

## ASPHALT SHINGLES

Larry Shively

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THE CITY OF  
**COLUMBUS**  
MICHAEL B. COLEMAN, MAYOR



### Oldcastle Materials Shingles Use

– Began using shingles in 2002

➤ 2014

- 7 of 8 Divisions used RAS
- 212k tons of unprocessed shingles received
- 275k tons RAS used in mixes
- Mid Atlantic and Southwest with over 90k used each, followed by Great Plains at 50k
- Shingles were used in:
  - Texas
  - Missouri
  - Oregon
  - Iowa
  - Massachusetts
  - Oklahoma
  - Pennsylvania
  - North Carolina
  - Alabama
  - Ohio

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## Background

- **MANUFACTURER'S WASTE**
  - THESE ARE END OF LINE PRODUCTION RUNS
  - TABS
  - NON SPEC MATERIALS
- **TEAR OFFS**
  - ROOFING REMOVED FROM BUSINESS AND HOUSES
  - REQUIRES A LITTLE MORE PROCESSING



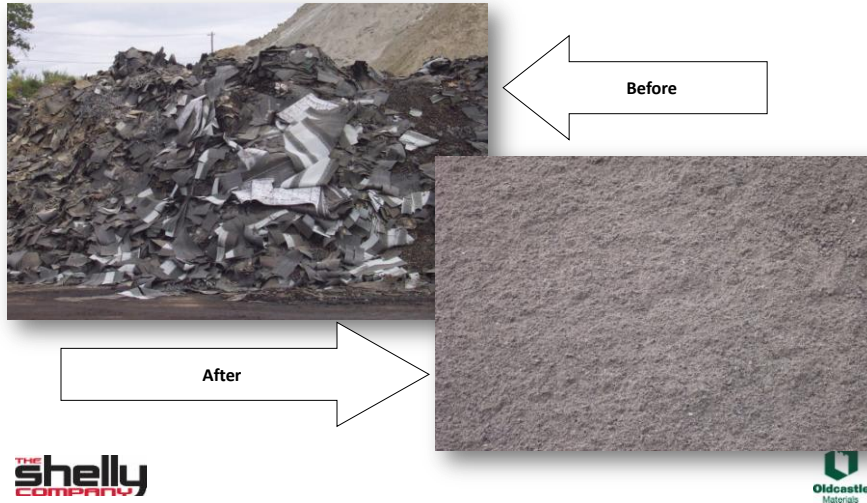
## Background

- Shingles typically contain:
  - Asphalt binder
    - Tear-offs contain 20 – 30% binder
    - Manufacturer waste 18 – 22% binder
  - 40 to 60% hard rock granules and fillers
  - 1 to 12 % fiber, felt, and miscellaneous materials



## Processing Shingles for Use in HMA

- Making the shingles into a useable product

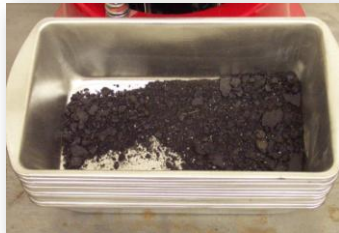


## Processing Shingles for Use in HMA

- Various equipment has been tried to grind the Shingles into a usable product
  - Shredding approach



## Processing Shingles for Use in HMA



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- Environmental concerns
  - Typical concerns for aggregate crushing and HMA production
  - HMA with Shingles is recyclable
  - Asbestos screening
    - Must comply with local agency requirements, which vary from state to state



## Processing Shingles for Use in HMA

- Carrier aggregate used to keep Shingles from agglomerating and allow to flow through cold feed bin
  - RAP, 3/8" Stone, Washed stone screenings, Natural sand (options)
  - *Also have locations that have been successful with no carrier aggregate*
- Blending by volume / weight
- Blending methods
  - Dual bin blender
  - Ground blending with additional processing



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## Processed Shingle Stockpile



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## Processing Shingles for Use in HMA



Grind is too coarse



Preferred Grind

- Most significant concern is proper sizing of the ground Shingle particle
  - Finer is better!
- Oversized Shingles particles impact:
  - Contribution to  $P_{be}$  (Effective asphalt content)
  - Mat texture
  - Consistency of blend with carrier aggregate

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## The plant-Shelly Materials Haul Road



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## RAP bins



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## BLENDING OF RAP AND RECYCLE (SHRAP)



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# RAP



# BLEND 70-30

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## Specifications

### ITEM 448 ASPHALT CONCRETE SURFACE COURSE (HEAVY TRAFFIC) PG70-22M, RAS AS PER PLAN:

- USE CITY OF COLUMBUS CMS 448 MIX PRODUCED WITH RECLAIMED ASPHALT SHINGLES (RAS) MANUFACTURING WASTE ONLY
- 4%-5% RAS
- RAP MAX 20%
- RAS FROM APPROVED SOURCE
- FOLLOW ODOT 401.04



## 2013 Ohio Department of Transportation Specifications

- **401.04 Reclaimed Asphalt Concrete Pavement and Reclaimed Asphalt Shingles**
- Determine RAS properties and usage as follows. Use no more than 5.0 percent RAS by dry weight of mix. For design assume 18.0 percent available RAS binder. Determine gradation and specific gravity according to AASHTO PP 53-09, Section 5 or subsequent AASHTO applicable standard. Provide the required certification forms in the JMF submittal documenting that the RAS meets AASHTO MP 15-09, sections 3.2 or 3.3 and that RAS from roofing tearoffs conforms to the EPA's NESHAP, 40 CFR 61 Subpart M, and other applicable agency requirements for asbestos.



## AASHTO Standard Practice

- PP 53-09 Design Considerations when Using Reclaimed Asphalt Shingles in New HMA
  - Provides guidance on:
    - Design considerations
      - “the size of the RAS can be expected to affect the fraction of RAS binder that contribute to the final blended binder”
      - “Particles of undissolved asphalt binder may act like aggregate particles that require more virgin asphalt binder to accomplish coating”
      - “fibrous material present in RAS may also require additional virgin asphalt binder to accomplish coating”



## AASHTO Standard Practice

- PP 53-09 Design Considerations when Using Reclaimed Asphalt Shingles in New HMA
  - Provides guidance on:
    - How to determine the shingle aggregate gradation
      - “it is suggested the shingle fiber present in the shingle be removed prior to testing”
    - How to estimate the contribution of the RAS binder to the final binder blend
      - “finer the grind, the greater the amount of the contribution of binder from the reclaimed asphalt shingle to the final blended binder”
      - “Recognized limitations in procedure due to assumptions related to: the amount of shingle binder released into the mix, the additional absorption due to the RAS present in the mix, the additional existing coating requirements due to the RAS present in the mix”



## AASHTO Standard Practice

- MP 15-09 Use of Reclaimed Asphalt Shingle as an Additive in HMA
  - Provides standard definitions for RAS
  - Requires RAS to be processed so that 100% passes the 12.5-mm sieve
    - Allows the blending of RAS with fine aggregate to prevent agglomeration of RAS particles
  - Requires additional testing of the composite binder if the percentage of liquid contributed by the RAS and RAP exceeds 30 percent
  - Addresses deleterious materials present in the RAS



## MIX DESIGN CONSIDERATIONS

- There is nothing different in the blending, and or batching.
- Make sure you use the correct liquid based on the RAP Viscosity chart. In most cases PG 58-28.
- Watch your P-200 sieve, the shingles have a significant amount of P-200.
- Watch your F/A ratio.
- Watch for the minimum added binder specification.
- All other procedures and testing is per usual.
- When grading the shingles, or mix containing shingles, you will find 'fiber balls' on the lower sieves. This is normal.



## MIX DESIGN CONSIDERATIONS

- Moisture control is essential.
- Gradation control is essential.
- Make sure the plant is properly calibrated to insure you get the correct amount of shingles desired. Too much or too little can lead to big problems.
- Generally, mix temperatures from the plant are a bit higher than normal to insure complete breakdown and comingling of the shingles.



## Blend

MARSHALL MIX DESIGN											
AGGREGATE BLEND SHEET											
DATE :	4/29/2015		Project :	Columbus Resurface			Mix Type:		Type 1 RAS 70-22M	JMF# :	0
	0	Shelly Materials- Columbus, Oh (Pugmill) GR/LS	0	Mar Zane-Zanesville	Shelly- Columbus	0	Composite 15-Fine Rap	Pit 90 Shingles			
	0		0	Natural	Limestone	0	0	X			
	0	#8	0	Sand	Sand	0	Composite 15-Fine Rap	Pit 90 Shingles			
	% USED	% USED	% USED	% USED	% USED	% USED	% USED	% USED			
	0.0	56.0	0.0	16.0	15.0	0.0	9.0	4.0	ACCUM.	TARGET	Surface
Sieve	% PASSING	% PASSING	% PASSING	% PASSING	% PASSING	% PASSING	% PASSING	% PASSING	% PASS.	% PASS.	Heavy - Traffic DESIGN LIMITS
2" (50.8)		100.0		100.0	100.0		100.0	100.0	100.0	100	100
1-1/2" (38.1)		100.0		100.0	100.0		100.0	100.0	100.0	100	100
1" (25.4)		100.0		100.0	100.0		100.0	100.0	100.0	100	100
3/4" (19)		100.0		100.0	100.0		100.0	100.0	100.0	100	100
1/2" (12.7)		100.0		100.0	100.0		99.5	100.0	100.0	100	100
3/8" (9.5)		92.0		100.0	100.0		97.3	100.0	95.3	95	100
#4 (4.75)		23.0		99.0	98.0		74.8	89.0	53.7	54	72
#8 (2.36)		5.0		89.0	74.0		53.8	78.0	36.1	37	55
#16 (1.18)		4.0		73.0	46.0		40.0	56.0	26.7	27	40
#30 (0.6)		3.0		43.0	30.0		28.5	40.0	17.2	18	30
#50 (0.3)		3.0		10.0	20.0		18.8	25.0	9.0	9	20
#100 (0.15)		3.0		2.0	12.0		12.8	17.0	5.6	6	12
#200 (0.075)		1.0		1.0	7.0		9.7	10.4	3.1	3.1	-



## MIX DESIGN-COMPONENTS

Coarse aggregate					
%	Size	Type	Producer/Location	Code	ODOT Gsb
56	#8	GR/LS	Shelly Materials-Columbus, Oh (Pugmill)	4502B-01	2.592
Fine aggregate					
%	Size	Type	Producer/Location	Code	ODOT Gsb
16	Sand	Natural	Mar Zane-Zanesville, Oh	04416-01	2.571
15	Sand	Limestone	Shelly Materials-Columbus, Oh	04502-01	2.602
*RAP & Shingles					
%	% AC	Type	Source	Composition	Gse
		Standard	Extended		
9	5.50		X	Composite 15-Fine Rap Pit 90 Shingles	Limestone 2.697
4	18.00		X		Shingles 2.383
AVG	9.35				

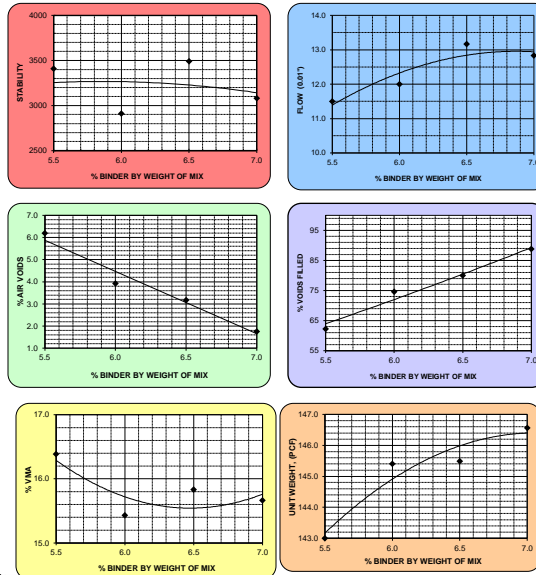


## MIX DESIGN

Mix Type	Type 1 RAS 70-22M
Usage; ("1" for Surface)	Surface
Traffic Designation:	Heavy
("1" if Heavy ; "2" if Light )	
Line Item Reference Number(s)	0023
% Binder Content @ Max. Stability	
% Binder Content @ Max. Unit Weight	
% Binder Content @ Opt. Air Voids	6.2
Max. Theoretical @ Optimum	2.418
PG Grade by Proposal	PG 70-22M
% Virgin Binder	5.0
Virgin Binder Grade	PG 70-22M
Binder Supplier	Shelly-Toledo
Polymer Type (SBR -or- SBS)	SBS
Mixing Temperature	315 F
Compaction Temperature	295 F
F/A Ratio	0.5 OK
50 - 30 Ratio	0 OK
TSR Ratio	NA OK



## Design charts



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## Paving with shingles

- Normal paving procedures
- Can be a “shifter” mix



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## Shingles Use

- No significant production or placement problems
- Mix design considerations
  - Typical use is 5 - 7% of mix (Private, ODOT restricts to 5%)
  - Percentage use is based on mix type, surface vs. binder
  - Marshall and Superpave designs developed
- Shingles used in batch and drum facilities
- Concerns regarding the control of the addition of small amounts of shingle materials
  - Belt scale, belt speed, or use of carrier aggregate to address
- Have not encountered serious problems with shingles stored over the winter



## Shingle Paving Projects



## Observations

- Issues and concerns noted:
  - Shingle sand and Shingle RAP blends tend to retain moisture
  - Mix working time reduced
  - Material handling
  - Shingle tabs can get through grinder
  - Lack of general acceptance of this recycling practice
    - Necessitates ability to use multiple recycled products at the same time



## Summary

- Shingles can be effectively used in HMA to produce a mix of equal or better quality
  - Binder savings in excess of those obtained from RAP use alone appear realistically achievable
- Practical issues need to be addressed
  - Use of multiple recycled products at the same facility at the same time
  - Material storage concerns
  - Consistency of Shingles and carrier aggregate blends
  - Required environmental testing



## QUESTIONS?



## MIX DESIGN





## Oldcastle Materials Observations

- Issues and concerns noted (continued):
  - Shingle contribution to the mixture's effective binder content
  - Increased wear on equipment due to Shingle use
  - Consistency of Shingle supply
    - Tear-offs
    - Manufacturers
  - Uniformity of Shingle grind supplied
    - Oversized particles may require screening after grinding
    - Binder content consistency



## Best Practices



Materials

## Best Practices



## Summary

- Additional research required
  - Development of mix design protocol and standard specifications
    - Considering contribution of Shingles to the mixture's effective binder content
    - Must be volumetrically based
  - Determine amount of binder blending and the resulting binder's low temperature performance
    - When are different virgin binders necessary?
  - Develop database of Shingle mix performance
  - Identify hurdles to general acceptance of this type of recycled product



## Appendix

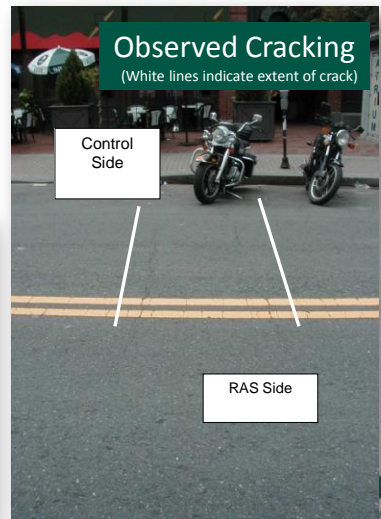
- Following slides are from some of the first projects to use shingles in North America



## Worcester, MA Demonstration Project 2000

### Site Description:

- Commercial Street, Worcester, MA
- 13/4-inch of surface mix placed over existing roadway
- 5-Percent, 1/2-inch RAS
- Manufacturer's Off-Spec Shingles
- Constructed September 21, 2000
- Standard Paving Equipment and Procedures
- Photos Taken June 28, 2002



## Saint Paul, MN Recreational Trail 1990



(Courtesy of Roger Olson / MnDOT)

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- MnDOT's 1<sup>st</sup> test section containing shingle pavement
- Subbase: old railroad track-bed
- Base: 4-inch crushed concrete
- Wearing Course: 2.5-inch thick,
- 12-foot wide HMA containing 6% & 9% shingles
- 1995: Performing well
- 2003: Performing well
- Result of project: Move forward with roadway demonstration projects.
- See MnDOT Report No. 96-34 for more details

## Mayer, MN TH25 Overlay 1991

1995

- Shingle sections performing as well as control
- Transverse reflective cracking evident in both control and shingle test sections.

2003

- Shingle sections performing as well as control



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**2002: 11-Years Later**  
(Courtesy of Roger Olson / MnDOT)



## Waterloo, Ontario, Canada Highway 86 1996

- 2-Lane road expanded to 4-lane highway
- Lower Binder: 1.5"
- Upper Binder: 2" with 3% shingles
- Wearing Course: 1.5" with 3% shingles
- See Yonke, *et.al.* Report for testing details

### Control mix, 1999

- Fine aggregate raveling
- Longitudinal joint raveling and opening
- Fatigue cracking in wheelpath

### Shingle mix, 1999

- No fine aggregate raveling
- No longitudinal joint raveling or opening
- No fatigue cracking in wheelpath

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(Courtesy Paul Lum, LaFarge, 2001)



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