# Performance Tests for RAP Mixtures and Update on RAP Plant Mix Study

Rebecca McDaniel
North Central Superpave Center

RAP ETG
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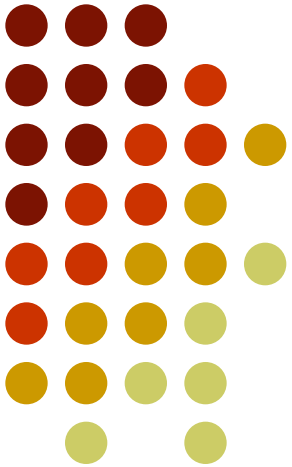


# Topics

- What is the current status of RAP Plant Mix Study?
  - A little history and new, preliminary data
- What performance tests are being used with RAP mixes?
  - Discussion

# Previous RAP Research - NCSC

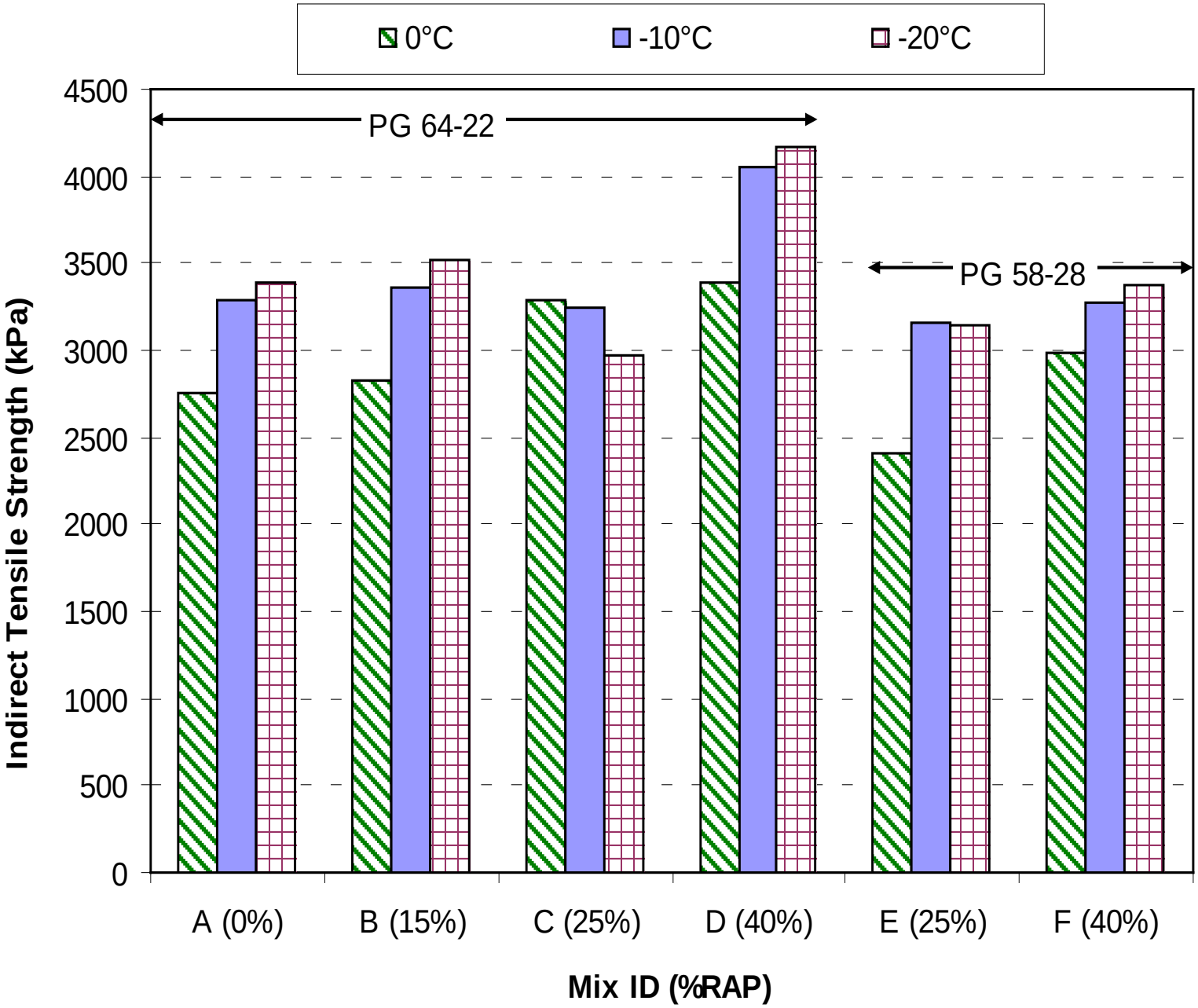
- *Low-Temperature Performance Properties of Hot Mix Asphalt Containing RAP*
  - Evaluated plant-produced mixes with up to 40% RAP and two virgin binder grades
  - Originally proposed to focus on effects of RAP on low temperature properties
    - Not strictly confined to low temps though

# What We Did

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

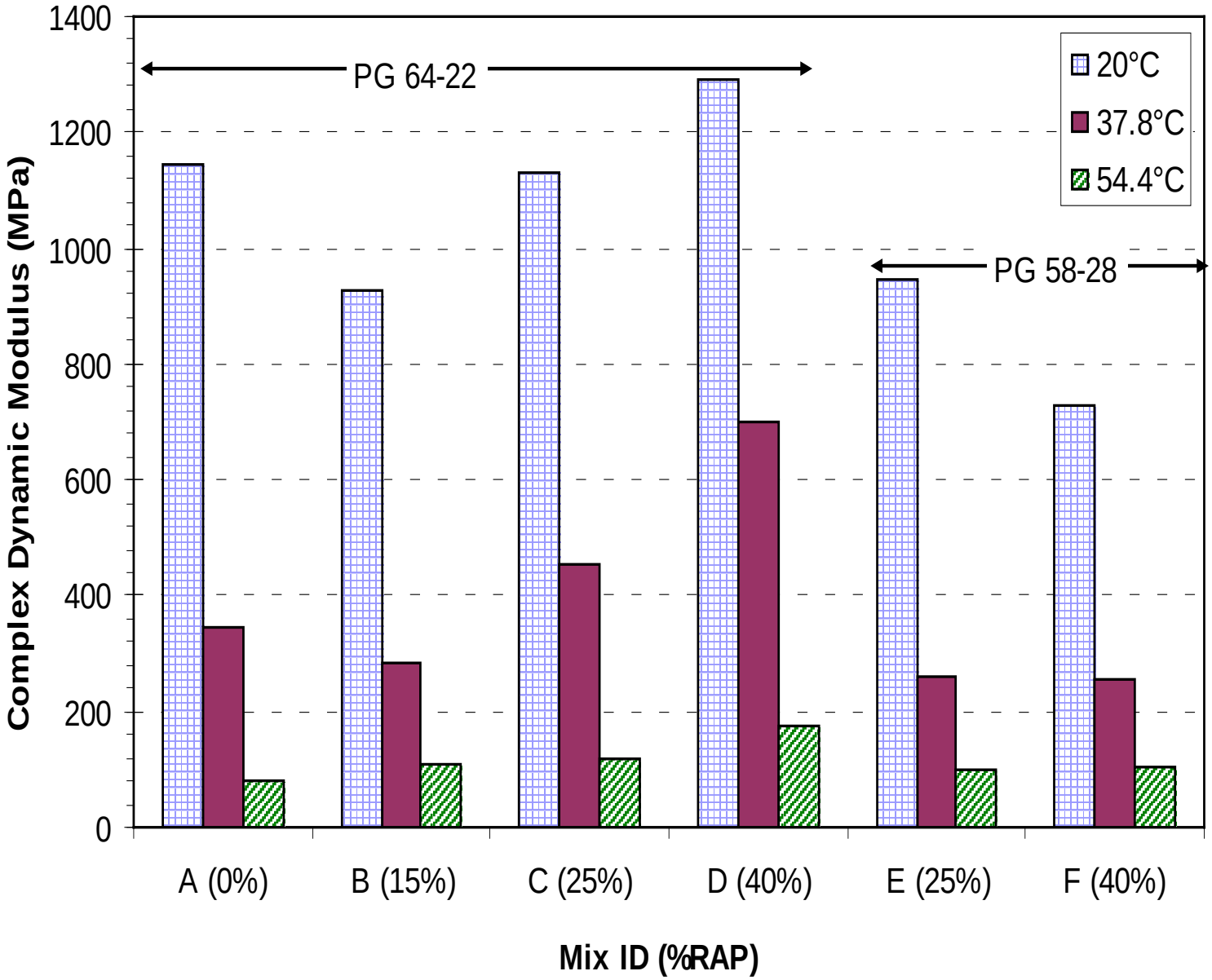
# Experimental Design

| | 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)

# Conclusions

- 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.
- In this case, dropping the virgin grade to PG58-28 was not necessary.
- *Limited study – one RAP, one plant.*

# Phase 2 Study

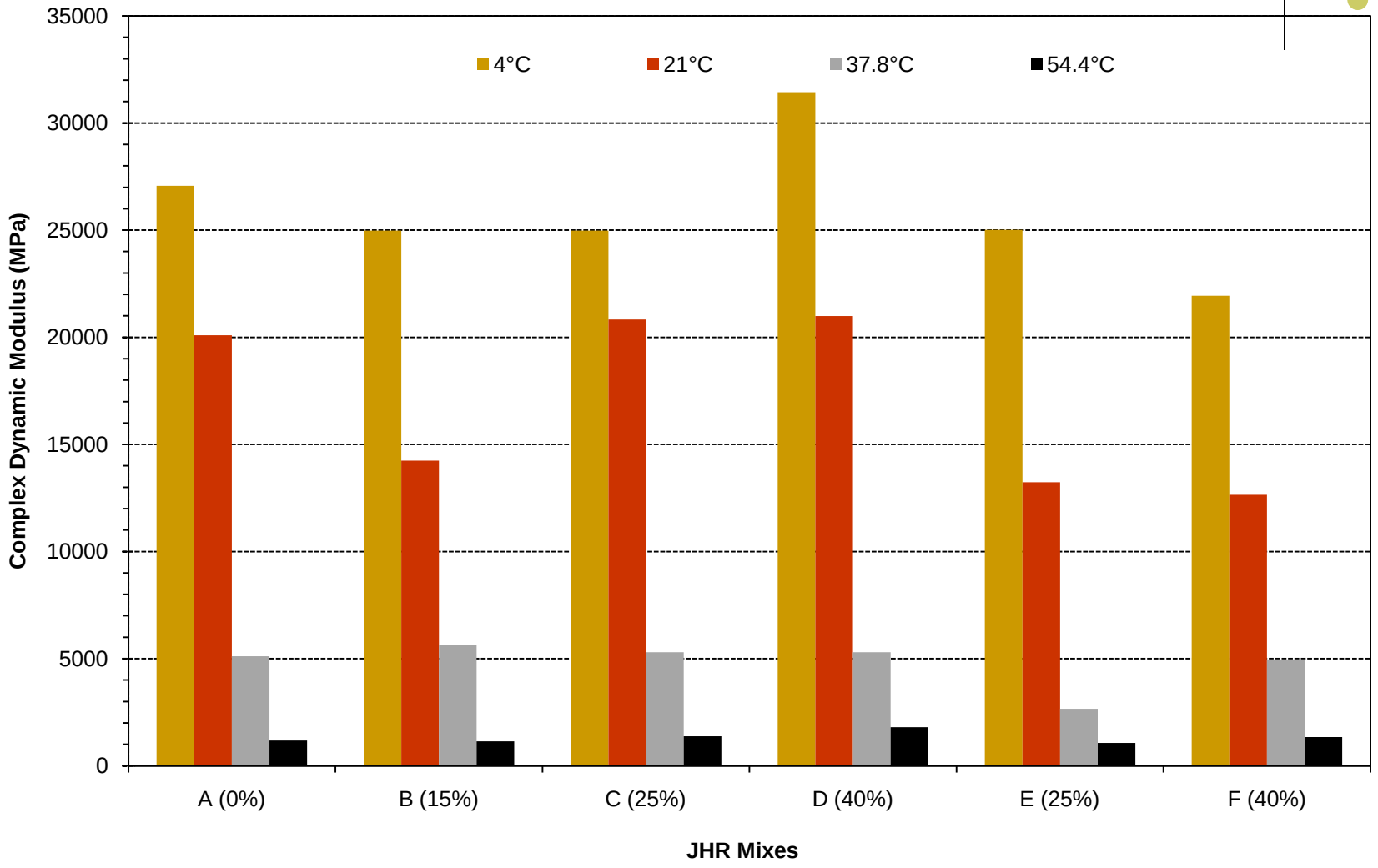
- Currently underway – preliminary results
- *Work in progress*

- Four more contractors have replicated the experiment in two states (MI and IN – North, Central and South )
- Expect most of the results to be available by the end of the year.

# Tests being Conducted

- Dynamic Modulus
  - Two done, samples ready for other two
- Indirect Tension
  - Samples prepared
- Binder extraction, recovery and PG grading
  - Extractions/recoveries complete

# Draft, Unfiltered Data



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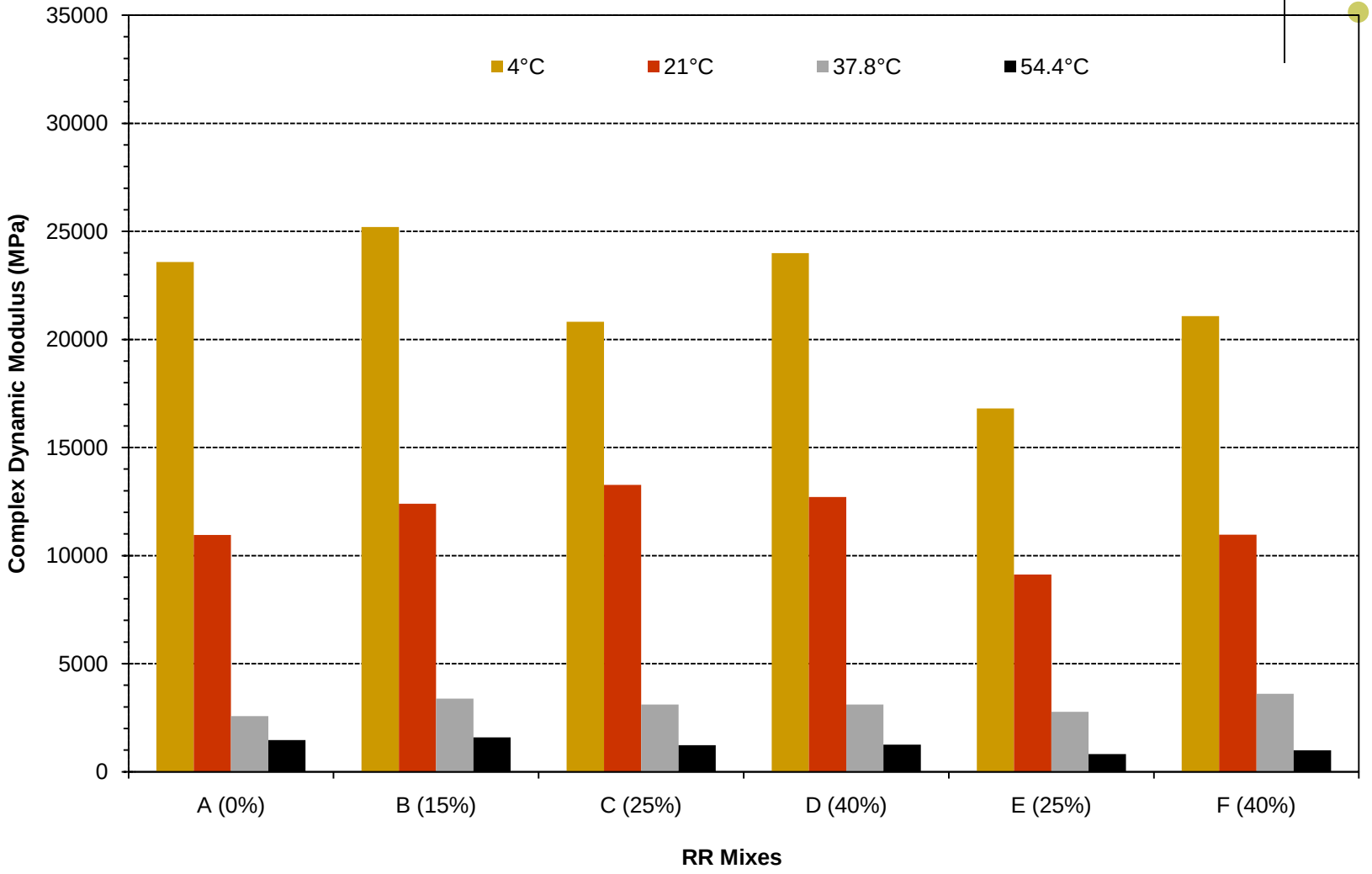


# Suggestions

- *Preliminary suggestion – not yet a finding*
- We have a lot more work to do.
- It appears that there may be more evidence to support allowing higher RAP contents before changing grade.
- By next meeting, should have the full data set and conclusions.

# Performance Tests for RAP Mixes

- Last meeting, volunteer requested to come up with a list of performance tests that could be used with RAP mixes.

- I couldn’t stand the silence, so volunteered!

# First Inclination

- Any good performance test used for asphalt mixes should be applicable to RAP mixes.

# Second Approach

- TRIS search – looked at top, most recent 100 documents/abstracts (back to about 2005)
- Identified performance related tests people were using in RAP studies
  - Noted a few of the authors (not all)
- Hope discussion will identify more methods and users

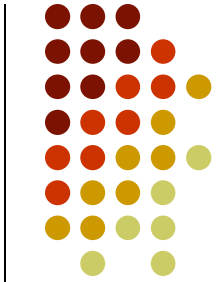
# Test Methods Used

- Dynamic Modulus
  - Li, Marasteanu, Williams, Clyne
  - Mallick et al.
  - Bonaquist
  - Daniel
  - McDaniel, Shah, Huber and Gallivan
  - Others

# Test Methods Used

- SCB
  - Li et al.
- Indirect Tensile Test
  - Mallick et al.
- T283
  - Watson et al.
- Beam Fatigue
  - Watson et al.

# Test Methods Used



- Indirect Tension Stress Relaxation (5 and 22C)
  - Carter and Stroup-Gardiner
- BBR on Mix Beams
  - Zofka and Marasteanu
- Others???
  - Discussion