Dial in Your Chip and Shot Rate For a Successful Project

Pavement Preservation Series

SDLTAP –

South Dakota State University

Why Chip Seal?

Extend service life of surfaces in good condition

Will retard weathering/aging of an asphalt surface

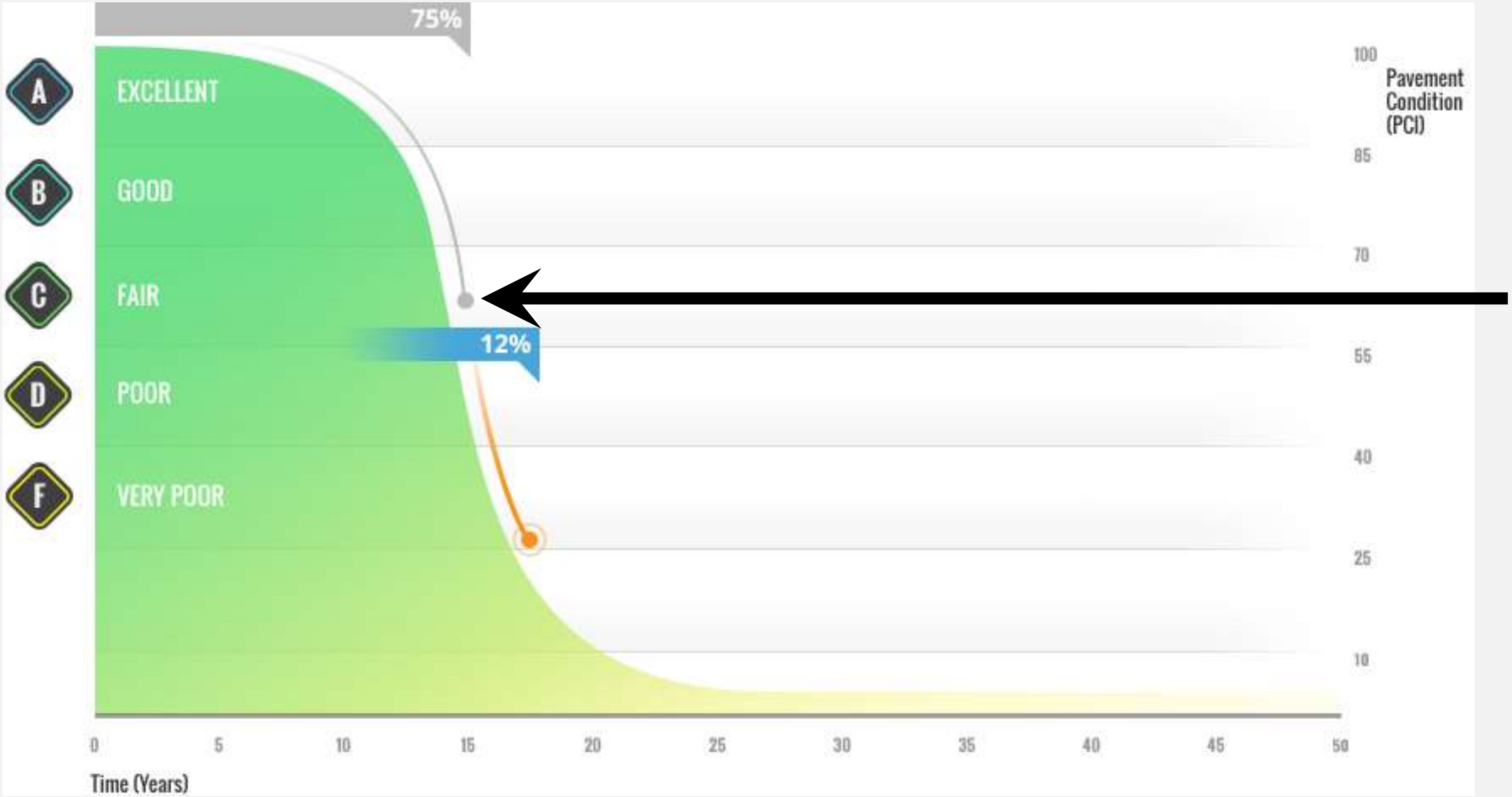
Will seal minor surface cracking

Restore skid resistance to the surface

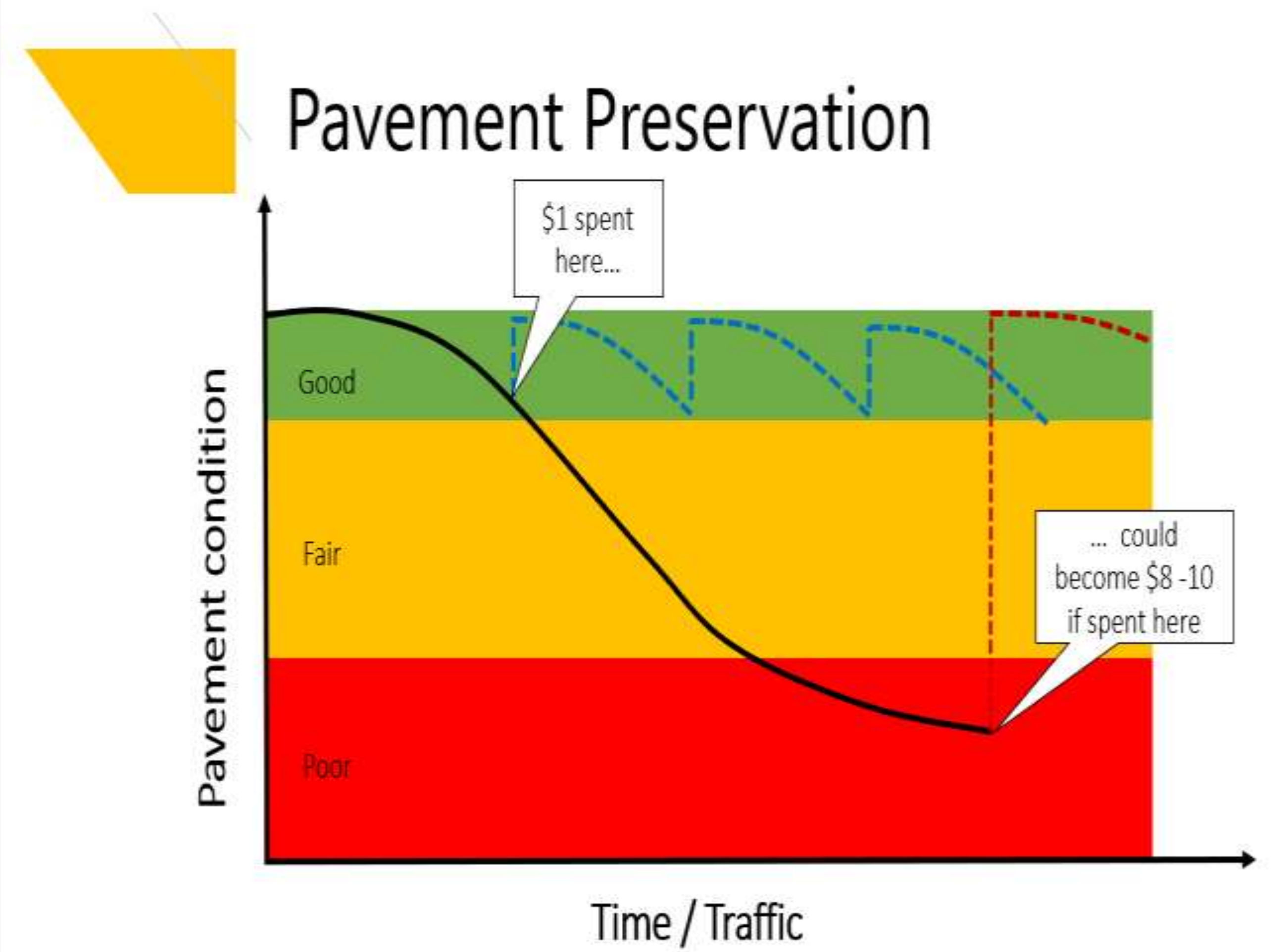
Needs more than a seal coat

Over the first 75% of a road's life, it will drop 40% in quality.

Over the next 12% of its life, it will drop another 40% in quality.



Seal coats really need to be applied before the surface deteriorates beyond this point



Pavement preservation is an important tool used to extend public agency resources to increase the useful life of roads at a significant cost savings over the life of the road.

Research shows spending **$1** to preserve a road in good condition precludes spending **$8 to $10** to reconstruct it later, after it's gone too far to maintain.

Chip Seal Design Method

What Should it Do?

- Provide an amount of aggregate to cover 1 sq. yd yard a single stone thick
- Provide a starting Emulsion/Cutback application Rate
  - Starting Rate should yield 70% embedment if there is no absorption by pavement surface
  - Must adjust for underlying pavement conditions

McLeod Chip Seal Design

Based upon a single rock source/sample

- Each rock source needs a design, do not assume two sources meeting the same specification are close enough

Needs to account for traffic effects

- Higher Traffic Volume will lower the Emulsion/Cutback rate needed to hold the rock and achieve the 70% embedment

Account For Road Surface Conditions

- The Rougher the Road Texture - Emulsion or Cutback Rate needs to be increased due to absorption of the material into into the existing surface

Aggregate Tests & Rate Calculations

Gradation (SD202 – ND T27)

- for Calculating Embedment, Average Least Dimension, and Median Aggregate Size

Loose Unit Weight [SD205]

- for Calculating Voids in the Aggregate

Specific Gravity& Absorption [SD209 & SD210 - NDT84 & NDT85]

- for Calculating Voids in the Aggregate

Flakiness Index (Flat and Elongated Particles) [SD203 – NDD4791]

- for Calculating Embedment (How high will the chips sit up when finally embedded)

Median Particle Size

- Chip Size obtained from the middle of the Gradation Band (50% passing) – The more sieves used to grade the material and the more cubical the stone size equates to a more accurate design rate

Aggregate Tests & Rate Calculations (Cont)

Voids in Loose Aggregate [SD205]

- Voids = (Loose Unit Weight (lbs./cu. Ft) / 62.4 * Specific Gravity of the Aggregate

Whip Off Factor

- 5% for Low Traffic, 10% for High Traffic (e.g. Low = 1+0.05 = 1.05)

Flakiness Index (Flat and Elongated Particles) [SD203 – ND D4791]

- Calculated from Test Procedure

Average Least Dimension

- H = Median Particle Size / (1.139285+(0.011506 * Flakiness Index))

Aggregate Application Rate

- C (Application Rate) = 46.8 * (1-(0.4) * Voids in Loose Aggregate * Average Least Dimension * Specific Gravity * Whip Off Factor

McLeod Emulsion Rate Calculation

Wheel Paths

- B(Gal /Sq. Yd.)=((2.244 * **Average Least Dimension** * Traffic Factor * Voids in Loose Aggregate) + Surface Condition Factor + Aggregate Absorption Factor) / Residual Asphalt Content of Emulsion/Cutback

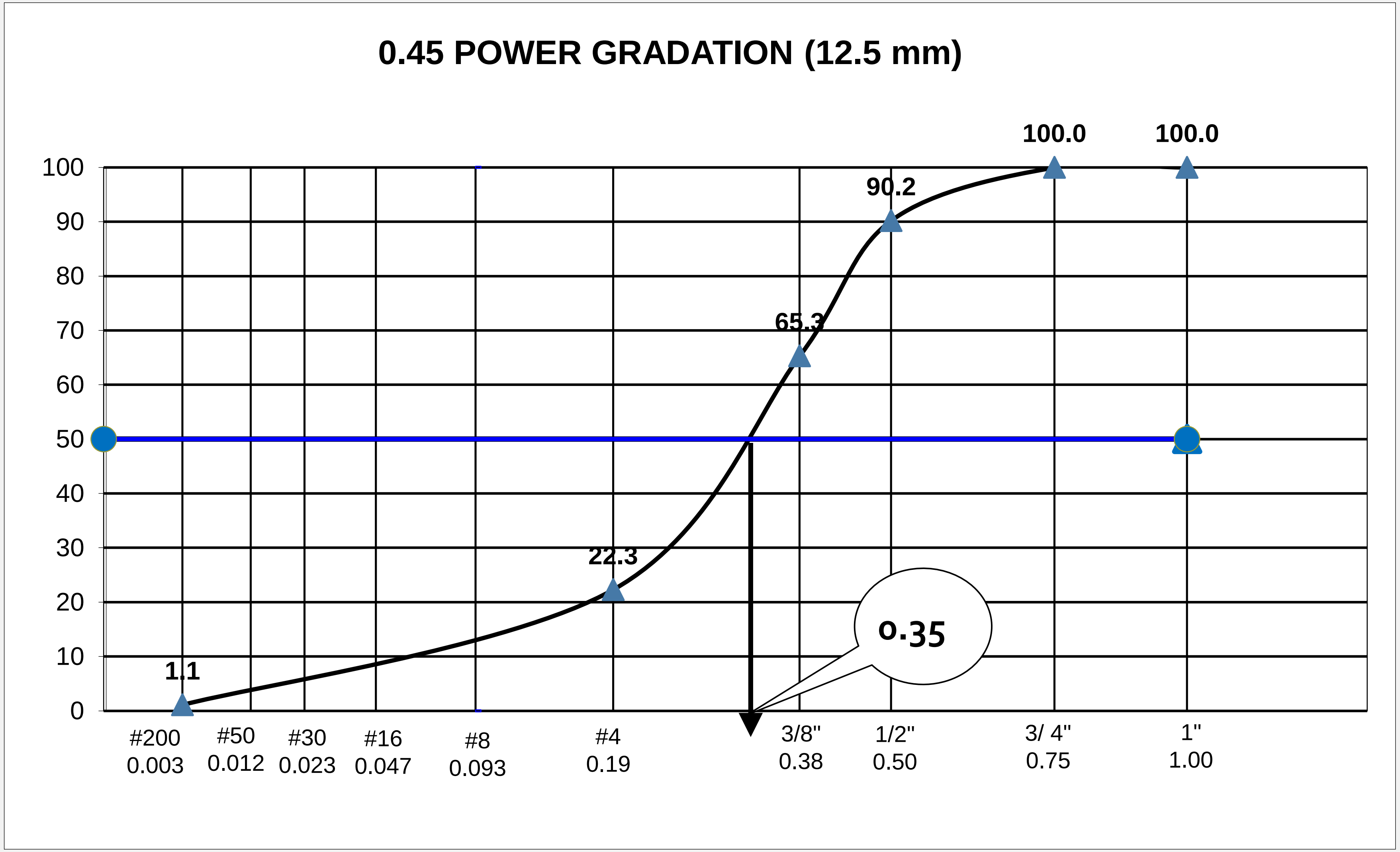
Non Wheel Paths

- B(Gal /Sq. Yd.)=((2.244 * **Median Rock Size*** Traffic Factor * Voids in Loose Aggregate) + Surface Condition Factor + Aggregate Absorption Factor) / Residual Asphalt Content of Emulsion/Cutback

Typical Starting Rate

- **Use the Average of the Wheel Path and Non Wheel Path Rates for the Starting Rate**

Modified McLeod Design Procedure – Gradation Analysis and Median Particle Size

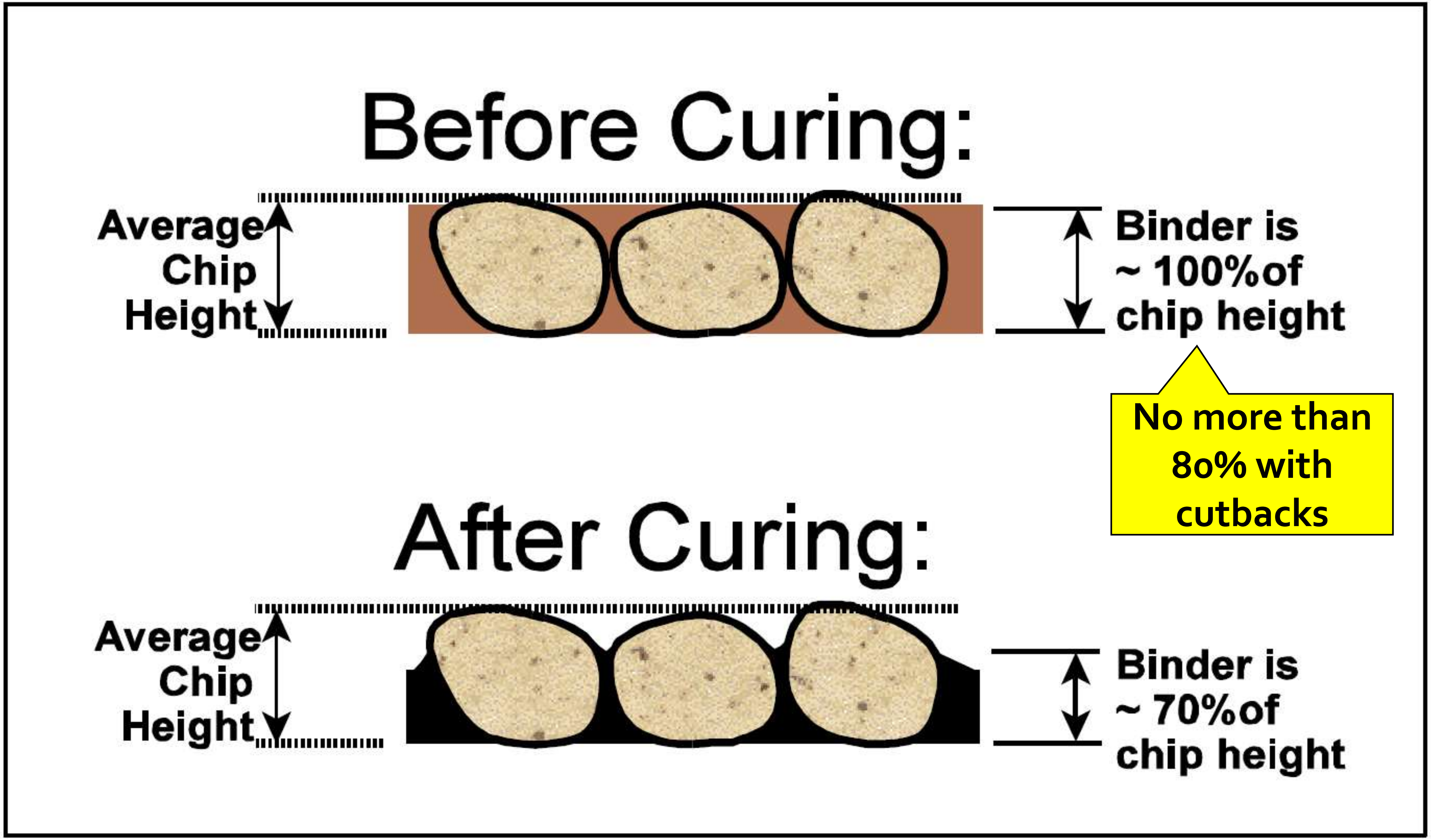


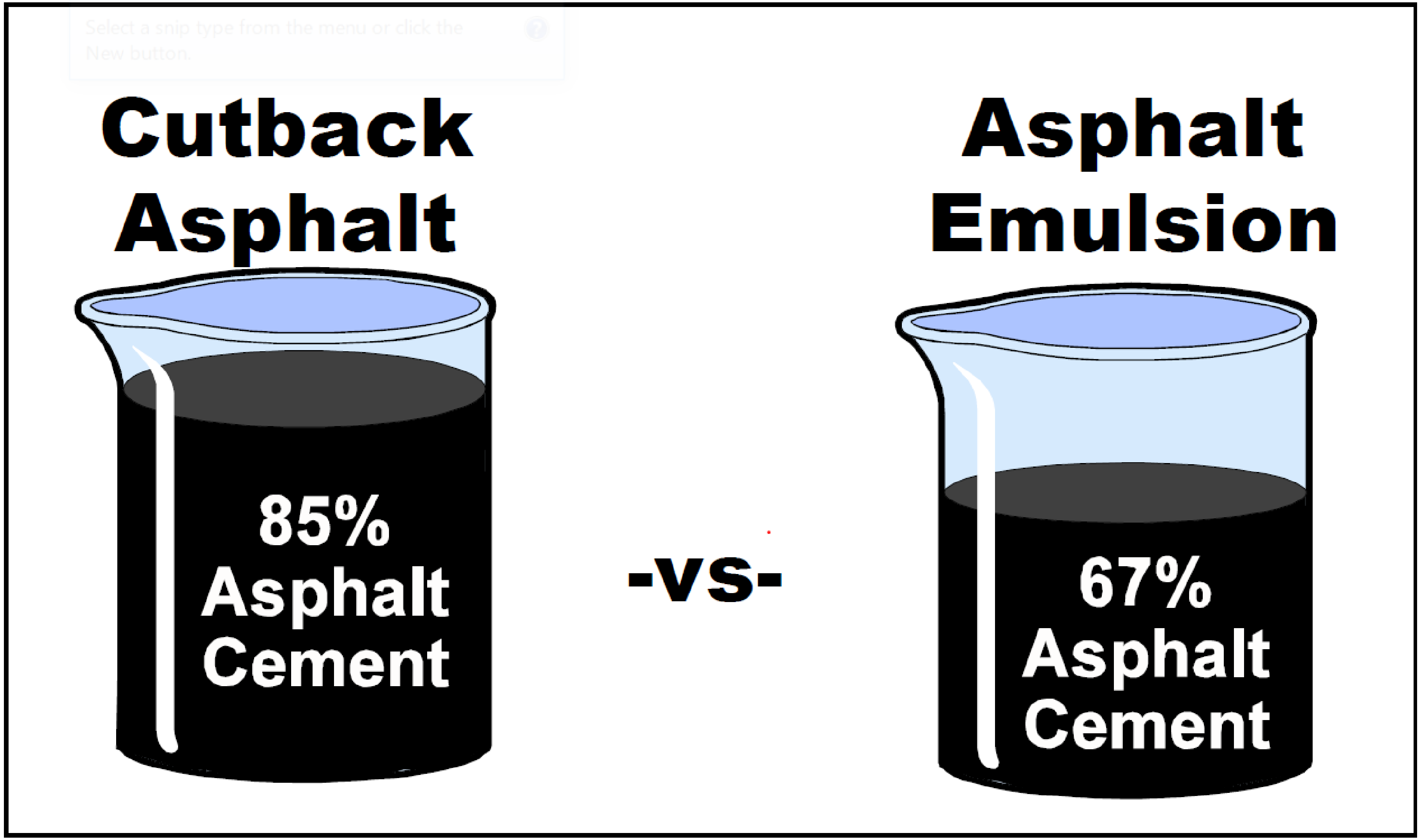
Sieve Size	% Passing
3/4"	100
5/8"	99.5
1/2"	90.2
3/8"	65.3
1/4"	32.9
#4	22.3
#8	5
#16	3.9
#30	3.6
#40	3.4
#200	1.1

Project #:	Aurora County - 262nd St	***Material Type:***	Type 3	
County:	Aurors	***Material Source:***	Spencer Quarry	
PCN:	-	***Quantity:***		
Date:	07/10/2018	***Description:***	262nd St E & W of Stickney	
S	Existing Pavement Surface Texture Correction Factor	Black Flushed = -0.01 to -0.06 Smooth Non-Porous = 0.00 Slightly Porous = +0.03 Slightly Pocked, Porous, and Oxidized = +0.06 Badly Pocked, Porous, and Oxidized = +0.09	**0.03**	gal/sy
T	Traffic Volume	ADT <100 = 0.85 ADT 100 - 500 = 0.75 ADT 500 - 1000 = 0.70 ADT 1000 - 2000 = 0.65 ADT > 2000 = 0.60	**0.75**	
A	Aggregate Absorption Factor (SD209 & SD210)	Over 1.5% = + 0.02 Over 2.0% = + 0.03 Over 2.5% = +0.04	**0.02**	gal/sy

G	Bulk Specific Gravity of Aggregate (SD209 & SD210)	Obtain From Materials Lab Report	**2.600**	
W	Loose Unit Weight (SD205)	Obtain From Materials Lab Report	**85.0**	lb/cu ft
E	Traffic Whip off Factor	Portion of the Aggregate Chips that will get thrown off the roadway before Curing and Embedment (5% Low and 10% High) E=1+P/100	**1.05**	
R	Residual AC in Emulsion	Obtain From Materials Lab Report	**0.65**	
M	Median Particle Size	Theoretical size thru which 50% of the Material Passes (From Gradation Chart)	**0.35**	in.
FI	Flakiness Index (SD203)	Measure of the percentage by weight of Flat particles (Calculated from SD203 worksheet)	**20.00**	

H	Average Least Dimension	Average Least Dimension represents a reduction of the Medial Particle Size after Accounting for the Amount of Flat Particles H=M/(1.139285+(0.011506*FI))	**0.26**	in.
V	Volume of Voids in Loose Aggregate (SD205)	**Voids in the Loose Aggregate represents the Voids after the Aggregate Chips are Placed on the Pavement V=1-(W/(62.4*G))**	**0.48**	
C	**Aggregate Application Rate:**	**C=46.8(1-0.4*V)*H*G*E**	**26.4**	**lb/sq yd**
B- Wheel Path Rate	**Binder Rate Calculated Using Average Least Dimension**	**B=(2.244*H*T*V+S+A)/R**	**0.39**	**gal/sq yd**
B- Non-Wheel Path Rate	**Binder Rate Calculated Using Median Particle Size**	**B=(2.244*H*T*V+S+A)/R**	**0.51**	gal/sq yd
Starting Point for Application In the Field		**Average of Wheel Path and Non-Wheel Path Rates**	**0.45**	**gal/sq yd**

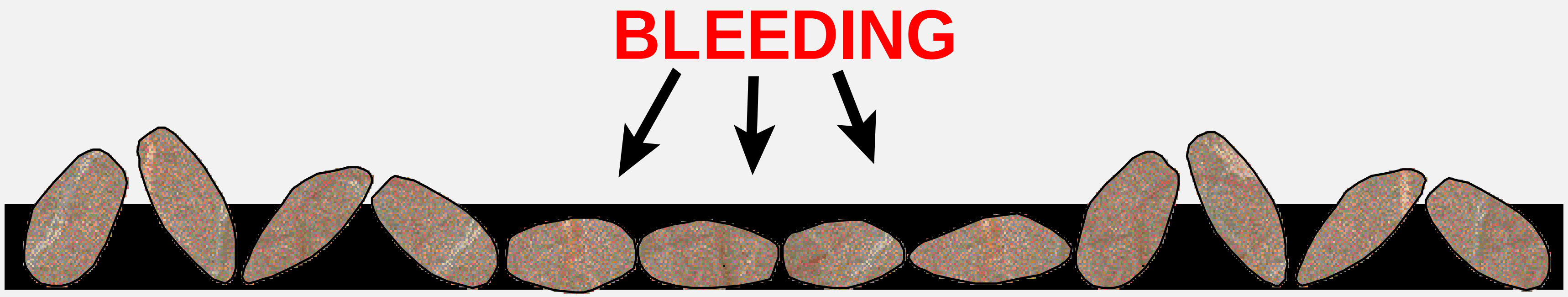

Before Curing:
Average Chip Height
Binder is ~ 100%of chip height
No more than 80% with cutbacks
After Curing:
Average Chip Height
Binder is ~ 70%of chip height



20% less asphalt after curing

Flakiness Index - Flat Chips

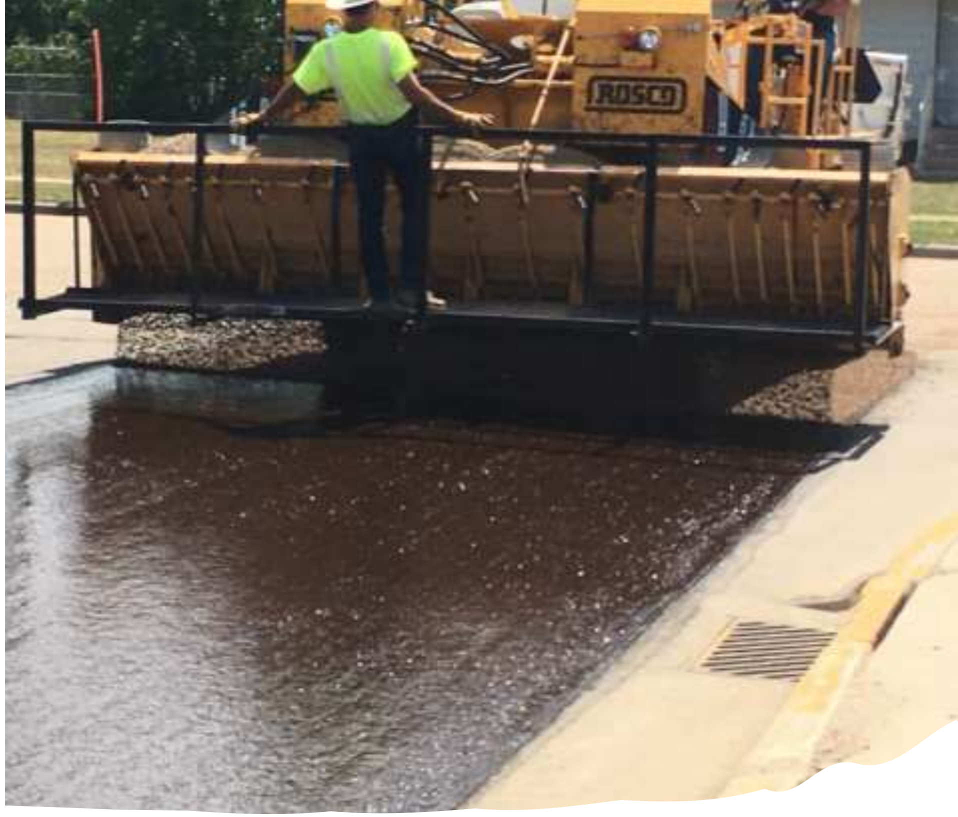
If the seal coat is designed for chips in the non- traffic areas:



There is too much binder in the wheelpaths after the flat chips lay on their flattest side.

Asphalt Surface Treatment – Quartzite Chips With CRS-2P Emulsion

Asphalt Surface Treatment – Natural Aggregate With CRS-2P Emulsion



Asphalt Surface Treatment – Working In A Municipality

City Street Chip Sealing – Note the Dark and Light Color, This is the Appearance You Are Looking For

What Can Make A Seal Coat Fail !!

- Heavy Rain or Overly Wet Surface
- Cool Temperatures
- Dusty and or Dirty Aggregate - Compatability
- Sealing in Late Season
  - Especially Mid September to Freeze up
- Low Shot/Spread Rate
- High Shot/Spread Rate
- Not Enough Rolling

Compatibility

Dirty Natural Aggregate (2.2% #200) with AE 150S Emulsion

Compatibility

Natural Aggregate (1.2% #200) with HFMS-2P Emulsion

Compatibility

Dirty Natural Aggregate (2.2% #200) with HFMS-2P Emulsion

Compatibility

Washed Natural Aggregate with HFMS-2P Emulsion

Bleeding

Severe Chip Loss

Final Tips for Successful Seal Coats

- Make sure pavement is clean
- Place Chip Seals from Mid May thru August for a Successful Project
  - A Pavement needs **160 Hours** of pavement temperatures exceeding **100 degrees** to effectively cure the chip seal
- Use Quality Materials
- Use a Proper Application Rate for the Binder
- Use a Proper Application Rate for the Aggregate
  - Excess Chips only Causes Failure and Leads to Waste

Tips for Successful Seal Coats (cont.)

- Minimum distance between distributor & chip spreader
  - Aggregate must be placed before emulsion starts to break or cutbacks begin to cool and stiffen.
- Minimum of three rollers; Speed under 5 mph
  - Compaction must be completed before emulsion is broken or cutbacks cool and stiffen.
  - Rolling will drop the voids in the seal to @ 30% and achieve the 70% embedment needed for a successful project.
- Final sweeping of roadway as soon as possible.
  - No later then cool of the next morning.

- **Remember that details count and Quality does not COST it PAYS**

800-422-0129

www.facebook.com/SDLTAP/

SDLTAP@sdstate.edu

www.sdstate.edu/jerome-j-lohr-engineering/sd-local-transportation-assistance-program

Location of the Minnesota DOT McLeod Design Procedure - http://www.dot.state.mn.us/materials/researchsealcoat.html

Thanks, you and if you have questions give me a call,

Gill L. Hedman

Technical Assistance Provider

South Dakota Local Transportation Assistance Program

Mobil Phone: 605-280-5525

Gill.Hedman@sdstate.edu