Asphalt Mix Performance Testing for PA
An Update

Pennsylvania
Asphalt Pavement Association
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DISCUSSION TOPICS

1. Performance Based Testing/SCB Initiative
2. Long Life Asphalt Pavements
3. An Update on SCB Test Results

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1. Performance Based Testing/SCB Initiative
2. Long Life Asphalt Pavements
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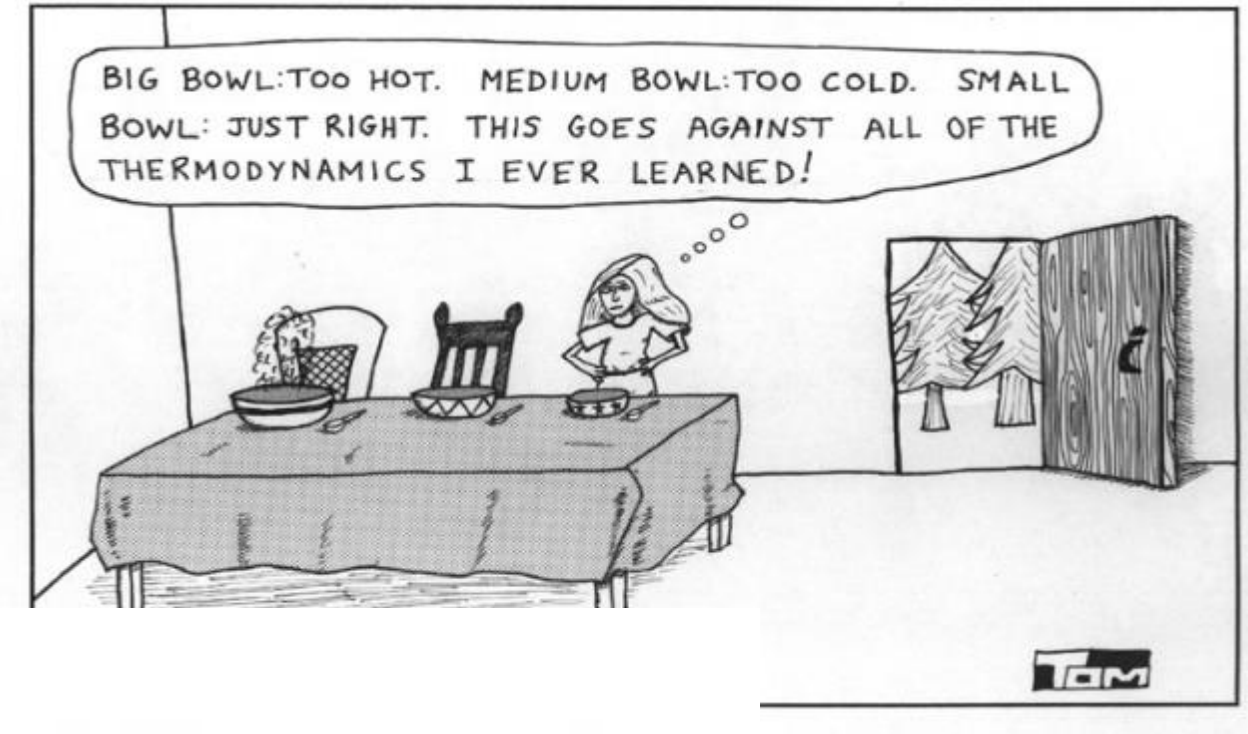
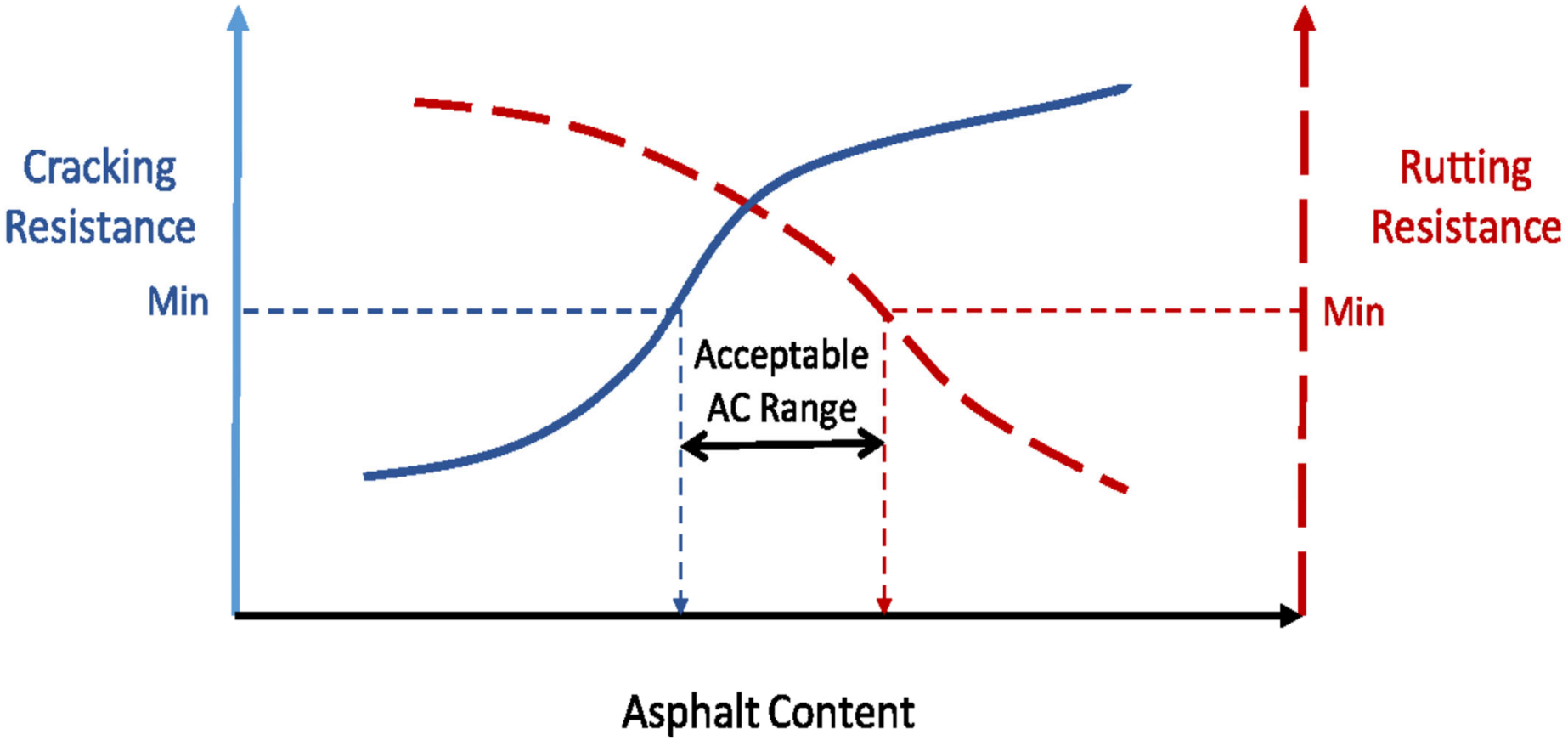
Design/Place A Mix that Does Not

RUT **CRACK**

Balanced Mix Design
The Goldilocks Principle



Balanced Asphalt Mix Design



Need Proper Performance Test for Balanced Mix Design

- Two Important Considerations:
  - **Need Right Test and Reliable Criteria**
  - **Don’t Forget the Effect of Pavement Structure**

Examples of Performance Tests

Wheel Tracking

DCT

SCB

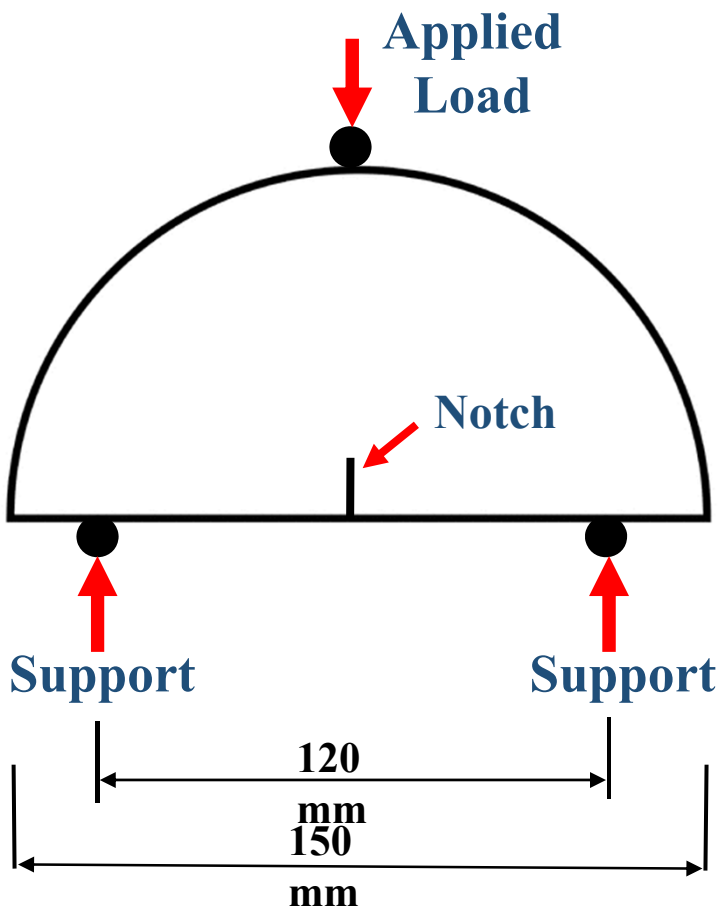
Industry SCB Testing: How Did It Start?

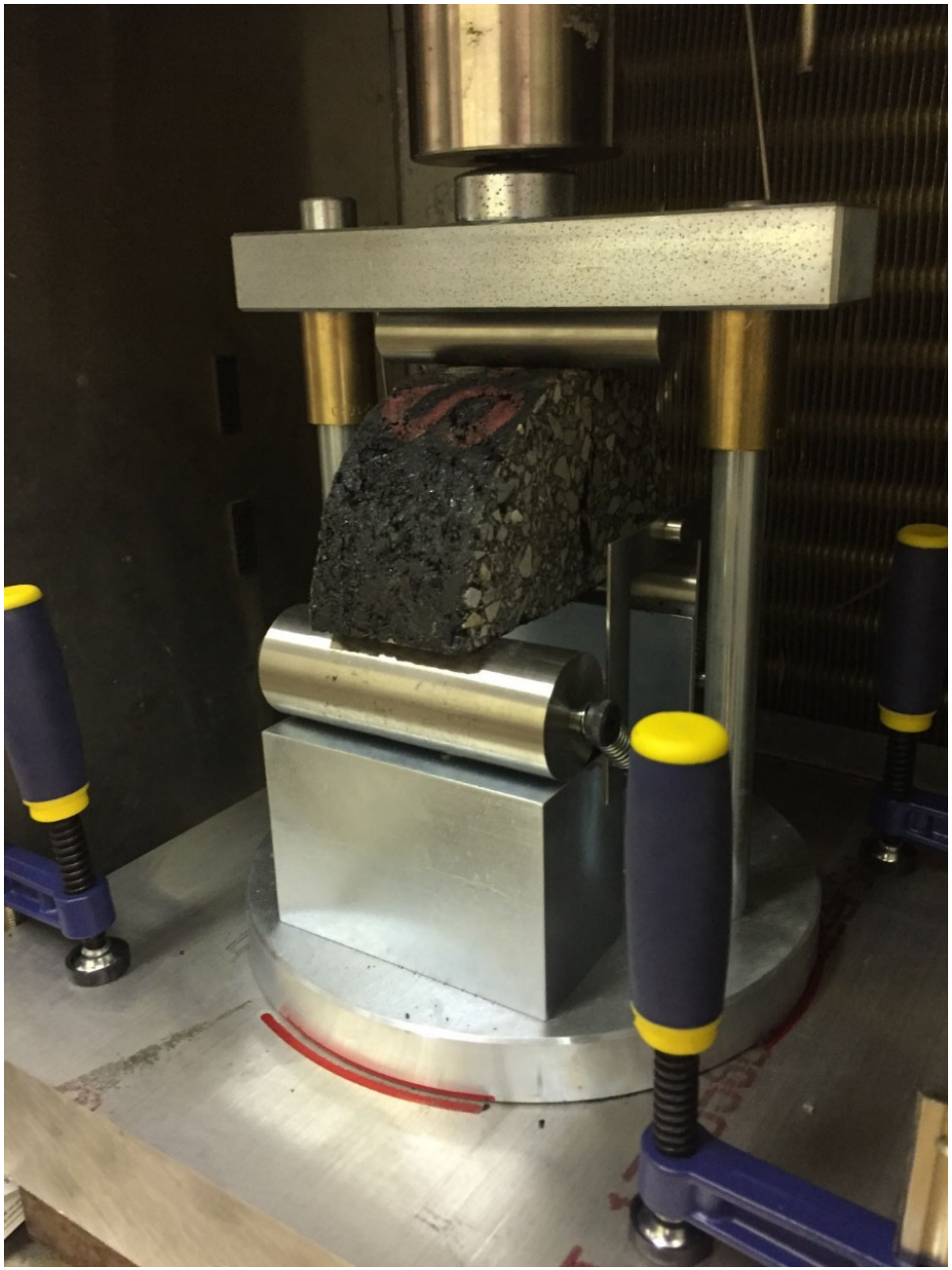
- **Move to Performance Testing**
- **Initiated by Asphalt Quality Improvement Committee and PAPA**
- **Industry Expressing Interest in Participating**

Purpose of the Effort

- **Bridge the Gap to Performance Testing**
- **Investigate Performance of PA Mixes in SCB**
- **Develop A Database of SCB Test Results**
- **Evaluate Sensitivity of the PA Mixes to the Test**
- **Evaluate Correlation with Field Performance**

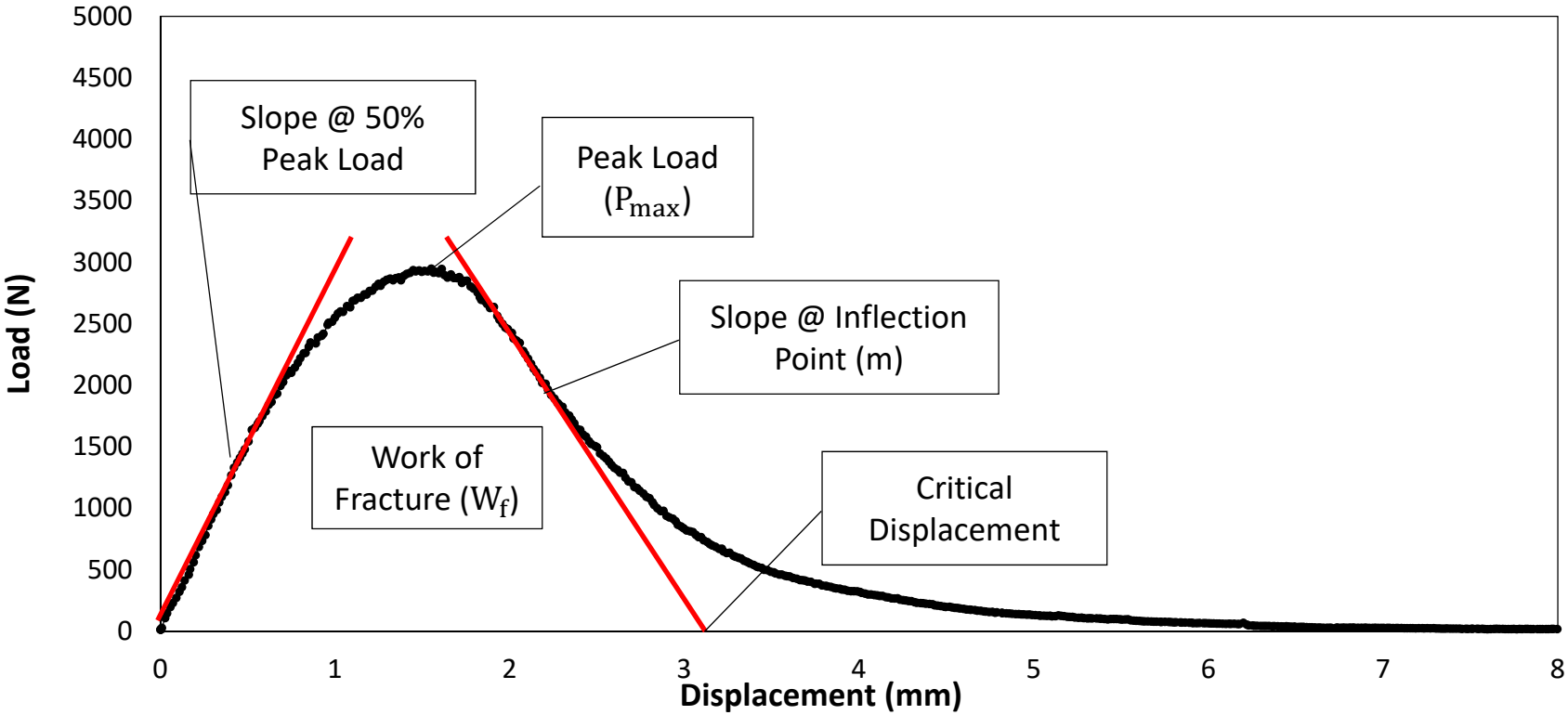
SCB Test Setup





Specimen Thickness: 50 mm
Notch Depth: 15 mm
Notch Width: 1.5 mm

Parameters Used For Evaluation



Fracture Energy

$$G_f = \frac{W_f}{B \cdot L}$$

B: Specimen Thickness
L: Ligament Length

Flexibility Index

$$FI = A \times \frac{G_f}{abs(m)}$$

A: Constant

Stiffness Index

Slope @ 50% Peak Load in Pre-Peak Curve

Performance Test & LLAP driven by:

- TQI
- STIC

DISCUSSION TOPICS

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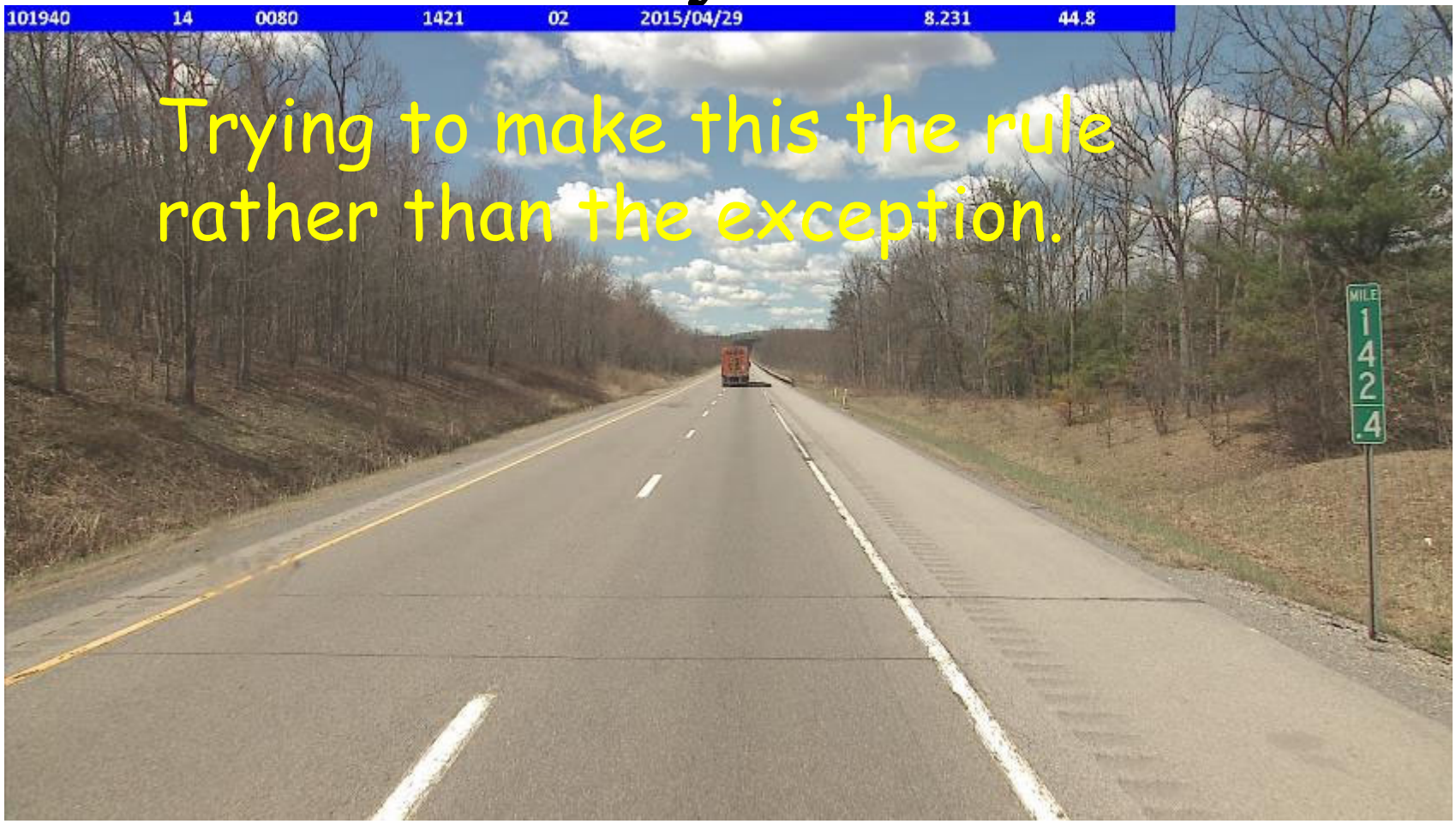
2. Long Life Asphalt Pavements
3. An Update on SCB Test Results

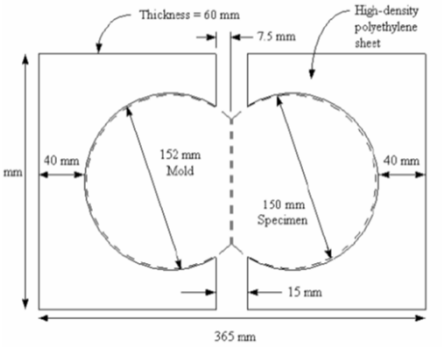
Heavy Duty ID2 placed in 1991 – 25 years

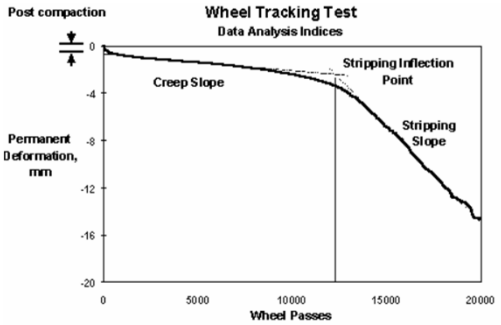


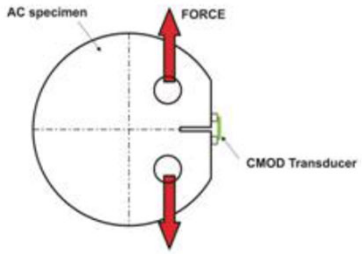
LLAP Best Practices

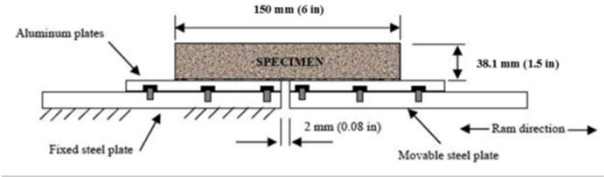
- **MTV Required**
- **Longitudinal Joint Density Specification**
- **Ride Specification Optional**
- **Tack Coat Every Layer (New Section 460)**
- **% Within Tolerance (PWT) Acceptance**
- **Incentivize Critical Elements (i.e. Mat Density)**

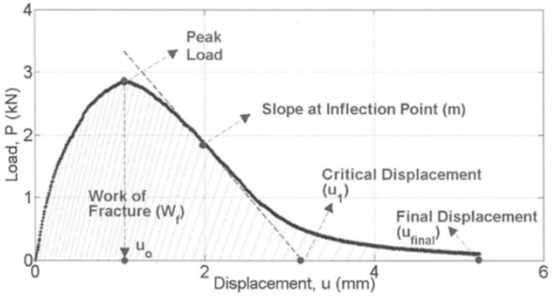
LLAP Performance Tests

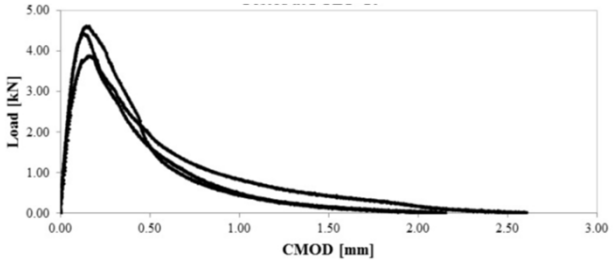






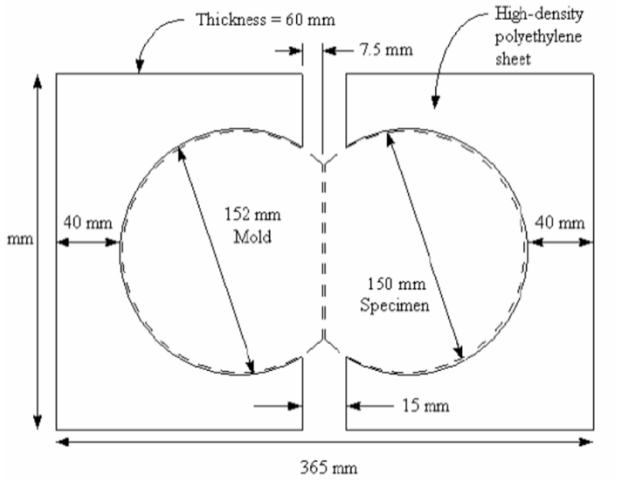


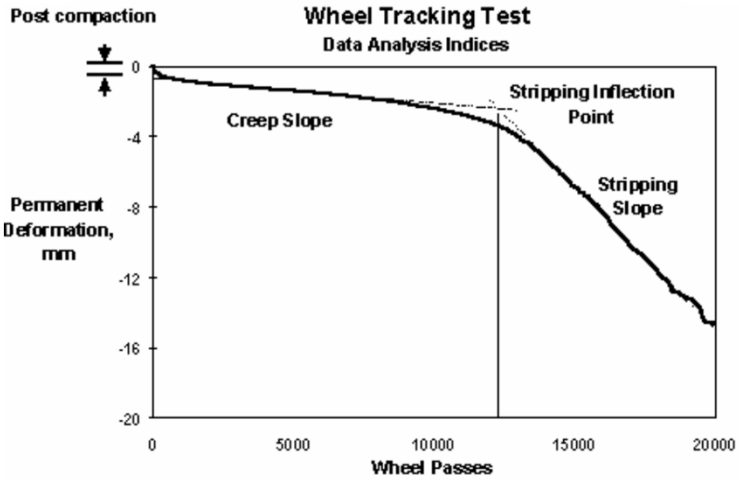




Rutting Test

- **Hamburg Wheel Tacking Test.** (AASHTO T 324)
  - Measures rutting potential and gives an indication of moisture sensitivity.
  - Gyratory samples %7.0 (+/- %1.0) air voids
  - Test run at 131^0 F (55^0 C)
  - 12.5mm (0.5 inch) rut at 20,000 cycles general rule of thumb for limit on superpave.





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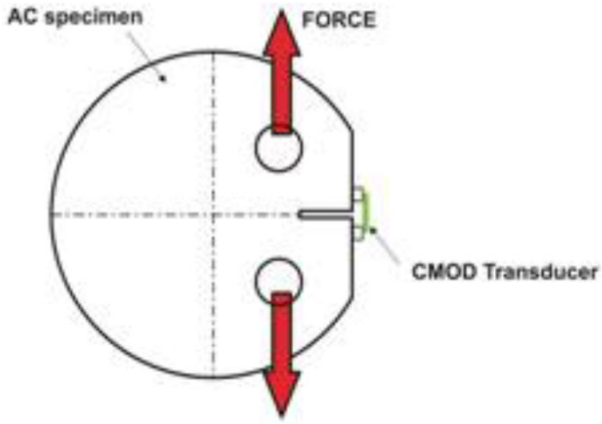
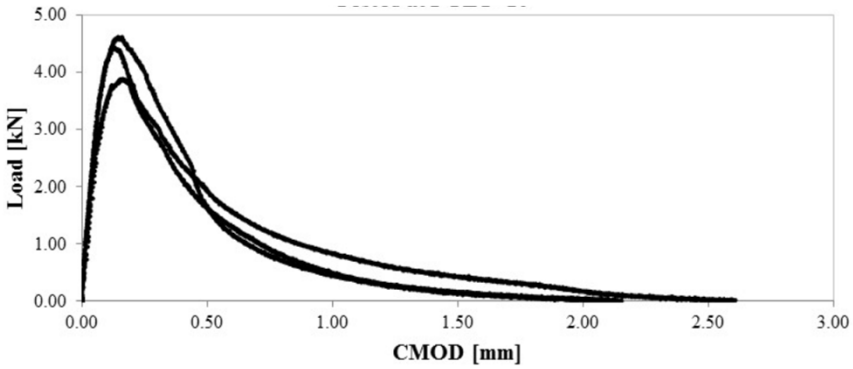
Cracking Test

- **Disk-Shaped Compact Tension** (DCT) testing. (ASTM D7313)
  - Measures fracture energy
  - Gyratory samples %7.0 (+/- %1.0) air voids.
  - Test run at 10^0 C above the low PG mix designation. (-12^0C (10.4^0 F) for PG64-22)
  - Fracture energy requirements vary depending on mix type (SMA) and layer (wearing, binder)





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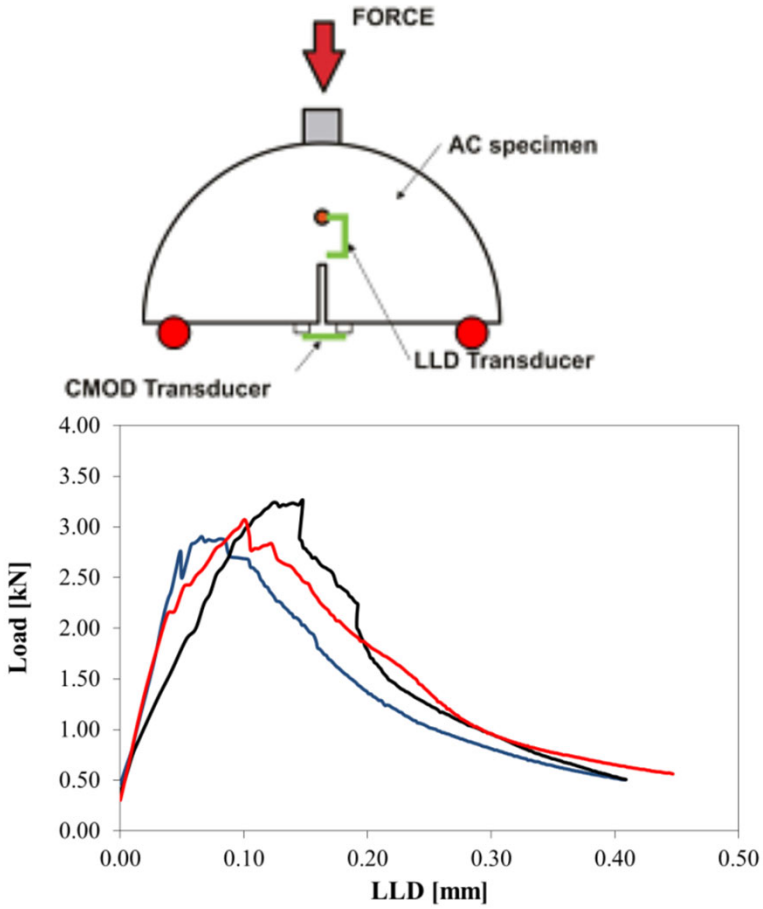
c1 cgoodhart, 1/11/2017

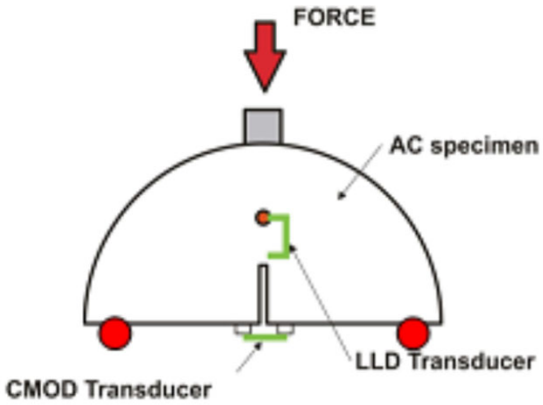
Cracking Test

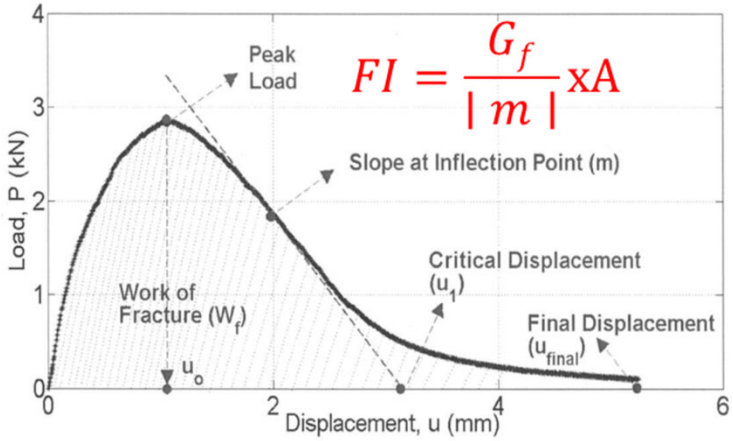
- **Semi-Circular Bending** (SCB) testing. (AASHTO TP 105)
  - Measures fracture energy
  - Samples fabricated from gyratory samples or cores.
  - Test run at 10^0 C above the low PG mix designation. (-12^0C (10.4^0 F) for PG64-22)
  - Fracture energy requirements vary depending on mix type (SMA) and layer (wearing, binder)



Cracking Test

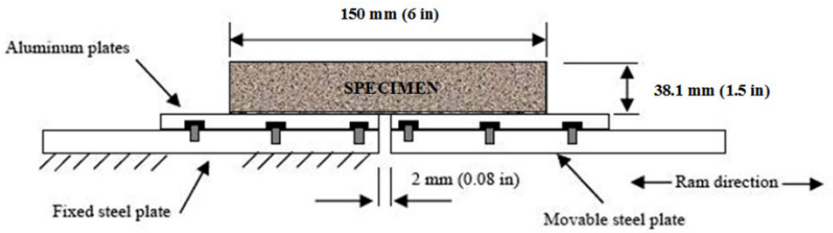
- **Illinois Flexibility Index** Test (IFIT). (AASHTO TP 124)
  - Measures fracture energy and post peek slope.
  - Uses fracture energy and load/displacement slope to compute Flexibility Index.
  - Gyratory samples %7.0 +/- %1.0 air voids
  - Test run at 25^0 C +/- 0.5^0C (77^0F).
  - Flexibility Index requirements vary depending on mix type (SMA) and layer (wearing, binder)

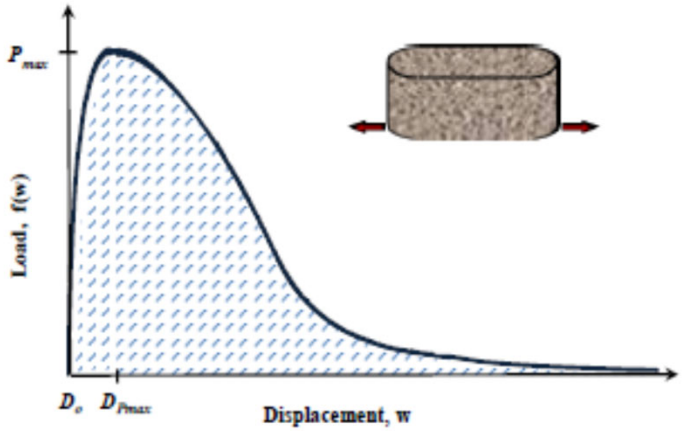




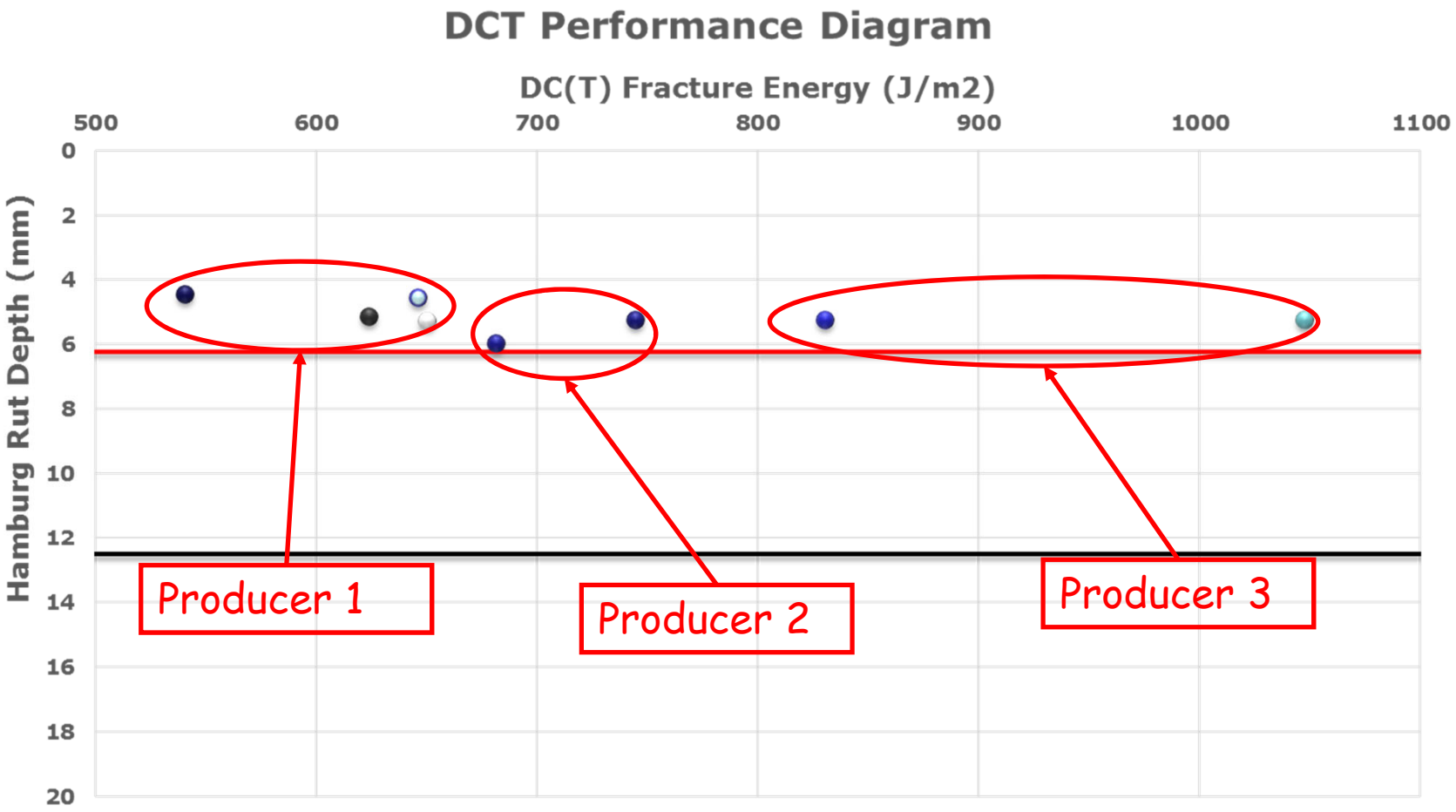
Cracking Test

- **Overlay Test** (OT). (TEX-248-F)
  - Measures fatigue or reflective cracking potential.
  - Gyratory samples %7.0 +/- %1.0 air voids.
  - Test run at 25^0 C (77°F).
  - Applies load to induce 0.025 (3/128ths) inches displacement.
  - Number of cycles to failure is reported along with percent decline in load.

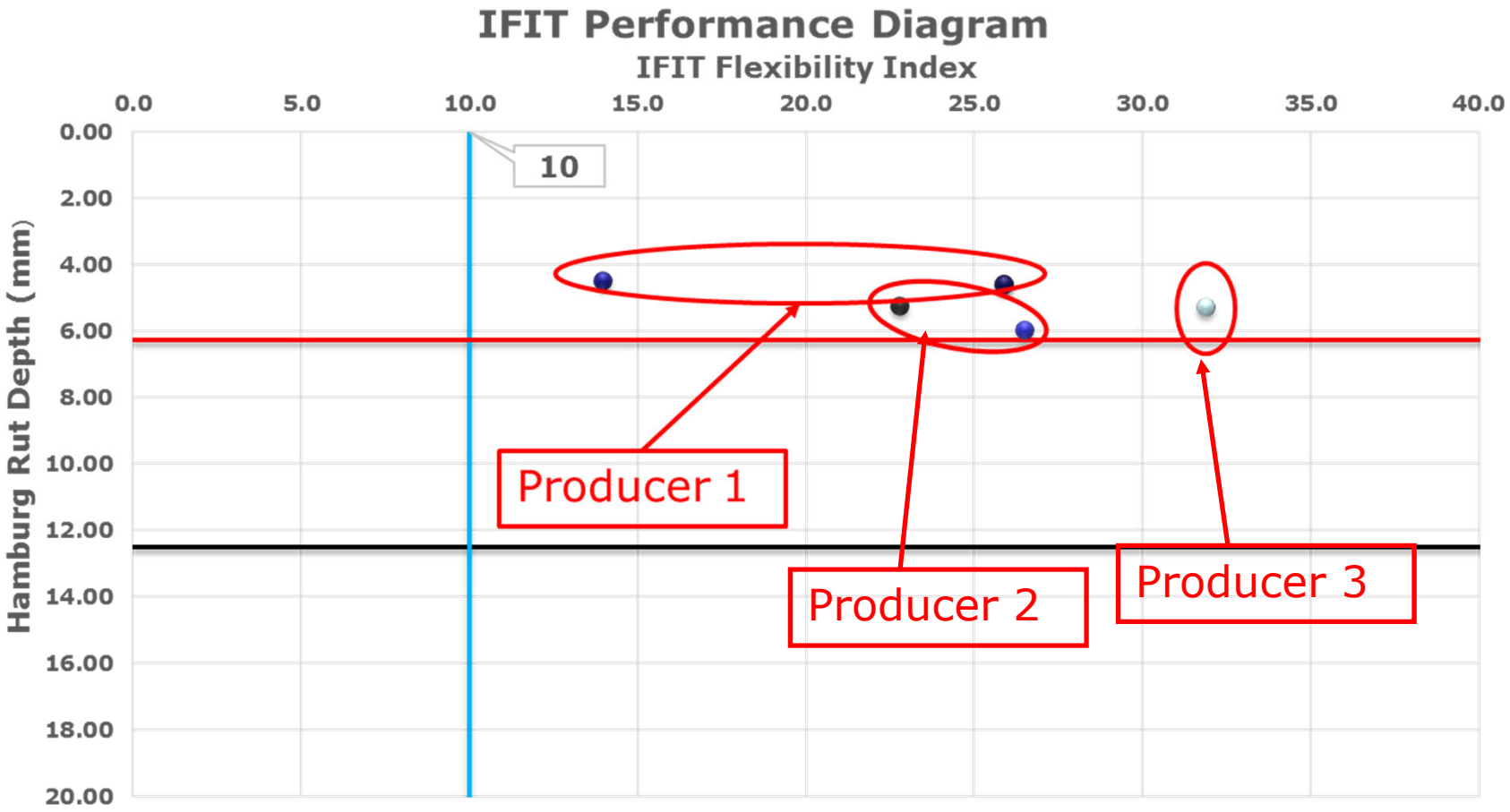




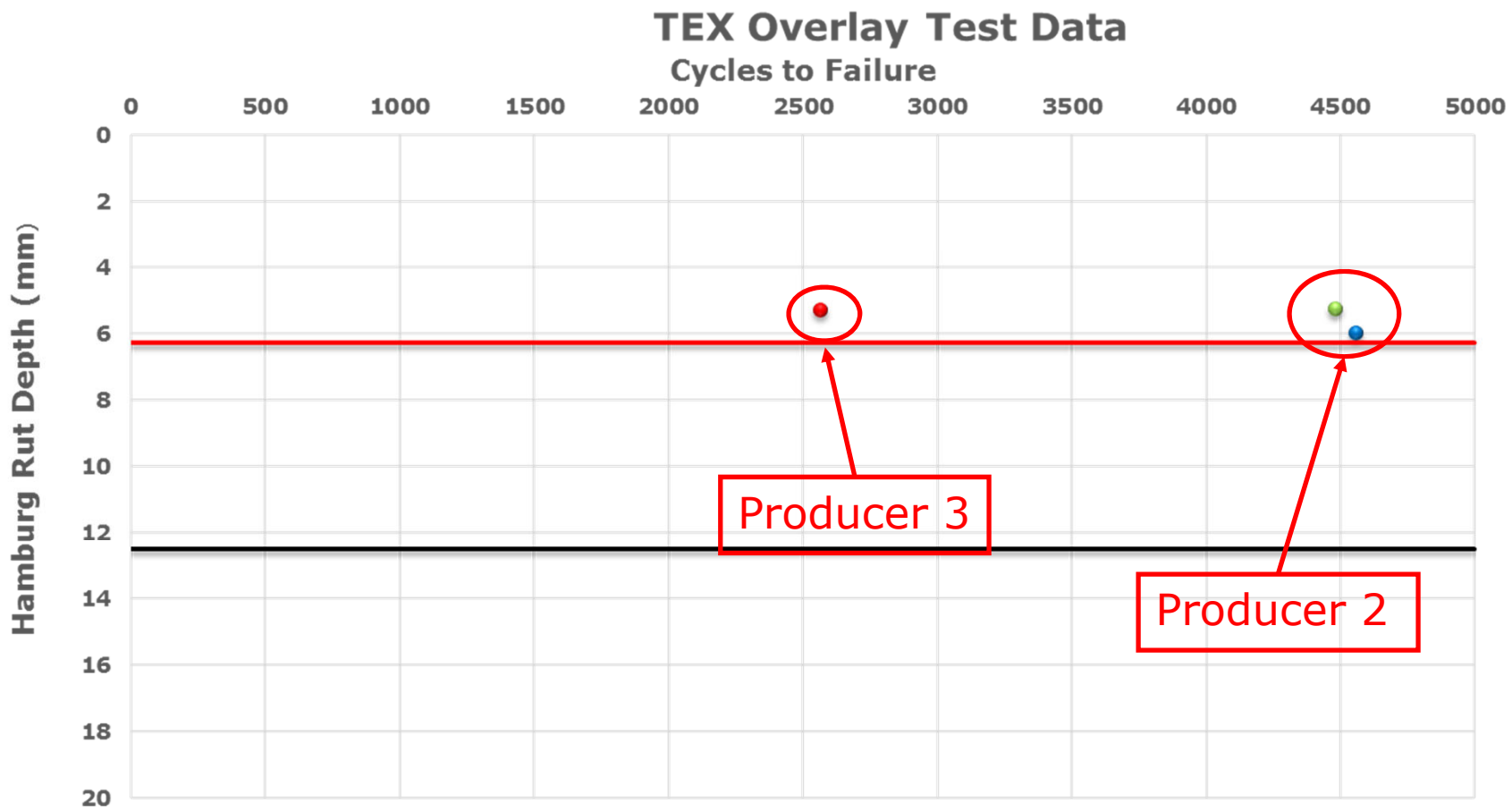
Long Life Asphalt Projects – DCT data



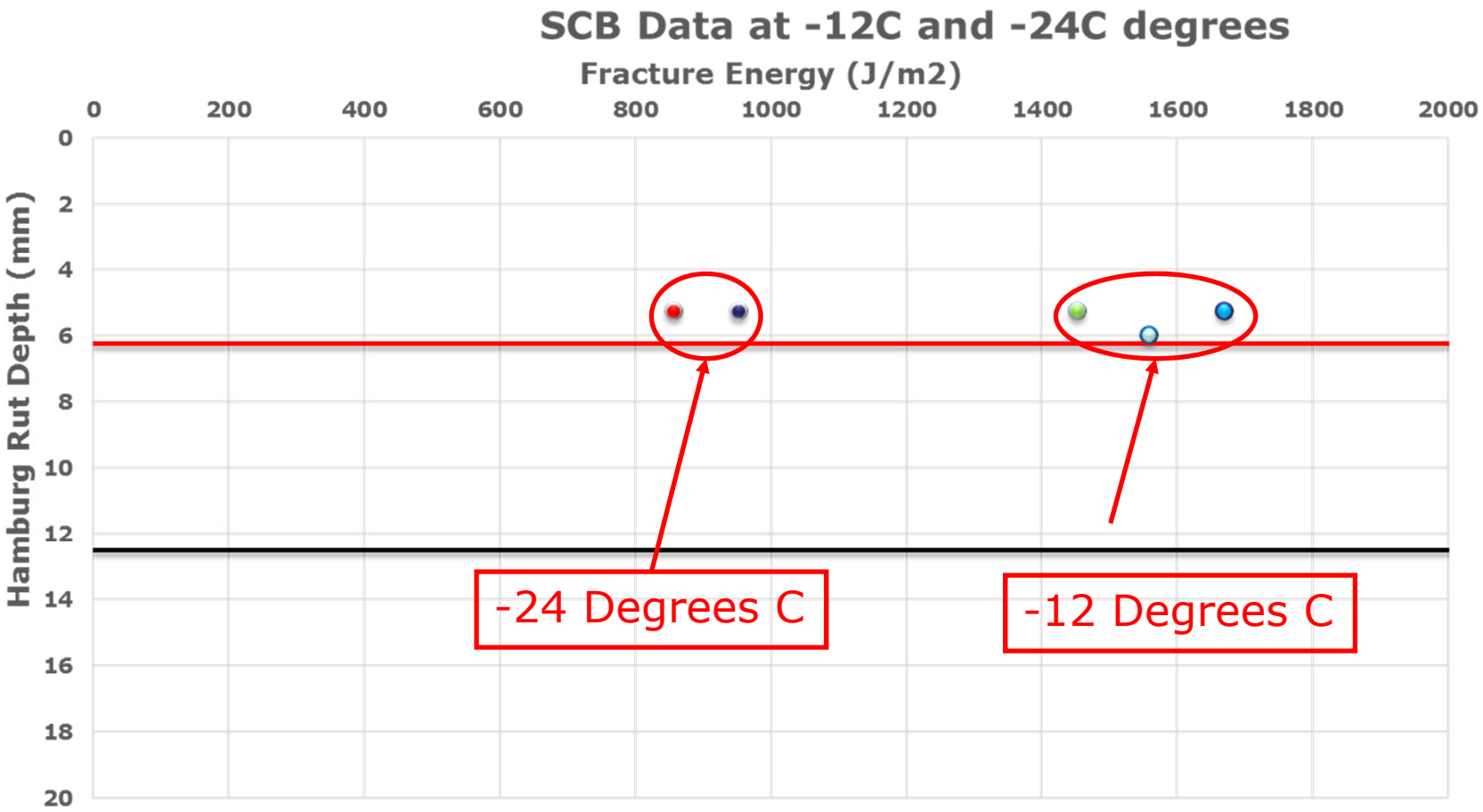
Long Life Asphalt Projects – IFIT data



Long Life Asphalt Projects – Overlay Test data



Long Life Asphalt Projects – SCB Test data



Data Comparison

Producer 1

- Eff.AC – 6.6%
- VMA – 18.7
- Pass #4 – 38% = 47% retained
- Pass #8 – 22% = 16% retained
- Coarse
  - Type – Calcareous Sandstone
    - Sodium – 1%, LA – 21%
    - Flat & Elongated 3:1 – 8.7%
- Fine
  - Type – Limestone
    - Sodium 5%

Producer 2

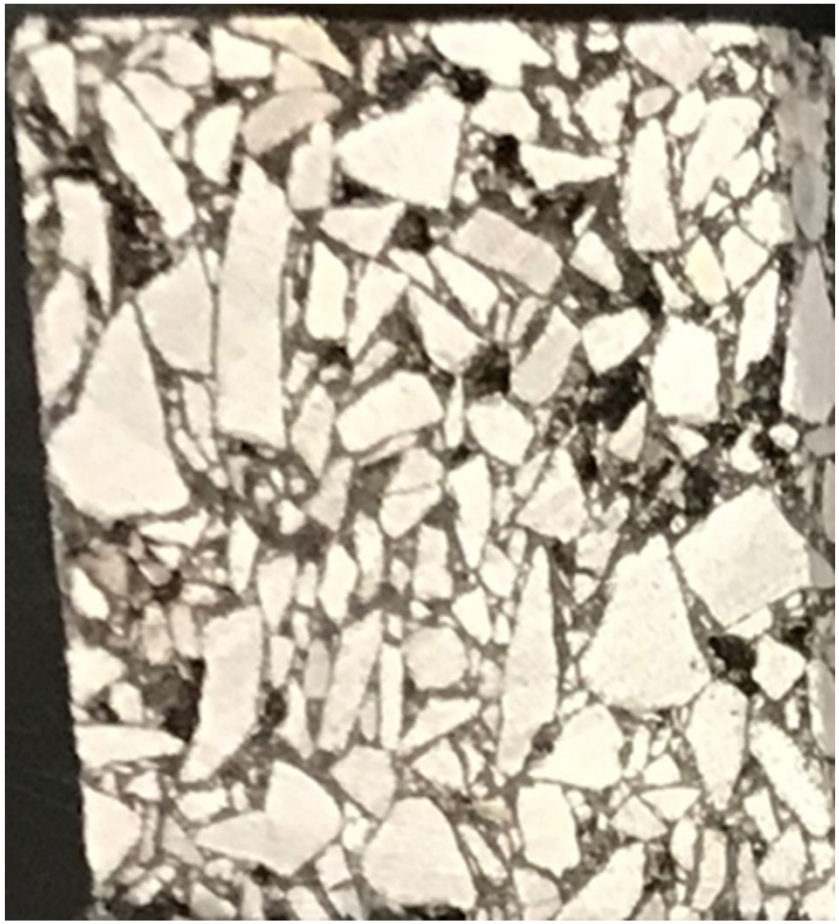
- Eff. AC – 6.5%
- VMA – 18.2
- Pass #4 – 39% = 52% retained
- Pass #8 – 21% = 18% retained
- Coarse
  - Type – Sandstone
    - Sodium – 5%, LA – 32%
    - Flat & Elongated 3:1 – 3.0%
- Fine
  - Type – Limestone / Dolomite
    - Sodium 2%

Producer 3

- Eff. AC – 6.2%
- VMA – 18.1
- Pass #4 – 48% = 54% retained
- Pass #8 – 25% = 23% retained
- Coarse
  - Type – Sandstone / Shale
    - Sodium – 2%, LA – 15%
    - Flat & Elongated 3:1 – 1.4%
- Fine
  - Type – Limestone / Dolomite
    - Sodium 2%

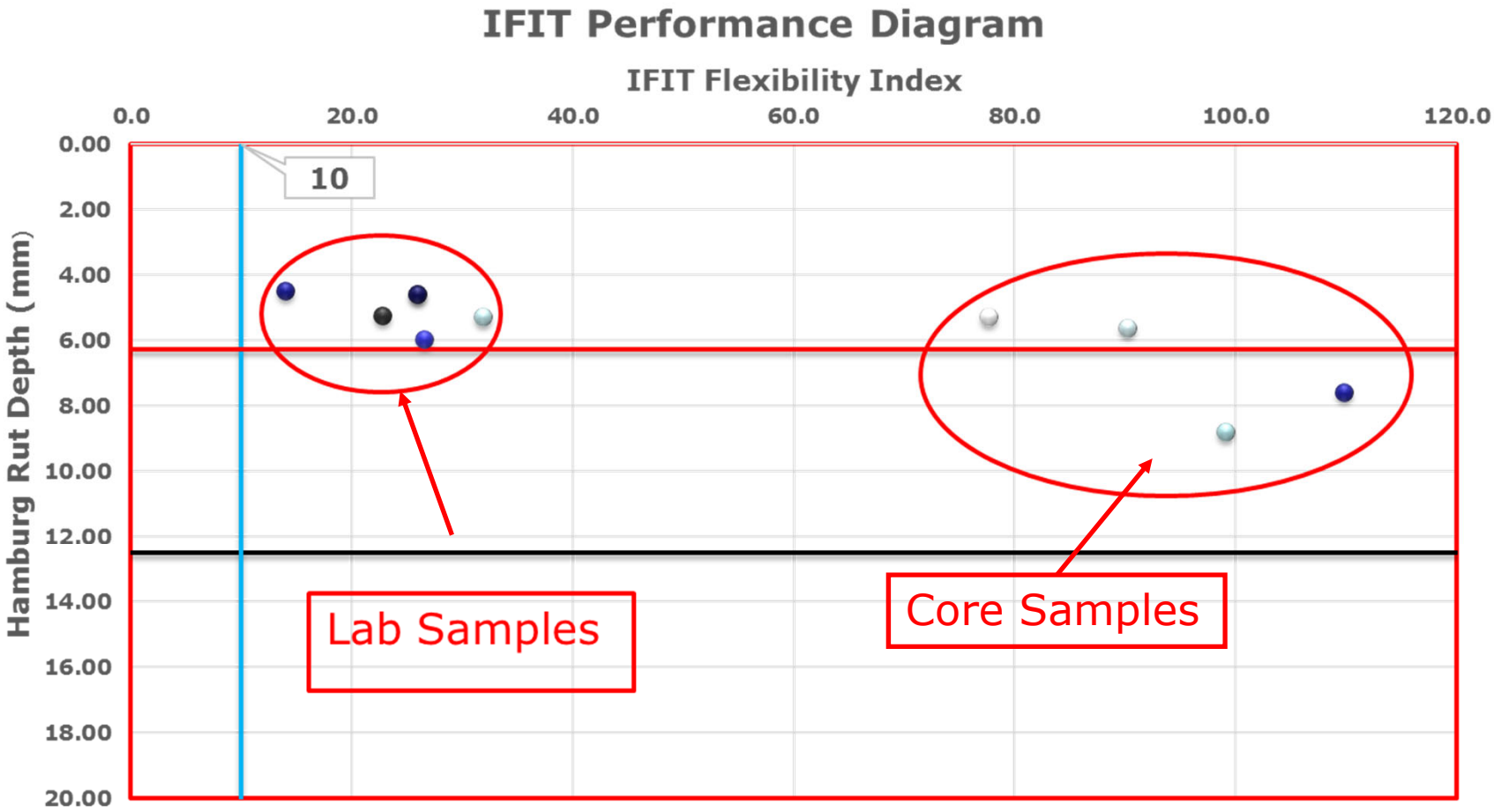
Mix Comparison

Producer 1



Producer 3

Long Life Asphalt Paving Project - IFIT



Challenges

- Limits from one region may not apply in all others.
- Aggregates seem to mater. (Not just liquid asphalt)
- Testing labs that can do the tests are very limited.

Implementation Challenges

- Implementation will not be quick or simple.
  - Pick performance test(s)
  - Decide on test protocols.
  - Specification pilot(s).
  - Who will be doing testing and how large of an investment is the equipment?
    - Contractors / Producers
    - Special Testing Labs
  - Enough lead time between project bid and paving?
  - Trained technicians to run testing?
  - After the initial rush to get testing done will there be enough tests run to sustain an industry?

DISCUSSION TOPICS

1. Performance Based Testing/SCB Initiative

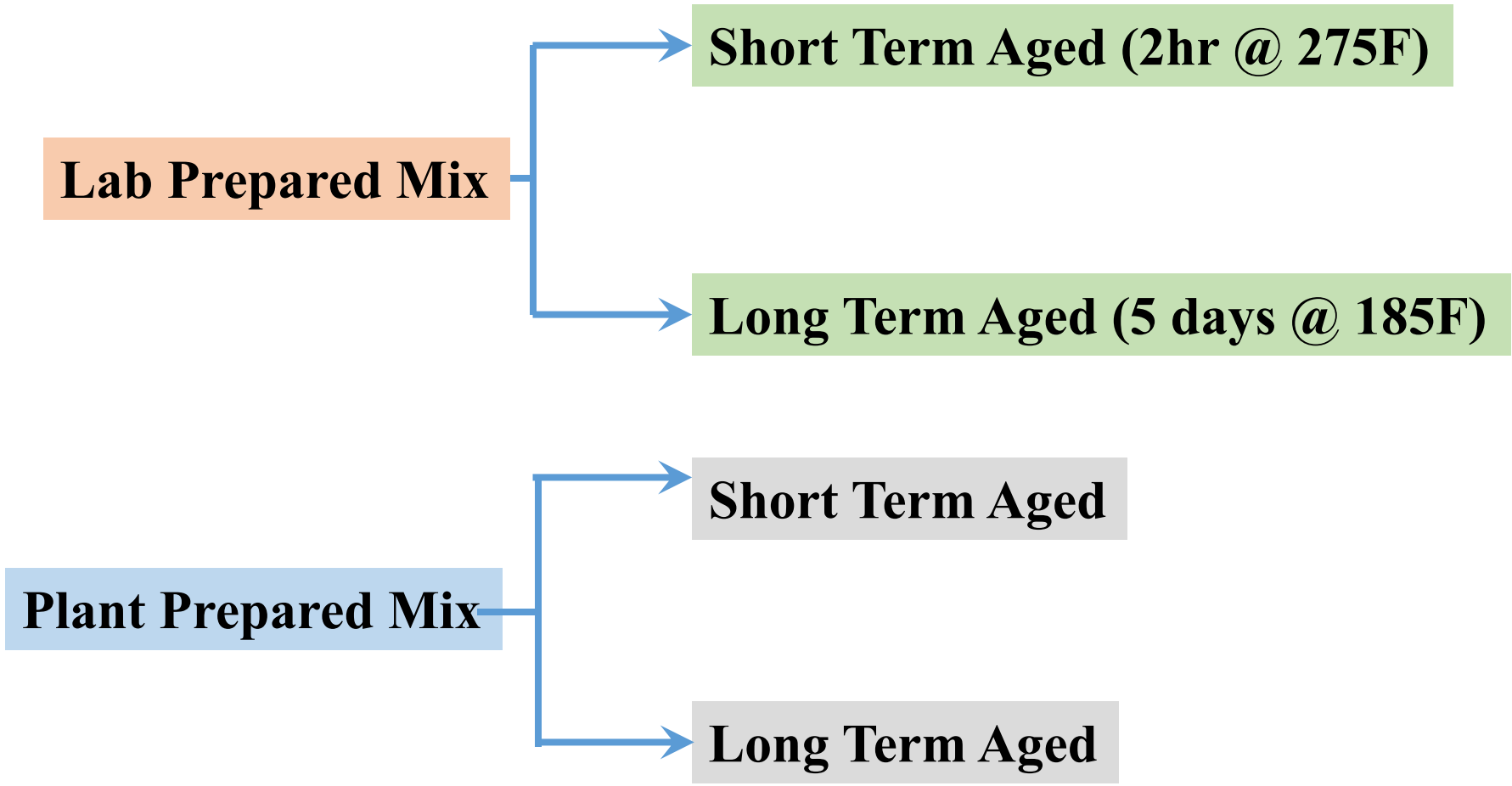
2. Long Life Asphalt Pavements

3. An Update on SCB Test Results

Mix Criteria and Variables

- **Air Void: 5.5% (Final SCB Specimen)**
- **Design Binder Content (and +0.5%)**
- **Mixes with 15% RAP at Design BC and at 0.5% Higher Binder Content**
- **Mixes at higher RAP Contents**
- **NMAS: 4.75, 9.5mm, 12.5mm, 19mm, 25mm**

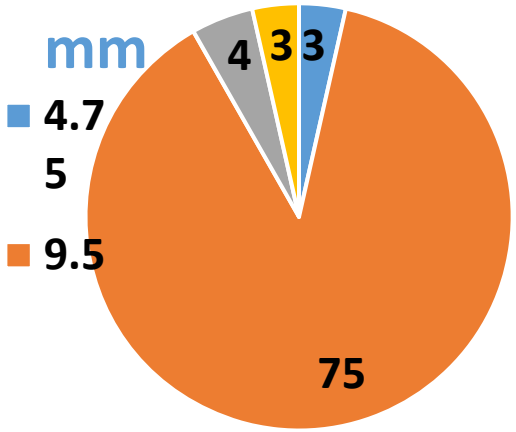
Plant vs Lab, and Aging Effect

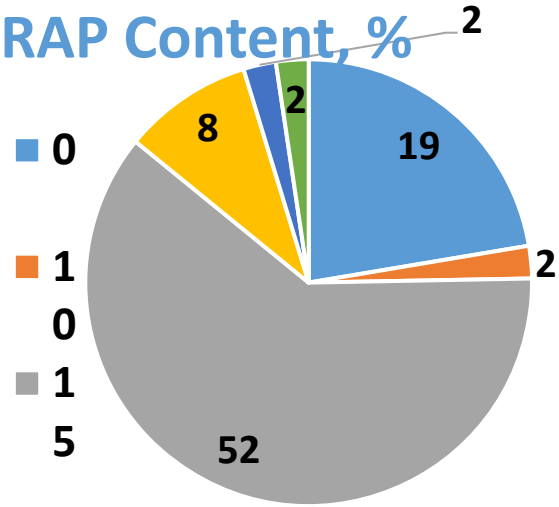


Statistics

TOTAL NUMBER OF SGC PLUGS RECEIVED = 85

Number of Plugs in each Category



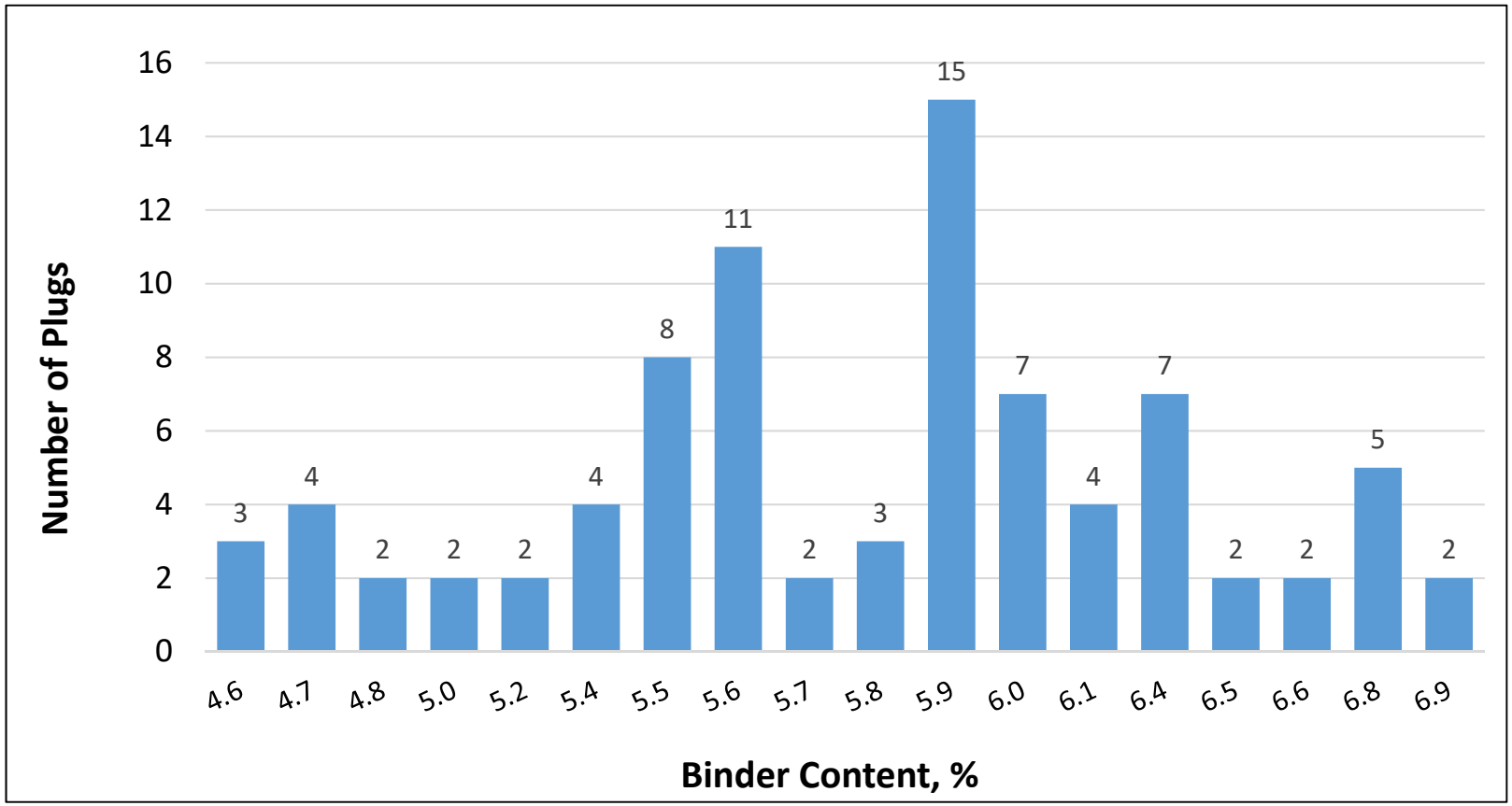


Summary of SGC Plugs Tested (total of 85)

Source	Mix Origin	Mix Condition	NMAS, mm	Binder Grade	# of Binder Contents	RAP
01	Plant	Long	9.5	64-22	1	15
02	Plant/Lab	**Short/Long**	9.5	64-22	6	0
03	Plant	Short/Long	9.5	64-22	2	0
04	Plant/Lab	Long	9.5	64-22	1	0
05	Plant/Lab	Short	4.75, 9.5, 25	64-22 76-22	4	0, 15, 30
06	Plant/Lab	**Short/Long**	9.5	64-22	6	15
07	Lab	Long			2	0, 15
08	Lab	Short	9.5, 19	64-22	4	10, 15
09	Lab	Long	9.5	64-22 76-22	1	15, 20
10	Lab	**Short/Long**	9.5	64-22 76-22	2	15, 20
11	Lab	Long	9.5	64-22	1	0, 15

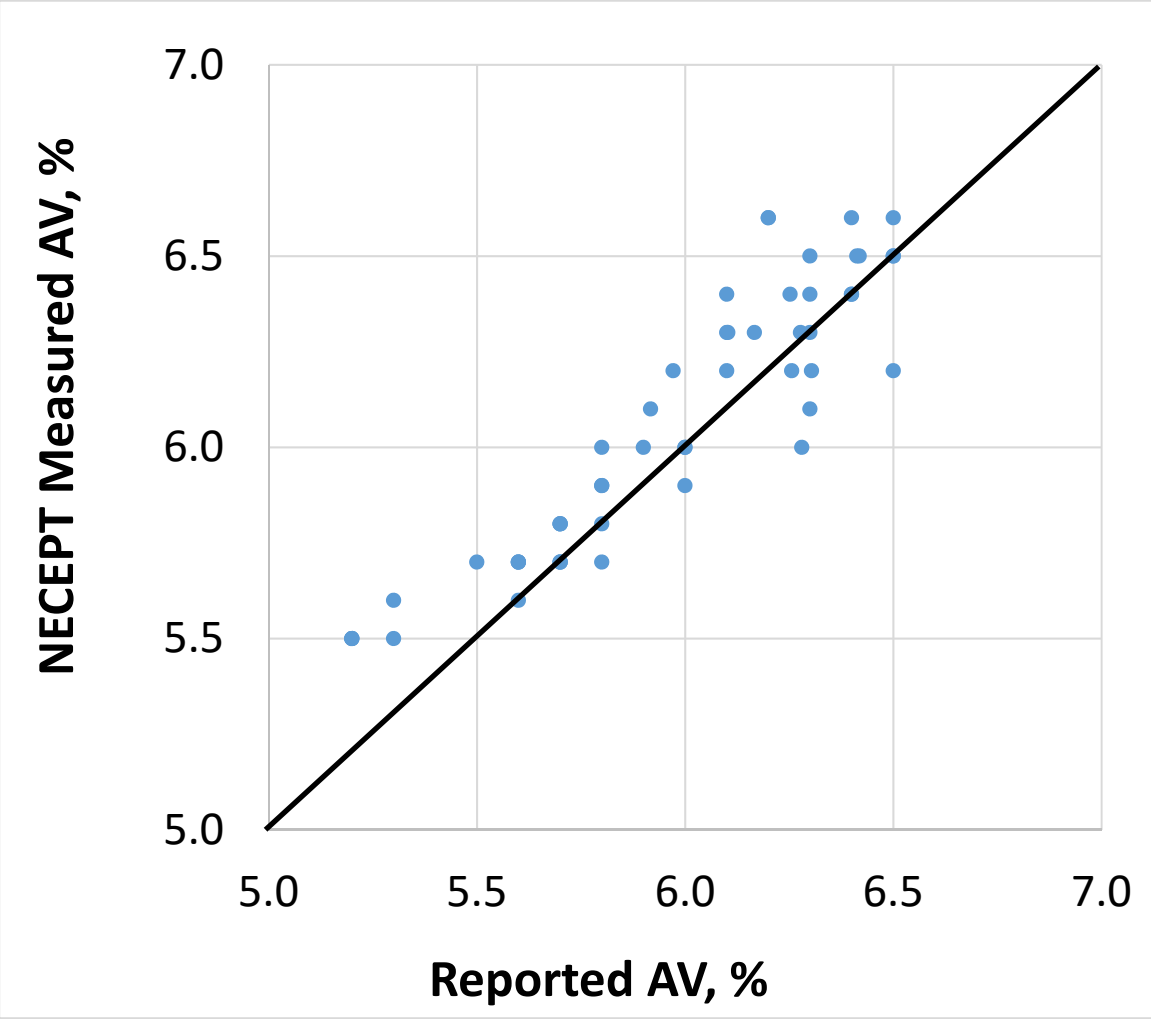
Asphalt Content

Number of Plugs in each BC Category



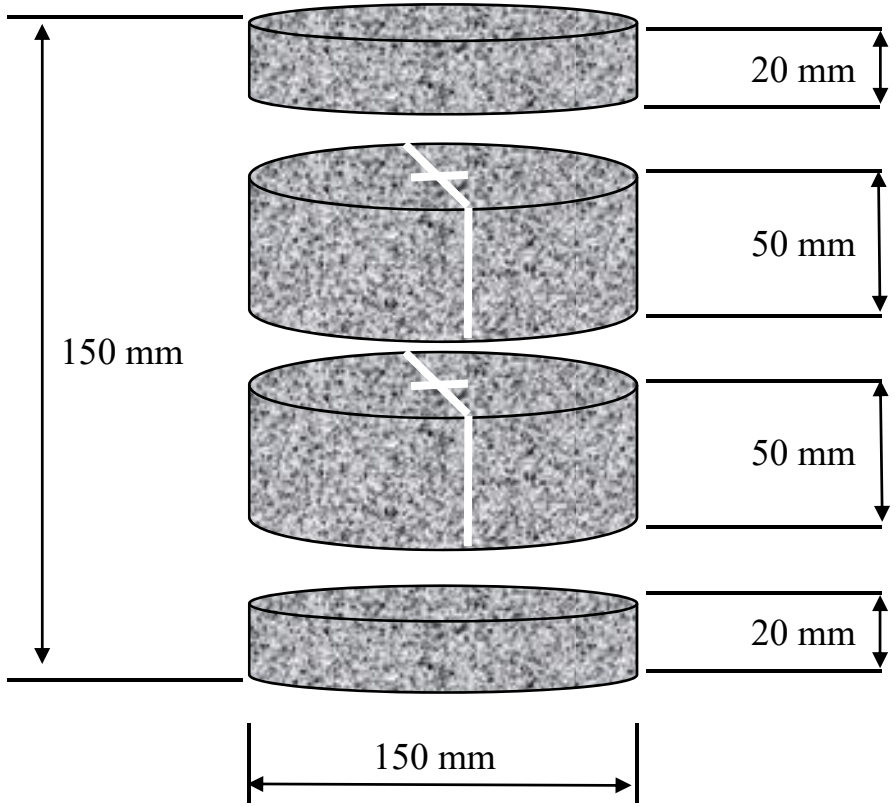
Industry SCB Test Results

Reported vs. NECEPT Measured Air Void Comparison



Specimen Preparation

- SGC Specimen or Field Cores
- Cut to Ensure Minimum AV Gradient
- Obtain Density
- Condition Specimens at Test Temperature
- Conduct Test



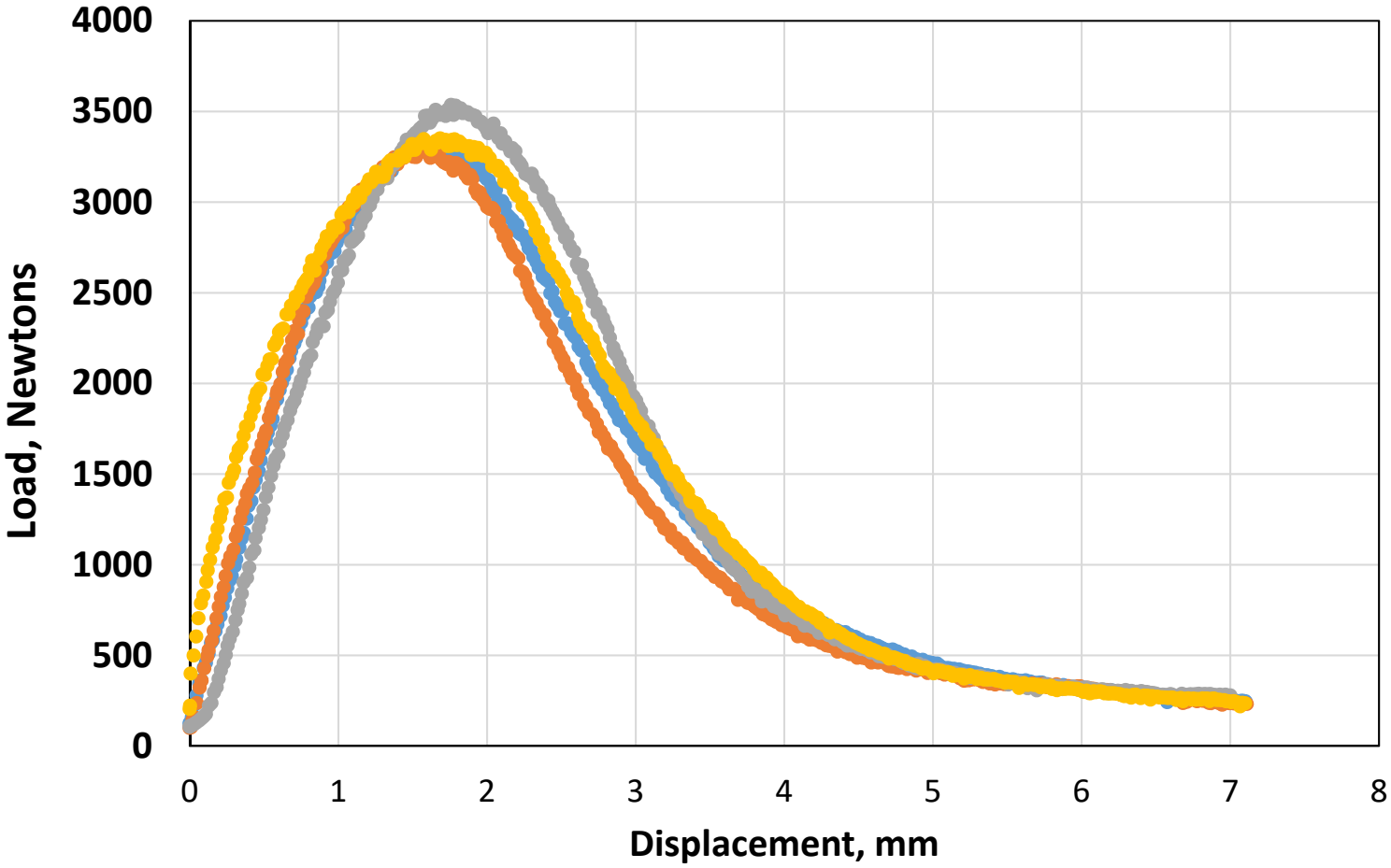
SCB Specimens

Specimens After Cutting
Ready for Testing

Specimens Before (L) / After (R)
Testing

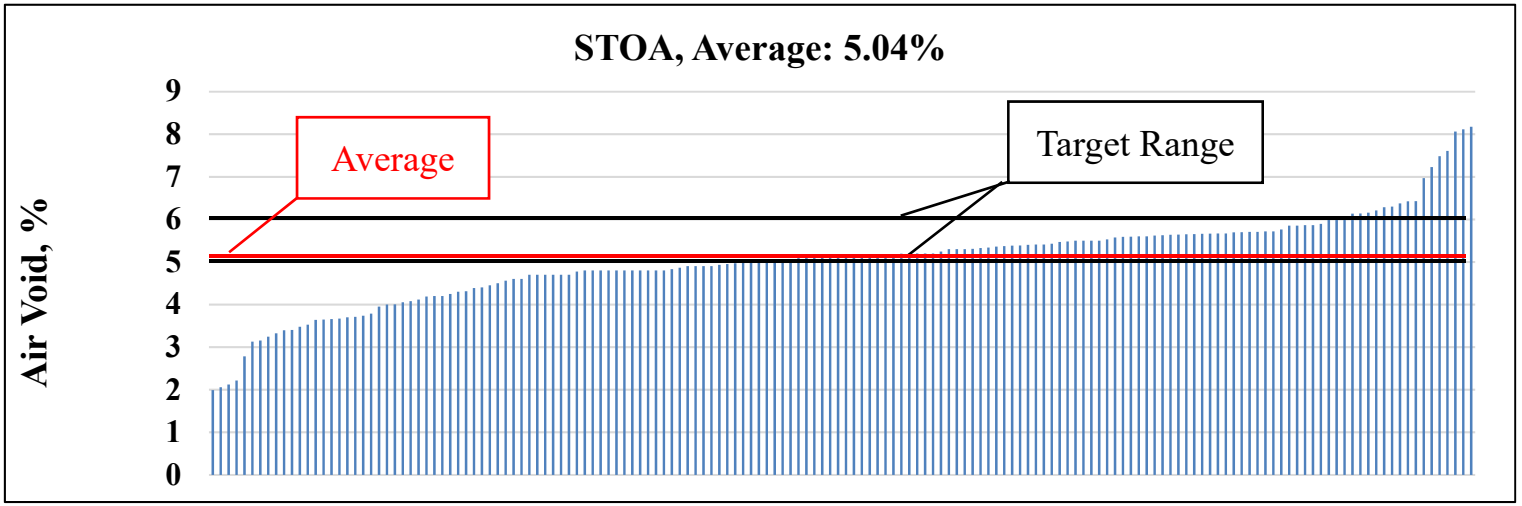
Industry SCB Test Results

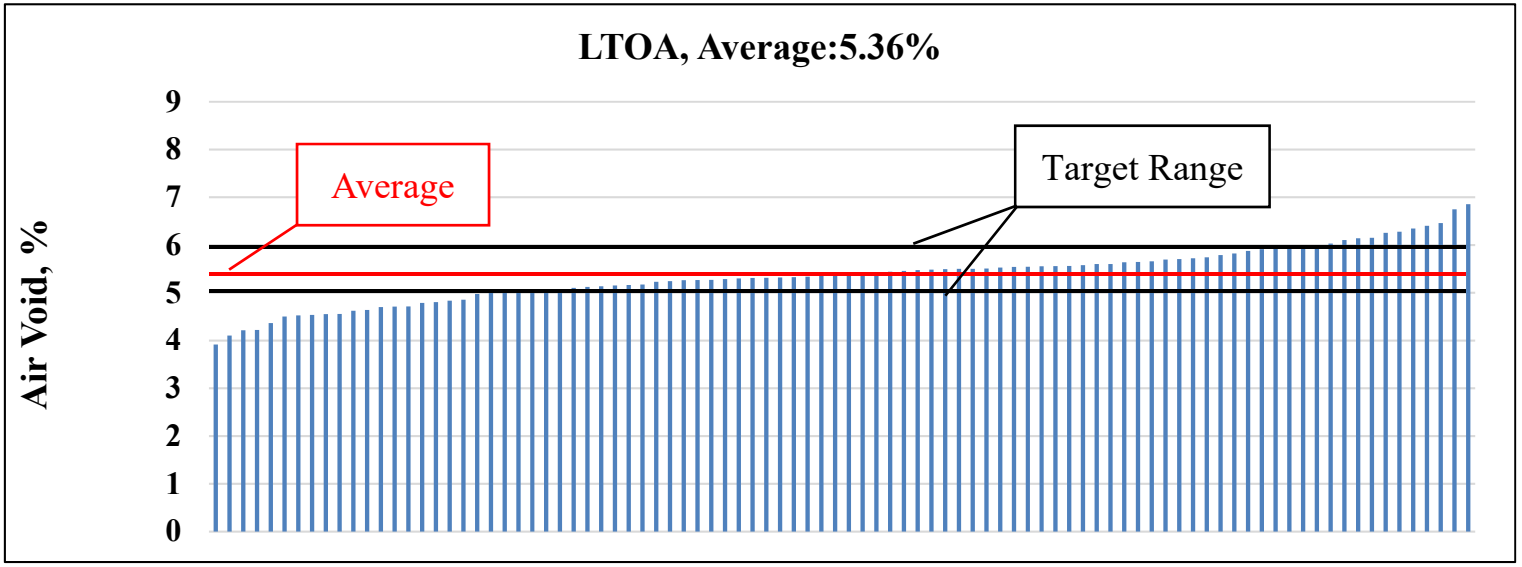
Results from Specimens Prepared with High Quality, COV of AV < 5%



Industry SCB Test Results

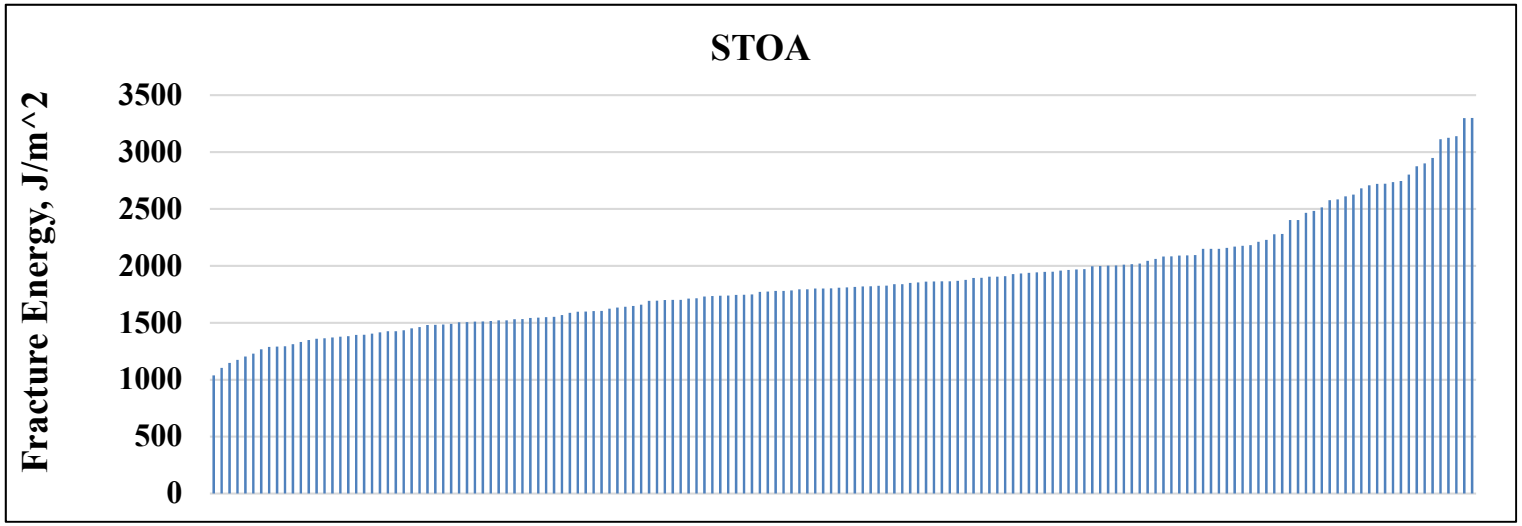
Overall Data Range and Distribution: Air Void (After Cutting)

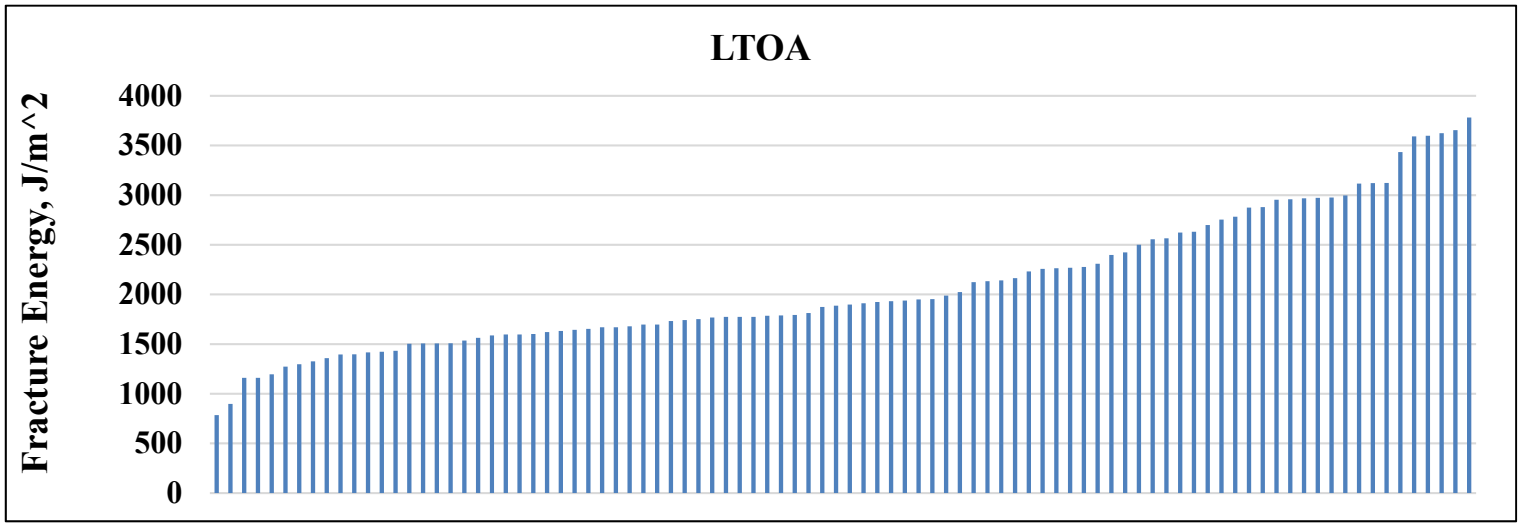




Industry SCB Test Results

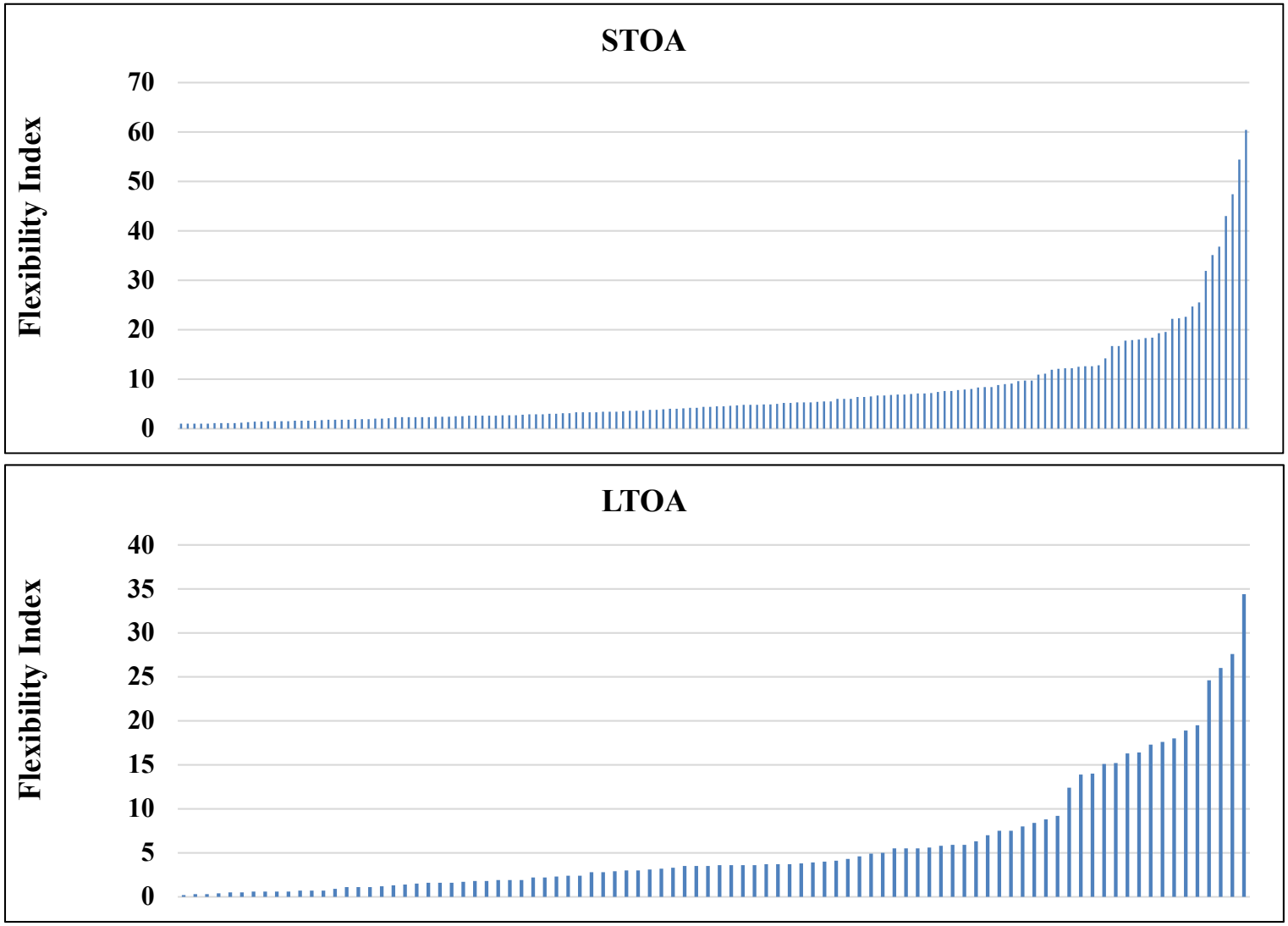
Overall Data Range and Distribution: Fracture Energy





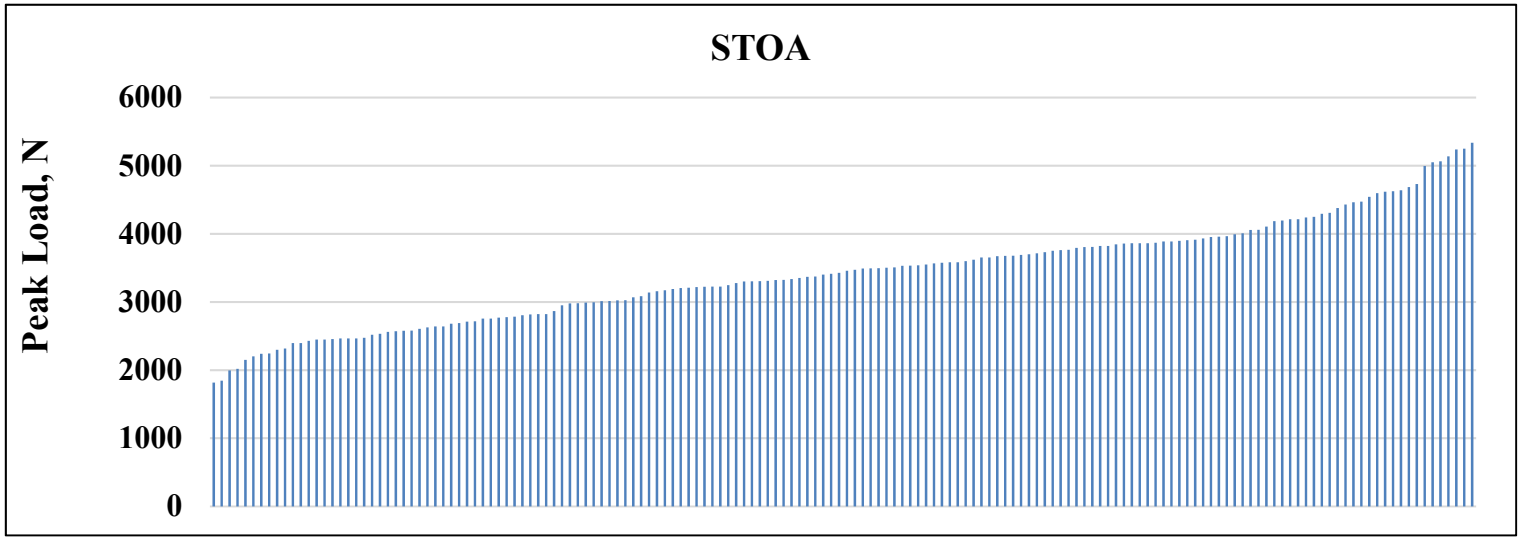
Industry SCB Test Results

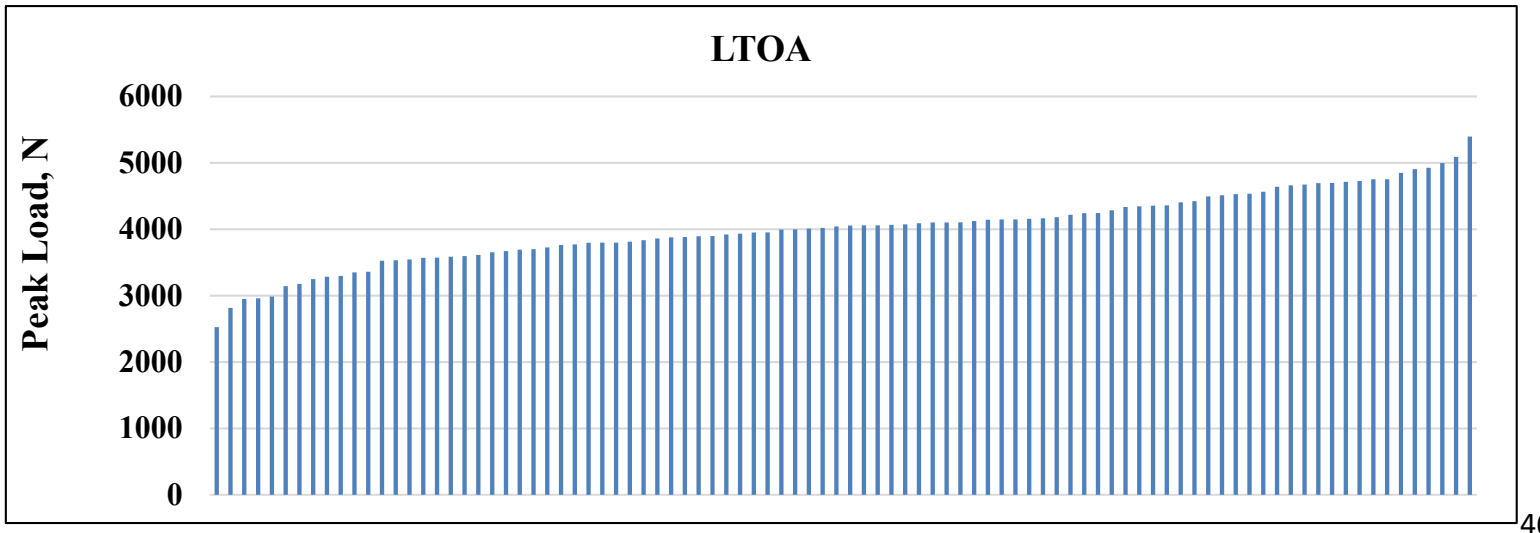
Overall Data Range and Distribution: Flexibility Index



Industry SCB Test Results

Overall Data Range and Distribution: Peak Load

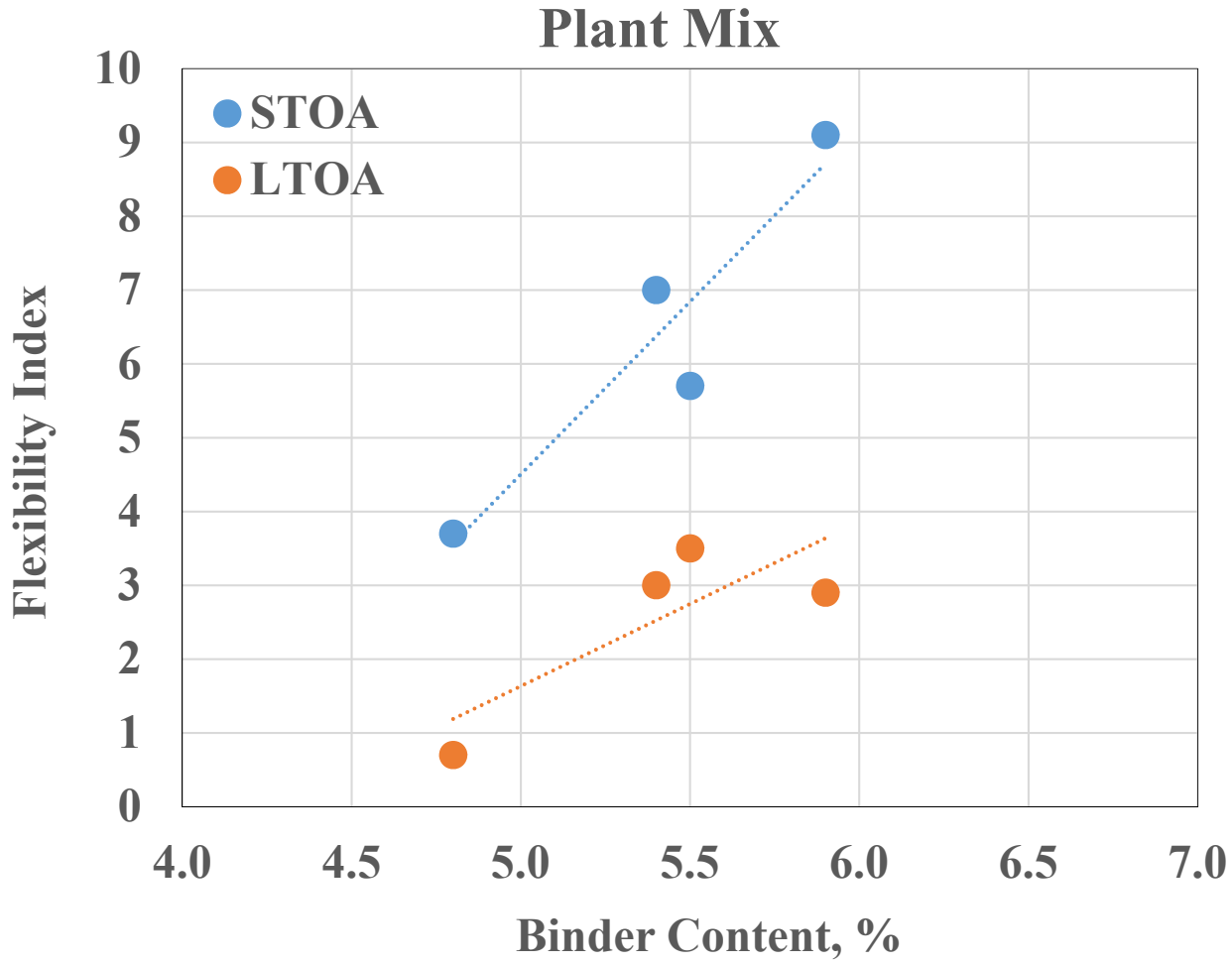




General Observations (G.O.)

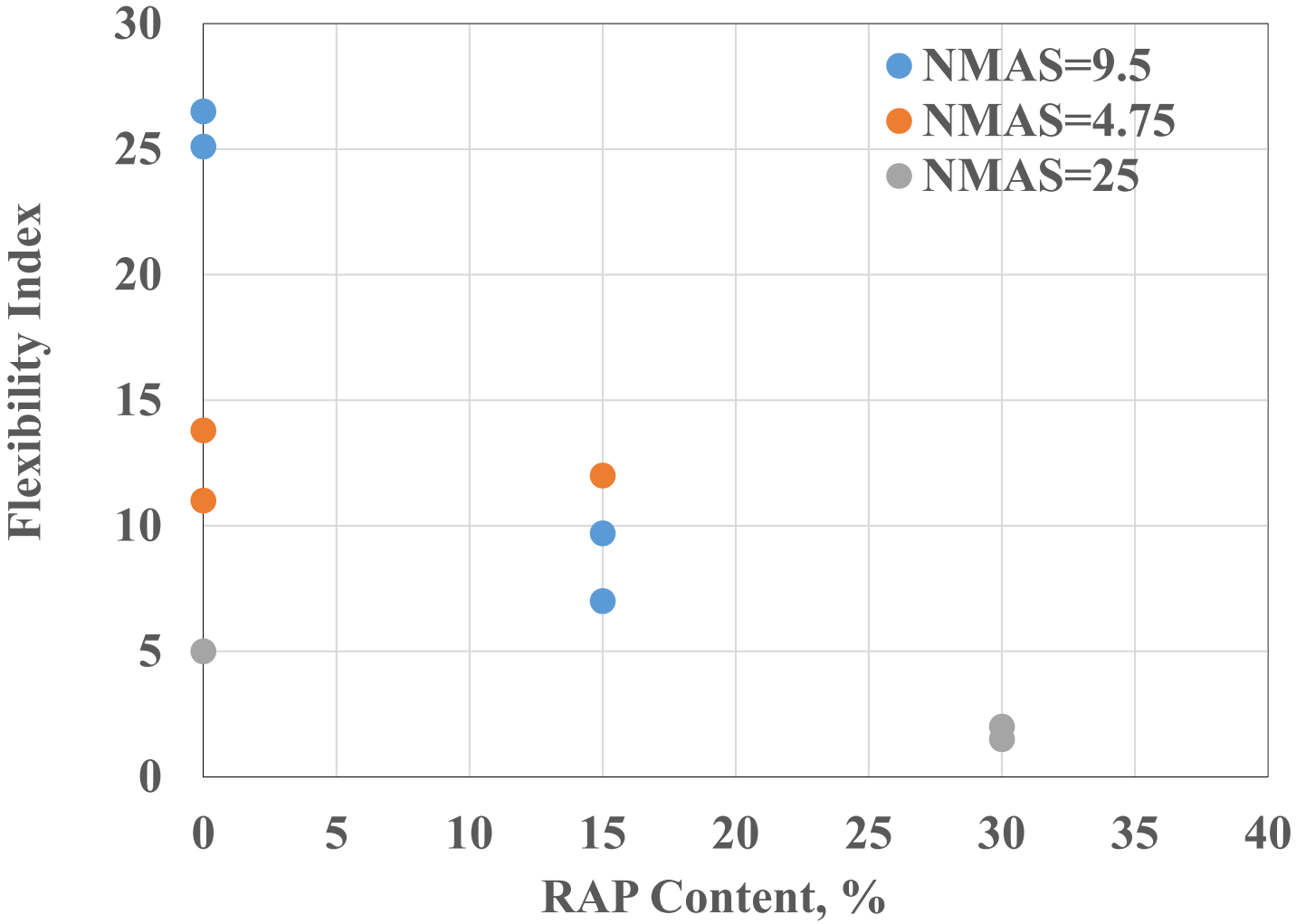
1. Higher AC Content → higher F.I.
2. Higher RAP content lower F.I.
3. Longer aging → lower F.I.
4. Plant mix has higher F.I. than lab mix
5 Higher voids → higher F.I.
6 SMA mix delivers high F.I.
7. Finer mix with high BC → higher F.I.

Binder Content Effect



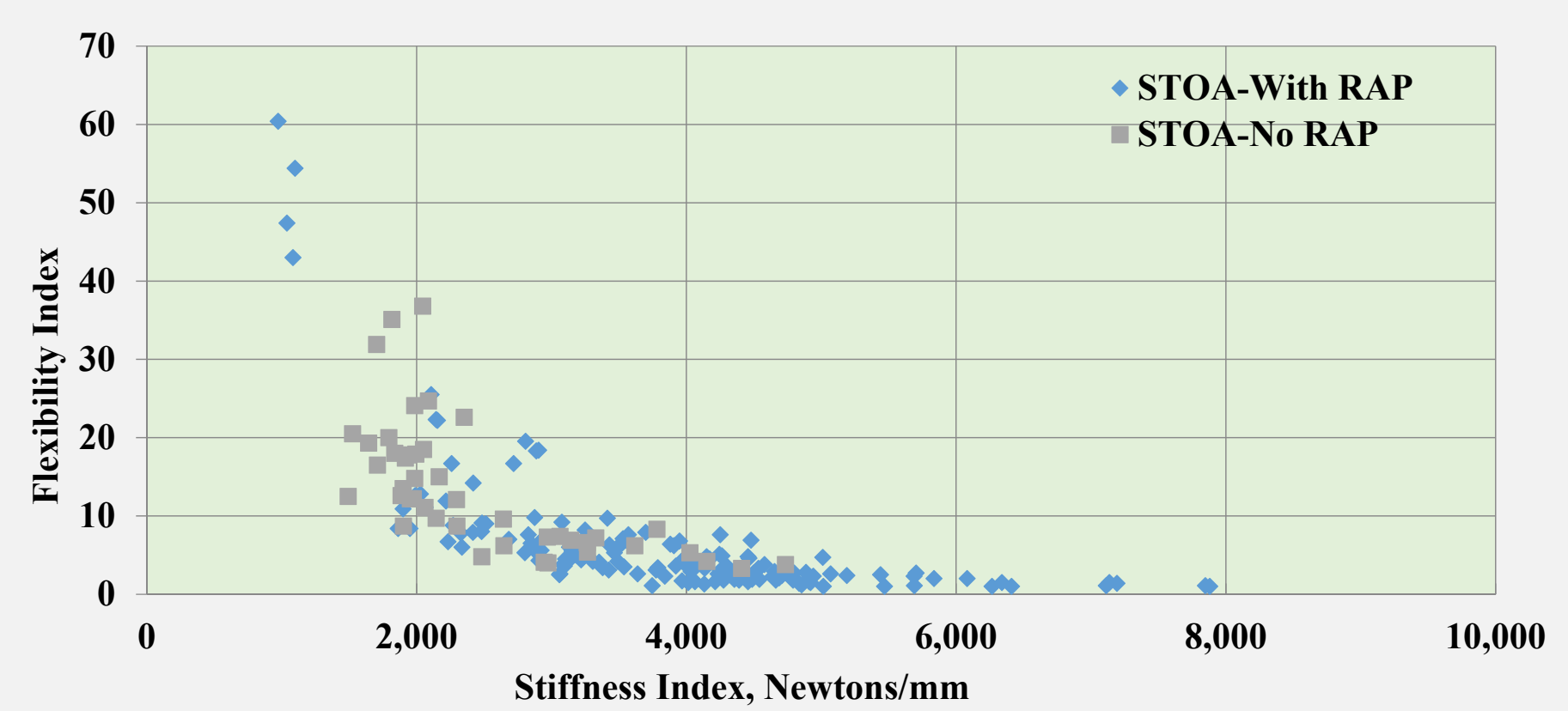
RAP Content Effect

All Specimens were STOA

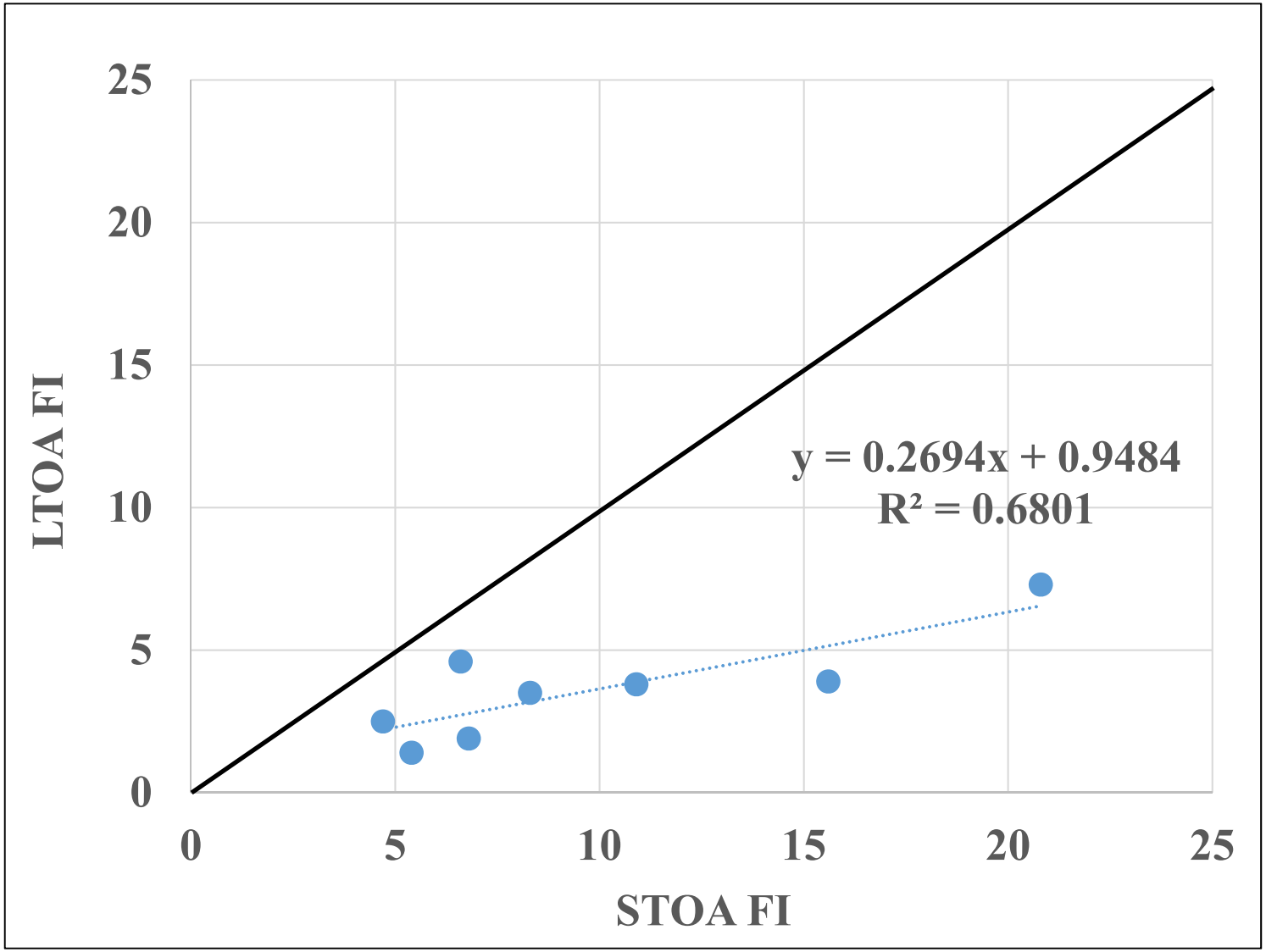


RAP Content Effect

All Producers

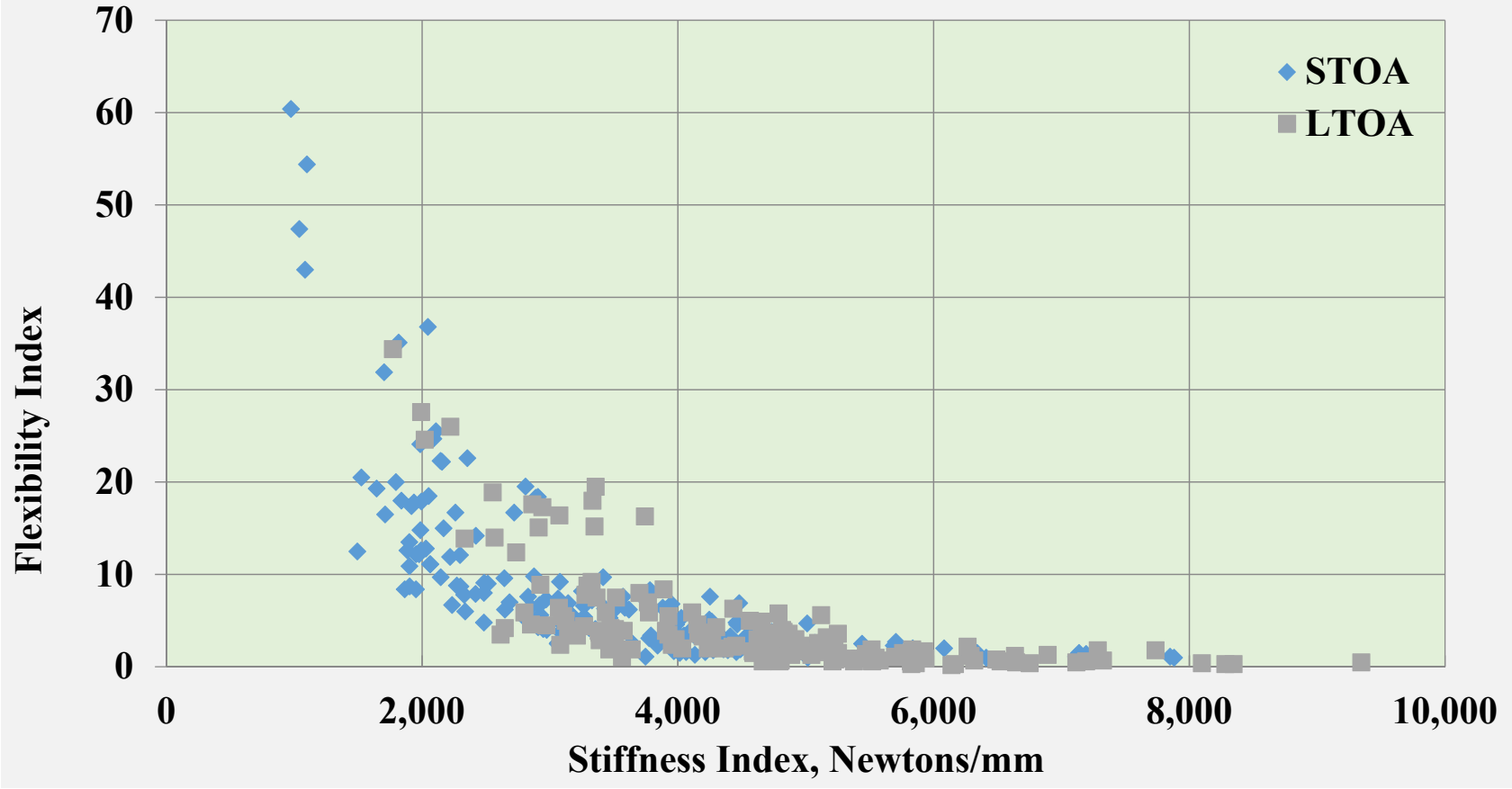


Aging Effect



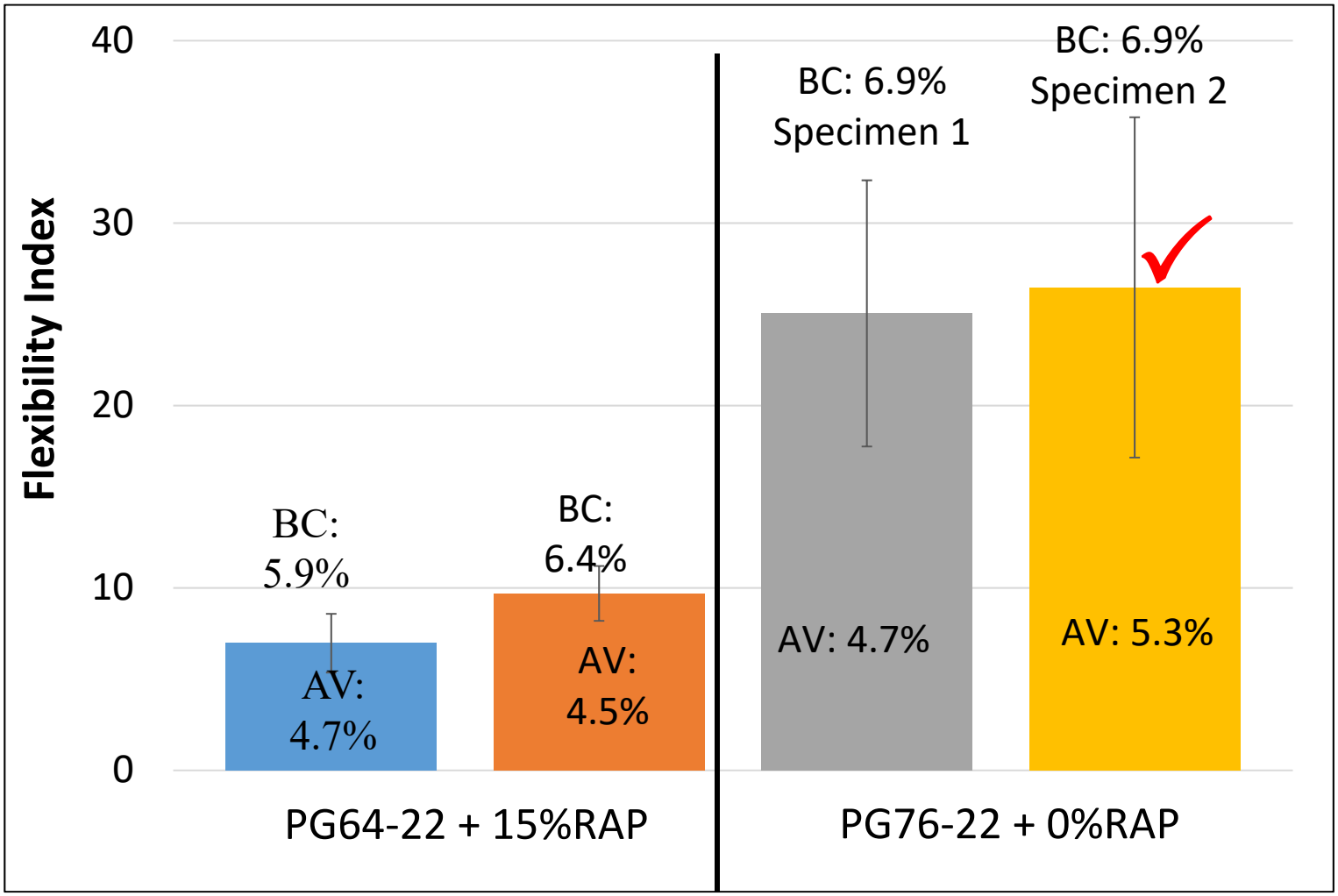
Aging Effect

All Producers



SMA vs Conventional Mix

- STOA
- **9.5mm**
- PG64-22/PG76-22
- 5.9/6.4/6.9%BC
- 0/15%RAP



Where should we go next?

1. Gather information from producers on details of aging protocol and specimen preparation
2. More SCB testing to fill in some of the gaps.
3. Test mix(es) with proven good long term performance.
4. Test to determine long term effects of rejuvenators.
5. Track mix performance in the field to verify lab predictions.