

The Rebirth of Chip Sealing in Minnesota

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The Issues

- In the early 1990's chip seal performance was very unpredictable.
 - Large amount of aggregate loss
 - Bleeding
 - Vehicle damage
 - Cost overruns
 - Average chip seal life was 5 to 7 years

LRRB funded a study of Chip Seals.

Mn/DOT adopted a modified McLeod design

- Determined amount of aggregate needed to cover 1 sq/y one stone deep
- Increased aggregate embedment depth from 50% to 60% - 65%

Seal Coat Design Summary

- Design for FA-3 (3/8") Chip
 - Previous Average (No Design):
 - 30 lbs/yd² Aggregate
 - 0.30 gal/yd² Binder
 - Current Average (With Design):
 - 17 lbs/yd² Aggregate
 - 0.42 gal/yd² Binder

“One state that adopted Mn/DOT’s design method reported a \$1 million savings in aggregate costs the first year”

Mn/DOT's Design Method

http://www.mrr.dot.state.mn.us/research/MnROAD_Project/restools/sealcoatprogram.asp

Print Form for Program Usage Only
Worksheet: Seal Coat Handbook

SEAL COAT DESIGN

Sample	Project	Location	Sampled	Tested	Test ID	App ID
PERCENT	DATE	PROJECT				
Planning 12	<input type="text" value="100"/>			07/20/00	0000100	
Planning 24	<input type="text" value="100"/>			07/20/00	0000100	
Planning 14	<input type="text" value="75"/>	Relaxed 1-24	<input type="text" value="0"/>		Planning 1-24	<input type="text" value="0"/>
Planning No. 4	<input type="text" value="50"/>	Relaxed 24-12	<input type="text" value="0"/>		Planning 24-12	<input type="text" value="0"/>
Planning No. 8	<input type="text" value="75"/>	Relaxed 12-24	<input type="text" value="0"/>		Planning 12-24	<input type="text" value="0"/>
Planning No. 16	<input type="text" value="75"/>	Relaxed 24-14	<input type="text" value="0"/>		Planning 24-14	<input type="text" value="0"/>
Planning No. 32	<input type="text" value="75"/>	Relaxed 14-16	<input type="text" value="0"/>		Planning 14-16	<input type="text" value="0"/>
Planning No. 64	<input type="text" value="50"/>					

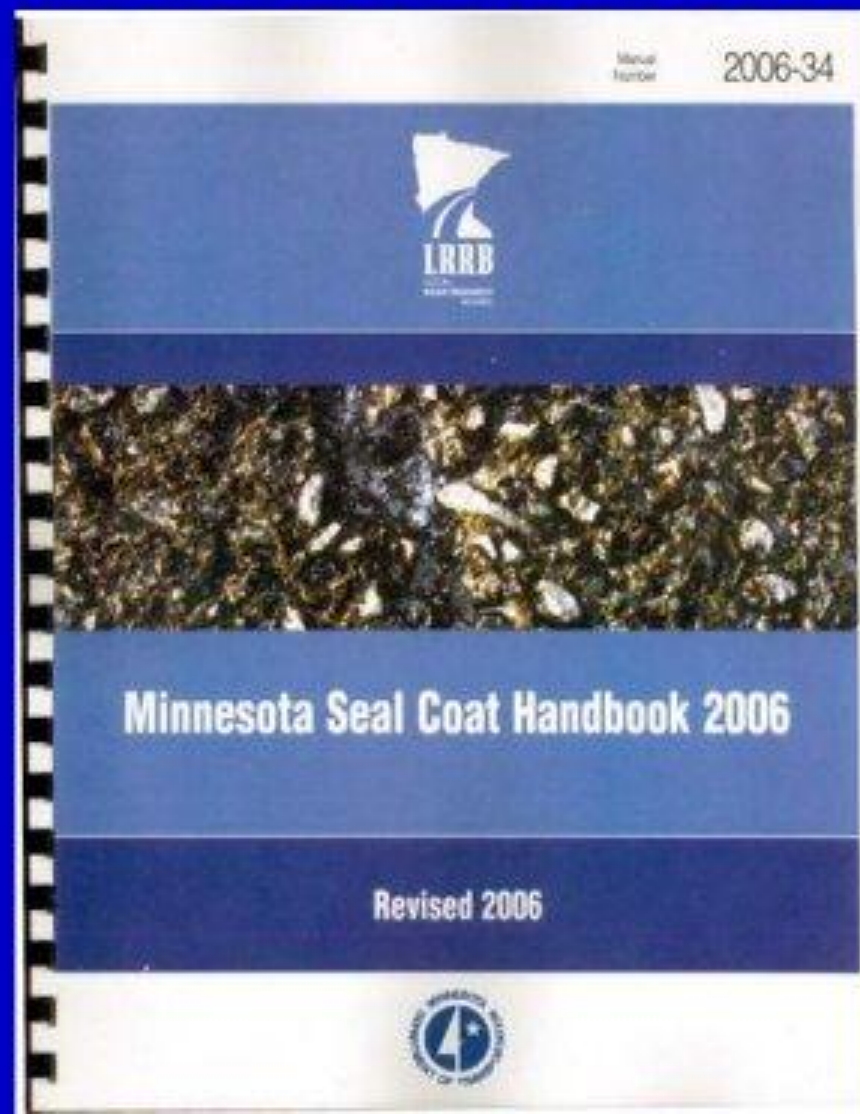
<input type="text" value="0.07"/>	Stone	<input type="text" value="1.00"/>	Residual	<input type="text" value="0.07"/>
<input type="text" value="0.10"/>	Tuffa	<input type="text" value="0.17"/>	Parquet	<input type="text" value="0.10"/>
<input type="text" value="0.10"/>	Surface	<input type="text" value="0.00"/>	COVA	<input type="text" value="0.10"/>
<input type="text" value="0.10"/>	Aggregate	<input type="text" value="0"/>	FLIT	<input type="text" value="0.10"/>
<input type="text" value="0.10"/>	Mineral	<input type="text" value="0"/>	NET FLAT	<input type="text" value="0.10"/>
<input type="text" value="0.10"/>	Application	<input type="text" value="0"/>	GROUP VALUES	
	Condition		Below 0.001	

Traffic	Early Period	Early Period	Early Period	Service Class
Factor				
0.6	1.170	1.190	1.240	Over 2000
0.66	1.200	1.220	1.270	1000 to 2000
0.7	1.230	1.250	1.300	500 to 1000
0.75	1.260	1.280	1.340	100 to 500
0.80	1.290	1.310	1.370	Under 100

APPLICATION RATE

Traffic Volume	Early Period (Gallons/Sq Yd)	Early Period (Gallons/Sq Yd)	Early Period (Gallons/Sq Yd)
Under 100	0.30	0.35	0.40
100 to 500	0.25	0.30	0.35
500 to 1000	0.20	0.25	0.30
1000 to 2000	0.18	0.22	0.26
Over 2000	0.15	0.18	0.22

Originally Published in 1997
Revised in 2006



Current Mn/DOT Special Provisions

- Requires use of CRS-2p emulsion
- Clean aggregate
- Proper methods
 - Minimum time between application of binder and aggregate (< 1 minute)
 - 3 rollers with minimum of 3 passes
- Chips shall be swept day of construction
 - Before traffic control is lifted

Current Mn/DOT Special Provisions

- Contractor responsible for all vehicle damage.
- All chip seals on State routes shall be fog sealed.
 - No earlier than the next morning.
 - Cms-1h diluted 1:1 at place of manufacture is required for fog seal.
 - Shoulders + Rumble Strips too!

Mn/DOT Special Provisions were re-written in 2001

- Old pay items
 - Tons aggregate
 - Gallons of binder
- New pay item
 - Gallons of binder
 - Square yards of chip seal applied
 - Pay for aggregate, application, sweeping, etc.

Outcome

- Many Agencies in MN have started to chip seal or increased their use of chip sealing.
- Average age of roadway to receive first chip seal application is 5 years
- The average size of chip used has increased from 1/4" chip to 100 percent passing 3/8".
- Maximum allowable traffic for placing chip seals increased from 500 - 1000 ADT to as high as 15,000+/- ADT.
- Average life of chip seals has increased from 5 – 7 years to 10 - 15 years.

What the Traveling Public Sees!



2 Years Later



Minnesota State Animal The Gopher



Bob Grotz

Minnesota Highway 25 Modified Emulsion Chip Seal Trial

Presentation to Midwestern Pavement Preservation
Partnership Annual Meeting – October 26-29, 2009

Arlis Kadrmas



Project Description

Why?

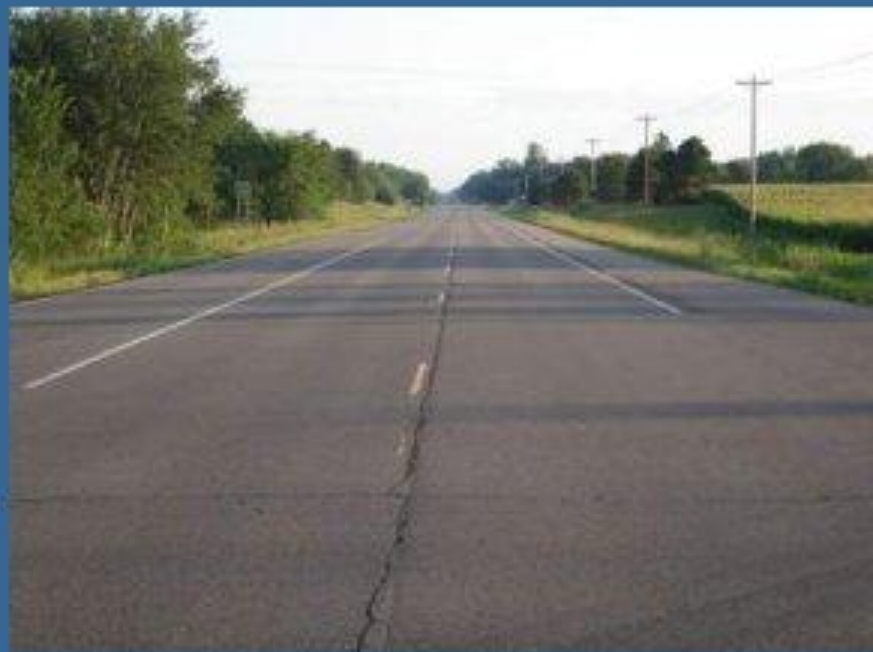
- CRS-2P (CRS made using a modified asphalt base) is the only acceptable modified CRS utilized by MNDOT and has proven performance
- Compare CRS-2L (CRS made by co-milling latex into the emulsified asphalt) with the CRS-2P
- If the performance is acceptable, provide an option to MNDOT for modified seal coat projects



Project Highlights

Location

- One mile section of US25 near Becker, Minnesota was used for the test sections (MP 82 to near MP 83)
- Northbound lane utilized CRS-2L (Latex based CRS emulsion)
- Southbound lane utilized CRS-2P (Polymer modified asphalt based CRS emulsion)



Project Highlights

Materials & Construction

- Martin Marietta Granite Chip (St. Cloud, MN Quarry)
 - **MNDOT FA3 Specification**
- CRS-2L (Latex based CRS emulsion) – HG Meigs
- CRS-2P (Polymer modified asphalt based CRS emulsion)
– Jebro, Inc.
- Emulsion Shot Rate 0.35 gal/yd² for both emulsions
- Pavement Temperature 82°F – 101°F during construction

Pictures During Application



Emulsion Application

Aggregate (Chip) Application



Traditional Residue Testing

Elastic Recovery and Penetration

ASTM D6934 - Residue by Oven Evaporation

				CRS-2L	CRS-2P
Sample #				3278	3279
ER 10C SS 20cm 5mn, %	103	T 301	58 min	78.8	78.8
ER 10C SS 20cm 5mn, %	103	T 301	58 min	73.8	77.5
ER 10C SS 20cm 5mn, %	103	T 301	58 min	72.5	78.8
AVG.				73.1	78.1
Pen 25°C, dmm	106	T49	60 - 150	93	101



Rheological Testing – Traditional DSR

Low Temperature Evaporation Procedure

ASTM D7497 – Low Temperature Evaporation Procedure

			3280 ltr	3281 ltr
Tests on unaged material:	°C	Spec Limit	AUT-W301	
Phase Angle (delta)	52		72.0	65.4
G*/sin delta @ 10 rad/sec,kPa	52	1.0 min.	11.47	9.10
Phase Angle (delta)	58		74.1	67.4
G*/sin delta @ 10 rad/sec,kPa	58	1.0 min.	5.65	4.62
Phase Angle (delta)	64		75.6	70.1
G*/sin delta @ 10 rad/sec,kPa	64	1.0 min.	2.95	2.48
Phase Angle (delta)	70		76.1	73.0
G*/sin delta @ 10 rad/sec,kPa	70	1.0 min.	1.60	1.40
Phase Angle (delta)	76		75.8	75.5
G*/sin delta @ 10 rad/sec,kPa	76	1.0 min.	0.91	0.82
Pass / Fail Temperature			75.0	73.8

Rheological Testing – MSCR

ASTM D7497 Residue Recovery Method

CRS-2L (Latex Modified Specimen)

Temperature (58°C)	100 Pa	3200 Pa
Total Average Creep Strain	0.15548	5.7443
Total Average Non Recoverable Strain	0.08155	4.5275
Percent Recovery	48%	21%
Difference in Percent Recovery		55%
Non Recoverable Compliance (Jnr) (kPa ⁻¹)	0.816	1.415
Percent Difference in Jnr		42%

Rheological Testing – MSCR

ASTM D7497 Residue Recovery Method



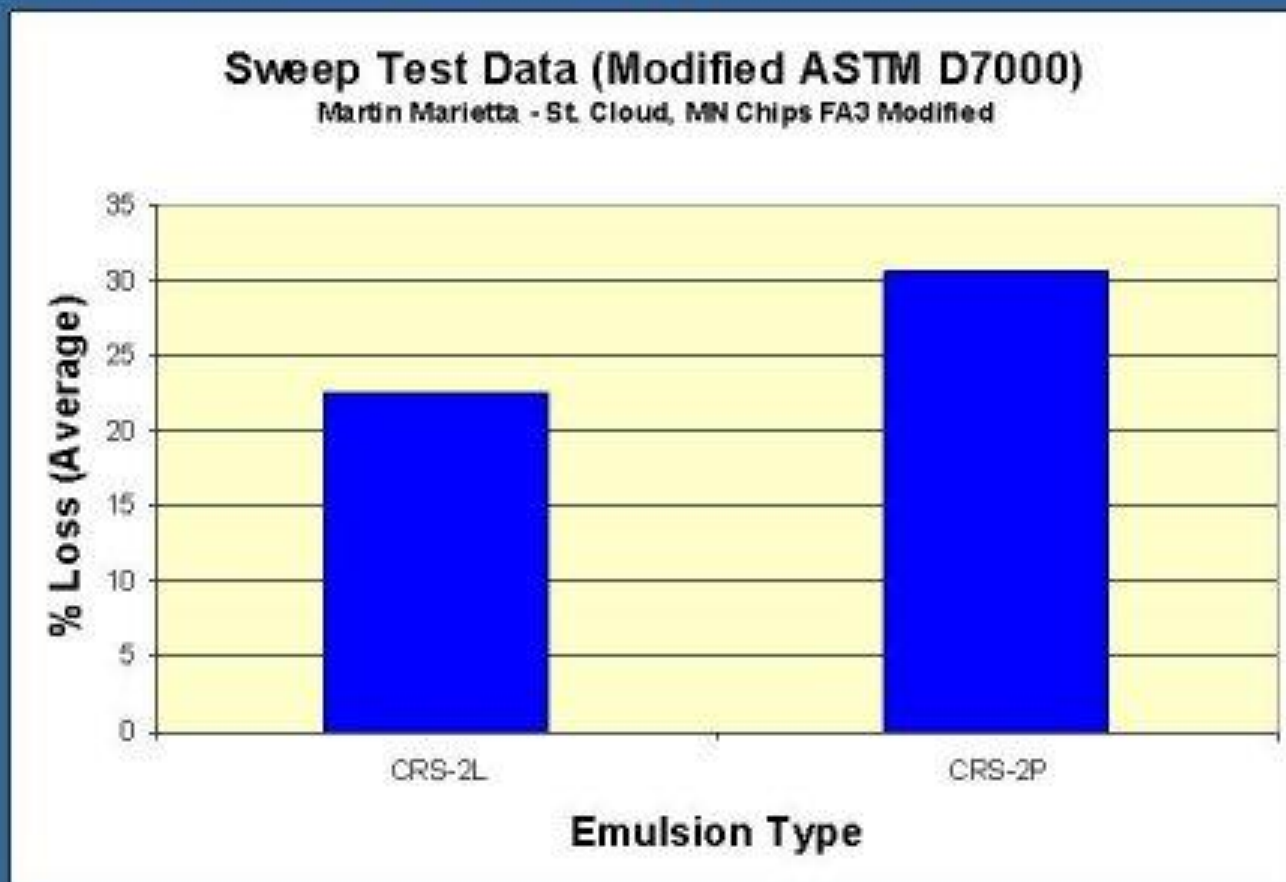
CRS-2P (Polymer Modified Asphalt Specimen)

Temperature (58°C)	100 Pa	3200 Pa
Total Average Creep Strain	0.15187	5.6865
Total Average Non Recoverable Strain	0.078235	4.4454
Percent Recovery	48%	22%
Difference in Percent Recovery		55%
Non Recoverable Compliance (Jnr) (kPa ⁻¹)	0.782	1.389
Percent Difference in Jnr		44%

Sweep Test Data

ASTM D7000 - Modified

Modified – Specimen cured for 2 hours at 35°C and emulsion stored at 60°C prior to application



Pictures After Chip Application and During Fog Seal Application



Final Seal Coat Application

Fog Seal Application



- Application
- Rolling
- Release to traffic
- Chip retention after winter
- Snow Plow Damage
- Flushing/Bleeding Evaluation

Questions?

