Pavement Rehabilitation

CIR/CCPR/FDR/SFDR

Presented by:

Sam Sveine, Mankato Manager
American Engineering Testing

Which Method should we use?

Historic Data

Coring

Borings/Geoprobe

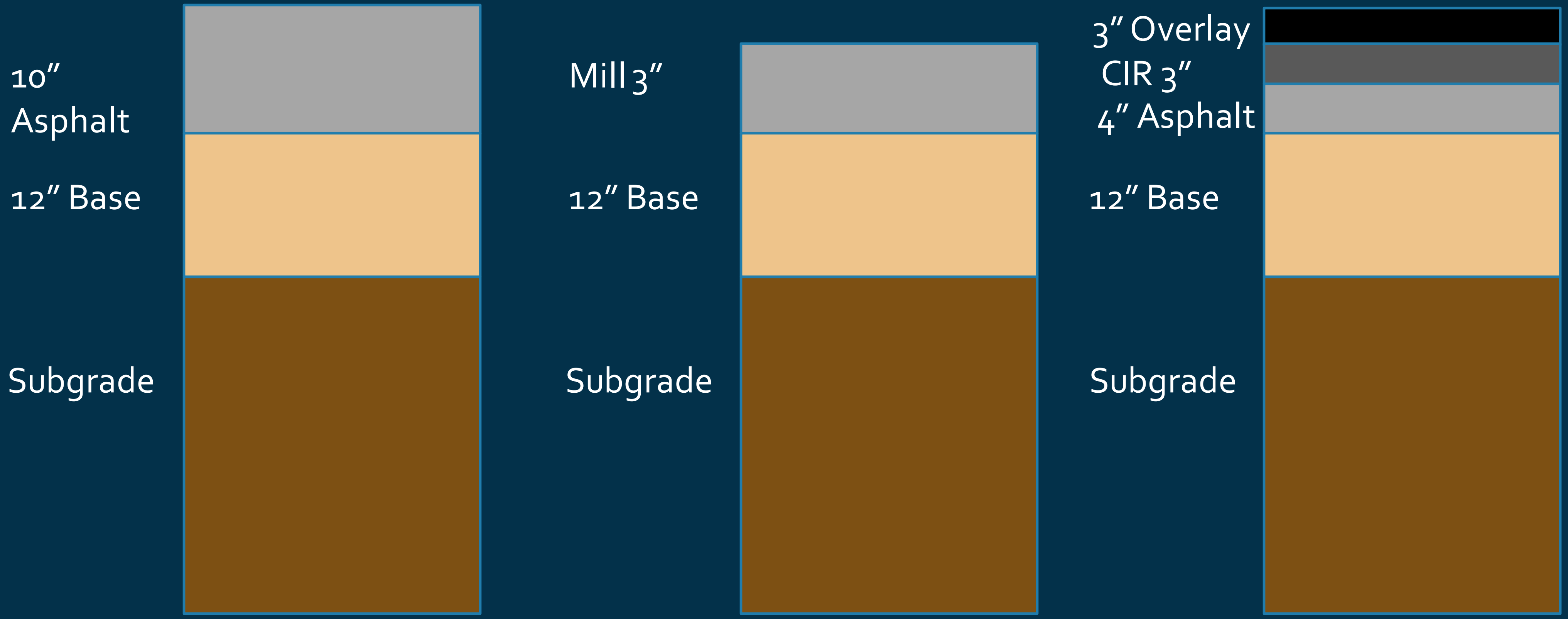
GPR

FWD

Cold-in-place Recycling

CIR can be used in a variety of situations, but most often used when defects in the roadway to not run the full depth of pavement.

CIR Should not be used when roadways have deficiencies in the base, HMA properties, or drainage issues, as problems will persist even after correcting


10"
Asphalt
12" Base
Subgrade
Mill 3"
12" Base
Subgrade
3" Overlay
CIR 3"
4" Asphalt
12" Base
Subgrade


CIR train setup

Quality Control Testing and Inspection

Rolling Pattern

Gradation- Complete and Simple

Depth Check

Stabilizing Agent Yield-Bituminous and/or Cement

Compaction Testing-Nuclear Densities

Moisture

Daily Report

Daily Report/Rolling Pattern

AMERICAN ENGINEERING TESTING, INC.

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Daily Site Visit Report

Client: [redacted]
Project: [redacted]

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Date of Issue: 10/11/2019
Reviewed By: Steven Ruesink, PE

Site Details

Technician: Sam Sveine
Weather/Temp: Sunny 50-65 degrees
Contractor: [redacted]
Contact: [redacted]
Phone#: [redacted]
Date: 10/7/2019

Rolling Patterns

Compaction Equipment				SD	SD	SD	SD	SD	RT	RT	RT
	Station	Offset		Pass 1	Pass 2	Pass 3	Pass 4	Pass 5	Pass 6	Pass 7	Pass 8
1.	13+00	6'R	1st:	105.3	106.7	109.1	111.7	115.1	115.9	117.0	118.8
Observed by Contractor?			180°:	105.0	106.6	109.6	112.6	115.4	115.4	116.3	119
	Yes		Average:	**105.2**	**106.7**	**109.4**	**112.2**	**115.3**	**115.7**	**116.7**	**118.9**

Compaction Equipment			SD or RT	RT
	Station	Offset		Pass 9
2.			1st:	118.0
Observed by Contractor?			180°:	118.2
	Yes/No		Average:	**118.1**

Compaction Equipment			RT								
	Station	Offset		Pass 1	Pass 2	Pass 3	Pass 4	Pass 5	Pass 6	Pass 7	Pass 8
3.			1st:								
Observed by Contractor?			180°:								
	Yes/No		Average:								

Compaction Equipment			SD or RT?
	Station	Offset	
4.			1st:
Observed by Contractor?			180°:
	Yes/No		Average:

Observations

Paving started today @ Station 15+00 on the eastbound lane moving west on CSAH 39. The train turned around at Station 9+50 and began heading east on the westbound lane. CIR not performed for Station 44+70 to 57+15 on westbound lane. A rolling pattern was performed at Station 13+00 and it was determined that 5 SD passes and 3 RT passes were needed to achieve a maximum wet density of 118.9 pcf. A full gradation was performed at Station 13+00 , and 2 simple gradations were performed at Station 33+00, and 86+00. Nine depth checks were performed (right and left), all at 4". Two yield checks were performed on 2 loads of oil. Seventeen density tests were performed, all meeting or exceeding 98%. Four moistures were taken, 2 before compaction (BC) and 2 from previous 2 day's paving after compaction (AC). 44.11 tons of oil was used today. Paving ended today on the westbound lane at station 92+40.

Gradations

G&B-101(8/09/17)

Work Sheet for Sieve Analysis of Granular Material (English Sieves)
See Grading & Base Manual, 5-692.215
Weigh Coarse in grams, kg, or pounds and Fines in Grams

Project No:	Date:	Test No:
[redacted]	10/7/2019	Full Gradation #6
Material Type:	Station:	Depth From Grading Grade:
CIR	13+00	NA
Total Wt. of Sample:	Units	Tester Name or Certification No:
3150.7	gram	Sam Sveine

Coarse Sieves:

	(1) Indiv. Weights	(2) Sieve Size	(3) Cumulative Wts. Passing	(4) Total % Passing	Gradation Requirements
*Pass Sieve, Ret. 1.5" Sieve	0.00		3118.10	100.0%	
*Pass 1.5" Sieve, Ret. 1.25" Sieve	0.00	1.5"	3118.10	100.0%	100
*Pass 1.25" Sieve, Ret. 1" Sieve	0.00	1.25"	3118.10	100.0%	100
*Pass 1" Sieve, Ret. 3/4" Sieve	206.80	1"	3118.10	100.0%	100
*Pass 3/4" Sieve, Ret. 3/8" Sieve	972.00	3/4"	2911.30	93.4%	85-96
*Pass 3/8" Sieve, Ret. #4 Sieve	663.00	3/8"	1939.30	62.2%	
*Pass #4 Sieve, Ret. Bottom	1276.30	#4	1276.30	40.9%	40-55
Check Total -	3118.10	- Shall Check Total Wt. Within 100 grams, 0.10 kg, 0.2 lbs			

*Enter necessary sieve sizes for class of material to be tested.
Column (1) Enter weights of material between each set of sieves individually.
Column (2) Enter the passing sieves size.
Column (3) Add column (1) from the bottom up to get cumulative weights passing each sieve.
Column (4) Divide column (3) by check total of sample to get total % passing.

Fine Sieves:

(A) Take two samples identical in condition and damp weight from "passing #4 material".
(B) Dry one sample and record weight. 596.7
(C) Wash and dry other sample and record weight. 596.7
(D) Loss in washing (B-C) (Enter Below) 0.0

	(5) Indiv. Weights	(6) Sieve Size	(7) Cumulative Wts. Passing	(8) Cum. % Passing	(9) % Passing of Total Pass.	Gradation Requirements
*Pass Sieve, Ret. Sieve						
*Pass Sieve, Ret. Sieve						
*Pass Sieve, Ret. Sieve						
*Pass Sieve, Ret. Sieve						
*Pass Sieve, Ret. #4 Sieve						
*Pass #4 Sieve, Ret. #10 Sieve	222.7	#4	595.1	100.0%	40.9%	40-55
*Pass #10 Sieve, Ret. #30 Sieve	257.9	#10	372.4	62.6%	25.6%	
*Pass #30 Sieve, Ret. Bottom	114.5	#30	114.5	19.2%	7.88%	4-14
Loss by washing-	0.0					
Check Total -	595.1	- Shall Check total Wt. Within 5.0 grams				
Percent Passing #200 Sieve Divided by Percent Passing 1 in. Sieve (if specified)						

Column (5) Enter weights of material between each set of sieves and loss by washing (DO NOT OVERLOAD SIEVES)
Column (6) Enter the passing sieve size.
Column (7) Add column (5) from bottom up to get cumulative weights passing each sieve. Be sure to add loss by washing to weight of material passing of material passing #200 sieve to get first entry at bottom of column (7).
Column (8) Divide column (7) by check total dry weight of fine sample (Column 5) to get cumulative % passing.
Column (9) Multiply column (8) by % passing final sieve from column (4) to get "Percent Passing" based on total sample.

CC: Project File

G&B-101(8/09/17)

Work Sheet for Sieve Analysis of Granular Material (English Sieves)
See Grading & Base Manual, 5-692.215
Weigh Coarse in grams, kg, or pounds and Fines in Grams

Project No:	Date:	Test No:
[redacted]	10/7/2019	Simple Gradation #8
Material Type:	Station:	Depth From Grading Grade:
CIR	33+00	NA
Total Wt. of Sample:	Units	Tester Name or Certification No:
3001.1	gram	Sam Sveine

Coarse Sieves:

	(1) Indiv. Weights	(2) Sieve Size	(3) Cumulative Wts. Passing	(4) Total % Passing	Gradation Requirements
*Pass Sieve, Ret. Sieve					
*Pass Sieve, Ret. Sieve					
*Pass Sieve, Ret. Sieve					
*Pass Sieve, Ret. Sieve					
*Pass Sieve, Ret. 1.5" Sieve	0.00		3001.10	100.0%	
*Pass 1.5" Sieve, Ret. 1.25" Sieve	0.00	1.5"	3001.10	100.0%	100
*Pass 1.25" Sieve, Ret. Bottom	3001.10	1.25"	3001.10	100.0%	100
Check Total -	3001.10	- Shall Check Total Wt. Within 100 grams, 0.10 kg, 0.2 lbs			

*Enter necessary sieve sizes for class of material to be tested.
Column (1) Enter weights of material between each set of sieves individually.
Column (2) Enter the passing sieves size.
Column (3) Add column (1) from the bottom up to get cumulative weights passing each sieve.
Column (4) Divide column (3) by check total of sample to get total % passing.

AET

G&B-401
7/24/2018

DEPTH REPORT - FDR, CIR, SFDR

Project No: [redacted]	T.H.: [redacted]	Inspector/Tester: Sam Sveine
Project Engineer:	Contractor: [redacted]	

Date	Station	Left Bit Thickness	Left Aggregate Thickness	Left Total Thickness	Right Bit Thickness	Right Aggregate Thickness	Right Total Thickness
10/7/2019	14+00 EB	--	--	4	--	--	4.0
10/7/2019	10+00	--	--	4	--	--	4
10/7/2019	20+00	--	--	4	--	--	4
10/7/2019	30+00	--	--	4	--	--	4
10/7/2019	40+00	--	--	4	--	--	4
10/7/2019	59+00	--	--	4	--	--	4
10/7/2019	69+00	--	--	4	--	--	4
10/7/2019	79+00	--	--	4	--	--	4
10/7/2019	89+00	--	--	4	--	--	4
		--	--		--	--	

G&B-403
6/30/2016

Yield Report Bitumen SFDR & CIR

Project No: [redacted]	Inspector/Tester: Sam Sveine		TH: [redacted]
Project Engineer:	Contractor: [redacted]	Date: 10/7/2019	

Load No.	Length (ft)	Width (ft)	Sq yds	Gallons of Oil Used	Application Rate (gal per sq yd)	Mix Design Application Rate (gal per sq yd))	Depth check (in)	Mix Design depth (in)
1	2750	12	3,667	4,250	1.16	0.84	4	4.00
2	3056	12	4,075	4,500	1.10	0.84	4	4.00

AET

G&B-405
1/17/2017

CIR, CCPR, or SFDR Compaction Report

Fill in Shaded areas

Project No:	T.H.:	Project Inspector:
[redacted]	[redacted]	Sam Sveine
Project Engineer:	**Contractor:**	**Date:**
	[redacted]	10/7/2019

Max Density from Mix Design (PCF)	120.6	Specified Density Percentage	98%	Proctor Optimum Moisture from Mix Design (%)		

Tester Name	Date	Station	Compaction Target from Control Strip (PCF)	Proctor Optimum Moisture (%)	Test Wet Density, (PCF) From Nuclear	Moisture Content, %	Relative Compact	Specified Compaction %	Pass/Fail
Sam Sveine	10/7/2019	11+00 6'R	118.9		118.9	10	100%	98%	Pass
Sam Sveine	10/7/2019	10+00 5'L	118.9		119	9.8	100%	98%	Pass
Sam Sveine	10/7/2019	15+00 6'L	118.9		120.5	9.9	101%	98%	Pass
Sam Sveine	10/7/2019	20+00 7'L	118.9		117.7	10	99%	98%	Pass
Sam Sveine	10/7/2019	25+00 8'L	118.9		118.1	10.3	99%	98%	Pass
Sam Sveine	10/7/2019	30+00 6'L	118.9		118.4	10.2	100%	98%	Pass
Sam Sveine	10/7/2019	35+00 4'L	118.9		119.3	9.8	100%	98%	Pass
Sam Sveine	10/7/2019	40+00 6'L	118.9		119	10.4	100%	98%	Pass
Sam Sveine	10/7/2019	44+00 7'L	118.9		117.7	10.4	99%	98%	Pass
Sam Sveine	10/7/2019	58+00 8'L	118.9		116.9	10.1	98%	98%	Pass
Sam Sveine	10/7/2019	63+00 6'L	118.9		117.1	9.6	98%	98%	Pass
Sam Sveine	10/7/2019	68+00 7'L	118.9		118.4	9.7	100%	98%	Pass
Sam Sveine	10/7/2019	73+00 6'L	118.9		119	9.9	100%	98%	Pass
Sam Sveine	10/7/2019	78+00 5'L	118.9		118.4	9.9	100%	98%	Pass
Sam Sveine	10/7/2019	83+00 6'L	118.9		118.3	9.6	99%	98%	Pass
Sam Sveine	10/7/2019	88+00 4'L	118.9		117.6	9.7	99%	98%	Pass
Sam Sveine	10/7/2019	92+00 6'L	118.9		116.9	10	98%	98%	Pass
								98%	

G&B-105
TP-21850

MINNESOTA DEPARTMENT OF TRANSPORTATION

MOISTURE TEST
GRADING & BASE CONSTRUCTION

Grading & Base Manual 5-692.230

Project No:	Date:	Page No:
[redacted]	10/7/2019	1

Test Identification Data

Date	10/719	10/7/19		10/7/19	10/7/19
Tester Initials or Certification No.	SS	SS		SS	SS
Test No.	19	20		21	22
Material Type	CIR	CIR		CIR	CIR
Station (X-Coordinate)	12+00	40+00		96+00	30+00
Roadway Lane & Offset (Y-Coordinate)	4'L	6'L		6'R	6'R
Depth Below Grading Grade (Z-Coordinate)	BC	BC		AC	AC

Moisture Determination

- Burner Method - 5-692.231					
(A) Pan Id.					
(B) Wt. Wet Material + Pan	1577.8	1602.7		1411.3	1600.3
(C) Wt. Dry Material + Pan	1560	1579.9		1406.8	1590.2
(D) Wt Moisture B-C	17.8	22.8		4.5	10.1
(E) Wt Pan	1044.1	1046		1045.3	1046.1
(F) Wt. Dry Material C-E	515.9	533.9		361.5	544.1
- Speedy Method - 5-692.232					
(G) Dial Reading					
(H) Sample Size Factor					
(I) % Moisture Wet Wt. GxH					

Moisture Content 5-692.237

(K) % Moisture Dry Wt. D/F x 100 (Burner) I/[1-(I/100)] (Speedy)	3.5	4.3		1.2	1.9

AET

A.16 Fog Seal and Bituminous Requirements

If directed by the Engineer, apply a CSS-1h bituminous fog seal per 2355, "Bituminous Fog Seal" at a rate of 0.10 to 0.16 gallons per square yard immediately prior to placing the asphalt pavement. The Engineer reserves the right to delete the fog seal from the Contract at his discretion.

If required of the Contract, place the next layer of material (HMA, seal coat, etc.):

(1) No sooner than three calendar days and no later than 14 calendar days after the CIR/CCPR, at any location, has been injected and compacted (note that the 14 day requirement may be extended with concurrence of the Engineer, if large rainfall events hinder the curing of the CIR),

(2) When the CIR/CCPR surface does not deflect under construction equipment and meets quality compaction per 2105.3.F.2,

(3) When the CIR/CCPR is capable of meeting the required strength to place and compact the next layer, and the moisture content of the CIR/CCPR does not cause a failure to the next material placement, and

(4) When the moisture content of the CIR/CCPR is low enough to not migrate into and damage the new surface.

AET

Cold Central Plant Recycling

CCPR is another method of doing pavement rehab, that works just like CIR, except the addition of stabilizing takes place at a central plant, and material is hauled to the site, and laid down using a regular paving practices.

This method is usually used when millings have already been hauled away to a different location.

Full Depth Reclamation

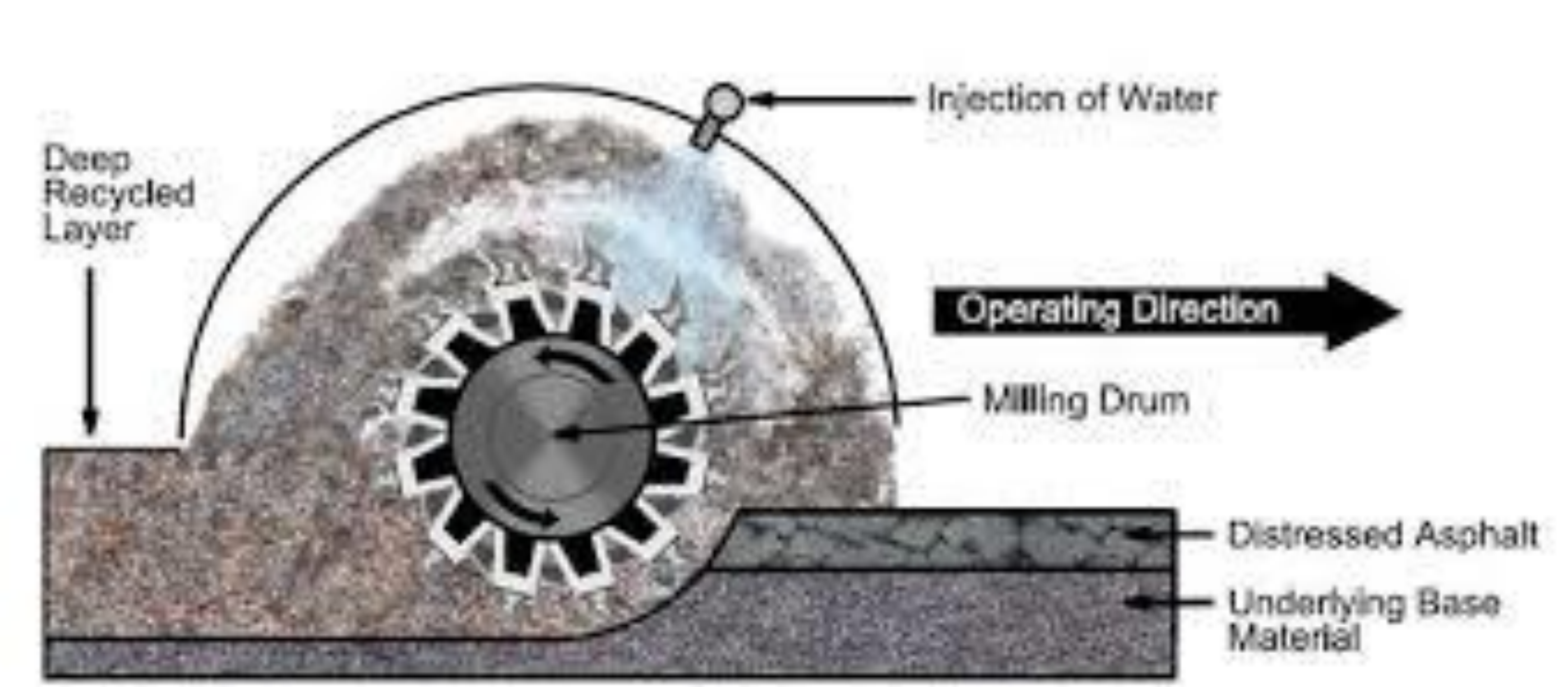
When roadway issues cannot be rehabilitated using CIR or CCPR, Full Depth Reclamation may be appropriate.

This is typically done on roads with unstable base, subgrade or issues with drainage.

Problems that indicate a need for FDR can include: rutting, edge failure, potholes, and deep, recurring cracking.

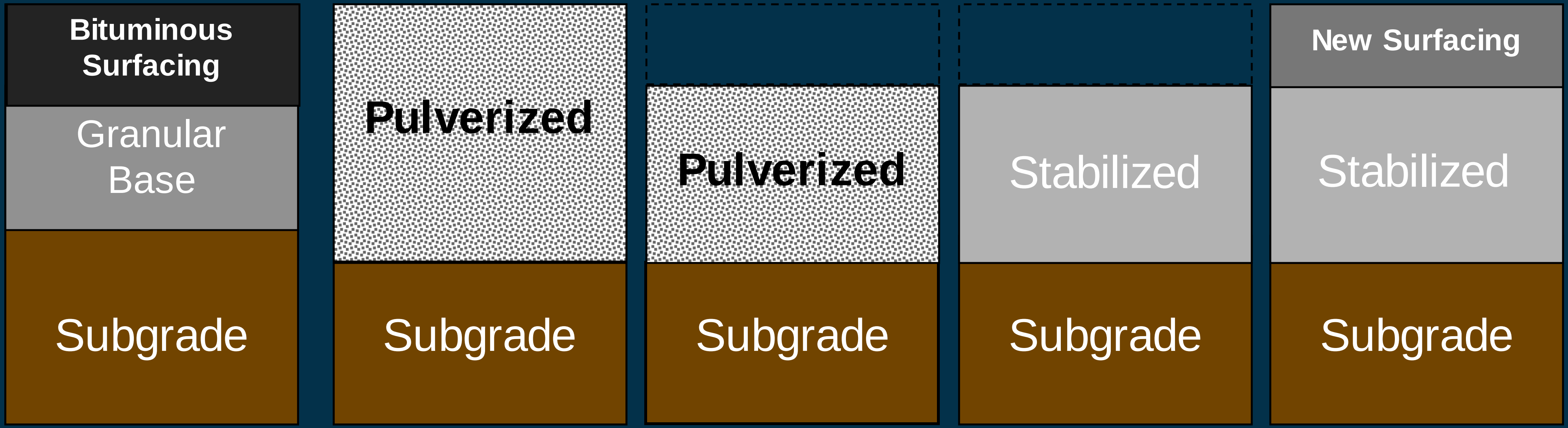
FDR Process

Some or all of the existing pavement is milled and mixed with the underlying base material to create a uniform and more stable product that is compacted and shaped to specification.



Stabilized Full Depth Reclamation (SFDR)

If pulverization and mixing of the existing asphalt and base is not sufficient to support intended loads, the addition of a stabilizing agent is recommended. This most commonly includes the addition of bituminous material (emulsion or foamed asphalt), cement, or virgin aggregate.



Existing road

Pulverization to desired depth

Removal of excess material (if necessary) and shaping

Addition of cement, mixing, reshaping, and compaction

Final surface application


SULLY
SULLY

Quality Control Testing and Inspection

Rolling Pattern

Gradation- Complete and Simple

Depth Check

Stabilizing Agent Yield-Bituminous and/or Cement

Compaction Testing-Nuclear Densities

DCP-Pregrind and Post Stabilization (CBR Value)

Moisture!!!

Daily Report

6.7 Curing. Finished portions of CTB that are traveled on by equipment used in constructing an adjoining section shall be protected in such a manner as to prevent equipment from marring, permanently deforming, or damaging completed work. After completion of final finishing, the surface shall be cured by application of a bituminous or other approved sealing membrane, or by being kept continuously moist for a period of 7 days with a fog-type water spray that will not erode the surface of the CTB. If curing material is used, it shall be applied as soon as possible, but not later than 24 hours after completing finishing operations. The surface shall be kept continuously moist prior to application of curing material. For bituminous curing material, the CTB surface shall be dense, free of all loose and extraneous materials, and shall contain sufficient moisture to prevent excessive penetration of the bituminous material. The bituminous material shall be uniformly applied to the surface of the completed CTB, at 0.2 gal/SY diluted a1 1:1 ratio. The exact rate and temperature of application for complete coverage, without undue runoff, shall be specified by the engineer. Should it be necessary for construction equipment or other traffic to use the bituminous-covered surface before the bituminous material has dried sufficiently to prevent pickup, sufficient sand blotter cover shall be applied before such use. Sufficient protection from freezing shall be given the CTB for at least 7 days after its construction or as approved by the engineer. Micro-cracking shall be utilized as a way to mitigate base cracks reflecting through the finished surface. Micro-cracking involves several passes (typically two to four, minimum 2) of a large vibratory roller over the cement stabilized base to produce a network of closely spaced hairline cracks, which act to

relieve the shrinkage stresses in the early stages of curing. This also provides a crack pattern that will minimize the development of wide shrinkage cracks later on. Since micro-cracking is performed shortly after stabilization, this procedure will not impact the pavement's overall structural capacity as the cracks will tend to heal and the cement stabilized material will continue to gain strength over time. Micro-cracking shall not be performed at a speed of over 2 ½ mph, no sooner than 24 hours after initial curing, and not more than 48 hours after initial curing.

Table 1. Soil Index Property Test Results

Test	Result
Maximum Dry Density (pcf)	123.4
Optimum Moisture (%)	9.1
Soil pH	8.4
Liquid Limit	24
Plastic Limit	19
Plasticity Index (PI)	5
Organic Content (%) (no RAP)	2.4

Table 2. Normalized Gradation Blend

Sieve	Percent Passing
3/4"	100
1/2"	82
3/8"	74
#4	55
#10	43
#40	19
#100	9
#200	6.0

Table 3. Average Unconfined Compressive Strength Results (psi)

Cement Content (%)	Optimum (9.1%)	Optimum +2% (11.1%)
3.0	252.2	170.0
5.0	379.7	280.1
7.0	550.2	421.5

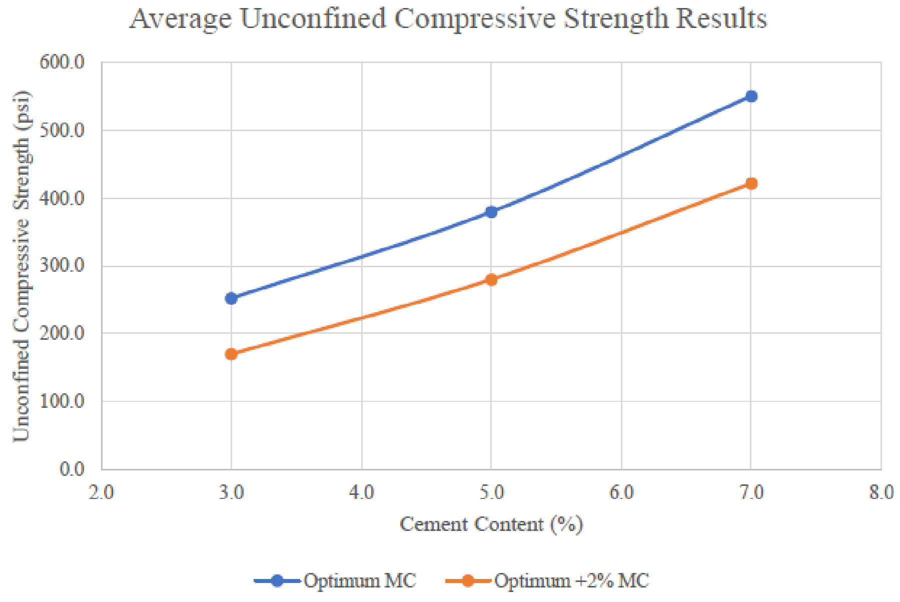


Figure 2.2.1. Cement Content vs. Average Unconfined Compressive Strength

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American Engineering Testing, Inc.

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Proctor Report

Report No: PTR:19-16553-S3
Issue No: 1

Client: [redacted]
Project:
Job No:

CC:

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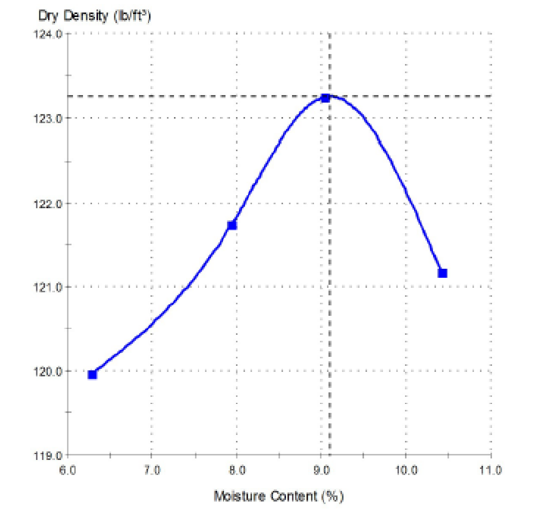
Date of Issue: 9/5/2019
Reviewed By: Krystle Staker

Sample Details

Sample ID:	19-16553-S3	**Field ID:**	Composite Blend
Date Sampled:	8/16/2019		
Sampling Method:	Sampled By American Engineering Testing		
Source:	On-site		
Material:	Composite Blend		
Specification:	Gradation		
Location:	Segment 1 & 2		
Sampled By:	32-Sioux Falls		

Dry Density - Moisture Content Relationship



Test Results

AASHTO T 99

Maximum Dry Density (lb/ft³):	123.3
Optimum Moisture Content (%):	9.1
Method:	A
Tested By:	
Date Tested:	

AASHTO T 89/T 90

Liquid Limit (%):	24
Plastic Limit (%):	19
Plasticity Index (%):	5
Tested By:	Vincent Lubbers
Date Tested:	9/4/2019

Comments

The standard Proctor was tested in general accordance with AASHTO T 134 Method B, with 5% cement content by dry weight of material.
The blend used was normalized to the 3/4" sieve and consisted of 50% RAP and 50% aggregate base material.

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3.0 CONCLUSIONS

The samples tested at optimum moisture content met the targeted range of 200 – 350 psi unconfined compressive strength at 3% cement content by dry weight of soil. The remaining samples at optimum moisture content exceeded the unconfined compressive strength target range.

The samples tested at 2% above optimum moisture content met the targeted unconfined compressive strength range at 5% cement content by dry weight of soil. The sample at 3% cement content did not achieve the targeted range and the sample tested at 7% cement content exceeded the targeted range.

Based on these test results, we recommend the following cement addition rates according to the relative moisture content of the material during stabilization.

Table 3. Recommended Cement Addition Rates

90% to 105% of Optimum	106% to 120% of Optimum
3%	4% - 5%

The stabilized layer should be tested with a dynamic cone penetrometer to determine the CBR value. The field measured CBR values after stabilization can vary due to many factors such as weather, temperature, curing practices, compaction, and underlying roadbed soil conditions which are out of our control. The cement content recommendations are a baseline starting point for stabilization and the changing conditions in the field may warrant changes in the cement addition rate to achieve the project specifications.

We recommend a minimum CBR of 20 prior to proof rolling (average minus one standard deviation). Typically, this value can be obtained within 2 to 3 days after cement stabilization has occurred and can be verified in the field using a DCP at a minimum of eight locations. Our empirical data has shown that if a CBR of 20 can be obtained at 2 days, a CBR of 30 or greater will normally be obtained within 7 days, and a CBR of 50 or greater will generally be obtained within 28 days. An empirical equation developed by the University of Illinois for Illinois DOT shows the following relationship between CBR and unconfined compressive strength:

$$\text{Unconfined Compressive Strength (psi)} = \text{CBR} \times 4.5$$

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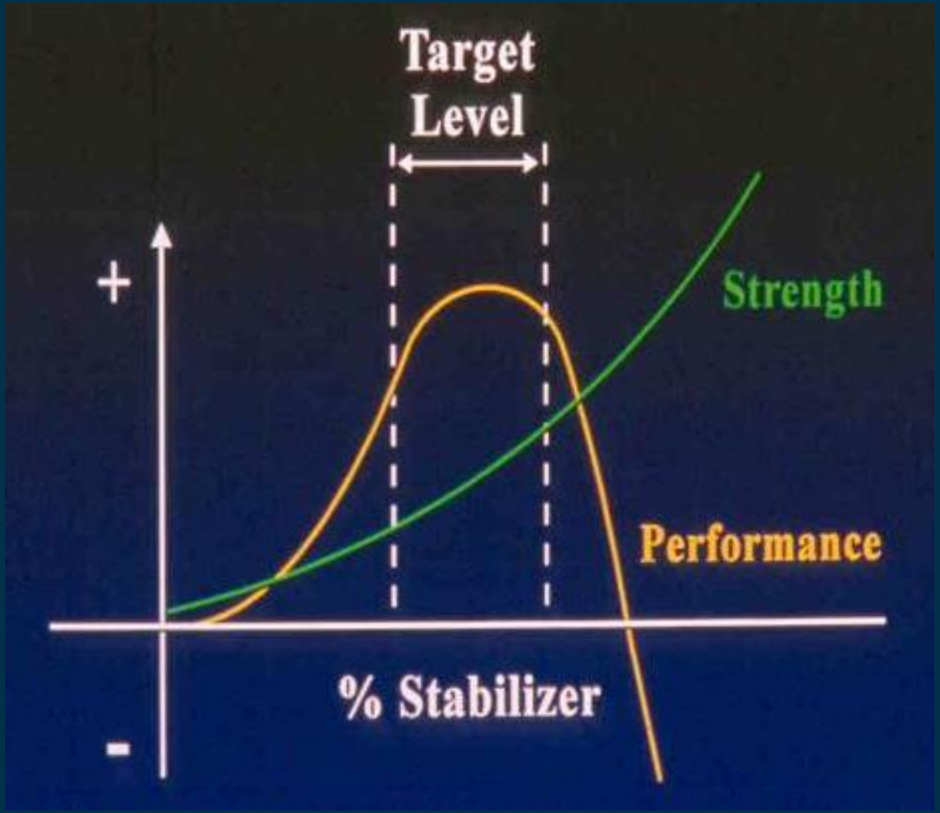
Please keep in mind that strength and performance are NOT the same thing!



The purpose of the mix design procedure is to select the correct amount of stabilizer that most closely balances both strength AND performance for the roadway materials!

Any Questions?