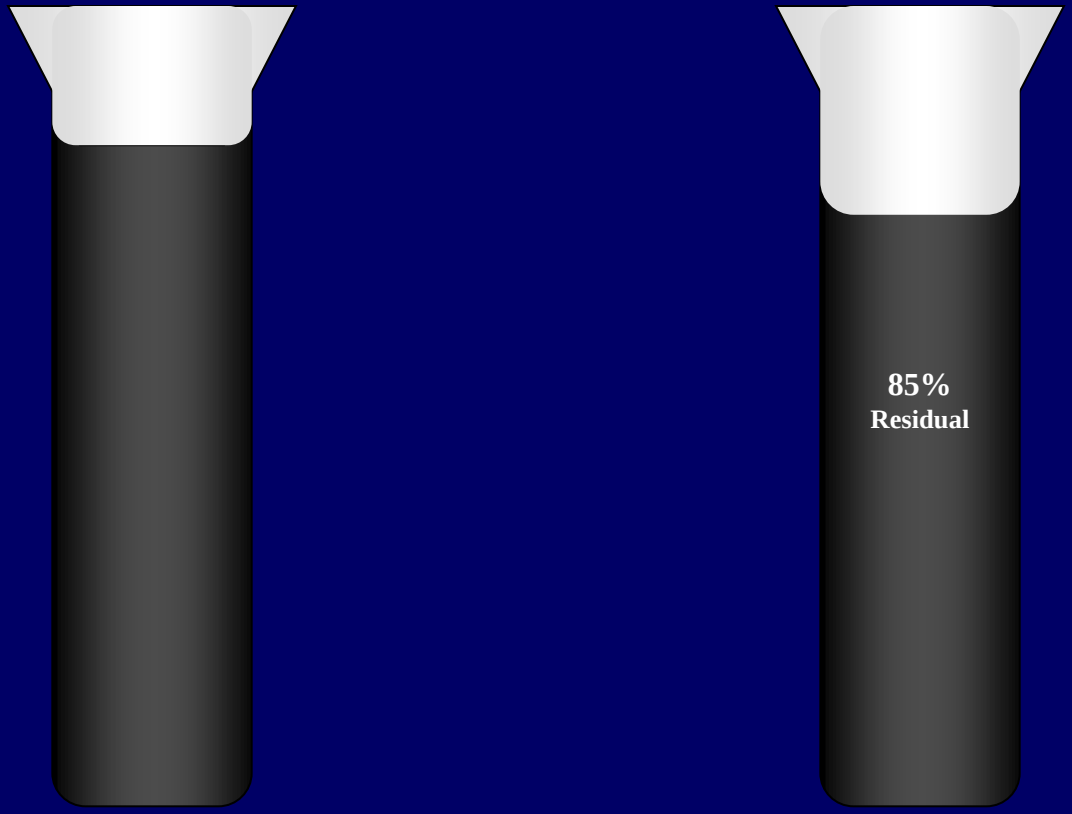
Hot AC



Asphalt Emulsion



Cut Back Asphalt

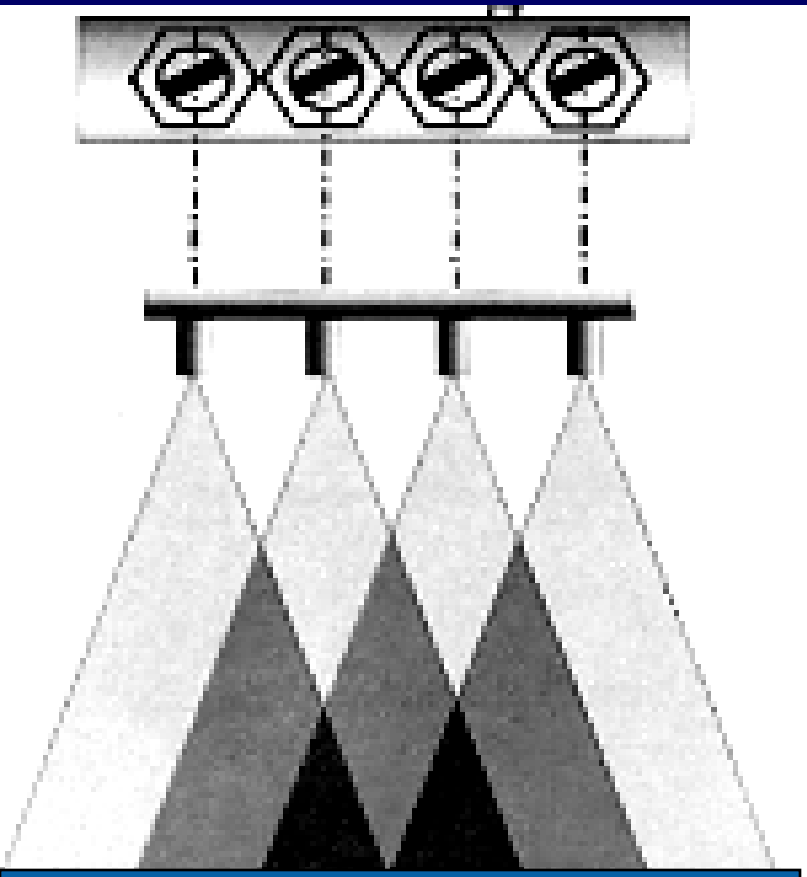


Construction Details

Distributors

YES

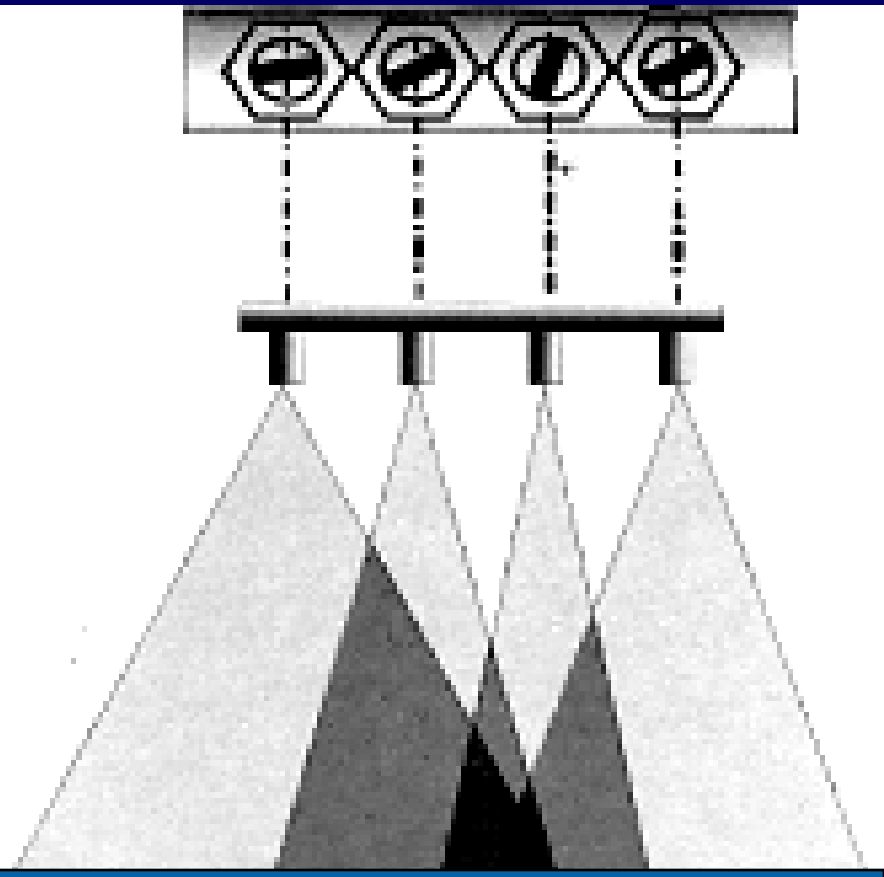
Same Angle



Fans are the same width

NO

Different Angles



Fans are different widths

Bar Height

What caused this?

Chip Spreaders

STOP

ASTM D5624-95

Setting Shot Rate

Trucks

- Gentle Starts / Stops
- Stagger trucks
- No leaks
  - Hydraulic oil
  - Fuel
  - Anti-freeze
- No turning on fresh seal
- **Don’t dump last of chips on roadway**

Brooms

- Pre-clean roadway
- Remove extra chips
  - From open lane
- Be careful on new seal
- Don’t stop with broom down

Rollers

- Minimum 3 roller
- Recommend 3 passes
- Speed 5 mph or less
- Work with trucks
- No fast starts or stops

Dealing with in place Pavement Markings

- Trouble with de-bonding of chip seal
- Options
  - Grind off
  - Water Blast
  - Cost $0.85 to $1.00 linear foot
  - Prime
  - CRS-2p 0.10 to 0.15 gal/y²
  - Cost $0.02 to $0.03 linear foot

Pavement Markings

1238

Modify Methods

Other Issues!

Fog Sealing

Topics

- What is a Fog Seal
- What are the Benefits of Fog Sealing of a chip seal
- Construction Issues
- Recreational Trail
- Cul-de-sac
- Parking Lots

What is a Fog Seal

- It is a light uniform application of asphalt emulsion
- Normally CSS-1h or SS-1h diluted

How does Fog Sealing help limit snowplow damage

- Increased embedment
  - Additional residual asphalt
  - Accelerates curing of pavement because of dark color
- Combination of binders
  - Combination of soft elastomeric asphalt underneath and harder asphalt over top

Other benefits of Fog Sealing Chip Seals

- Locks down marginally embedded chips
- Makes pavement marking more visibly
  - Reduces amount of paint needed
- Customer perceives surface treatment as a new HMA overlay not a chip seal

Construction Issues

- No rain forecasted for next 3 hours
- Environmental conditions dictates speed of cure
- Proper nozzle size for uniform application
- Properly functioning equipment and qualified operator
- Overlap the centerline at least 1 foot
- Light coat of sand in intersections/high volume areas

NOT THIS!
07/14/2005

What the Traveling Public See

4 Years Later

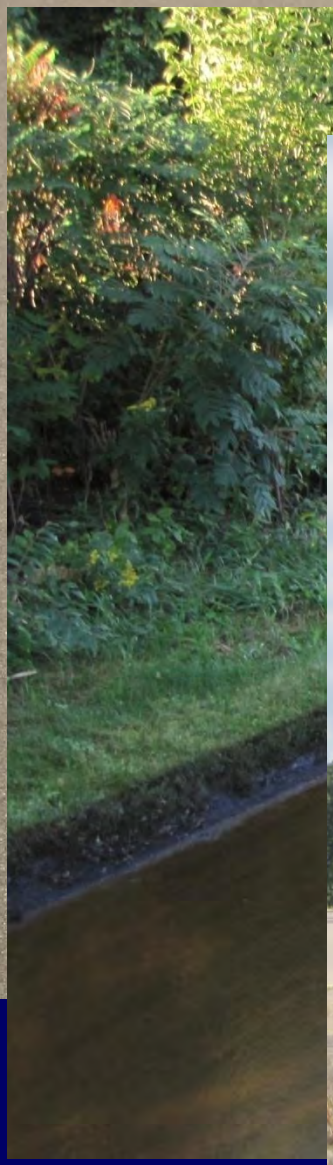
Fog Sealing Recreational Trail

Recommendations for Fog Sealing

- Start with construction
  - Seal surface and fill voids
- Use CSS-1h diluted
  - Diluted one part water to one part emulsion at place of manufacture
  - Use on newer trails
  - Soaks in because of lower viscosity
- CRS-2Pd
  - Old trails with lots of raveling.

09/01/2010

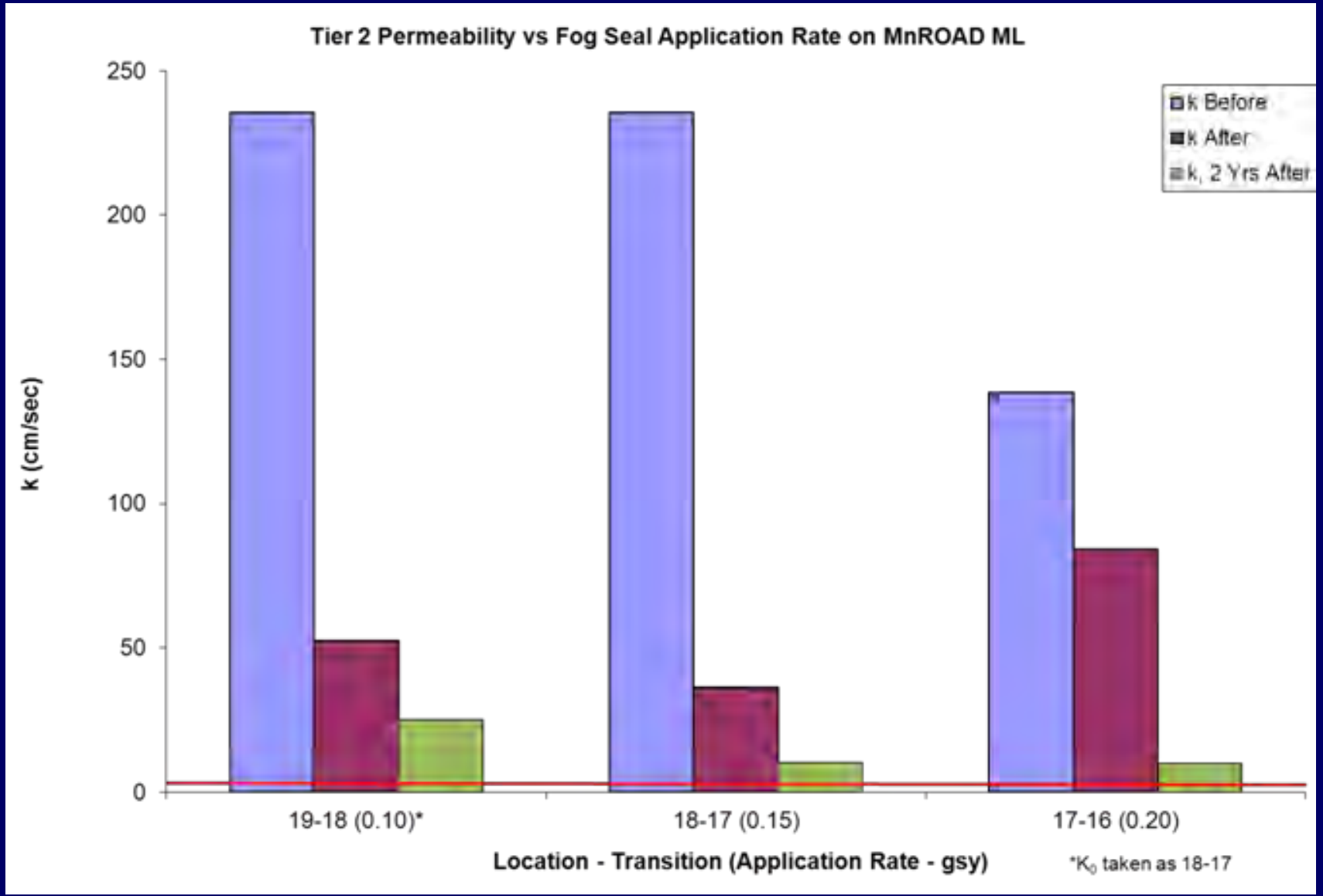
09/08/2010



SPEED
LIMIT
50
09/08/2010

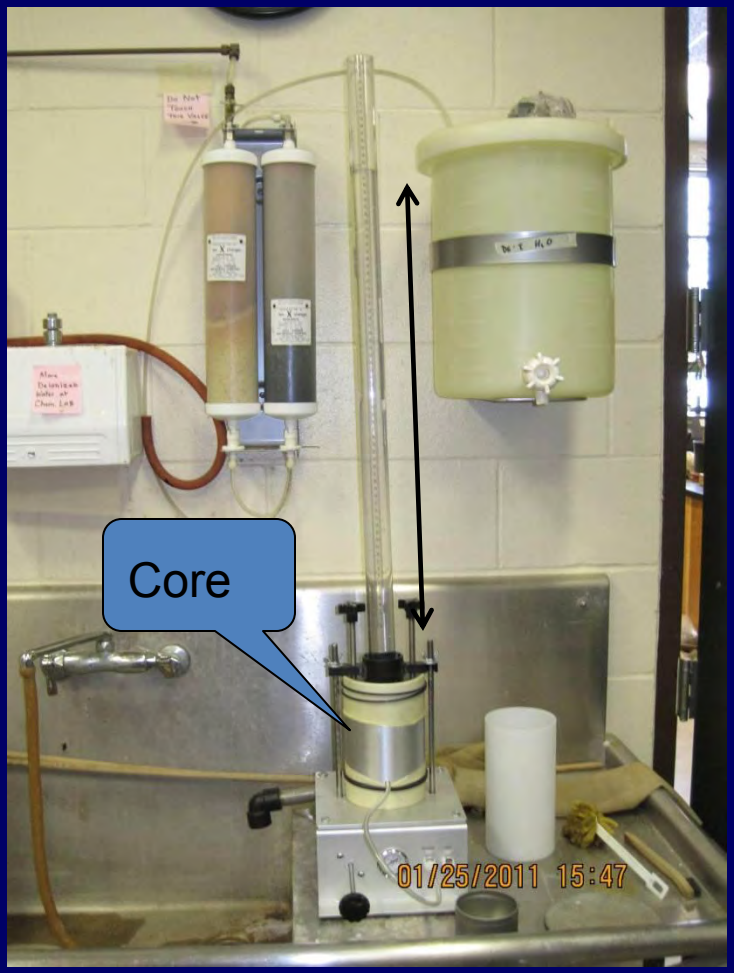
Cul-de-sac

But Fog Seal Disappear in 2 Years



Permeability Testing

- Measure Time for water to "fall" a given distance:
  - 7% AV ~20 min
  - 15% AV ~1.5 min



Parking Lots

Chip Sealing

- Use small rock
  - CRS-2P
  - Fog sealed
    - Css-1h diluted 1 to 1
- Why
  - Reduced turning damage
  - Good job of sealing small cracks

09/09/2011 13:27

09/17/2011 12:15

01/06/2012 12:03

No Tire Damage

09/17/2011 10:15

09/17/2011 10:14

09/17/2011 1

09/17/2011 16:46

Fog Sealed Parking Lot

Tips for Successful Seal Coat

- Make sure pavement is clean
- Use high quality materials
- Proper application rate for binder
- Proper application rate for aggregate
  - Excess aggregate only causes failure
  - Extra cost and waste

Tips for Successful Seal Coat

- Minimum distance between distributor & chip spreader
  - Aggregate must be placed before emulsion starts to break
- Minimum of three rollers; Speed under 5 mph
  - Compaction must be completed before emulsion is broken

Tips for Successful Seal Coat

- Final sweeping of roadway as soon as possible.
  - No later then next morning.
- Quality does not cost. It pays!
- Remember that details count.

Questions?