TRENDS IN RAP AND RAS USE:
BUILDING ON SUCCESS
AND EXPANDING THE BOUNDARIES

Rebecca S. McDaniel
Arizona Pavements/Materials Conference
November 13, 2013
BUILDING ON PAST SUCCESS

- Asphalt pavement is *the* most widely recycled material in the USA
- 100 million tons reclaimed annually
- 95% is reused or recycled
- $1.8 billion in savings each year
- Reduces demand for new aggregates and binder and the energy to produce them
- Can perform as well as virgin mixes
TODAY IN THE USA

Strong incentives to recycle more

- **Economics**
  - Saves money
  - Makes contractors more competitive
  - Helps asphalt retain market share

- **Environmental**
  - Increasing awareness, legislation, regulations
INCREASING TRENDS IN ASPHALT PAVING

- Recycling
  - Reclaimed Asphalt Pavement
  - Recycled Asphalt Shingles
  - Ground Tire Rubber
  - Other waste or by-product materials
    - Total Recycle Mix in Illinois

- Warm Mix Asphalt
  - May offer ability to use higher recycled contents through reduced aging
RECLAIMED ASPHALT PAVEMENT (RAP)

Recycling began in USA over 40 years ago because of:

- Arab oil embargo – shortages and high prices
- Environmental concerns
- Development of milling machines
RECLAIMED ASPHALT PAVEMENT (RAP)

Recycling began in USA over 40 years ago because of:

- Oil embargo – shortages and high prices
- Environmental concerns
- Development of milling machines

And today???
WHAT TO DO WITH THE RAP?
CURRENT AASHTO GUIDELINES

- Adjust grade of binder added to account for the hard, oxidized binder in the RAP
  - 0 to 15% RAP, no binder grade change
  - 16–25% RAP, decrease virgin binder grade
  - Over 25% RAP, test RAP binder to determine appropriate virgin grade (or allowable RAP content)

- Percentage by weight of RAP in the mixture.
- Based on non-fractionated mixes with about 5% binder in RAP and new mix.
GUIDELINES MAY BE CONSERVATIVE

- Study for Indiana DOT showed they could use higher RAP contents before changing grade
  - Up to 25% RAP before changing grade
  - Up to 40% RAP by using one grade softer
- INDOT evaluated over 30 RAP stockpiles around the state
  - They know what their RAP is like
CHANGES OCCURRING IN US PRACTICE

- States are moving to higher RAP contents in more mixtures (with or without grade change)
- More contractors are splitting the RAP into different size fractions
- More interest in using asphalt shingles; increasing use of tear–off shingles
- More states are expressing RAP content in terms of percent of RAP binder
**Fractionated RAP**

- Crushed and screened into different sizes
- Improves uniformity (remixes)
- Allows use of different sizes to meet mix design
- Better control of gradation (and binder content)
FRAP
HOW MUCH RAP IS IN AN AVERAGE MIX?

Average Percent All Mixes

- 2009: 16
- 2010: 18
- 2011: 20

2012 NAPA/FHWA Survey
2011 Average RAP Content by State

2012 NAPA/FHWA Survey
Recycled Asphalt Shingles (RAS)
Recycling began in 1970’s; increasing last 15 years
Shingles can have high binder contents, ≥30%.
  • Contain hard, angular fine aggregate and fibers
    ○ Good for SMA
But, shingle binder is very stiff (oxidized) so there is concern about cracking.
So, allowable shingle content is about 20–25% of allowable RAP content.
Tons of RAS Used in Asphalt Mixes

Asphalt mix producers in 32 States use RAS

2009

2010

2011

2012 NAPA/FHWA Survey
**Binder Replacement**

\[
\frac{(A \times B) + (C \times D)}{E} \times 100\%
\]

where
- \(A\) = binder content in RAP, %
- \(B\) = RAP content in mixture, %
- \(C\) = binder content in shingles, %
- \(D\) = shingle content in mixture, %
- \(E\) = total binder content in mixture, %

*Alternates: Maximum Reclaimed Binder Content or Minimum Virgin Binder Content*
WHAT WE HAVE LEARNED

- High RAP contents can work – can perform well – if properly designed, produced and constructed.
- Start with good mix design that accounts for the RAP.
- But, need attention to detail during construction.
BUILDING ON PAST SUCCESS: GAME PLAN FOR INCREASED USE

- Sourcing
- Processing
- Stockpiling
- Reducing moisture
- Control during production
In Composite Pile

After Processing
STOCKPILING PRACTICES

- Avoid segregation
- Avoid contamination
- Reduce stockpile moisture
- Test stockpiles regularly – *know what is in your stockpiles!*
**Reduce Stockpile Moisture**

- Expect to lose 12% production capacity for every percent stockpile moisture above 2%
- Reduce fuel consumption and drying costs by keeping your materials dry
- Lower moisture leads to increased production capacity
- Lower maintenance costs
- Lower paving costs
BEST PRACTICES

- Mill layers separately when you can
- Process RAP and stockpile properly
- Consider fractionating the RAP
- Avoid contamination
- Keep the RAP and RAS dry – paved and sloped area, covered stockpile
- Test the RAP stockpiles regularly
- Watch plant production
CONCLUSIONS

- History of successful RAP and RAS use
- Building on past successful use and expanding
- Asphalt recycling is sustainable
- Asphalt recycling is economical
- Asphalt recycling works!
THANK YOU!

Rebecca S. McDaniel  
Technical Director  
North Central Superpave Center  
Purdue University  
West Lafayette, IN  
rsmcdani@purdue.edu  
765/463–2317 ext 226  
https://engineering.purdue.edu/NCSC