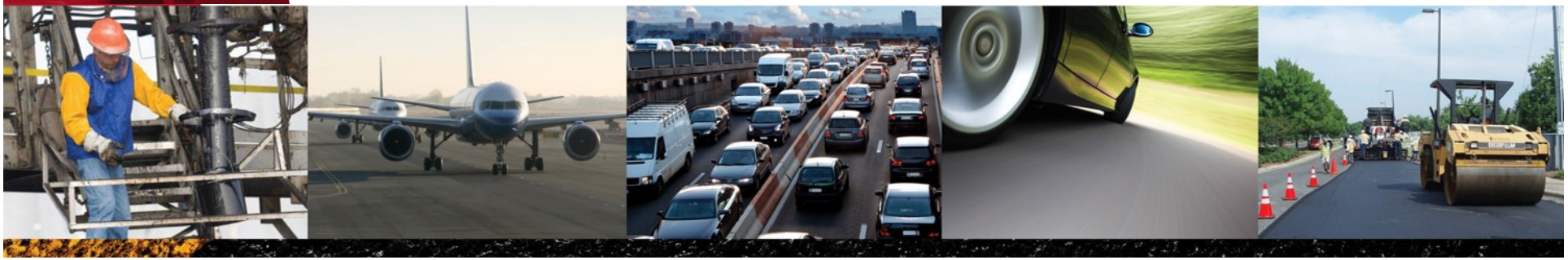
# StellarFlex GTRH

## Route 14 Milford, DE

Bruce Rideout
Senior Technical Services Manager



# Outline

- Project Background
- What is Ground Tire Rubber (GTR)?
- Types of GTR
  - Dry Process
  - Wet Process
  - Terminal Blended
  - GTR Hybrid (GTRH)
- GTRH Projects
- GTRH Mix Performance Testing

# Project Background

- Delaware Route 14
- Mill and Overlay
- Advertised as Asphalt Rubber
  - AKA The “wet process”
- Contractor:  Allan Myers

**The Proposal**:  In lieu of the blending Asphalt Rubber onsite, to supply a terminally blended GTRH.

# Ground Tire Rubber

- Ground Tire Rubber (GTR) can contain a wide range of polymers
  - Natural rubber
  - Styrene Butadiene Rubber (SBR)
  - Polybutadiene
- GTR also contains non-polymer ingredients
  - Carbon black
  - Silica
- Average automobile tire = 22lbs
  - 20lbs rubber
  - 2lbs metal and fabric
  - Data from Waste Recovery Inc.

# Ground Tire Rubber

- GTR contains polymers that have been locked-up by vulcanization
- Much of the GTR polymer is not available to create a network in the asphalt
- GTR imparts elastomeric properties to asphalt binder by adding discrete rubber particles

# Ground Tire Rubber

- Types of GTR asphalt products
  - Dry Process – “Plus Ride”
    - Add GTR into asphalt plant as an aggregate
    - Filler more than modifier

# Ground Tire Rubber

- Asphalt Rubber (ASTM D-6114) – Wet Process
  - 15-20% GTR added to asphalt in processing unit at the asphalt plant
  - GTR particles absorb light hydrocarbons and swell
  - After swelling, asphalt rubber is used immediately
  - Adequate agitation is necessary
  - Amount of discrete rubber particles requires room in an asphalt mix
    - Used in open graded and gap-graded mixes
    - **Cannot** be used in dense graded mixes

# Ground Tire Rubber

- Types of GTR asphalt products
  - Terminal Blended GTR Modified Asphalt
    - Add GTR into asphalt at a terminal facility
    - Processing techniques and/or additives help stabilize the product
    - Adequate agitation at asphalt plant is suggested
  - Hybrid GTR Binder
    - Terminal blended GTR modified asphalt may add polymer and/or other additives
    - Polymer network helps to hold rubber particles in suspension
    - Adequate agitation at asphalt plant is suggested
- GTR modified asphalt products typically require agitation to prevent separation

# StellarFlex GTRH

- StellarFlex GTRH is a Ground Tire Rubber Hybrid asphalt binder produced with chemically-treated GTR and SBS polymer
- Formulated to meet PG 76-22 and PG 64E-22 specifications
- GTR content at least 50% more than SBS content

# StellarFlex GTRH

- Results indicate StellarFlex GTRH is a very stable product not requiring agitation
- Viscosity and workability similar to SBS modified PG 76-22

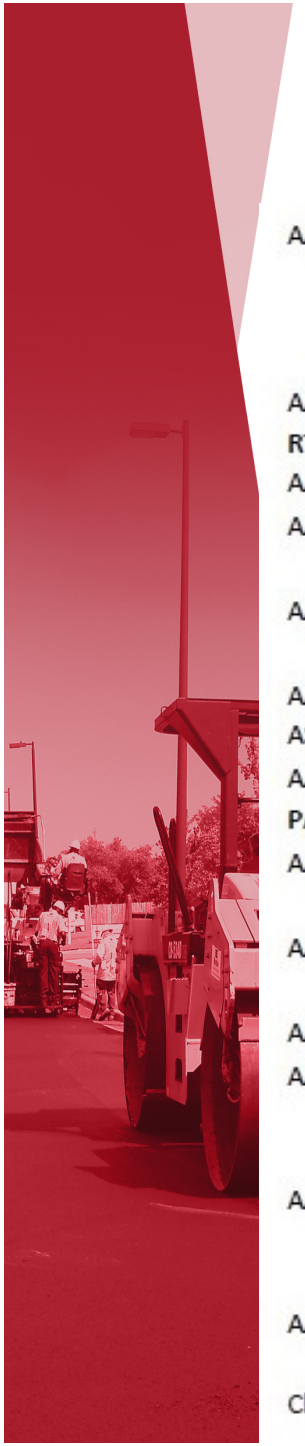
# StellarFlex GTRH

**Certificate of Analysis**

axeon Specialty Products

| | | | |
|---|---|---|---|
| Supplier: | Axeon Specialty Products, LLC | | Phone: 856-579-5109 |
| Terminal: | Axeon Specialty Products, LLC | | |
| Address: | Paulsboro, NJ 08066 | | |
| Sample Grade: | StellarFlex GTRH PG 76-22 | Specification: | AASHTO M320 |
| Tank: | 75 | Date Sampled: | 9/12/2015 |
| Lot: | 1 | Date Tested: | 9/14/2015 |
| | | Binder Type: | GTR and SBS Modified |

| Method | Test | Result | Units | Spec Limit |
|---|---|---|---|---|
| **Unaged Binder** | | | | |
| AASHTO T53 | Softening Point Top | 141 | °F | |
| | Softening Point Bottom | 145 | °F | |
| | Difference | 4 | °F | |
| | | 2.2 | °C | |
| AASHTO T44 | Soluble, Percent | 97.6 | % | Min 88% |
| AASHTO T228 | Specific Gravity @ 77°F | 1.042 | | |
| | Specific Gravity @ 60°F | 1.048 | | Calculation |
| | API Gravity @ 60°F | 3.5 | °API | Calculation |
| | LBS/GAL | 8.730 | | Calculation |
| AASHTO T48 | Flash Point | 266 | °C | Min 230 |
| AASHTO T316 | Viscosity @ 135°C | 1.645 | Pa.s | Max 3.0 |
| | Viscosity @ 165°C | 0.412 | Pa.s | Report |



# StellarFlex GTRH

| | | | | |
|---|---|---|---|---|
| AASHTO T315 | ODSR Test Temperature | 76 | °C | |
| | G*/sin delta | 1.73 | kPa | Min 1.00 |
| | ODSR Test Temperature | 82 | °C | |
| | G*/sin delta | 0.95 | kPa | Min 1.00 |
| AASHTO T315 | ODSR Fail Temperature | 81.50 | °C | |
| **RTFO Aged Binder** | | | | |
| AASHTO T240 | Mass Change | -0.422 | Wt% | Max +/- 1.0 |
| AASHTO T315 | RDSR Test Temperature | 76 | °C | |
| | G*/sin delta | 4.43 | kPa | Min 2.20 |
| AASHTO T315 | RDSR Test Temperature | 82 | °C | |
| | G*/sin delta | 2.48 | kPa | Min 2.20 |
| AASHTO T315 | RDSR Fail Temperature | 83.30 | °C | |
| ASTM D6084 | Elastic Recovery; RTFO Residue | 84.00 | % | |
| AASHTO T315 | High End True Grade | 81.50 | °C | |
| **PAV Aged Binder** | | | | |
| AASHTO T315 | PDSR Test Temperature | 22 | °C | |
| | G*sin delta | 4870 | kPA | Max 5000 |
| AASHTO T315 | PDSR Test Temperature | 19 | °C | |
| | G*sin delta | 6800 | kPA | Max 5000 |
| AASHTO T315 | Intermediate True Grade | 21.8 | °C | |
| AASHTO T313 | BBR Test Temperature | -12 | °C | |
| | Creep Stiffness @ 60 sec | 142 | MPa | Max 300 |
| | m-value @ 60 sec | 0.334 | | Min 0.300 |
| AASHTO T313 | BBR Test Temperature | -18 | °C | |
| | Creep Stiffness @ 60 sec | 307 | MPa | Max 300 |
| | m-value @ 60 sec | 0.297 | | Min 0.300 |
| AASHTO T313 | Low Temperature True Grade | -17.50 | °C | |
| | | | | |
| Classification | **TRUE GRADE CLASSIFICATION** | 81.50-27.50 | | |

# StellarFlex GTRH

| | | | |
|---|---|---|---|
| AASHTO T350 MOD | Test Temperature | 64.0 | °C |
| | Percent Recovery of RFTO Residue @100 PA | 70.4712 | % |
| | Percent Recovery of RFTO Residue @3200 PA | 61.6054 | % |
| | % Difference between Average % Recovered | 12.58 | % |
| | Non-Recoverable Creep Compliance @ 100 PA (Jnr) | 0.1040 | kPa-1 |
| | Non-Recoverable Creep Compliance @ 3200 PA (Jnr) | 0.1381 | kPa-1 |
| | % Difference between Average Non-Recoverable Creep Compliance | 32.80 | % |
| AASHTO T350 X1 | Test Temperature | 64.0 | °C |
| | Min % Recovery @ 3200 PA (y=29.371x^-0.263) | 49.4 | % |
| | Difference Between Percent Recovery @ 3200PA and Min% Recovery | 12.2 | |
| AASHTO T240 | Mass Gain + (or) Loss - | -0.594 | Wt % |
| AASHTO R28 | PAV Aging for 20hrs @ 2.1 MPa | 100 ºC | |
| AASHTO T315 PAV | Test Temperature | 31.0 | °C |
| | Complex Modulus (G*) | 2170 | kPa |
| | Phase Angle (DELTA) | 47.6 | deg |

# StellarFlex GTRH

- First two GTRH projects supplied to PennDOT in 2015
  - Philadelphia District – 10,000 mix tons
  - Pittsburgh District – 2,000 mix tons
- Philadelphia project interrupted by Pope Francis visit
  - All construction halted for one week
- Tested GTRH Stability
  - Turned off agitation and circulation
  - Sampled tank daily for nine days
  - No change in properties or separation results

# StellarFlex GTRH

- Penn DOT Project information
  - Used existing 9.5mm mix designs with PG 76-22 – no changes to asphalt content required
  - Neither plant storage tank had agitation
  - No problems running the mix
  - Passing QC test results
    - Asphalt content
    - Volumetrics

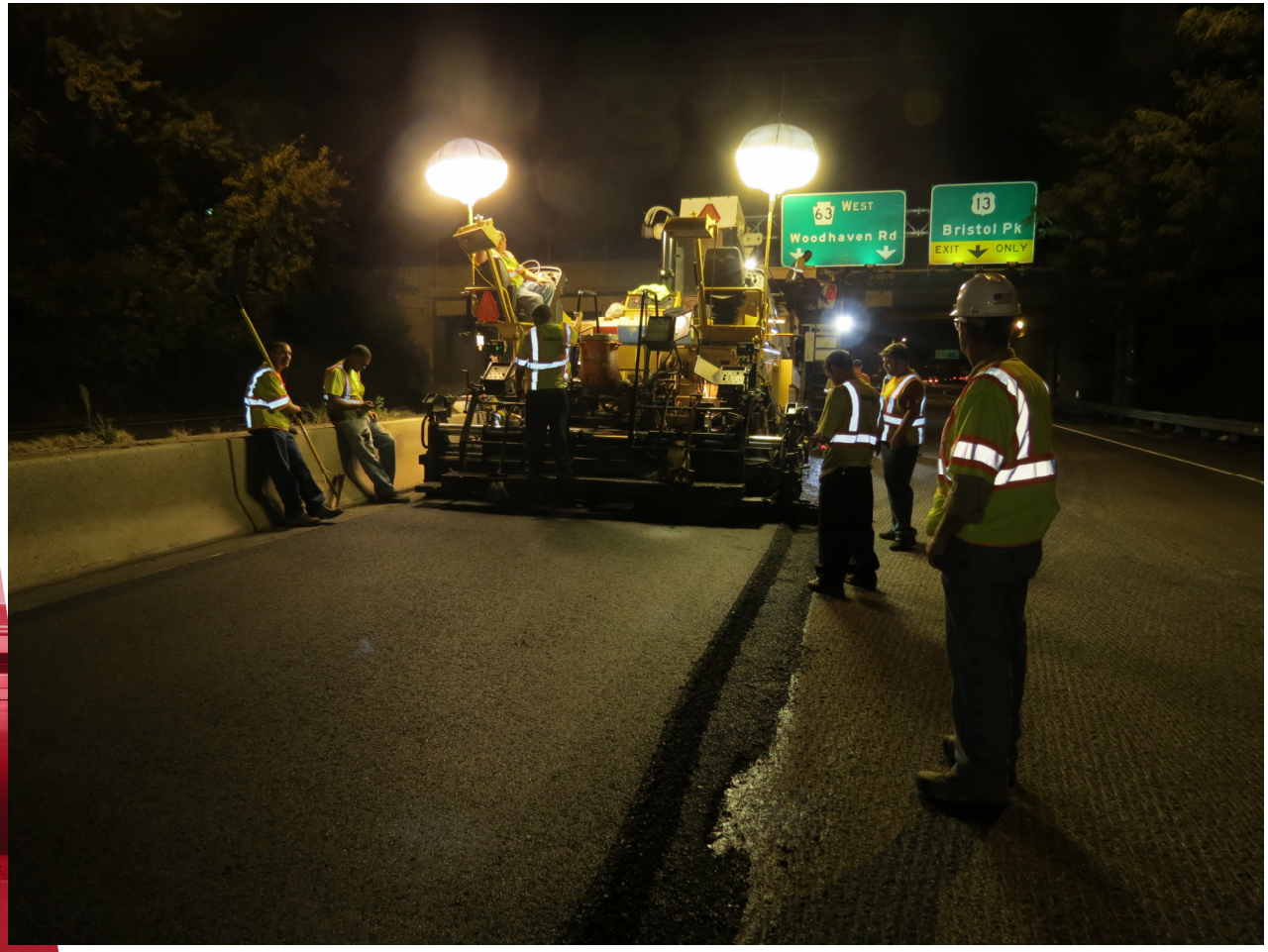
# StellarFlex GTRH

## Philadelphia Project

- Project information
  - Supplied StellarFlex GTRH with Evotherm warm mix additive
  - Plant temperatures 280-320°F
  - No problems running the mix through MTV and paver
  - 95% density after 4 passes of vibratory rollers

# StellarFlex GTRH

## Philadelphia Project



# StellarFlex GTRH

## Philadelphia Project

# StellarFlex GTRH

## Philadelphia Project

# StellarFlex GTRH

Philadelphia Project

- Paving Superintendent stated he thought the StellarFlex GTRH was easier to work with than PG 76-22 asphalt

# StellarFlex GTRH

## Philadelphia Project

# StellarFlex GTRH

## Philadelphia Project

# StellarFlex GTRH

## Pittsburg Project

- Plant Location
  - ½ hour further than the contractors closest plant.
  - Plant was scheduled to be torn down after this project.
  - Contractor was sure that his tank and asphalt lines would be ruined.

# StellarFlex GTRH

## Pittsburg Project Mix Production

- Production Rate: 200tph (plant was rated for 300tph)
- Mix Temp: $280^0$ – $330^0$F
- Liquid Storage: Horizontal Tank w/no agitation maintained between $330^0$F – $340^0$F

- All plant operating parameters, including motor amperages, were normal.

# StellarFlex GTRH

## Pittsburg Project

# StellarFlex GTRH

## Pittsburgh Project

# StellarFlex GTRH

## Delaware Project

- Plant:  400 TPH CMI Triple Drum
- Mix Tons:  6,225
- Liquid Storage:  One side of a 30,000 gallon split tank
- Agitation:  No

- "Material ran like we were making 76-22" (Tom Rousan, Allan Myers)

# StellarFlex GTRH

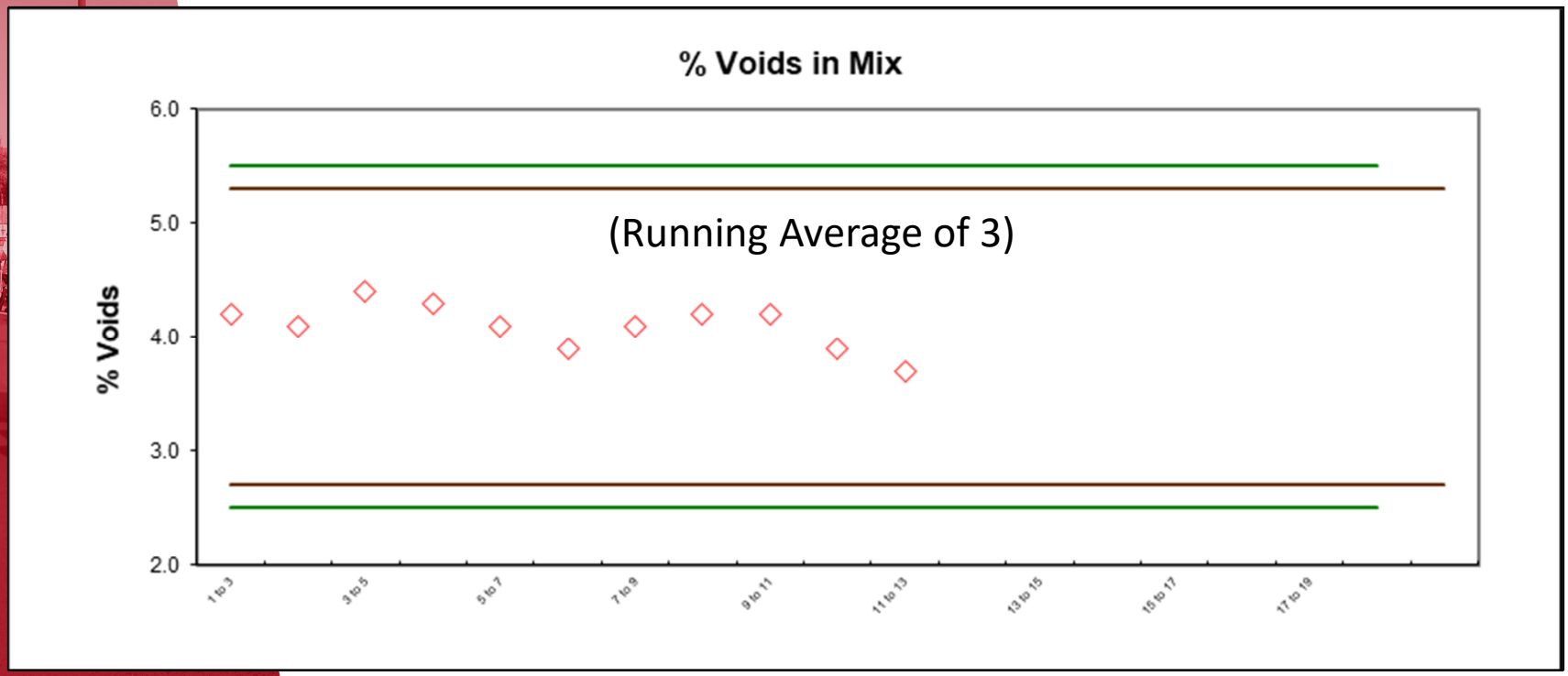
Delaware Project

- Mix Design:
  - Coarse Graded 9.5MM
  - N Design: 100 Gyrations
  - Aggregates
    - Fine – Dolomitic Limestone
    - Coarse – Granodiorite
    - Rap – 10%

# StellarFlex GTRH

Delaware Project

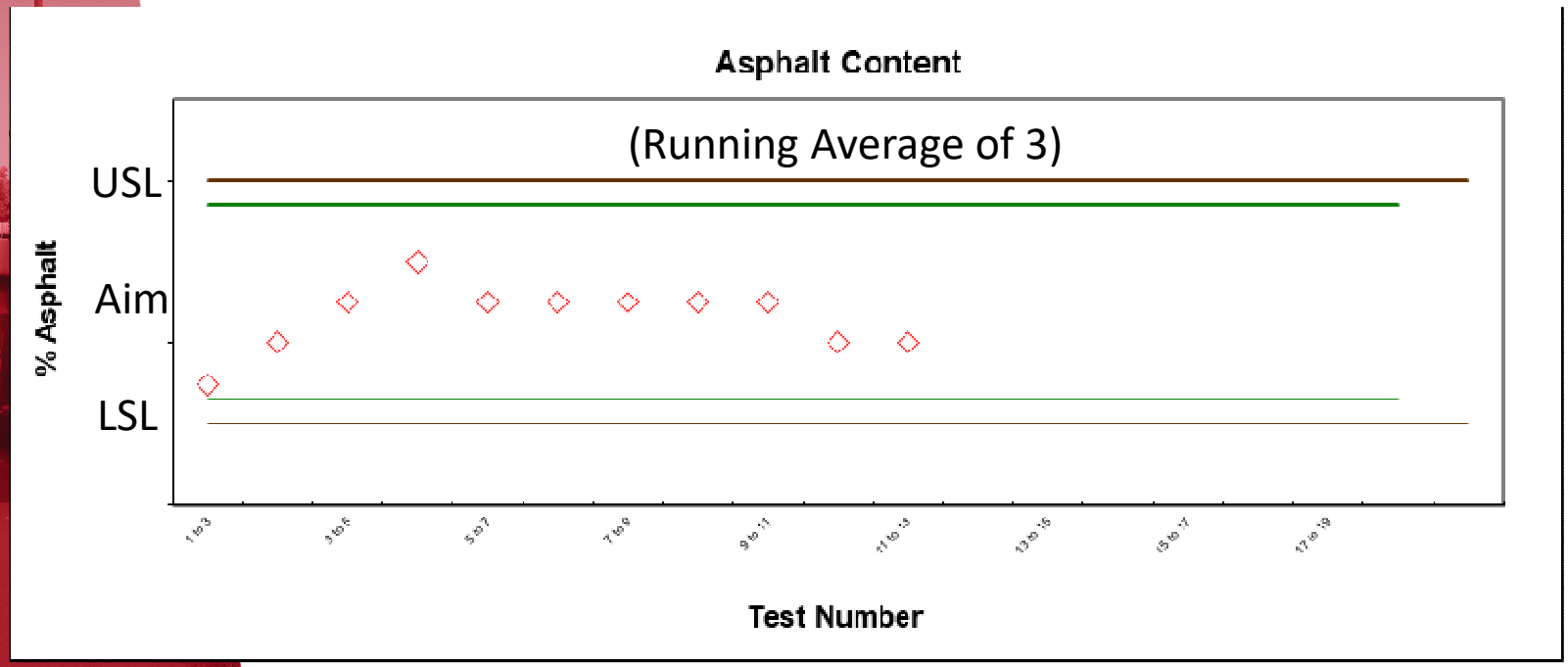
- Mix Results (13 Samples):
  - Average Air Voids: 4.1%
    - Range: 3.6% to 4.7%



# StellarFlex GTRH

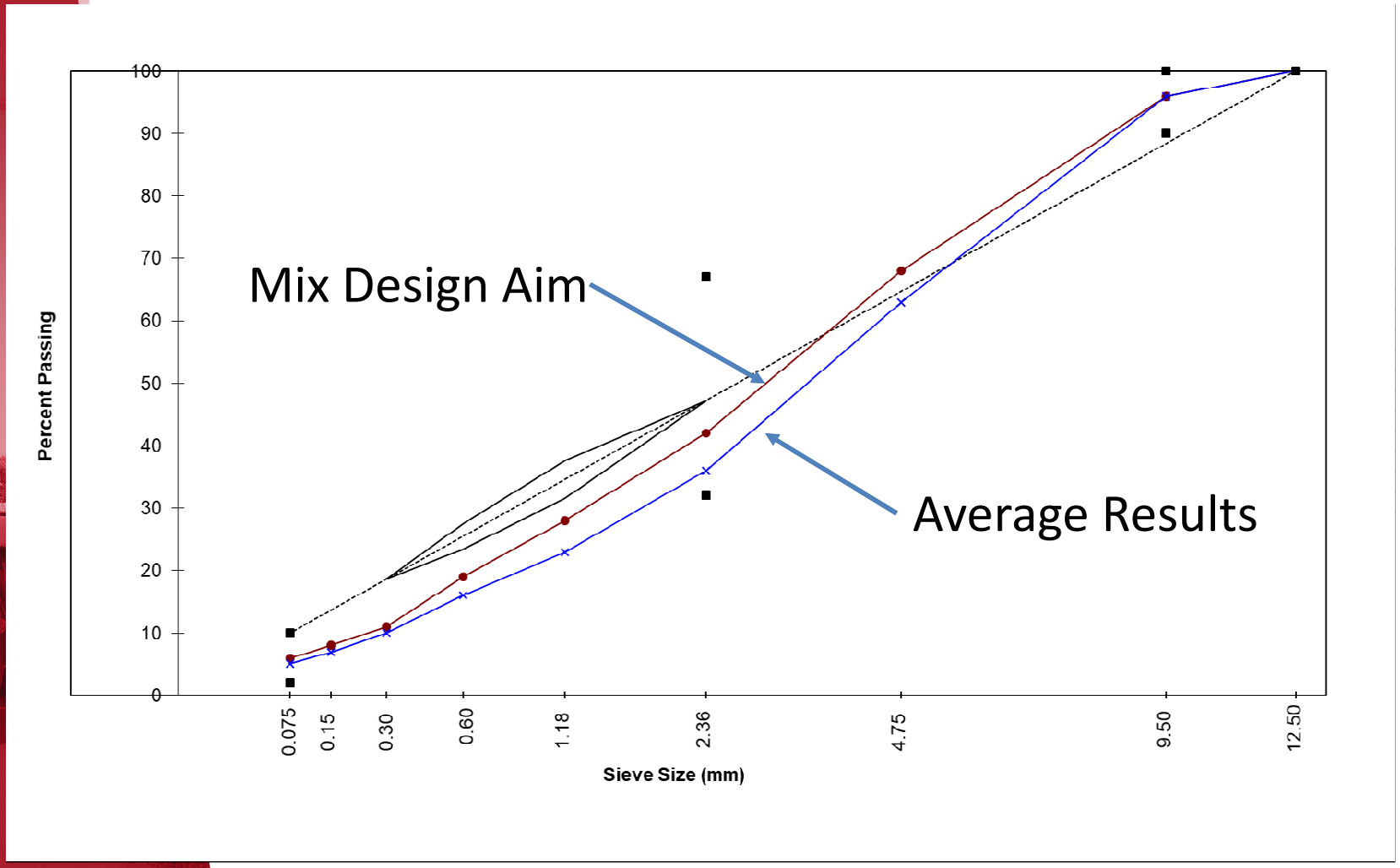
Delaware Project

- Asphalt Content
- Range: 0.2% below aim to 0.1% above aim



# StellarFlex GTRH

## Delaware Project – Gradation Results



# StellarFlex GTRH

## Delaware Project

# StellarFlex GTRH

## Delaware Project As of 2/7/18

GTRH

Adjacent Side Road

# StellarFlex GTRH

## Delaware Project As of 2/7/18

# StellarFlex GTRH

## Delaware Project As of 2/7/18

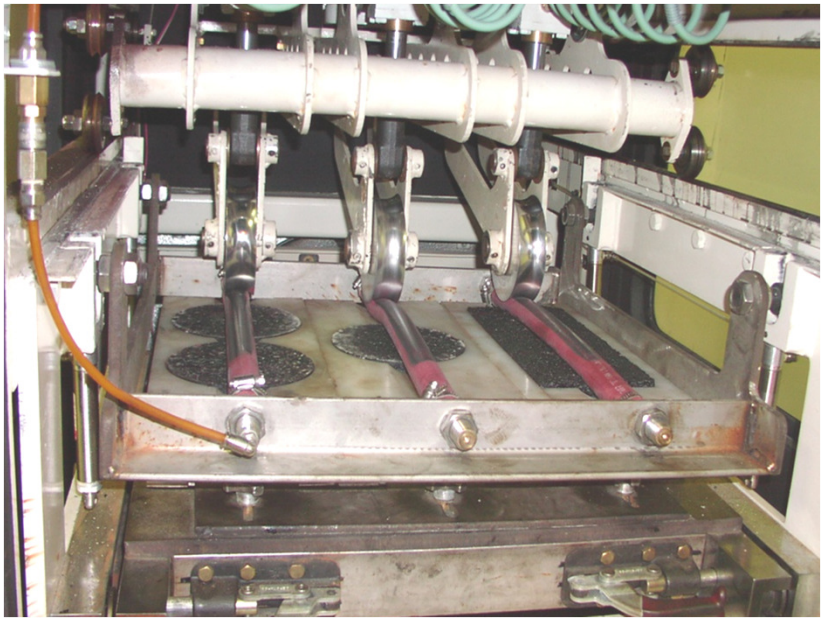
# Delaware Department of Natural Resources and Environmental Control

(Curiosity of Jason Sunde, Environmental Program Manager)

- 1 Licensed Scrap Tire Facility in DE
  - Processed 7,100 tons in 2017
    - All used for a landfill “fluff layer”
  - Need to increase the beneficial use of tires to:
    - Increase the life of landfills
    - Reduce costs to eliminate illegal dumping
    - Reduce mosquito breading grounds
  - Rt. 14 consumed an estimated 23.1 tons of rubber or 2,310 tires.
    - 0.3% of available supply

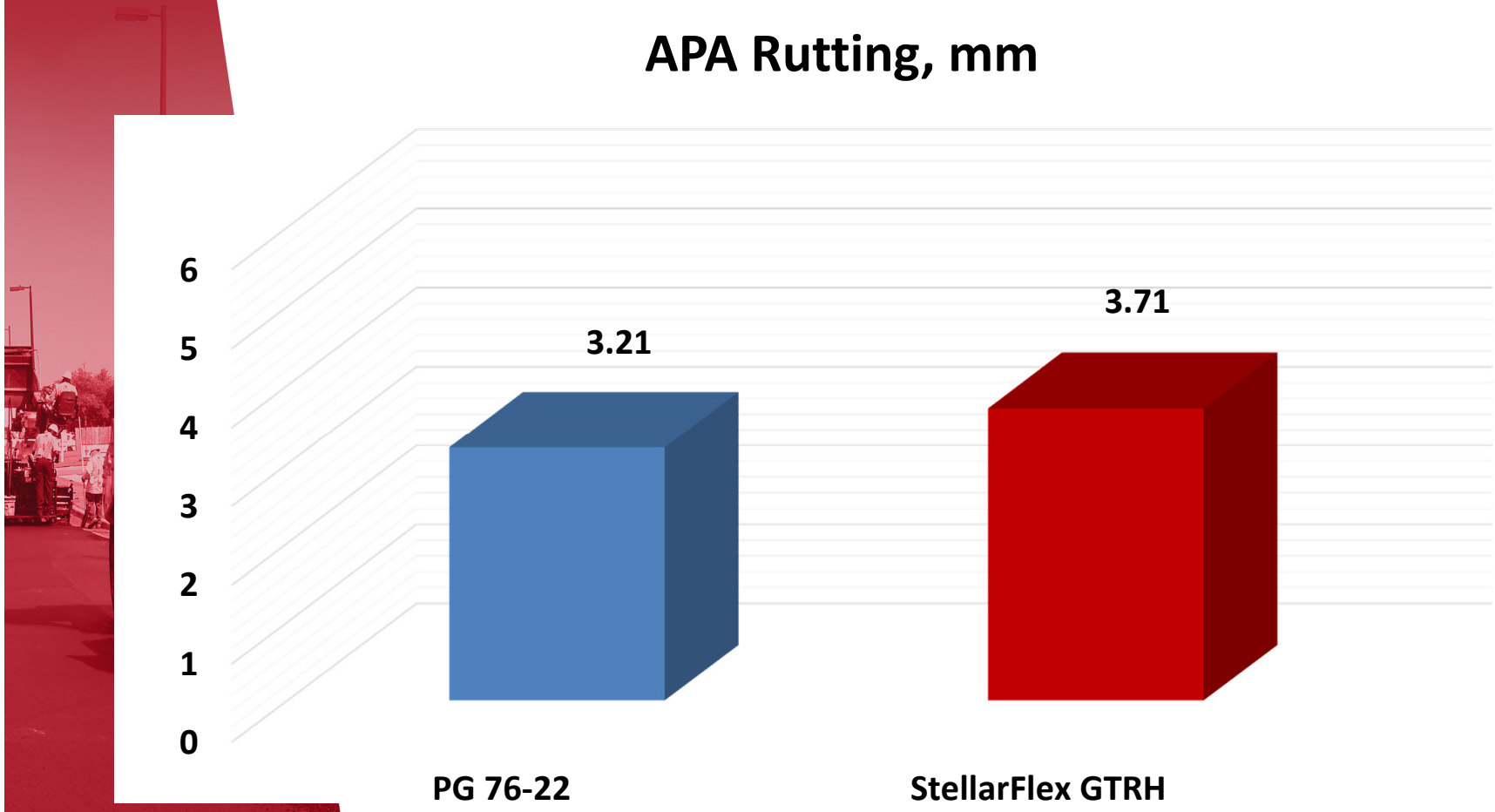
# STELLARFLEX GTRH MIX PERFORMANCE

# Asphalt Pavement Analyzer (APA) – Rutting Evaluation of HMA

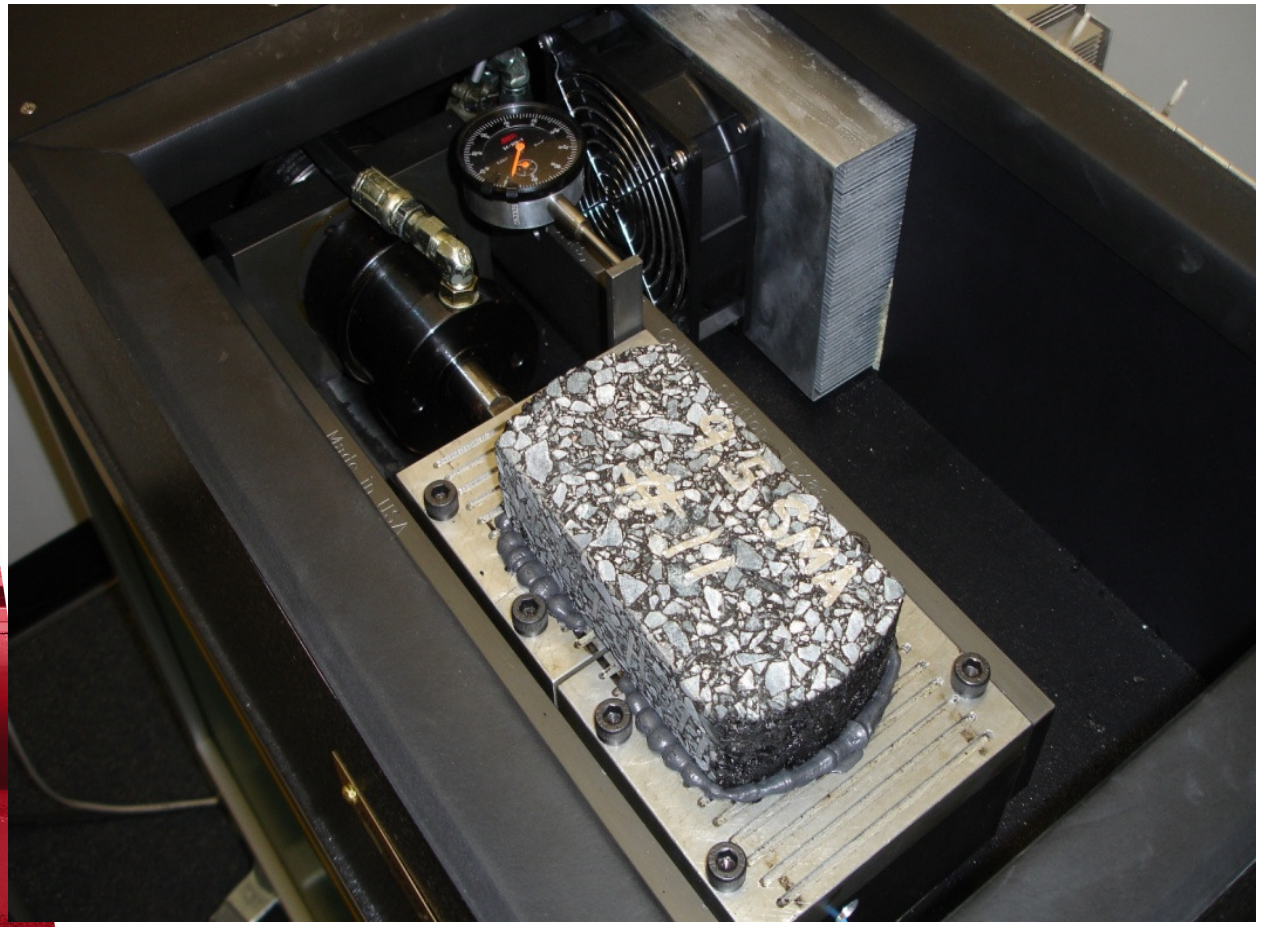


- Moving wheel load (100 lbs) applied to a pressurized hose (100 psi) which lies on top of asphalt samples
- Tested at 64°C for 8,000 loading cycles
- Computer data acquisition system

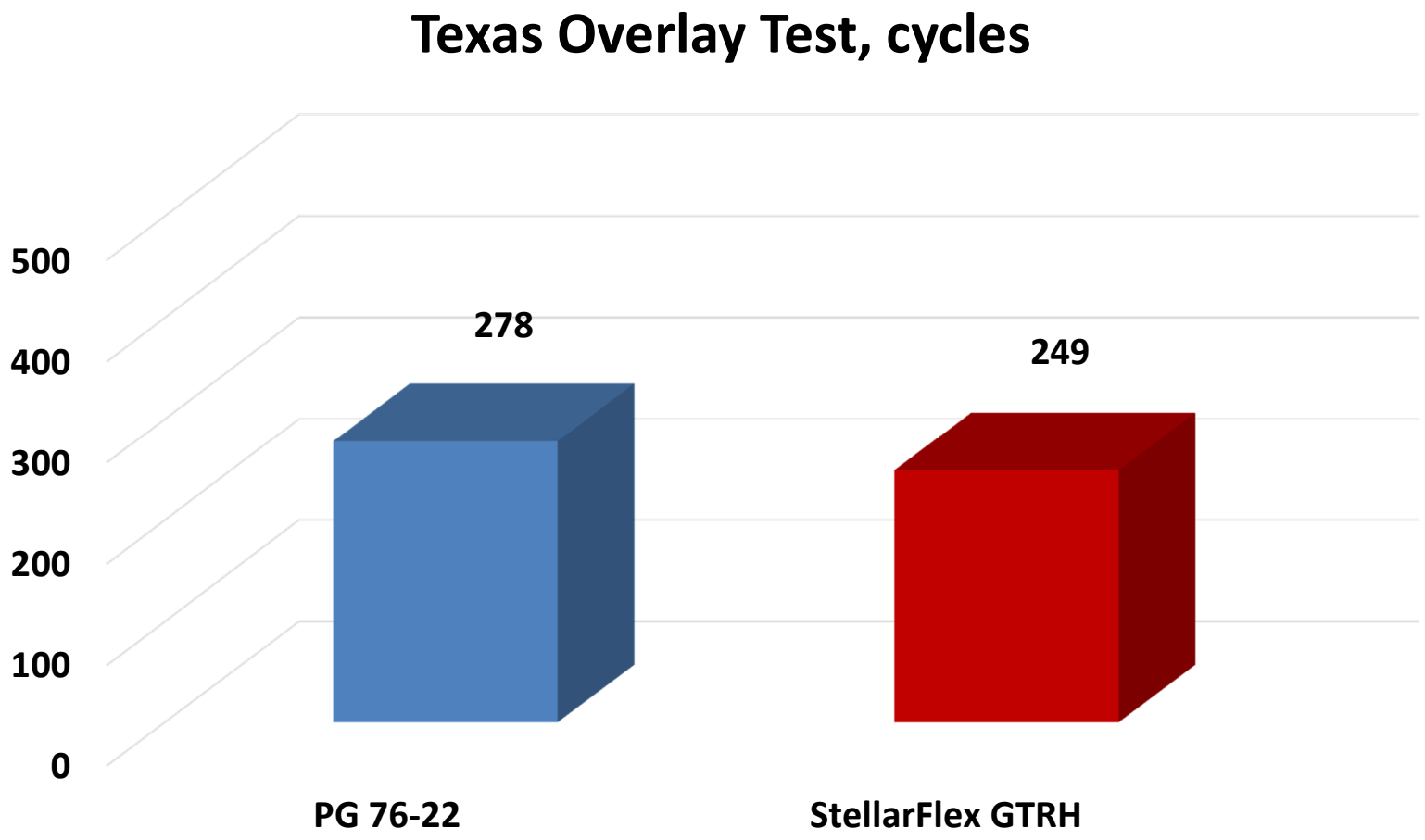
# StellarFlex GTRH Rutting Performance



# Texas Overlay Tester – Fatigue Cracking



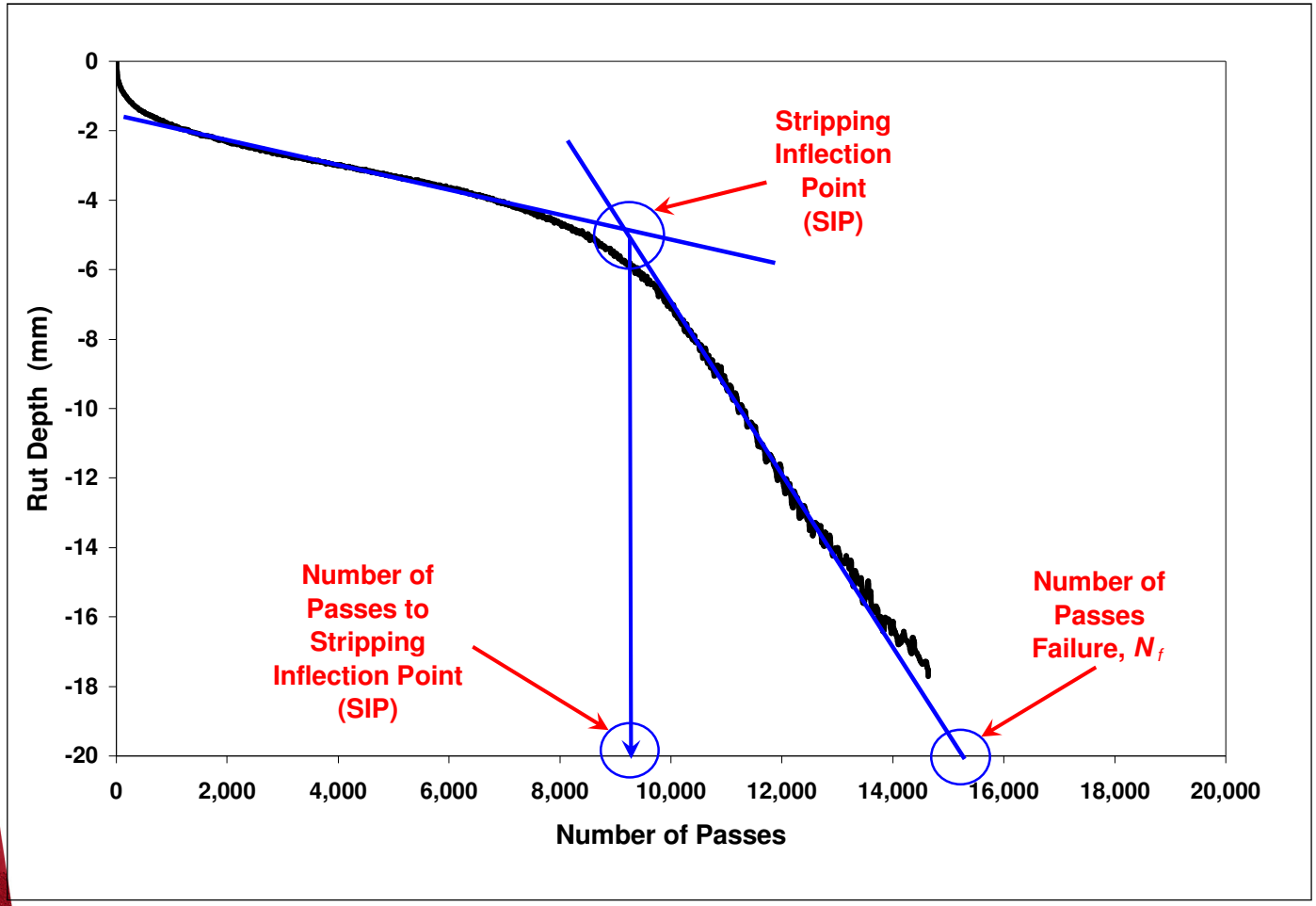
# StellarFlex GTRH Fatigue Performance



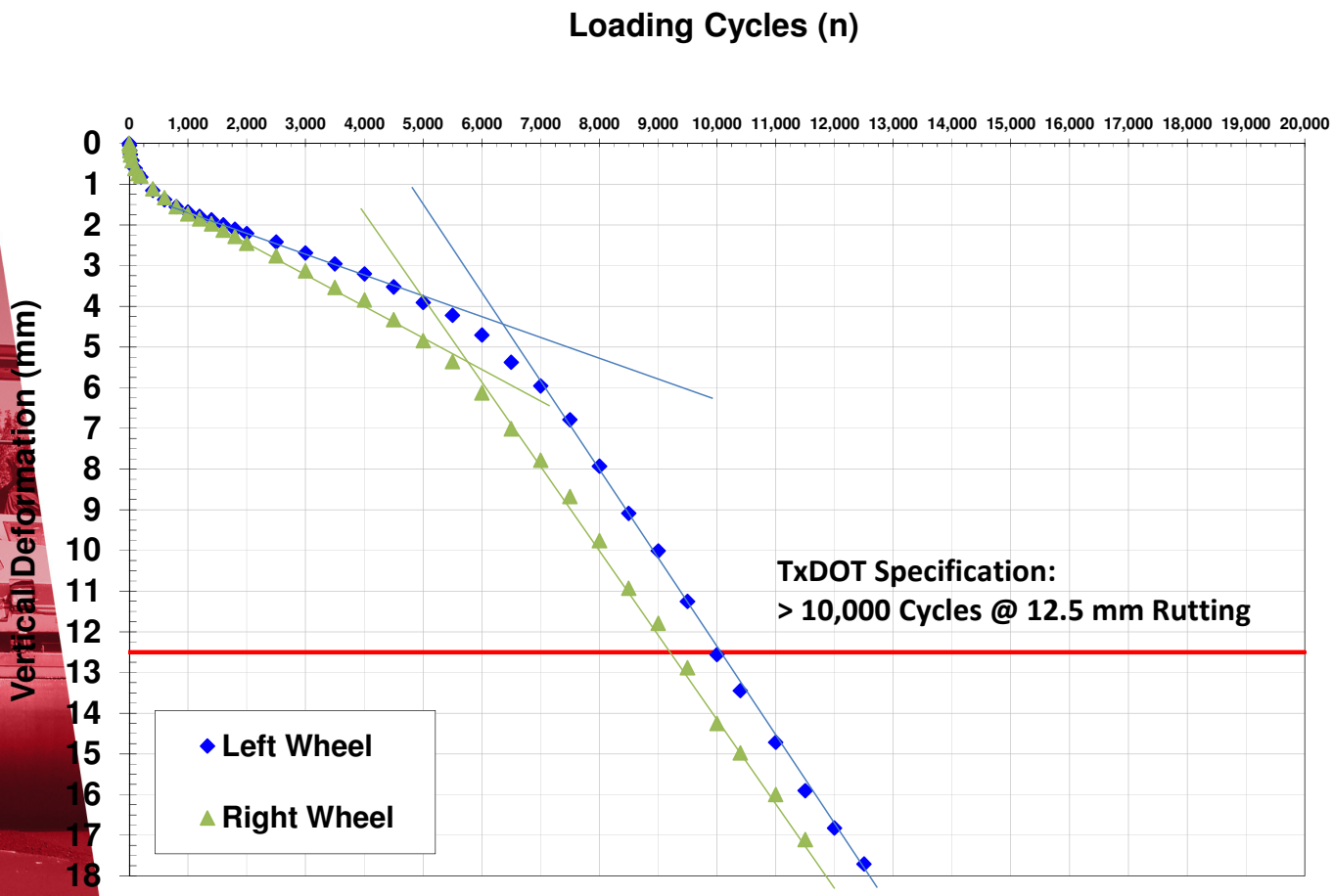
# Hamburg Wheel Tracking Test

- Measures rutting and stripping potential
- Severe test
- Soak samples in 50°C water for 30 minutes
- Test temperature 50°C
- Steel wheel – 158 lbs.
- Number of cycles to 12.5mm rut depth (maximum 20,000 cycles)
- Number of cycles to Striping Inflection Point (SIP)

# Hamburg Wheel Tracking Test

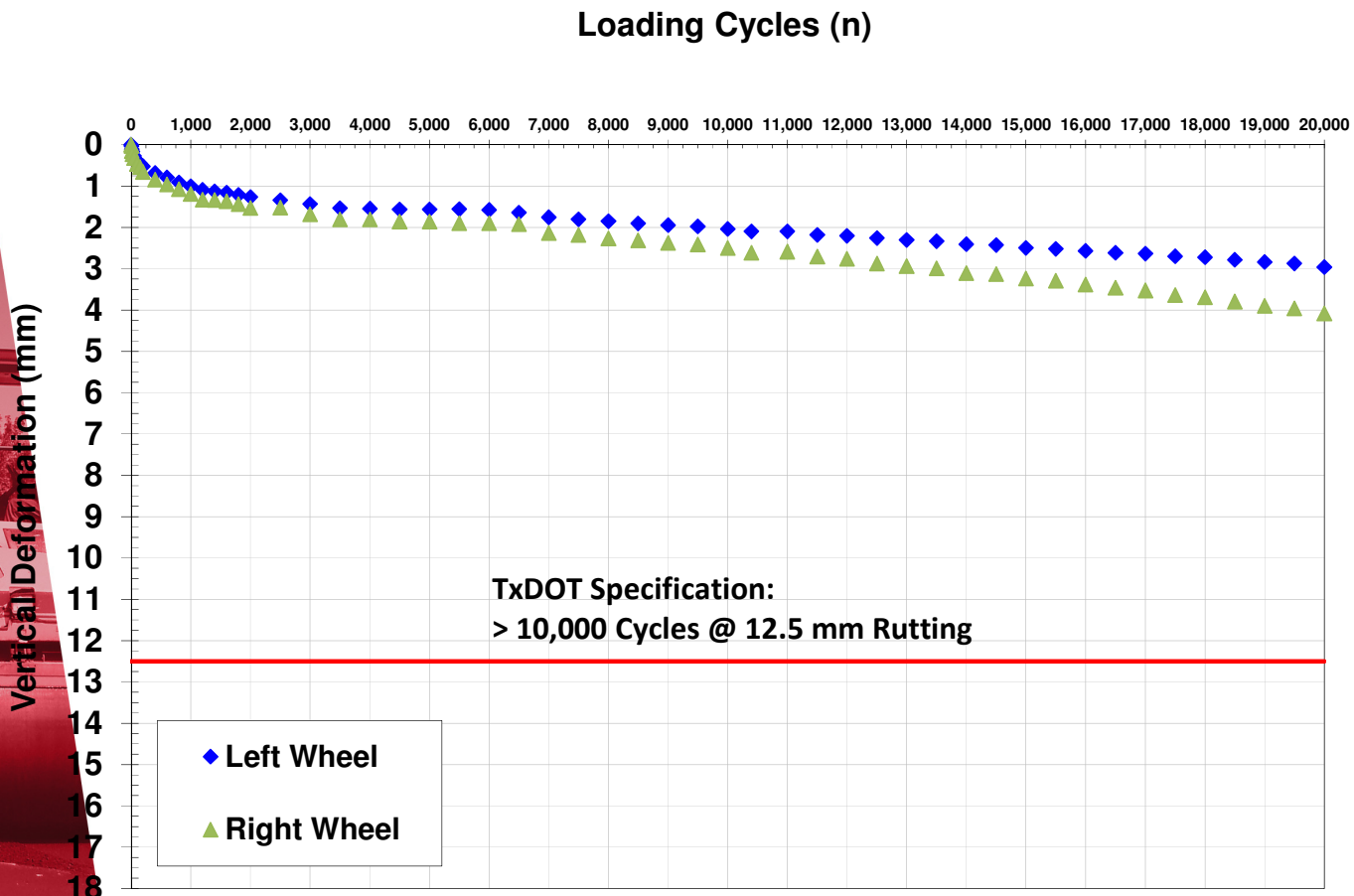


# Hamburg Wheel Tracking Test




**PG 76-22 Mix**

# Hamburg Wheel Tracking Test




**StellarFlex GTRH Mix**

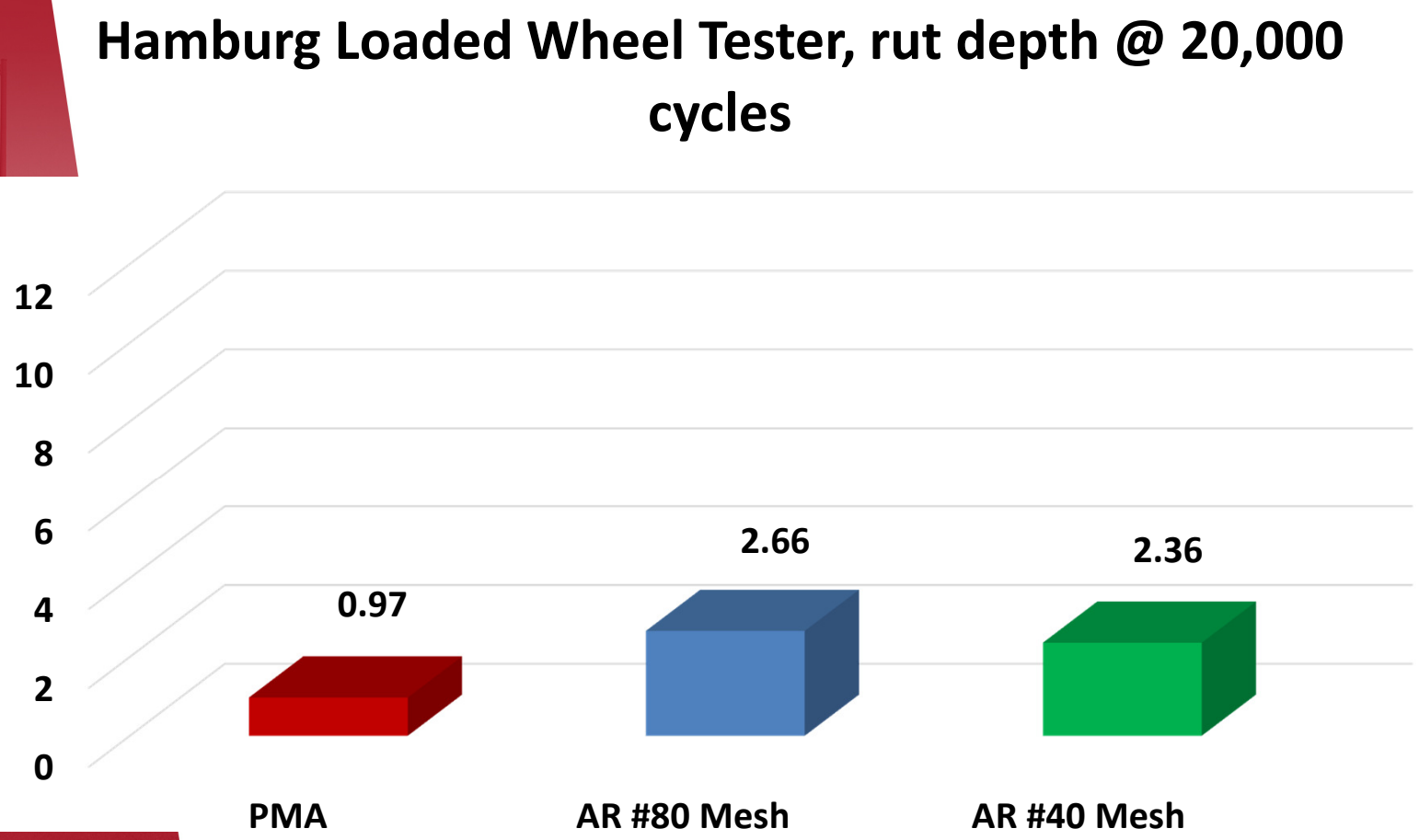
# StellarFlex GTRH Mix Performance

- StellarFlex GTRH mix performs equally to PG 76-22 PMA mix in both APA rutting and Texas Overlay Fatigue Cracking
- StellarFlex GTRH mix substantially outperforms PG 76-22 PMA mix in Hamburg Loaded Wheel Test
- How does StellarFlex GTRH perform compared to Asphalt Rubber?
- Cannot put Asphalt Rubber in a dense graded mix

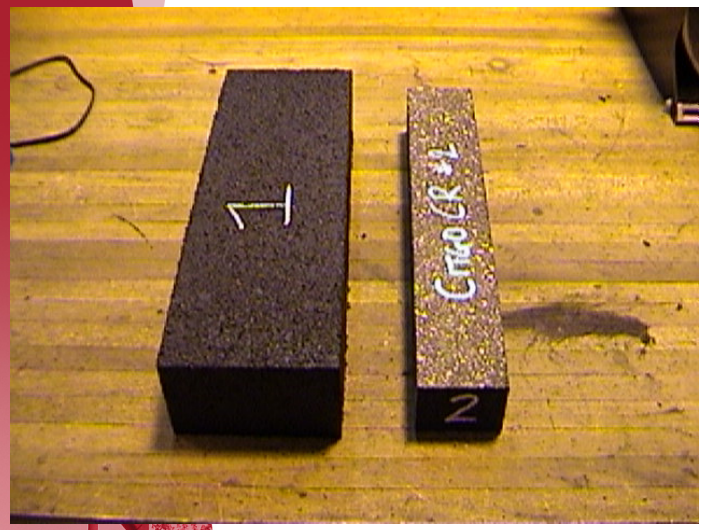
# StellarFlex GTRH Mix Performance

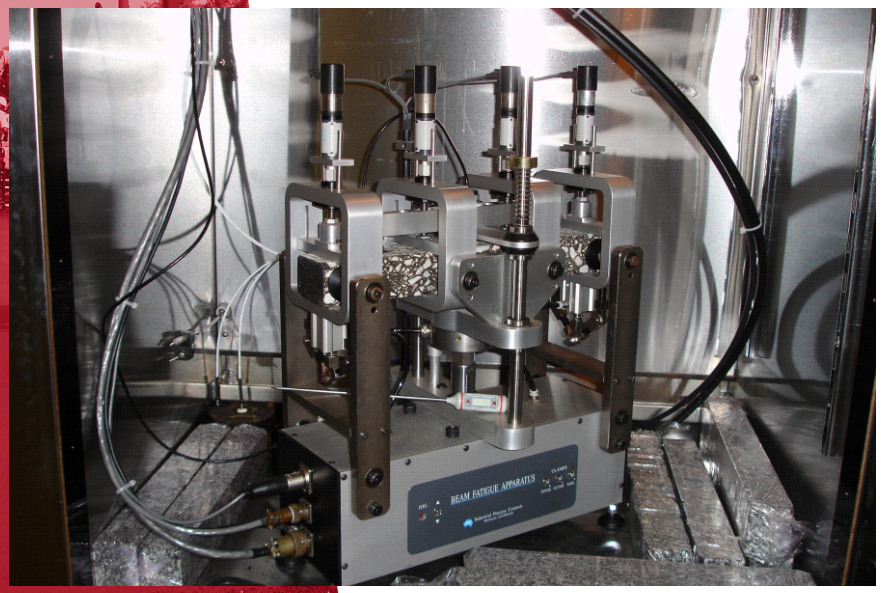
- Dr. Walaa Mogawer, U Mass Dartmouth, compared Asphalt Rubber to PG 76-28 PMA in a gap-graded overlay mix.
- Presented the following information at the 2015 NEAUPG meeting

# PMA vs. Asphalt Rubber



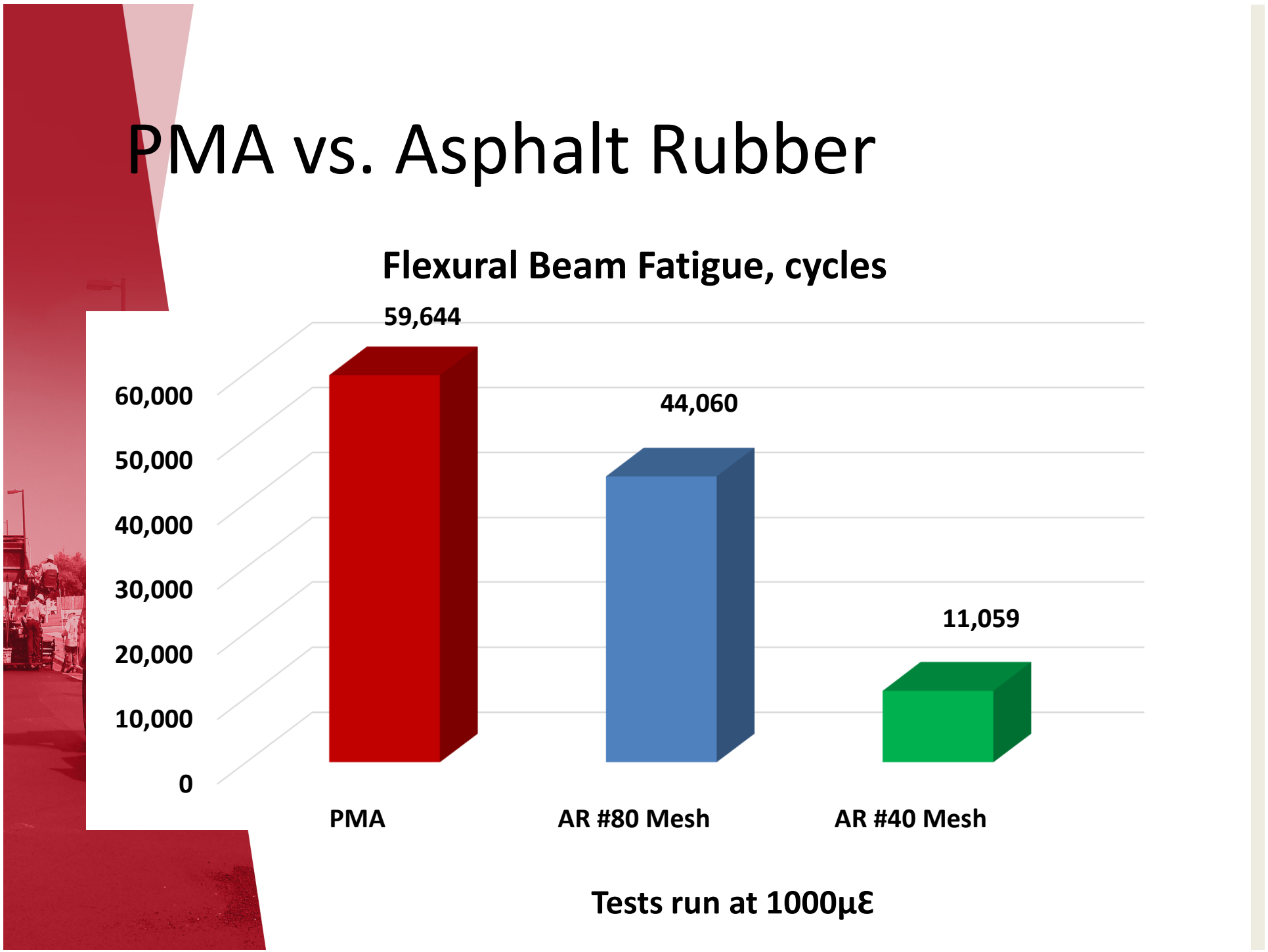
# Flexural Beam Fatigue Test



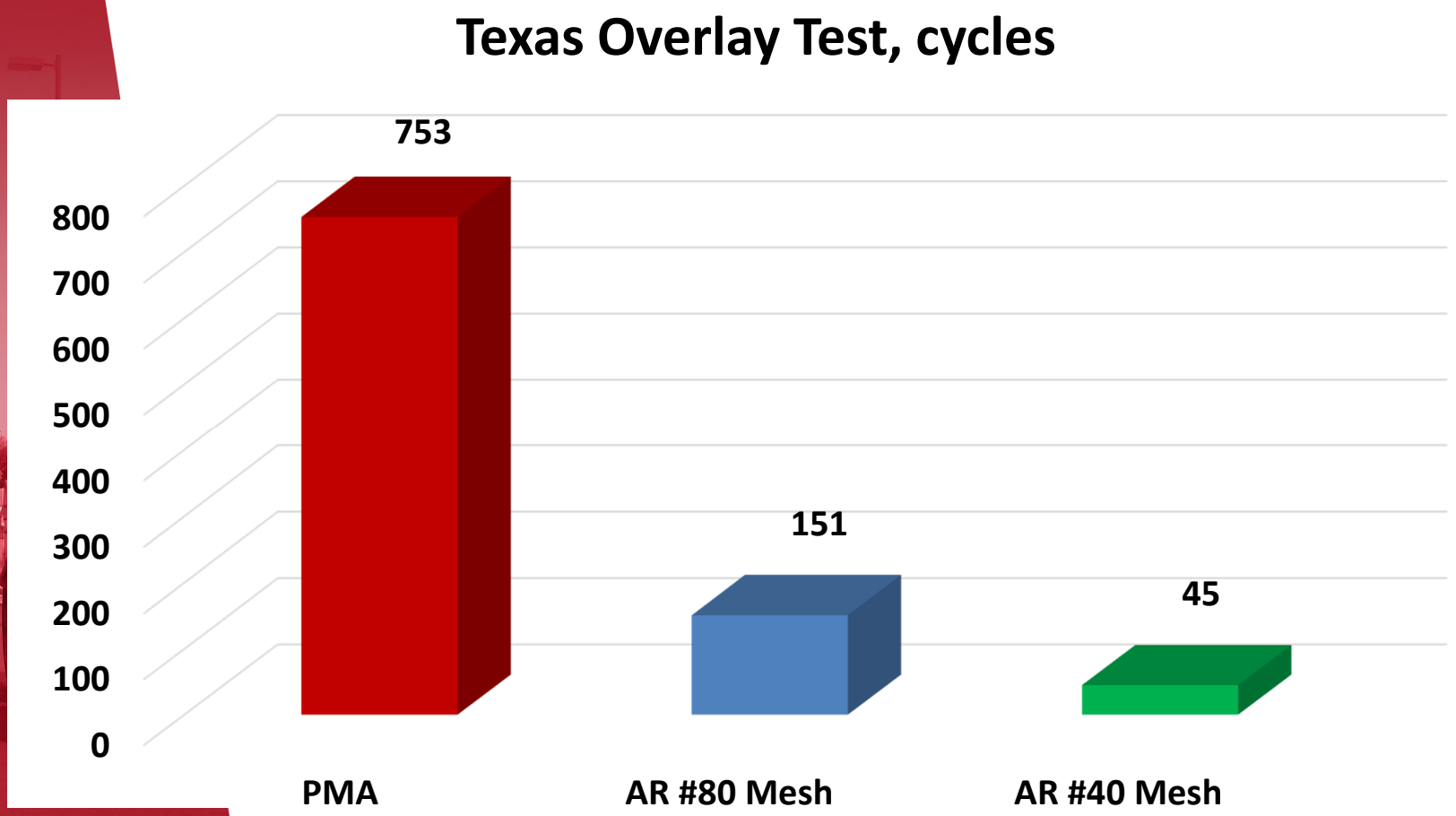




- Flexural Beam Fatigue Device, AASHTO T-321
  - Tests mix's ability to withstand repeated bending which causes fatigue failure
  - Data = number of loading cycles to failure (loss of stiffness)
  - Failure occurs when stiffness of beam < 50% of initial stiffness

# PMA vs. Asphalt Rubber



# PMA vs. Asphalt Rubber



# PMA vs. Asphalt Rubber

- PMA mix is slightly better in Hamburg rut test
- PMA mix  is slightly better than #80 mesh AR mix and substantially better than #40 mesh AR mix in Beam Fatigue
- PMA mix is substantially better than both #80 mesh and #80 mesh AR mixes in Texas Overlay Fatigue Cracking Test

# Summary

- StellarFlex GTRH is an effective, high performance GTR product
  - Meets specifications for PG 76-22, including Elastic Recovery
  - Mets specifications for PG 64E-22, including MSCR Recovery
  - Mix performance equal to PG 76-22 (PG 64E-22) in rutting and cracking
  - Stable product – requires no agitation
  - Excellent workability
  - Works in any mix – including dense graded

# Questions?