Cold In-Place Recycling (CIR)

North Dakota Asphalt Conference
April 4, 2012, Bismarck, ND

Mark Watson, MnDOT

Outline

- What is CIR?
- MN & National CIR Use
- Project Use
  - Challenges (Lessons Learned)
  - Successes
- Summary

In-Place Recycling Terms

Full Depth Reclamation (FDR)

- Grind HMA with Base

Stabilized FDR (SFDR)

- Grind HMA with 1 to 2 inches of Base & add additive (liquid or dry)

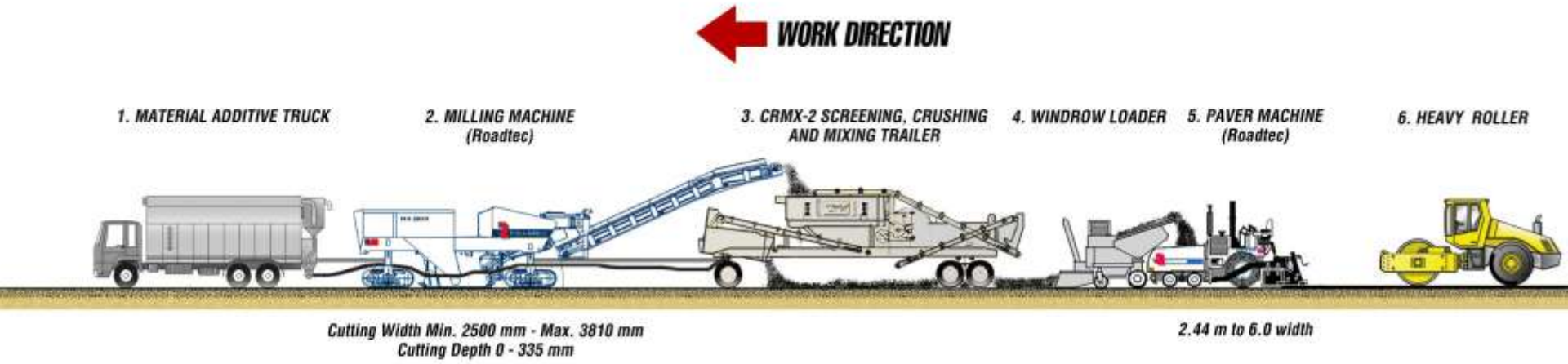
Cold-in Place Recycle (CIR)

- Grind HMA ONLY & add liquid additive (can add dry too)

Cold In-Place Recycling

- Partial depth (2 – 4") of HMA (No Heat).
- Uses mill, crushing and screening units, pavers, mixers & rollers
- Typically leaves a small amount (~1") of HMA for equipment Support

CIR Equipment



Pavement In-Place Recycling from Roadtec

1. Mill Pavement
2. Process (Screen & Crush) RAP Material
3. Mix Processed RAP with Additives
4. Place & Compact CIR

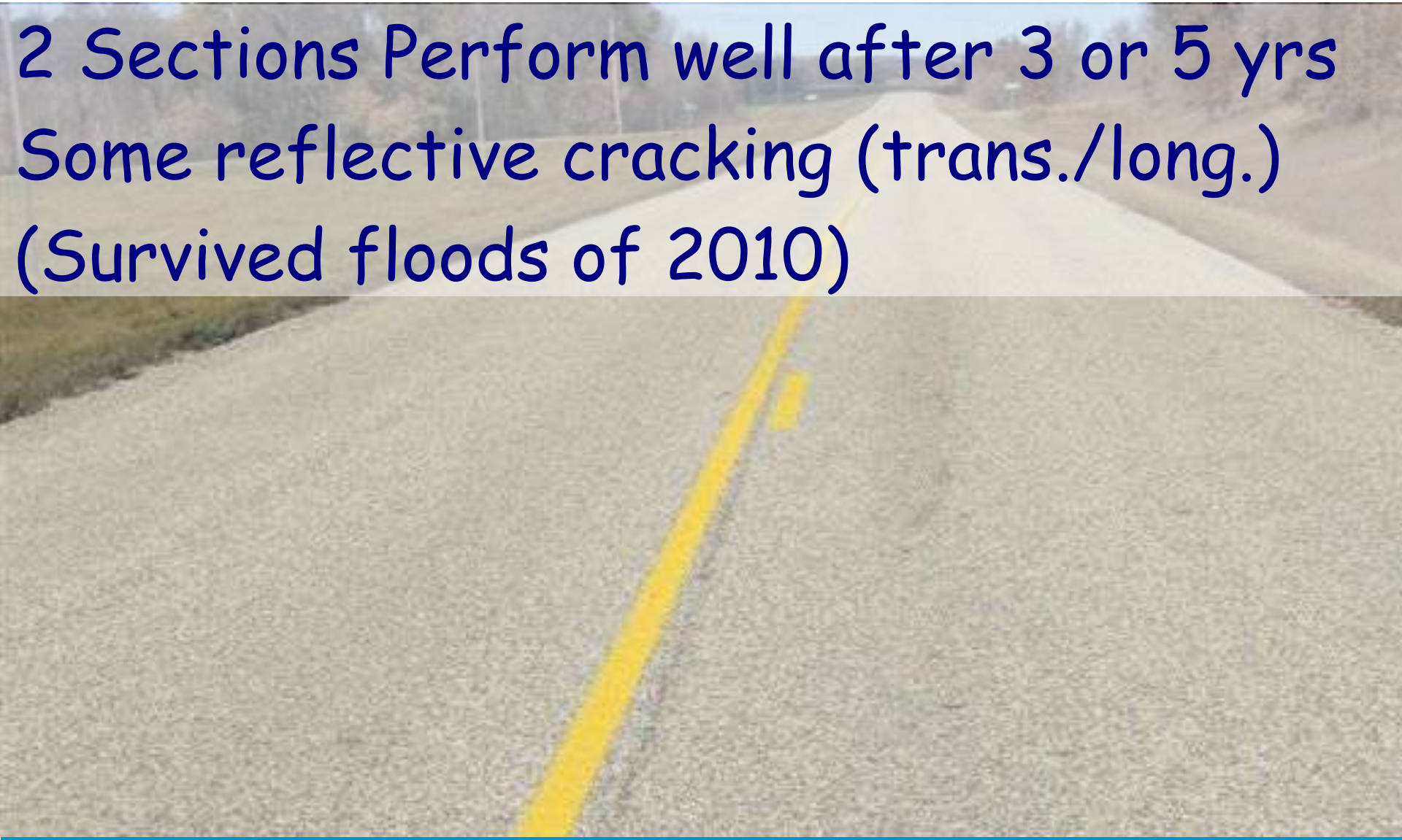
CIR Train in North Dakota

TH 21, Barnes County, ND

- Rural 2-lane, South of Valley City
- CIR 4" @3.2% Emulsion + Granite Chips
- Chip Seal Surface Treatment

Patching
Cracking

2012 Performance



2 Sections Perform well after 3 or 5 yrs

Some reflective cracking (trans./long.)

(Survived floods of 2010)

National CIR Use

- Nat'l. Recycling Center in CA, sponsored by ARRA
- Several 20 Year Performance Reports: NM, WA, PA, NV, NY
- Upcoming NHI Class: "Asphalt Pavement In-Place Recycling"
- Ontario & IA have inspired MN Specs.

MN CIR Use

- Ramsey & Other Counties in Mn used for 'many years'
- MnDOT Inconsistent Use
  - Late 80's Early 90's Started, then pulled back due to issues
  - One District ~ 100 miles
  - Starting to be Used Again

MNDOT CIR Issues

- Rutting
  - Material Choice? Thickness?
  - Did Mix Designs, then stopped because all came back at 2.0% add oil
- Cure Times (Before Overlay)
  - Material Choice?

County Continued CIR Use

- Used MnDOT Specs
- Equipment Requirements
  - Closed Loop System Screened, Crushed => Consistent Product
  - Oil Added based on Weight
- Better Mix Design
- Engineered Emulsion => Cure Times, Strength

MN Use of CIR

- 2010: MnDOT Innovation Money: 5 Stabilized FDR + 2 CIR projects in last two years
- One upcoming State project (No Innovation Money)
- County Project: CIR with Engrd. Emulsion & Cement, Chip Seal Surface

TH 27: Project Overview

- Rural 2-lane with 1,400 ADT
- 16+ Miles of CIR ($\frac{1}{2}$ Emulsion + $\frac{1}{2}$ Foam)
- Mill 2", CIR 4" (2" In-Place), 3.5" HMA

IRI: 150's – 220+
Patching
Cracking

TH 67: Project Overview

- Rural 2-lane with 1,400 ADT
- 8+ Miles of CIR (Engr. Emulsion)
- Mill 4", CIR 4" (4*" In-Place), 4" HMA

IRI: 130's – 150+
Patching
WP Cracking

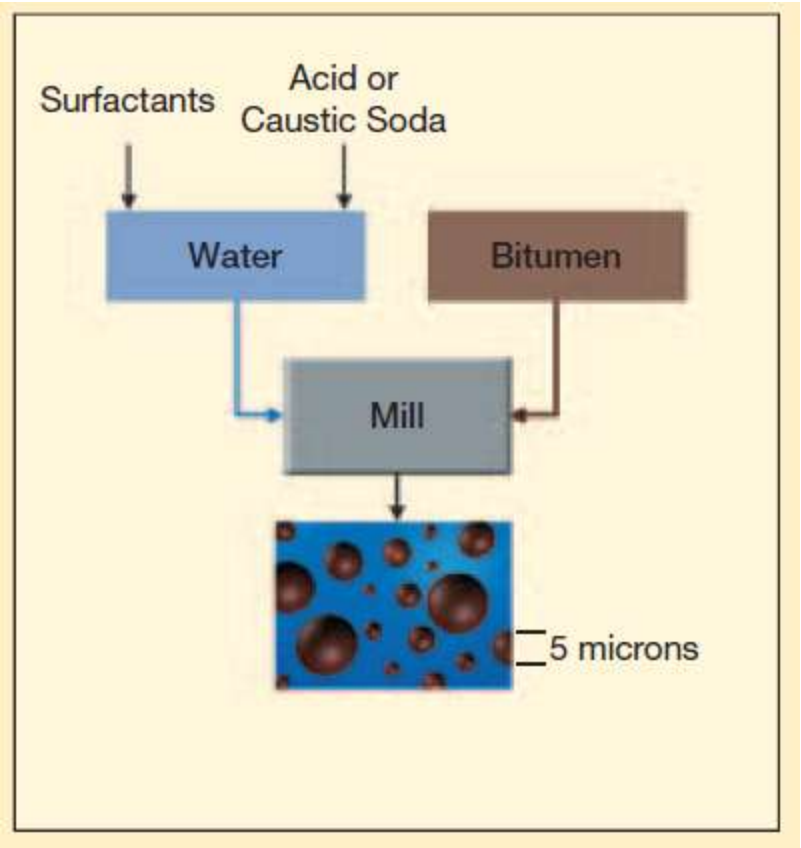
TH 27: 2 Sections

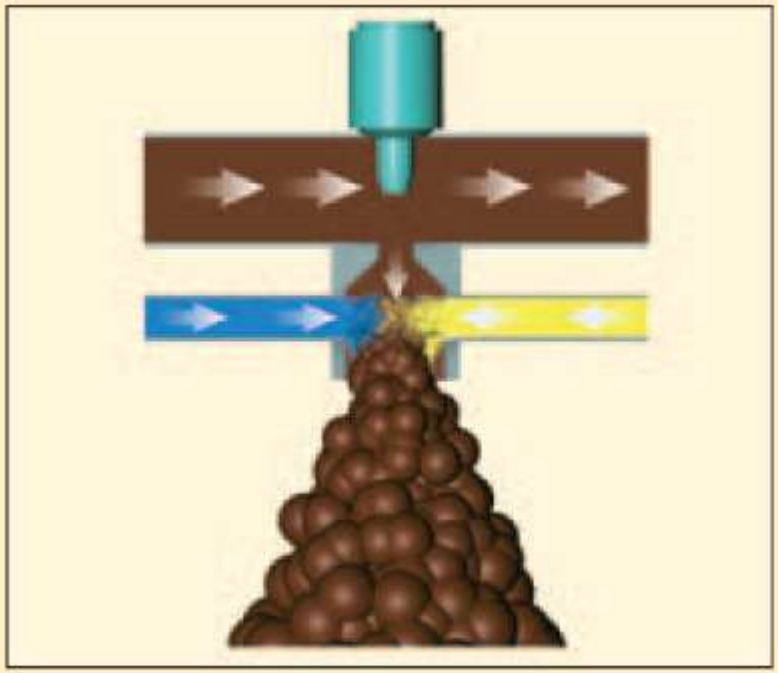
- HFMS-MP (Emulsion) @2% (No Design)
- Foamed AC @2% (Mix Design)

Foamed Oil / Emulsion

Emulsion ~ 33% H_2O + 67% Oil (2%=1.3%)

Foamed AC ~ 100% Oil (2%=2%)

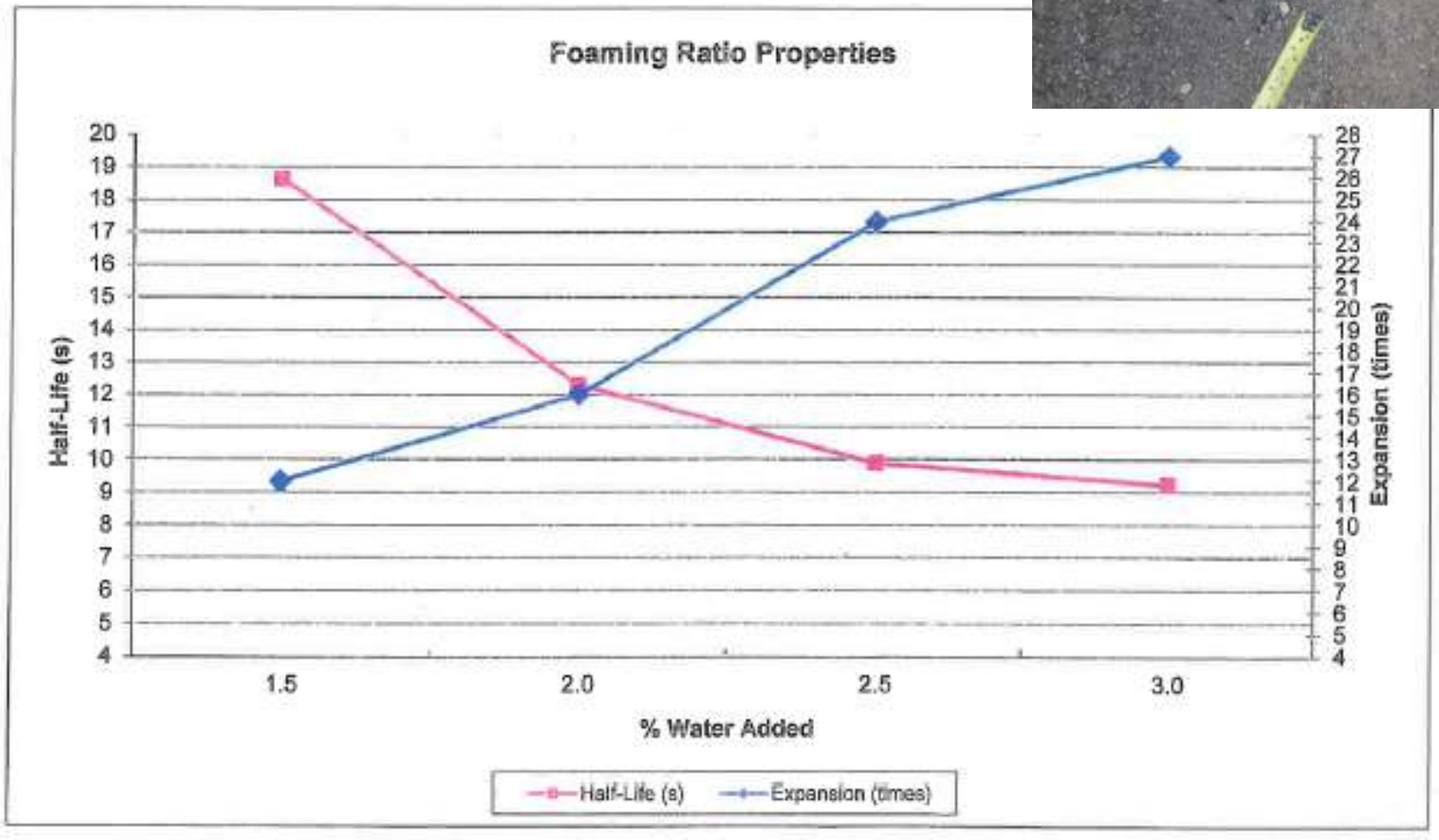




Foamed Bitumen Production in Expansion Chamber

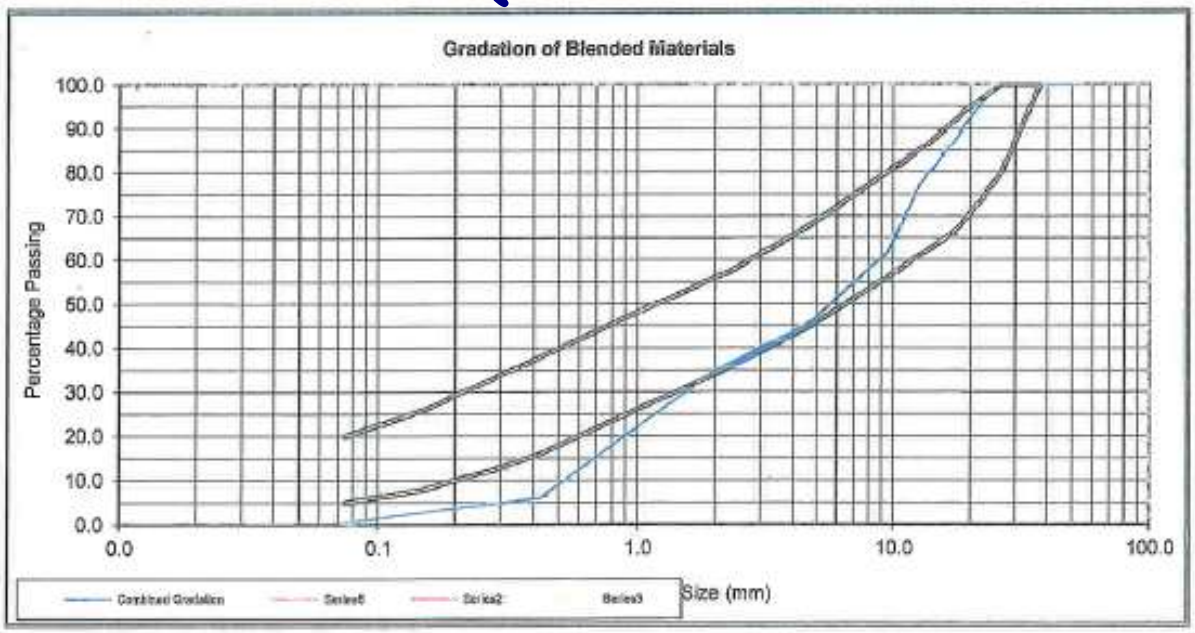
Foamed AC

Measure the foaming properties
Compare against Design, & Adjust



TH 27: Foamed Mix Design

- Used IA Procedure (Modified Wirtgen)
- Indirect Tensile Strength (Dry/Wet) 66 / 46 (70% Retained)
- Fines Needed? (Too Much = Bad)



TH 67: Emulsion Mix Design

Property	Criteria	Purpose
Compaction effort, **Superpave Gyratory Compactor**	**1.25° angle, 600 kPa stress, 30 gyrations Report**	Density **indicator**
Density, **ASTM D 2726 or equivalent**	**Report**	Compaction **indicator**
Retained stability **based on long-term stability**	70% min.	**Resistance to** moisture damage
Marshall stability, **ASTM D 1559 Part 5, 40° C**	1,250 lb min.	Stability **indicator**
Raveling test, **ASTM D7196-06**	2% max.	**Resistance to** raveling
Indirect tensile test, **AASHTO T322, Modified**	**LTPPBind temperature for climate & depth**	**Resistance to** cracking

Mix Design: Stability Test

- Resistance to Plastic Flow
- Average Retained Strength => Moisture Sensitivity

Mix Design: Raveling Test

- Evaluate Emulsion/ RAP compatibility
- ASTM D 7196-06 (2% Loss Max.)

1% Loss after 15 minutes

11% Loss after 10 minutes

TH 67: Emulsion Mix Design

- Dry Stability: 1,682 lbs.
- Retained Stability: 1,441 lbs. (85%)
- Raveling Test: 0.86%
- Indirect Tensile : -32°C (Cracking)

RECOMMENDATION (See Conclusion Below)				
	3.3% +/- 0.3%	Based on 12 ft. width	gal./ft	gal/SY
	1.5% +/- 0.5%	for 3 in. depth	1.47	1.11
		for 4 in. depth	1.96	1.47

Q/C & Q/A

- Depth
- Gradation
- Yield (Asphalt Binder)
- Moisture
- Establishing Rolling Patterns (Nuke)

Check Depth & Gradation

- Depth - Adjust to Ensure Adequate Support
- 100% passing 1.5"; 90-100% passing 1.0"

Monitor Oil Addition Rate

- Too Much => Rutting issues, $$
- Too Little => Failures, Raveling, Durability
- Affected by Temperature & Gradation

Observe Test Strip

- Use Nuke Device
- Check Density (Info. Only)
- New Test Strip if "Changes"

6 – 8 Passes to break down

Finish Roll Until: Density Breaks or no change

Curing

- Moisture ≤ 1.5 % (weight) ~ 7 - 10 days before placing HMA.
- If Moisture > 1.5% & < 2.5% & has not changed by more than 0.2% over of five days, the Engineer may allow HMA Placement
- Fog Seal to prevent raveling if open for extended period of time

Drainage

Recycling will find weak/poor areas

- Recycling does not fix Soft Spots

TH 27 Won a Paving Award

Another project to be built this year

Cost Information

Two Items (SY & Ton)

- ~$1.70 / SY CIR Bit. Mixt.
- $535 - $683 / TON Oil
  - $35,700 for Lane*Mile 4" CIR
  - $38,600 for Lane*Mile 2" HMA

- Relaxing equipment Requirements Reduced Prices => $.04/SY

CIR Keys to Success

- Conduct Pre-Project Evaluations
  - Existing Pavement Thickness (GPR all Projects)
  - Drainage Evaluations
  - Subgrade/Support Conditions
  - Conduct Mix Designs
    - Evaluate potential products
    - Apply at Proper rates

CIR Keys to Success

Measure & Observe During Project

- Gradation
- Bituminous Material
  - Addition Rate, Foaming Properties (if applicable)
- Density – Establish a rolling pattern using nukes & continuously observe

Thank You!

Mark Watson
mark.watson@state.mn.us
(651) 366-5596
(651) 338-3707