Current NCSC RAP Research

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HMA Recycling ETG
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Current RAP Research - NCSC

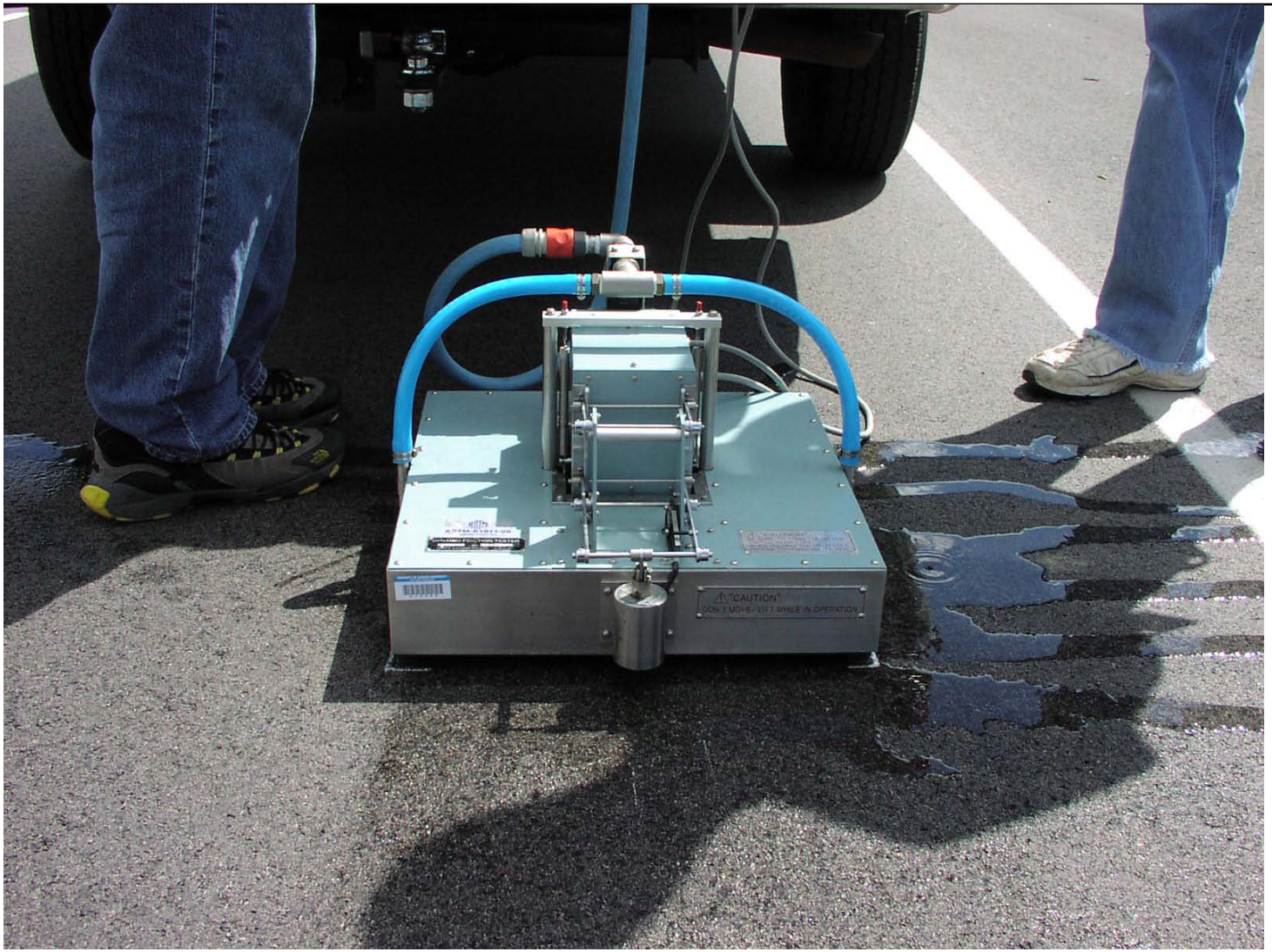
- *Evaluation of RAP for Surface Mixtures*
  - Determine if INDOT can allow the use of RAP in mainline surface courses for high volume roadways
    - Either method to ensure RAP agg meets certain properties and provides adequate friction
    - Or determine threshold level of RAP that will not have negative impact on friction
  - Mainly a friction study, though will check effects on performance

RAP for Surfaces

- Evaluate different blends of
  - RAP -- four or five sources at up to 40%
  - Binder Grades – up to five grades
  - Mix Types – SMA and HMA
  - NMAS – 9.5mm and 12.5mm
  - Aggs – crushed gravel, slag and dolomite
- Lab fabricate “worst case” RAP
- Fabricate slabs, polish in lab and test texture and friction

Slab Polisher

Dynamic Friction Tester



Circular Texture Meter

DFT and CTM

- DFT tests friction from 80-90 kilometers per hour to zero
- CTM tests surface texture
- Together they can be used to calculate the IFI

- Another study at NCSC is attempting to correlate IFI to towed friction trailer data in the field.

Current RAP Research - NCSC

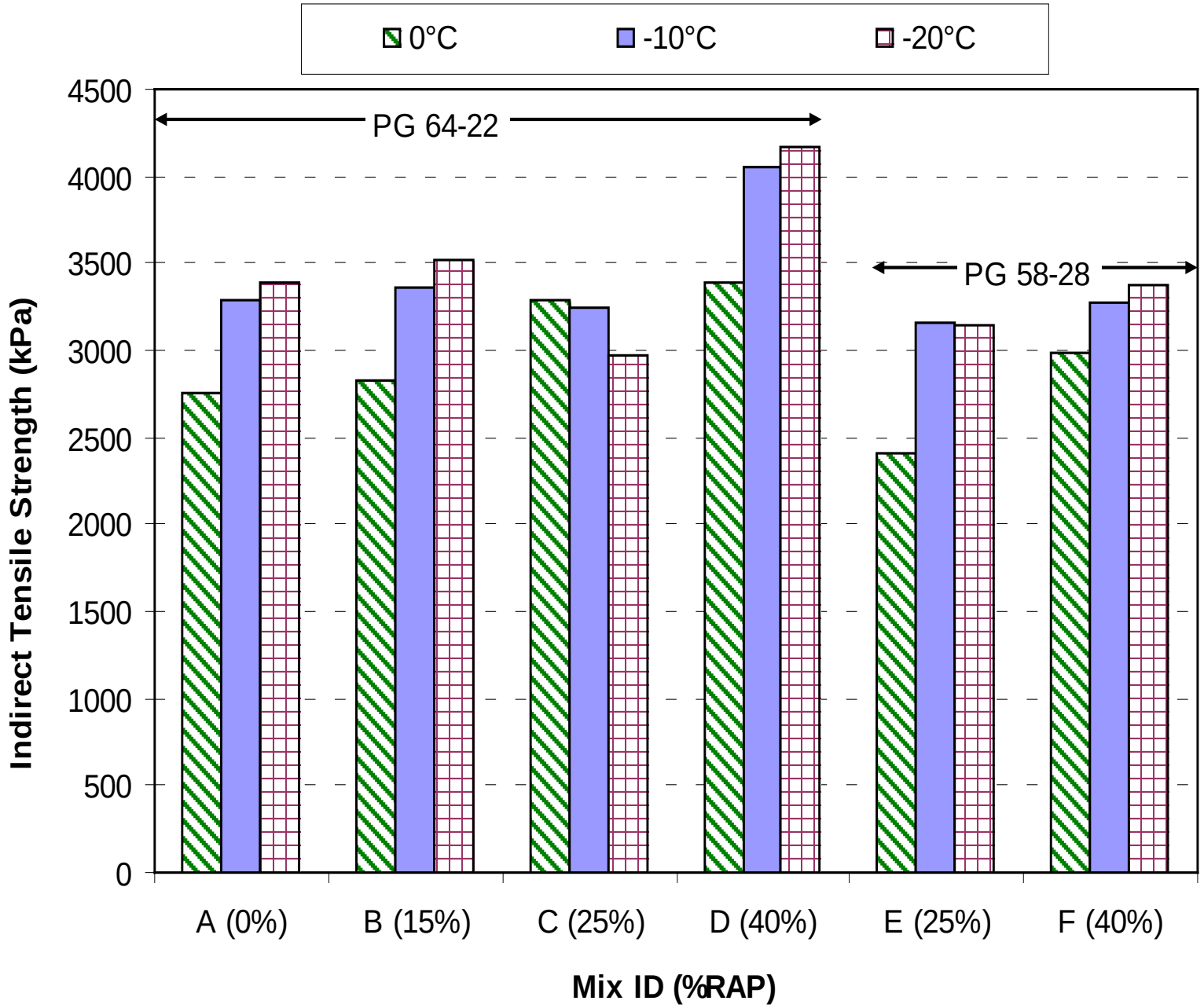
- *Low-Temperature Performance Properties of Hot Mix Asphalt Containing RAP*
  - Evaluated plant-produced mixes with up to 40% RAP and two virgin binder grades
  - Originally proposed to focus on effects of RAP on low temperature properties
  - Expanded and soon to expand further….

What We Did

- Milestone Contractors LLC produced 6 mixes through one plant over 2 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

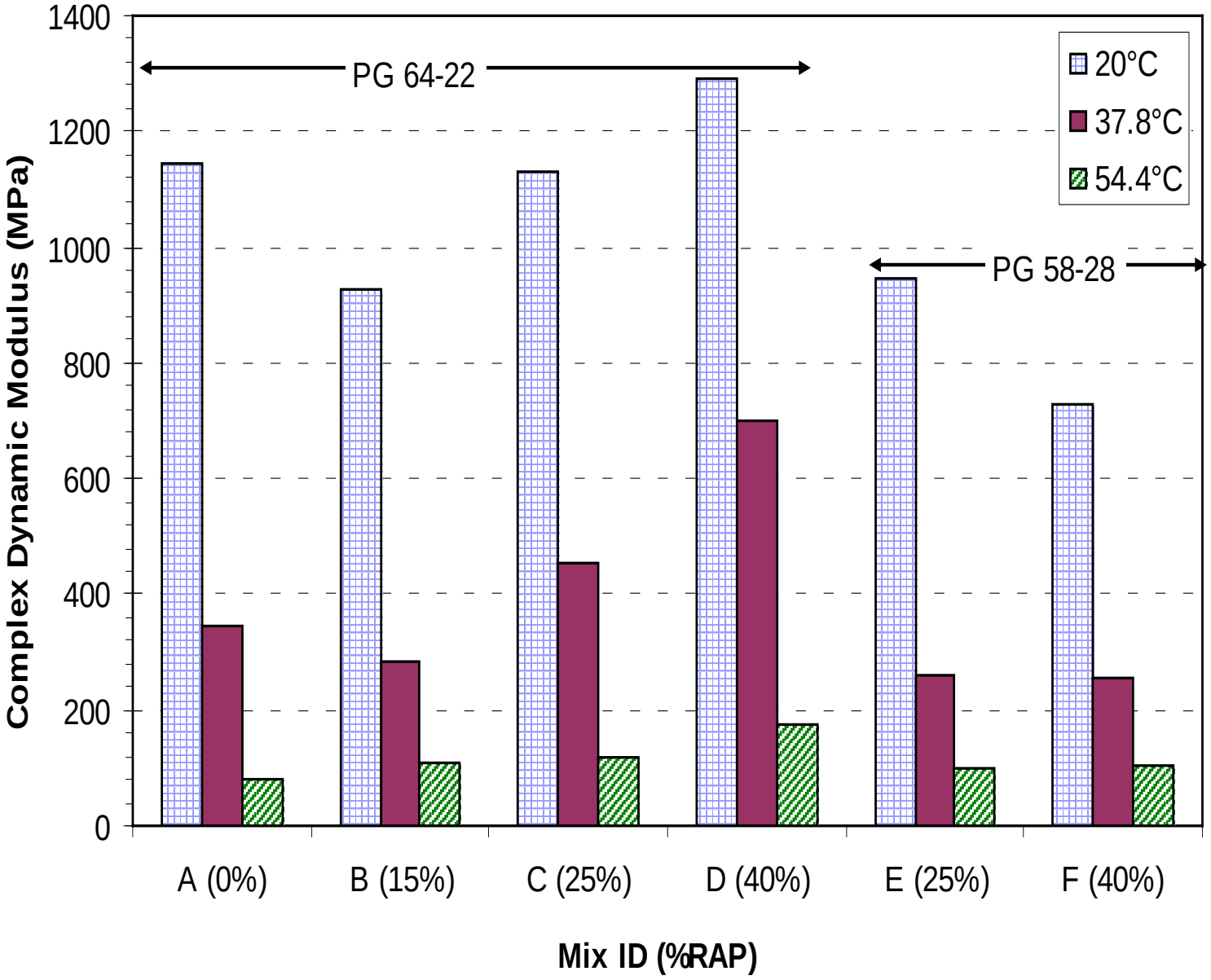
Experimental Design

	Reclaimed Asphalt Pavement			
Binder Grade	0%	15%	25%	40%
PG 58-28			X	X
PG 64-22	X	X	**X**	X

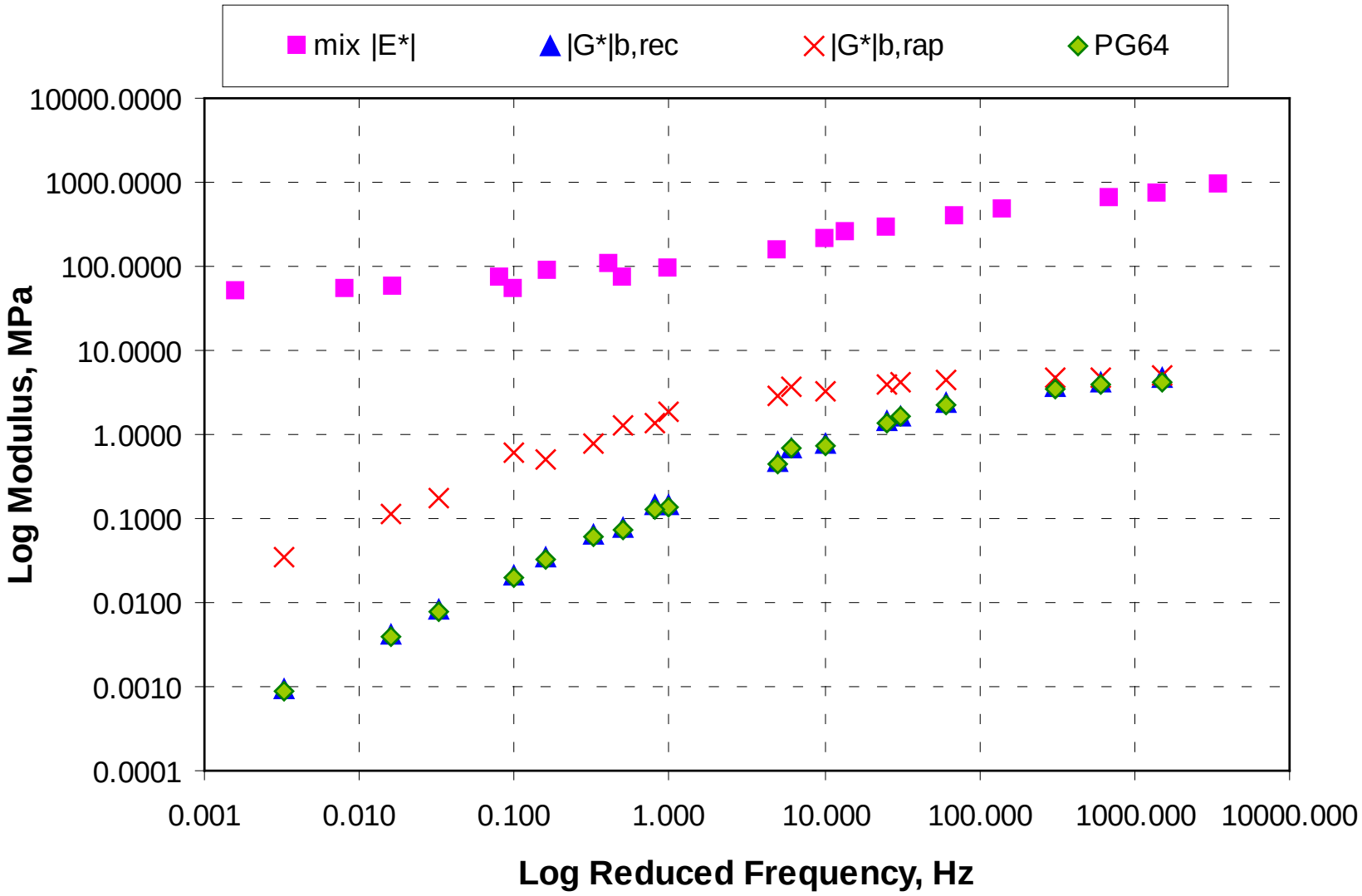

0°C
-10°C
-20°C
PG 64-22
PG 58-28
Indirect Tensile Strength (kPa)
4500
4000
3500
3000
2500
2000
1500
1000
500
0
A (0%)
B (15%)
C (25%)
D (40%)
E (25%)
F (40%)
Mix ID (%RAP)

Critical Cracking Temperatures

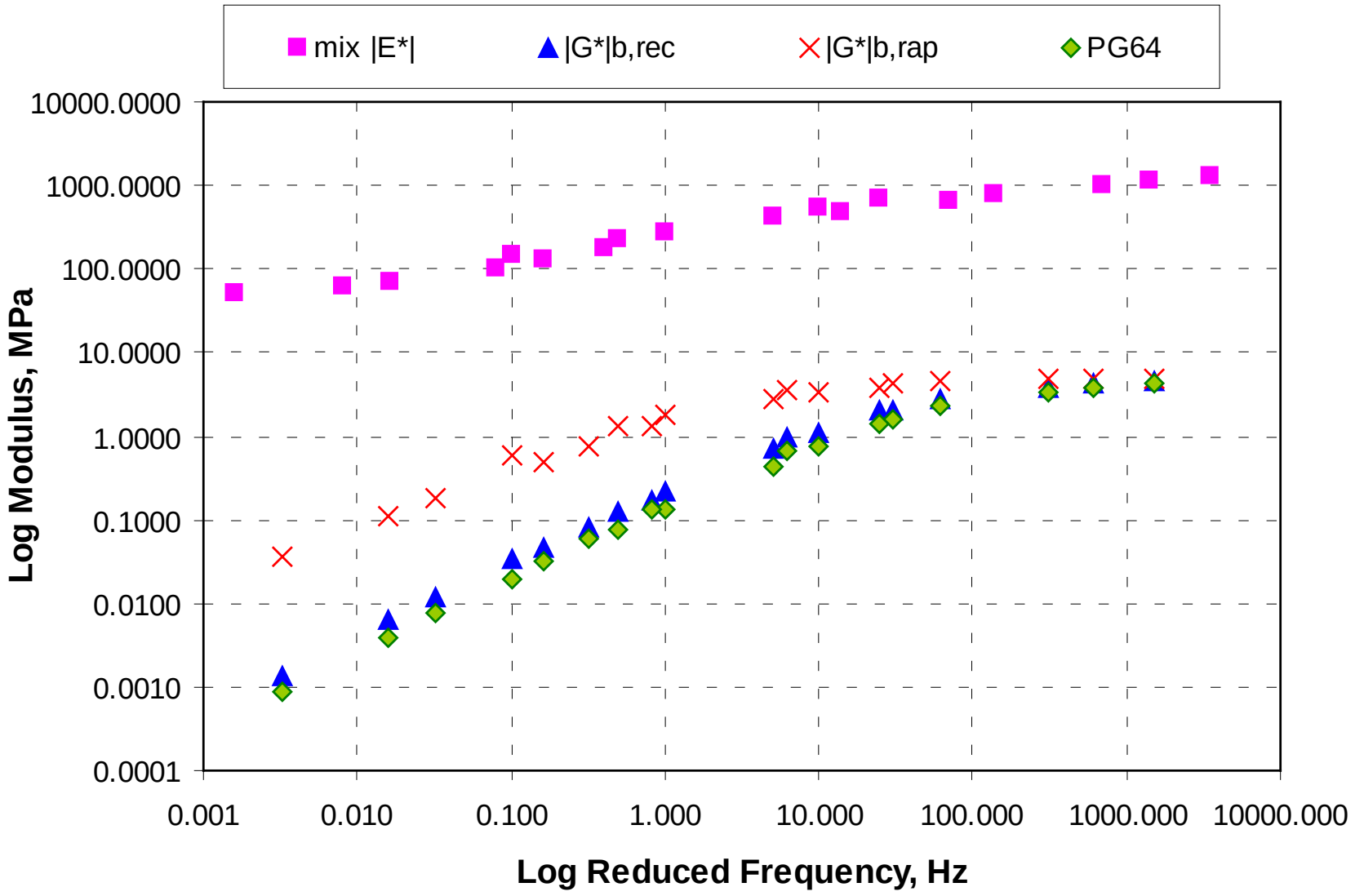
Mix	RAP Content	Tc (°C)
A – PG64-22	0	-28.9
B – PG64-22	15	-23.3
C – PG64-22	25	-25.6
D – PG64-22	40	-22.8
E – PG58-28	25	-27.2
F – PG58-28	40	-23.9


1400
1200
1000
800
600
400
200
0
Complex Dynamic Modulus (MPa)
PG 64-22
PG 58-28
20°C
37.8°C
54.4°C
A (0%)
B (15%)
C (25%)
D (40%)
E (25%)
F (40%)
Mix ID (%RAP)

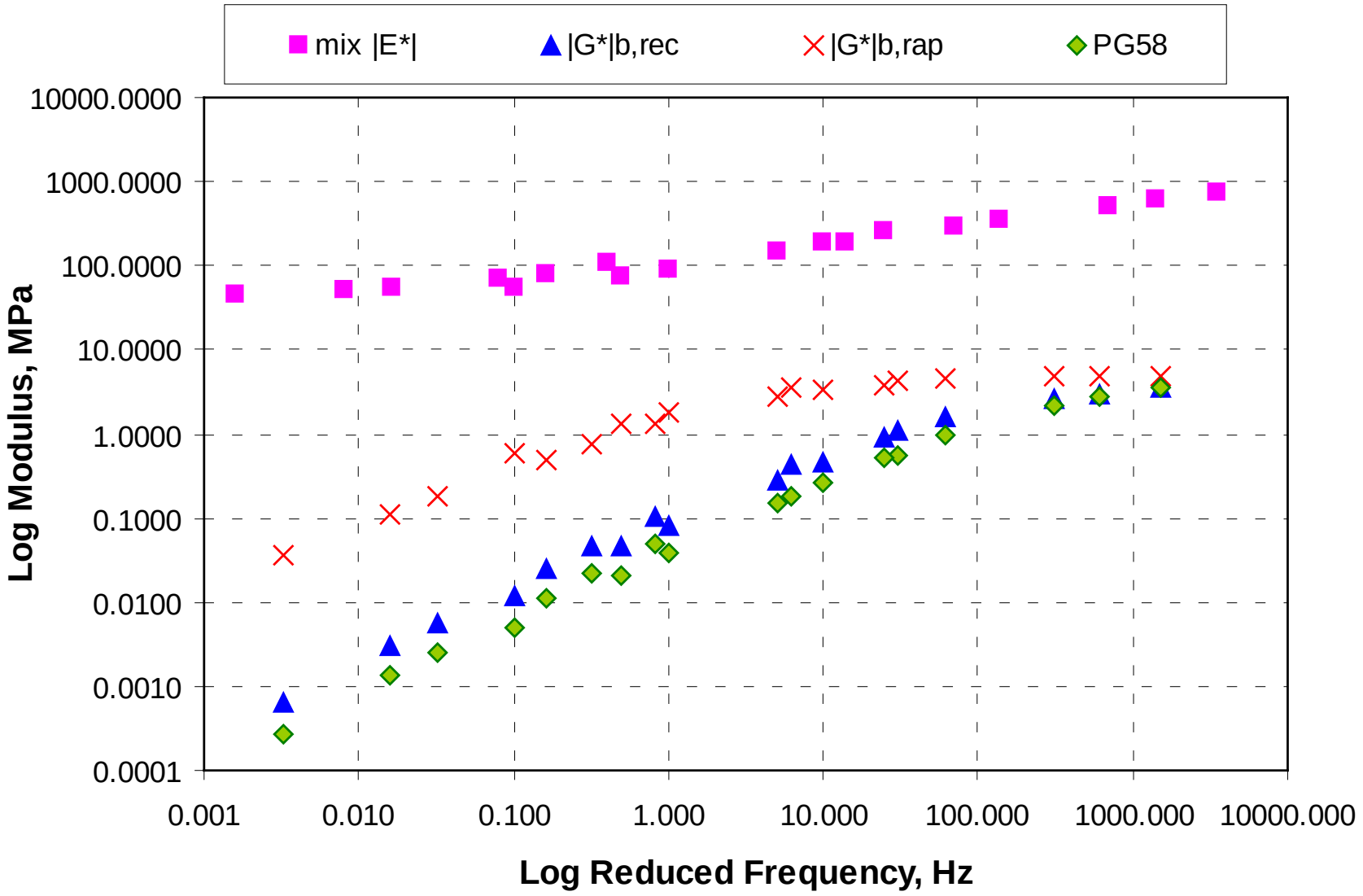
PG64-22, 15% RAP



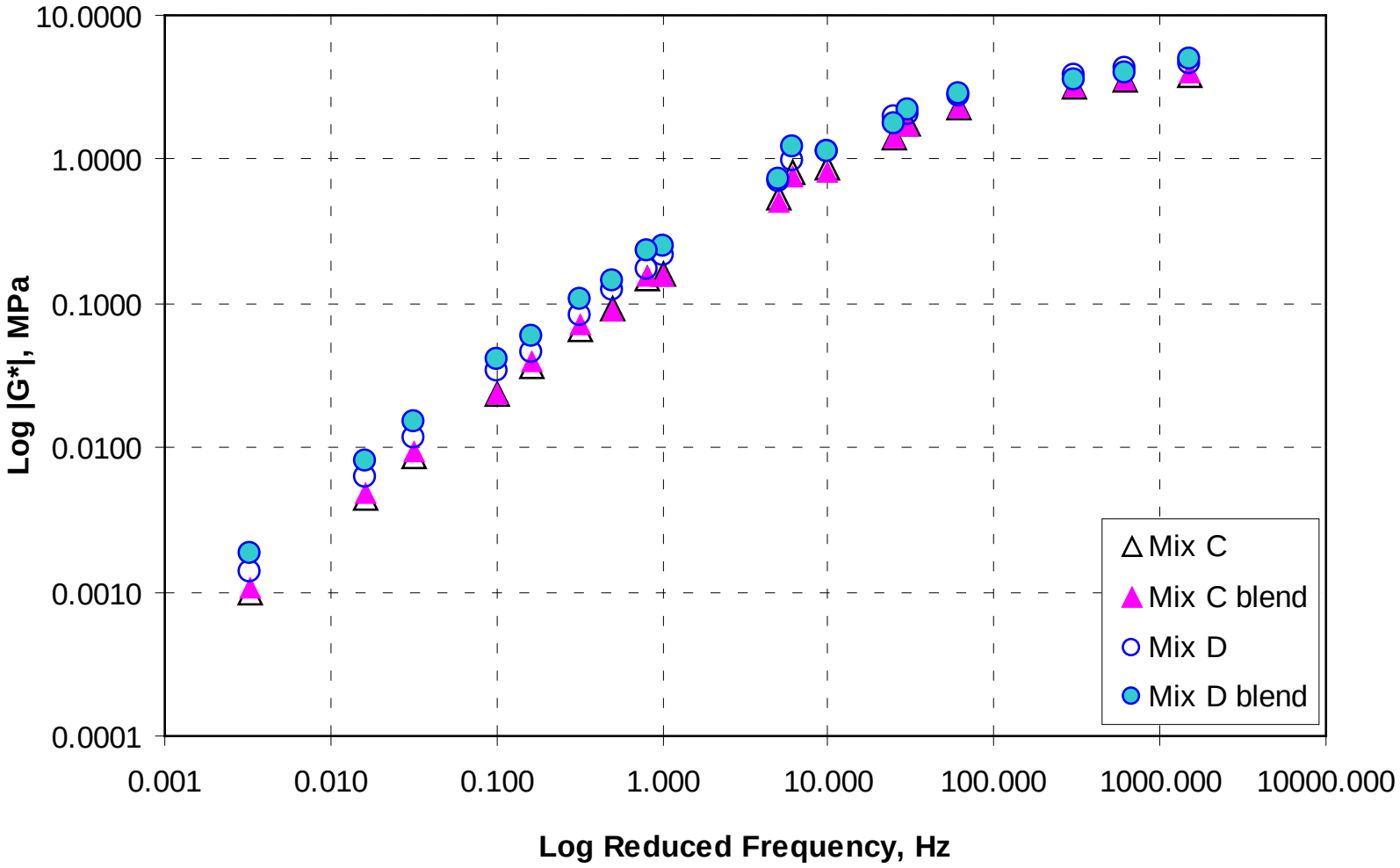
PG64-22, 40% RAP



PG58-28, 40% RAP



Physically Blended Binders



What does this suggest?

- For *these materials and this plant*, the RAP did not have as much impact as expected.
- The higher RAP contents were, in general, not significantly stiffer than virgin mix.
- The binder did not stiffen linearly with increasing RAP content.
- Compatibility problem?
- In this case, dropping the virgin grade to PG58-28 for 25% RAP was not necessary.

Doesn’t this contradict earlier work?

- Not necessarily. (More following.)
- Also recommended states look at their typical materials to verify appropriate breakpoints.
- Regional Pooled Fund study also had one non-linear example that was stiffer than expected.

Preliminary NCHRP Tiers

	Recovered RAP Grade		
Recommended Virgin Binder Grade	PGxx-22 or lower	PGxx-16	PGxx-10 or higher
No change in binder	<20%	<15%	<10%
One grade softer	20 – 30%	15 – 25%	10 – 15%
Use blending charts	>30%	>25%	>15%

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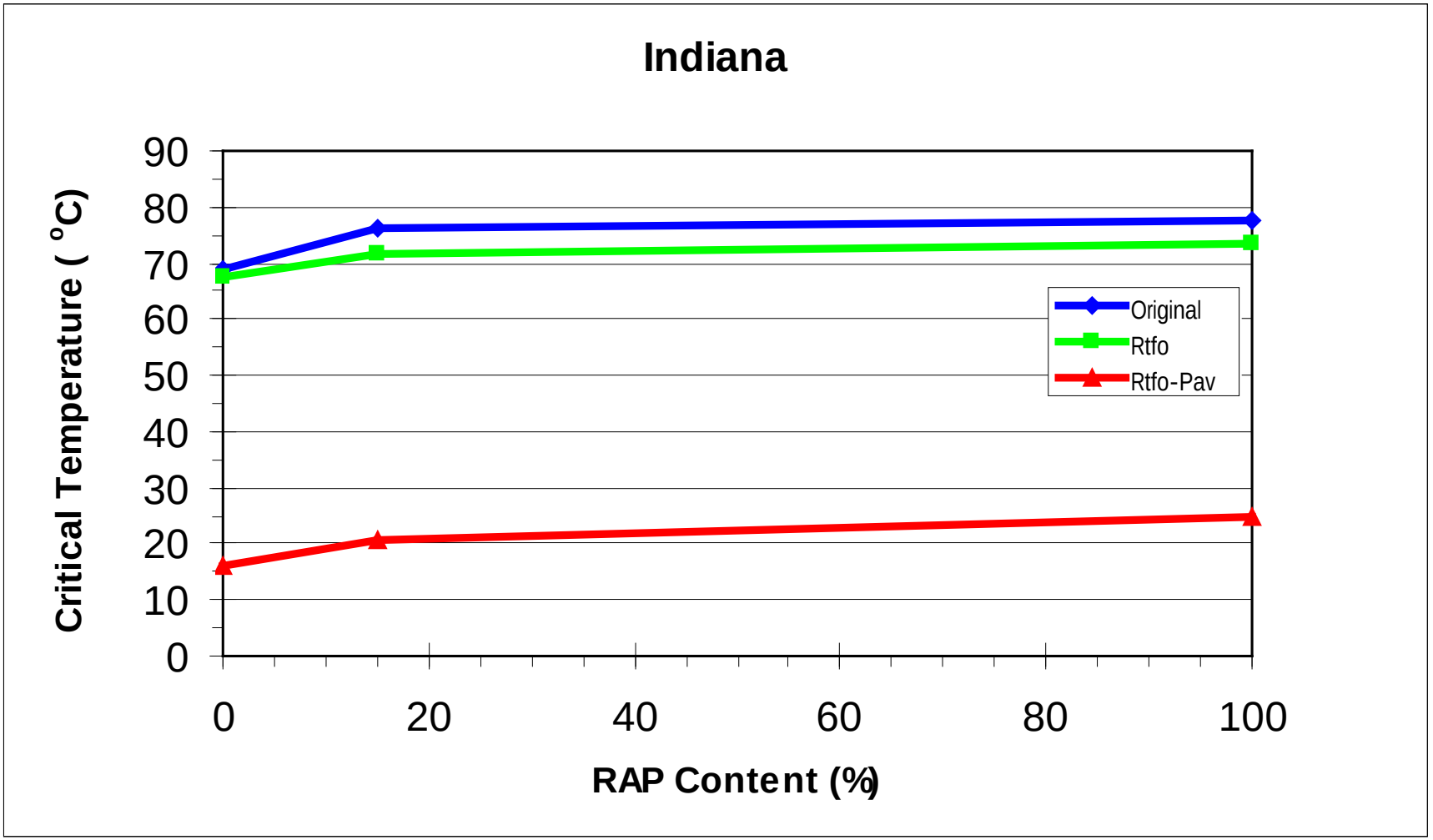

Not linear – but stiffer than expected.

Is this conclusive?

- Certainly not.
  - Only one plant, one RAP source, one set of virgin materials
- Exception rather than rule.
- But, it does suggest that there is more that we need to understand about RAP, its effects and its “compatibility” with virgin materials plus plant operations.

What this suggests

- Maybe current binder grade recommendations are too restrictive – too simplified.
- We need to test more materials from more plants to understand true effects.
- Two more contractors have signed on.
- We will also investigate effect of extraction/recovery method.