RECYCLED ASPHALT PAVEMENT
SAVING PAVEMENT · SAVING MONEY · SAVING THE ENVIRONMENT

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TODAY’S TOPICS

 What: RAP and its History
 Where: Uses of RAP
 When: Limitations to Use
 How: RAP Processing, Equipment, QC, Best Practices
 How: Current INDOT Specs, Other Specs and Potential Changes in Specs
 Why use RAP?
WHAT IS RAP?

- Reclaimed Asphalt Pavement (RAP)
- Existing pavements removed and reused
- Produced by
  - Milling -- Upper pavement layers removed and replaced with new pavement
  - Full-Depth Removal -- Pavement completely removed and reprocessed
TYPICAL ASPHALT MIX

- 95% aggregate (approx. 30% of cost)
- 5% asphalt binder (approx. 70% of cost)

Reusing:
- Reduces need to quarry more aggregate
- Reduces energy/costs to produce, process, transport aggregate
- Reduces asphalt demand
HISTORY OF RAP USE

- First used in 1915 (!)
- Major emphasis started in 1970’s
  - Oil embargo and increased oil prices
  - Improved milling machines
  - Counterflow drum plants
- Became routine in many states
  - Necessary to be competitive (lower bid prices)
USES OF RAP

- RAP can be used for
  - Base
  - Fill
  - Shoulders
  - Alleys
- But, the highest and best use of RAP is back into new asphalt mixtures.
  - Most beneficial
  - Most cost effective
PERCENT RECYCLED - 1993

Asphalt: 80%
Steel: 64%
Cans: 60%
News: 56%
Plastic: 37%
Glass: 31%
Along Came Superpave

- No guidelines for using RAP
- New system – lots of unknowns
- Interim guidance based on old Marshall mixes
  - Up to 15% RAP, no change
  - 16-25% RAP, drop binder grade one increment
  - Over 25% RAP, blending chart needed
- National research confirmed those levels in 2001
CURRENT USAGE

- Most states are back to *or above* pre-Superpave usage levels.
  - Nationwide only a few states do not allow RAP.
  - AASHTO specs allow easy use of up to 25%.

- Contractors in most states reported using RAP whenever they can.
  - Lower bid prices.

*Performance as good as virgin mixes.*
TODAY

- **Strong incentives to increase RAP use**
  - Increased material and energy costs
    - Binder costs rose over 300% in 2007 & 2008
  - Material supply issues
  - Growing environmental concerns

- **Growing demand**
  - Use RAP in more mixes (i.e. surfaces)
  - Use higher RAP quantities
  - Increased Availability of RAP from projects
WHERE CAN RAP BE USED?

- Virtually any mix – following best practices
- Base and intermediate
  - Potential to use higher amounts
- Surface mixes
  - Tendency to allow lower amounts
  - Friction and cracking are potential concerns
  - Increased resistance to rutting
AGENCY CONCERNS (LIMITATIONS)

- Quality Concerns (including friction)
- Consistency of RAP
- Ability to Meet Volumetric Requirements
- Durability of Mixes
- Stiffness of Binder
- Use with Polymers
WHAT CONTRACTORS CAN DO TO OPTIMIZE RAP
OBTAINING & PROCESSING RAP
COMPOSITE SOURCES (GOK)

• Usually chunks and slabs from full depth pavement removal
• Plant cleanout
• Reject material or excess returned from jobs
• Excavation
• Other sources
In GOK Pile

After Processing
Composite RAP is reprocessed (i.e. crushed, screened, stockpiled and QC tested)
The reprocessed products are very consistent components.
RAP FROM MILLING

- Removes old/distressed pavement
- Improves smoothness
- Eliminates costly shoulder work
- Maintains drainage features, curbs, clearance
- Valuable rehab option
• Millings generally require no additional processing.
• After testing they may be incorporated into HMA mixtures
• Millings are stockpiled separately by job and size
FRACTIONATING TO -1/4”
Cost/Benefits of RAP

- Milling or Pavement Salvage Costs
  - Mill, haul & stockpile: ≈$6.50/ton
  - Excavate, haul & stockpile: ≈ $7.00/ton
  - Reprocessing: ≈ $5.00/ton

- Virgin Material Costs
  - Coarse Aggregate ≈ $12.00/t
  - Fine Aggregate ≈ $8.00
  - PG Binder ≈ $450.00
## Cost Savings Using RAP for a Typical 19.0mm Intermediate

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<th>% RAP</th>
<th>Per ton Savings $ (materials only)</th>
<th>Notes</th>
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<tbody>
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<tr>
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25% RAP in an intermediate 19.0mm HMA will save approximately 11% per ton. Assuming a 3” lay; for every 1 million resurface dollar this will equate to approximately 2.2 lane miles of additional paving.
### Cost Savings Using RAP for a Typical 9.5mm Surface

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25% RAP in a Surface 9.5mm HMA will save approximately 9% per ton.
Assuming a 1.5” lay; for every 1 million resurface dollars this will equate to approximately 2.6 lane miles of additional paving.
RAP MANAGEMENT & BEST PRACTICES

- Monitor & control incoming RAP
- Stockpile job millings by job and size
- QC tests on all RAP
- Fractionate RAP (when applicable)
- Avoid contamination
- Keep the RAP dry –paved and sloped area, covered stockpile (BTU’s= $$)
- Know Plant limitations (e.g. Batch plant)
Contamination - Not Good
RAP IS JUST ANOTHER COMPONENT OF HMA
SAME STANDARDS AS VIRGIN MIXES

• INDOT Sec. 400 Standard Specifications
• Aggregate quality
• Superpave volumetric lab mix designs
• QC/QA verification testing and acceptance
Shingles

RAP
CURRENT INDOT SPECS

- Up to 25.0% RAP by weight of total mixture
- Up to 15.0% RAP in surface courses for 3 million ESALs or higher or for open graded mixtures
- No change in binder grade up to 15.0% RAP; drop one grade for greater than 15.0% RAP
Potential Change in INDOT Specs

- Current research and testing suggests higher RAP contents may be feasible
  - RAP blending study
  - RAP friction study
- INDOT – industry meeting tomorrow
- Potential to allow up to 25% RAP without a grade change and up to 40% with change
- Watch for final decision and supplemental specs
REMOVING/LOWERING BARRIERS

- Nationwide specs vary widely
- Several states allow up to 50% RAP

- Work is on-going to encourage all states to allow RAP use
- Research is continuing to explore higher RAP contents
- Potential for WMA plus RAP
HMA Recycling ETG

- FHWA initiated in May 2007
- Managed by NCAT
- Purpose – Coordinate, develop national guidance and recommendations on RAP use
- Goal – encourage all states to allow 15-20% RAP, then increase some to 25-30%
- Demo projects, document performance, share info, best practices, research
HIGHER RAP CONTENTS

- Do work – do *perform* – if properly designed, produced and constructed

- But, need attention to detail

- Some precautions are needed
  - Many of these are the same as for aggregate best practices
CONCLUSIONS

- RAP has long history of successful use.
- Asphalt recycling is sustainable.
- Asphalt recycling is economical.
- Asphalt recycling works!
THANKS TO:

- LTAP and APAI
- NAPA, AASHTO, FHWA, APAI sponsored workshop, *Materials and Energy Conservation in Hot Mix Asphalt*
  - Available on NAPA website
- Gerry Huber
- And to you!