

STELLARFLEX GTRH GROUND TIRE RUBBER HYBRID ASPHALT BINDER

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BACKGROUND



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

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 Designation) – 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



- ▶ Early lab results indicated 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



Phone: 856-579-5109

Supplier: Axeon Specialty Products, LLC
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 °C	
AASHTO T315 PAV	Test Temperature	31.0	°C
	Complex Modulus (G*)	2170	kPa
	Phase Angle (DELTA)	47.6	deg

STELLARFLEX GTRH – 1ST PROJECT

- ▶ First GTRH projects supplied to PennDOT
 - ▶ Philadelphia District – 10,000 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 – 1ST PROJECT



- ▶ Project information
 - ▶ Used existing 9.5mm mix designs with PG 76-22 – no changes to asphalt content required
 - ▶ Plant storage tank did not have agitation
 - ▶ No problems running the mix
 - ▶ Passing QC test results
 - ▶ Asphalt content
 - ▶ Volumetrics

STELLARFLEX GTRH – 1ST PROJECT



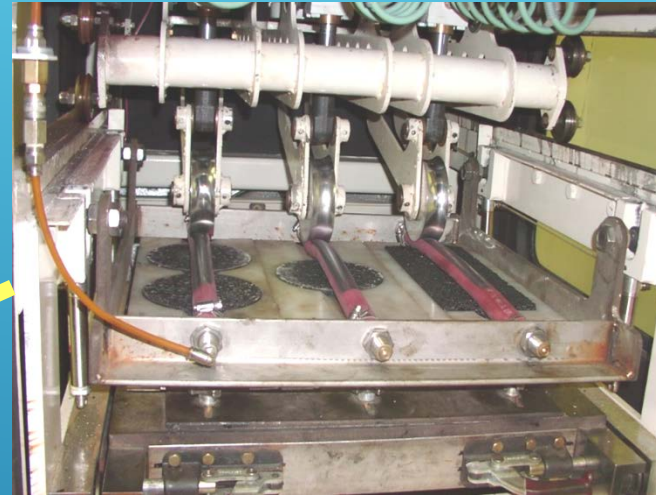
- ▶ Project information
 - ▶ Supplied StellarFlex GTRH with Evotherm warm mix additive
 - ▶ Plant temperatures 280-320°F
 - ▶ No problems running the mix through MTV and paver
 - ▶ 95% density after 4 passes of vibratory rollers

STELLARFLEX GTRH MIX PERFORMANCE



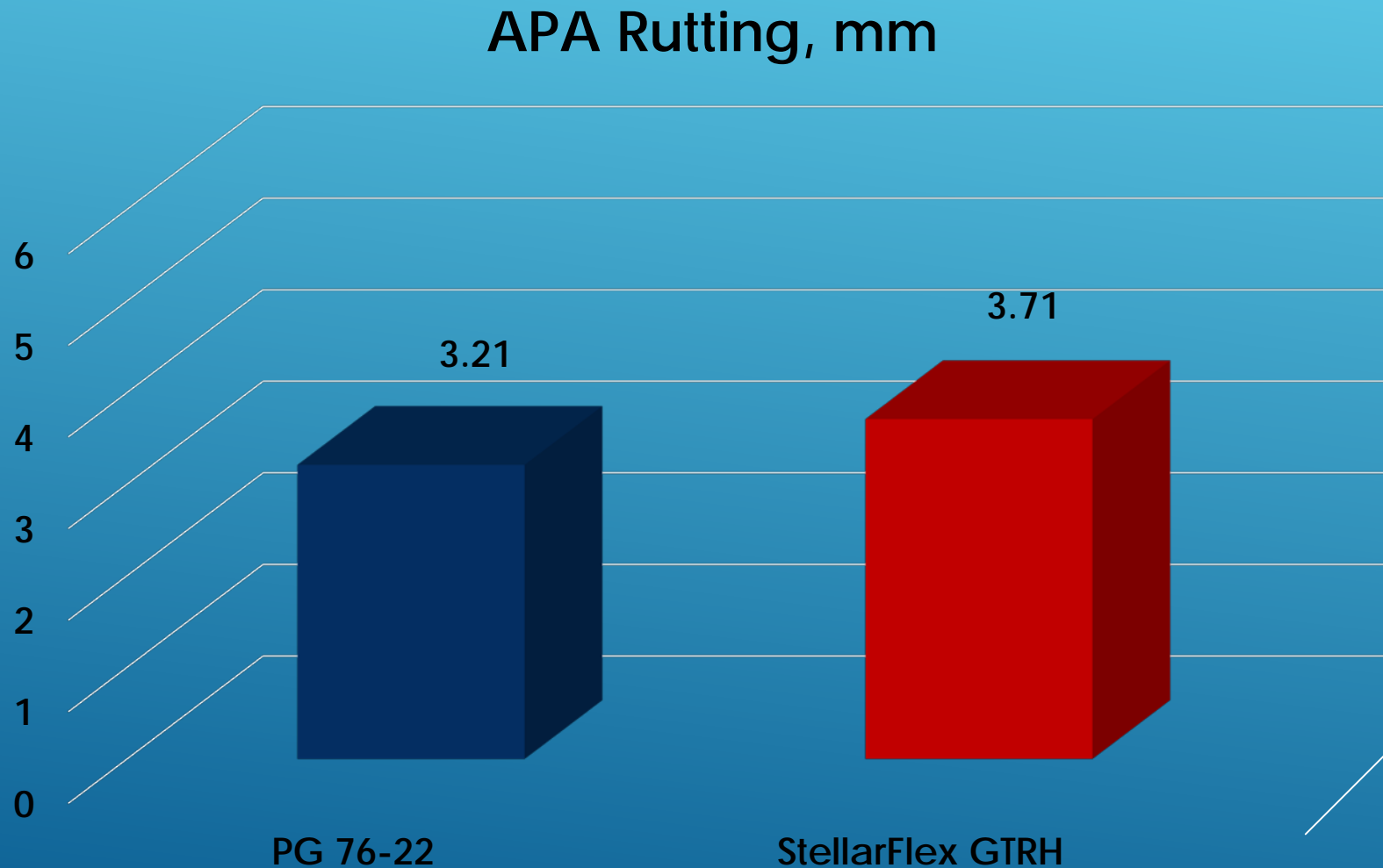
ASPHALT PAVEMENT ANALYZER (APA)

– 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

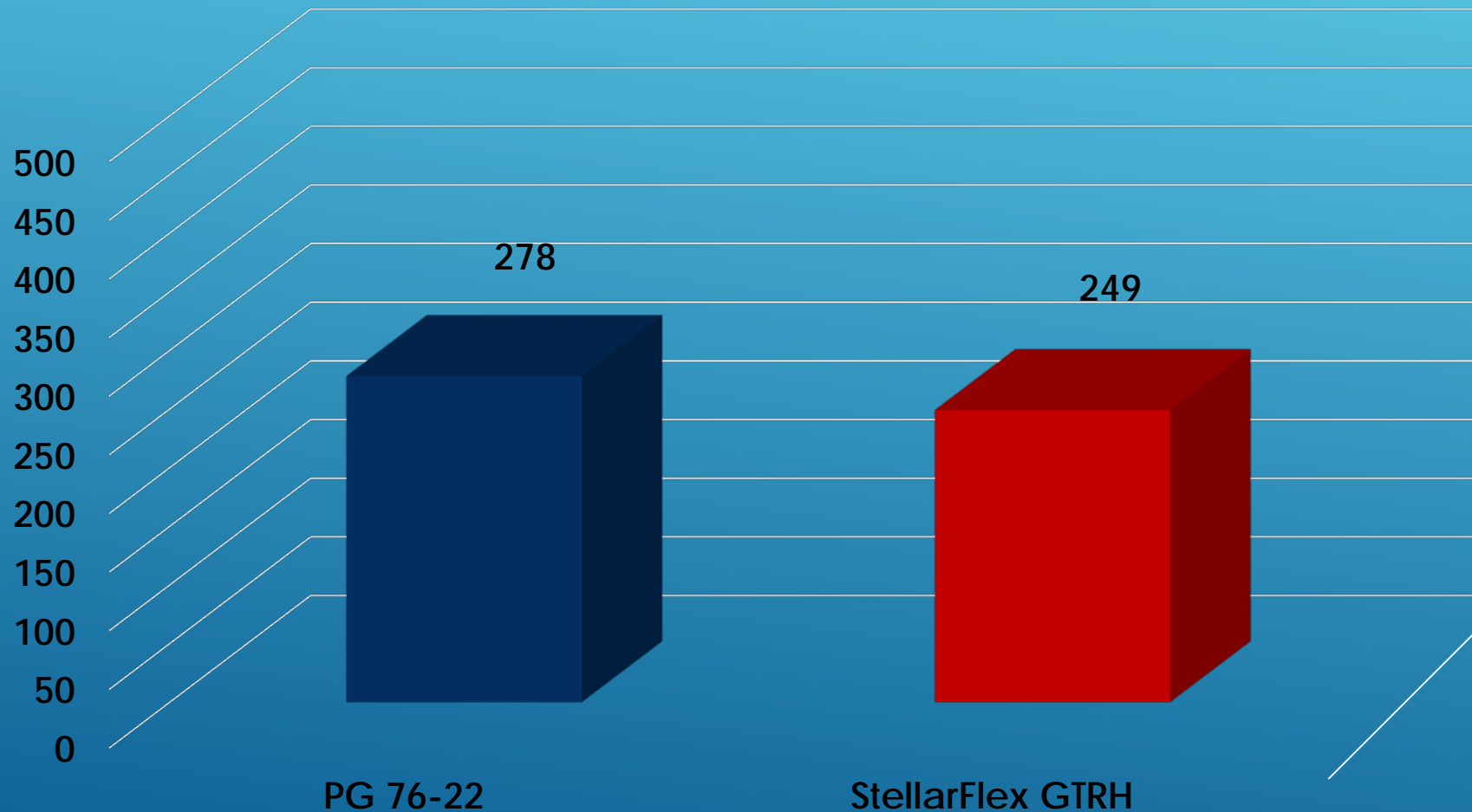


TEXAS OVERLAY TESTER – FATIGUE CRACKING



STELLARFLEX GTRH FATIGUE PERFORMANCE

Texas Overlay Test, cycles

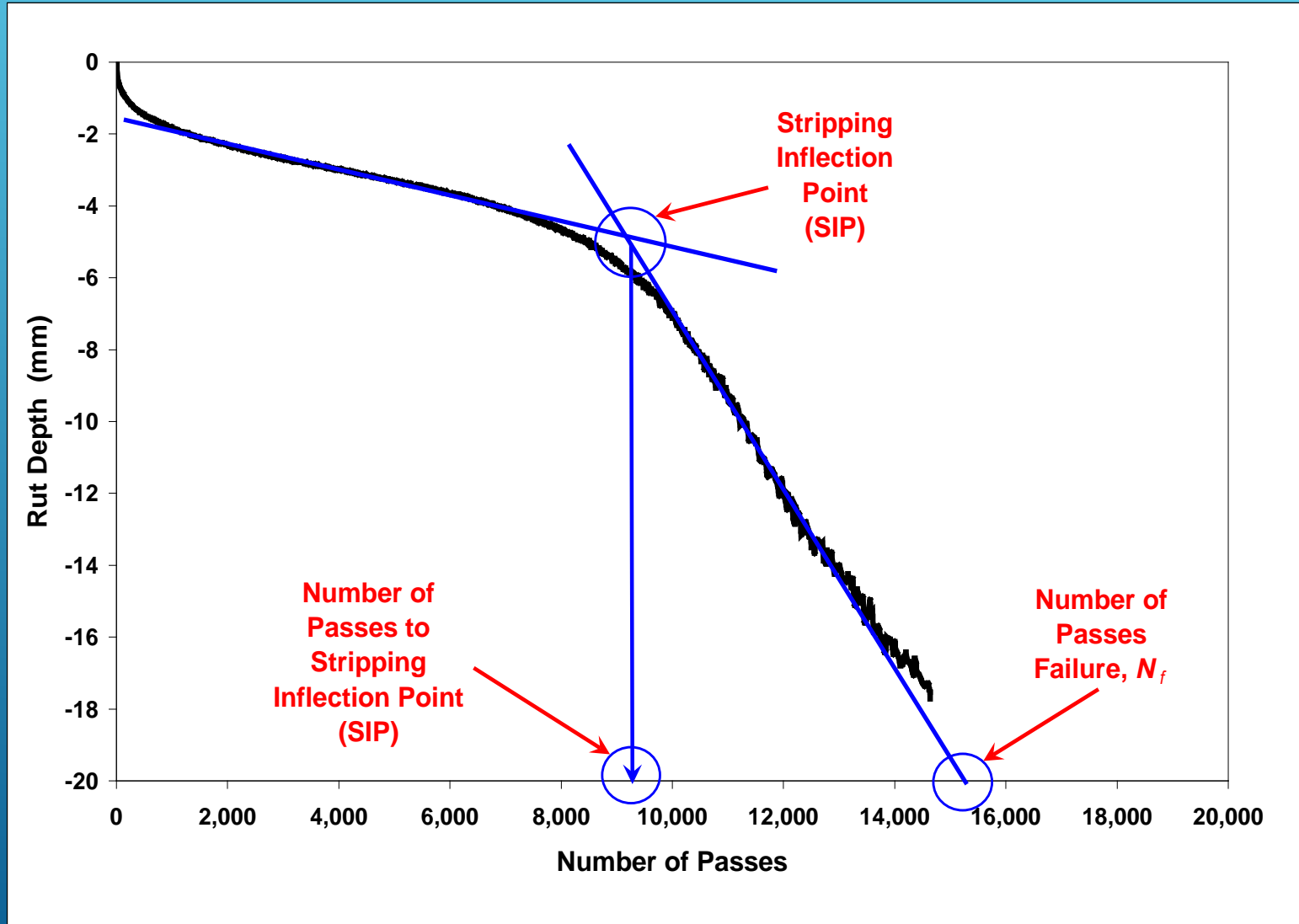


HAMBURG WHEEL TRACKING TEST

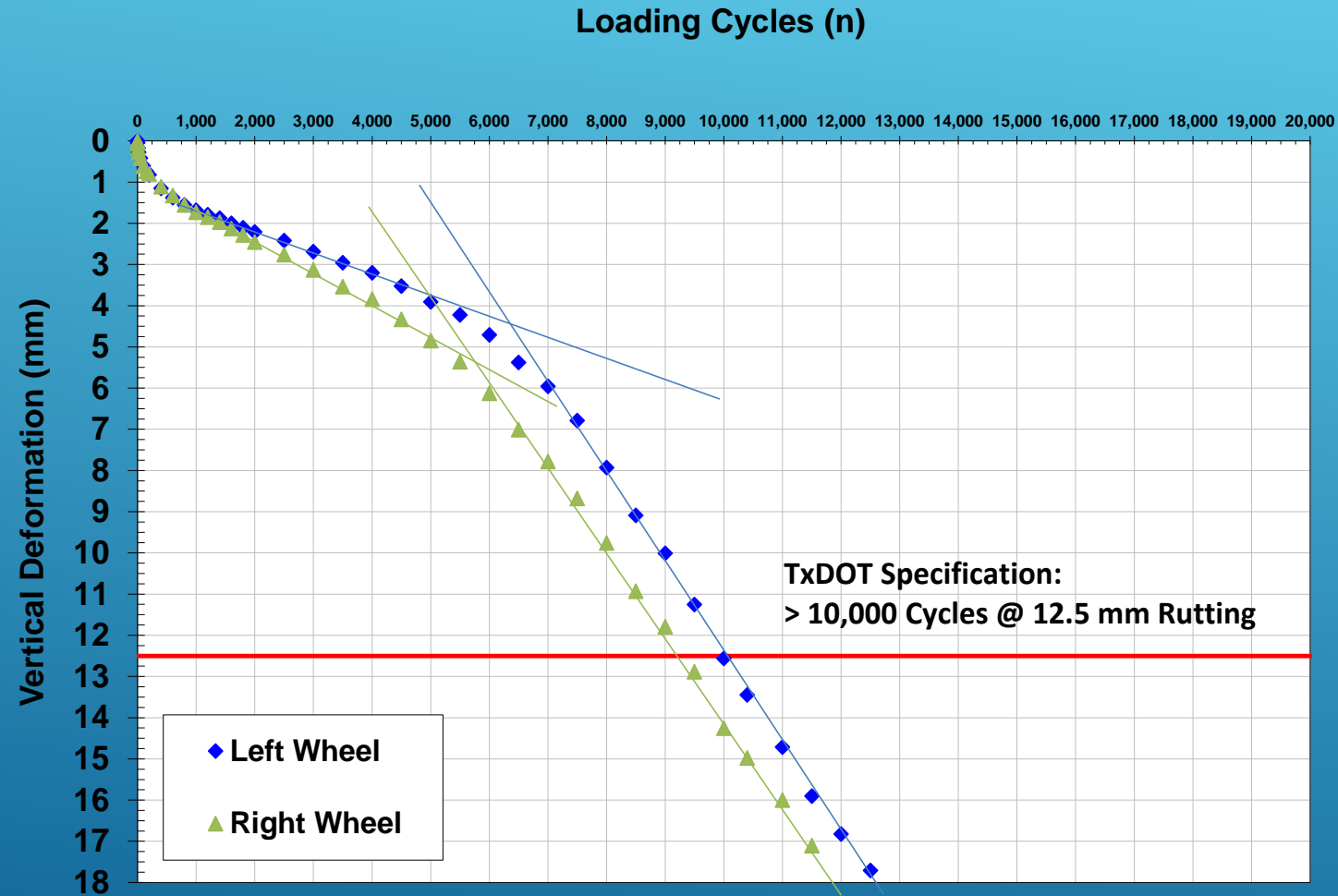


- ▶ Measures rutting and stripping potential
- ▶ Severe test
- ▶ Soak samples in 50°C water for 30 minutes
- ▶ Test temperature 50°C
- ▶ Steel wheel – 158 lbs.
- ▶ Number of cycles to 12.5mm rut depth (maximum 20,000 cycles)
- ▶ Number of cycles to Stripping Inflection Point (SIP)

HAMBURG WHEEL TRACKING TEST

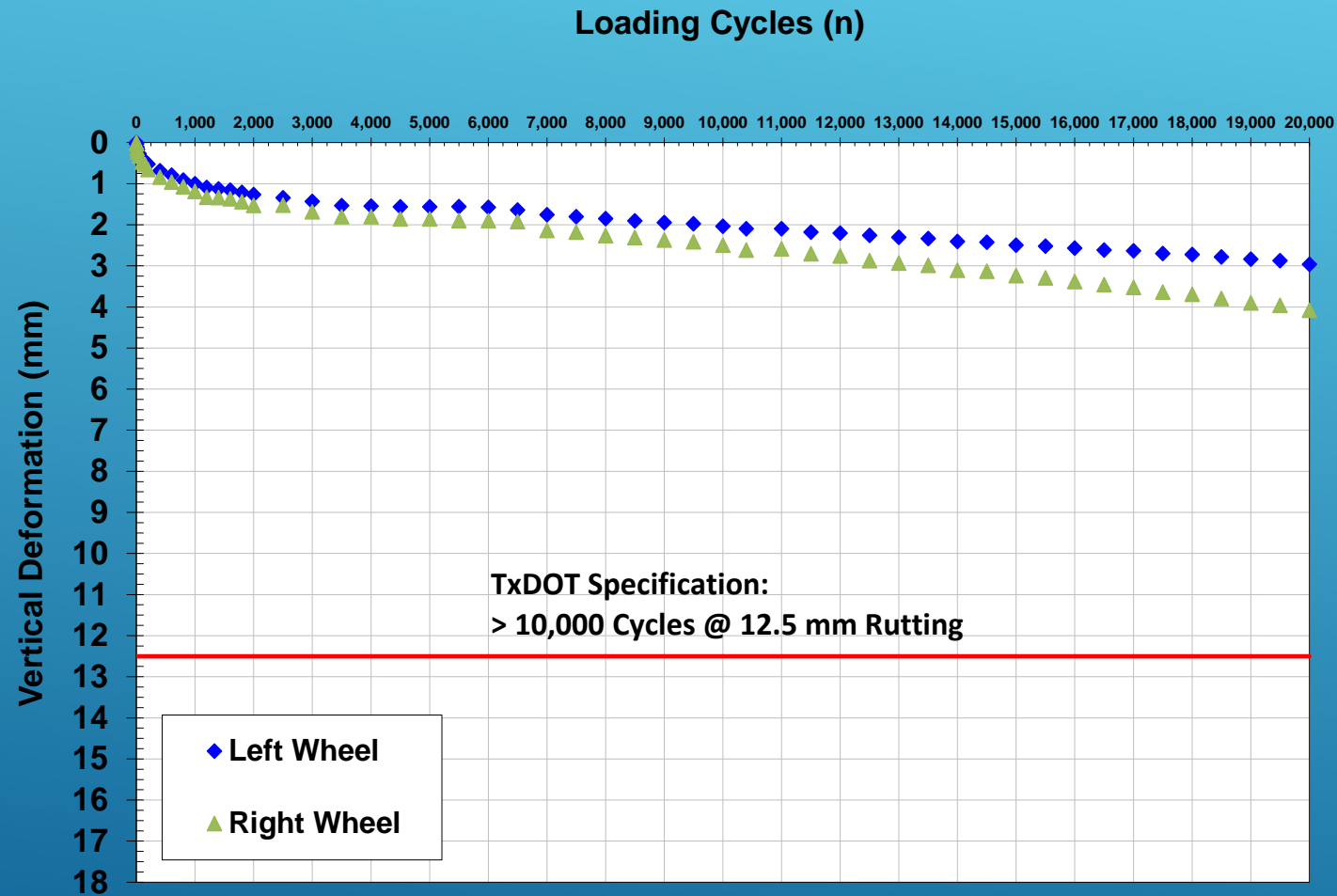


HAMBURG WHEEL TRACKING TEST



PG 76-22 Mix

HAMBURG WHEEL TRACKING TEST



StellarFlex GTRH Mix

STELLARFLEX GTRH MIX PERFORMANCE

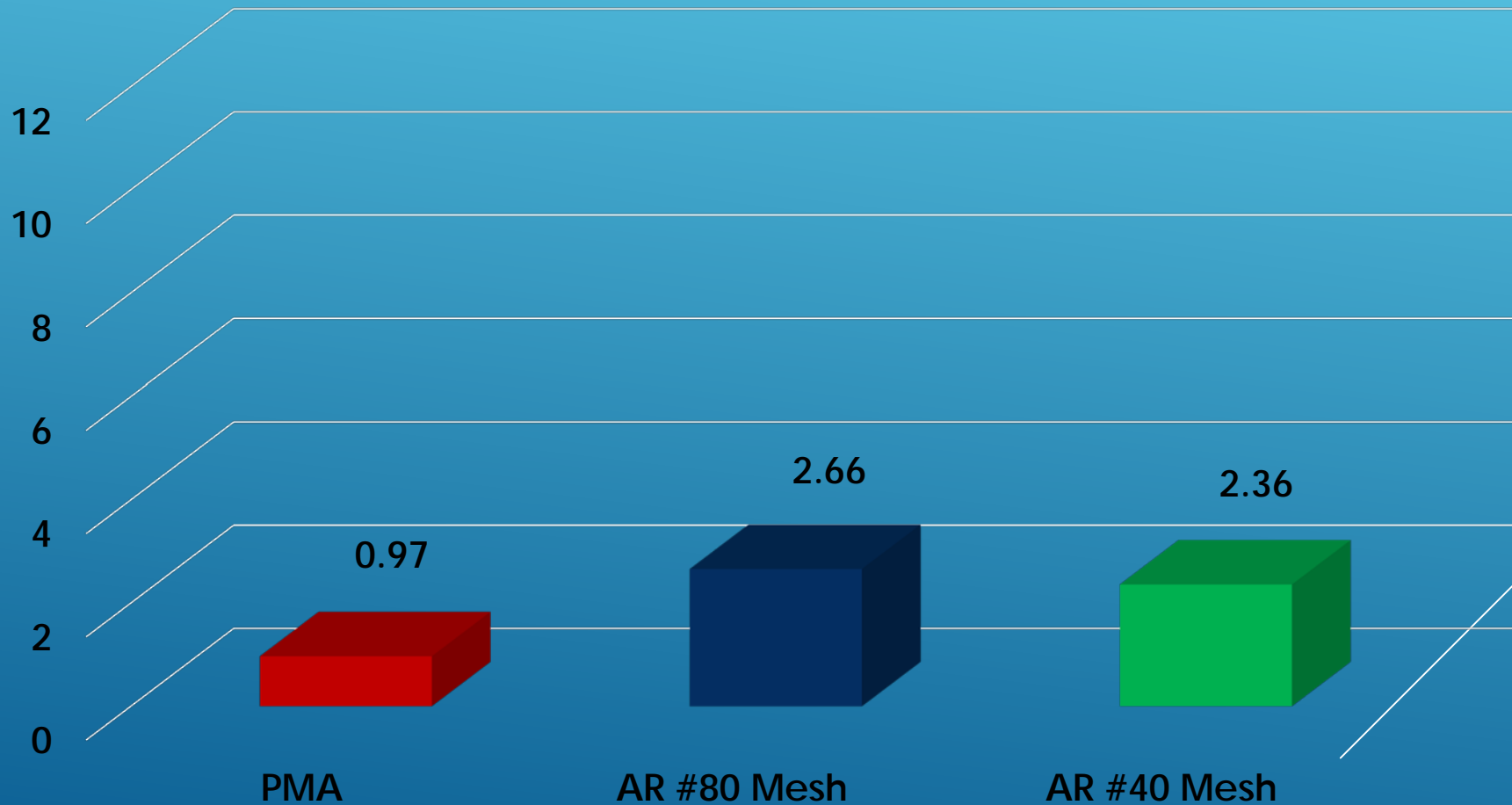
- ▶ StellarFlex GTRH mix performs equally to PG 76-22 PMA mix in both APA rutting and Texas Overlay Fatigue Cracking
- ▶ StellarFlex GTRH mix substantially outperforms PG 76-22 PMA mix in Hamburg Loaded Wheel Test
- ▶ How does StellarFlex GTRH perform compared to Asphalt Rubber?
- ▶ Cannot put Asphalt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

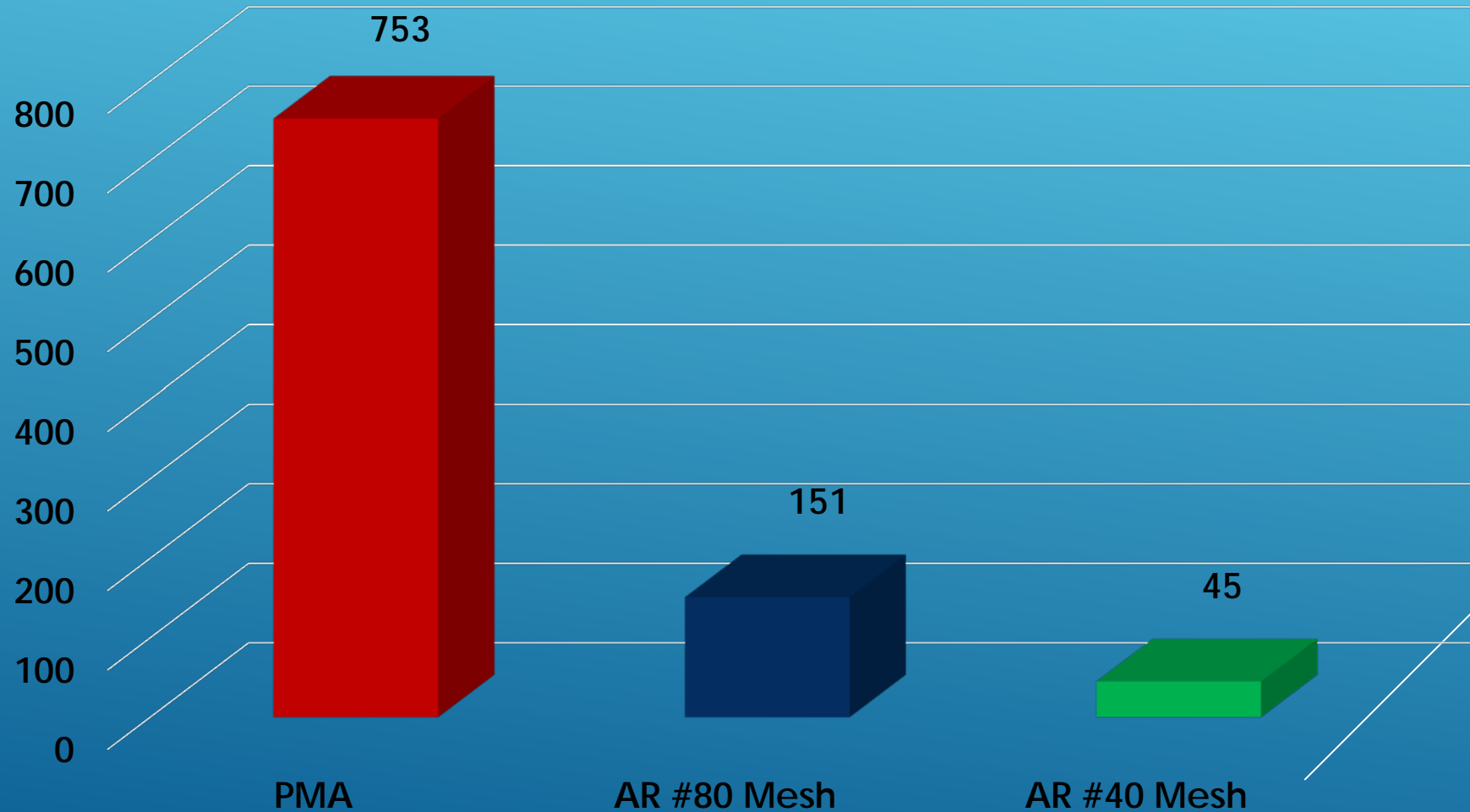
PMA VS. ASPHALT RUBBER

Hamburg Loaded Wheel Tester, rut depth @
20,000 cycles



PMA VS. ASPHALT RUBBER

Texas Overlay Test, cycles



SUMMARY

- ▶ StellarFlex GTRH is an effective, high performance GTR product
 - ▶ Meets specifications for PG 76-22, including Elastic Recovery
 - ▶ Meets 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

