Illinois Flexibility Index Test

79th IAPA Annual Meeting

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I-FIT

- Background on I-FIT
- Development of FI Threshold
- Implementation
- IDOT Experience with I-FIT
- CTL Experience with I-FIT

Next Step in HMA Improvement

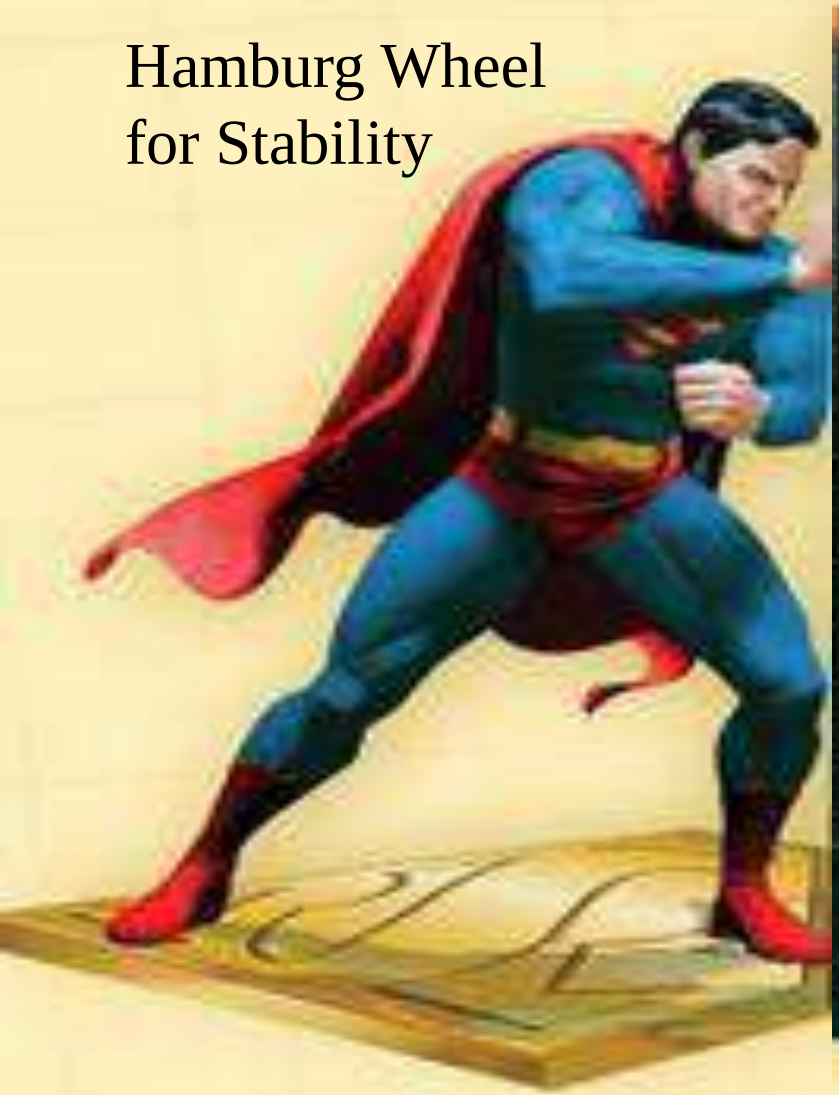
Book-End Performance Tests

One for Stability

One for Flexibility

Book-End Performance Tests

Hamburg Wheel
for Stability



I-FIT for Flexibility

Illinois Flexibility Index Test I-FIT

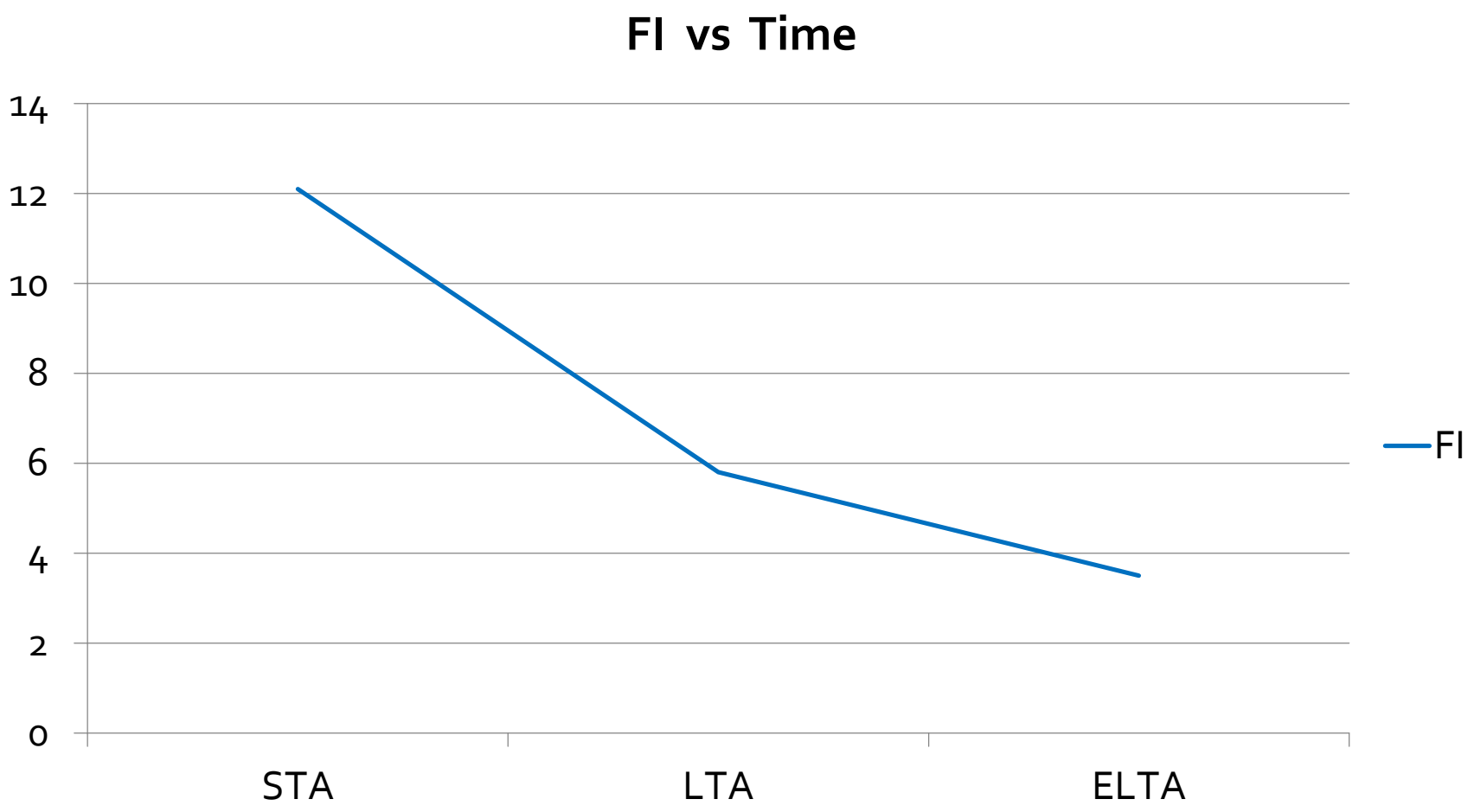
- A Performance Test Like Hamburg Wheel
- Developed thru ICT Research R27-128
  (Testing Protocols to Ensure Performance of High Asphalt Binder Replacement Mixes Using RAP & RAS)
- Uses Semi-Circular Bend (SCB) Configuration w/ Gyratory or Core Specimens @ Room Temp
- Test Can Be Completed in a Day

I-FIT

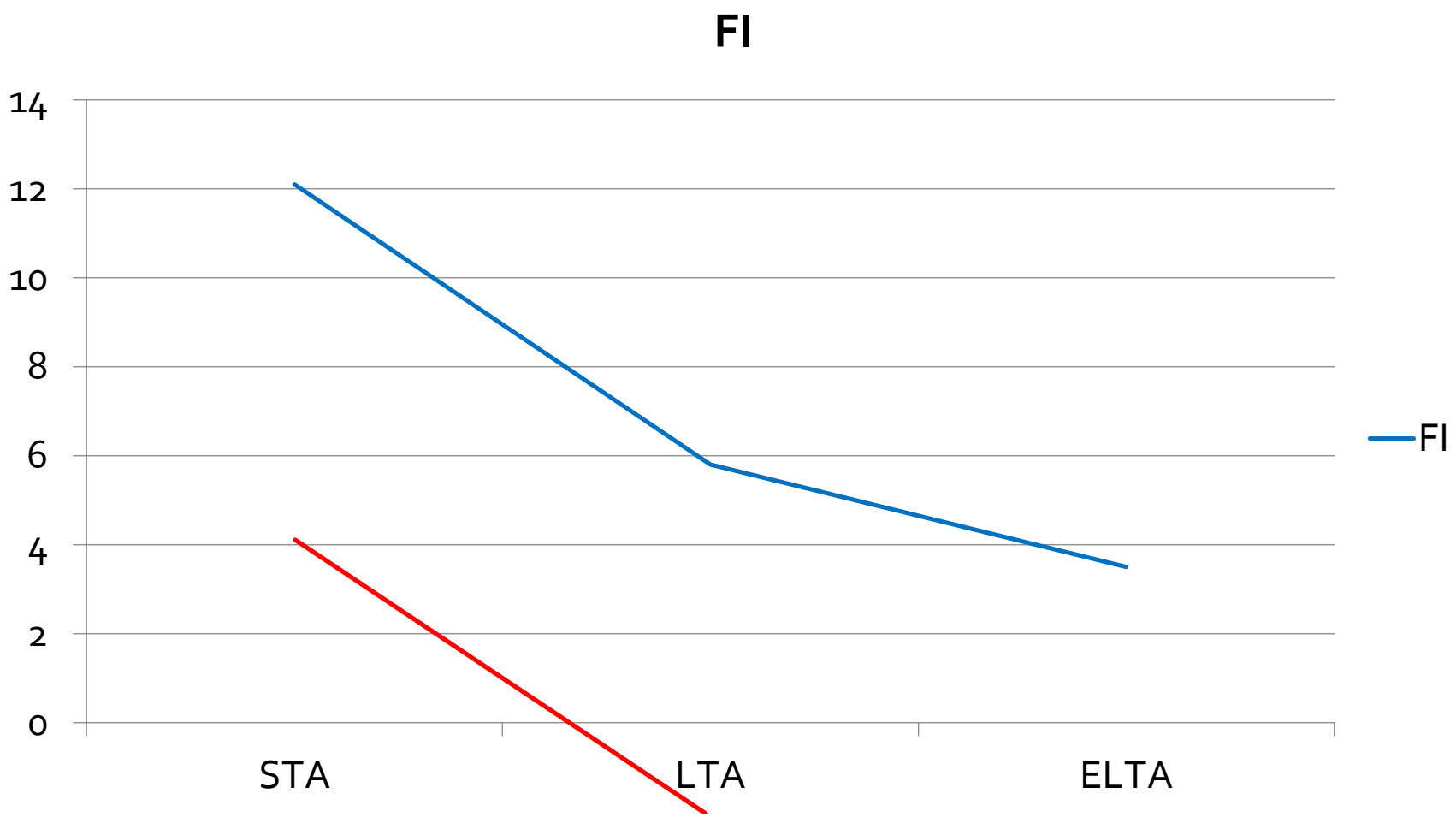
What Minimum FI Should We Use?

- As Part of the ICT R27-128 Research
  - Cores from Good & Bad Performing Pavements submitted from each District for FI testing
  - Dividing Line was FI ≈ 4
- So does that mean we should we set our Min. FI at 4?

FI Decay

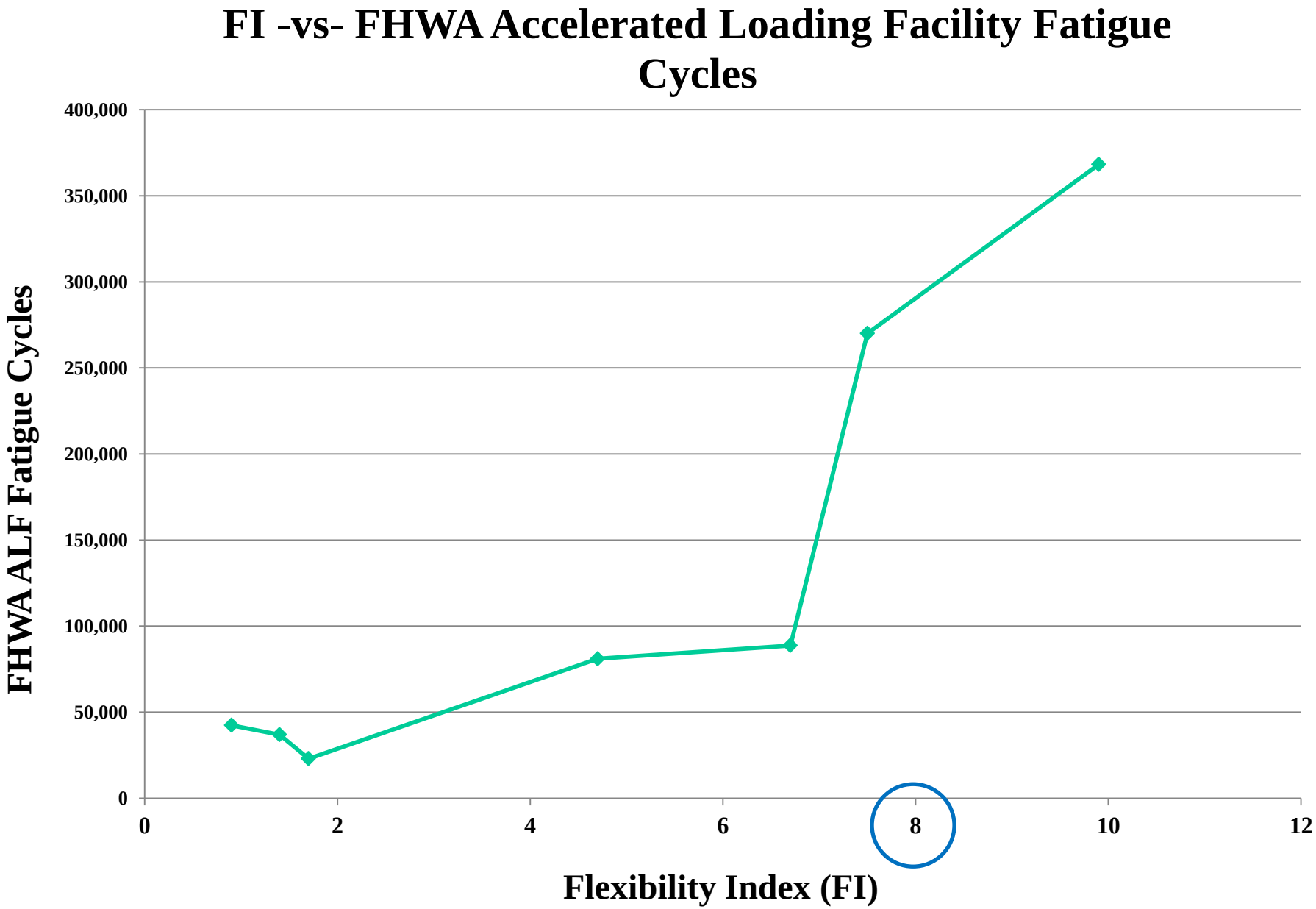


FI Decay

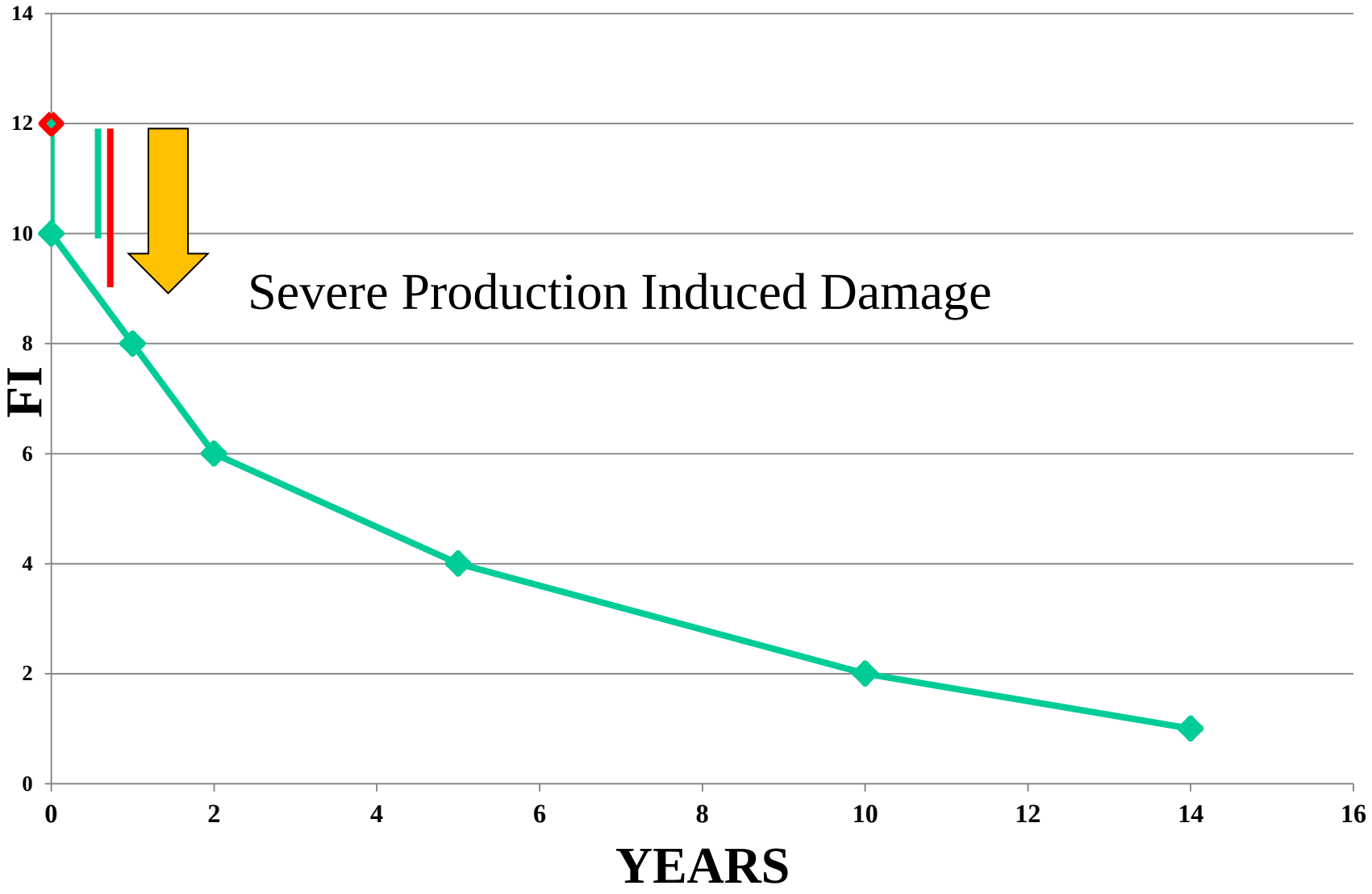


What Should the Minimum FI Value Be?

- U of I obtained plant mixes used in FHWA Research @ Turner Fairbanks
  - Mixes were designed to have wide range of flexibility
  - Mixes were tested to fatigue failure w/ the ALF
- Fatigue Failure = Rapid Onset of Cracking


FI -vs- FHWA Accelerated Loading Facility Fatigue Cycles
FHWA ALF Fatigue Cycles
400,000
350,000
300,000
250,000
200,000
150,000
100,000
50,000
0
0
2
4
6
8
10
12
Flexibility Index (FI)

FI -vs- Years


14
12
10
8
6
4
2
0
FI
Severe Production Induced Damage
0
2
4
6
8
10
12
14
16
YEARS

Possible Causes for Production Induced Reduction of FI

- Cold/Wet Stockpiles
- Cold/Wet RAP & RAS Stockpiles
- High Production Temps
- Extended Silo Storage Time
- Long Haul Time
- Lower AC Content from Design
- Increased Dust Content
- Time/Temp of Asphalt Binder Storage

I-FIT Implementation

- 2016 Pilot Projects (11 Statewide)
  - Targeted January → April 2016 lettings for Experimental Feature Projects:
    - I-FIT Design Verification & Production Testing Requirements (Mixes must have FI ≥ 8)
    - Contractor DCT Design Verification & Production Testing (for Informational Purposes)
    - Excludes: Pavement Patching & Incidental HMA
    - RAP/RAS spec revised (for Pilot Projects Only) to allow 5% increase in ABR (except D1 Poly mixes)

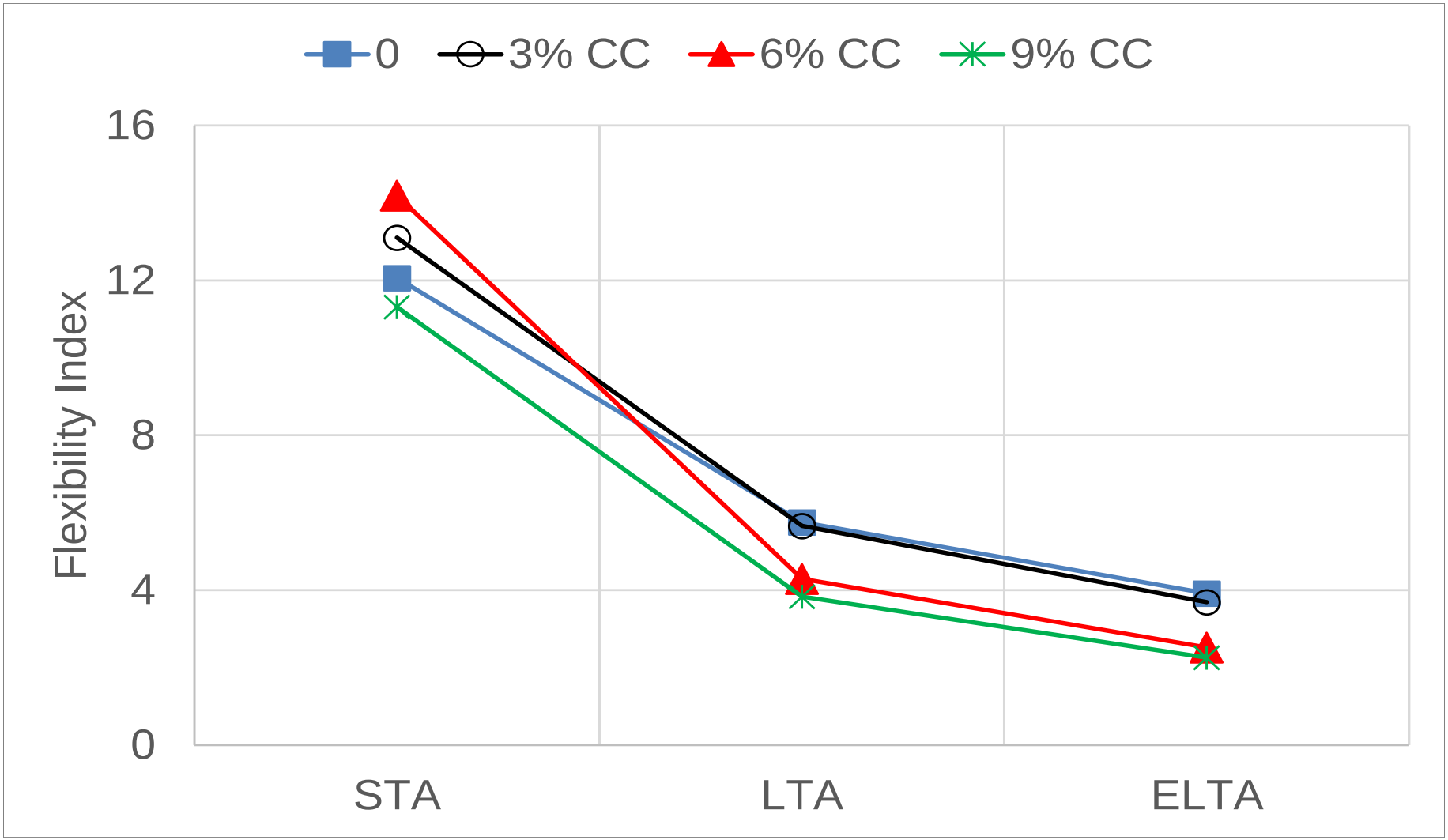
I-FIT Implementation

- 2016 Cont'd
  - Districts 1 & 9 received new I-FIT's
    - District 1 will cover Pilot Testing for Dists 1-3
    - BMPR will cover Dists 4-6
    - District 9 will cover Dists 7-9
- 2017 Implementation
  - Purchase I-FIT Devices & Tile Saws w/Jigs for Remaining Districts
  - More Pilot Projects

Future I-FIT Testing

- Evaluate Use of I-FIT to Screen/Allow Asphalt Modifiers through Long Term Aging Protocol

FI vs Aging (ReOB vs Unmodified)



Future I-FIT Testing

- Mix Design Verification for I-FIT
  - 1 Sample **STA** to verify FI ≥ 8.0
  - 1 Sample **LTA** to verify FI ≥ X.x
- Production
  - 1 Sample **As-Produced** to verify FI ≥ 8.0
  - 1 Sample **LTA** to verify FI ≥ X.x
- LTA Protocol to be Developed thru ICT Research

BMPR Priorities

1. PFP Dispute Samples
2. I-FIT Pilot Project Testing
3. I-FIT Mix Characterization Testing
4. Other BMPR Projects

Please Hold Questions Until End

Thank You!

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Illinois Dept of, Transportation

I-FIT at BMPR

79th IAPA Annual Meeting

Tom Zehr – IDOT BMPR

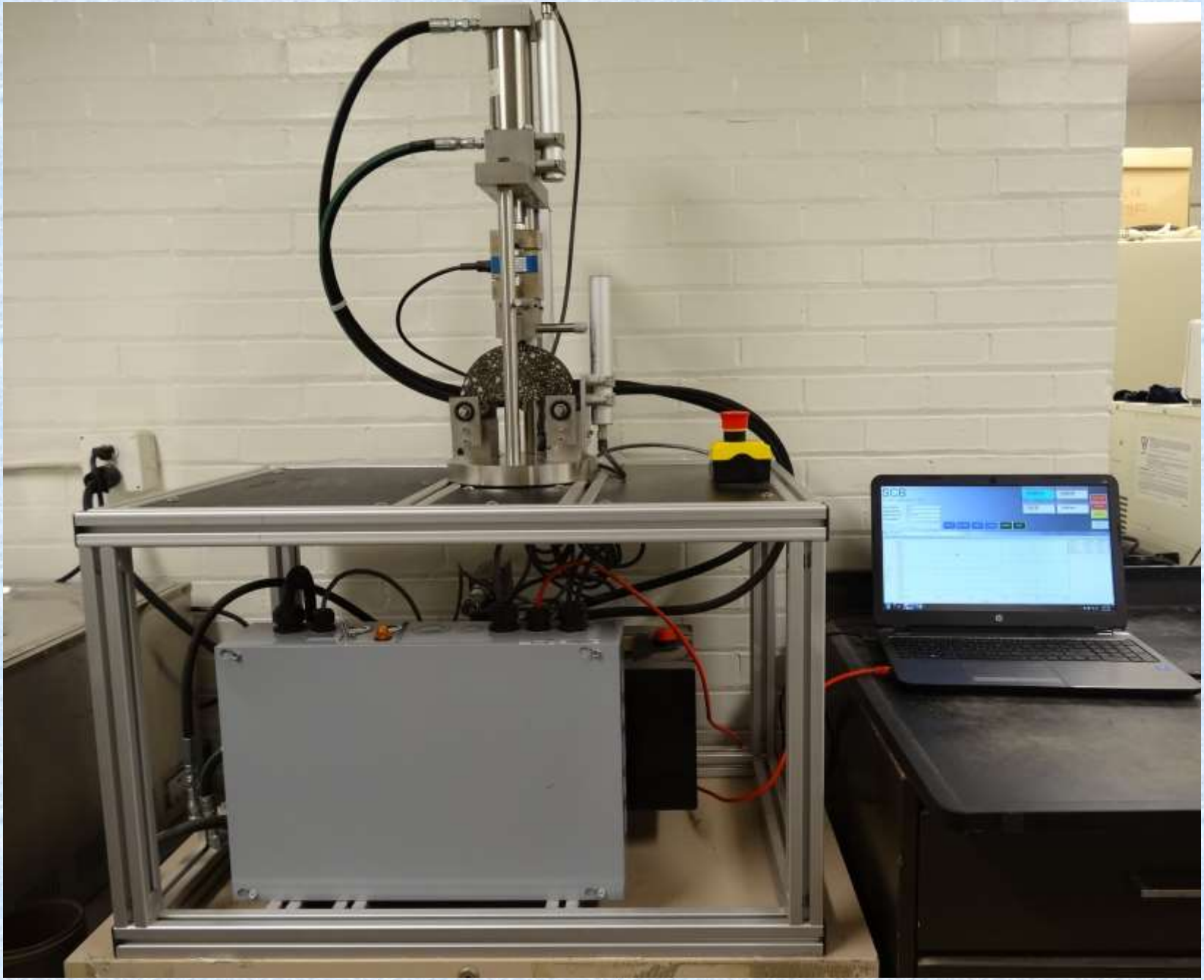
03-14-16

I-FIT Specimen

- Background
- Initial Testing
- Specimen Prep
- Voids
- Aging
- Mixes Tested

Background

- Test Loading Rate is Fast – 50 mm per min
- Test Temp = 77°F
- DRAFT AASHTO spec on May 17, 2015
  - Balloted & Now Being Published
- Also Developed IL Test Procedure 405
  - Attached to Spec for Pilot Projects
- Received Initial Machine in July 8, 2015
- “Re-designed” Machine delivered July 23, 2015

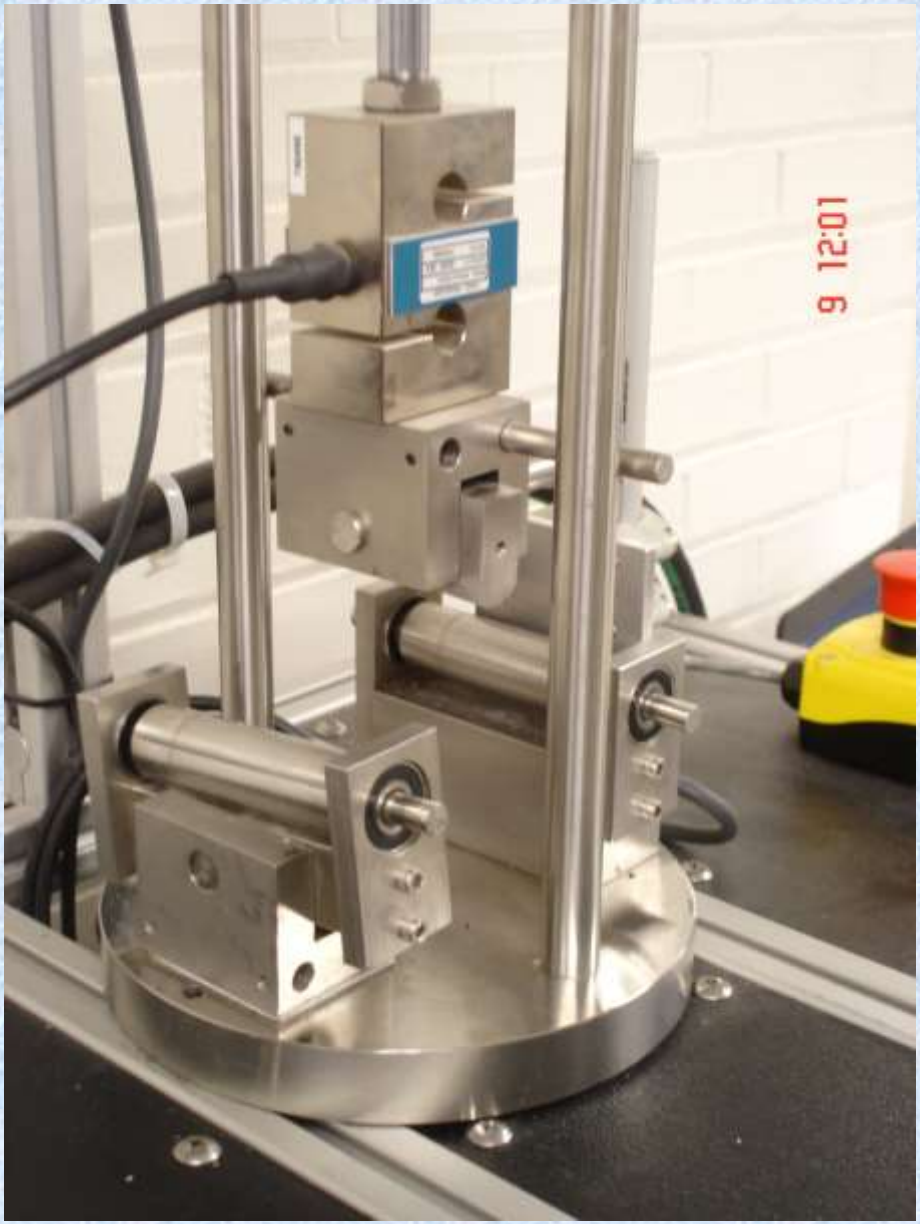


Initial Testing

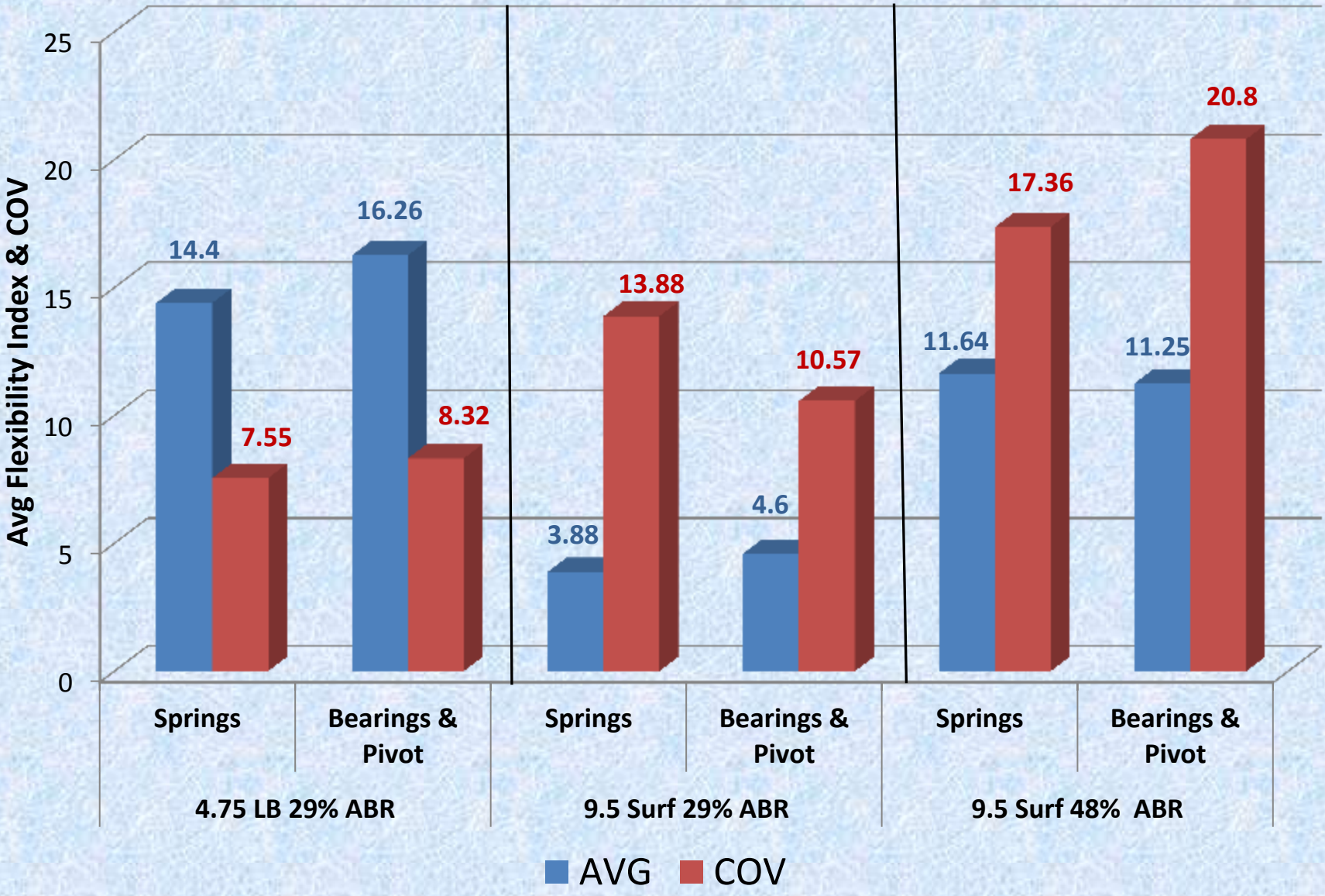
- All Mixes Plant Mix (Aged on shelf for varying times (bags of specimens)
- 1st Testing to Evaluate & Learn About Machine
- Round Robin Study
- Compared Springs –vs- Pivoting Bearing Base
  - 4.75 Level Binder Mix (6 gyros each)
  - 2) 9.5 Surface Mixes (3 gyros each)
  - 24 Gyro Bricks & 96 Test Specimens

Roller & Spring

Bearings & Pivot



Springs -vs- Bearings with Pivot

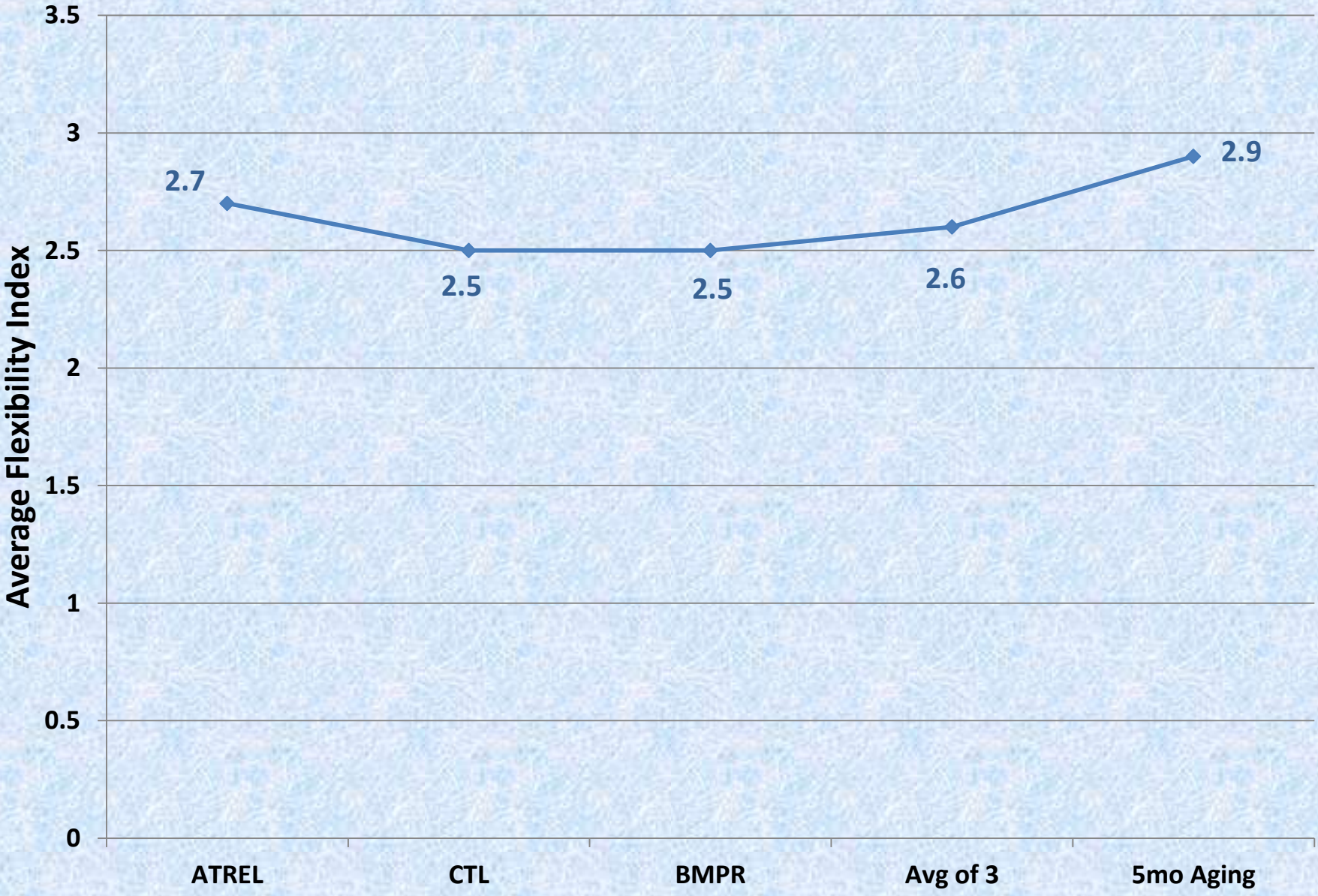


Round Robin

- U of I ATREL, CTL, & BMPR
- Each Lab, 2 mixes
  - 4.75 Level Binder
  - 9.5 Surface
- BMPR Prepared ALL Specimens
- (2 gyros – 8 specimens) per mix
- Also Looking at Effect of Specimens Aging on Shelf (Extra Specimens)
  - 5 month (done)
  - Then 8 mo, 1 yr, & 1 ½ or 2 yrs

I-FIT Round Robin - 4.75 Level Binder (35% ABR)

I-FIT Round Robin - 9.5 Surface (29% ABR)



Future Round Robin

- When Funding is Available, BMPR Intends to Purchase a Machine for Each District and Provide Training.
- BMPR is working on an Instruction Video on I-FIT Operation
- After Each District has Equipment, a Round Robin Study Will Be Conducted with Districts & Private Labs to Evaluate Variability

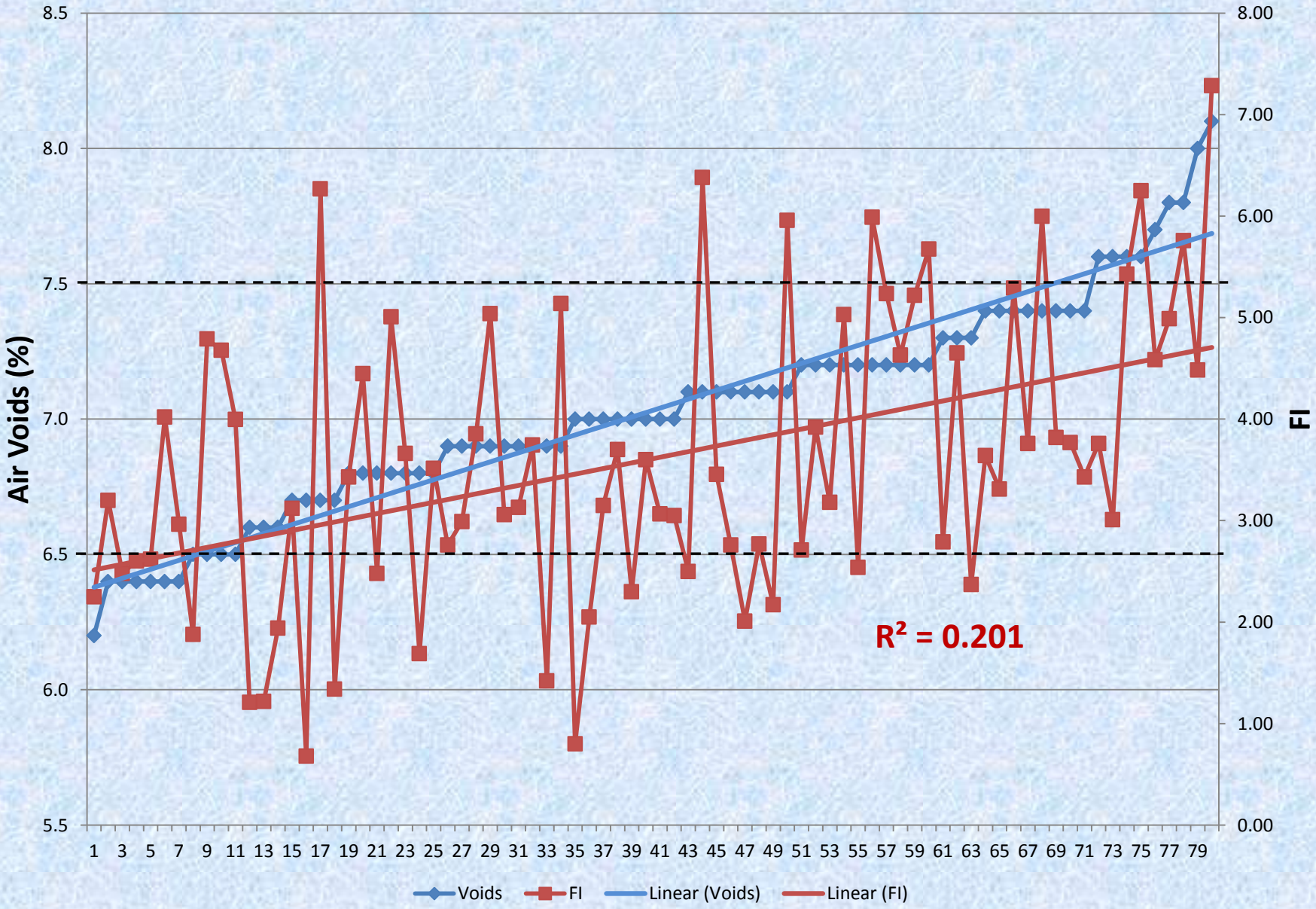
Specimen Prep

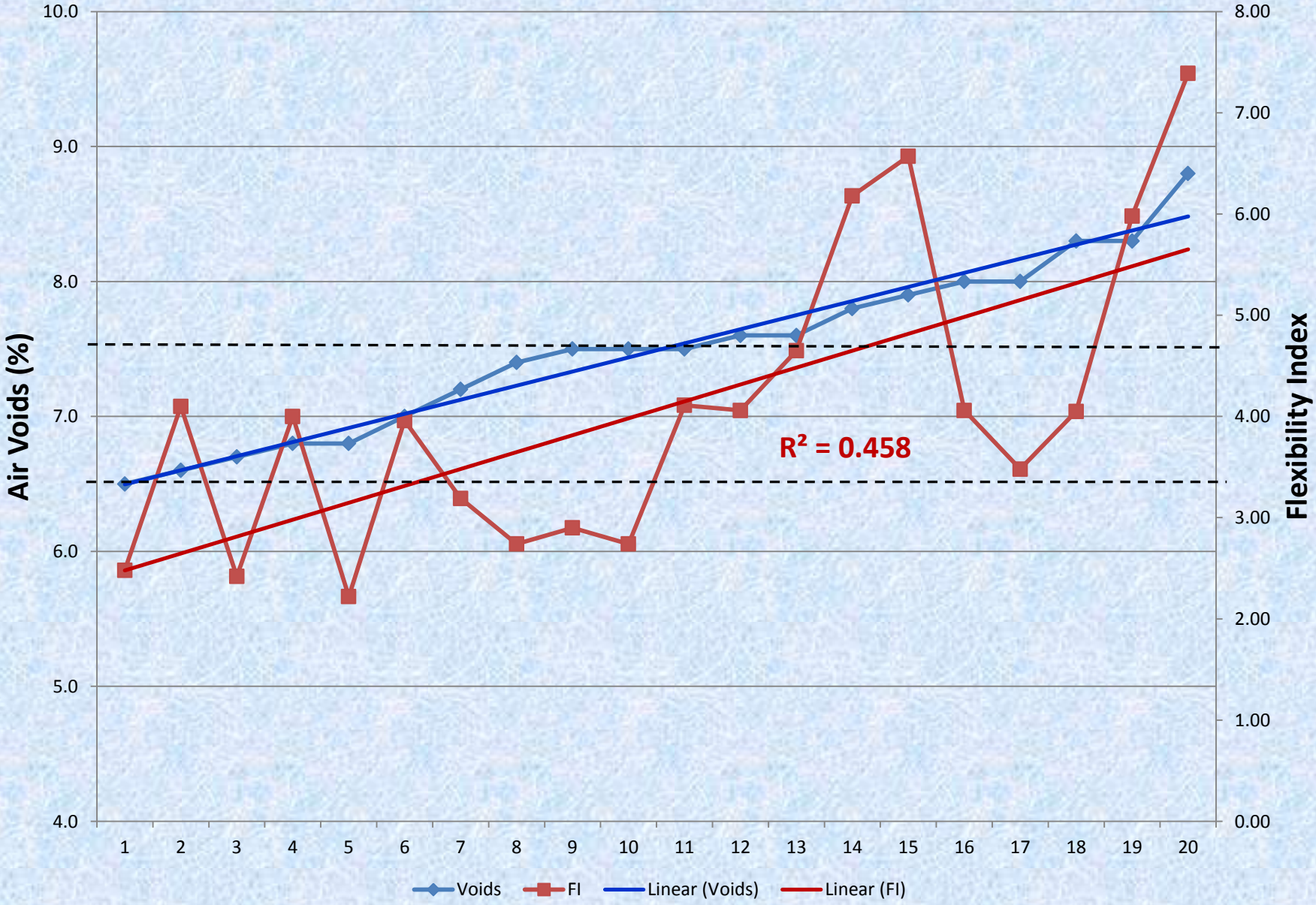
Specimen Prep

- Typical Gyro Brick Height is 160 mm
- However, 160 mm may not work for certain compactors, so at least 115 mm & cut 1 disk
- Saw Cuts need to be Accurate to ensure Flat Surfaces, Perpendicular, & Correct Dimensions
  - Disk Thickness – 50 ± 1 mm
  - Notch Length – 15 ± 1 mm
  - Notch Width – 1.5 ± 0.1 mm
- **Consistent Specimen Prep is Important!**

Voids –vs- FI

- Current Spec for Air Voids is 7.0 ± 0.5%
- Common Sense says Voids should have large affect on FI,
- Our Testing so far does not indicate that FI is highly dependent on voids at 7.0 ± 0.5%


Voids -vs- FI for 81Bit157M
Air Voids (%)
FI
8.5
8.0
7.5
7.0
6.5
6.0
5.5
8.00
7.00
6.00
5.00
4.00
3.00
2.00
1.00
0.00
1 3 5 7 9 11 13 15 17 19 21 23 25 27 29 31 33 35 37 39 41 43 45 47 49 51 53 55 57 59 61 63 65 67 69 71 73 75 77 79
R² = 0.201
Voids
FI
Linear (Voids)
Linear (FI)


Voids -vs- TI for 83Bit116Z
Air Voids (%)
Flexibility Index
10.0
9.0
8.0
7.0
6.0
5.0
4.0
8.00
7.00
6.00
5.00
4.00
3.00
2.00
1.00
0.00
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
R² = 0.458
Voids
FI
Linear (Voids)
Linear (FI)

Voids –vs- FI

- So, for 2016 Pilot Projects, the Air Void Goal is 7.0 ± 0.5% but 7.0 ± 1.0% will be considered
- Future Consideration: Contractor submit several Compacted Gyro Bricks at Same Air Void Level with Half Tested for I-FIT and Half Tested for Hamburg.

More Air Void Observations

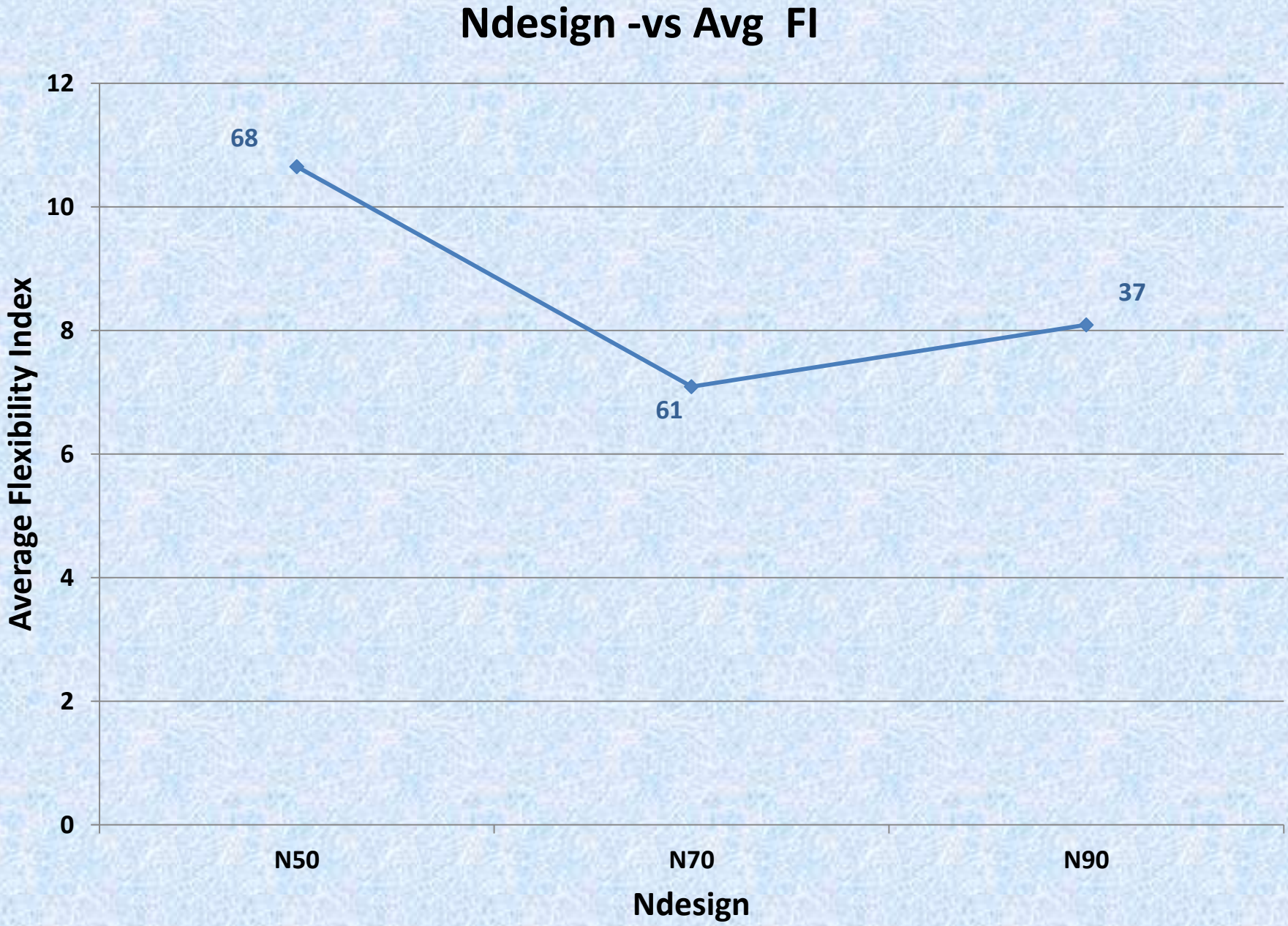
- Voids Typically 0.2 - 0.3 Higher on the Top Disk than on Bottom Disk
- Voids Often Considerably Greater in 2 Halves of the SAME Disk than Top & Bottom
- Voids Req't Is for Disk rather than for Each Individual Specimen
- 7.0 ± 0.5% Voids often easier for Level Binder than Surface or Binder

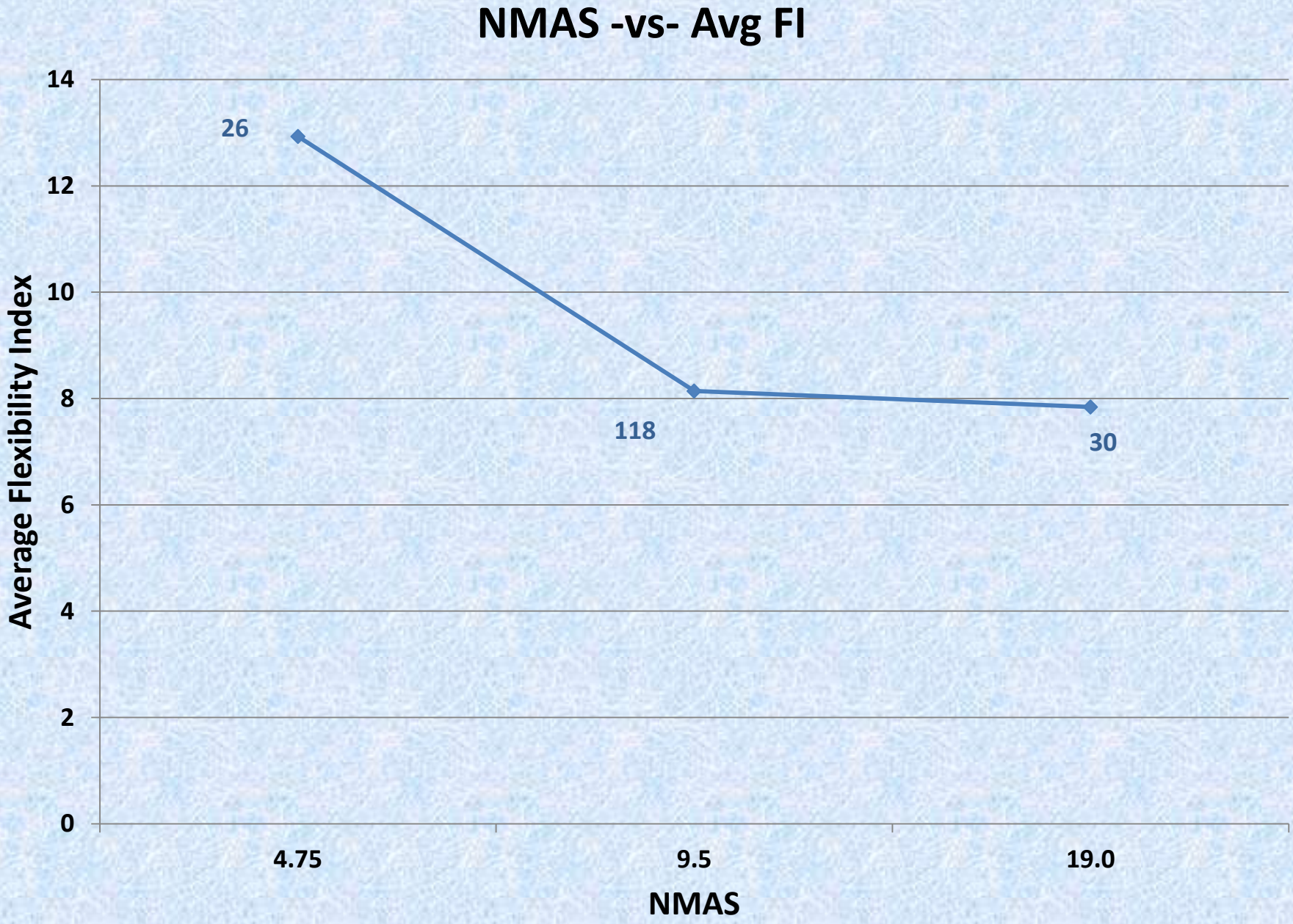
Ambient Aging

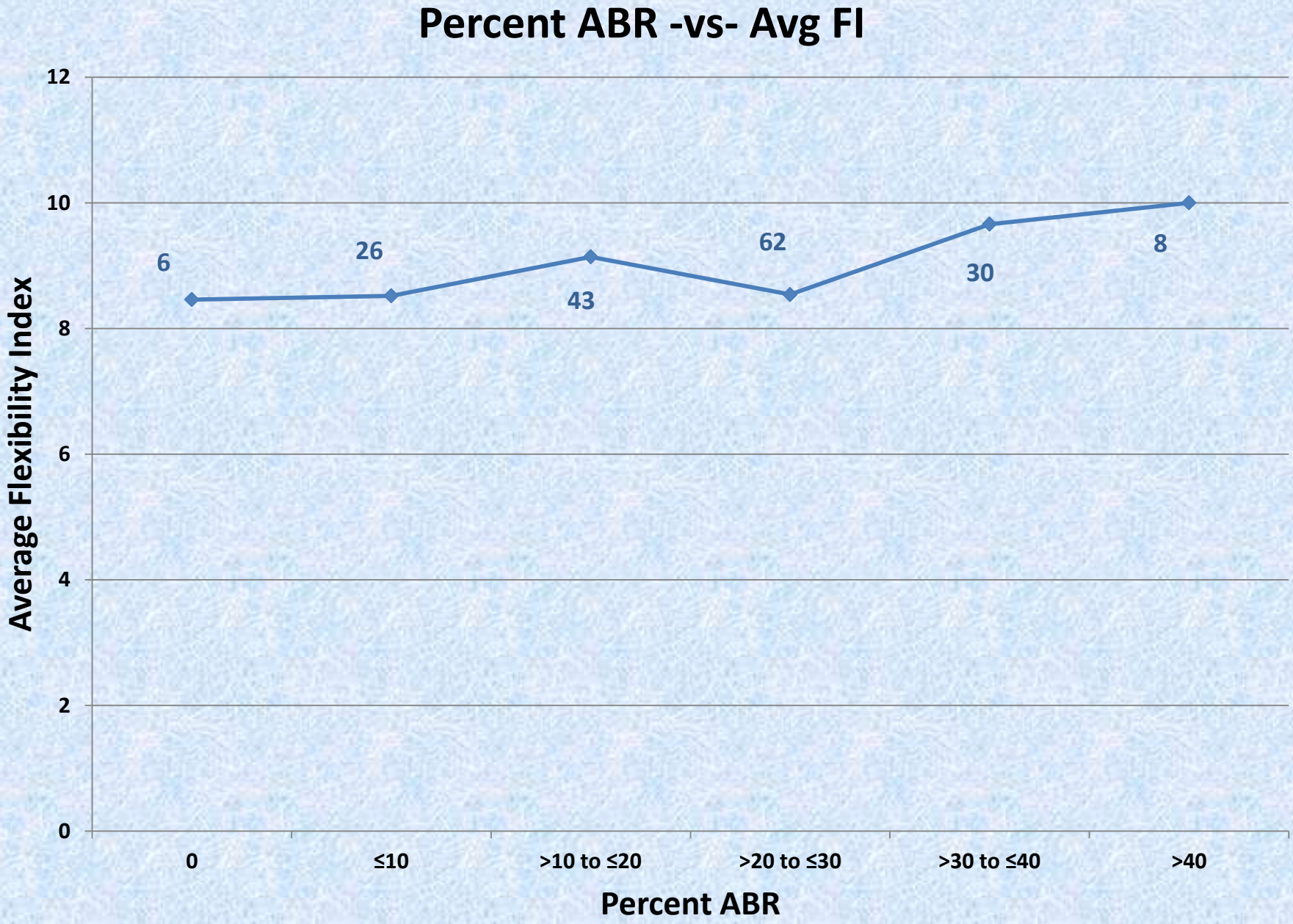
- Jim talked about Need for Oven Aging to Predict Long-Term Mix Flexibility Properties
- Also Need to Determine Effect on FI of Bags of Mix and Gyro-compacted or Prepared I-FIT specimens Sitting on the Shelf
- Plan to sample Mix
  - Compact Bricks & Saw Specimens, Keep on Shelf, and Test at Intervals for Up to 2 years
  - Keep Bags of Mix on Shelf Then Prepare and Test Specimens at Intervals for Up to 2 years

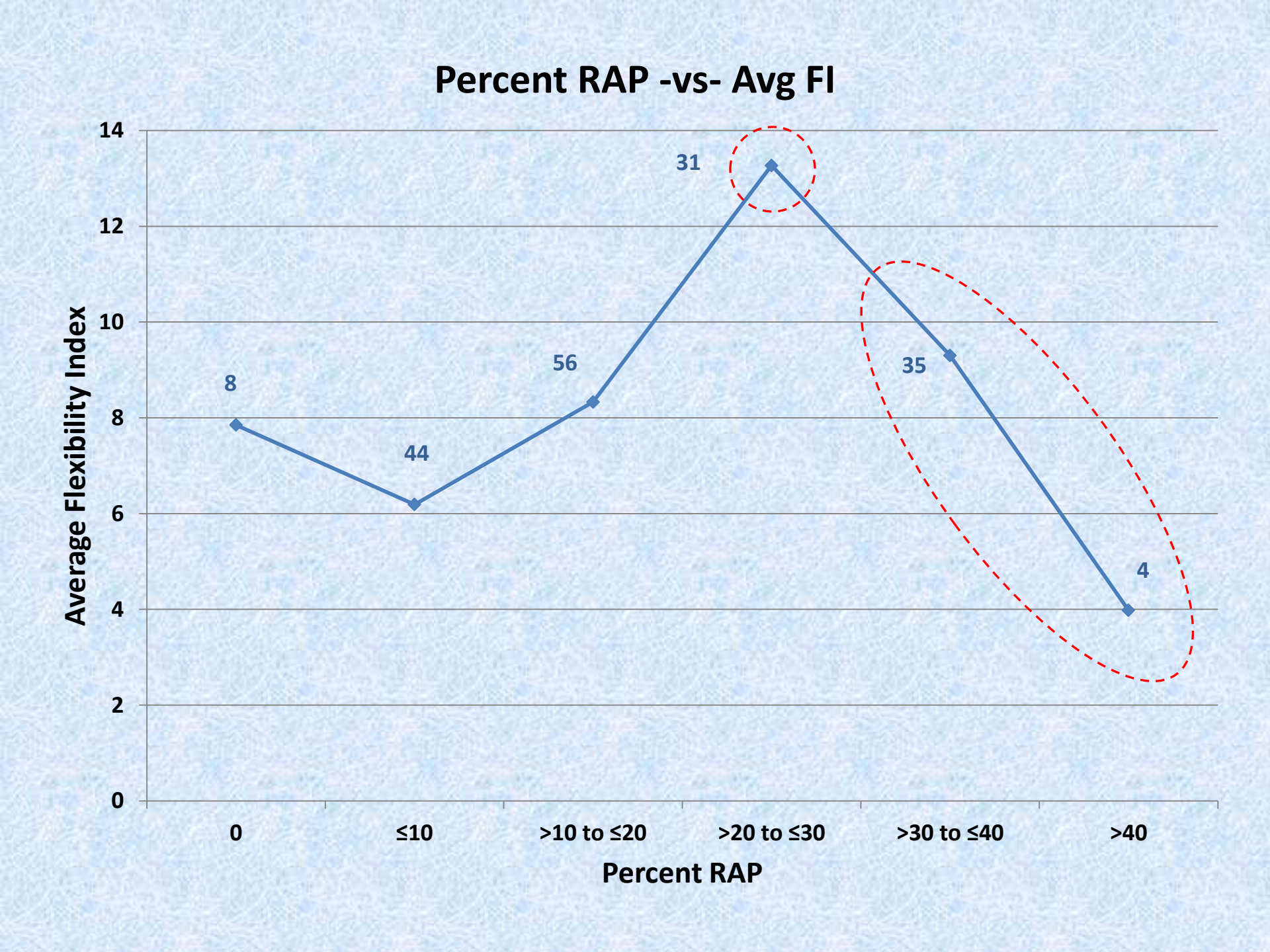
Mixes Tested

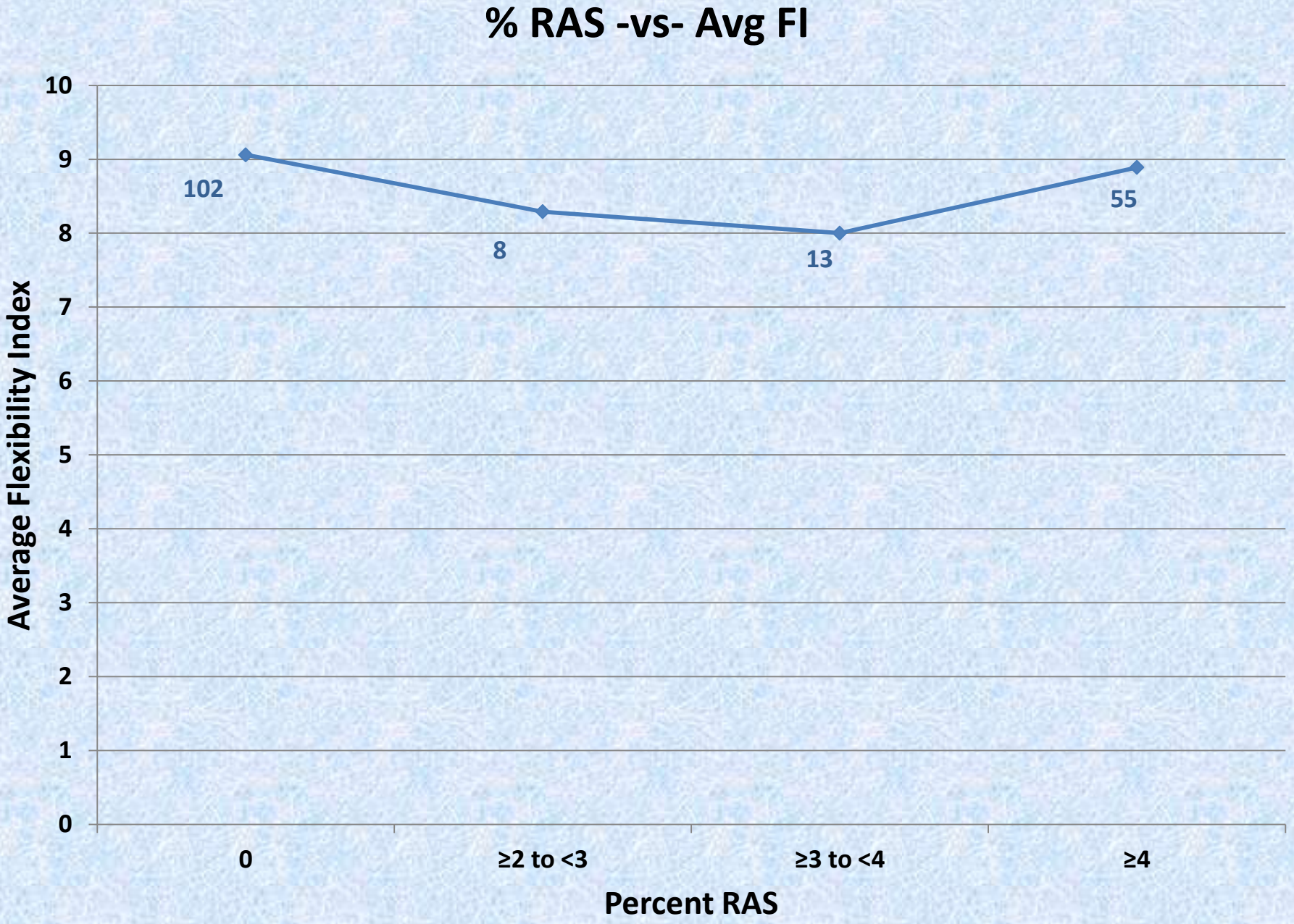
- Have tested 55 mix designs
- 178 gyro bricks
- Currently have a backlog of ≈ 20 mixes
- Report 3 most similar FI values from each Gyro Brick (after ‘Outlier’ Removed)

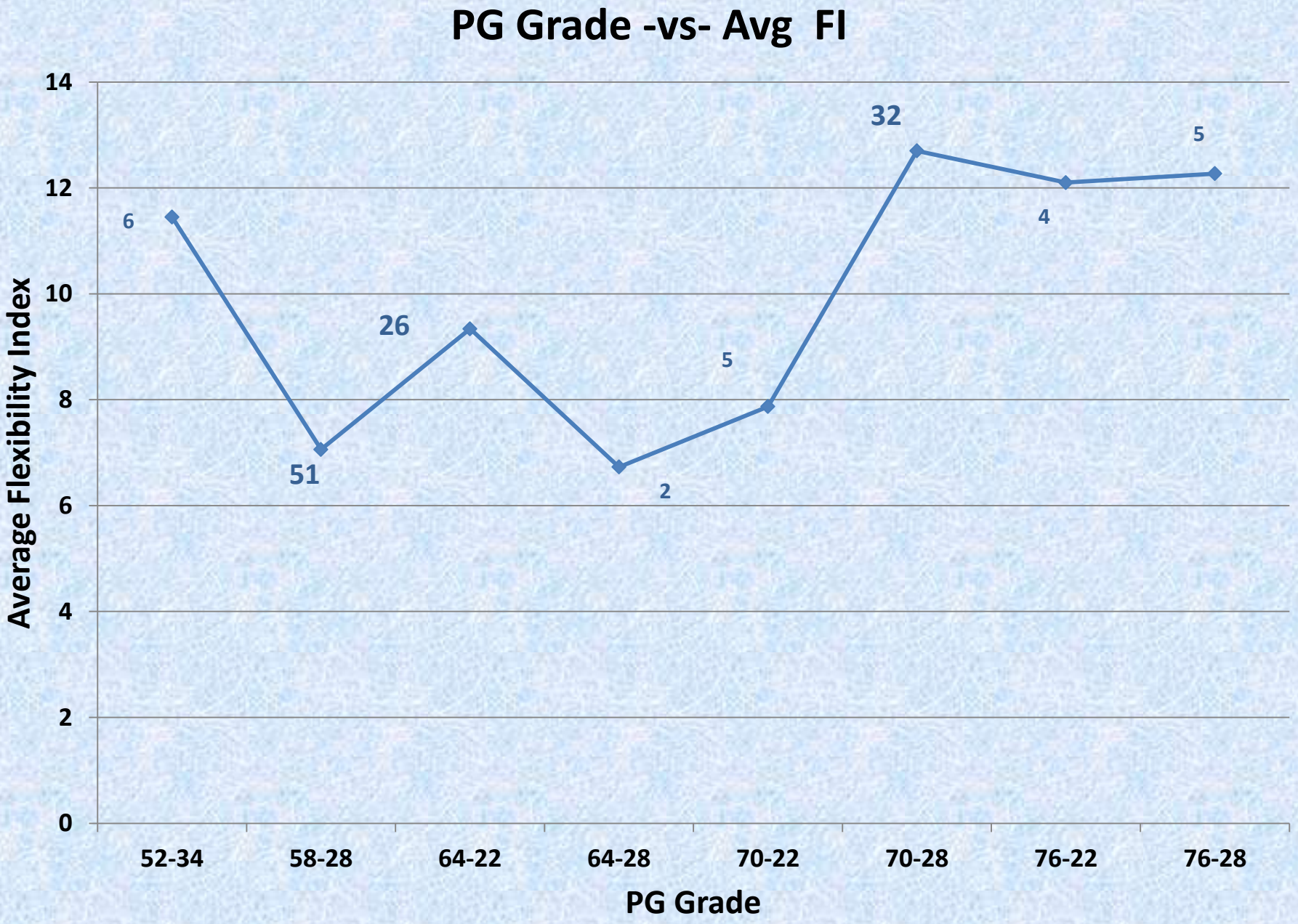

Ndesign -vs Avg FI
Average Flexibility Index
12
10
8
6
4
2
0
68
61
37
N50
N70
N90
Ndesign

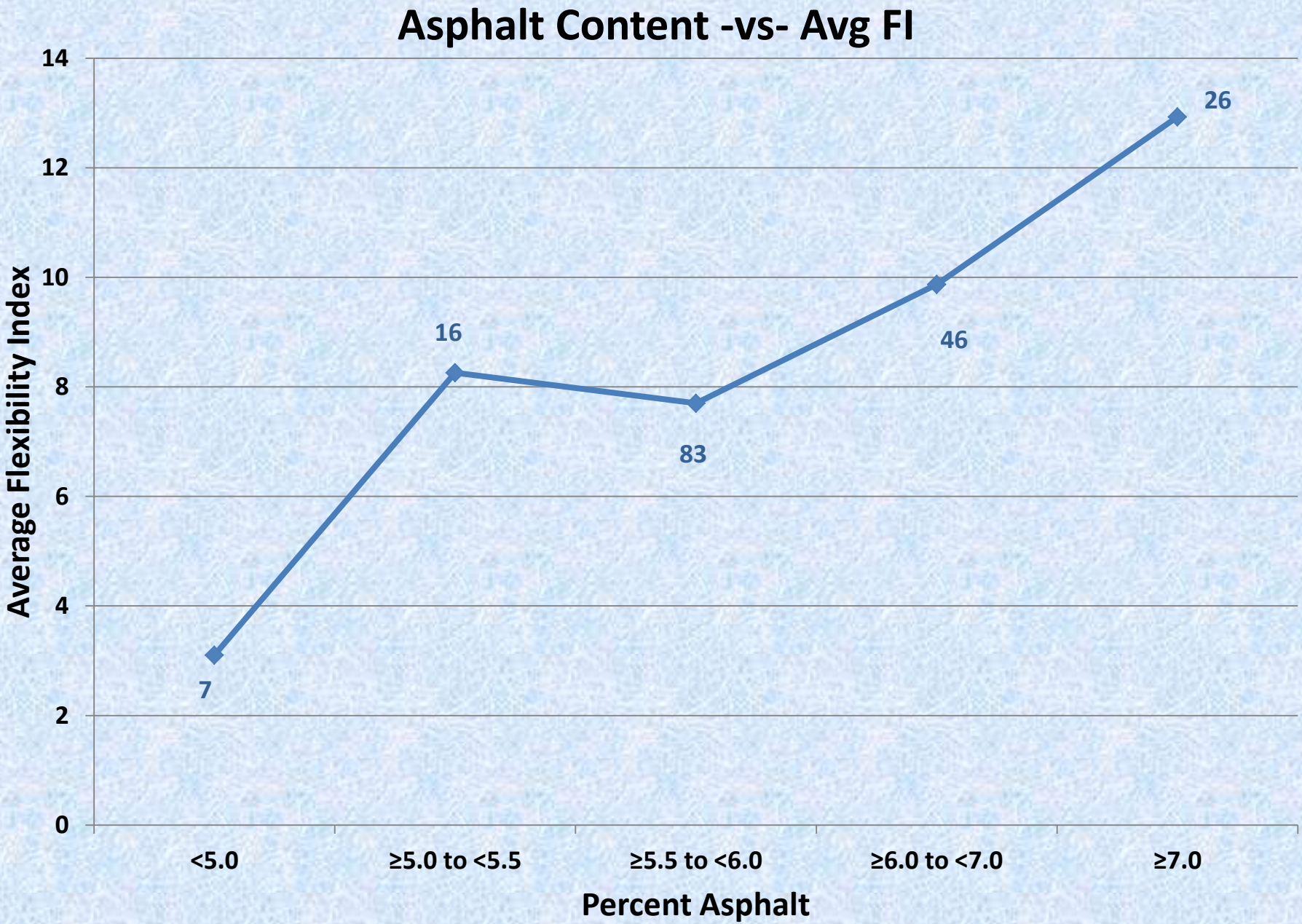

NMAS -vs- Avg FI
Average Flexibility Index
14
12
10
8
6
4
2
0
26
118
30
4.75
9.5
19.0
NMAS


Percent ABR -vs- Avg FI
Average Flexibility Index
12
10
8
6
4
2
0
6
26
43
62
30
8
0
≤10
>10 to ≤20
>20 to ≤30
>30 to ≤40
>40
Percent ABR


Percent RAP -vs- Avg FI
Average Flexibility Index
14
12
10
8
6
4
2
0
8
44
56
31
35
4
0
≤10
>10 to ≤20
>20 to ≤30
>30 to ≤40
>40
Percent RAP


% RAS -vs- Avg FI
Average Flexibility Index
10
9
8
7
6
5
4
3
2
1
0
102
8
13
55
0
≥2 to <3
≥3 to <4
≥4
Percent RAS


PG Grade -vs- Avg FI
Average Flexibility Index
14
12
10
8
6
4
2
0
6
51
26
2
5
32
4
5
52-34
58-28
64-22
64-28
70-22
70-28
76-22
76-28
PG Grade


Asphalt Content -vs- Avg FI
Average Flexibility Index
14
12
10
8
6
4
2
0
7
16
83
46
26
<5.0
≥5.0 to <5.5
≥5.5 to <6.0
≥6.0 to <7.0
≥7.0
Percent Asphalt

Thank You

The 79th Annual Convention IAPA 2016

Abdul Dahhan, P.E.

Chicago Testing Laboratory

March 14th, 2016

Presentation Outline

1. CTL experience with I-FIT
2. Data Analysis & Observations
3. Summary
   - Takeaways..

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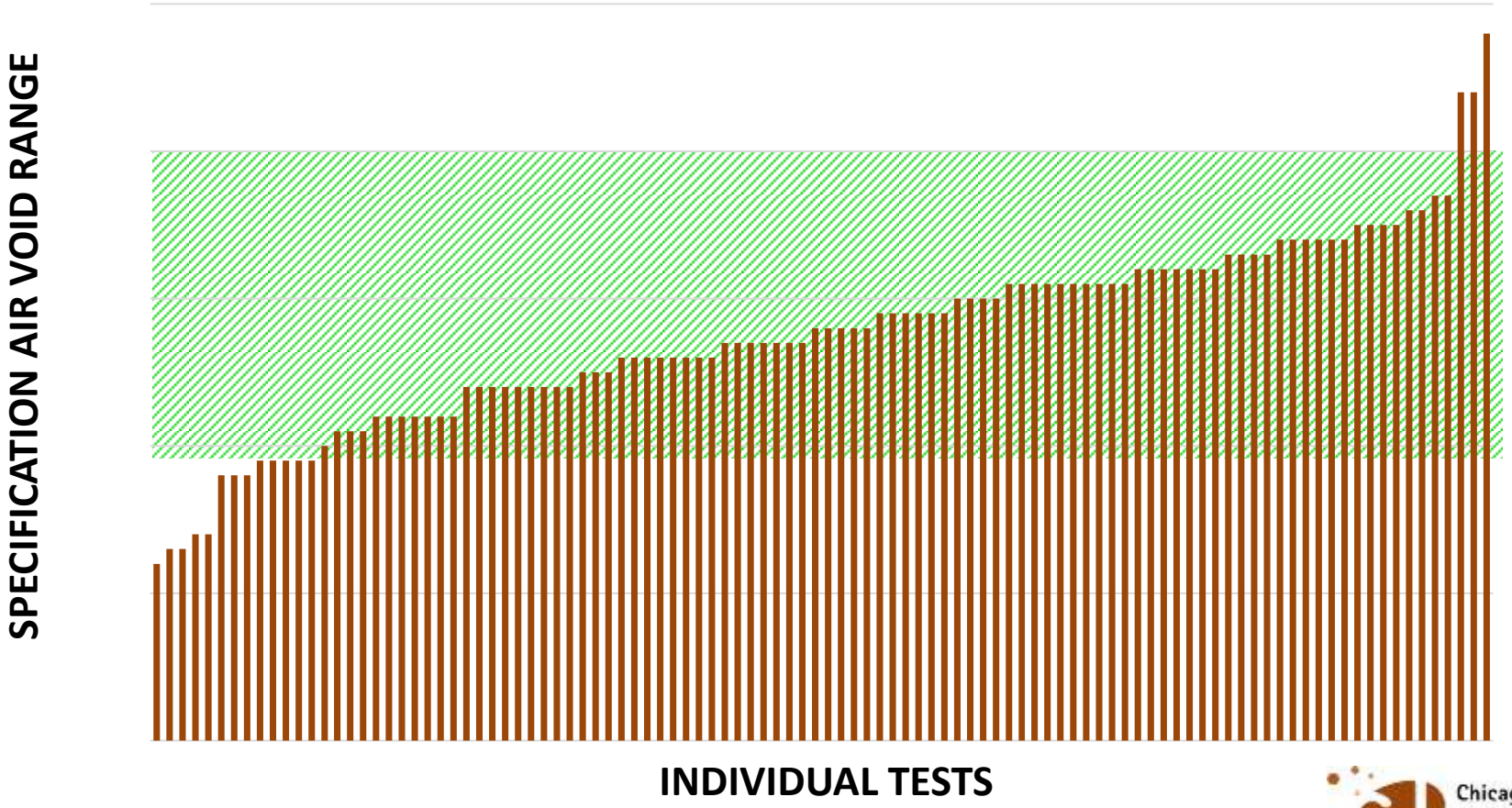
Air Void Control



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Database

- **Over 60 plant mixtures of varying parameters from different plants tested under the I-FIT test method.**

NMAS	N-Design	%ABR	%RAP	%RAS	PG Grade	Total AC Content
4.75-19.0 mm	N30-N90 (SMA)	Virgin-52.1%	Virgin-50.0%	Virgin-5.0%	[PG 58-28]-[PG 70-28]	4.6-8.2%

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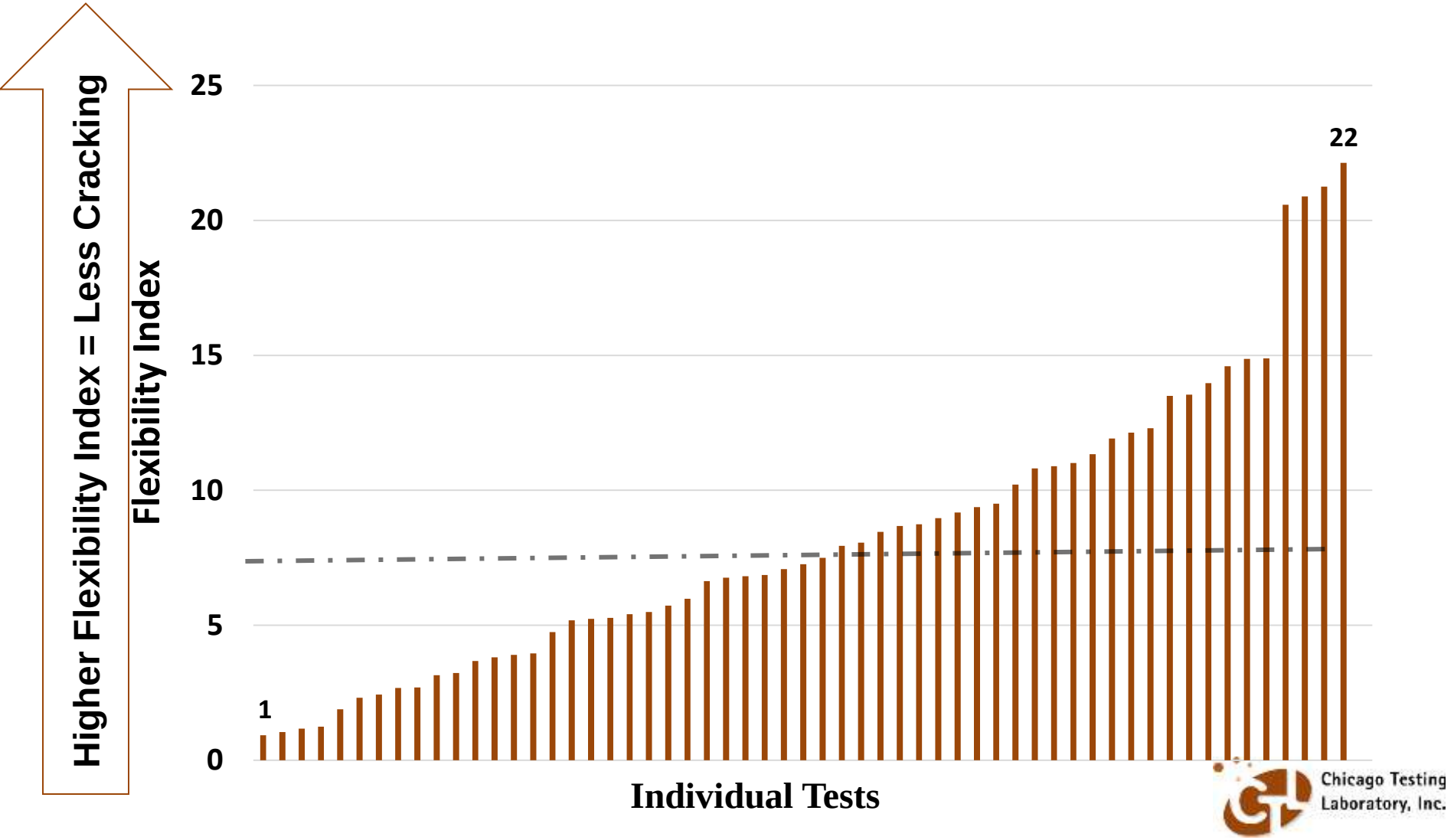
Flexibility Index



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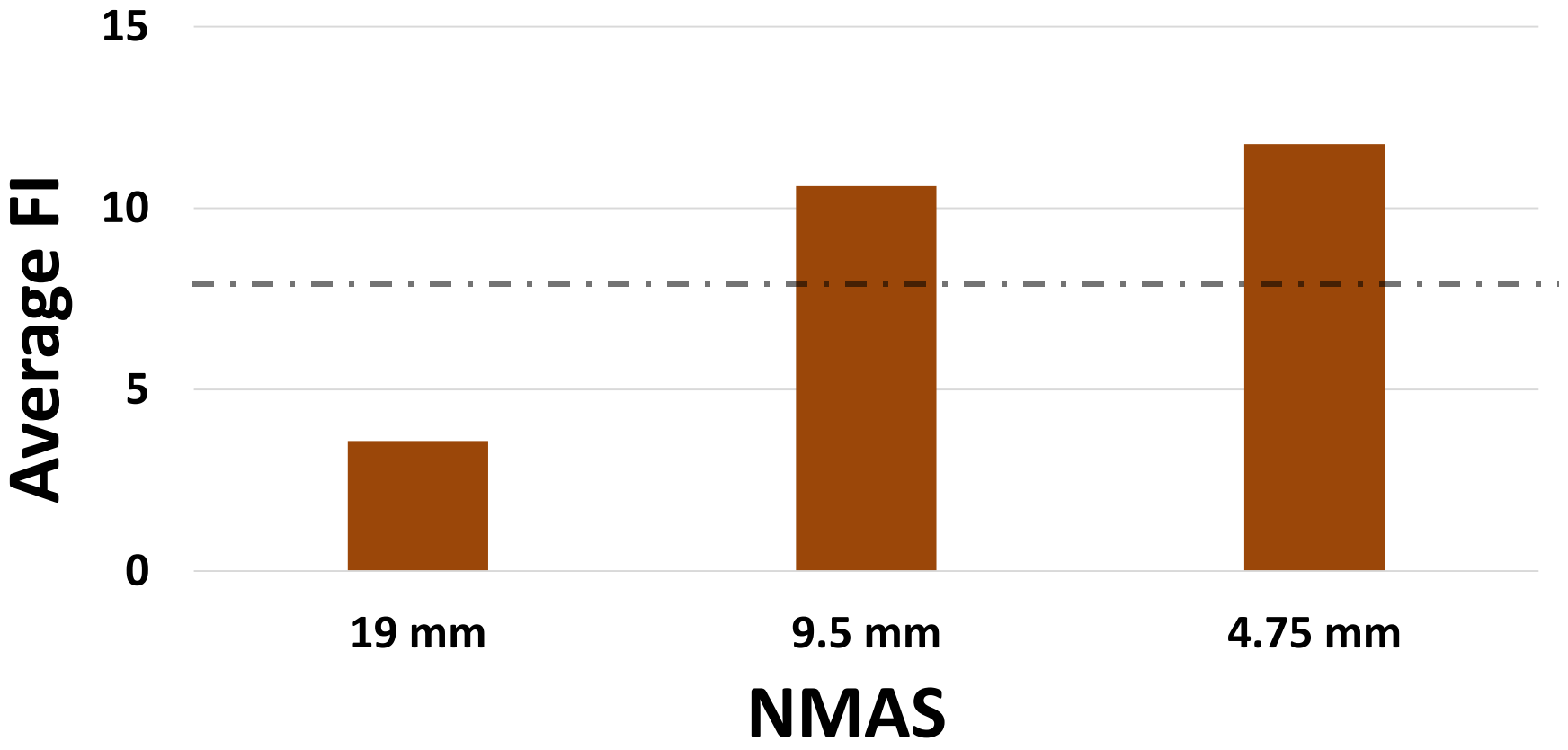
FI vs. NMAS



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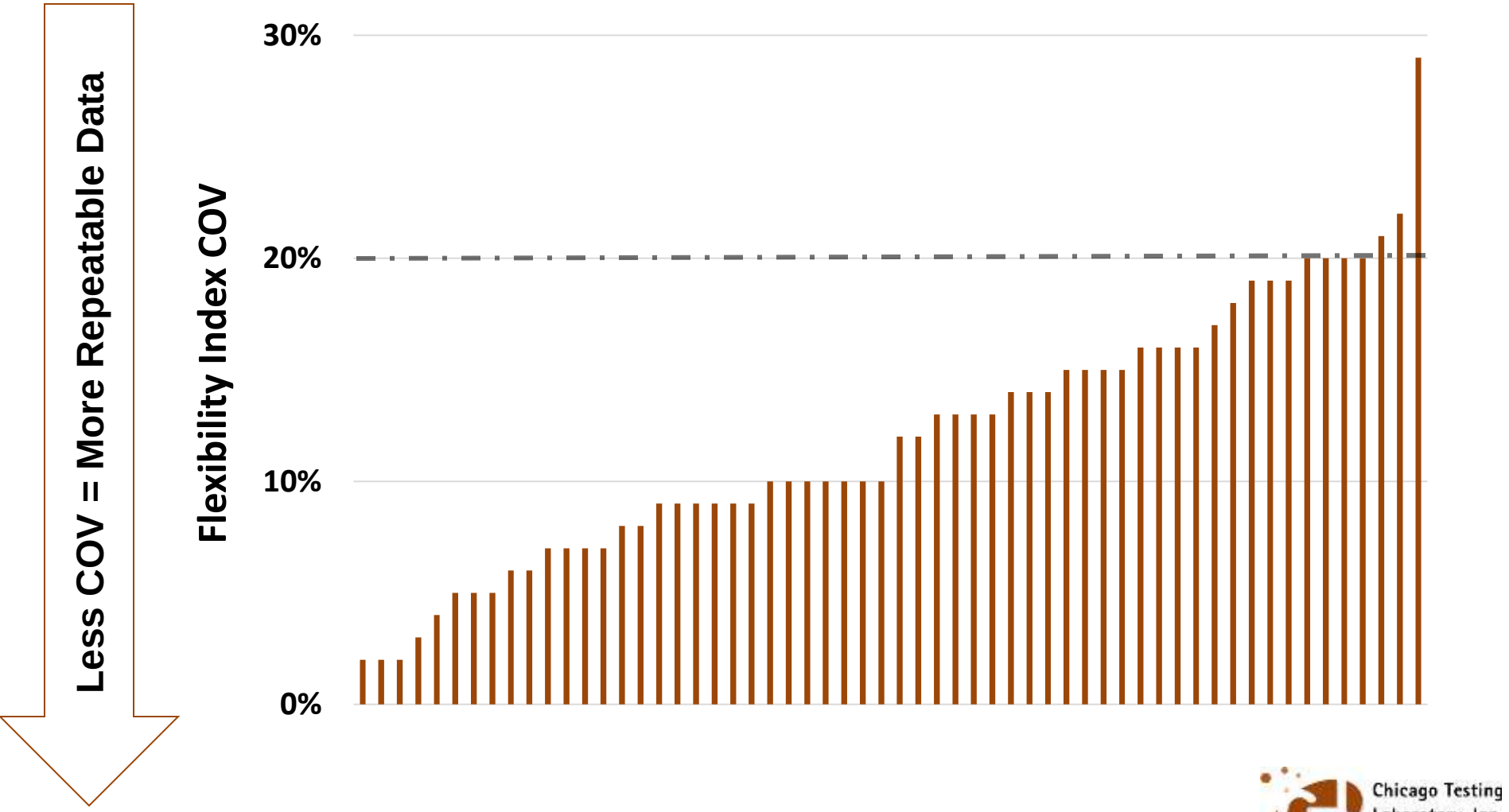
I-FIT FI Repeatability



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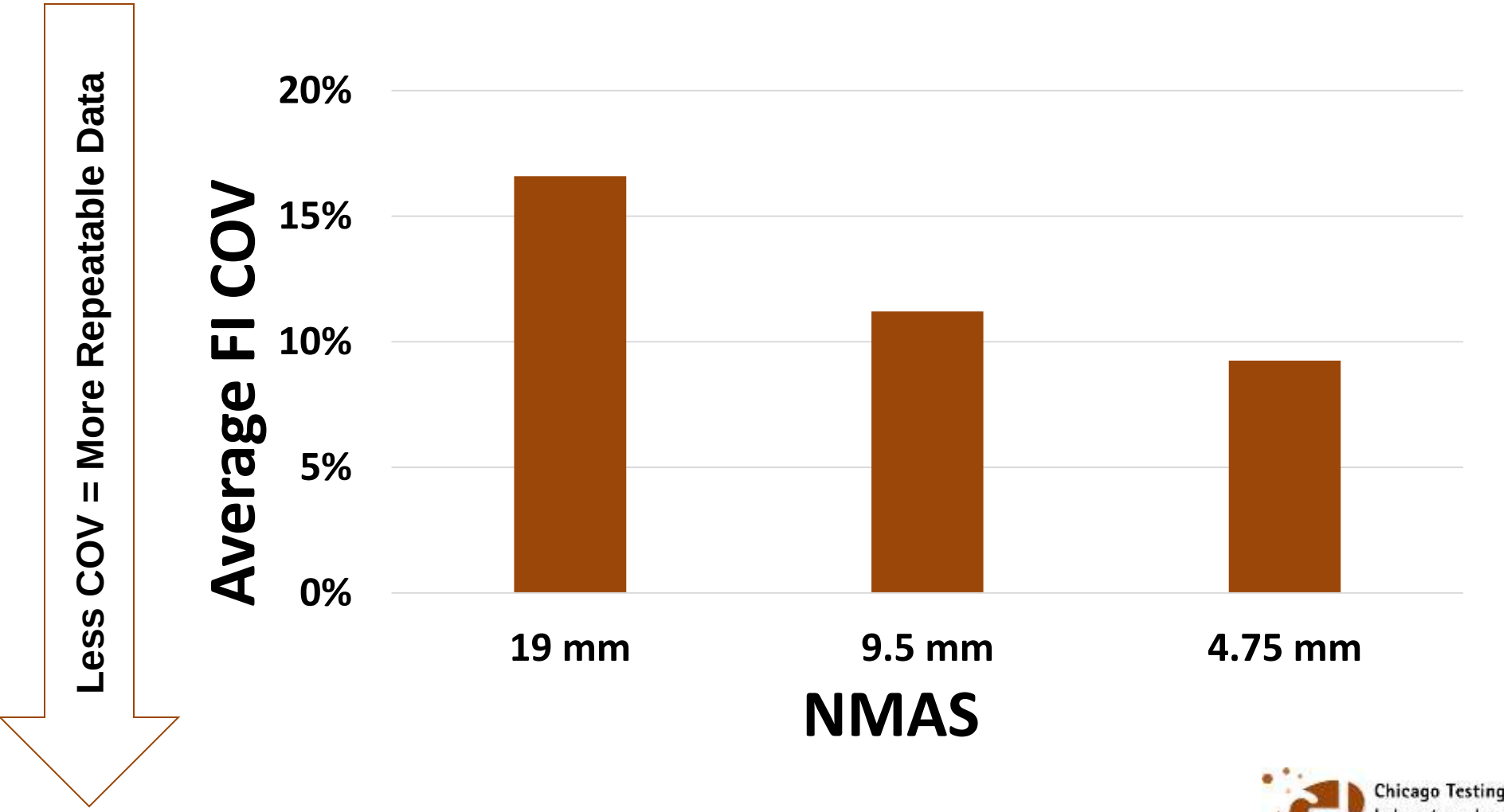
FI COV vs. NMAS



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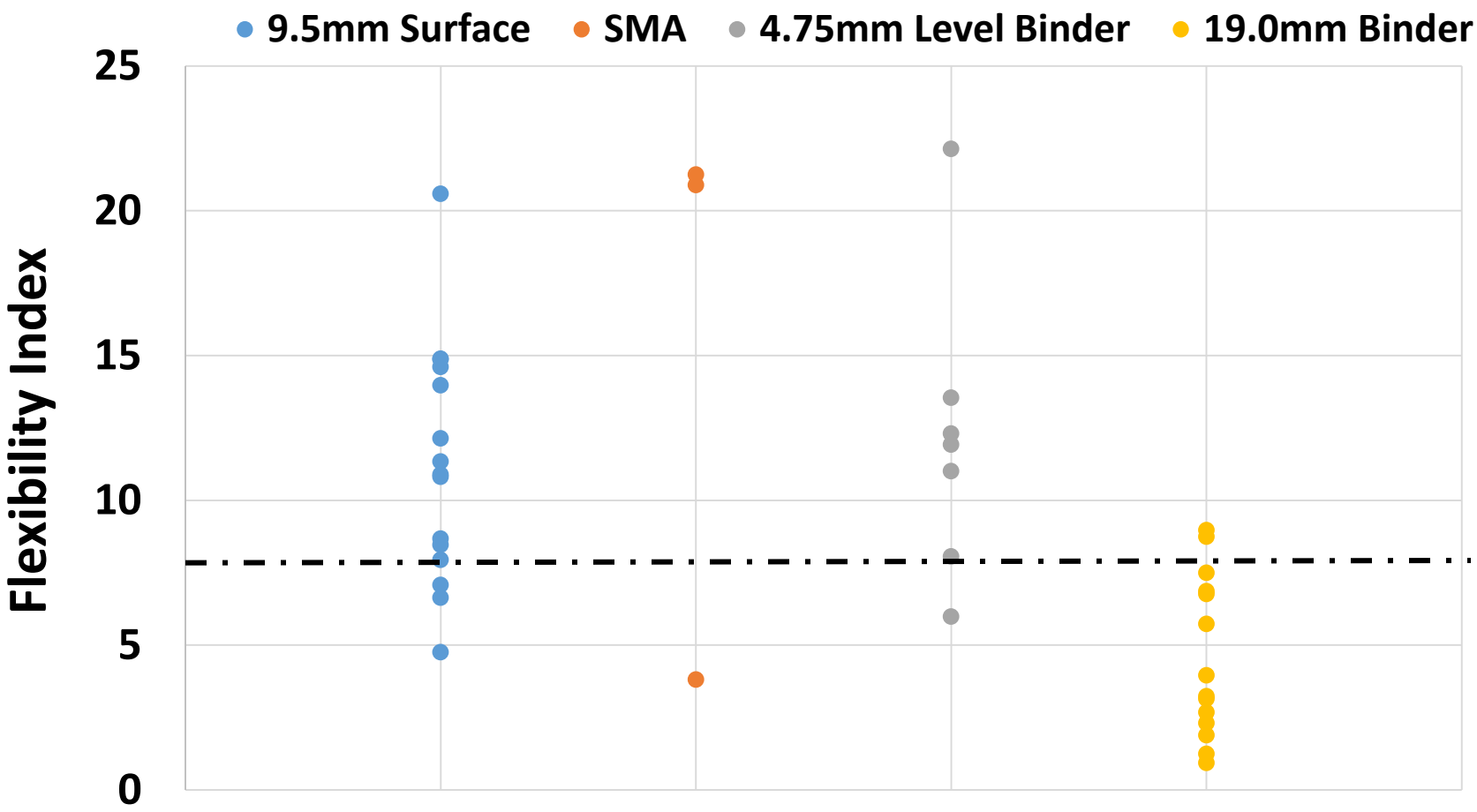
Mix Types vs. Flexibility Index



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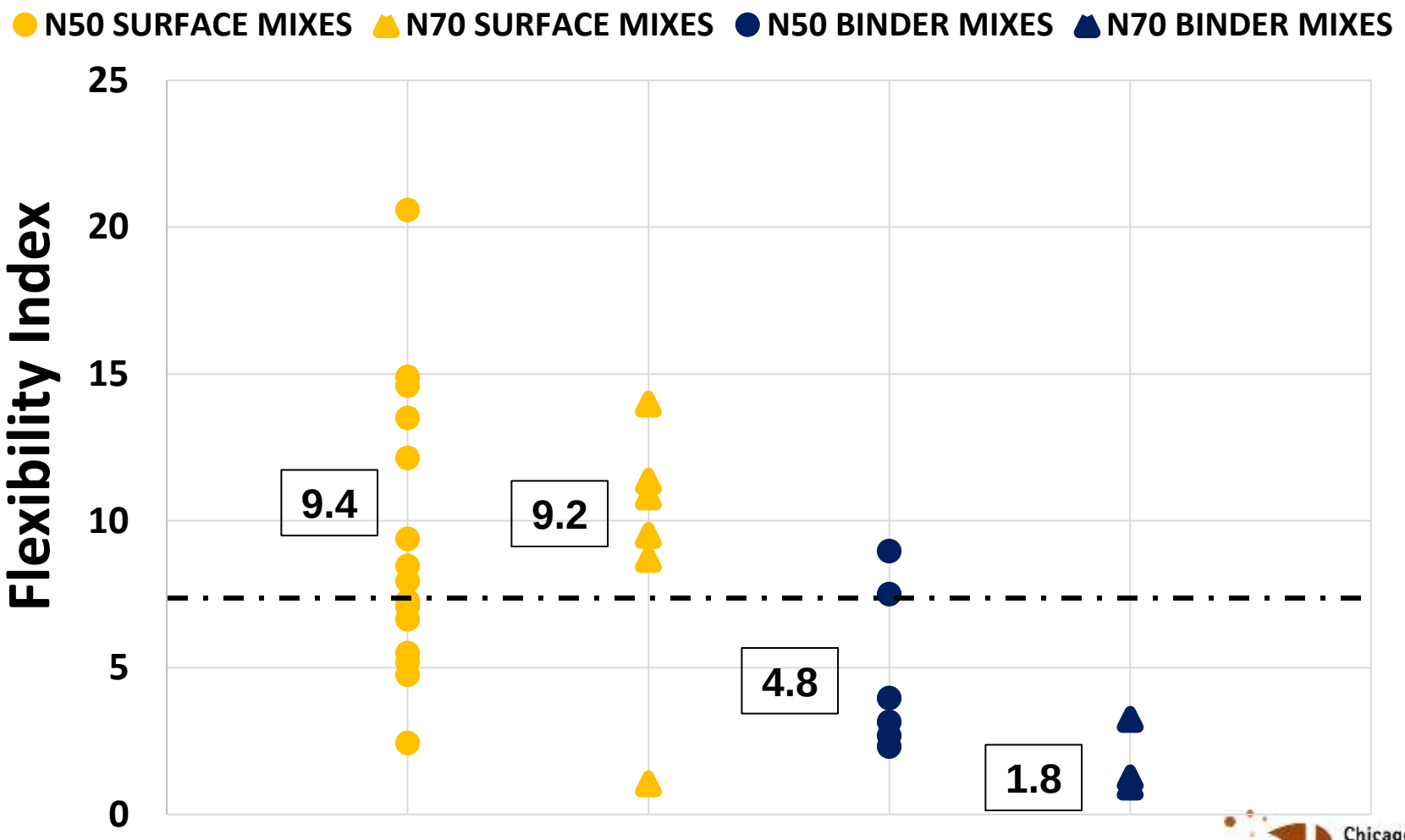
Surface and Binder Mixtures



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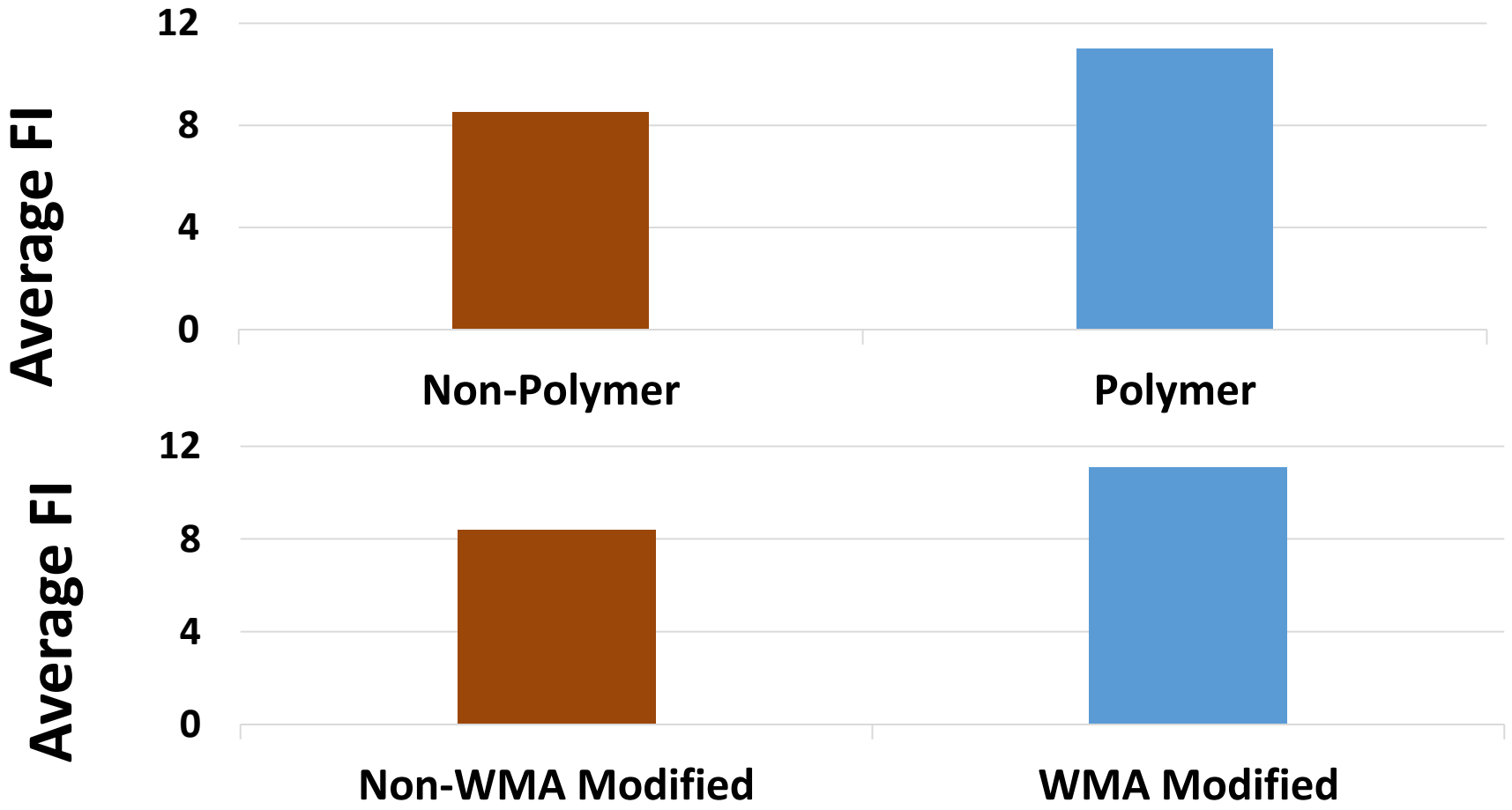
Polymer & Warm Mix Additive Effect



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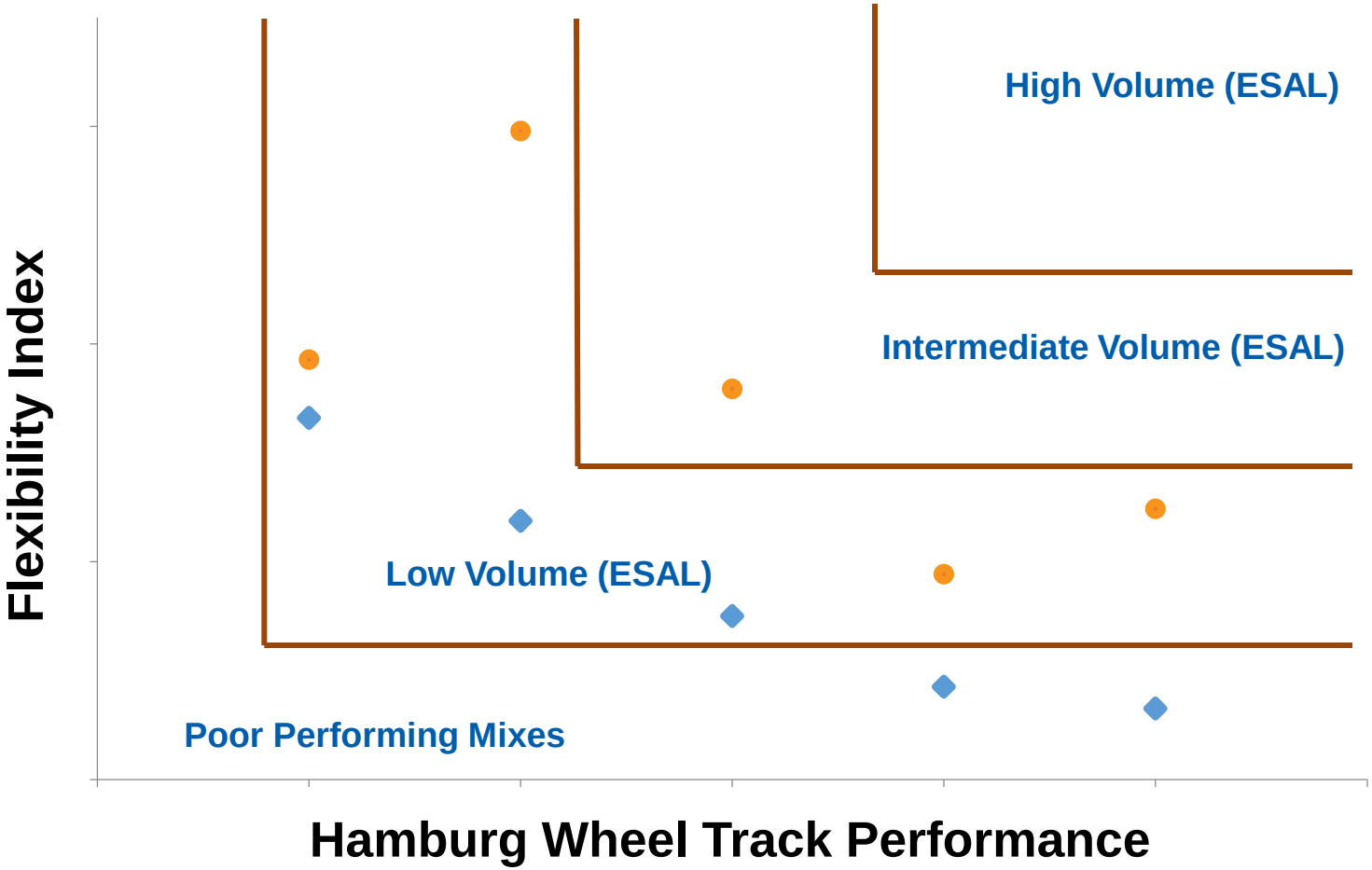
Effect of Warm-Mix Additives



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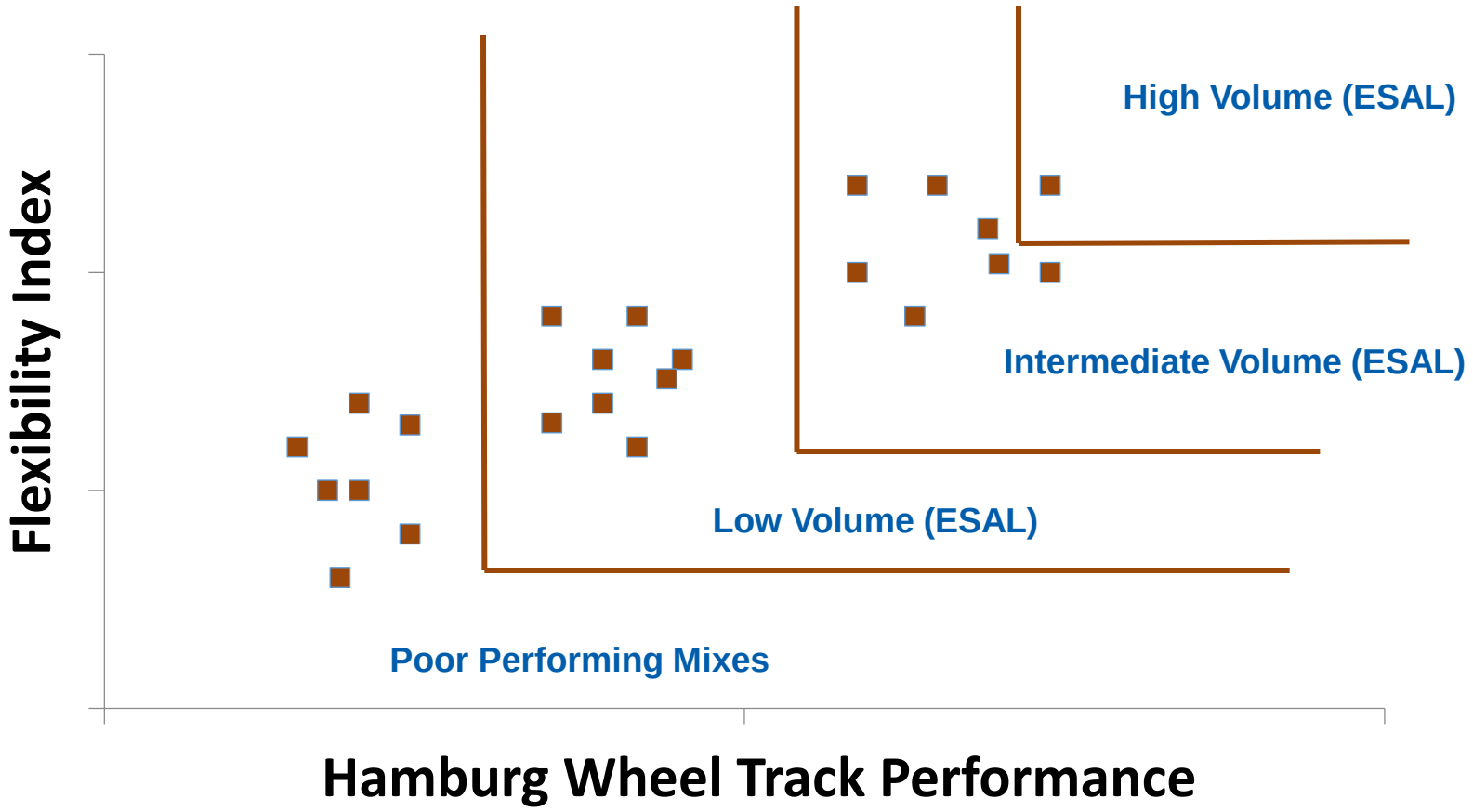
What's the data really telling us?



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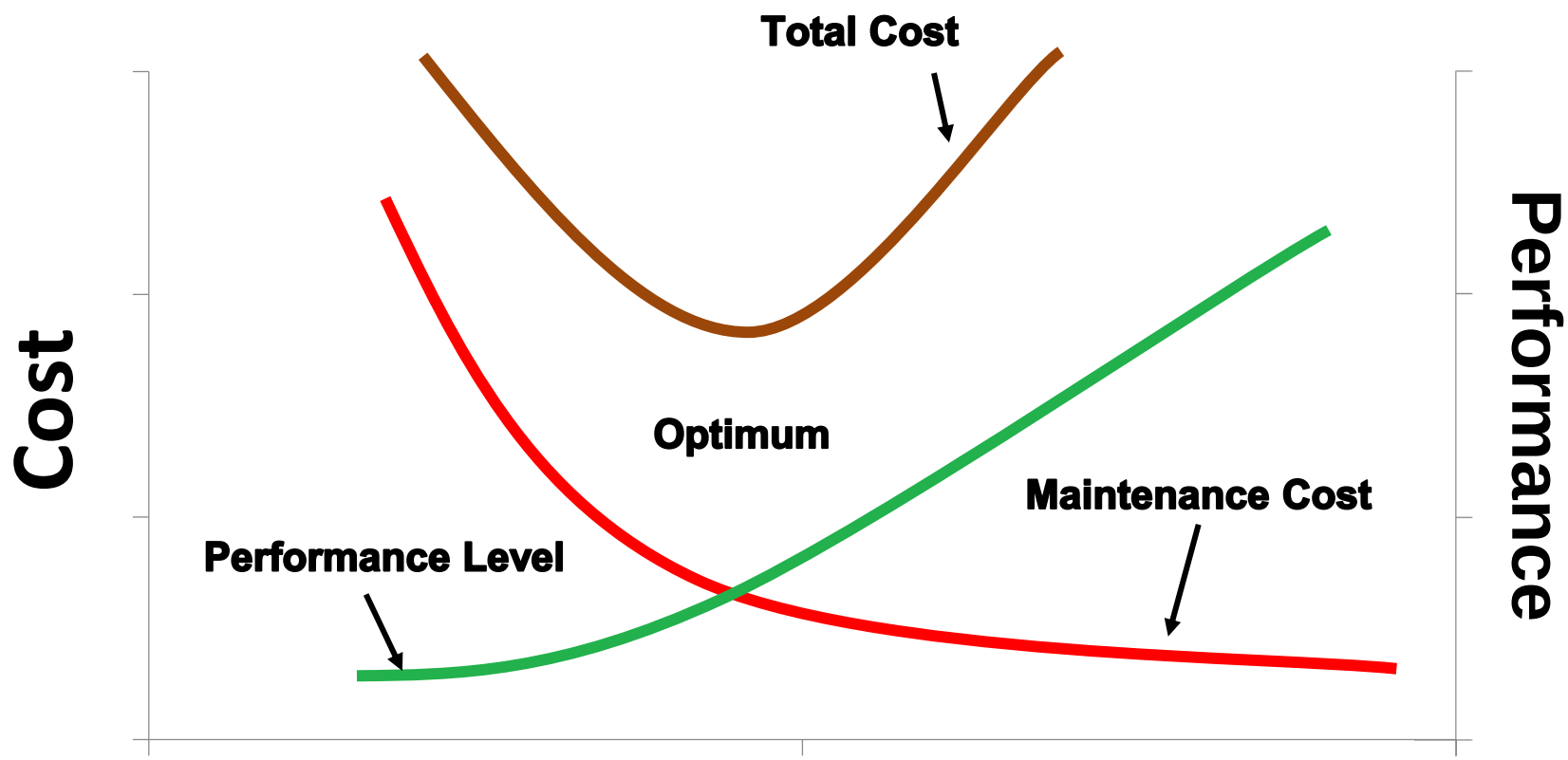
Performance Economics



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Takeaways…

1. Importance of proper testing
    a) Need for a uniformity study across all facilities
        - Consistency of compaction, fabrication, testing, analysis
2. Many mixes meet 8.0 FI criteria
3. Importance of cost-effective design
    1. Multi-tiered approach for FI?

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Thank you

Questions

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