Reclaimed Asphalt Pavement (RAP) and Reclaimed Asphalt Shingles (RAS)

ASPHALT PAVEMENT ASSOCIATION OF MICHIGAN

Reduce / Reuse / Recycle

Reclaimed Asphalt Pavement (RAP) and Reclaimed Asphalt Shingles (RAS)

ASPHALT PAVEMENT ASSOCIATION OF MICHIGAN

- Benefits of using RAP
- Overview of RAS
- Specification changes
- New MDOT RAP / RAS specification
- Recommended practices

Recyclability

- Asphalt is the No. 1 recycled material in the US

- Asphalt Pavements are 100% recyclable
  - Can re-use binder
  - Return on investment

Why Recycle RAP into HMA?

- Best and Highest use
- Same or better performance as virgin mix
- Reduces demand for new materials
- Reduces carbon footprint
- Contains valuable materials
- Save $

Why Recycle RAP into HMA?

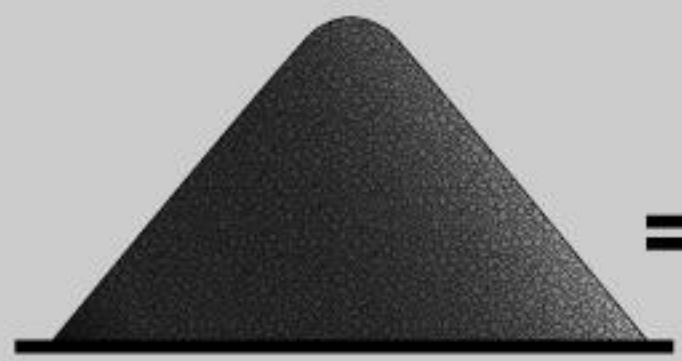
- **RAP contains valuable materials :**
  - **Aggregate ~95% @ $15/ton**
  - **Asphalt ~5% @ $550/ton**
  - **Value = $41.75 /ton (minus processing)**

Economics Savings Example

- Aggregate: $15.00/ton
- Asphalt: $550.00/ton
- RAP: $9.00
- Mix Design AC Content: 5.0%

Material	0% RAP	12% RAP	25% RAP
Aggregate	$14.25	$12.45	$10.50
Asphalt	$27.50	$24.20	$20.63
RAP		$1.08	$2.25
Total	$41.75	$37.73	$33.38
$ Savings		**$4.02**	**$8.37**
% Savings		**9.6%**	**20.1%**

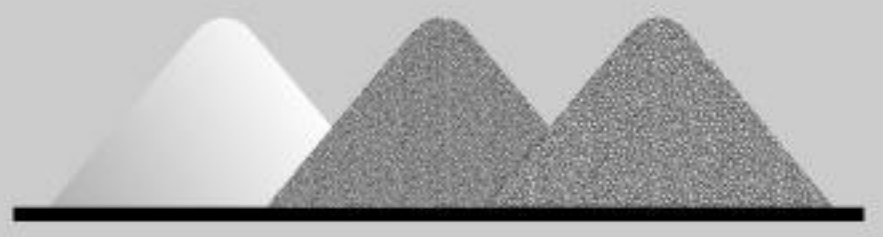
ASTEC
INDUSTRIES, INC.



30,000 Tons of RAP

=

70 - 6,000 Gallon Transport Trailers
and 28,200 Tons of Clean Aggregate



RAP is Worth the Virgin Material It Replaces

Binder Properties

- Binder in the RAP is aged and much harder than Virgin Binder

- Need to account for this at higher RAP %
  - Use a softer asphalt with higher Rap %
  - This will prevent brittle mixes and ensure good performance

Binder Replacement Calculation

Asphalt Pavement Association of Michigan

$$\text{Binder Replacement, \%} = \frac{(A \times B)}{C} \times 100\%$$

Where:

A = RAP percent binder content

B = RAP percent in mixture

C = Total percent binder content in mixture

Binder Replacement Calculation

Example: For a mix containing 20 % RAP

A = 4.5 % (binder in the RAP)

B = 20 % (RAP in mixture)

C = 5.7 % (Total binder in mixture)

$$\text{Binder Replacement} = \frac{(A \times B)}{C} \times 100\%$$

$$= \frac{4.5 \times 0.20}{5.7} \times 100\%$$

$$= .90 / 5.7 \times 100\%$$

$$= \mathbf{15.8\ \%}$$

Superpave Asphalt Binder Specification

The grading system is based on climate

PG 58 - 28

Performance Grade

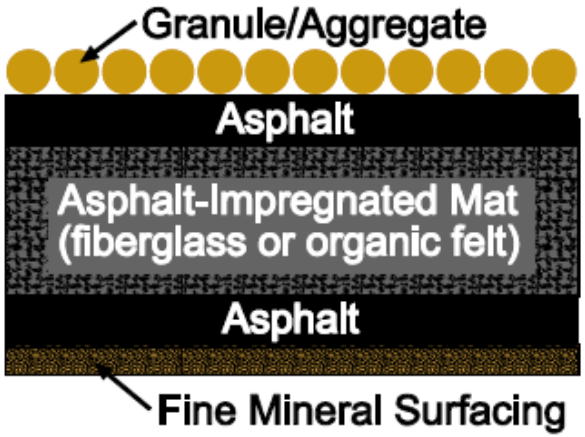
Average 7-day max pavement temperature

Min pavement temperature

Reclaimed Asphalt Shingles (RAS)

Reclaimed Asphalt Shingles (RAS)

Why use asphalt shingles in asphalt pavement?



All materials commonly used in asphalt pavements

NAPA Webinars

Reclaimed Asphalt Shingles (RAS)

- Sources of shingles:
  - Manufacturers' waste (Post-manufacture)
  - Tear offs (Post-consumer)

Reclaimed Asphalt Shingles (RAS)

- Manufacturers' waste vs. Tear offs
- Different characteristics need to be accounted for :
  - Asphalt binder content
  - Binder stiffness

Reclaimed Asphalt Shingles (RAS)

Minnesota DOT 2007

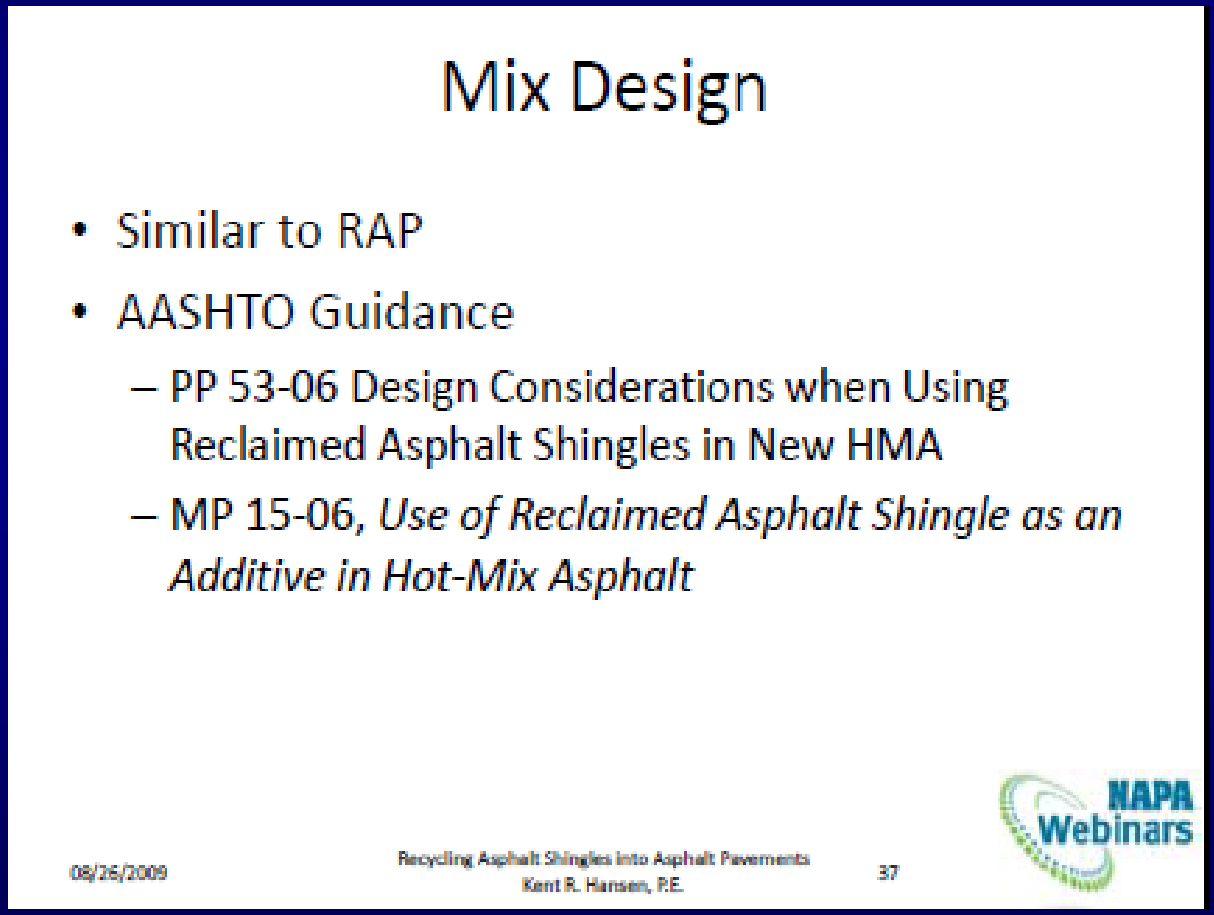
Material	Asphalt Content, % Total Weight	PG Binder Grade
Virgin Asphalt	NA	58-28
RAP	7.0	76.1-25.8
RAS (tear-off)	36.4	126.0+1.1
RAS (manufacturer)	19.6	141.7-11.0

Ref: McGraw, Zofka, Krivit, Schroer, Olson, & Marasteanu, 2007

Reclaimed Asphalt Shingles (RAS)

- Shingles are valuable due to high AC content
- But need to be used correctly to account for their stiffer binder properties
- Follow best practices for processing

Reclaimed Asphalt Shingles (RAS)



MDOT RAP Spec Changes For 2013

1. November 2012 - Changes made to Superpave RAP spec

2. New Combined RAP / RAS Spec approved in Feb 2013

   - Allows permissive use of RAS
   - Incorporates changes made in 2012

3. Marshall mix RAP spec under discussion

MDOT RAP Spec Changes For 2013

SPECIAL PROVISION
FOR
RECYCLED HOT MIX ASPHALT MIXTURE IN SUPERPAVE MIXTURES
DATED 11-05-12 03SP 501(G)

- **Allows the E3 to E50 leveling and top course mixes to go into tier 2 (27%)**

- **Removed the restriction for (P) grades of PG Binder to be limited to Tier 1 (17 %) RAP, ie PG 70-22(P)**

MDOT RAP /RAS Spec 2013

SPECIAL PROVISION
FOR
RECYCLED HOT MIX ASPHALT MIXTURE
(PERMISSIVE USE OF RECYCLED ASPHALT SHINGLES)
DATED Feb 2013 03SP 501(I)

- **Allows the permissive use of RAS**
- **Addresses the combined use of RAP and/or RAS**

MDOT RAP /RAS Spec 2013

DATED FEB 2013 03SP501(I)

- RAS materials must not contribute more than 17 percent by weight of the total binder content for any HMA mixture.
- The percentages of RAP and/or RAS must be as specified on the Mix Design and Job Mix Formula.

MDOT RAP /RAS Spec 2013

DATED FEB 2013 03SP501(I)

- RAS is defined as:
- Processed asphalt shingle material from:
  - Manufacturing of asphalt roofing shingles.
    - "Post-manufacture RAS"
  - Tear-off shingles from residential structures.
    - "Post-consumer RAS"

MDOT RAP /RAS Spec2013

DATED FEB 2013 03SP501(I)

- Process the RAS by ambient grinding or granulating
  - 95-100 percent passing the 3/8 inch size sieve
  - 90-100 percent passing the No. 4 sieve.

- RAS must be stockpiled separately from other materials plus
  - separated into post-consumer RAS and post-manufacture RAS stockpiles.

MDOT RAP /RAS Spec2013

DATED FEB 2013 03SP501(I)

- RAP and RAS must be fed to the plant by separate feed systems capable of metering at the design rate.
- RAS may be blended with up to 20% fine aggregate during processing
  - Avoids clumping
  - Allows proper metering

MDOT RAP /RAS Spec 2010

DATED FEB 2013 03SP501(I)

- RAS must not contain extraneous waste materials:
  - asbestos, metals, glass, rubber, nails
  - soil, brick, tars, paper, wood, cellulose mat, plastics

- Waste materials:
  - shall be removed by hand (before processing)
  - must not exceed 1.5 percent by weight as determined on material retained on the No. 8 sieve.

MDOT RAP /RAS Spec 2010

DATED FEB 2013 03SP501(I)

- RAS must contain less than the maximum percentage of asbestos fibers based on testing procedures and frequencies established by state or federal environmental regulatory agencies.

Guidance available at :

http://www.shinglerecycling.org/content/regulatory-issues-regarding-asbestos

MDOT RAP /RAS Spec 2013

DATED FEB 2013 03SP501(I)

3 Tier system

Determines the grade of binder used in the mix

Based on the amount of the total binder that comes from the RAP and /or RAS (%) (Binder Replacement)

Tier 1: 0 – 17%
Tier 2: 18 – 27%
Tier 3: ≥ 28%

MDOT RAP /RAS Spec 2013

DATED FEB 2013 03SP501(I)

The maximum amount of RAS is limited by specification:

"RAS materials must not contribute more than 17 percent by weight of the total binder content for any HMA mixture."

MDOT RAP /RAS Spec 2013

DATED FEB 2013 03SP501(I)

Asphalt Pavement Association of Michigan

Tier 1 - 0% to 17% RAP and/ or RAS (binder replacement)

Use same grade (design binder grade)

Tier 2 - 18% to 27% RAP and/ or RAS (binder replacement)

At least one grade lower for the low temperature
Optional- lowering the high temperature one grade

If design binder grade is PG58-28 :

Use PG58-34 or 52-34

MDOT RAP /RAS Spec 2013

DATED FEB 2013 03SP501(I)

Tier 2 - 18% to 27% RAP and/ or RAS (binder replacement) (continued)

No binder grade change for:

All shoulder or temporary road mixes

LVSP, E03 and E1 mixtures used as leveling or top course.

Restrictions (on leveling and top course mixes):

E3 ,E10, E30 and E 50 mixes – maximum 27% RAP/ RAS

MDOT RAP /RAS Spec 2013

DATED FEB 2013 03SP501(I)

Tier 2 - 18% to 27% RAP and/ or RAS (binder replacement)

(continued)

When using RAS in Tier 2 :

The asphalt binder grade will be selected using a blending chart for high and low temperatures.

Another option :

When using only RAP in Tier 2 :

A blending chart may be used to select the high and low temperatures of the binder

MDOT RAP /RAS Spec 2013

DATED FEB 2013 03SP501(I)

Tier 3 - ≥ 28% RAP and /or RAS (binder replacement)

Use a blending chart to determine the high and low temperature values

MDOT RAP /RAS Spec 2013

DATED FEB 2013 03SP501(I)

ASPHALT PAVEMENT ASSOCIATION OF MICHIGAN

Blending Chart / Formula

$$\%RAP = \frac{T_{blend} - T_{virgin}}{T_{RAP} - T_{virgin}}$$

T_{virgin} = Critical temperature of virgin asphalt binder (high, intermediate, or low).

T_{Blend} = Critical temperature of blended asphalt binder (final desired) (high, intermediate, or low).

$\%RAP$ = Percentage of RAP expressed as a decimal.

T_{RAP} = Critical temperature of recovered RAP binder (high, intermediate, or low).

MDOT RAP /RAS Spec 2013

DATED FEB 2013 03SP501(I)

How much RAS can be added ?

- Manufacturers' waste (Post-manufacture) 4.25 to 5 %
- Tear offs (Post-consumer) 2.5 to 3 %

based on 5 - 6 % total binder in mix, and 17 % binder replacement

Recommended Practices for Use of RAP (and RAS)

Follow best practices for the processing and management of RAP/RAS

Contractor to sample and test RAP during processing.

RAS must also be tested

Typical Gradations

Parameter	Typ. RAP	Typ. RAS	Typ. E-1	Typ. E-10
AC	4.80%	29.10%	5.00%	4.91%
19.0mm	100.0	100.0	99.5	99.4
12.5mm	100.0	100.0	92.5	92.6
9.5mm	96.0	100.0	82.7	83.1
4.75mm	73.0	94.0	61.9	63.6
2.36mm	56.0	88.5	46.3	43.3
1.18mm	45.0	71.0	36.1	30.2
0.600mm	36.0	49.0	27.1	21.1
0.300mm	23.0	41.5	14.6	11.8
0.150mm	23.0	33.5	7.0	6.5
0.075mm	10.0	27.0	4.6	4.4

Mix w/25% RAP and 5% RAS requires all Virgin Aggregates <1% P200

Washing Aggregates

Recommended Practices for Use of RAP (and RAS)

RAP/RAS usage specification

RAP/RAS mixes should meet same specs as virgin mixes

Adjust binder grade appropriately

Approved mix design including RAP /RAS

Recommended Practices for Use of RAP (and RAS)

Asphalt Pavement Association of Michigan

Test the produced Mix:

- (Binder, Gradation)
- Contractor Quality Control Tests
- Owner Quality Assurance / Acceptance tests

If you have performance concerns:

- Consider testing/monitoring other properties
- Mix volumetrics (Air Voids, VMA)
- Fines to Effective Binder

Recommended Practices for Use of RAP (and RAS)

Follow best practices for the processing and management of RAS

- Shingles are considered a solid waste
- Shingles that are recycled are granted a site / source separated exemption (from the definition of solid waste)

Recommended Practices for Use of RAP (and RAS)

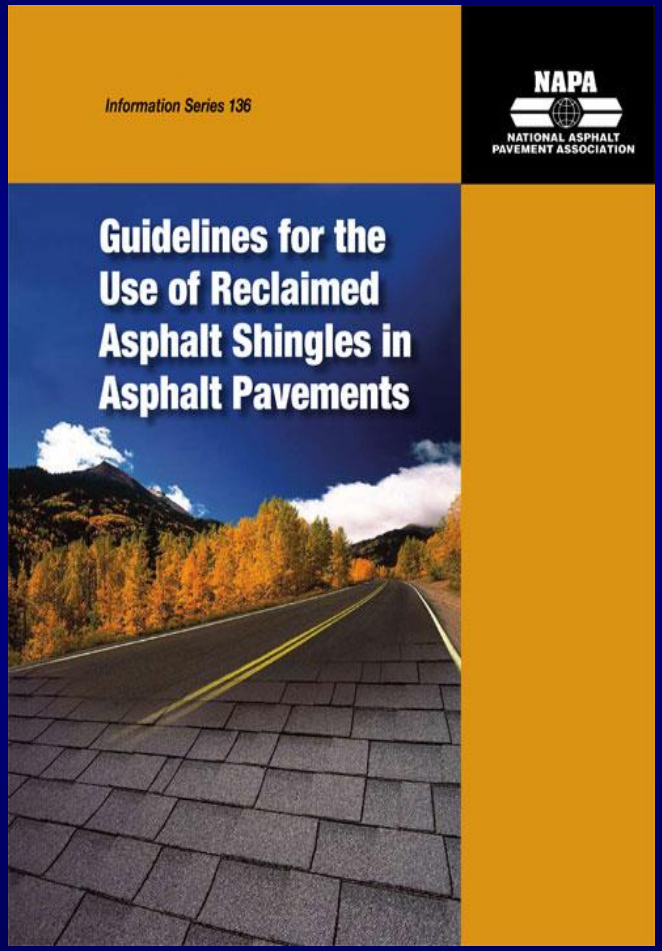
Follow best practices for the processing and management of RAS

- Shingle processors must follow rules and conditions for processing, storage and site management Per Asphalt Shingle Exemption (3-27-12)
- Michigan Department of Environmental Quality – Solid Waste Division
- http://www.michigan.gov/documents/deq/deq-whmd-swp-Exemption-AsphaltShingle_247530_7.pdf

Resources

www.asphaltpavement.org

- Guidelines for the Use of Reclaimed Asphalt Shingles in Asphalt Pavements



Resources

www.shinglerecycling.com

- Recycling Tear-off Shingles Best Practices Guide
- Environmental Issues Associated with Asphalt Shingle Recycling

MDOT RAP Spec Changes For 2013

1. November 2012 - Changes made to Superpave RAP spec

2. New Combined RAP / RAS Spec approved in Feb 2013

   Allows permissive use of RAS
   Incorporates changes made in 2012

3. Marshall mix RAP spec under discussion

Current MDOT Marshall RAP Spec

12SP501 (E), dated 06-06-11

For Marshall mixes only:

Tier 2 - 18% to 27% RAP (binder replacement)

- **No grade change required**
- **Optional - lowering the high temperature one grade**
- **Except in the Metro Region: Must lower the high temperature one grade**
  - If design binder grade is PG 64 -22, Use PG 58-22

Current MDOT Marshall RAP Spec

12SP501 (E), dated 06-06-11

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3. Marshall mix RAP spec under discussion ?

Discussion between CRAM and MDOT local agency division to require changing the low temp grade in Tier 2

Now : PG 58 – 28 use PG 58 – 28 or 52 -28

Proposed : PG 58 – 28 use PG 58 – 34 or 52-34

(MDOT spec used for Superpave mixes)

Caution Advised

Current MDOT Marshall RAP Spec

12SP501 (E), dated 06-06-11

ASPHALT PAVEMENT ASSOCIATION OF MICHIGAN

3. Marshall mix RAP spec under discussion ?

Caution Advised - risk of flushing / rutting using the softer liquid (-34) in tier 2 without strong aggregate structure.

SuperPave mixes have a tougher Aggregate Skelton (more rut resistant)

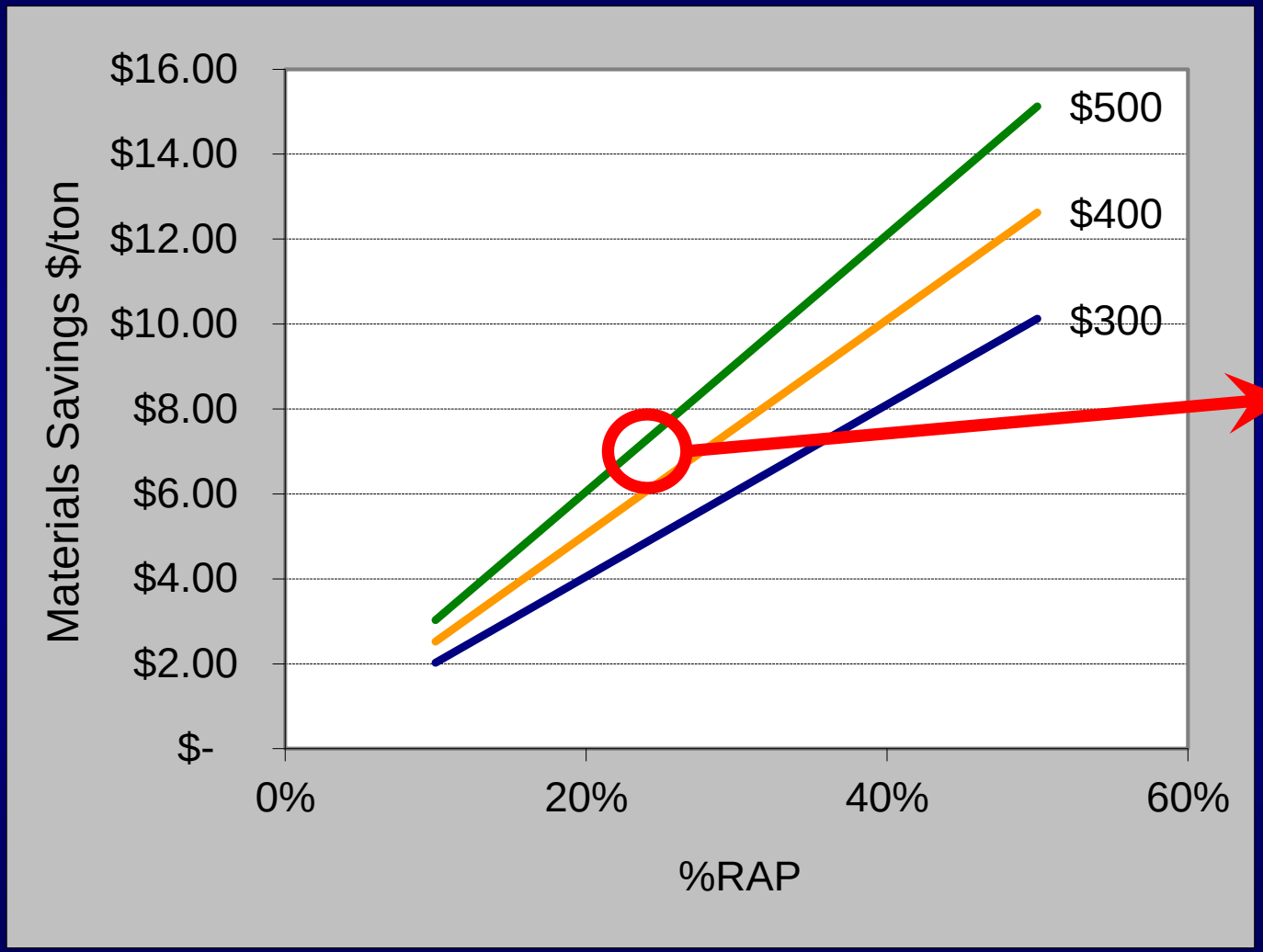
Marshall mixes - 50 Blow designs, Lower Crush Count & Lower Fine Aggregate angularity

- Especially the 13A and 36A mixes

Why Recycle RAP into HMA?

- Best and Highest use
- Same or better performance as virgin mix
- Save $

Example Materials Savings for RAP Utilization



Based on $15 Aggregate, $9 RAP

Resources

Reclaimed Asphalt Pavement in Asphalt Mixtures: State of the Practice

Publication No. FHWA-HRT-11-021 April 2011

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Asphalt Pavement Association of Michigan

Questions ????

Reduce / Reuse / Recycle

www.apa-mi.org