

# SUSTAINABLE AGGREGATES IN ASPHALT PAVEMENTS

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# Sustainability

- Meeting the needs of the present without compromising the ability of future generations to meet theirs.
  - Conservation of resources (materials and energy)
  - Reduction of environmental impacts (GHG, carbon footprint, landfills, quarries, etc.)
- Growing awareness and demand from the public for sustainable practices.

# Aggregate Sustainability

- Utilization of sustainable products
  - Recycling
  - Balance with production (fine, small NMAS mixes)
- Use of sustainable designs
  - Perpetual pavements - designed to last over 50 years without major structural rehabilitation and needing only periodic surface renewal

# Asphalt Pavements and Aggregate Sustainability

- Virtually 100% recyclable
  - Most recycled material in the US
  - Over 80% of old asphalt pavement reused
  - Reduces demand for new aggregates and binder
    - Reduces energy/costs to produce, process, transport
- *Beneficial* reuse of waste materials and by-products
  - Slags
  - Asphalt Shingles
  - Foundry sands
  - Glass
  - Crumb rubber
  - Waste oils



# Asphalt Pavements and Sustainability

## □ Perpetual Pavements

- New or staged construction

## □ Warm Mix Asphalt

- Reduced fuel consumption (15 to 30% reduction)
- Reduced GHG
- Construction benefits

## □ Lower energy consumption and green house gas emissions than concrete (COLAS, Robinette)

## □ Porous Surfaces

- Reduced noise (and need for noise walls), improved safety
- Improved water quality

# Indiana Efforts

## Increased Use of RAP

- *Investigation of Low and High Temperature Properties of Plant-Produced RAP Mixtures (FHWA funded)*
- *Evaluation of Recycled Asphalt Pavement for Surface Mixtures*

## Increased Use of Local Materials

- *Maximizing the Use of Local Materials in HMA Surfaces*

# PLANT- MIXED RAP MIXES

- Evaluated 5 sets of plant-produced mixes with up to 40% RAP and 2 virgin binders
- Compared
  - Modulus
  - Low temperature properties and cracking
  - Estimated blending
  - Fatigue (TFHRC)
- Also tested extracted/recovered binders

# Conclusions

- As RAP content increased, mix modulus generally increased
- No statistically significant difference between moduli of mixes with PG64-22 with 0, 15 and 25% RAP
  - Significant difference for 40% RAP in most cases
- Use of softer virgin binder did reduce modulus
- Implies grade change is needed for 40% RAP but not for 25% RAP



# Conclusions

- Significant blending of RAP and virgin binders was observed in most cases
- Low temperature mix testing showed slight change in critical cracking temperature at up to 25% RAP with no grade change
- Critical cracking temperatures were lower with PG58-28, but may not be needed
- Fatigue results were unexpected; no clear effect of RAP content or binder grade

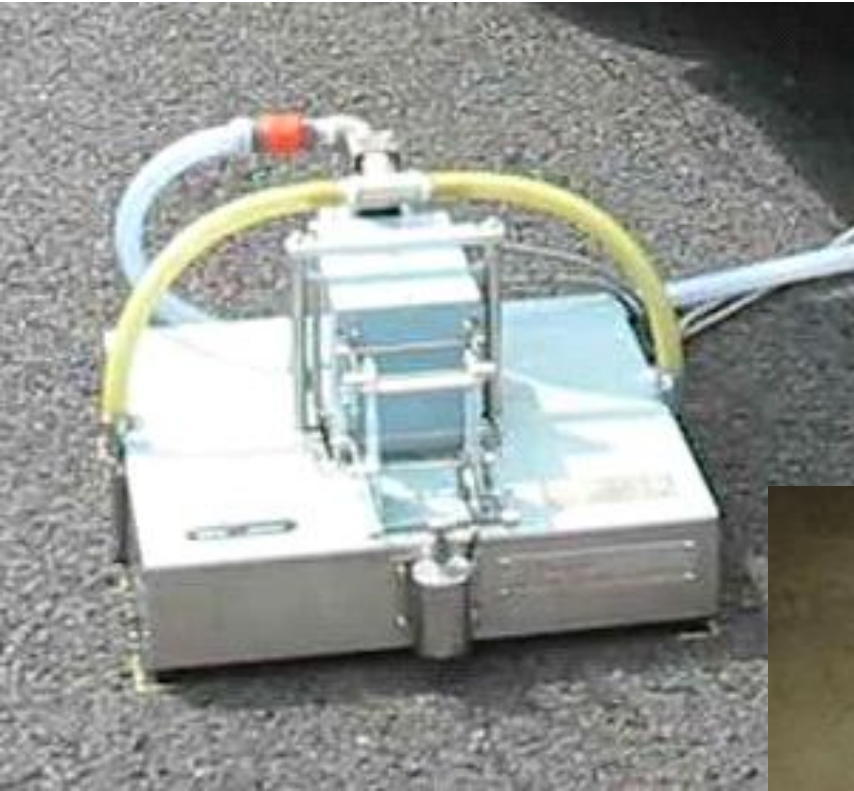
# Outcome

- INDOT OMM explored PG grading of 33 RAP sources across the state (average PG90.1–11.1)
- Based on all these results, spec change was approved
  - 25% with no grade change, 40% max
  - Also changed to binder replacement
- Reports that some other states are verifying these results

# RAP FOR SURFACE MIXTURES

- RAP historically not used to full extent in surfaces
  - Unknown aggregates and unknown frictional properties
- Determine threshold level of RAP that has minimal effect on friction
- Evaluated lab-fabricated RAP at up to 40% blended with steel slag and ACBF Slag in HMA and SMA
- Friction testing of 8 existing surfaces with 15-25% RAP
- Draft final report reviewed, final report next week.

# Surface Characteristics



# Findings and Recommendations

- Field friction testing suggests 15% RAP is acceptable and higher RAP contents are possible for medium volume roadways.
- Recommended limit of 20% RAP by binder replacement for Category 3 and 4 roadways.
  - Further field testing for Category 5.
  - On case by case basis, consider higher RAP contents when RAP aggregates can be known.

# INDOT Specs for RAP and RAS in Surface Mixes

- 2012 Specifications allow
  - 40% maximum binder replacement for Category 1 and 2 surfaces
  - 15% maximum for Category 3 through 5
  - RAS no more than 25% of total binder content

# INDOT Efforts

## ***Maximizing the Use of Local Materials in HMA Surfaces***

- Objective – explore opportunities to allow the use of more local materials in HMA in place of “imported” fine and coarse aggregates
- Local coarse aggregate up to 40% blended with steel slag, ACBF and sandstone
- Local fine aggregate up to 20%
- HMA and SMA mixes
- Draft final report submitted but not yet reviewed

# Experimental Design

- Local coarse aggregate content – up to 40% blended with steel slag, ACBF and sandstone
- Local fine aggregate content – up to 20% (with steel slag, ACBF slag and sandstone CA)
- HMA and SMA mixes



# Preliminary Findings

- Adding polish susceptible agg caused decrease in surface friction in HMA and SMA.
- But friction was still acceptable at up to around 20% local agg.
- Fine aggregate data was somewhat erratic.
- Appears fine agg up to 20% has small negative effect on friction.
- Other considerations besides friction.

# Potential Cost Savings

Substituting local agg for steel slag could save:

- \$1.50 to 2 per ton of hot mix (fine aggregate)
- \$3 to 4 per ton of hot mix (coarse agg)
- \$4.50 to 6 per ton of hot mix (both)
- Up to 10% of cost of mix
- \$3000 to 4000 per lane mile of surface mix

# ANCIENT GREEK PROVERB

*A society grows great when old men plant trees in whose shade they will not sit.*

# MODERN TWIST

*A society is sustainable when people  
pave roads their children can recycle.*

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