



# Shingles: Problems and Solutions

## Or **Mistakes I Have Made**

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# N.B. West Contracting

- ◆ Founded in 1956
  
- ◆ Two Offices –
  - St. Louis and Sullivan, MO
  
- ◆ 3 Asphalt Plants
  - 300,000 -500,000 Tons Annually
  
- ◆ Novachip, Warm Mix Asphalt, Chip and Seal, some HMA



# Ode to David Letterman

- ◆ Top 10 Shingles Problems and Solutions from the home office in Indianapolis, IN.



# Top Ten Shingle Problems and Solutions

10. Shingles have too much moisture in them causing feed problems, clumps in the mix, rich spots in the mix or dry mix.

Solution: Use Warm Mix Asphalt chemical additive with a good surfactant and cover the shingle pile.



# Collar on Asphalt Plant



Clogged every  
7,000 Tons

# Recycle Chute on Asphalt Plant



# Cover the Shingles



# Top Ten Shingle Problems and Solutions

9. Shingles are Too Large and pop up behind the rollers, mix looks brown, mix falls apart

Solution: Use MoDOT spec 403.2.6.2

“Shingles shall be ground to 3/8” minus.





# Shingle Grind Size

- ◆ Smaller ground shingles are easier to use, but they take longer to grind
  - Release more oil
  - “Dissolve” into the asphalt mix easier
  - Less chance of tab “pop-ups”

# Shingle Grinding



# Processed Shingles 2005



# Processed Shingles 2010



# Top Ten Shingle Problems and Solutions

8. Over heating the mix to get all of the oil out of the shingles

Solution: Turn the temperature down and add more virgin asphalt cement. High temperatures cause the mix to be brittle.

MoDOT maximum temperature 350°F



# Top Ten Shingle Problems and Solutions

7. High shingle content in the mix. Shingle binder is too hard. Mix is prone to cracking.

Or Polymer Modified Asphalt with shingles leads to a hard binder.

Solution: Specify PG XX-28 asphalt cement. MoDOT 403.2.6.2. “Softer” binder provides better crack resistance.



# PG 70-22 with 4% Shingles and 11% RAP



# Rte. 63 Rolla





# Top Ten Shingle Problems and Solutions

6. Thin lift BP-2, 1” or less, high shingle content, mix experiences segregation or shadowing.

Solution: Increase lift thickness, increase mix temperature slightly, use a transfer machine.

Shingle oil “cools” more quickly than virgin on long hauls.



# BP-2 or Surface Leveling

- ◆ Revised the VMA requirements
  - 13% to 14%
  - Air Voids changed from “3.5% to 4.5%” to 3.5%
  - Reduced field tolerance on AC content from 0.5% to 0.3%

# Top Ten Shingle Problems and Solutions

5. High deleterious content in shingles.

Solution: Start with a cleaner source of shingles. Remove as much trash as possible before grinding.



# Deleterious Material

- ◆ Nails
- ◆ Wood
- ◆ Plastic
- ◆ Cellophane
- ◆ Paper
- ◆ Fiber Board



# Shingle Collection 2003



# Shingle Collection 2010



# Top Ten Shingle Problems and Solutions

4. Mix Design: Shingle mix meets all of the requirements on paper, mix looks brown, **ship it.**

Solution: The mix has to perform in the field. It may meet spec but your laydown crew still has to build the job. Check reasonableness of design, develop a history of successful mixtures.



# Top Ten Shingle Problems and Solutions

3. Mix Design: Using too high of specific gravity for the shingles to meet VMA requirements.

Solution: Use a specific gravity that represents the material





# Top Ten Shingle Problems and Solutions

2. Mix Design: Using high asphalt content percentages when designing the mix.

Solution: Do not use the highest asphalt content to design your mix with.



# Shingle Specific Gravity

<b><u>SHINGLES SPECIFIC GRAVITY</u></b>			
		Dry Sample Weight:	1062.2
		Volumeter Weight:	1355.9
		Wt. of Volumeter + Sample + Water:	1859.2
		Dry Back:	1071.8
		<b>Gmm:</b>	<b>1.868</b>
		Gb From Shingles:	1.028
		% AC From Shingles:	23.00
		<b>Gse:</b>	<b>2.472</b>

# Change AC content in shingles from 23% to 28%

## SHINGLES SPECIFIC GRAVITY

			Dry Sample Weight:		1062.2
			Volumeter Weight:		1355.9
			Wt. of Volumeter + Sample + Water:		1859.2
			Dry Back:		1071.8
			<b>Gmm:</b>		<b>1.868</b>
			Gb From Shingles:		1.028
			% AC From Shingles:		28.00
			<b>Gse:</b>		<b>2.739</b>

# Impact

- ◆ Shingle Gse changes from 2.472 to 2.739
- ◆ VMA increases 0.4% at 3% shingles.
- ◆ VMA increases 0.7% at 5% shingles.

# Top Ten Shingle Problems and Solutions

1. Over Usage of Shingles as a binder replacement. Trying to use too high of a percentage of shingles.

Solution: Design a mix that has a reasonable amount of shingles



# Shingle Issues

- ◆ If 3% is good 12% is 4 times as good
  - Durability issues
- ◆ Wet weather paving without Evotherm
  - Virgin aggregate moisture
  - RAP moisture
  - RAS moisture
- ◆ Cold weather paving without Evotherm

# How to avoid mix design problems - Agency

- ◆ Use “Joe’s Spreadsheet” for Effective Binder Replacement
- ◆ “RAP AsphaltPercentEffective”
- ◆ [http://www.modot.org/business/contractor\\_resources/forms.htm](http://www.modot.org/business/contractor_resources/forms.htm)

## Contribution of Binder from Recycled Materials

### Effective Binder Computation

Pb	5.30	Gmm	2.461	Gse	2.670
Pbmv w/o RAS	4.48	Gb	1.026	Pba	1.01
Pbmv w/ RAS	4.00	Gsb	2.598	Pbe	4.29

Stockpile	Type	$P_s$	$P_{br}$	$P_{sr} \times P_{br}$	$F^*$	$P_{smv}$	$P_{smr}$	$P_{bmr}$
1								
2								
3								
4	virgin	80				76.78		
5	RAP	17	4.8	0.82			15.53	0.77
6	RAS	3	22.9	0.51	0.74		2.39	0.48
7								
8								

100

94.7

$P_{be}$	4.29
$P_{bev}$	2.99
$P_{smv}$	76.78
$P_{sr} \times P_{br}$	1.32
$P_{smr}$	17.92
$P_{bmr}$	1.25
R	70

F= 1.00

\* Leave F blank to calculate, then insert calculated F in table.



## Contribution of Binder from Recycled Materials

### Effective Binder Computation

P <sub>b</sub>	5.70	G <sub>mm</sub>	2.461	G <sub>se</sub>	2.688
P <sub>bmv w/o RAS</sub>	5.00	G <sub>b</sub>	1.026	P <sub>ba</sub>	1.10
P <sub>bmv w/ RAS</sub>	4.00	G <sub>sb</sub>	2.608	P <sub>be</sub>	4.60

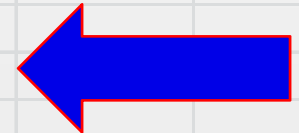
Stockpile	Type	P <sub>s</sub>	P <sub>br</sub>	P <sub>sr</sub> x P <sub>br</sub>	F*	P <sub>smv</sub>	P <sub>smr</sub>	P <sub>bmr</sub>
1								
2								
3								
4	virgin	80				76.59		
5	RAP	17	4.8	0.82			15.49	0.77
6	RAS	3	22.9	0.69	1.00		2.21	0.65
7								
8								
		100				94.29		

P <sub>be</sub>	4.60
P <sub>bev</sub>	2.90
P <sub>smv</sub>	76.59
P <sub>sr</sub> x P <sub>br</sub>	1.50
P <sub>smr</sub>	17.7
P <sub>bmr</sub>	1.42
R	63

F = 1.00

\* Leave F blank to calculate, then insert calculated F in table.

Total binder (P<sub>b</sub>) overestimated from reclaimed binder contribution.



# 2012 Changes

- ◆ BP-1, BP-2, BP-3 and Bit Base Mixes
  - Lowered the design air voids to 3.5%
  - Increased the VMA requirement on BP-1 and BP-2 (13.5% and 14.0%)
  - Reduced the field tolerance from 0.5% to 0.3% on the asphalt content during production
  - Reduced the design gyrations from 50 to 35. 35 blow Marshall still acceptable

# Warm Mix Asphalt and Shingles

- ◆ Warm Mix Asphalt
  - Longer Haul
  - Lower Temperatures
    - ◆ Moisture?
    - ◆ TSR impact
    - ◆ Stiff binder
  - Less Aging of Binders
    - ◆ Shingles have stiff oil

# Warm Mix & Shingles

MWV

**EVO THERM**  
WARM MIX ASPHALT TECHNOLOGY

- ◆ **Evothem 3G M1**
- ◆ **Surfactant**
  - Works with residual moisture in the shingles
- ◆ **Lower Drying Costs**
- ◆ **Anti-Strip Agent**

# Warm Mix & Shingles



MWV



**EVO THERM**  
WARM MIX ASPHALT TECHNOLOGY

- ◆ **Evotherm 3G M1**
- ◆ **Compaction Aid**
  - Stiffer RAS Oil
- ◆ **Longer Haul Distances**
- ◆ **Cold Weather Paving**
  - 14° F lowest so far

# Continuous Grade

## RECOVERED BINDER GRADE

Since the dynamic modulus testing and analysis concluded that there was good mixing of the new and recycled materials, the performance grade of the binder in the mixture was determined on the recovered binder. The grading was performed in accordance with AASHTO R29 treating the recovered binder as Rolling Thin Film Oven Test (RTFOT) aged. The results for the mixture are summarized in Table 18. The recovered binder grades are:

- PG 76-16 for the PG 58-22+0.4% M1
- PG 76-16 for the PG 58-22
- PG 70-22 for the PG 58-28+0.4% M1
- PG 76-16 for the PG 64-22+0.4% M1
- PG 82-16 for the PG 64-22

The recovered binder properties may be acceptable for the environmental conditions in Sullivan, Missouri considering the depth in the pavement that the mixtures will be used (Figure 8) in order to provide thermal cracking resistance.

Table 18 Results of Recovered Binder Grading

Condition	Test	Temperature °C	PG58-22+0.4% M1	PG58-22	PG58-28+0.4% M1	PG58-28	PG64-22+0.4% M1	PG64-22	
As Recovered	G'sini, kPa AASHTO T 315	58	26.40						
		64	11.70						
		70	5.23	6.78	4.17		7.96	10.1	
		76	2.39	3.17	1.97		3.78	4.73	
		82	1.14	1.53			1.81	2.24	
		88						1.10	
	G'sini, kPa AASHTO T 315	20					7950	4585	
		25	4685	4490	4110		5860	8215	
		22	6310	6135	5610		4340		
		19			7350				
	Creep Stiffness, MPa AASHTO T 313	-18			282.5			212.5	231.5
		-12	186	175	153.5			91.8	102.5
		-6	69.9	79.0					
		-18			0.270				
m-value	-12	0.289	0.282	0.307			0.277	0.264	
	-6	0.343	0.323				0.322	0.312	
Continuous Grade, °C	High		75.7	75.0	75.1		69.4	65.2	
	Intermediate	NA	24.3	24.0	23.1		26.6	27.1	
	Low		-20.7	-19.3	-23.1		-18.9	-17.6	
Grade	AASHTO M 320	N/A	76-16	76-16	70-22		76-16	82-16	

◆ PG 64-22 w/ 38%  
Virgin Binder  
Replacement

◆ WMA with Evotherm

◆ HMA

# Continuous Grade

	<b>WMA with Evotherm 3G M1</b>	<b>HMA</b>
High	80.4	82.2
Intermediate	26.6	27.1
Low	-18.9	-17.5

# Rte. 50, Gasconade County Hot Mix Asphalt

- ◆ SP 125C, PG 64-22
  - RAP
  - Shingles
  - **Hot Mix Asphalt**
- ◆ 60 minute haul to the job
- ◆ Experienced VMA Collapse



# Rte. 50 Warm Mix Asphalt

- ◆ 1<sup>st</sup> Day of Warm Mix
- ◆ Air voids: 3.5%
- ◆ Density: 95.9%, 96.1%
- ◆ Joint Density: 95.0%
  
- ◆ Smoothness improved
  - Less joint bumps

# Rte. 50 Warm Mix Asphalt

## ◆ Job Overall

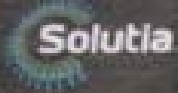
◆ Average density (Job): 93.5%

- 19.1% DEDUCT on density

- Target Range 94.0% +/- 2.0%

# Summary

- ◆ Shingles are good
- ◆ Too many can cause problems
- ◆ Proper mix design is essential
- ◆ Quality Control
  - Moisture
  - Dust



# Rock'n'Roll

## 1/2 MARATHON



competitor.com

ST. LOUIS, MO

competitor.com



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