Dial in Your Chip and Shot Rate For a Successful Project

Gill Hedman

Technical Assistance Provider

SDLTAP

Moving Forward

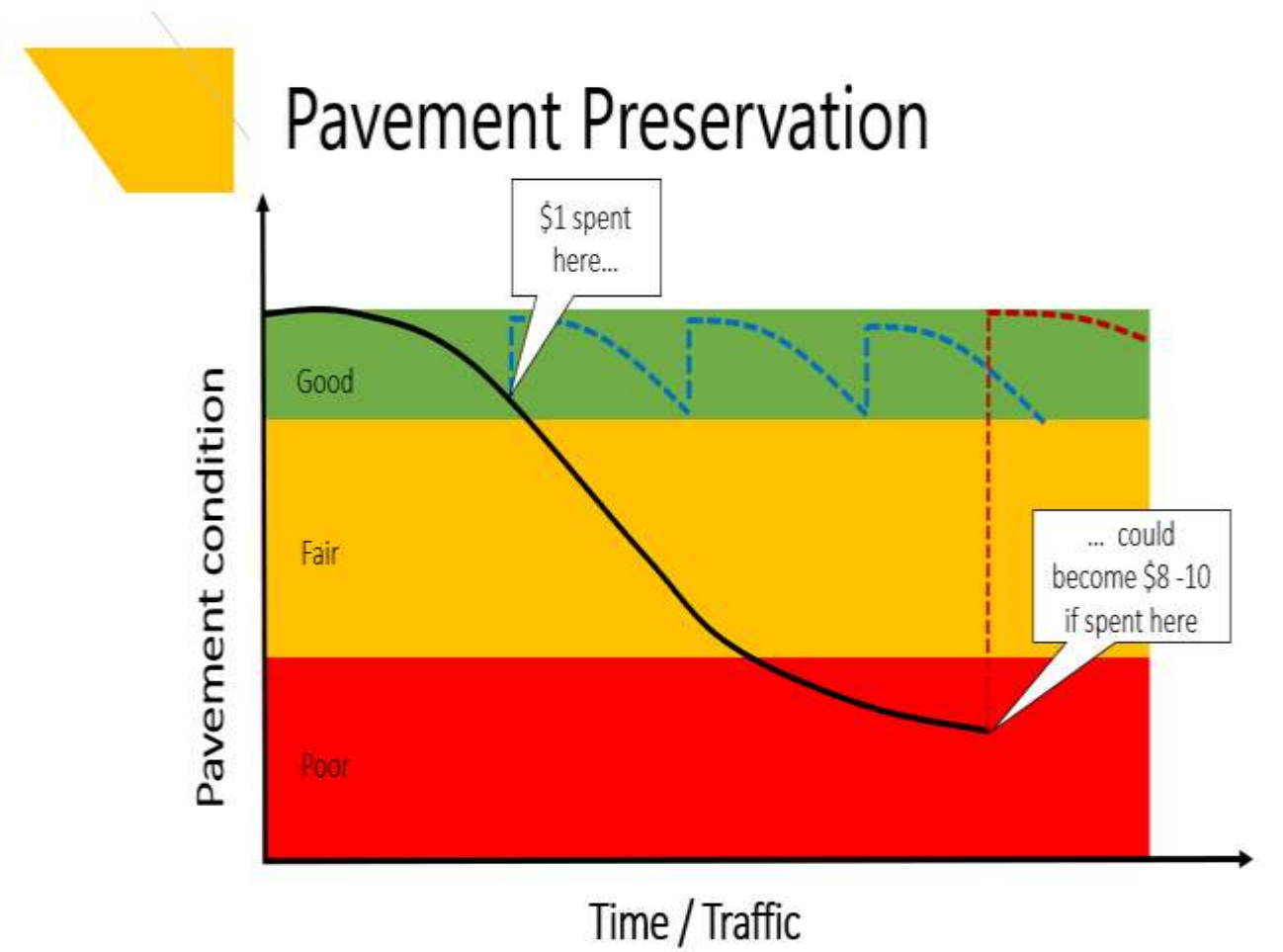
36th Annual North Central Local Roads Conference
Sioux Falls, SD - October 19-21, 2021

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!

Good Candidate For a Seal Coat!



Pavement preservation is a tool used to extend public agency resources 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**
  - For Obtaining Chip Size 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)

- **Whip Off Factor**

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

- **Voids in Loose Aggregate [SD205]**

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

- **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))

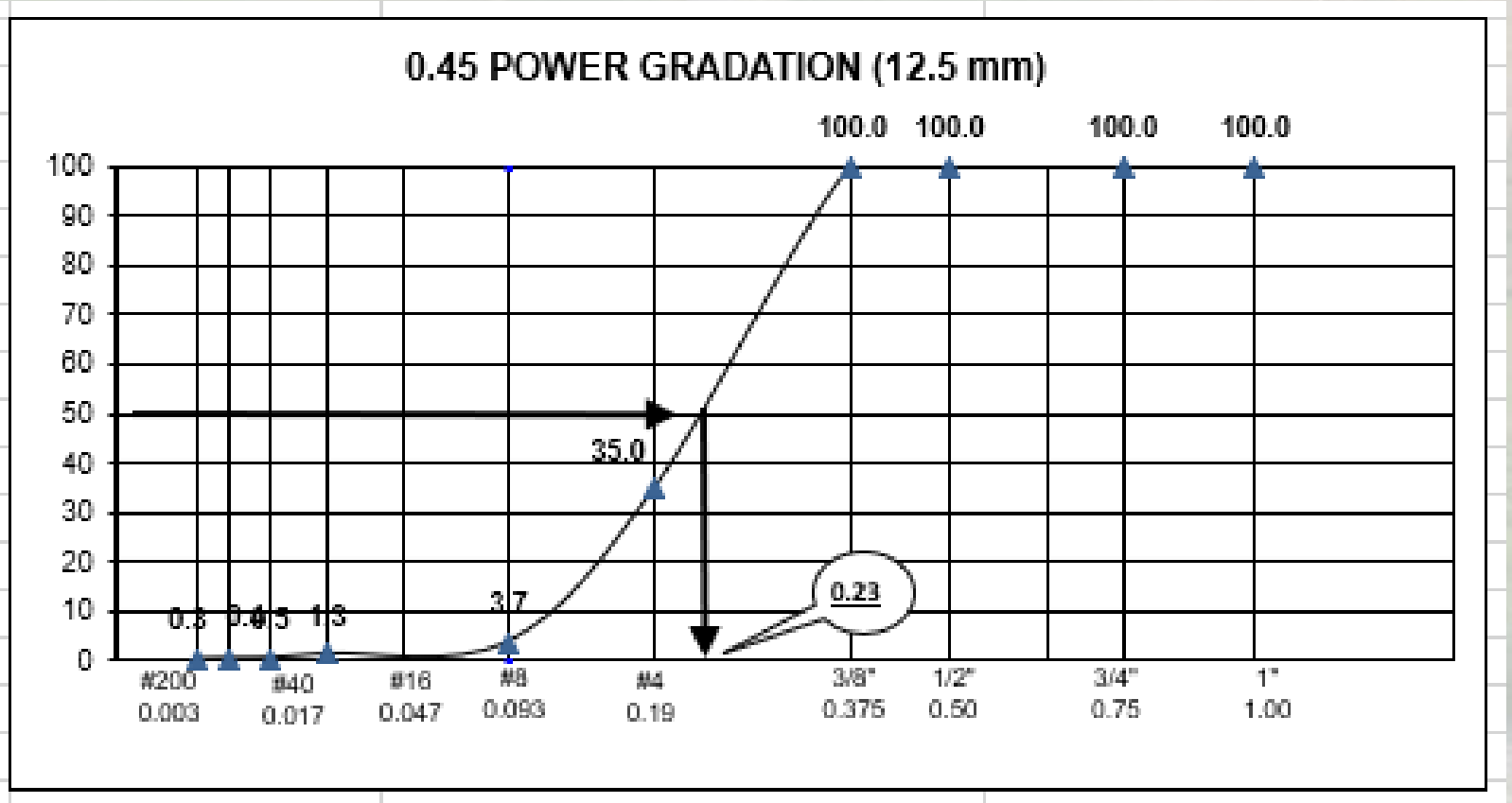
- **Aggregate Application Rate**

  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 for the Starting Rate

Modified McLeod Design Procedure – Gradation Analysis and Median Particle Size



Sieve Size	% Passing
3/8"	100
1/4"	32.9
#4	35
#8	3.7
#30	1.3
#50	0.5
#100	0.4
#200	0.3

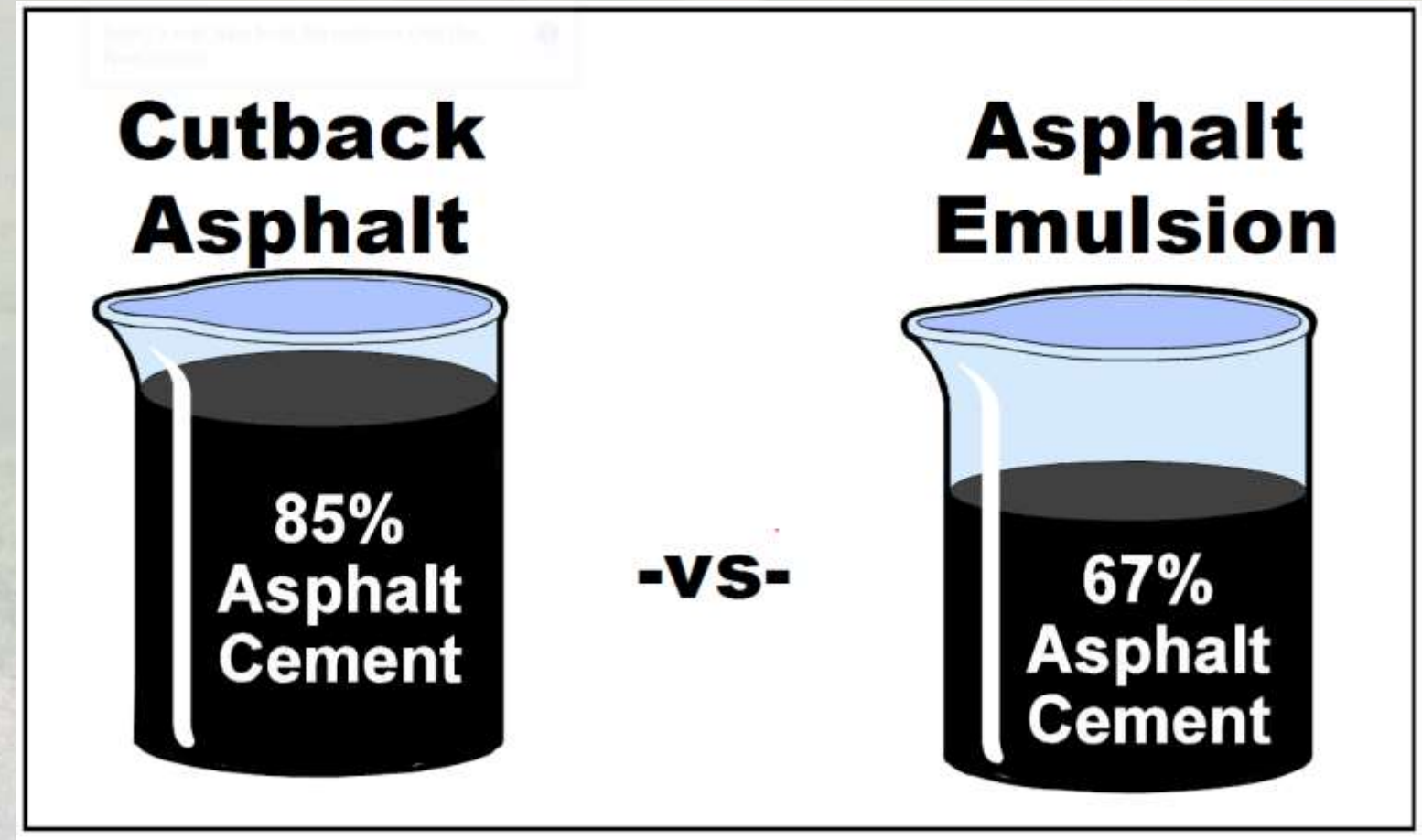
Modified McLeod Design Procedure

Project #:	2021 Pottawattamie Iowa County AST	***Material Type:***	LG Everist 3/8" Stone	
Entity:	Pottawattamie	***Material Source:***	LG Eversit	
PCN:	-	***Quantity:***		
Date:	08/30/2021	***Description:***		
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	0.09	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	2.620	
W	Loose Unit Weight (SD205)	Obtain From Materials Lab Report	81.9	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**	1.08	
R	Residual AC in Emulsion/Cutback	Obtain From Materials Lab Report	0.65	
M	Median Particle Size	Theoretical size thru which 50% of the Material Passes (From Gradation Chart)	0.23	in.
FI	Flakiness Index (SD203)	Measure of the percentage by weight of Flat particles (Calculated from SD203 worksheet)	31.50	

Modified McLeod Design Procedure

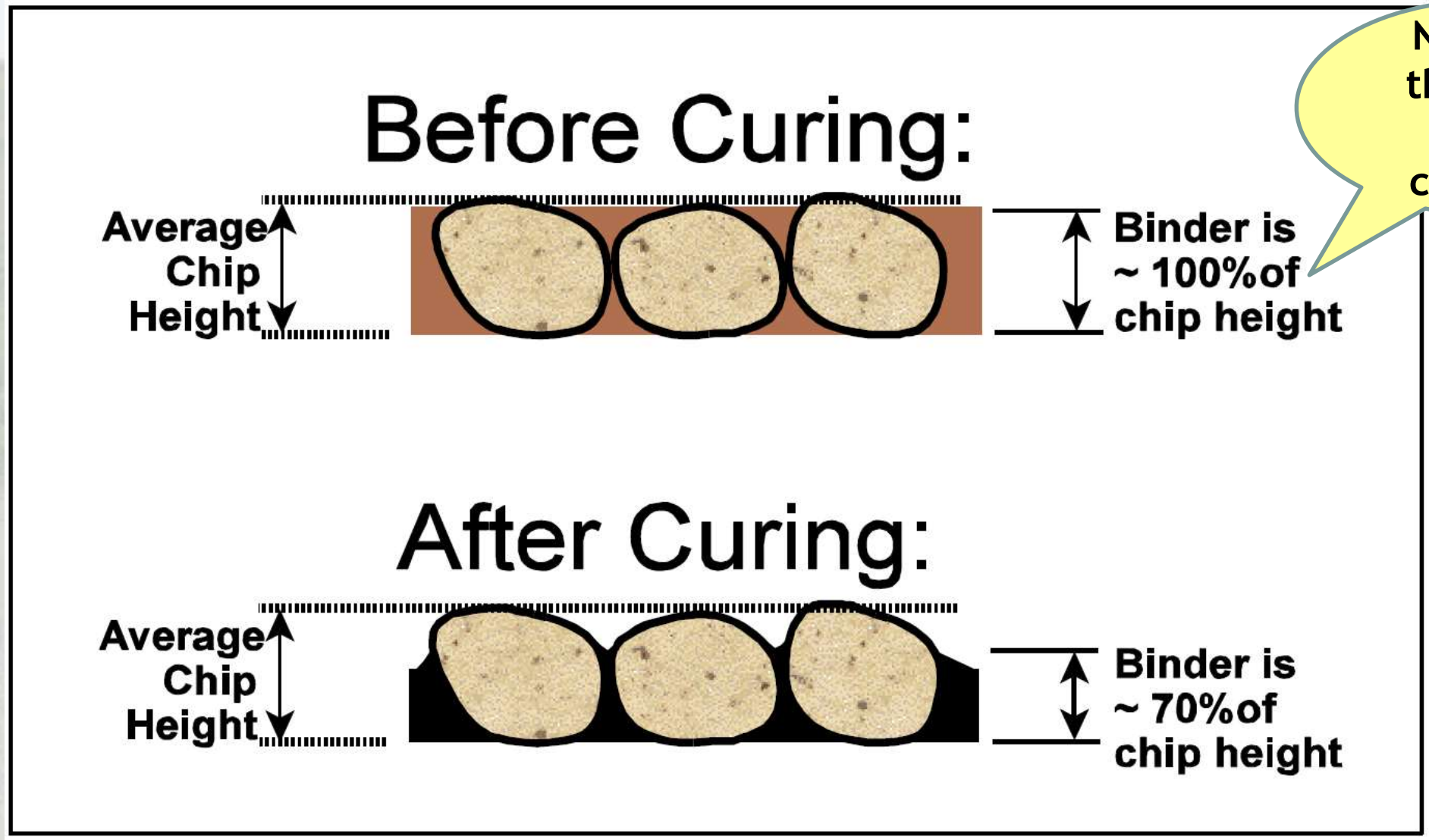
H	Average Least Dimension	Average Least Dimension represents a reduction of the Medial Particle Size after Accounting for the Amount of Flat Particles H=M/(1.139285+(0.011506*FI))	0.18	in.
V	Volume of Voids in Loose Aggregate (SD205)	Voids in the Loose Aggregate represents the Voids after the Aggregate Chips are Placed on the Pavement V=1-(W/(62.4*G))	0.50	
C	**Aggregate Application Rate:**	**C=46.8(1-0.4*V)*H*G*E**	**19.1**	**lb/sq yd**
B- Wheel Path Rate	**Binder Rate Calculated Using Average Least Dimension**	**B=(2.244*H*T*V+S+A)/R**	**0.40**	**gal/sq yd**
B- Non-Wheel Path Rate	**Binder Rate Calculated Using Median Particle Size**	**B=(2.244*H*T*V+S+A)/R**	**0.47**	gal/sq yd
Starting Point for Application In the Field		**Average of Wheel Path and Non-Wheel Path Rates**	**0.43**	**gal/sq yd**

Emulsion and Cutback Comparison



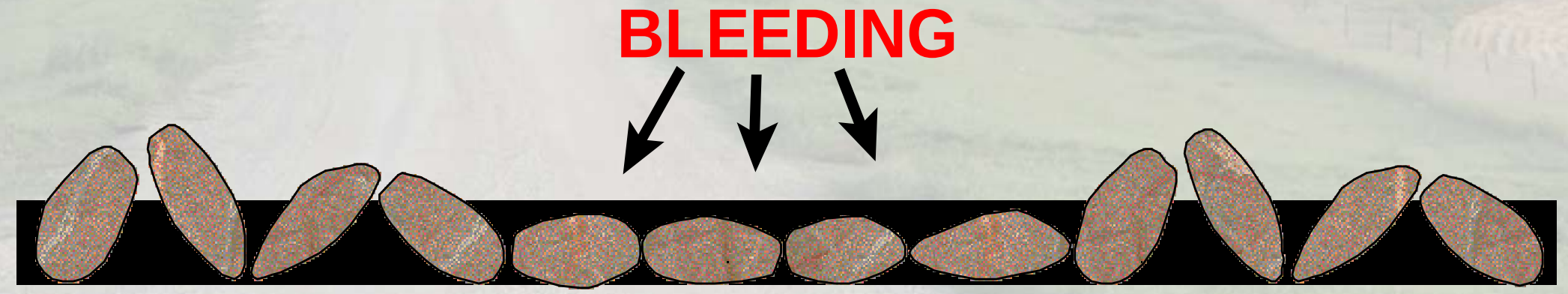
An Emulsion has 20% less asphalt after curing

Proper Emulsion and Chips Embedment



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

SD 322 - Method of Test for Determining Compatibility of Cover Aggregates

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

Washed Natural
Aggregate
with HFMS-2P Emulsion

Severe Chip Loss

Bleeding

What Can Cause A Seal Coat To Fail?

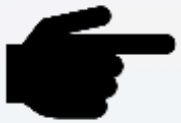
- Heavy Rain or Overly Wet Surface
- Cool Temperatures – Application at 70^0 F and Above
- Dusty and or Dirty Aggregate - Compatibility
- Sealing in Late Season (**Especially Mid September to Freeze up)**

- Low Shot/Spread Rate
- High Shot/Spread Rate
- Not Enough Rolling

Tips for Successful Seal Coats

- Make sure pavement is **Clean** and **Dry**
- Placement
  - Place from Mid May thru August
  - A Pavement needs **160 Hours** of pavement temperatures exceeding **100 degrees** to effectively cure the chip seal
- Use Quality Materials
  - Wash the Chips to remove Dust
  - 1.0% Maximum Minus #200 Material is a Key
- Consider using a Fog Seal
- Use a Proper Application Rate for the Binder and Chips
  - 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

Moving Forward

36th Annual North Central Local Roads Conference

Sioux Falls, SD - October 19-21, 2021