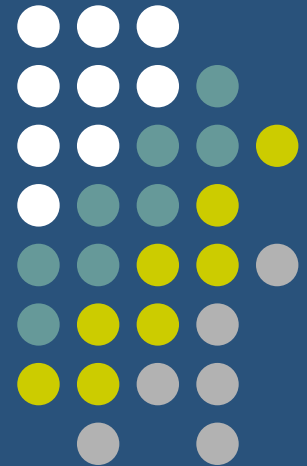


Current National Research: Increasing the RAP Content

Rebecca McDaniel
North Central Superpave Center

Special Joint Conference
January 10, 2008





Interest in RAP Use

- Strong incentives to increase RAP use – mainly economics, environment, supply
- Still barriers to increased use – state specs, variability, performance concerns
- Good news – people are working on overcoming these obstacles.

HMA Recycling ETG



- FHWA initiated in May 2007
- Gerry will tell you more.
- Among activities so far:
 - Identification of obstacles to higher use
 - Identification of research needs



Top Ten Research Needs

1. Performance test for evaluating RAP
2. Best practices manual
3. Solventless method to characterize RAP
4. Binder grade changes necessary?
5. Degree of blending of binders
6. Field performance of high RAP mixes
7. Replicating plant heating in lab
8. Guidance for states to allow higher RAP
9. Identification of RAP variability
10. Guidance for processing/fractionating RAP

What Research is Underway?



- Projects at NCSC
- Summary of Selected Other Projects

NCAT/NCSC/UNH Proposal



- Develop documentation to inform states and industry about benefits of RAP
 - Best practices
 - Guidelines for designing, producing and constructing high RAP content surface mixes (>25%)
 - Database of performance information
 - Guide spec for high RAP content mixes

NCAT/NCSC/UNH



- Goal is to develop information quickly for use agencies and industry to increase RAP use
- Will be coordinated with NCHRP RAP research
- FHWA funding through NCAT (pending?)
- 30 month project beginning October 2007

NCHRP 9-46



- *Mix Design, Evaluation and Materials Management Practices for HMA with High RAP Content*
- Develop mix design and analysis procedure for mixes with >25% RAP
- Propose changes to existing specifications for high RAP content mixes
- Contract pending. 24 month project.

State Sponsored Projects



- Illinois – useable residual binder in RAP
- Minnesota – leaching, hydraulic, mechanical properties, including RAP in roadbeds
- Alabama – mix tests to characterize RAP without solvent extractions
- Maine – Warm Mix
- Other projects in Hawaii, New Hampshire, Utah, North Carolina, Virginia, Georgia, Mississippi, others

Current RAP Research - NCSC



- *Evaluation of RAP for Surface Mixtures*
 - Determine effects of using RAP containing unknown aggregate in mainline surface courses for high volume roadways
 - Either develop method to ensure RAP agg meets certain properties and provides adequate friction
 - Or determine threshold level of RAP that will not have negative impact on friction
 - INDOT funded



RAP for Surfaces

- Evaluate different blends of
 - RAP -- lab fabricated “worst case” RAP
 - Mix Types – SMA and HMA (9.5mm)
 - Virgin Agg Types – slag and dolomite
- Fabricate slabs, polish, test texture and friction
- Test field friction of existing RAP surfaces
- Verify acceptable friction and mechanical properties with 6-8 sources of real RAP

Slab Polisher

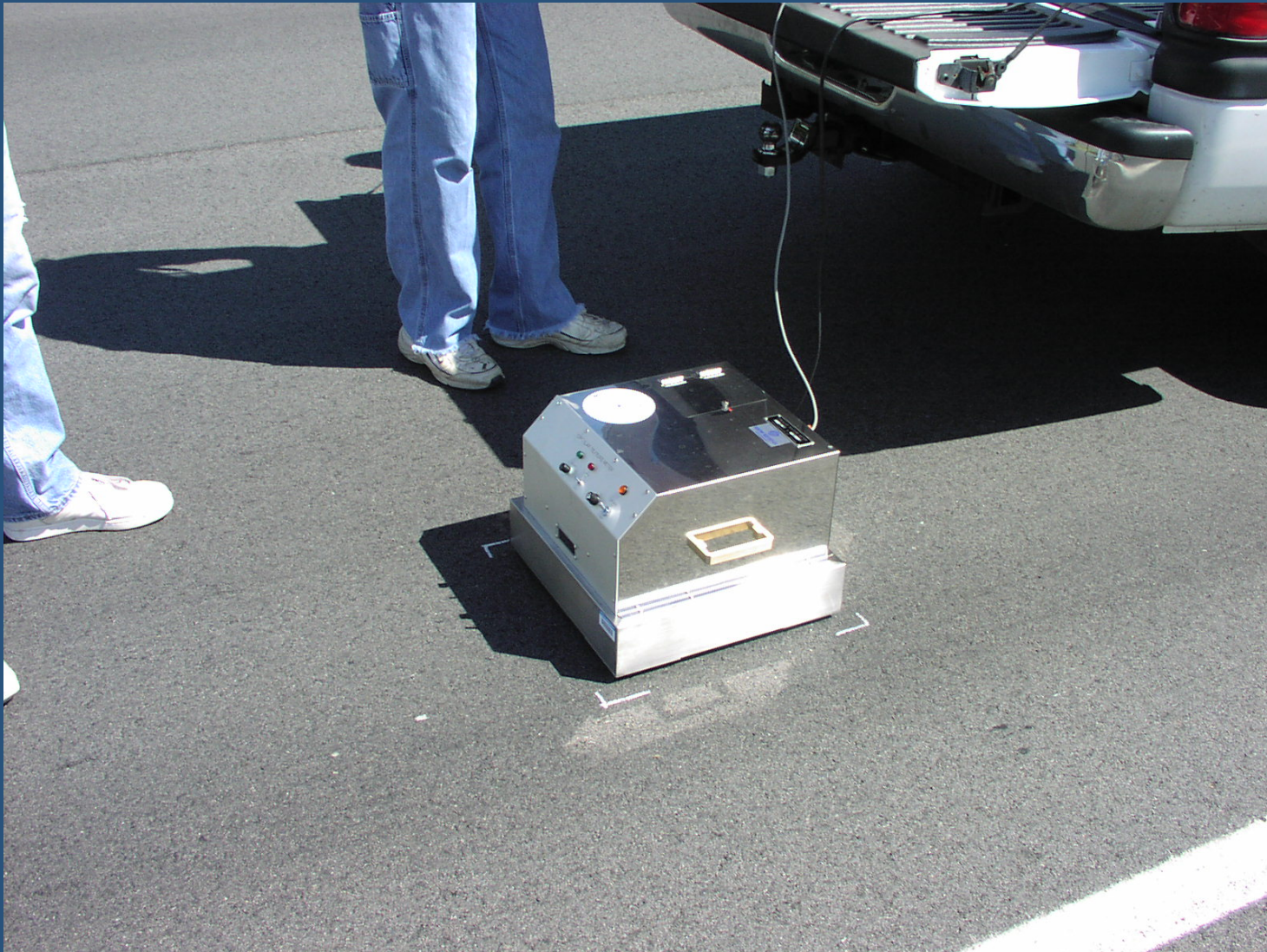




Dynamic Friction Tester



Circular Texture Meter



Current RAP Research - NCSC



- *Low-Temperature Performance Properties of Hot Mix Asphalt Containing RAP*
 - 2006 -- Evaluated plant-produced mixes with up to 40% RAP and two virgin binder grades
 - Originally proposed to focus on effects of RAP on low temperature properties
 - 2007 -- Expanded – 4 more contractors/plants
 - FHWA funded

What We Did - 2006



- Milestone Contractors LP produced six mixes through one plant over two days.
- Heritage Research Group and NCSC tested RAP, virgin and mixture properties
 - Binder properties – PG binder tests
 - Mix properties – Indirect Tensile Strength, Dynamic Modulus, Shear Modulus

Experimental Design



Reclaimed Asphalt Pavement

Binder Grade	0%	15%	25%	40%
PG 58-28			X	X
PG 64-22	X	X	X	X

2006 Findings



- For these materials and this plant, the RAP mixes were not as stiff as expected.
- The binder did not stiffen linearly with increasing RAP content.
- In this case, dropping the virgin grade to PG58-28 for 25% RAP was not necessary.



Not Conclusive

- Only one plant, one RAP source, one set of virgin materials
- E&B, J.H. Rudolph, Reith-Riley, Phend & Brown repeated this in their plants
 - Similar testing is underway at NCSC now on these mixes
- Other evidence suggests blending does happen. *Why or why not?*



Possible Explanations

- RAP binders are reportedly sometimes not as stiff as in years past.
- RAP, especially fractionated, may not have ~5% binder – need to account for percentage of RAP binder.
- Compatibility or plant issues?

Maryland/ Pennsylvania Study



- Dynamic Modulus Data Can Be Used to Evaluate RAP and RAS Mixtures
 - Test Is Highly Sensitive to Binder Stiffness
 - Assess Mixing of New and RAP Binders
 - Interpreted to Estimate the Effective Grade of the Combined Binder (Hirsch Model)
 - Mixture Modulus = $f(\text{Binder modulus, VMA, VFA})$
 - Compare recovered binder properties to those predicted from testing the mix.

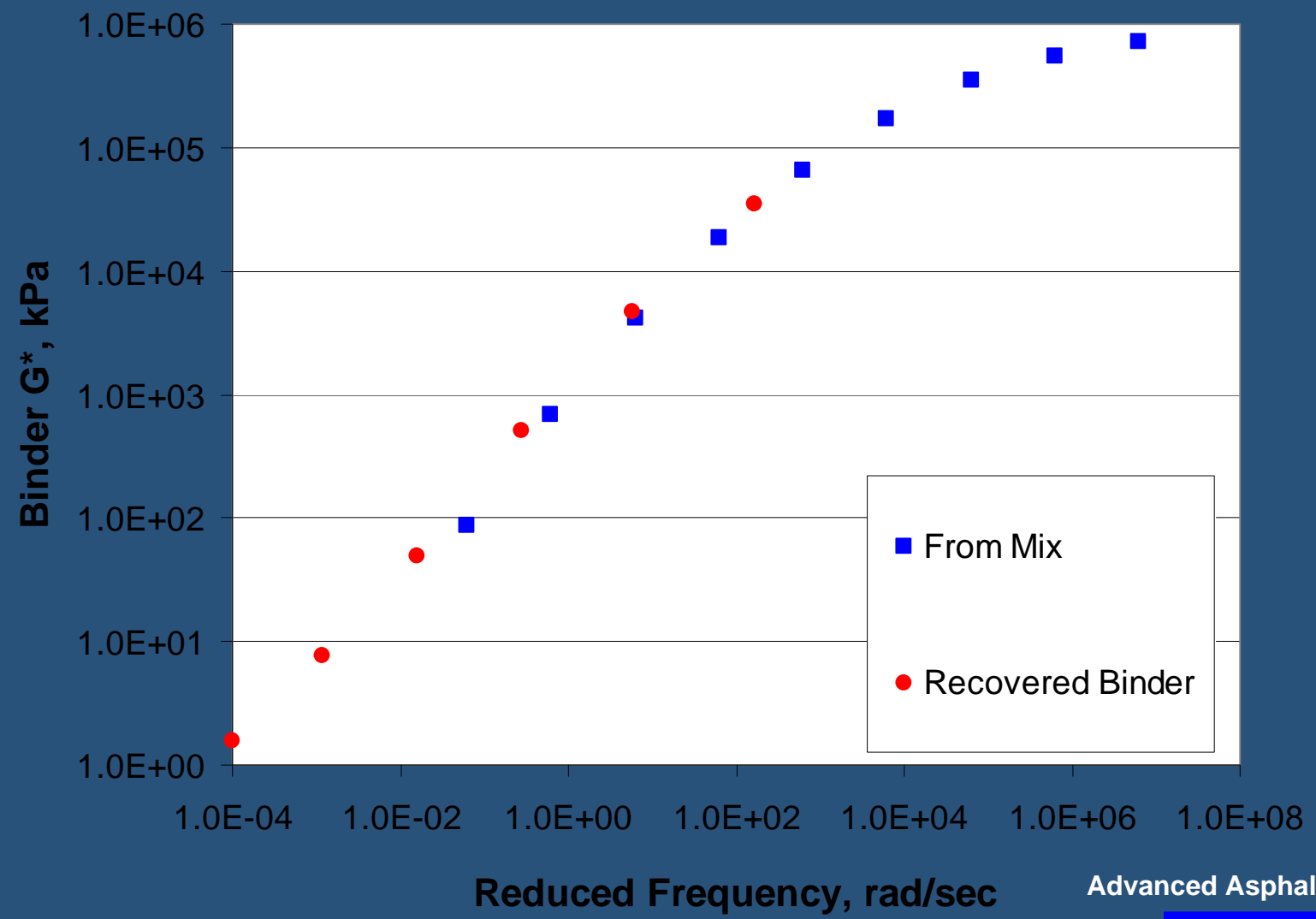
Advanced Asphalt Technologies, LLC



“Engineering Services for the Asphalt Industry”



9.5 mm with PG 64-22, Batch Plant

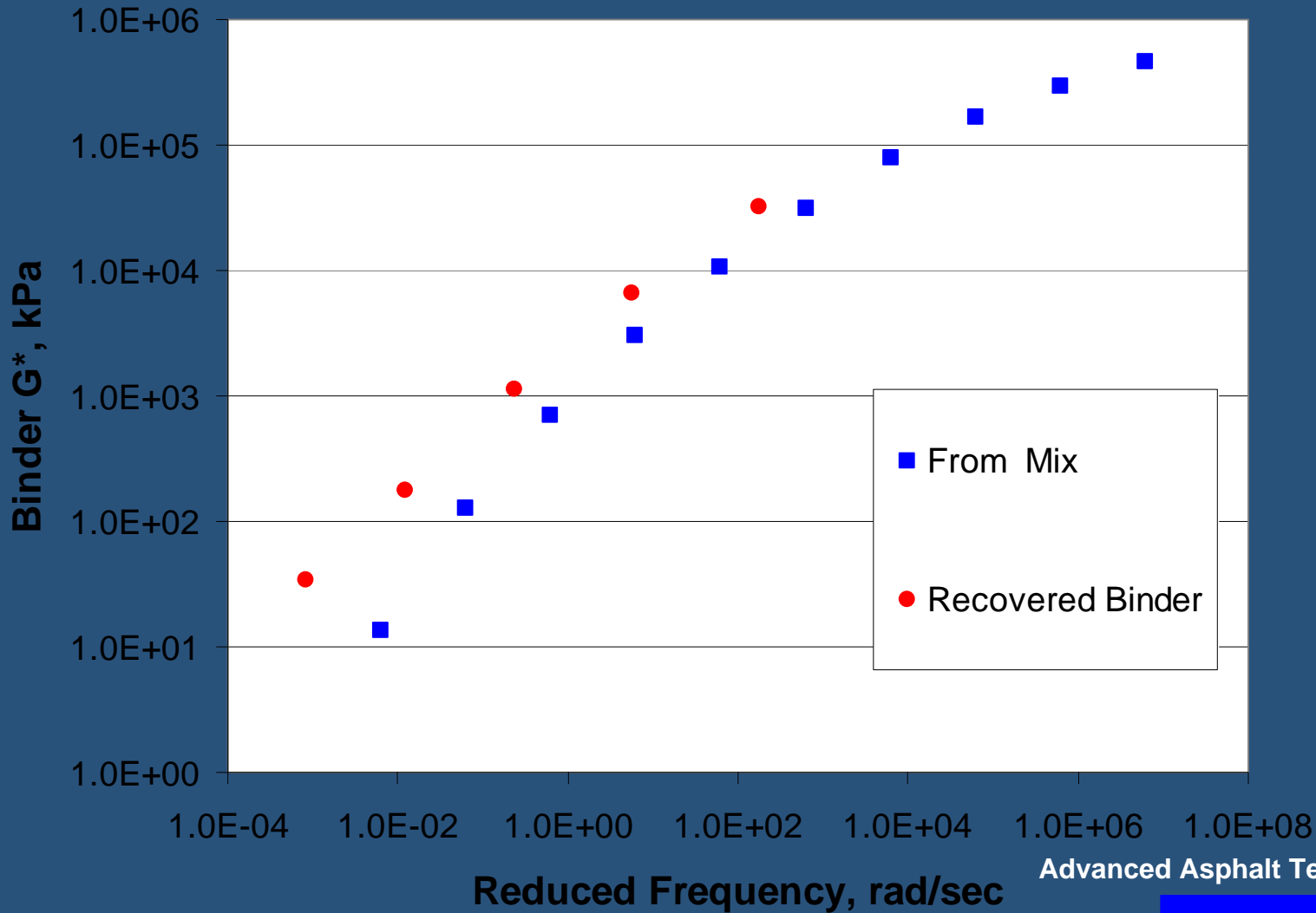


Advanced Asphalt Technologies, LLC



"Engineering Services for the Asphalt Industry"

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



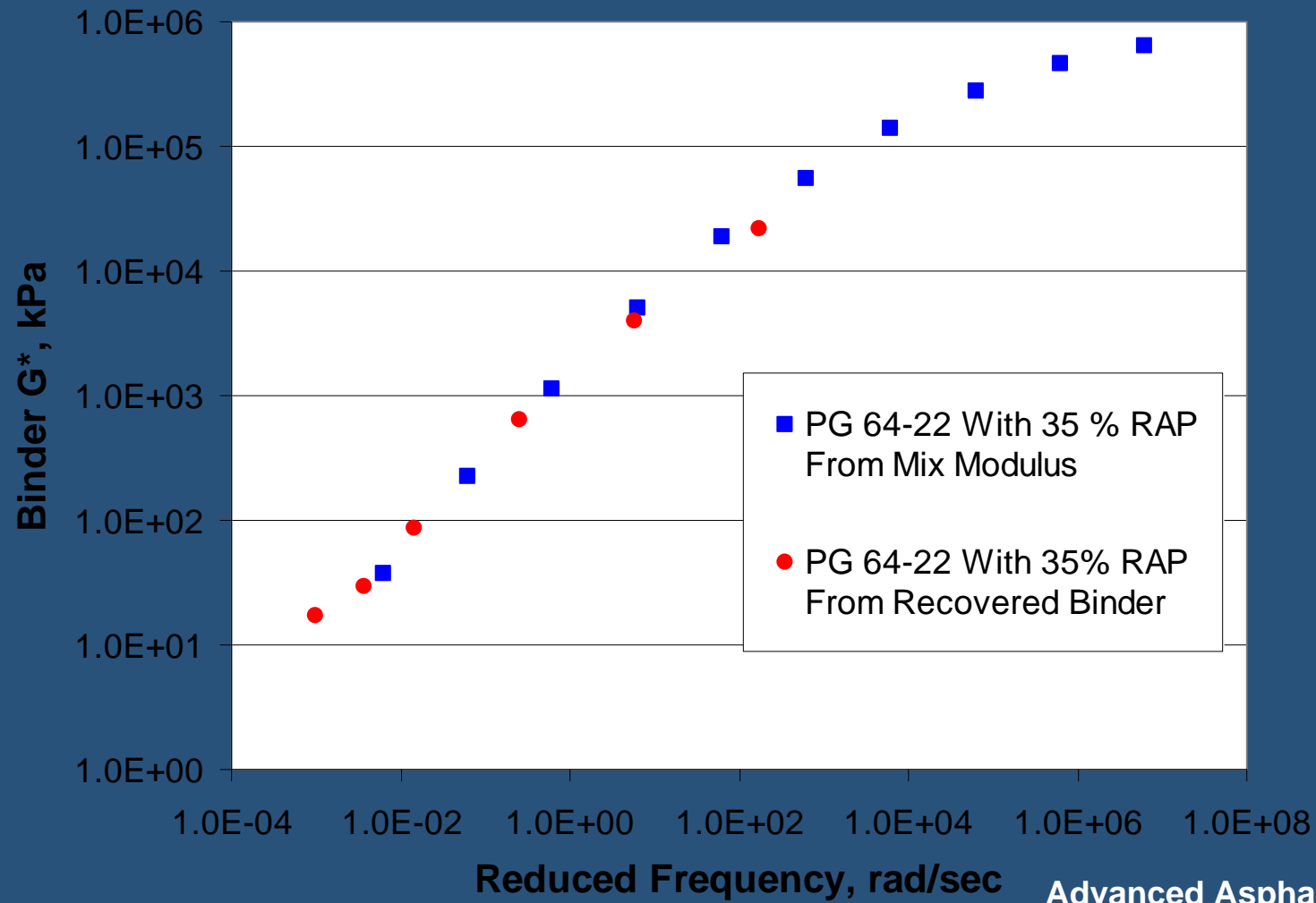
Advanced Asphalt Technologies, LLC



"Engineering Services for the Asphalt Industry"



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



Advanced Asphalt Technologies, LLC



"Engineering Services for the Asphalt Industry"



Current State of Knowledge

- With many materials and plants, complete (or nearly complete) blending does occur.
- In other cases -- especially with very hard binders (shingles), high RAP contents or ???-- complete blending may not occur.
 - Temperature, Time, Compatibility, Plant
- *There is much we still do not understand about RAP*



In the Meantime

- Current RAP specifications can be used to produce quality hot mix asphalt.
- RAP mixes can perform as well as, or better than, virgin mixes.
- And in the near future, we hope to see increased RAP use.