



# MnDOT'S EXPERIENCE: Efforts to Improve Micro Surfacing Performance

## MNDOT SPECIFICATIONS SUMMARY

MnDOT has a long history and success with using micro surface. Throughout our use, MnDOT has looked into improving the process and performance. The table below is a summary of the Specifications MnDOT uses to show changes that have and will be made:

	Prior to 2016 (Traditional)	2016 Specifications		2018 Specifications	Available by Special Provision
		Traditional	Softer	Softer	Very Soft
<b>Emulsion Name</b>	CQS-1hP	CQS-1hP	CQS-1P	CQS-1P	CQS-1SP
<b>PG Grade</b>	64-22	64-22	58-28	58-28	49-34
<b>Softening Pont (spec)</b>	135° F	135° F	128° F	128° F	128° F*
<b>Penetration</b>	40-90 dmm	40-90 dmm	90-200 dmm	90-200 dmm	180-300 dmm*
<b>Min Mix Design % Residual Asphalt</b>	5.5 - 10.5%			7.0 - 10.5%	
<b>Fog Prior to Micro</b>	0.05 - 0.10 gal /sq. yd of CSS-1h diluted				
<b>Construction Application Rates</b>	13 - 16% emulsion				
<b>Pay Items</b>	2354.03 Bituminous Material 2354.504 Rut Fill 2354.504 Scratch Course 2354.504 Surface Course				
<b>Polymer Type</b>	natural latex, manmade latex, and SBS				
<b>% polymer</b>	min 3%				

\* Specification are currently being developed. If planning on using CQS-1SP before 2018, contact the office of Material and Road Research.

This report summarizes experiences MnDOT has had using of softer base asphalts in the emulsions constructing micro surfacing.

## INTRODUCTION / HISTORY OF MICRO SURFACING

Micro surfacing is an advanced form of slurry seal. It was developed by Germany in the late 1960's to fill in wheel ruts in hot mixed asphalt (HMA) on the autobahn. It is the same basic ingredients as traditional slurry; except it combines these ingredients with advanced polymer additives.

There are four main factors that allow micro surfacing to be used in ruts successfully. These factors are:

- Micro surfacing cures from the bottom up by using emulsifiers that chemically break, which forces the water up and out of the mixture.
- The aggregate gradation is a dense gradation that is 100% crushed. This yields a very stiff mixture
- The use of a hard penetration (pen) asphalt binder to make the asphalt emulsion. The current International Slurry Surfacing (ISSA) specification for micro surfacing requires 40 to 90 pen asphalt (PG 64-22).
- The asphalt to fines ratio is low when compared to HMA with average asphalt to fines ratio of 0.7 to 1. The combination of very high quality crushed aggregate, hard base asphalt, and lean asphalt content have made micro surfacing one of the most successful methods to fill rutted HMA roadways



The reason micro surfacing is successful at filling ruts tends to be the reasons micro surfacing is quick to have the reflective cracks come through. This has led to some believing micro surfacing is not an effective preservation treatment. Thus MnDOT began efforts to improve the performance of micro surfacing starting in 2005.

### 2005 MNROAD - FLEXIBLE MICRO SURFACING RESEARCH

In September of 2005 four (4) cells at MnROAD low volume road were selected to test a flexible micro surfacing. The base asphalt for the emulsion selected was a PG48-34 and had a penetration of 163. At this time, normal micro surface designs contained approximately 13.5% emulsion. At MnROAD asphalt emulsions were increased to 16.5% for the surface course. Evaluations of these cells included cracking, rutting, and smoothness and were performed before construction, after construction, and then repeated 6 months later (after 1 winter).



MnROAD Cell 24 - 8 Months After Placement

After one winter, 71% of all transverse cracks reflected through. However, only 5% of the longitudinal cracks reflected through. The increase emulsion and the softer base asphalt proved to be rut resistant. For more information on this project see the report, "Flexible Slurry-Microsurfacing System for Overlay Preparation," found here: <http://dotapp7.dot.state.mn.us/research/pdf/2007MRRDOC017.pdf>.

Based on the initial successes of the 2005 project, MnDOT continued to investigate what could be done to improve micro surfacing performance.

### 2012 MNROAD AND TH23 IN DISTRICT 3 - KRATON POLYMER

In 2012 MnDOT partnered with Kraton Polymer Company to test using a higher polymer loading in micro surfacing. Normal micro surfacing uses 3% polymer typically made with latex. The asphalt emulsion was manufactured with a PG 49-34 (230 pen) asphalt and 6.5% poly styrene-butadiene-styrene (SBS) polymer. Cell one at MnROAD was micro surfaced using this and had an emulsion content of 16% in place of typical mix designs with 13%. Performance of this cell is listed to the right.

Year	Event	Driving Lane IRI (in/mi)	% improvement	Passing Lane IRI (in/mi)	% Improvement
1994	New construction	50		50	
2006 before	Mill and fill (1.5")*	205	61%	140	0%
2006 after	Mill and fill (1.5")*	80		140	
2012 before	Micro Surfacing	137	33%	175	48%
2012 after	Micro Surfacing	92		92	
March 2016	4 yrs after Micro Surface	120	12%	127	27%

\*Mill and Fill in 2006 was performed in the driving lane only and used a PG52-34 Binder



Cell 1 Before Micro Surfacing 2012



Cell 1 After Micro Surfacing and 1st Winter 2013

District 3 placed a one-mile section on the westbound TH 23 (between MP 227 – 228) using the same highly polymer modified emulsion used in cell 1 at MnROAD. The emulsion application rate for this section was 13% with the same 6.5% SBS polymer loading. District 3 personnel observations are as follows:

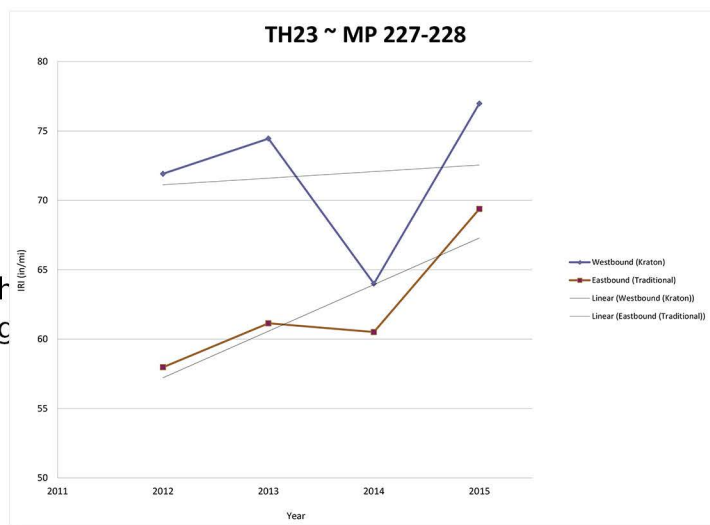


TH 23 Highly Modified Emulsion Right Lane  
Picture taken 2015. 3 years after placement

- The test section is darker than the traditional micro surfacing.
- The fog line stripes appear to be more durable. There is less damage from snow plows in the westbound lanes.
- TH 23 was a bituminous overlay over jointed concrete. The reflective cracks at the joints of concrete in the westbound lanes are tighter with less deterioration than eastbound lane. The eastbound lane received traditional micro surfacing.

To the left is a chart showing the performance of each lane in the test section since its placement in 2011. The softer base micro was placed initially rougher than the traditional. This was most likely due to the starts and stops of the traditional and changing the mix for the mile test section. The eastbound lane was placed continuously without stops and starts. Looking at the trend lines for each lane, it is apparent the westbound lane is not losing ride value as quickly as the eastbound lane.

Due to the success with both MnROAD and TH23, District 3 constructed two (2) projects requiring the use of 120 to 150 pen (PG 58-28) base asphalt emulsion in 2013.



TH23 Eastbound Traditional Micro vs. Westbound Kraton Polymers and Softer Asphalt Binder

## 2014 TH64 - MOTLEY MINNESOTA

After initial successes District 3 had with softer base asphalt micro surfacing, the District decided to use PG49-34 asphalt with 4.5% SBS polymer modified emulsion on TH64 near Motley MN. Asphalt emulsion content was increased to 14.5% from the 13% traditionally used. This project was also micro milled prior to placement of the modified micro surfacing to help further improve the ride of the road.

Below are pictures of before and after one (1) year performance as related to cracking of TH64 and a section of TH23 completed the same week. TH23 received a traditional micro surfacing emulsion with PG 64-22 base binder. TH23 traditional micro surfacing had all the cracks reflected through. The District performed a clean and seal crack treatment to prevent water infiltration. On TH64 the number of reflective cracks were greatly reduced. The cracks that did reflect through appear very fine and seem to heal themselves (knead back together) during hot weather.



TH64 Before Condition



TH64 Condition After 1 Year



TH23 Before Traditional Micro Surfacing



TH23 One Year After Traditional Micro Surfacing



## 2016 STANDARD SPECIFICATION BOOK REVISIONS

The 2016 Standard Specification Book contains two (2) options for micro surfacing emulsions based on the above projects successes. The first is the standard harder based asphalt emulsion (PG64-22). This is designated as CQS-1hP. The second option is a softer base asphalt emulsion made with PG58-28. This is designated CQS-1P. Based on the observed performances noted above, it is recommend to use CQS-1P on any upcoming projects. The 2018 Standard Specification Book will include a new specification for the asphalt emulsion made with PG49-34 as an additional option.

## CONCLUSION

Reflective cracks are hard to mitigate with micro surfacing. The outcome of the above showed some success with slowing the appearances of reflective cracks. It also showed reduced damage to the surface and the paint stripes due to snow plows. Further investigation will be ongoing. For more information please contact either:

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