WisDOT Pilot: High Recycle Mixes

WAPA 55th Annual Conference
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Agenda

- Specification Development & Background
- Performance Testing
- Projects
- Lessons Learned
- Contractor Experience

Background

- Desire to improve the way we work with recycled materials
- Industry looking for more economical ways to produce mixes
- Desire to use more than volumetrics as a means to accept pavements.

Specification Development Team

- WisDOT
  - Dan Grasser
  - Rebecca Burkel
  - Barry Paye
  - Debbie Schwerman
- Consultant Support
  - Signe Reichelt, BME
  - Jay Behnke, STATE
- WAPA
  - Brandon Strand (WAPA)
- Industry
  - John Bartoszek (P&D)
  - Brett Stanton (P&D)
  - Steve Kennedy (RR)
  - Steve Bloedow (RR)
  - Dan Staebel (Mathy)
  - Erv Dukatz (Mathy)
- NCAT
  - Richard Willis
  - Randy West

Pilot Program Activities

- Look at using mixes beyond 25-40% Percent Binder Replacement (PBR) limits currently allowed
- Using best practices from NCAT research & workshops
- Use performance testing to ensure baseline performance levels
- Verify binder blending charts for Wisconsin materials

Department Goals

- Implement better practices for the use of recycled materials
- More economical mixes without sacrificing pavement performance
- Develop performance testing protocols and target values

Department Goals

- Review performance of lower target air void mixes
- Develop protocols for verifying asphalt content
- Upgrading of standard specifications for the use of recycled materials

Current Recycled Product Specs

SS 460.2.5 & 460.2.6

MAXIMUM ALLOWABLE PERCENT BINDER REPLACEMENT

RECYCLED ASPHALTIC MATERIAL	LOWER LAYERS	UPPER LAYER
RAS if used alone	25	20
RAP and FRAP in any combination	40	25
RAS, RAP, and FRAP in combination[1]	35	25

[1] When used in combination the RAS component cannot exceed 5 percent of the total weight of the aggregate blend.

(2) The contractor may replace virgin binder with recovered binder up to the maximum percentage allowed under 460.2.5 without changing the asphaltic binder grade. If using more than the maximum allowed under 460.2.5, furnish test results indicating that the resultant binder meets the grade the contract originally specified.

Pilot Project Specification Limits

MAXIMUM ALLOWABLE PERCENT BINDER REPLACEMENT

RECYCLED ASPHALTIC MATERIAL	LOWER LAYERS	UPPER LAYER
RAS if used alone	25	20[2]
Any blend of RAM [3] (from more than 1 source)	50[1]	40[1,2]

[1] When used in combination the RAS component cannot exceed 5 percent of the total weight of the aggregate blend.

[2] For RAS only and any combination RAM with a percent binder replacement greater than 25%, Virgin binder grades used to produce these mixes will be adjusted as follows:

Plan Specified Binder Grade	Supplied Virgin Binder Grade
PG 58-28	PG 52-34 or 46-34

This virgin binder grade adjustment may be waived if the contractor furnishes test results indicating that the resultant binder meets the grade of the contract originally specified as referenced in 460.2.7 of this SPV article

Other Standard Spec Modifications

- Target TSR raised from 0.70 to 0.75
- Target Air Voids lowered from 4.0% to 3.5%
- Relaxed Dust to Binder Ratio ceiling to 1.6
- Daily production extractions for Asphalt Content required
  - Ignition Oven
  - Centrifuge
  - Reflux
  - Vacuum

RAS Stockpile Testing Requirements

- One Test per 250 Tons during pile production
  - Gradation (Pilot)
    - 100 % Passing the 3/8” Sieve
    - 93% Passing the #4 Sieve
    - Less than 1% Deleterious on R4 Material
- Old specification
  - 100% Passing ½” Sieve

RAS Stockpile Testing Requirements (Con't)

- P200 must be within 2.0% of stockpile average
- Asphalt content must be within 2.0% of stockpile average
- All properties must be within described tolerances for 80% of the tests for stockpile to be accepted
- Minimum of 5 tests per stockpile

RAP Stockpile Testing Requirements

- One Test per 2000 Tons during pile production
  - P200 within 2% of stockpile average
  - Asphalt content within 0.75% of stockpile average
  - All properties within described tolerances for 80% of the tests
  - Minimum of 5 tests

Performance Testing

- Striping Resistance – Hamburg Wheel
  - AASHTO T324-11
- Fatigue Cracking – Semi Circular Bend Test (SCB)
  - AASHTO XXXX-XX – In Development (ASTM & AASHTO)
- Low Temperature Cracking – Disc Shaped Compact Test (DCT)
  - ASTM D 7313-07

Performance Test Intervals

- QC
  - Mix Design
  - Test Strip (Start up)
  - Once every 10,000 Tons of production
- QV
  - Test Strip (Start up)
  - Once every 10,000 Tons of production

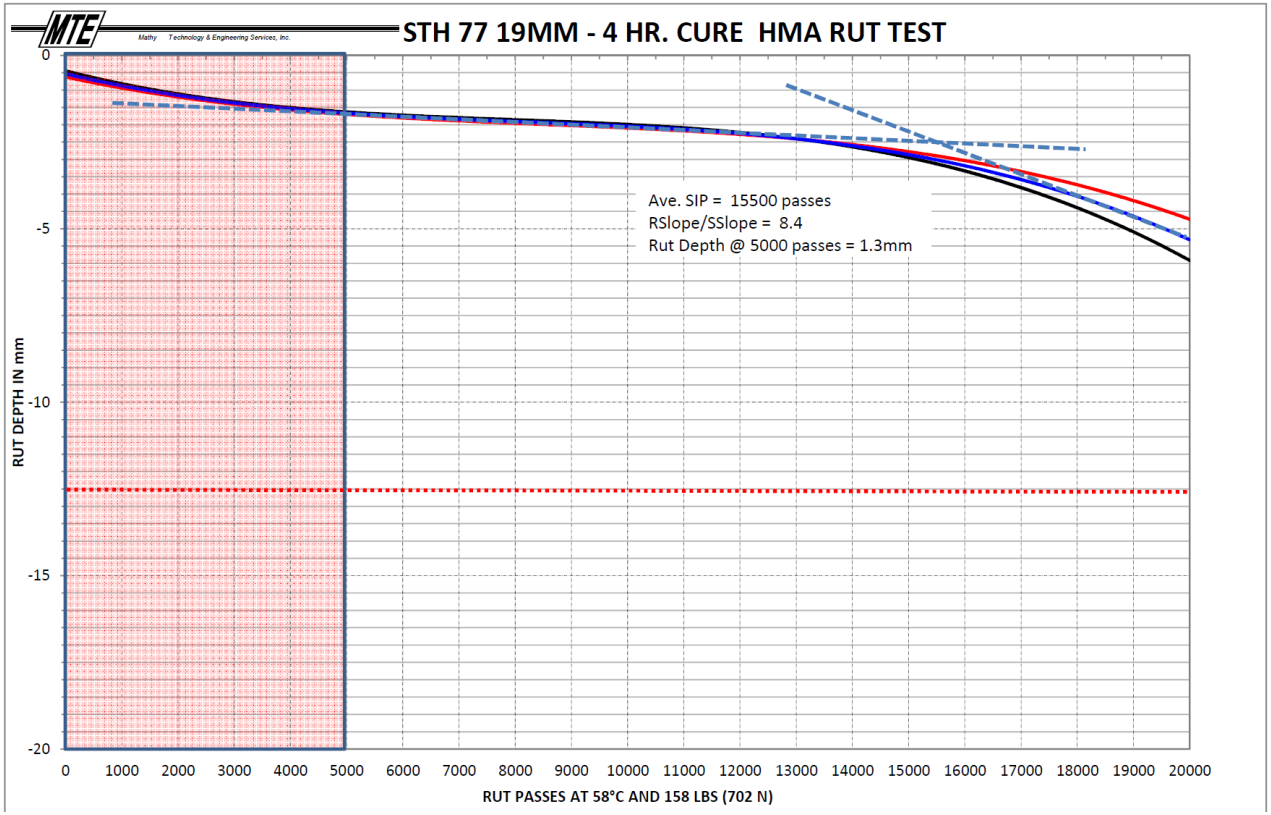
Aging Requirements

- Long Term Aging Required (AASHTO R30)
  - 120 hours at 85C (5 Days)
  - Required for DCT, SCB Tests
  - Significant lead time needed to obtain results

Hamburg Wheel Samples

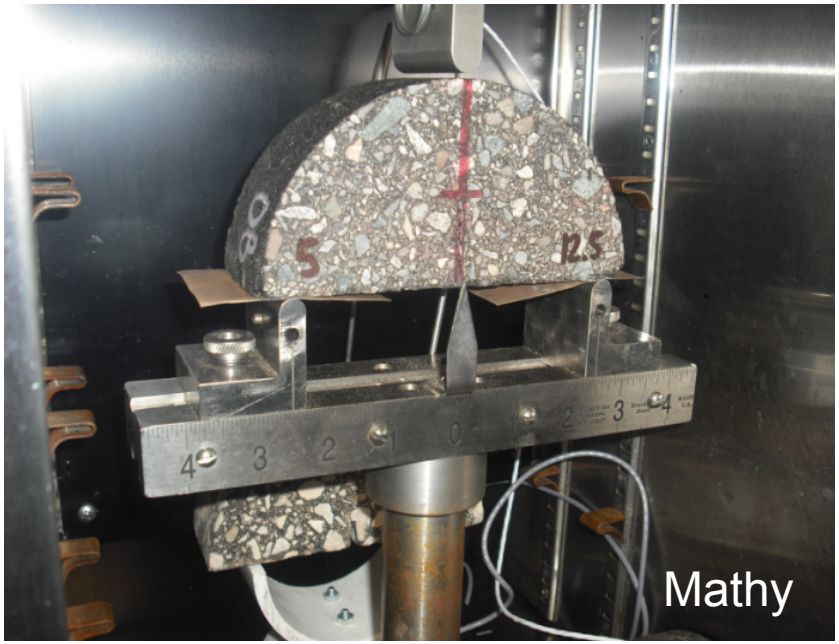
- Moisture sensitivity and rutting potential
- Limits based on high temperature PG grade
- Less than 0.5” rut depth @ defined # of passes
  - PG 58 – 5,000 passes
  - PG 64 – 10,000 passes
- Stripping & Inflection Point (SIP) for mix stability

Hamburg Wheel Result



Mathy

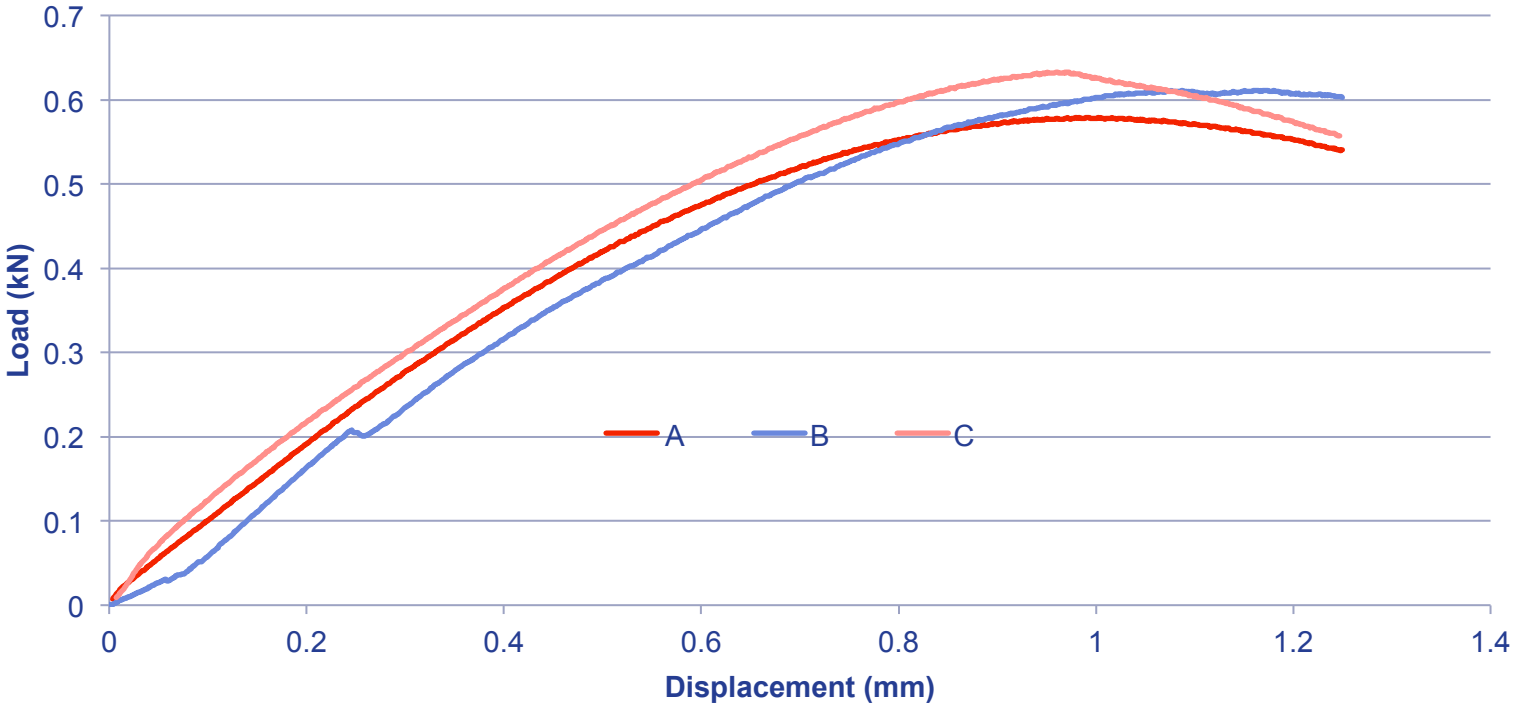
Semi-Circular Bend Test



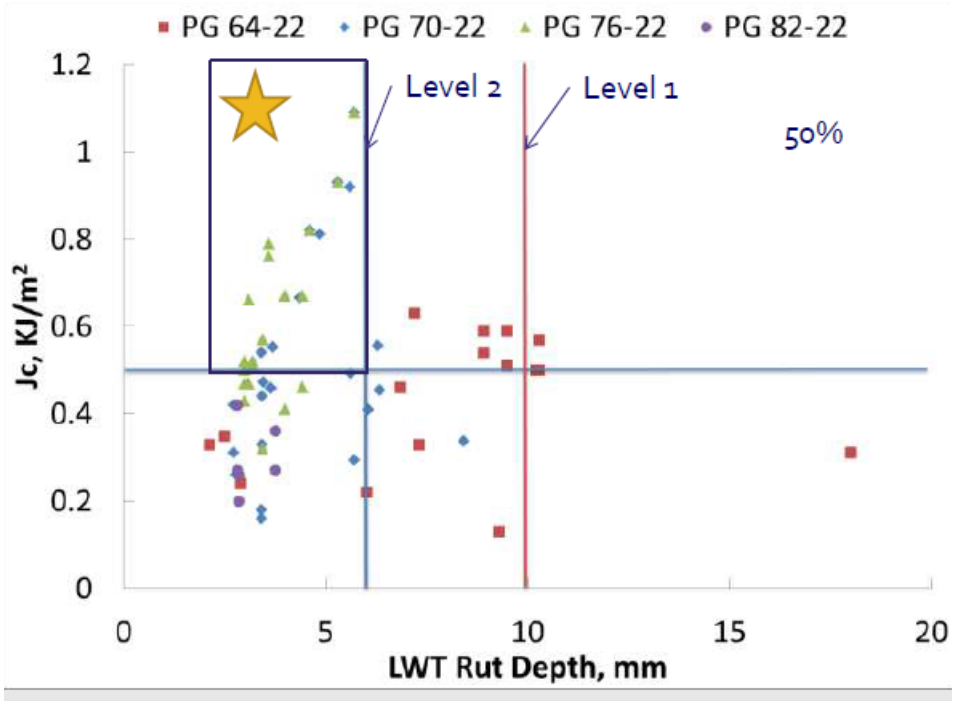
SCB Samples

- Wheel path fatigue cracking
- Following the Louisiana Procedure
- 3 different notch depths
  - 25.4, 31.8 and 38.1 mm
- No set limit, as specification is still in development

SCB Result


0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
Load (kN)
0
0.2
0.4
0.6
0.8
1
1.2
1.4
Displacement (mm)
A
B
C

SCB Spec Limit - Louisiana



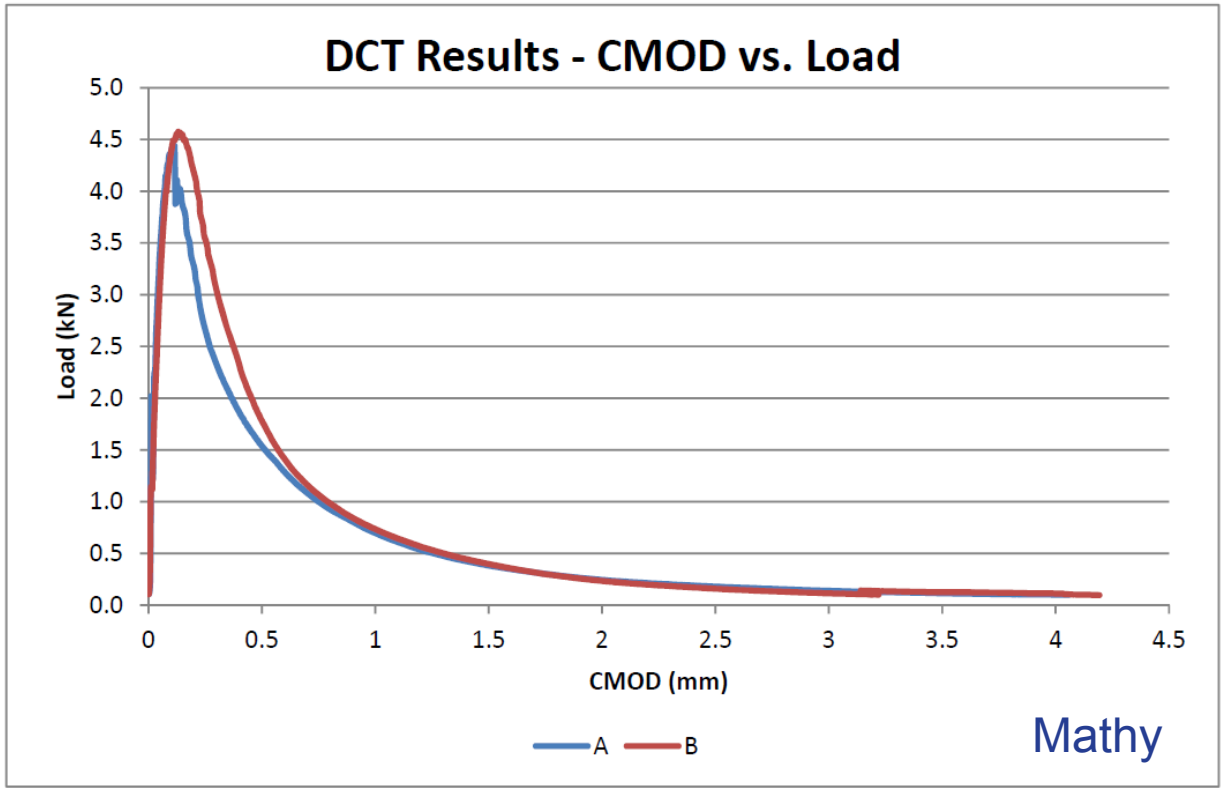
Mathy

Disc Shaped Compact Test

DCT Samples

- Low temperature cracking
- 400 J/m^2 the desired minimum
- Run at 10C above the design required minimum
  - -34 C = -24 C Test temperature

DCT Result


DCT Results - CMOD vs. Load
Load (kN)
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
CMOD (mm)
A
B
Mathy

Test Strips

- Verify mix design
- 600 Tons placed on project or elsewhere
- Sampled mix to verify:
  - Performance Testing (Hamburg, DCT, SCB)
  - Volumetrics
  - Density
- 10 business day lead-time before paving
- Pay item (SPV)

Pilot Projects

- STH 77, Ashland County
- STH 73, Dane County
- USH 141, Marinette County

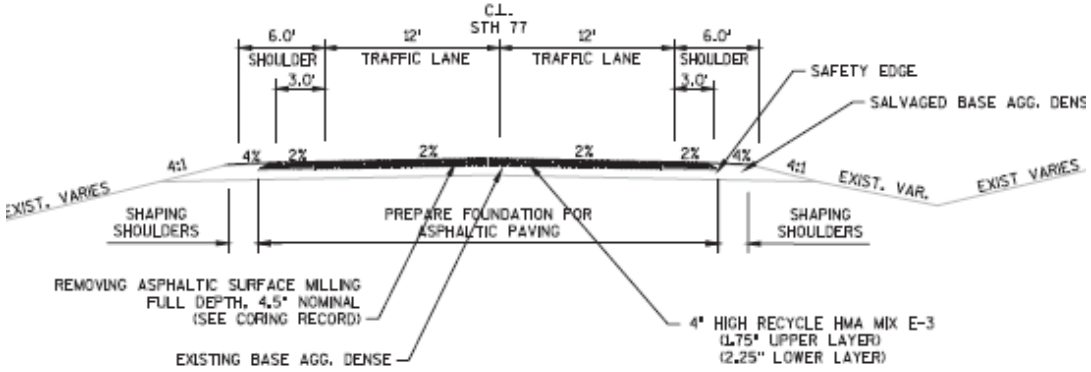
Leveraging National Support

- FHWA National Panel on Performance Based Technologies for ME
  - Effort led by ARA and AAT
  - Recycle Impacts for Wet Freeze Climate
- FHWA Mobile Lab
  - Located at Rock Road Plant
- NCAT RAP/RAS Workshop
  - Randy West & Ray Brown
  - March 6 & 7, 2014

STH 77 – Clam Lake to STH 13 (8530-14-71)

- High Recycle Mix Used on 19mm lower and 12.5mm upper layer of the mill & overlay project
  - Total Project Length – 13.69 miles
    - 3” pavement depth
      - 1.25” Leveling Layer
      - 1.75” Upper Layer
  - High Recycle Length – 4.08 miles (West End)
    - 4” total pavement depth
      - 2.25” Lower Layer
      - 1.75” Upper Layer

STH 77 Typical Section



FINISHED TYPICAL SECTION
(HIGH RECYCLE HMA MIX E-3)
STA. 1748+89.00 - 1964+50

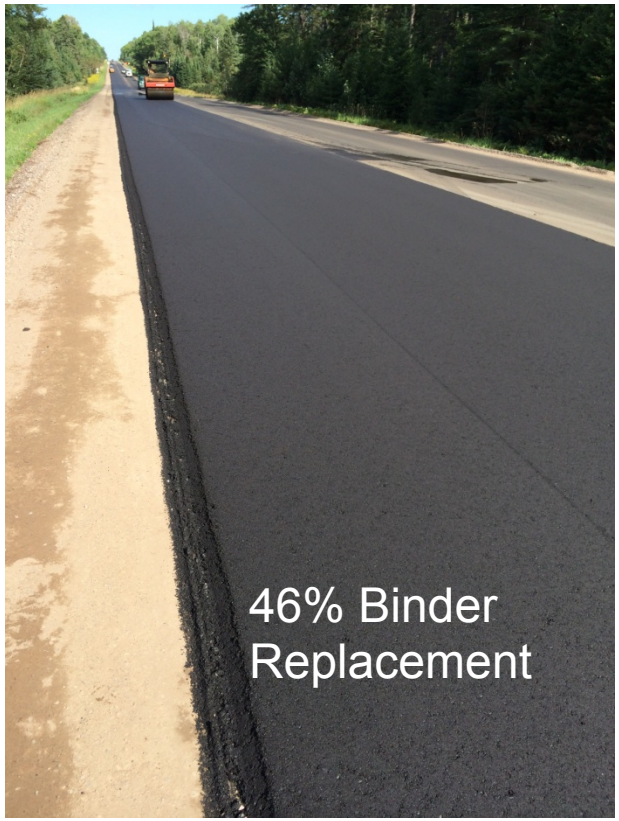
STH 77 Quantities

- Plan Quantities
  - All pavement – E3
    - Standard Specification E3 – 29,219 Tons
    - High Recycle E3 – 16,367 Tons
- PG Binder Type
  - Standard Mix – PG 58-34
  - High Recycle – PG 58-34 Resultant
    - Blending recycled binder with virgin binder needed to meet PG 58-34 requirements

STH 77 Mix Designs

- All designs used RAP – Single Stockpile
  - RAP Obtained from STH 77 Millings
- 12.5 mm mix design
  - 33% RAP (by agg wt.) in mix
  - 36.7% binder replacement
- 19 mm mix design
  - 35% RAP
  - 45.9% binder replacement

STH 77, Ashland County



STH 77 Performance Testing Data

Mathy Design #	Pbr	Plan PG Binder	PG Binder	DCT - Aged		SCB		Hamburg		PG Grading
				Mathy	QV	Mathy	QV	Mathy	QV	Mathy
E-3 19.0mm										
774 - Design	46	PG 58-34	58-40	561 (SD 36.8)	485.761 (SD 9.451)	0.326	0.982	1.3 (@5000 w/ 4hr cure)	2.33 (@5000)	76.7-35.1
774 - Test Strip	46		58-40	593.6 (SD 140.4)	561.545 (SD 16.313)	0.330	1.811	2.05 (@5000)	3.09 (@5000)	76.6-36.4
E-3 12.5mm										
775 - Design	36.7	PG 58-34	58-40	698 (SD 26.9)	681.194 (SD 169.038)	0.213	0.945	3.4 (@5000 w/ 4 hr cure)	3.47 (@5000)	79.1-34.0
775 - Test Strip	36.7		58-40	631.6 (SD 30.3)	529.562 (SD 23.3)	0.26	1.284	3.18 (@7500)	5.68 (@5000)	79.2-34.0

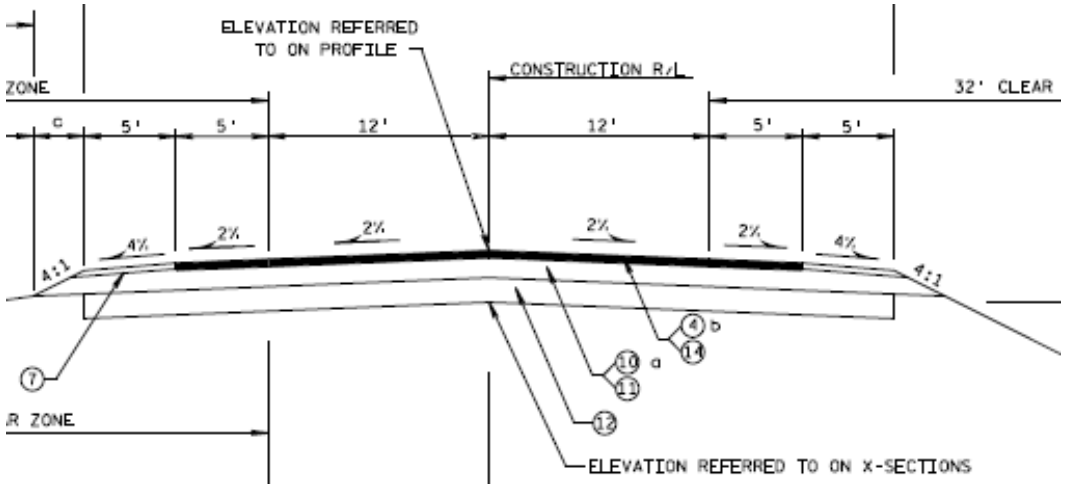
STH 77 Issues/Lessons Learned

- Language cleanup on procedures
  - Sampling
  - Aging
- Timeline needed for the process
  - 5 day long term aging of DCT, SCB impact project & mix design timelines
- SCB equipment related issues
  - Equipment setup
  - Test temperature

STH 73, USH 12/14 to IH 90 (3070-00-72)

- Reconstruction project run as a research project with various levels of recycling used in both the lower and upper lifts.
- Total project length 9.623 miles
  - Lower layer – 3.5” 19 mm
  - Upper layer – 1.75” 12.5mm
- Target PG Binder Grade PG 58-28
- Total 66,153 Tons E 3 mix

STH 73 Cross Section



STH 73 Test Matrix

STH 73 RESEARCH MIX DESIGN TABLE

PROJECT MIX ID #	Rock Road Design #	WisDOT Approval#	Nom Max	Type	ABR	PG GRADE	ADDITIVE	VOID TARGET
RRSTH73 #1	RR0282EX	0-250-0329-2014	19 mm	E-3	65%	58-28		3.5
RRSTH73 #2	RR0282EX	0-250-0329-2014	19 mm	E-3	65%	52-34		3.5
RRSTH73 #3	RR0282EX	0-250-0329-2014	19 mm	E-3	65%	58-28	Yes	3.5
RRSTH73 #4	RR0282	0-250-0330-2014	19 mm	E-3	50%	58-28		3.5
RRSTH73 #5	RR0282	0-250-0330-2014	19 mm	E-3	50%	52-34		3.5
RRSTH73 #6	RR0282	0-250-0330-2014	19 mm	E-3	50%	58-28	Yes	3.5
RRSTH73 #7	RR0276	0-250-0104-2014	19 mm	E-3	35%	58-28		4.0
RRSTH73 #8	RR0276	0-250-0104-2014	19 mm	E-3	35%	52-34		4.0
RRSTH73 #9	RR0283	0-250-0331-2014	12.5mm	E-3	50%	58-28		3.5
RRSTH73 #9.5	RR0283	0-250-0331-2014	12.5mm	E-3	50%	52-34P		3.5
RRSTH73 #10	RR0283	0-250-0331-2014	12.5mm	E-3	50%	52-34		4.0
RRSTH73 #12	RR0277	0-250-0105-2014	12.5mm	E-3	25%	58-28		3.5
RRSTH73 #13	RR0277	0-250-0105-2014	12.5mm	E-3	25%	52-34		4.0

STH 73 Mix Designs

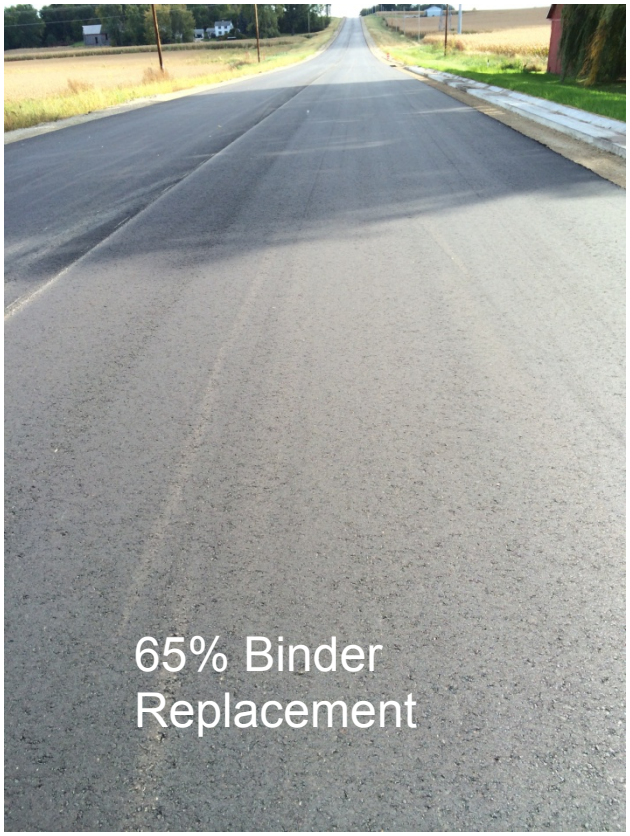
- Recycled asphalt from fractionated RAP (coarse & fine) and RAS

Mix Design	%RAP	%RAS	Total % Binder Replacement
276 (19mm)	14%	4.0%	34.6%
282 (19mm)	33%	4.0%	50.3%
282EX (19mm)	40%	6.0%	68.3%
277 (12.5mm)	13%	3.0%	24.6%
283 (12.5mm)	32%	5.0%	48.4%

STH 73 Performance Testing Results

RR Design #	Pbr	PG Binder	Additive	Sampled?	DCT - Aged		DCT - Unaged	SCB		Hamburg		PG Grading
					Rock Road	QV		Rock Road	QV	Rock Road	QV	Rock Road
E-3 19.0mm												
1	65	58-28	No	10/7/2014		279.01 (SD 47.58)					2.10 (@5000)	
2	65	52-34	No	9/16/14	267.57 (SD 28.25)	349.68 (SD 4.497)		0.639 (2 sets)	0.721 (full set)	2.35 (@7500)	1.67 (@5000)	96.7-15.7
3	65	58-28	Yes	10/8/2014		362.67 (SD N/A)					2.39 (@5000)	
4	50	58-28	No	9/16/14	304.28 (SD 18.52)	333.44 (SD 29.37)		0.785 (2 sets)	0.957 (full set)	2.20 (@7500)	1.48 (@5000)	87.9-24.9
5	50	xx-34	No	10/3/14		261.44 (SD 29.02)					1.42 (@5000)	
6	50	58-28	Yes	9/16/14	294.64 (SD 41.68)	284.67 (SD 12.51)		0.959 (2 sets)	0.6346 (full set)	2.44 (@7500)	1.62 (@5000)	87.7-23.4
7	35	58-28	No	10/10/14		Bag/Hold			Bag/Hold		Bag/Hold	
8	35	xx-34	No	10/9/2014		Bag/Hold			Bag/Hold		Bag/Hold	
E-3 12.5mm												
9	50	58-28	No	10/7/2014	321.58 (SD 22.72)	292.87 (SD 16.12)	332.69 (SD 9.8)			1.24 (@5000)	2.24 (@5000)	86.2-23.1
9.5	50	XX-34P	No	10/21/2014		382.110 (SD 8.103)	342.085 (SD 0.995)			1.95 (@5000)	2.49 (@5000)	
10	50	XX-34	No	10/18/2014		385.615 (SD 13.640)	397.210 (SD 60.557)			2.64 (@5000)	3.79 (@5000)	
12	25	58-28	No	10/16/2014		338.885 (SD 41.189)	394.750 (SD 71.206)			3.29 (@5000)	5.17 (@5000)	
13	25	XX-34	No	10/16/2014		446.260 (SD 35.511)	455.935 (SD 94.576)			5.52 (@5000)	12.72 (@4430)	

STH 73, Dane County



STH 73 Lessons Learned

- Impacts of binder aging on performance
- Benefits of Hamburg Wheel Test
- Be careful of additives used

- Will monitor for long term performance
  - Signs placed on project to mark different mixes
- Still waiting for FHWA Trailer results
- Warranted by contractor for long term performance

USH 141, Marinette County

- Moved to 2015 construction season
- Pilot specs will be updated based on lessons learned from first 2 pilot projects

Economics

- All projects were let with a Standard Specification & High Recycle Pilot mix (All E-3 mixes)

- Let savings of varied from 5 to 15% on HMA Items (including asphalt binder costs) for higher recycle mixes than standard E-mix.

Next Steps

- Updated specification and procedures with lessons learned
- Look for other pilot projects
- Monitor performance
- Use pilots to update standard specifications
  - Asphalt content testing
  - Recycled product specifications
  - Performance testing
  - Potentially mix design targets

Questions

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