National Perspective on RAP and Green Technology

Annual Asphalt Contractor's Workshop

Brooklyn Center, Minnesota

March 2, 2010

Outline

- Introduction
- Asphalt-Related Green Technologies
  - Past, present and future
- The most widely recycled material
- National initiatives

Focus on the Environment

- Environment, climate change and sustainability
- Global focus
- Green technologies

Old News

- Asphalt pavement is *the* most widely recycled material
- 100 million tons reclaimed annually
- 95% is reused or recycled
- $1.8 billion in savings
- Reduces demand for new aggregates and binder and the energy to produce them

More Old News

- ***Beneficial*** **reuse of waste materials and by-products**
  - **Slag**
  - **Asphalt Shingles**
  - **Crumb rubber**
  - **Glass**
  - **Waste oils**
  - **Foundry sands**

Recent Developments

- Warm Mix Asphalt
  - Reduced fuel used for heating (15 to 30% reduction)
  - Reduced Greenhouse Gases
  - Construction benefits
- Porous or Open Graded Mixes
  - Reduced noise, improved safety
  - Improved water quality, stormwater management

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Perpetual Pavement

- Asphalt pavement designed to last over 50 years without requiring major structural rehabilitation and needing only periodic surface renewal.
- The ultimate in sustainability.
  - Better use of resources
  - Reduced CO_2 emissions
  - Reduced energy consumption

On the Horizon

- **Biofuels and Biobinders**
  - **Plant based**
  - **Animal based**
  - **Algae**
- **Alternate Energy Sources**
- **Harvesting Energy**
- **Removing Pollutants**
  - Photocatalytic pavements

Carbon Footprint of Roadway Construction and Maintenance

- Lifecycle assessment
- Lower energy consumption and green house gas emissions than concrete (COLAS, Robinette, Brown, others)
- Perpetual and conventional asphalt pavements lower than concrete during initial construction and 50-year life cycle

“Black is Green”

- **Asphalt Pavement:**
  - **Is 100% recyclable**
  - **Uses other recycled materials**
  - **Has lower carbon footprint**
  - **Is quieter**
  - **Provides drainage of water**
  - **Is more sustainable.**

Today

- Strong incentives to increase RAP use
  - Increased material and energy costs
  - Material supply issues
  - Growing environmental concerns
- Growing demand to
  - Use RAP in more mixes (i.e. surfaces)
  - Use higher RAP quantities

Typical Asphalt Mix

- 95% aggregate
- 5% asphalt binder

Reusing:

- Reduces need to quarry more aggregate
- Reduces energy/costs to produce, process, transport aggregate
- Reduces asphalt demand

Higher RAP Contents

- Can work – can *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

Some Keys to Success

- Processing the RAP
- Stockpiling the RAP
- Control during production

In GOK Pile

After Processing

Processing RAP

- Mixed RAP can be variable
  - Crushing/Screening to break up clumps
  - Processing can improve uniformity
  - Uniformity essential to meet specifications

Fractionating RAP

- Improves uniformity (remixes)
- Allows use of different sizes to meet mix volumetrics
- Allows better control of gradation (and binder content)

Stockpiling Practices

- Avoid segregation
- Avoid contamination
- Reduce stockpile moisture
  - Reduce fuel consumption and drying costs
  - Increased production capacity

But …

Good production and construction has to start with a proper mix design

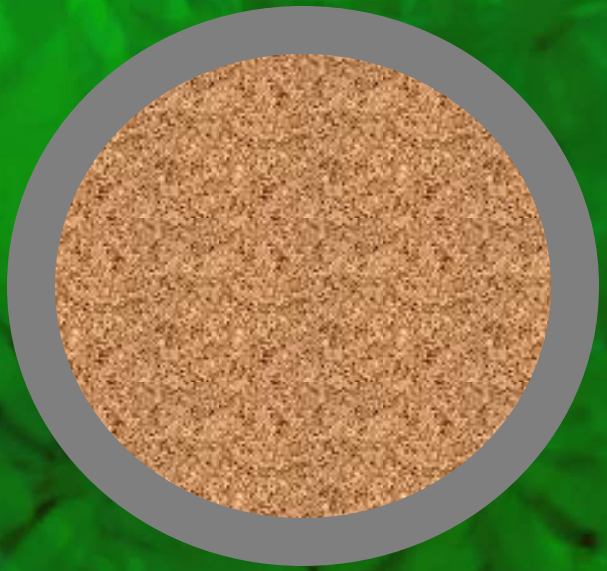
How do you account for the RAP?

Does it blend?

Conventional Wisdom

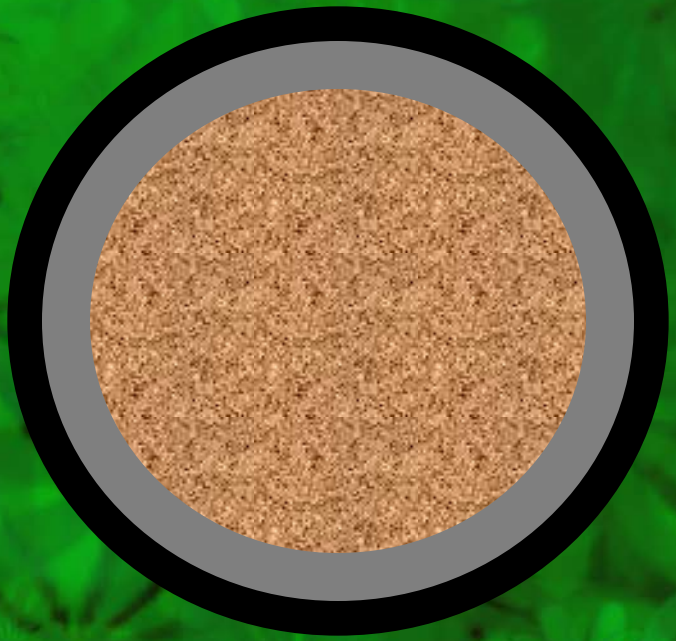
- RAP contains old, hardened binder that will stiffen the mix
- This will help reduce rutting
- May increase cracking tendencies
- There is research and experience to support conventional wisdom
  - And some that doesn't.

Possible Effects of RAP Binder



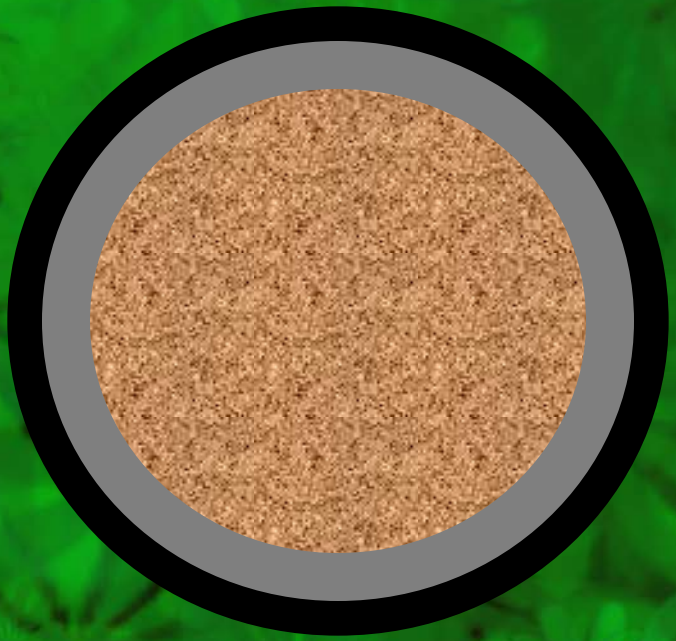
RAP aggregate with oxidized binder film

Possible Effects of RAP Binder



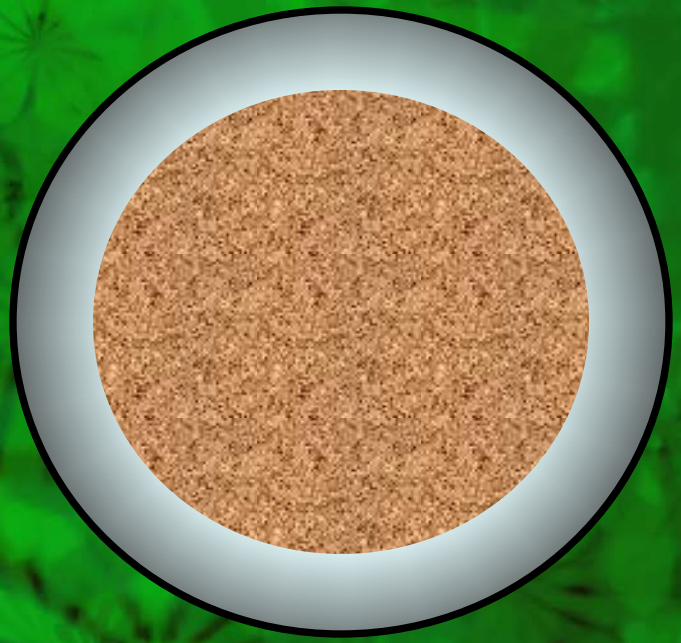
RAP aggregate with oxidized binder film plus virgin binder film

Possible Effects of RAP Binder



If RAP and virgin binders do not blend, effective binder properties will be those of the virgin binder only.

Possible Effects of RAP Binder



If RAP and virgin binders blend or merge, effective binder properties will be determined by the amount of blending that occurs.

Current Guidelines

- Assume that significant blending occurs
- Assume threshold level of RAP that can be added without affecting effective binder grade
  - 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)
- Based on non-fractionated mixes with about 5% binder in RAP and new mix.

Impacts of Blending on Performance

- If we assume there is blending and there isn't, virgin binder grade may be softer than desired.
  - Increased chance for rutting
  - Decreased chance for cracking
- If we assume there is no blending and there is, effective binder grade may be stiffer than desired.
  - Decreased chance for rutting
  - Increased chance for cracking

Risks of False Assumptions

- Assuming there is blending may be more conservative.
  - Shouldn't rely on binder to control rutting
  - Increased cracking can have performance and economic impacts
- But, if RAP binder does not blend and act like binder, mix could be under-asphalted.
- Current guidelines are a starting point, but not the definitive answer

Better options

- Know a reasonable threshold level for your typical materials.
- Above threshold, know if blending is occurring or not.
- Contractors, know and manage RAP stockpiles to control the assumptions.
- But *how*?

Threshold Values

- Test and know your typical RAP materials (recommended at state level)
  - What kinds of binder did you use?
  - How much aging is typical?
  - How stiff are typical RAP binders?
  - Extract and grade RAP binders, mixes
- Based on testing and experience, some states have changed the tiers
  - Say, up to 20% RAP without changing grade

Mixture Testing

- Test lab mixes at various RAP contents with different binder grades
- Test plant produced mixes
- Suggested mixture tests
  - Dynamic modulus
  - Indirect tensile strength
  - Other familiar tests

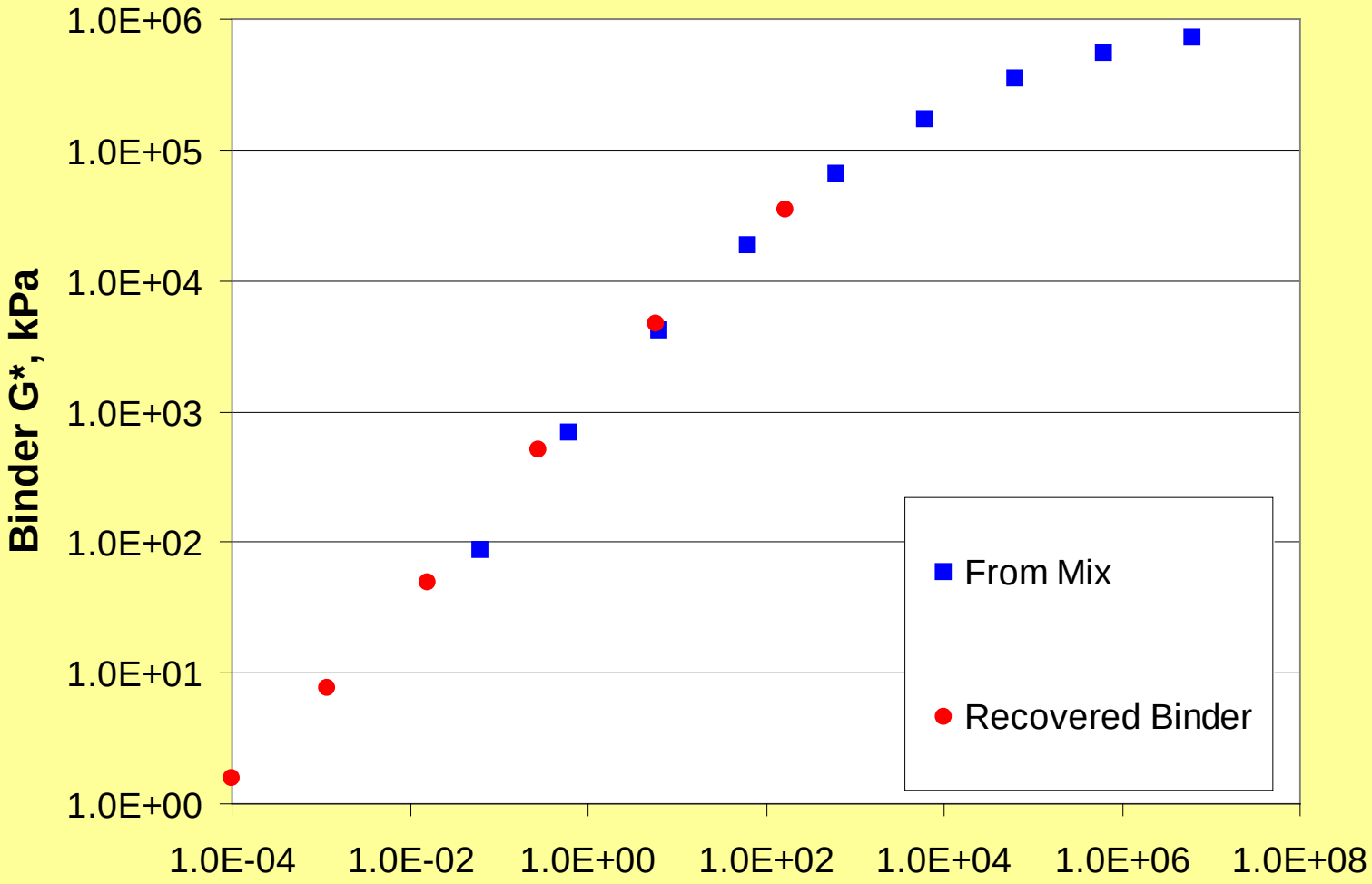
Blending - Bonaquist approach

- Measure mix dynamic modulus
- Develop master curve
  - Stiffness over range of temperatures and loading rates
- Estimate effective binder modulus in mix
  - Hirsch model uses binder shear modulus and mix volumetrics to estimate mix stiffness

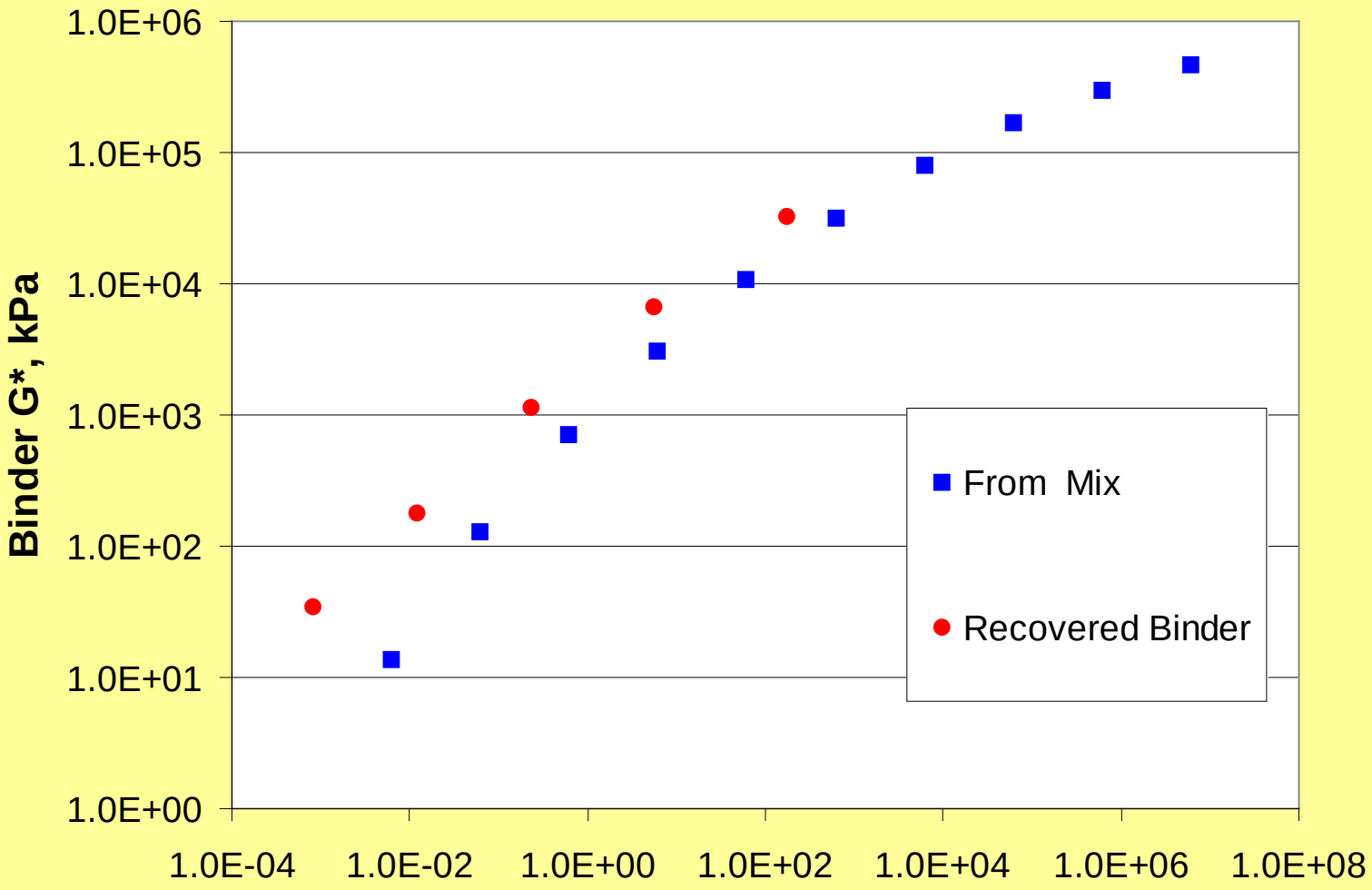
Blending - Bonaquist approach

- Extract and recover binder (total blending)
- Measure binder shear modulus
- Compare binder modulus and effective binder modulus from mix
  - Overlap indicates good mixing

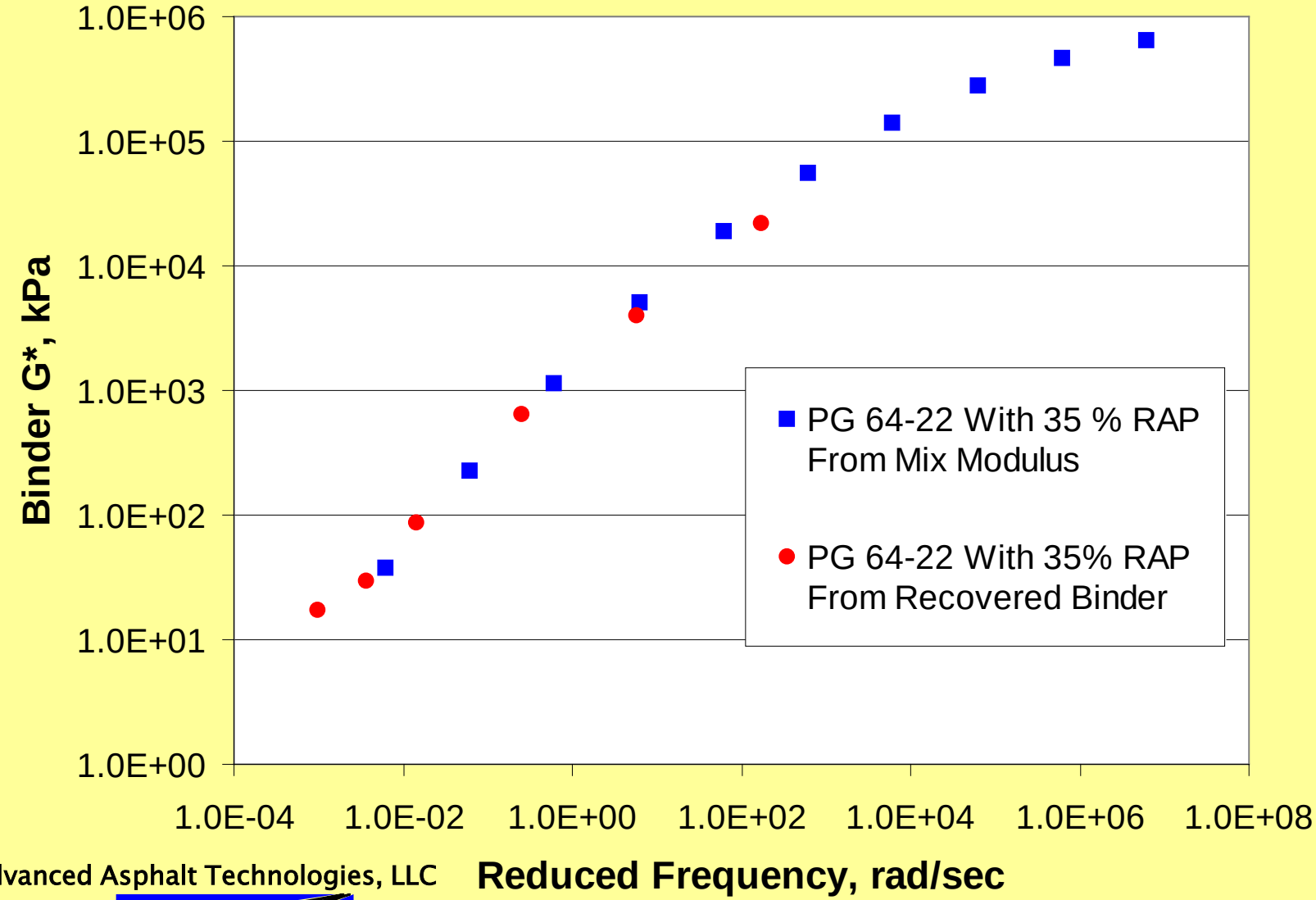
9.5 mm with PG 64-22, Batch Plant



9.5 mm with PG 64-22 + 5% RAS, Batch Plant



9.5 mm with PG 64-22 + 35 % FRAP, Double Barrel



Bonaquist Approach

- Advantage – allows assessment of production variables
  - RAP processing
  - Production rates and temperatures
  - Additives
  - Storage time, etc.
- More information *Hot Mix Asphalt Technology*, September/October 2007.

RAP Agg Specific Gravity

- Estimate from RAP binder content, RAP Gmm and estimated binder absorption
- Measure after extraction or ignition oven
- Requires knowledge of typical materials
- Impact of errors in estimation increase as RAP content increases

National Initiatives

- FHWA Policy on Recycling
- NAPA and ARRA cooperative agreement to double rate of reuse/recycling within five years
- Environmental rating systems for roads

HMA Recycling ETG

- FHWA initiated in May 2007
- Coordinate, develop national guidance and recommendations on RAP use
- Goals – encourage all states to allow 15-20% RAP, then increase some to 25-30%
- Demo projects, document performance, share info, best practices, research
- www.morerap.us

WMA Technical Working Group

- Discuss issues and share experiences to advance development and implementation of WMA in the US
- www.warmmixasphalt.com

National RAP Research

- NCHRP 9-46, *Improved Mix Design, Evaluation and Materials Management of High RAP Content HMA*
- FHWA Funded, *Development of High RAP Content Mix Guidelines and Informational Documents*
- Other state and FHWA funded studies ongoing

WMA Research

- NCHRP 9-43, Mix Design Practices for Warm Mix Asphalt (in publication)
- 9-47A, Properties and Performance of Warm Mix Asphalt Technologies
- 9-49, Performance of WMA Technologies: Stage I--Moisture Susceptibility
- 9-49A Stage II--Long-Term Field Performance
- State and other research

Summary

- RAP, WMA and Perpetual Pavements are sustainable today
- Future advances will continue to improve the sustainability of asphalt
- Tools and resources are available to help you today and tomorrow.

Sustainability

Meeting the needs of the present without compromising the ability of future generations to meet theirs.

Ancient Greek Proverb

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

Modern Mash Up

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

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