# Evaluation of Laboratory Performance Tests for Fatigue Cracking of Asphalt Pavements

FHWA Cooperative Study at Asphalt Institute

# Project

- Principal Investigator
  - Mike Anderson, Asphalt Institute
- Evaluation of current cracking performance tests

# Background

- Several factors affect fatigue cracking of asphalt pavements:
  - Asphalt, aggregate, and their interactions
  - Pavement structure
  - Material aging, hardening, and embrittlement
  - Traffic and environmental loads
  - Moisture damage
  - Additives, recycles materials
  - Healing and relaxation properties of asphalt

# Background

- Several tests have been developed by different research institutions.
  - Various geometries
  - Various analysis method
  - For different applications
    - Bottom-up cracking
    - Thermal cracking
    - Top-down cracking
    - Reflective cracking

# Objective

- To assist with deployment of a fatigue cracking test that is:
  - Sensitive properties of mix components
  - Sensitive to mixture aging
  - Repeatable and reproducible
  - Easy to implement
  - Practical, low cost

# Plan

- An experimental study to examine various cracking tests
- Evaluate capability of the tests in discerning the factors of interest
- Evaluation on practicality and ease of use

# Primary Factors

- Asphalt grade
- Mix properties
- Load range (test strains/stresses)
- Asphalt aging and hardening
- RAP/RAS content
- Warm-mix additives

# Initial Testing Plan

| Test | Test Temperature | Test Strain / Load Rate |
|---|---|---|
| 4-Point Bending Beam Fatigue | 20°C | 400 & 600 με |
| AMPT Push/Pull Fatigue (S-VECD) | 19°C | TBD |
| Indirect Tensile Strength (IDT) | 25°C & 4°C | 12.5 mm/min |
| Disk-Shaped Compact Tension [DC(t)] | -12°C | 1 mm/min |
| Texas Overlay | 25°C | TBD |
| Dissipated Creep Strain Energy (DSCE) | TBD | Standard Methods |
| Semi-Circular Bending (SCB) | 25°C | 0.5 mm/min |

# Phase 1 Testing Plan

- Lab Standard Mix

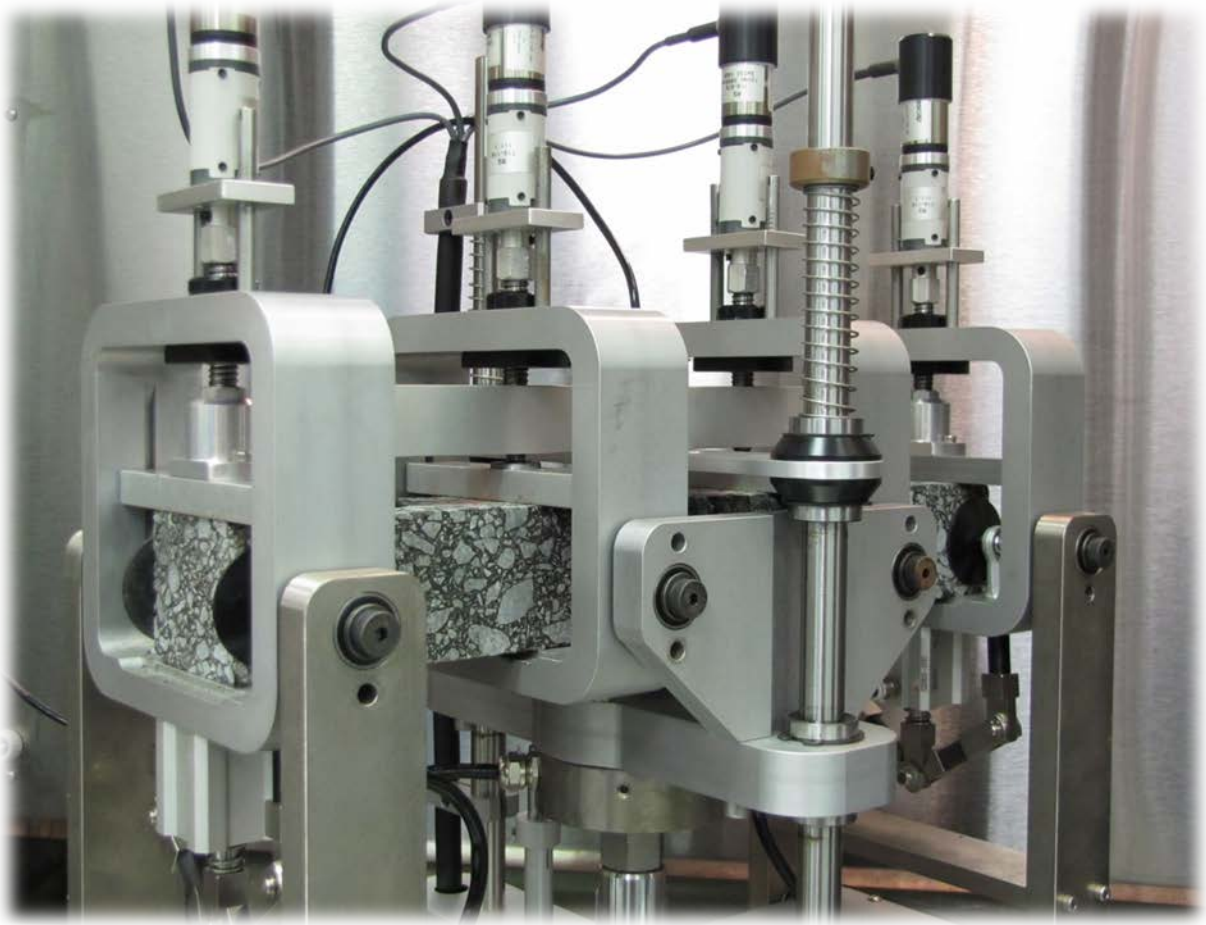
- Aging:
  - 4-hour loose mix aging at 135°C
  - 24-hour loose mix aging at 135°C

# Why 24 Hour Loose Mix Aging

- Buttlar work in IL
- AAPTP non-load associated cracking study
- KY RAP/ RAS study

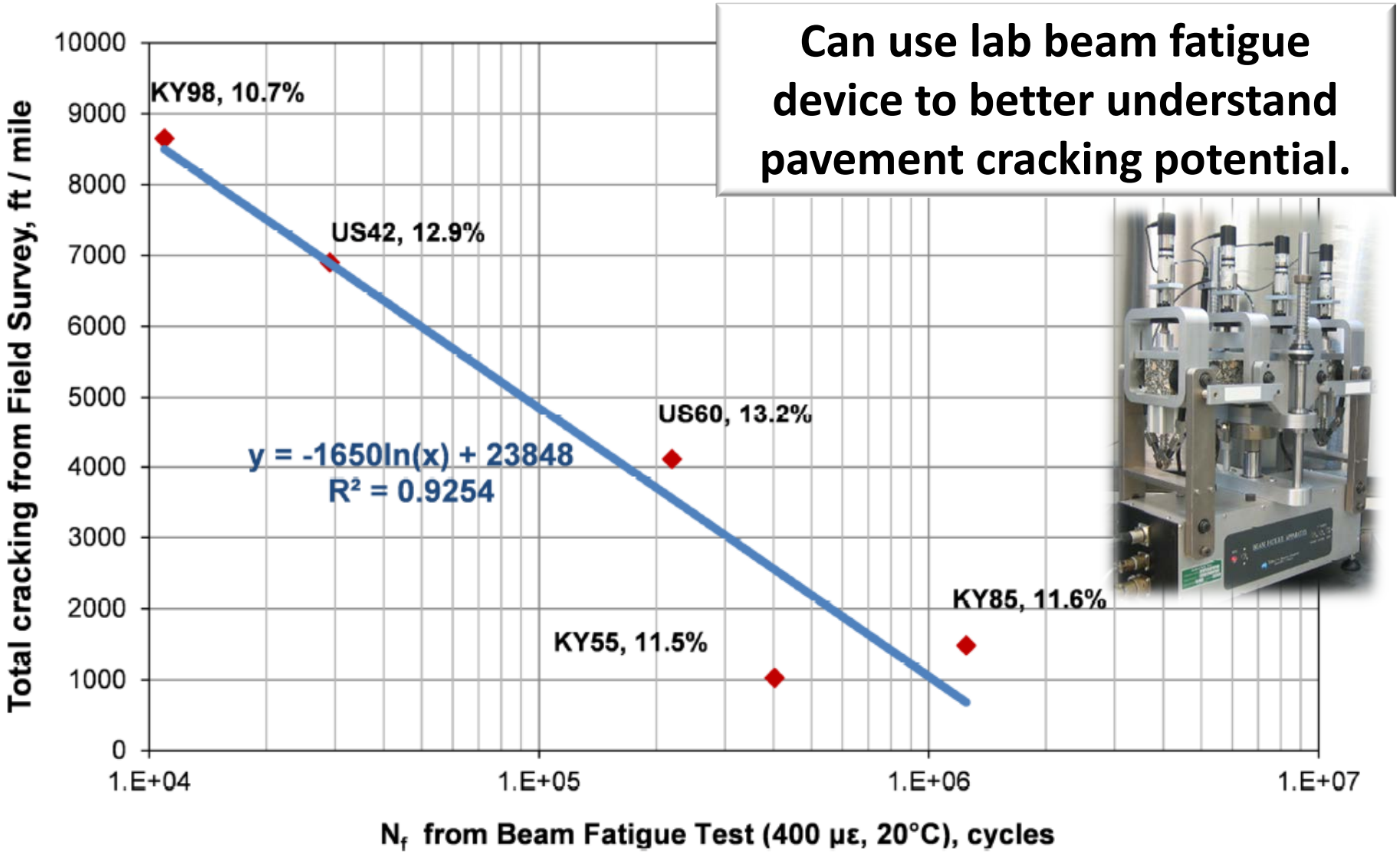
# 4-Point Bending Beam Fatigue

4-point bending beam fatigue (1950's / SHRP)

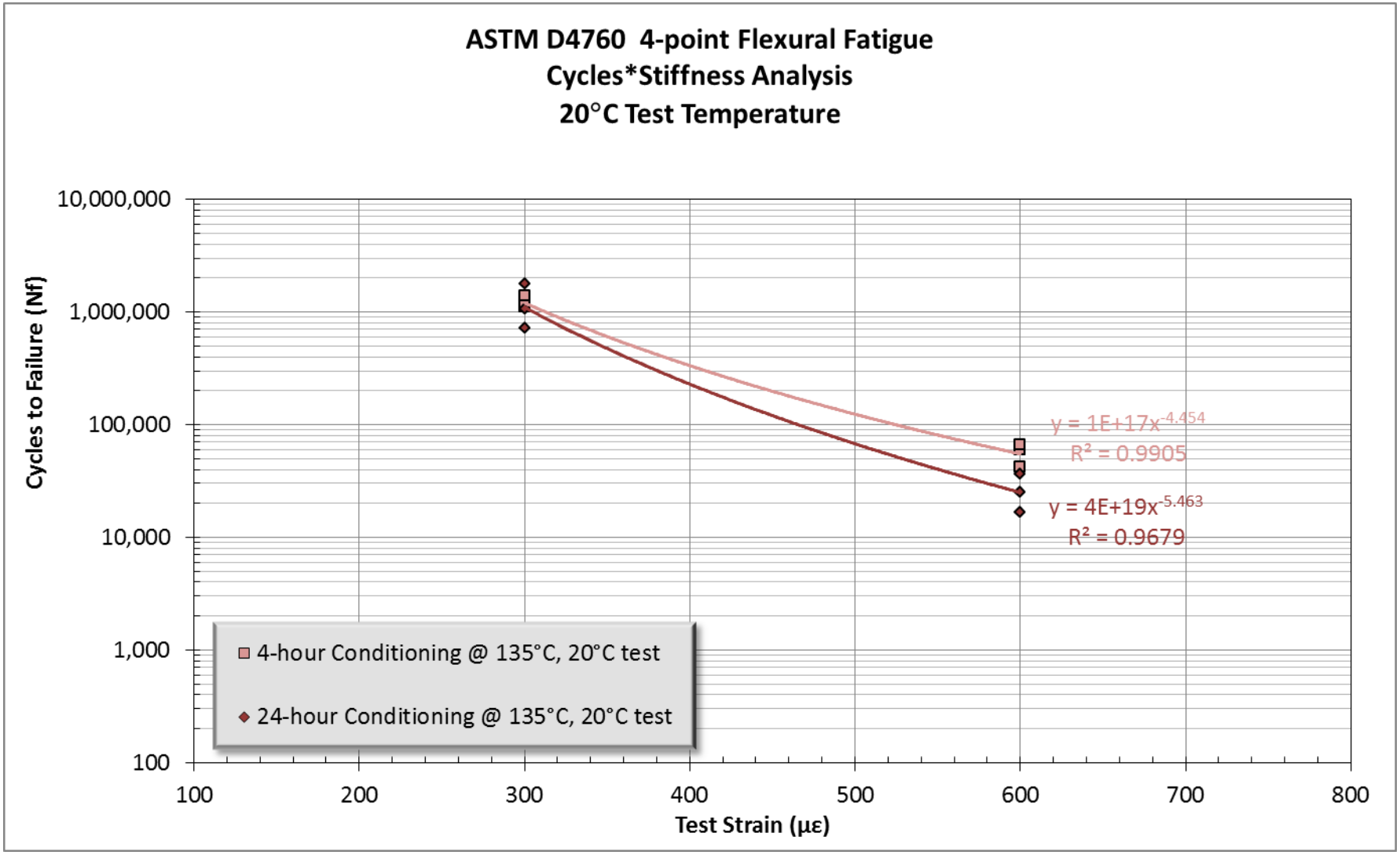


# KY Density Study Findings

## Density Matters



# Beam Fatigue



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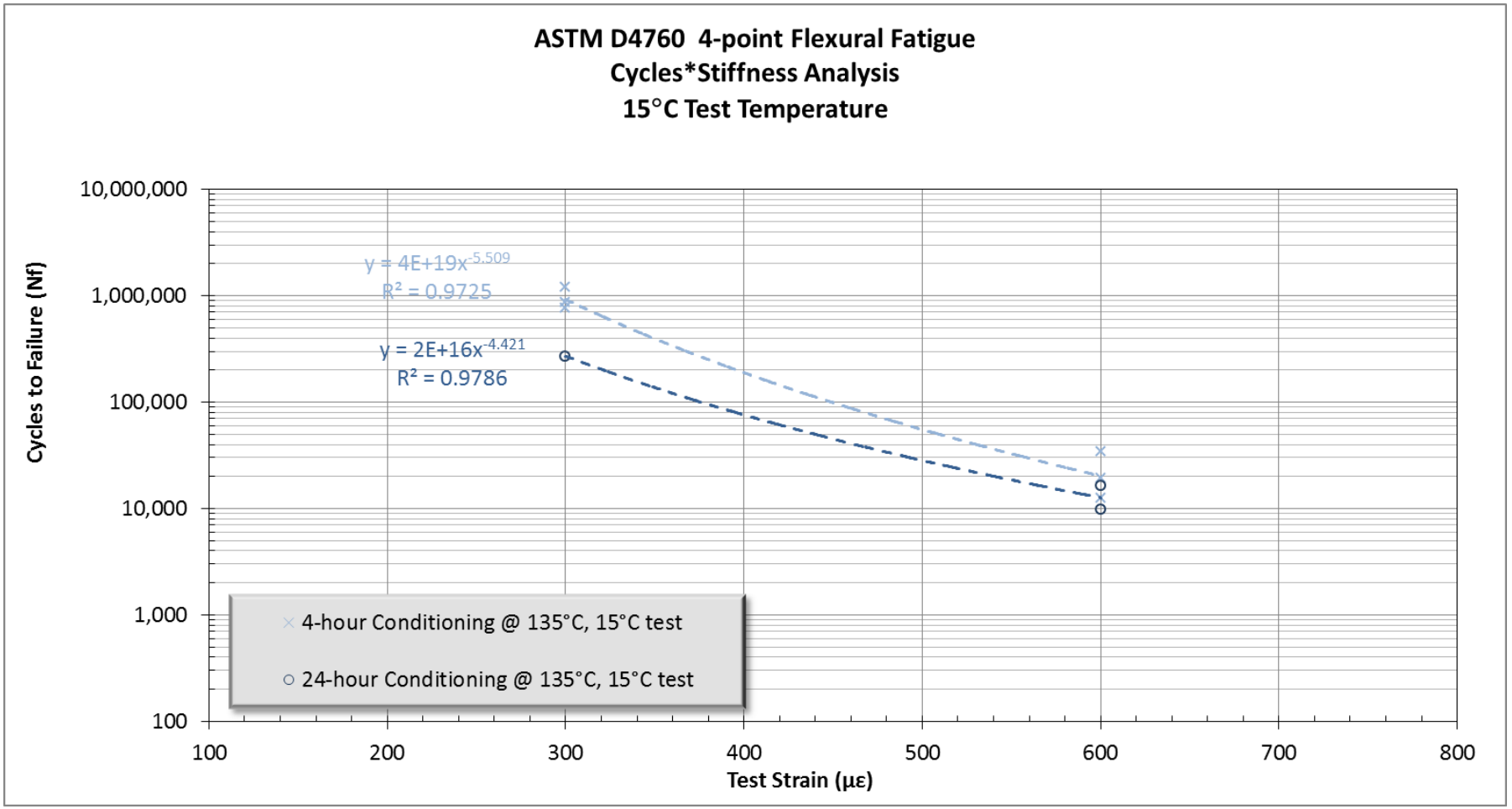

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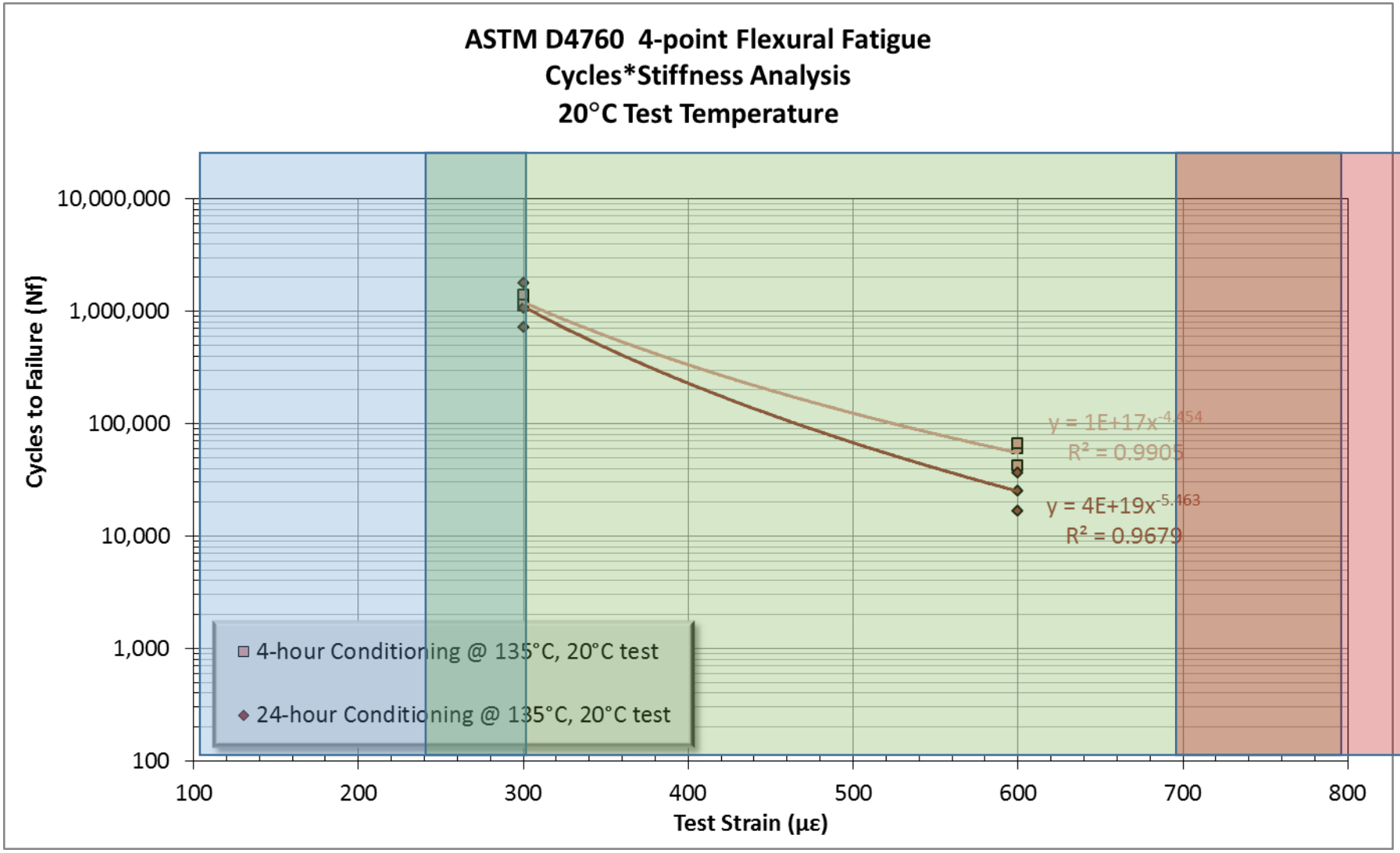

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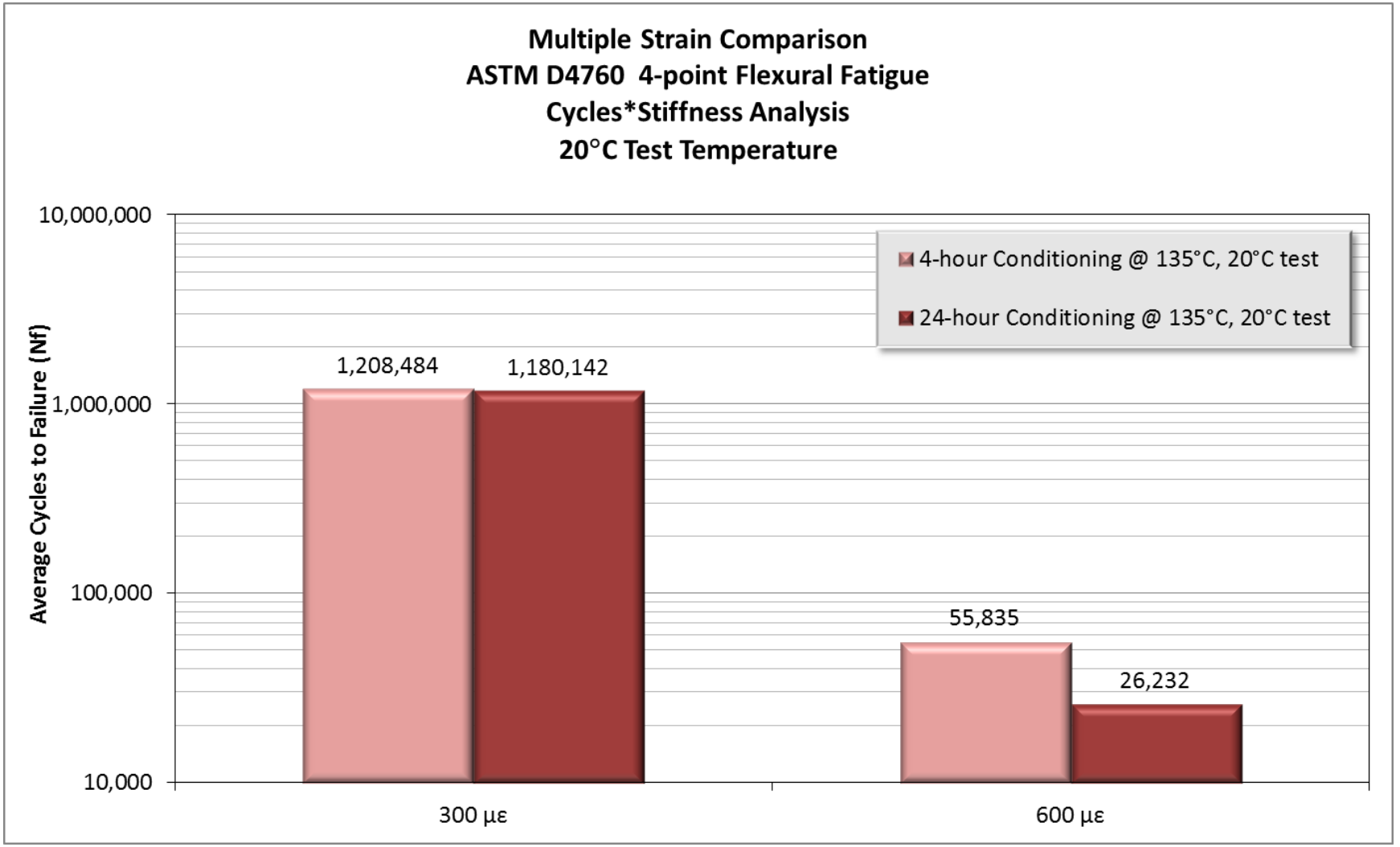

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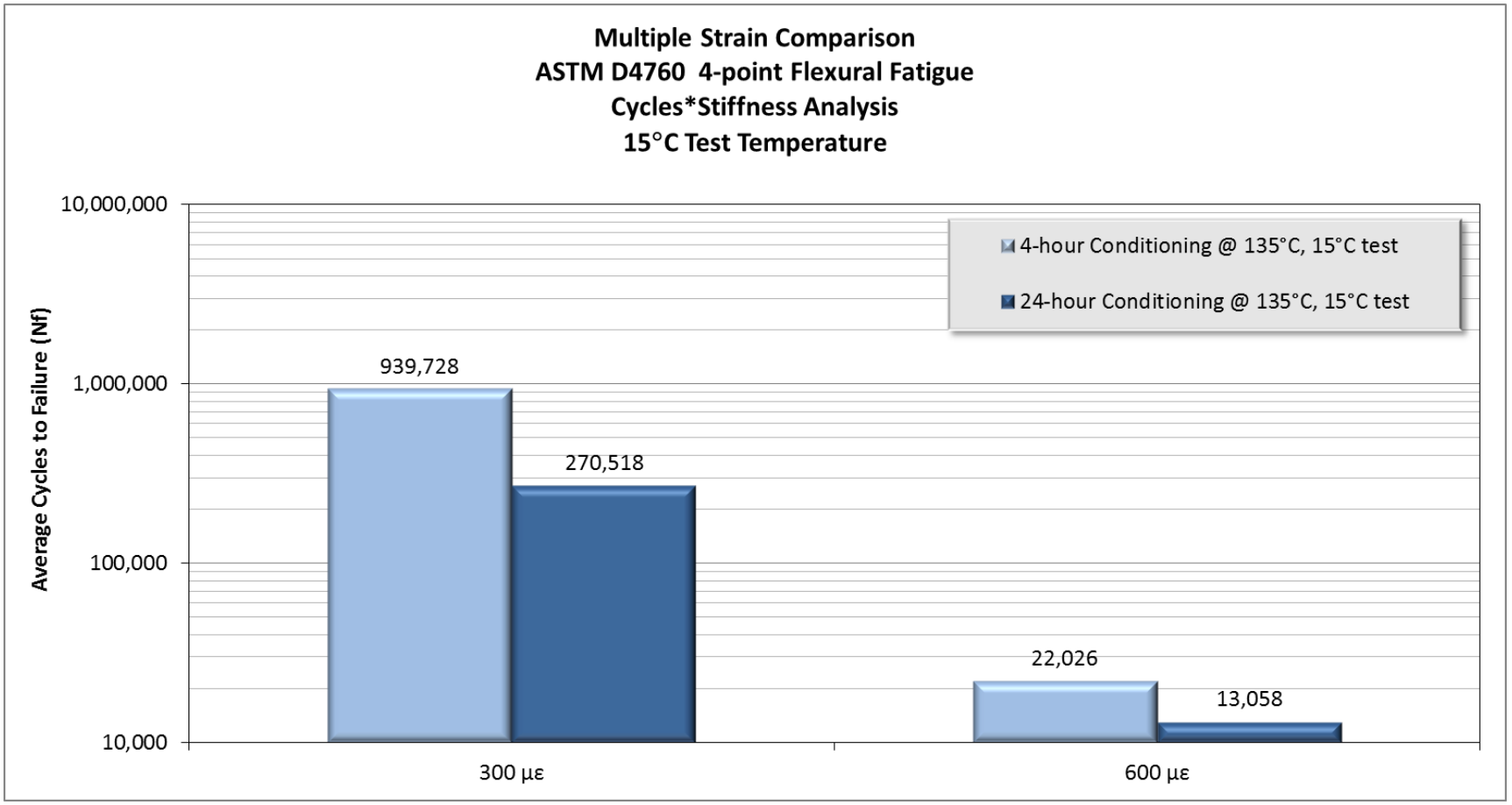
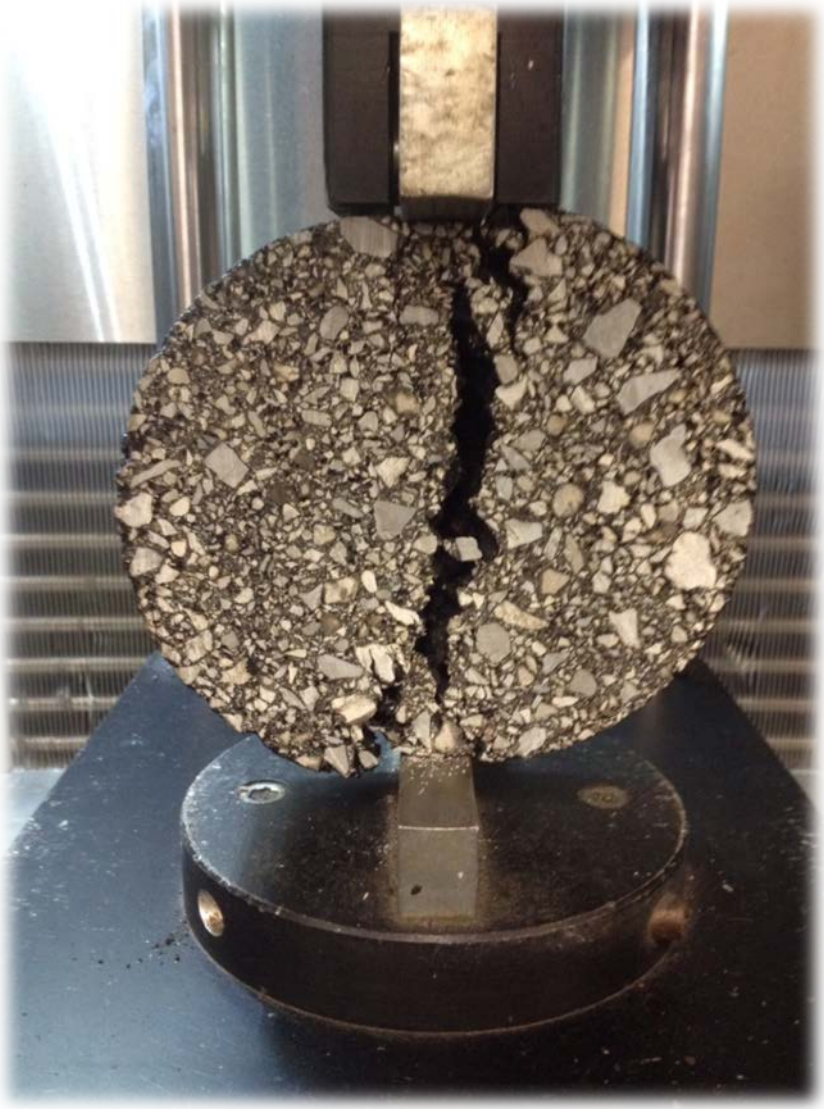


# AMPT Push/Pull Fatigue (S-VECD)

# Indirect Tensile Strength (IDT)

- **ASTM D 6931**
- **Related AASHTO T322**

- **Rate of Movement: 12.5 mm/min**



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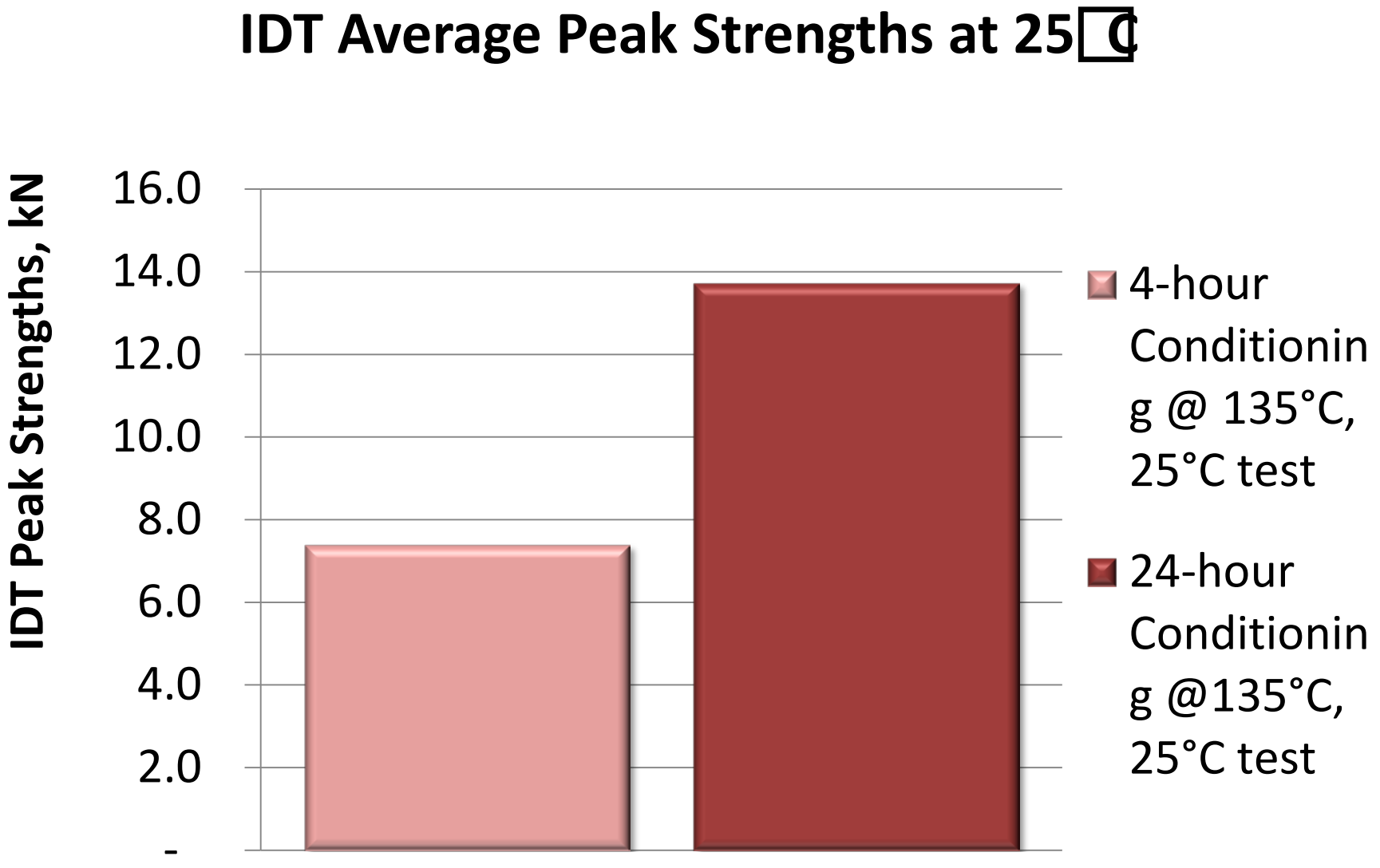

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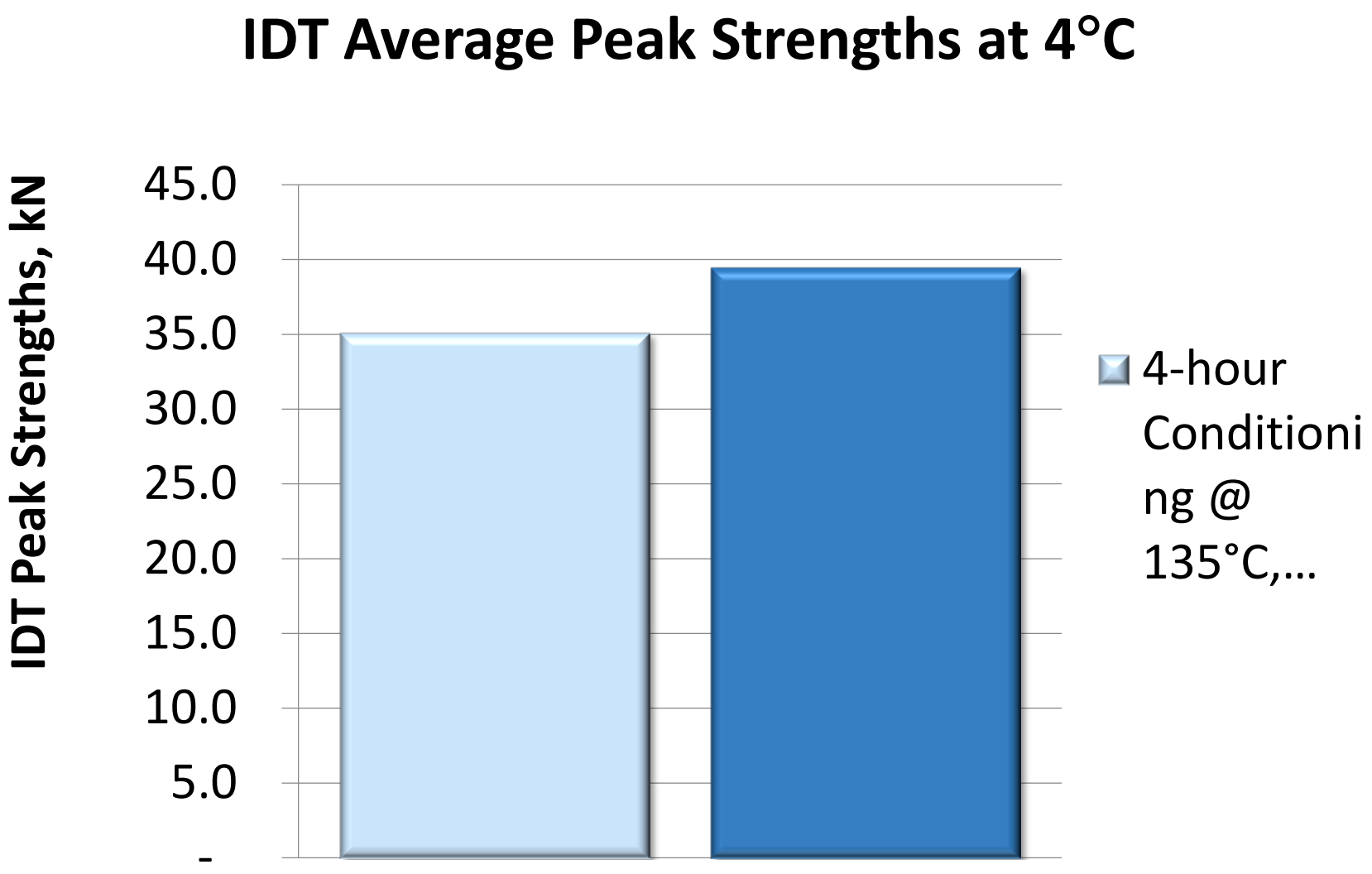
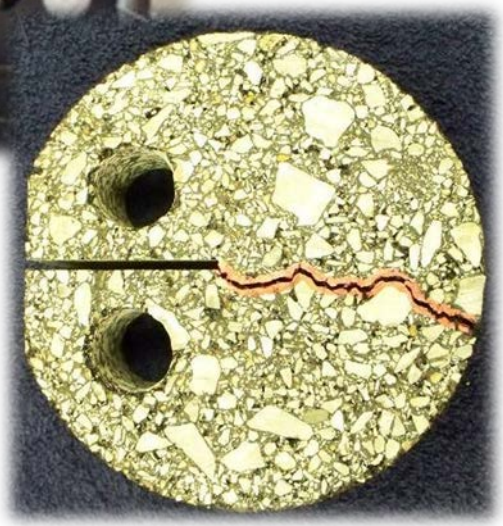


# Disk-Shaped Compact Tension [DC(t)]

- **ASTM D 7313**
- **Rate of Movement: 1 mm/min**



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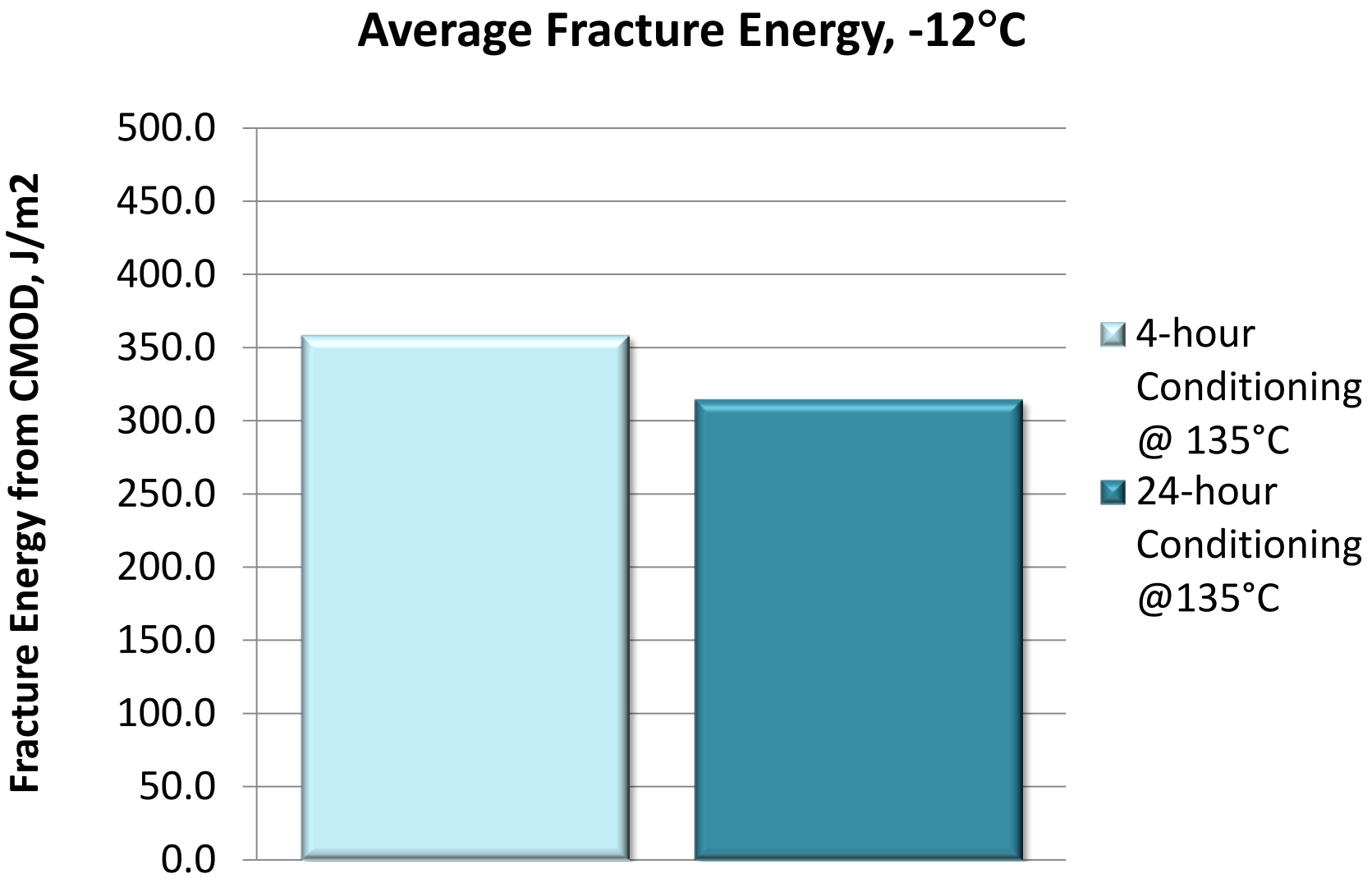
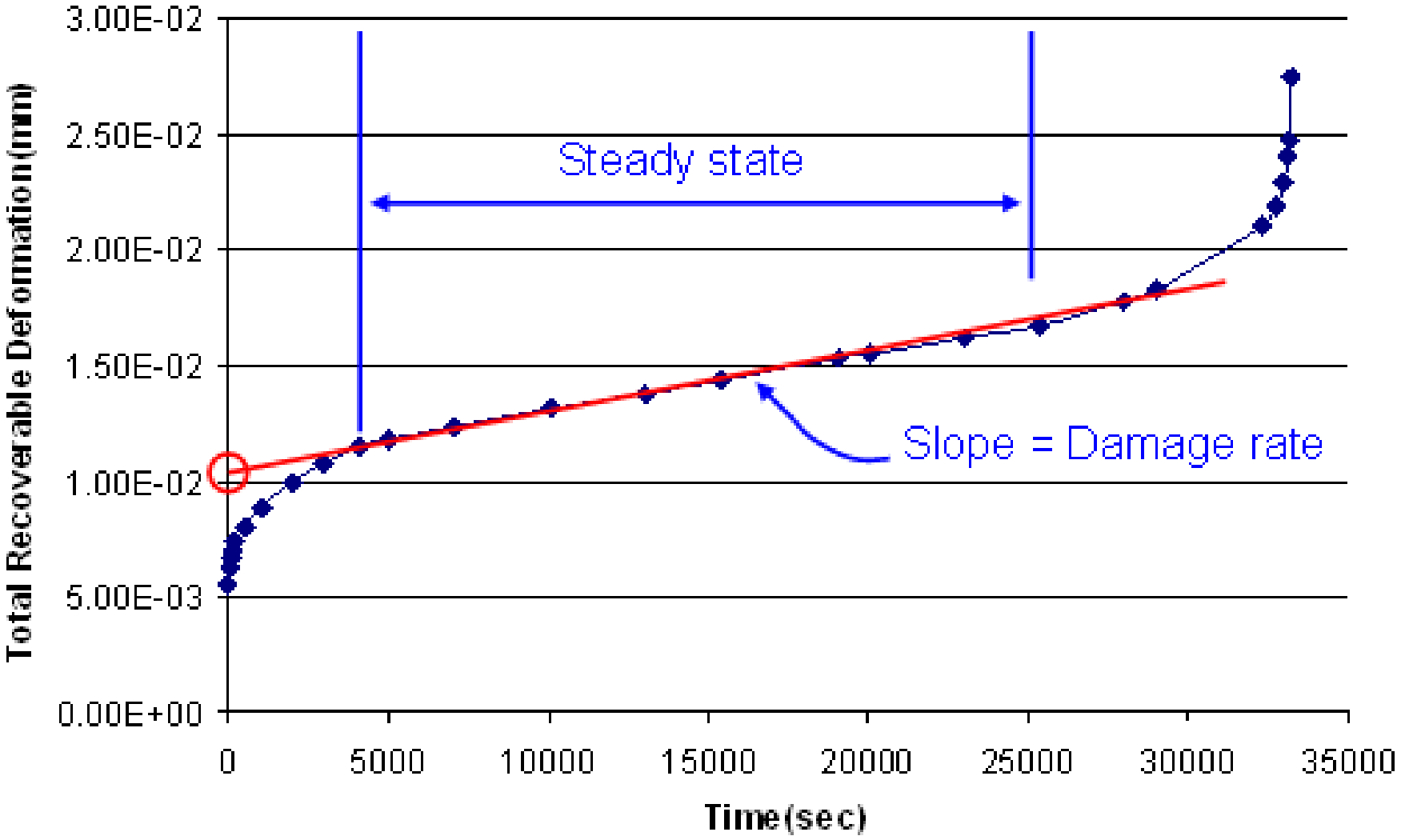


# Texas Overlay

# Dissipated Creep Strain Energy (DSCE)



# Semi-Circular Bending (SCB)


# Test Summary

**0-easy, 5-difficult**

| Test | Cost – saw/coring not included | Sample Prep. | Perform Test | Data Analysis | Speed of Test (3x)-conditioning not included | Sensitive to Aged (24hr) vs. Unaged (4hr) Samples |
|---|---|---|---|---|---|---|
| 4-Point Bending Beam Fatigue | $50,000 | 3-trim 4x | 2 | 2-normalized cycles | 3-24 hours | |
| AMPT Push/Pull Fatigue (S-VECD) | $10,000 to $15,000 to upgrade | 5-trim 2x, core, glue | 5 | 5-specialized software | | |
| Indirect Tensile Strength (IDT) | 0 – could use TSR device at 25°C | 1-trim 1x | 1 | 1-direct reading | 10 min. | |
| Disk-Shaped Compact Tension [DC(t)] | $ to upgrade AMPT | 5-trim 2x, cut, core (2 samples) | 2 | 3-area under curve | 30 min | |
| Texas Overlay | $ to up to upgrade AMPT | 1-trim 1x | 2 | 1-cycles to failure | | |
| Dissipated Creep Strain Energy (DSCE) | ? | | | | | |
| Semi-Circular Bending (SCB) | & to upgrade AMPT | 2-trim 2x | 2 | 3-area under curve | | |

# Conclusions

- None at this time

# Phase 1 Test Plan

- Test devices: 7
- Binder:
  - PG 64-22
- Aggregates:
  - Virgin mix
  - 9.5 mm NMAS, dense mix
- Aging:
  - 4-hour loose mix aging at 135°C
  - 24-hour loose mix aging at 135°C

# Phase 2 Test Plan

- Test devices: 7
- Binder:
  - PG 64-22, 76-22, 58-34
- Aggregates:
  - Virgin mix, RAP/RAS
  - 9.5 mm NMAS, dense mix; 12.5mm
- Aging:
  - 4-hour loose mix aging at 135°C
  - 24-hour loose mix aging at 135°C

# Phase 2 Test Plan

- Other suggestions from Mix ETG:
  - Add ALF mixture to validate
  - Possible DOT mixtures

# Thank you