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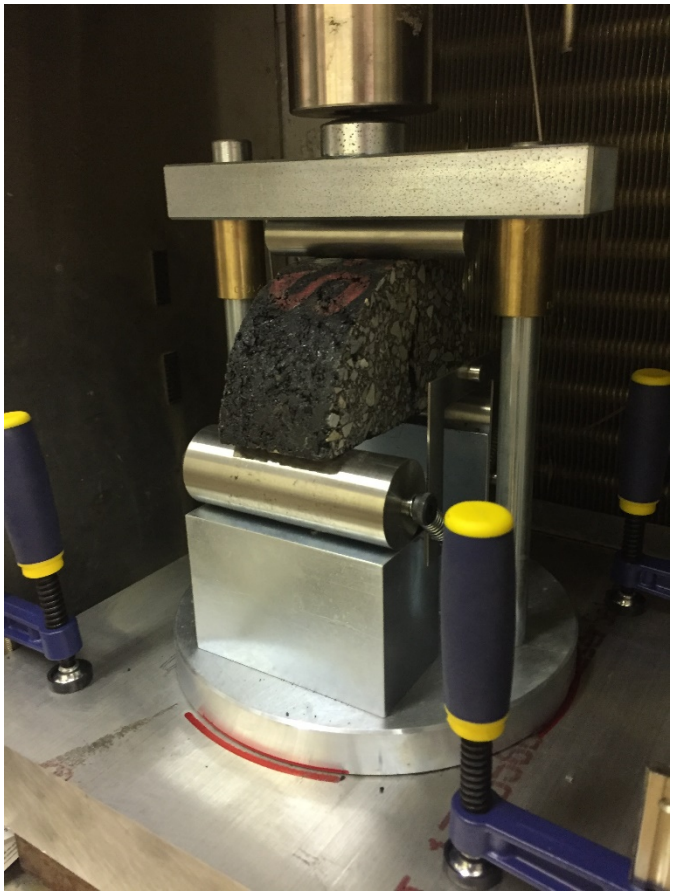
Moving towards Performance Based Testing

Semi-Circular Bend Test



Pennsylvania Asphalt Pavement Association
58th Annual Conference
January 17, 2018

Mansour Solaimanian,
Pennsylvania State University

Our Great Folks on This Project

Scott Milander
NECEPT Lab Coordinator

Xuan Chen
PhD Candidate

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Outline

- A Review of Asphalt Concrete Fatigue Tests
- Semi-Circular Bend (SCB) Test
- PennDOT/Industry Initiative on Performance Testing

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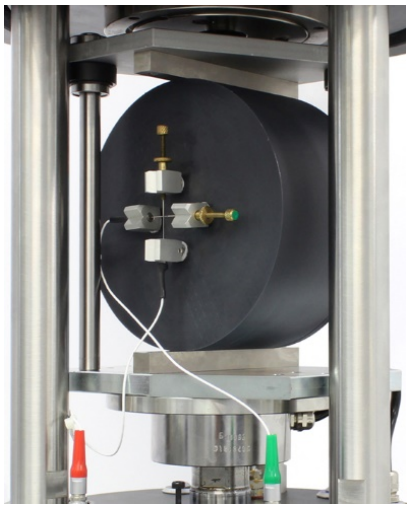
Lab Scale Tests

Monotonic Tests

- Indirect Tensile
- Semi-Circular Bend
- Disk-Shaped Compact Tension



Cyclic Tests

- Four Point Bending Beam
- Indirect Tensile
- Uniaxial Push-Pull
- Texas Overlay

Picture Curtesy: IPC Global, Umass, Penn State

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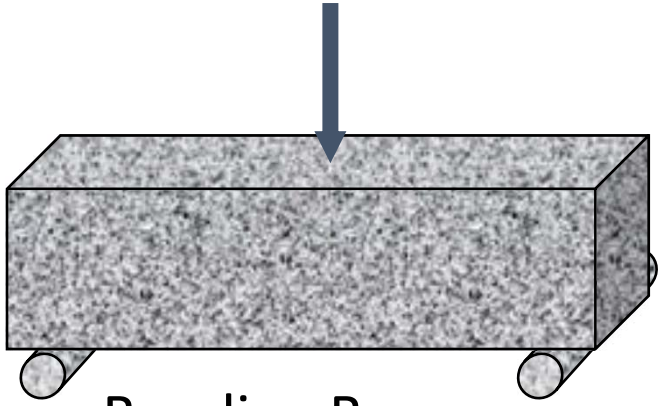
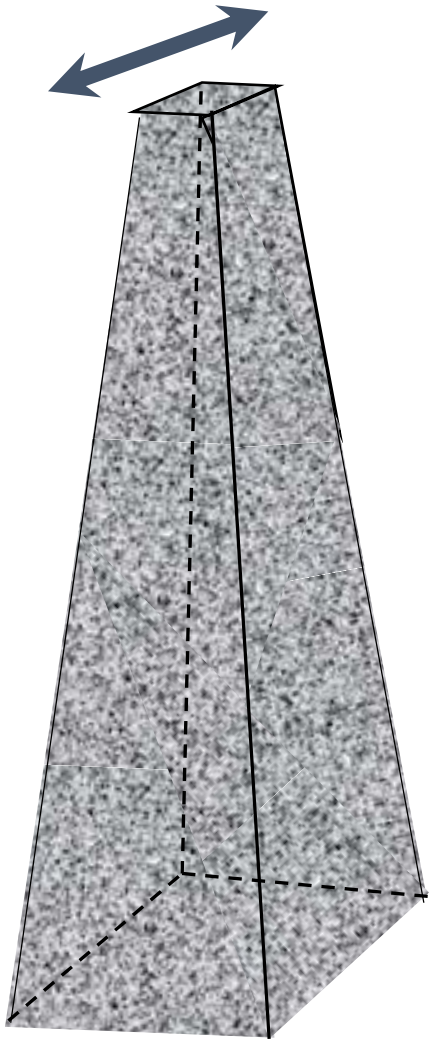
Lab Scale Tests (Cyclic Tests)

Texas Overlay Tester



Bending Beam

Fatigue/Cantilever Trapezoid



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- PennDOT/Industry Initiative on Performance Testing

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Background on SCB

- Early Work on Rocks (Chong and Kuruppu, 1984)
- Introducing SCB for Asphalt Testing (Molenaar, 2000 & 2002)
- Further Research (Mohammad et al., 2004) - LA
- Further Research – IFIT (Alqadi et al., 2015) - IL
- Implementation in Specs (Mohammad et al., LTRC, 2016)

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SCB Test Apply on Rocks (Initial Application)

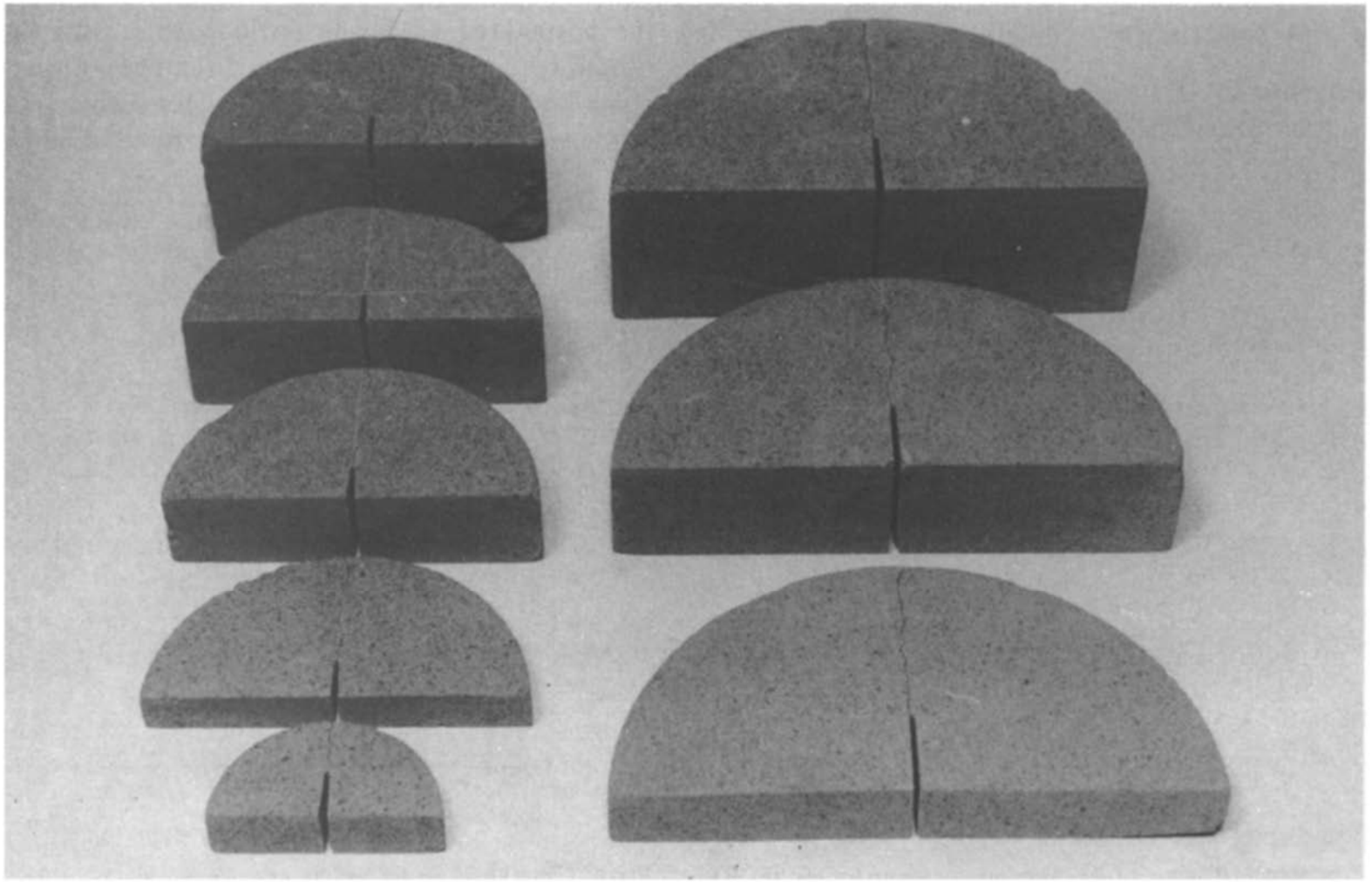

Photo Source: Lim et al. 1984

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SCB Test Applied to Rocks

SCB Testing of Granite Rock

Photo Source: Dynamic Behavior of Materials, Vol.1

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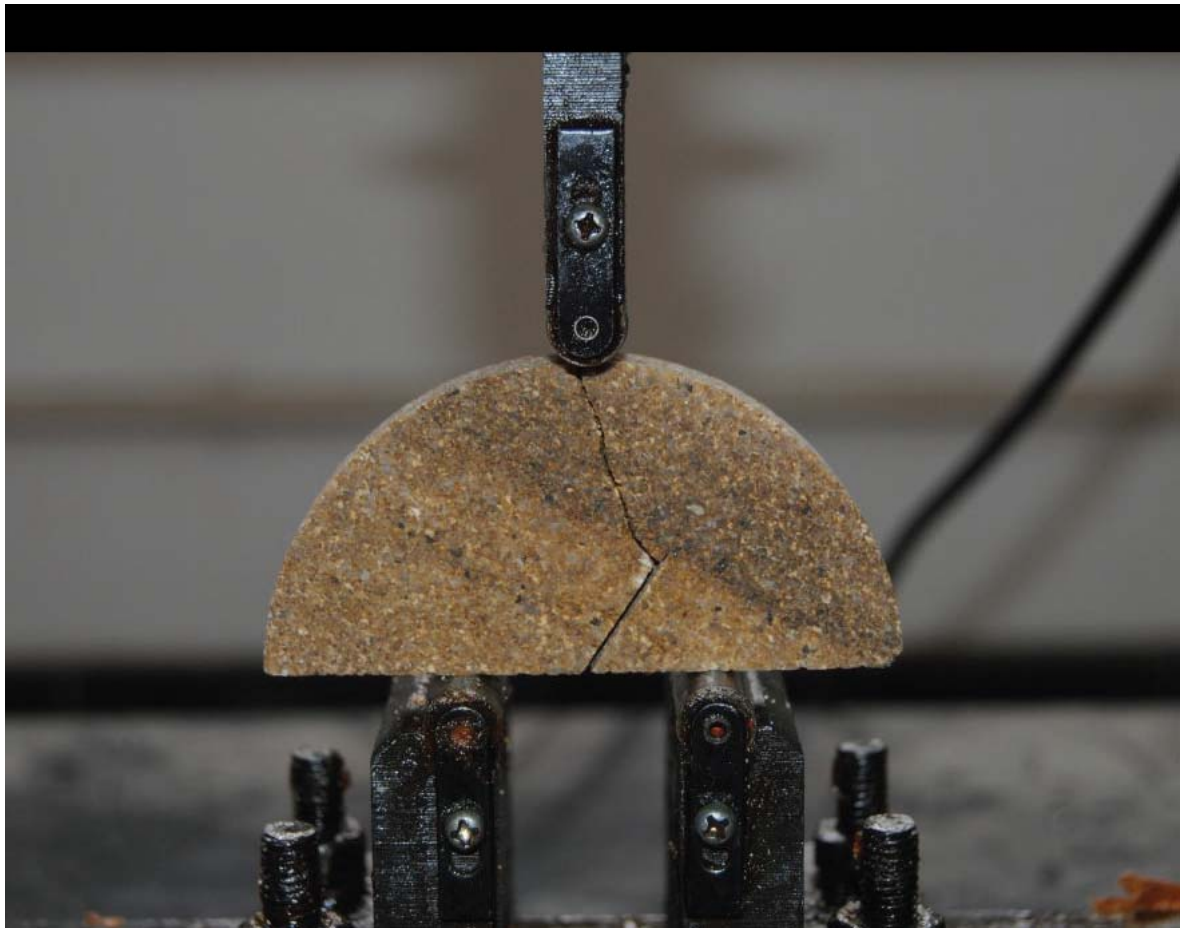
SCB Test Applied to Rocks



Compression-Induced Fracture Surfaces and Failure Mechanism

Photo Source: Advances in Materials Science and Engineering Vol. 2014, Article 814504

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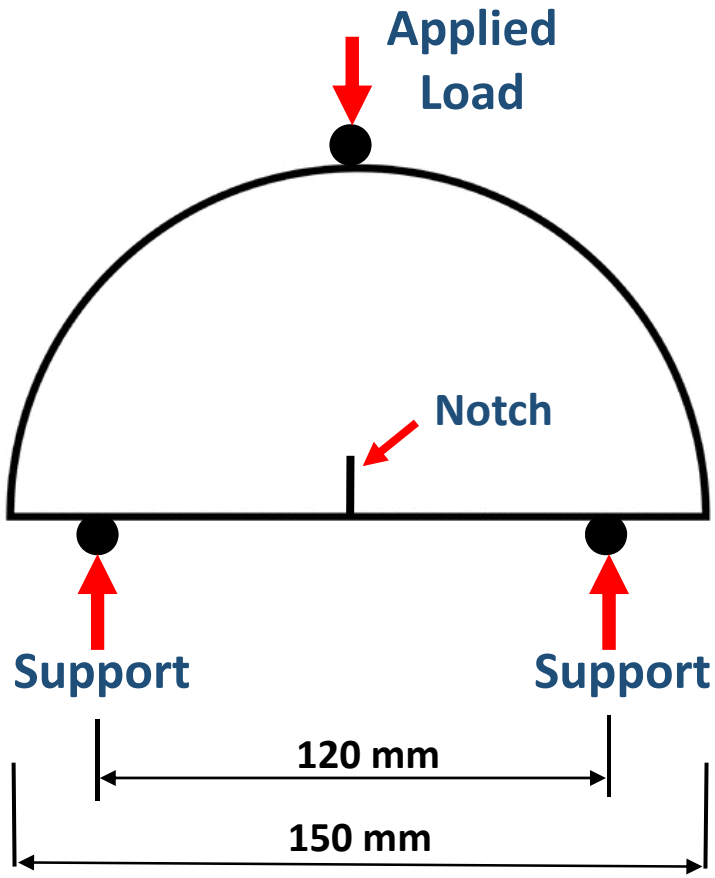
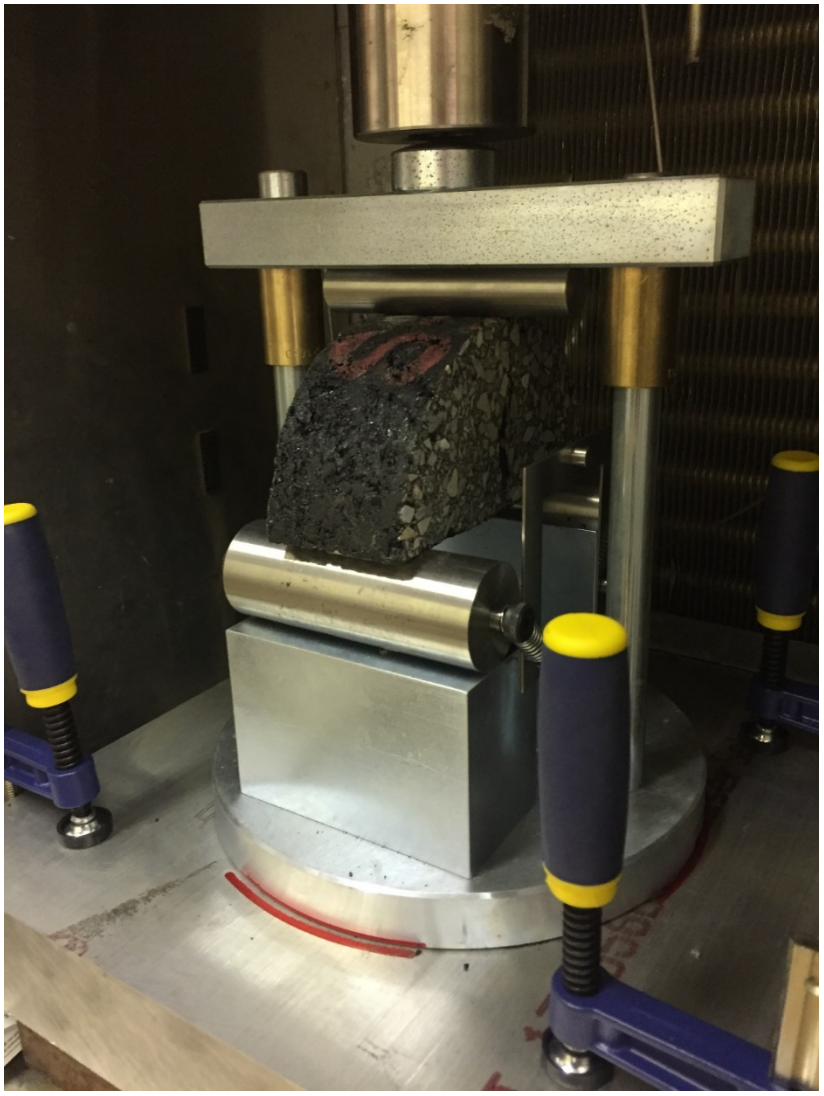
SCB Test Setup



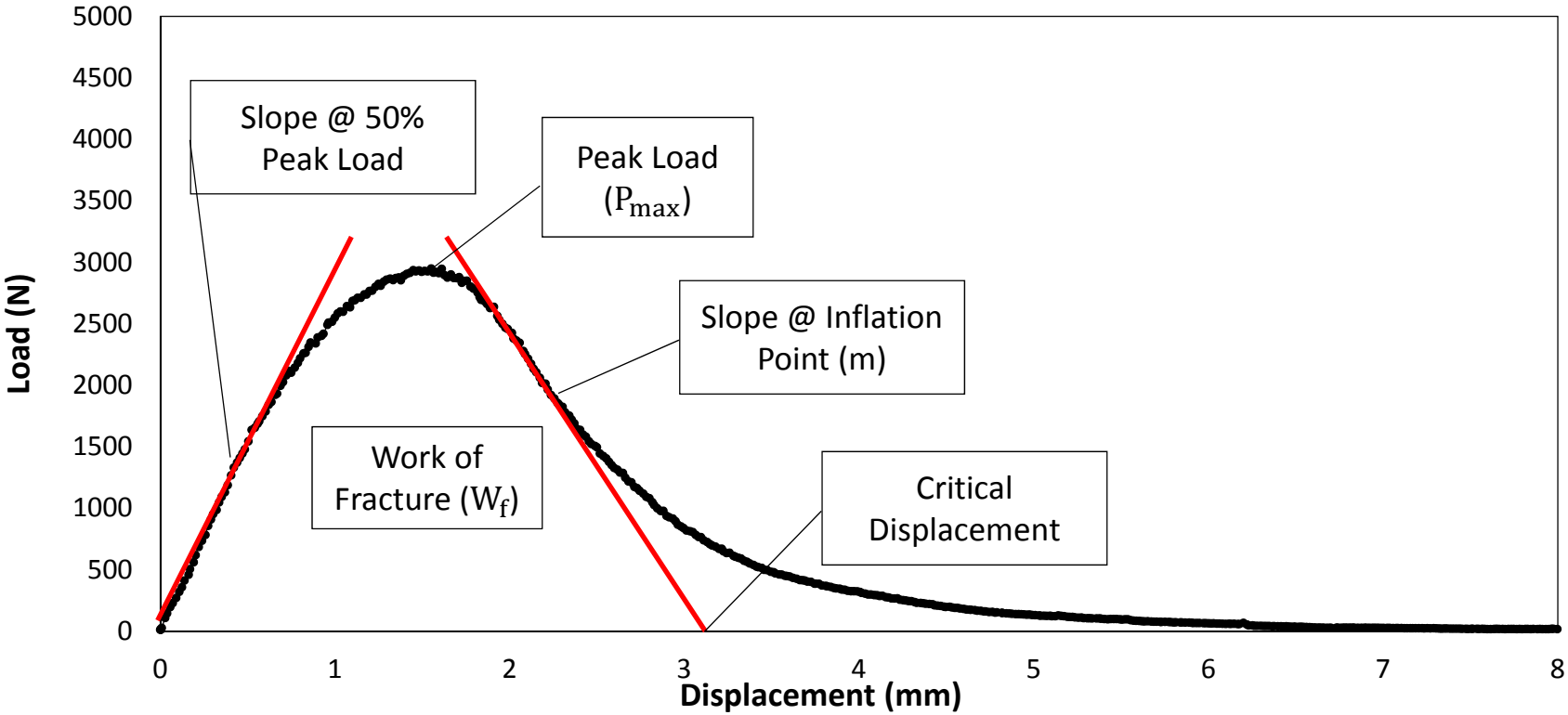


Specimen Thickness: **50** mm

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

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Advantages of SCB Test

- Specimen Easily Prepared Using SGC or Field Cores
- Four Specimens from One Compacted Mix
- Easy to Perform and Simple to Analyze
- Possible To Perform Test Using Marshall-Type Stability Tester

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Test Loading Rate

Current Protocols:

- 50 mm/min (too fast, not enough data points, higher COV)
- 0.5 mm/min (too slow, affected by creep)

Findings:

- Loading rate between **5 to 20 mm/min** will minimize the effect of creep, and provide a reasonable range for FI for long term aged mix.

Specimens After Cutting
Ready for Testing

Specimens Before (L) / After (R) Testing

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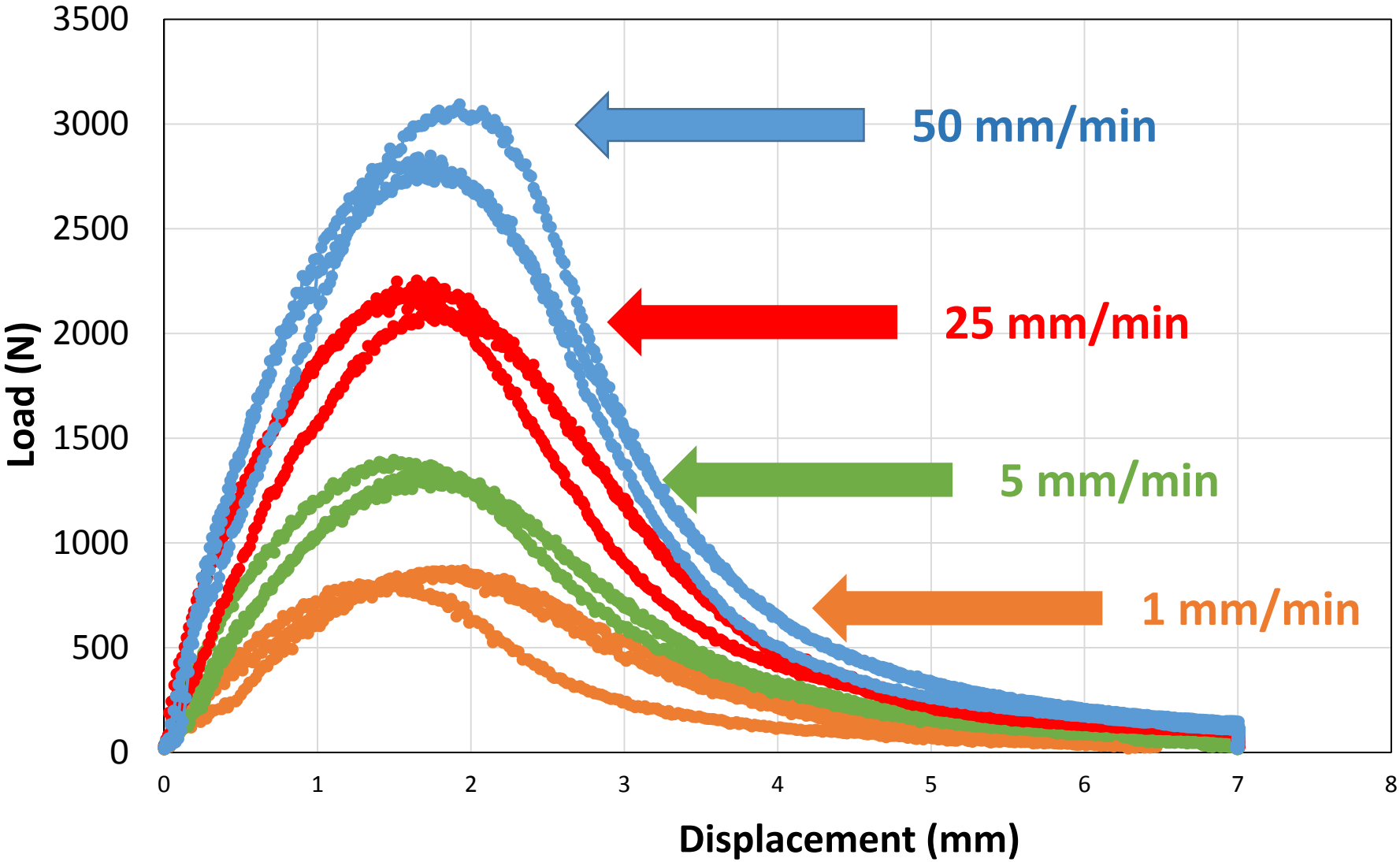
Typical Load vs Displacement Curves
3 Replicates, PG 58-28, 25°C



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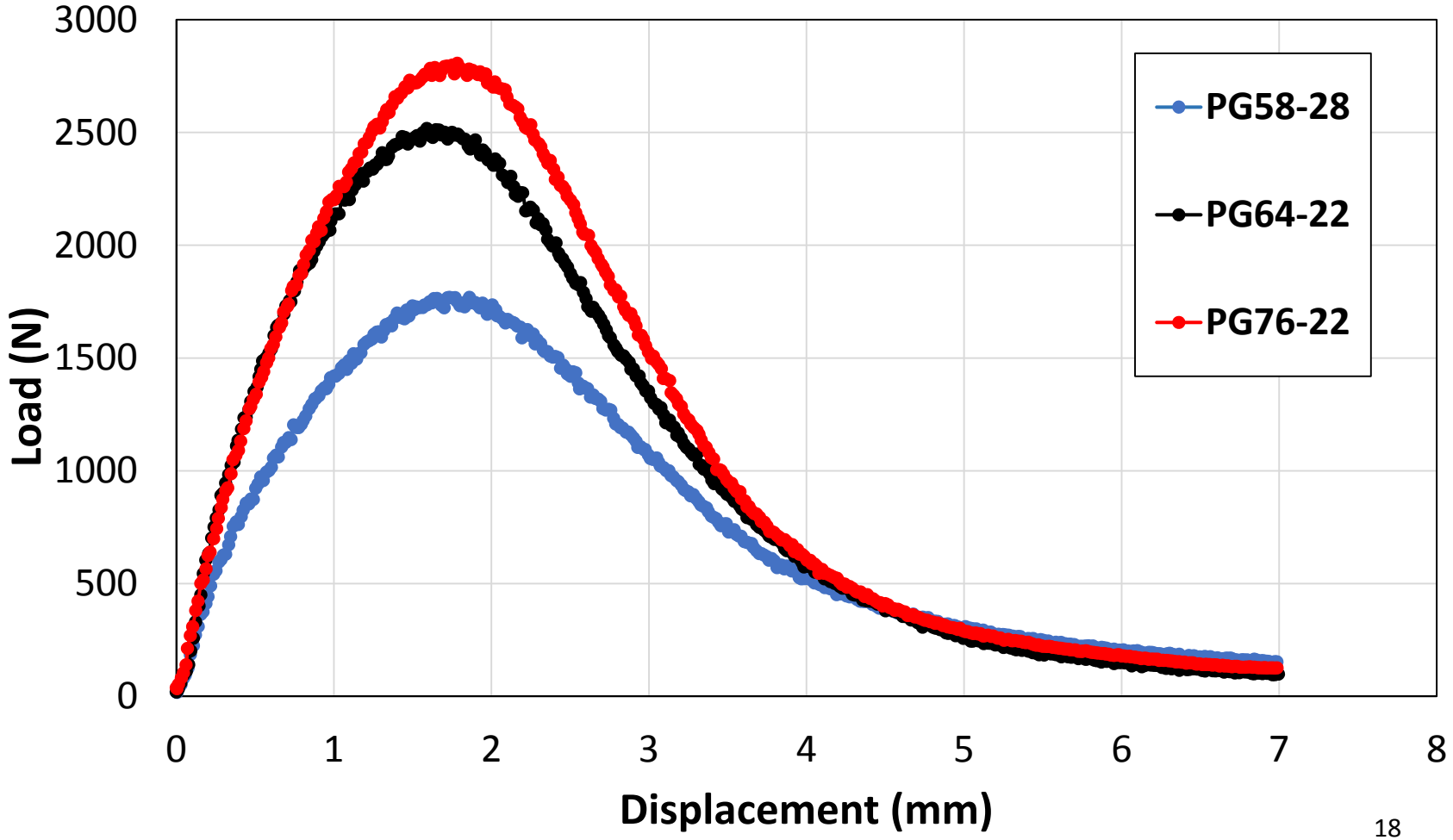
Effect of Binder Grade (Stiffness)

STOA, 7% AV, 5.2% BC



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Outline

- A Review of Asphalt Concrete Fatigue Tests
- Semi-Circular Beam (SCB) Test

- **PennDOT/Industry Initiative on Performance Testing**

How Did it Start?

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

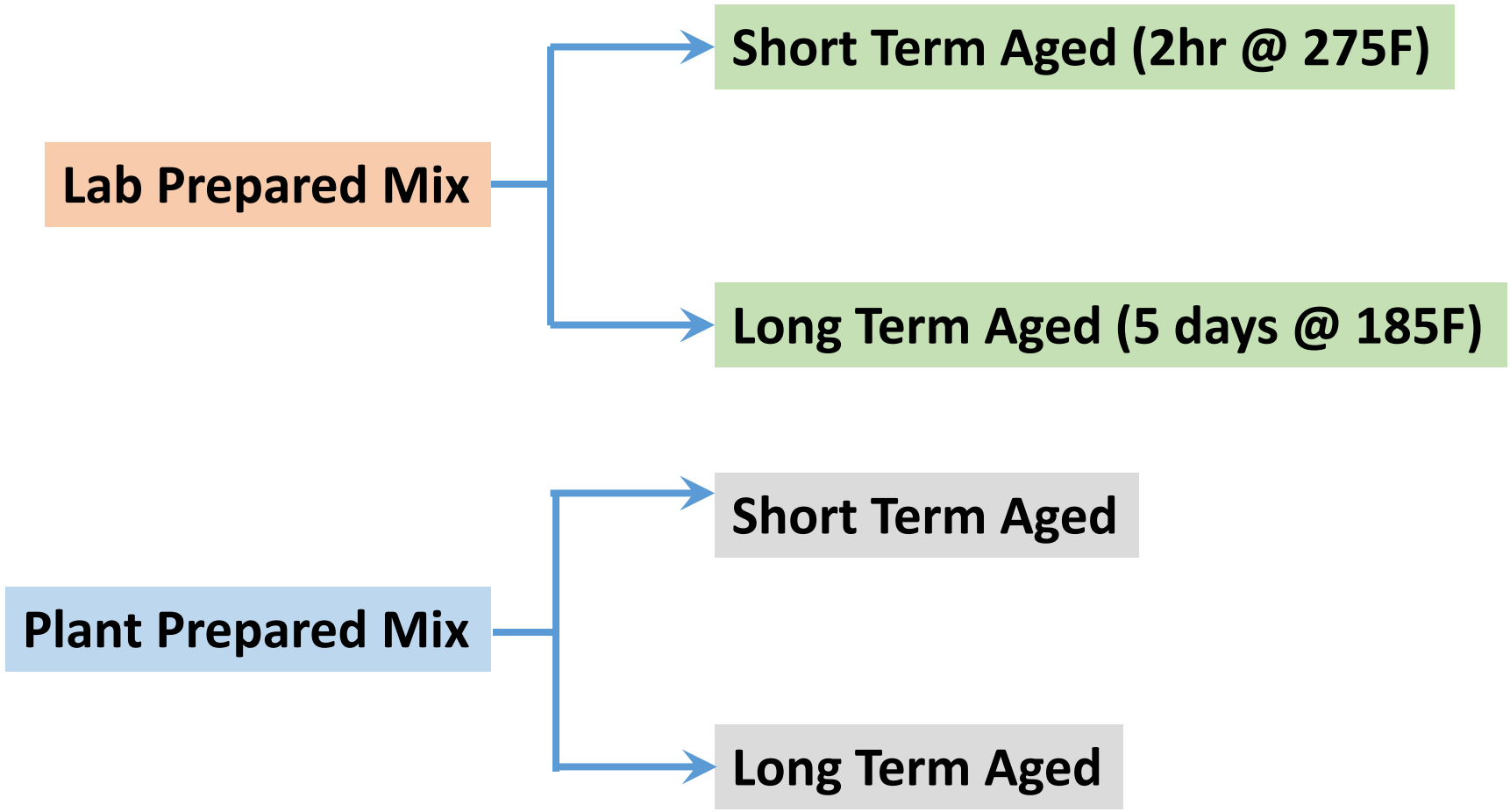
Purpose of the Effort

- **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**

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

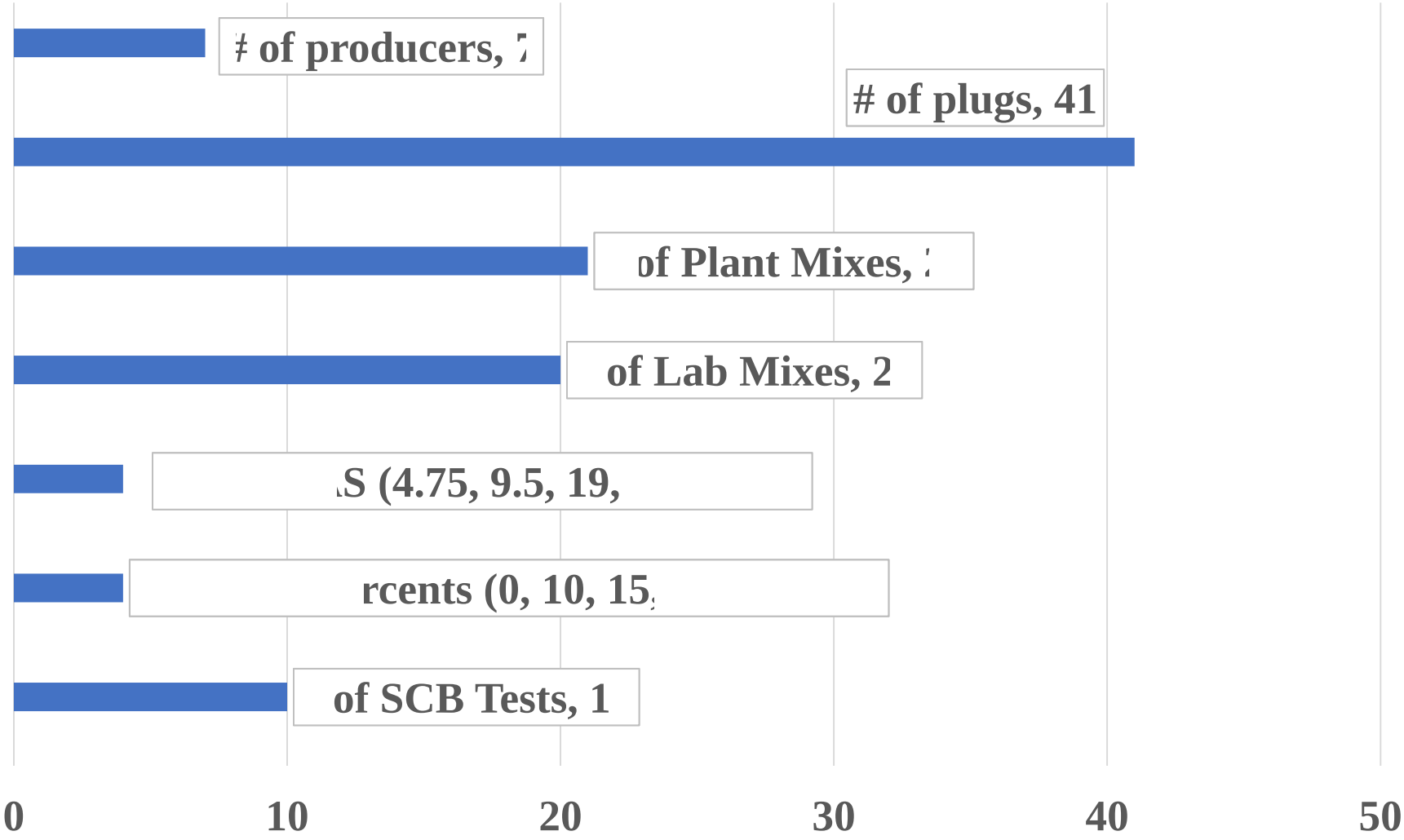


What Do We Do with the Plugs?

Once Received at NECEPT, Enter into Database:

- Identification Code
- Source
- Date of Compaction
- Date of Receipt at NECEPT
- Lab vs Plant Mix
- Aging Condition
- Air Void

Current Status (as of 1/15/18)



Current Status (As of 1/15/18)

- # of plugs from producers varies:
  1, 2, 3, 4, 10, 16
- All with PG 64-22
- First Plug received: 11/28/2017
- Latest Plug received: 1/10/2018

Processing/Testing Specimens

- Photos
- Specific Gravity Measurement
- Cut into 4 Specimens
- Specific Gravity Measurement
- Conduct SCB

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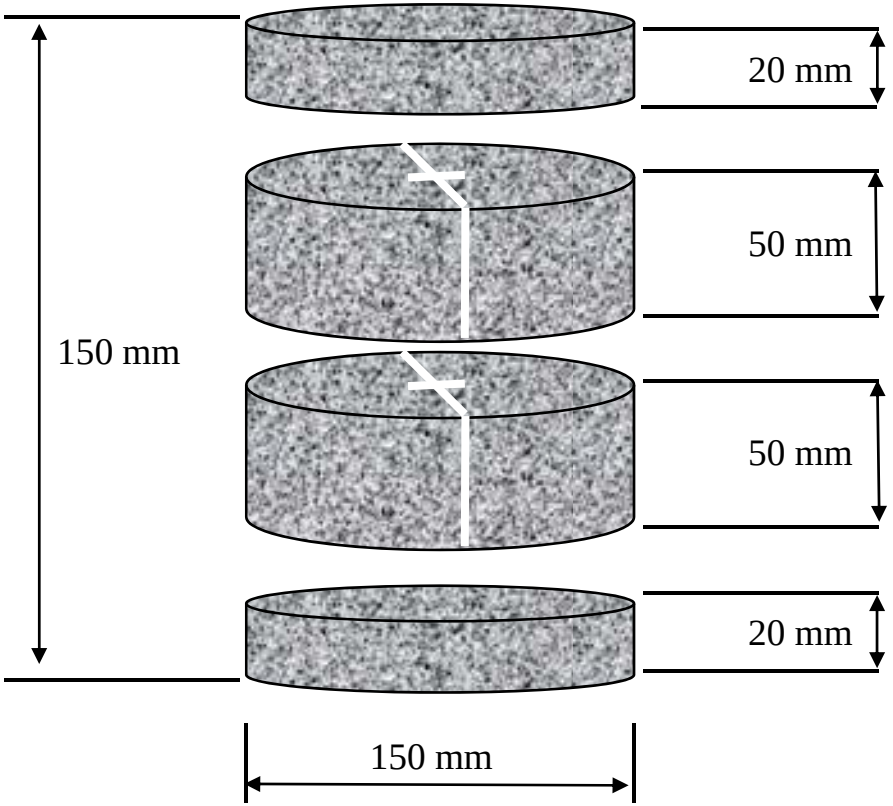
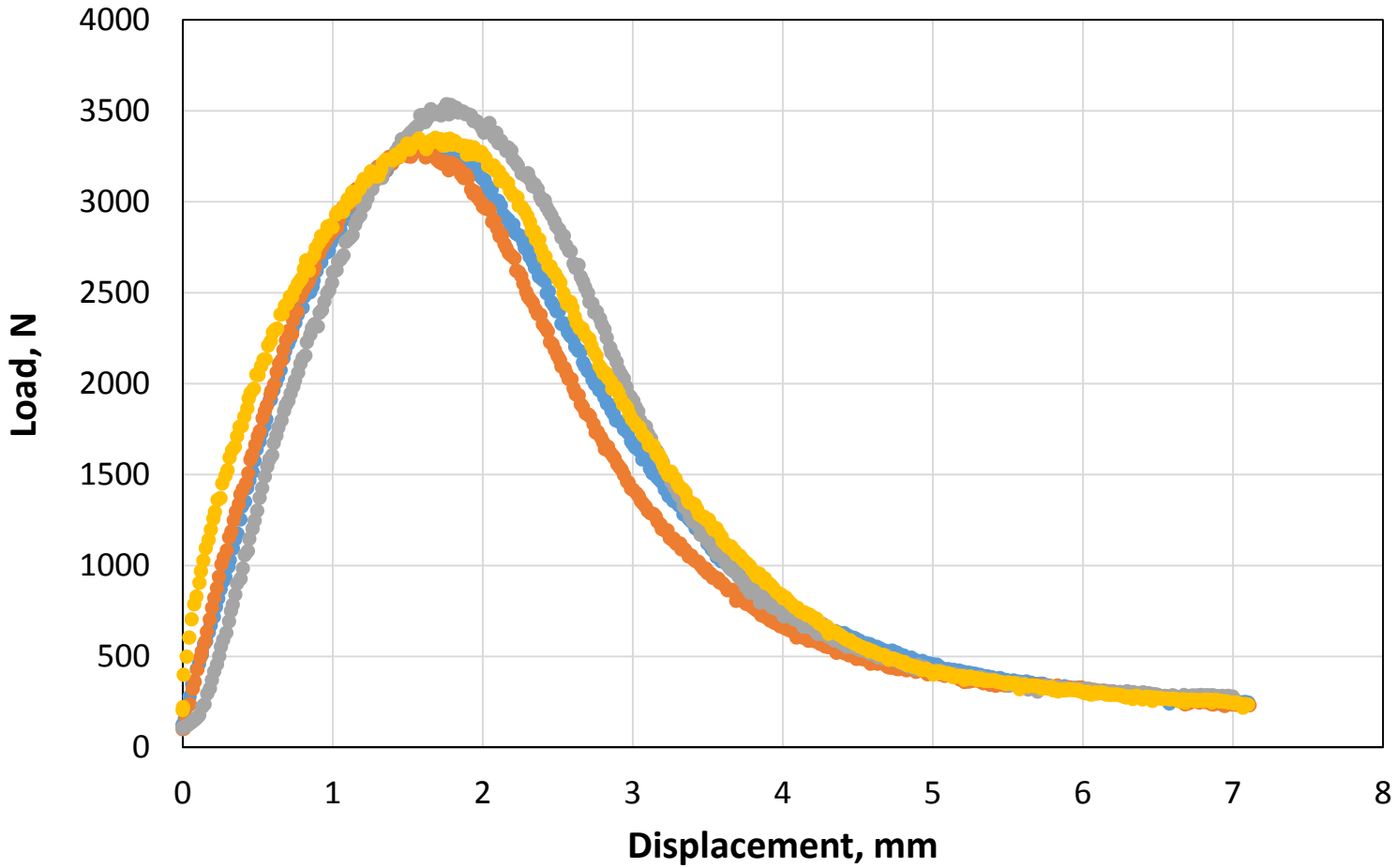
Specimen Preparation

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



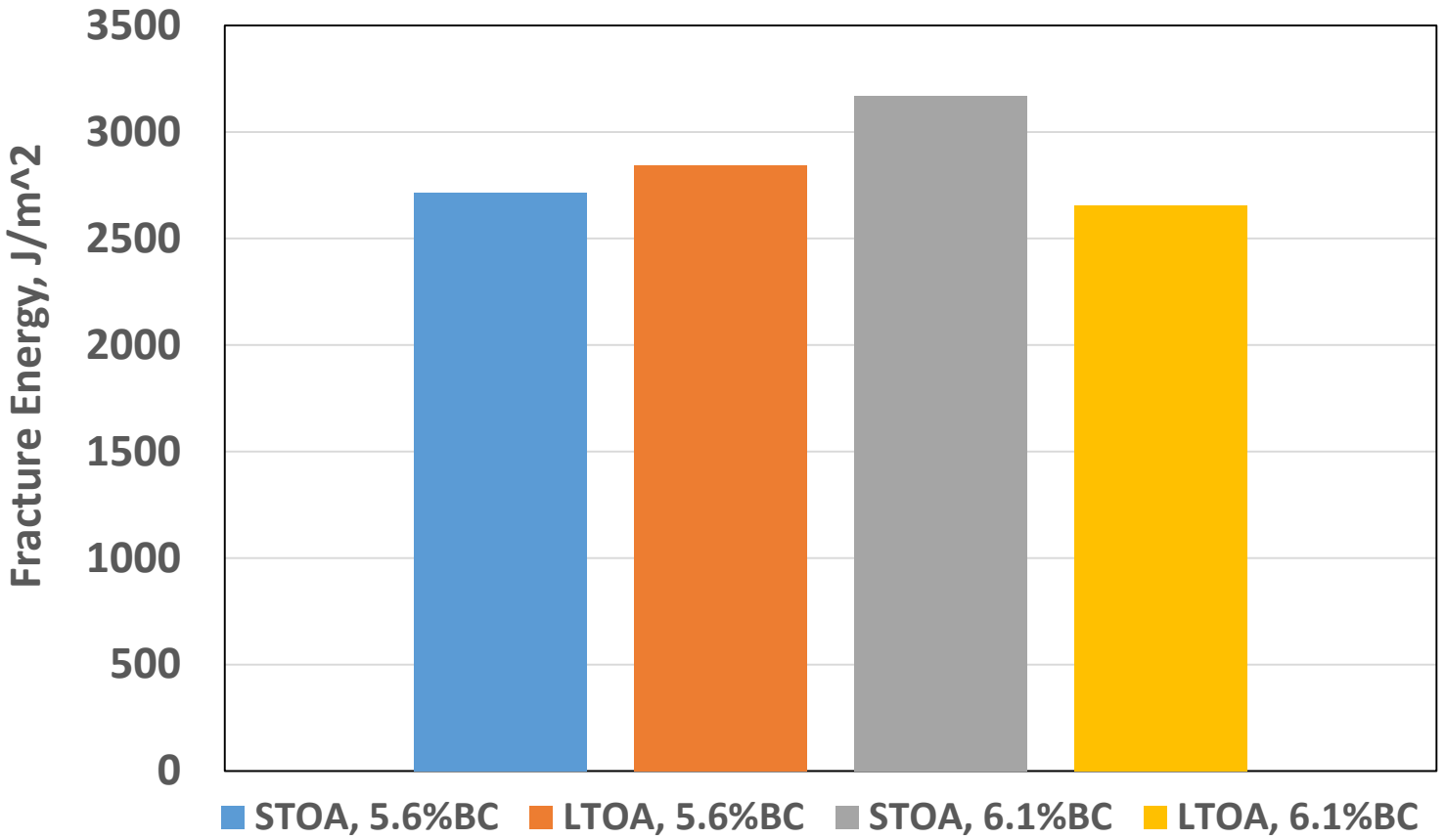
Industry SCB Test Results

Repeatability of Industry SCB Specimens



Industry SCB Test Results

Mix Source A: Plant mix, NMAS 9.5mm, PG64-22, 4.5% AV.



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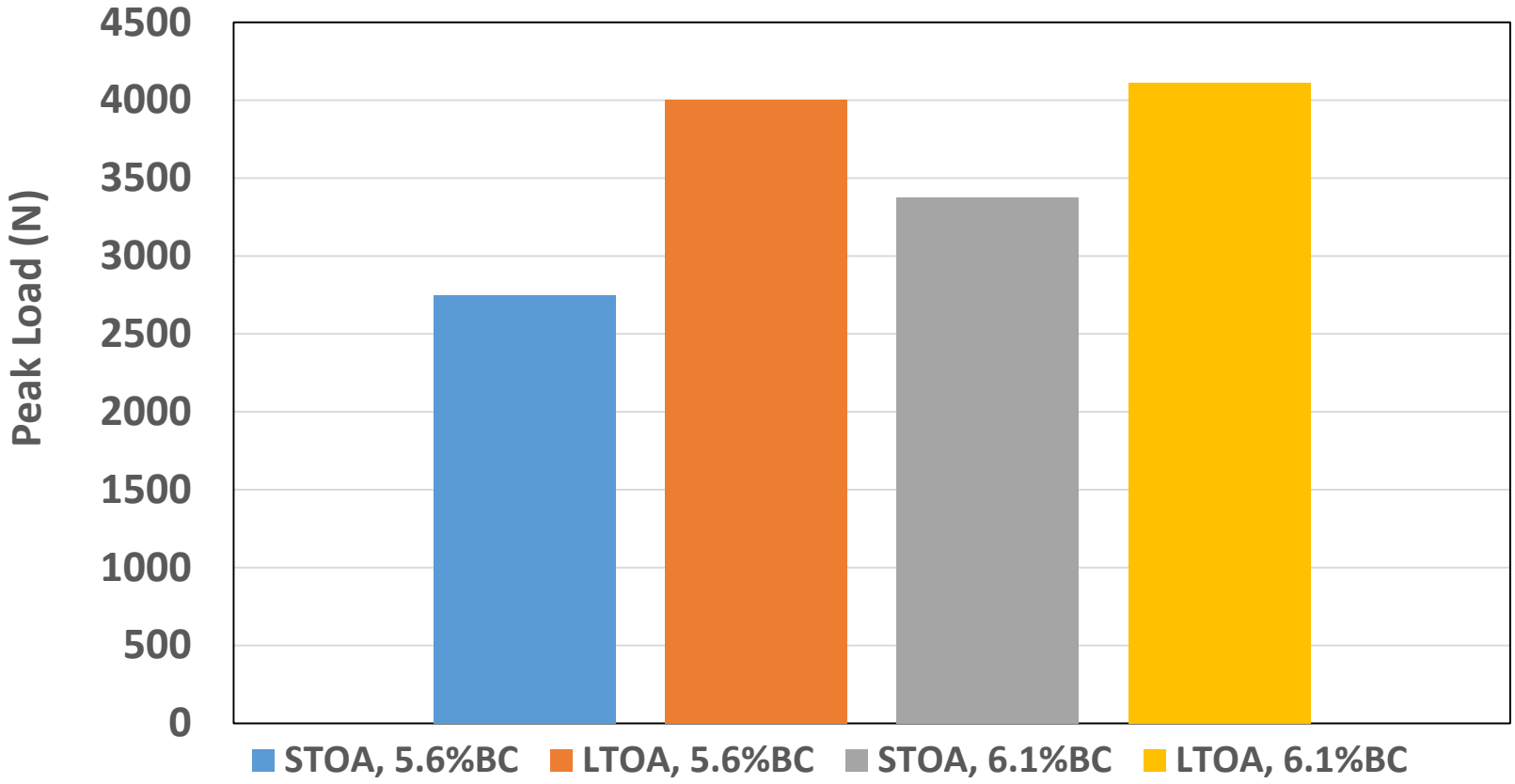

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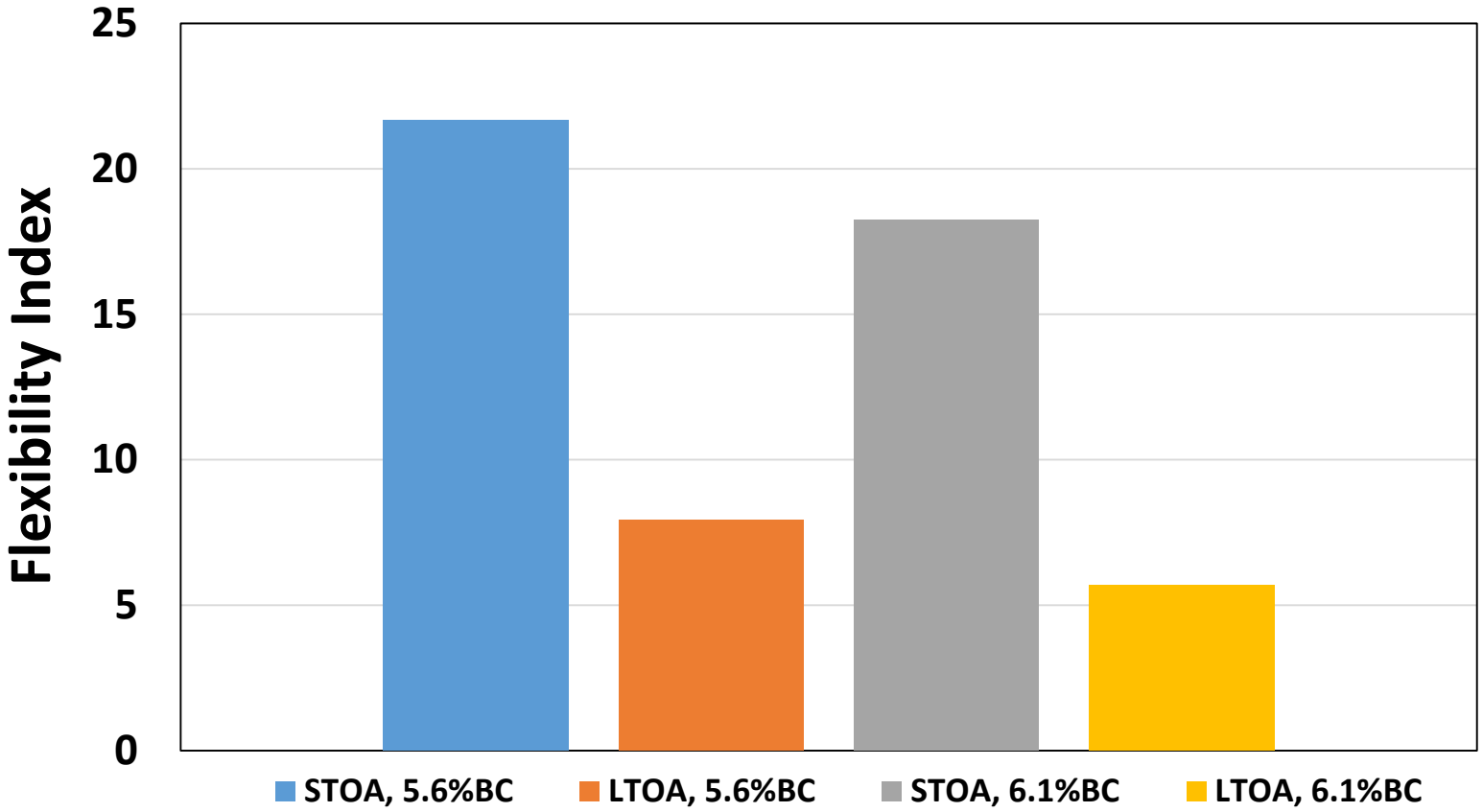

Waiting for More Specimens

- Continue Receiving Material
- Continue Cataloging/Testing Materials
- Continue Analysis

PLEASE:

- Label Materials Properly
- Ship/Transport Safely
- Include Mix Information/JMF/Compaction Date

Thank You!