# Use of High Performance-Graded (HPG) Binders in Texas

Amit Bhasin (CTR, UT Austin), Pravat Karki (MTD, TxDOT)

# Overview

- What is HPG?
- Why use HPG?
- HPG binders in TX
- HPG test sections in TX
- Workability of HPG
- HPG binder properties
- HPG mixture properties

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A modified binder but with much higher concentration of polymer or modifier compared to typical modified binders.

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Typically to:

- improve performance for the same structure,

and/or

- reduce layer thickness to achieve similar performance.

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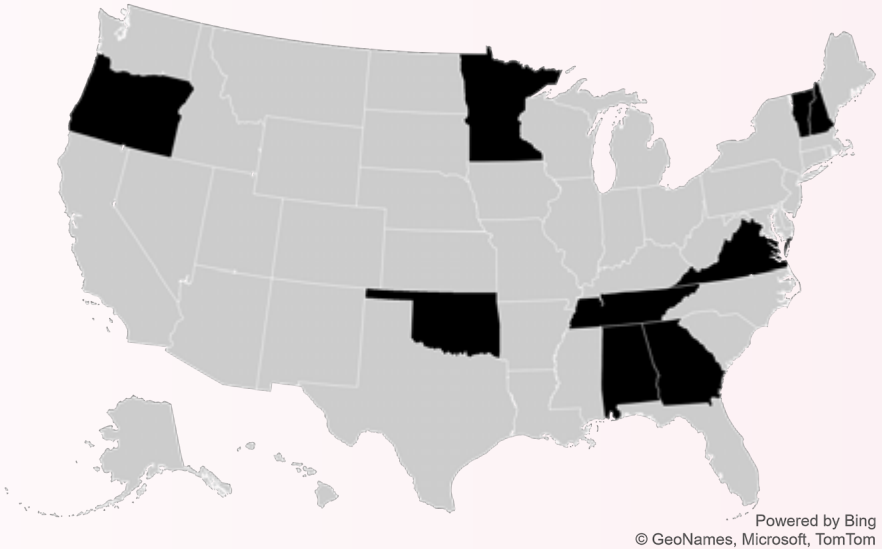
Mulitple sections across US have shown positive results with the use of binders with higher polymer content




Ref.:
Habbouche, J., Hajj, E.Y., Sebaaly, P.E. and Piratheepan, M., 2020. A critical review of high polymer-modified asphalt binders and mixtures. *International Journal of Pavement Engineering*, *21*(6), pp.686-702.

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Example: NCAT – reduced thickness from 7” to 5.75”

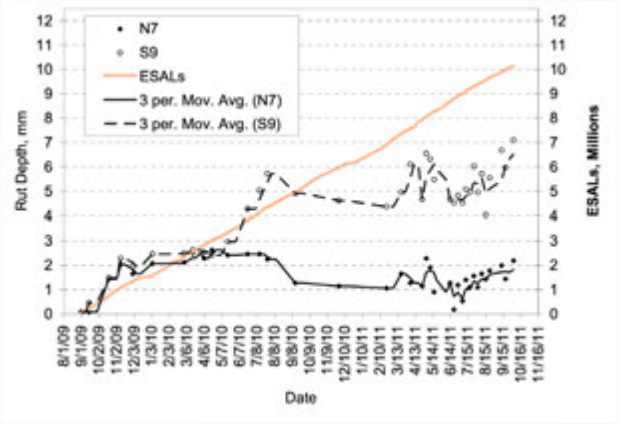


Fig. 1. Rut depth since 2009

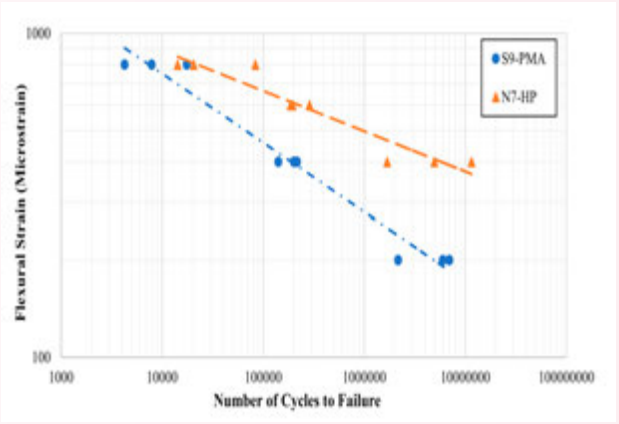


Fig. 2. Estimated Life until Failure


Refs.:
Timm, D.H., Robbins, M.M., Willis, J.R., Tran, N. and Taylor, A.J., 2013. Field and laboratory study of high-polymer mixtures at the NCAT test track. *Final report*, pp.13-03.
Habbouche, J., Hajj, E.Y., Sebaaly, P.E. and Piratheepan, M., 2020. A critical review of high polymer-modified asphalt binders and mixtures. *International Journal of Pavement Engineering*, *21*(6), pp.686-702.

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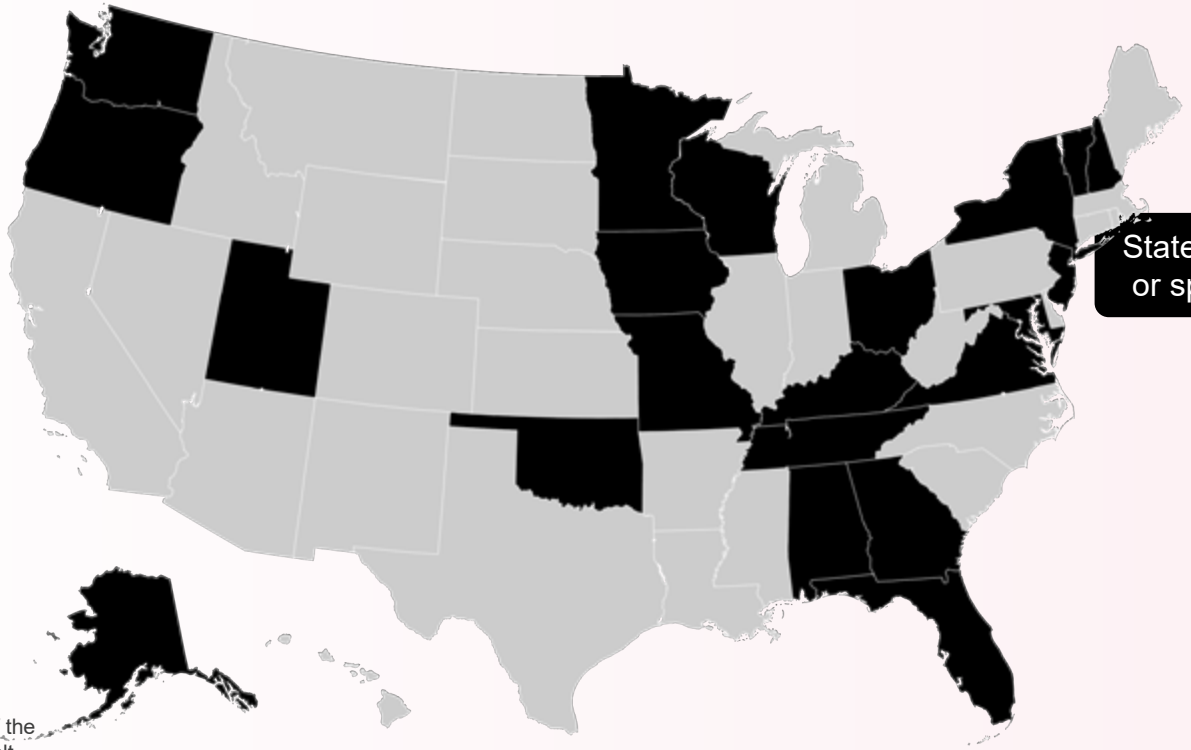
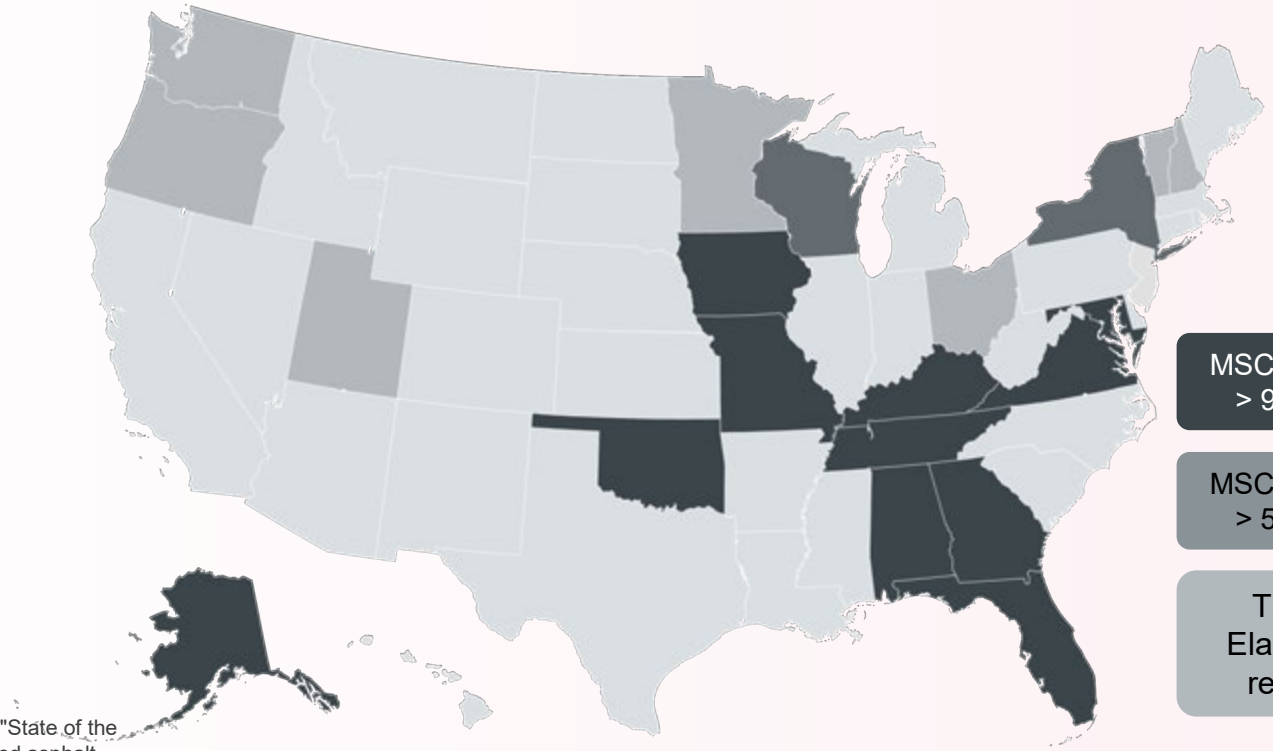
# HPG Binders in other states




Data: Habbouche, Jhony, et al. "State of the practice for high polymer-modified asphalt binders and mixtures." *Transportation Research Record* 2675.7 (2021): 235-247.

# HPG Binders in other states



MSCR %Rec. requirement > 90-95% at 64 or 76C

MSCR %Rec. requirement > 55-75% at 58 or 76C

T301 Ductilometer Elastic Recovery (ER) requirement > 90%

Data: Habbouche, Jhony, et al. "State of the practice for high polymer-modified asphalt binders and mixtures." *Transportation Research Record* 2675.7 (2021): 235-247.

# HPG Binders in TX

- TxDOT published Special Specification 3096-002 One-Time-Use (OTU) specification in Feb. 2022 to allow the use of HPG in Austin district to address the impact of skyrocketing number of near-stopping traffic vehicles.
- TxDOT gathered experience from agencies and industry in Oklahoma, Florida and Virginia and shared relevant info with their counterparts in Texas.
- TxDOT asked asphalt binder suppliers to provide binders that meet SS3096-002 OTU spec. requirements (esp. MSCR %Rec. ≥ 90% and 7.5% SBS Polymer) or ***their equivalents***. Several were identified as OTU compliant ***or equivalent***.
- TxDOT started certifying binders that do meet SS3096-002 OTU spec. requirements from 2023, 2nd Quarter.

# HPG Binders in TX

- Special Provision to Special Spec. 3096: SS3096-002 (02/22)
- HPG = High Performance Grade
- Typically a modified asphalt binder with higher polymer content

Higher viscosity allowance at 135C (5.0 Pa-s for HPG compared to 3.0 Pa-s for other PGs)

Stringent intermediate temperature requirement at 25C (4,000 kPa for HPG compared to 5,000-6,000 kPa PG76-28)

**High Performance-Graded (HPG) Binder**

| Test Method and Property | HPG |
|---|---|
| **Original Binder** | |
| Flash Point, AASHTO T 48, Min. °C | 230 |
| Viscosity, AASHTO T 316, Max. 5.0 Pa-s, test temperature, °C[1] | 135 |
| Polymer Separation, Tex-540-C, Max. % | 4.0 |
| Polymer Content, Tex-533-C[2], Min. % | 7.5 |
| **Rolling Thin-Film Oven (AASHTO T 240)** | |
| Mass Change, AASHTO T 240, Max. % | 1.0 |
| Multiple Stress Creep Recovery, AASHTO T 350:<br>Jnr, at 3.2 kPa, Max. 0.10 kPa$^{-1}$,<br>% Recovery, at 3.2 kPa, Min. 90.0%,<br>Test temperature, °C | 76 |
| **Pressure Aging Vessel (PAV) Residue (AASHTO R 28)** | |
| PAV aging temperature, °C | 100 |
| Dynamic shear, AASHTO 315:<br>G*sin(δ), Max. 4,000 kPa<br>Test temperature @ 10 rad/sec., °C | 25 |
| Bending Beam, AASHTO T 313[3]:<br>S @ 60 sec, Max. 300 MPa,<br>m-value @ 60 sec, Min. 0.300,<br>Test temperature, °C | -18 |

Higher %Rec. requirement at 76C (90% for HPG compared to 60% for a PG76-28)

A softer -28 low grade required

# HPG Sections in Texas

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- TxDOT/MTD has been and will be reaching out to Districts that want to try both SS3096-002 compliant and alternative HPGs in SMA, PFC, TOM, Superpave, etc.
- TxDOT/MTD has asked CTR under an interagency contract to collect/test the materials (binders and mixtures), document the districts' experience from construction to performance, and provide recommendations.
- TxDOT/MTD and CTR are running SS3096-002 prescribed tests as well as some newer tests (such as Poker chip and 8 mm DSR) being developed under Item 300 research Project 0-7073.
- TxDOT/MTD will revise the HPG specification based on these experience and recommendation.

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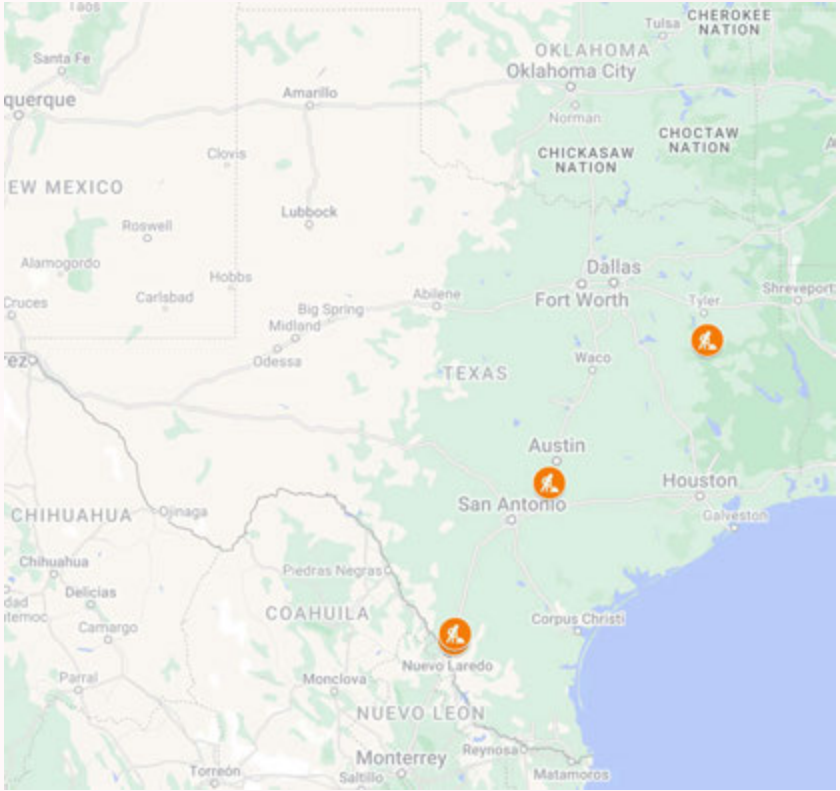

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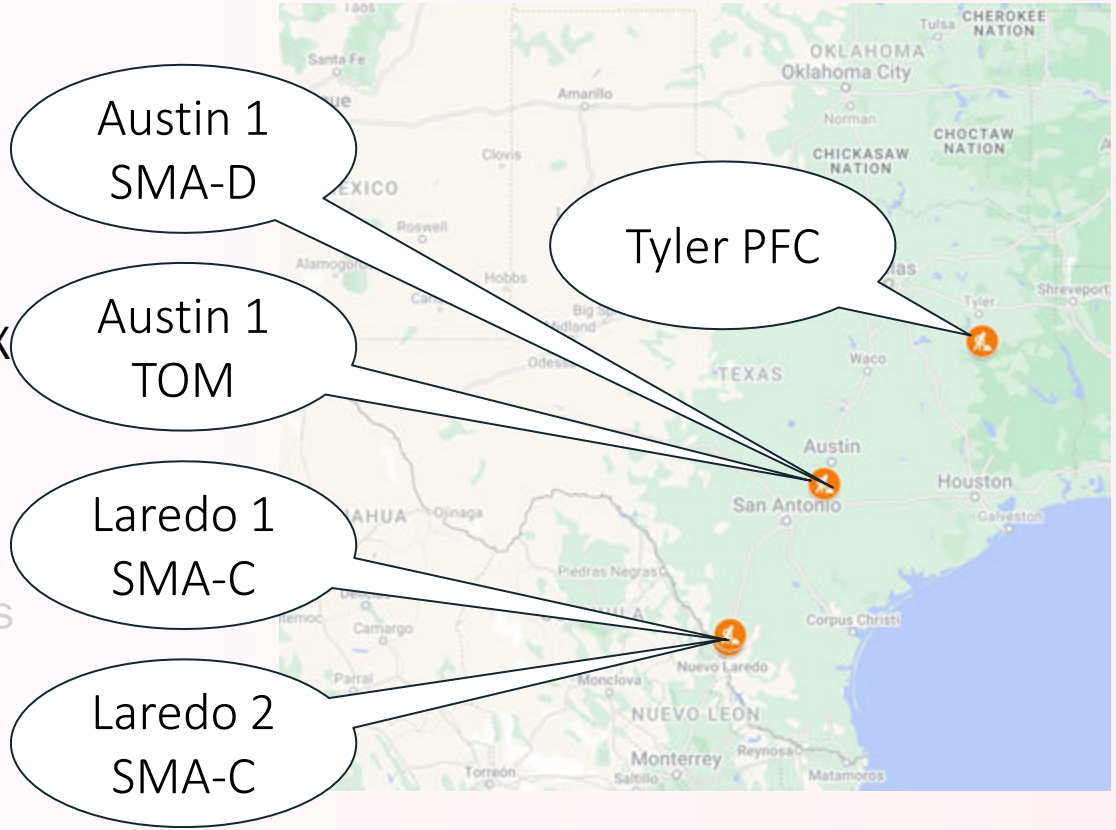

## Workability – Lab Binder Lab Mix Field Construction

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# Workability – Lab Binder Lab Mix Field Construction

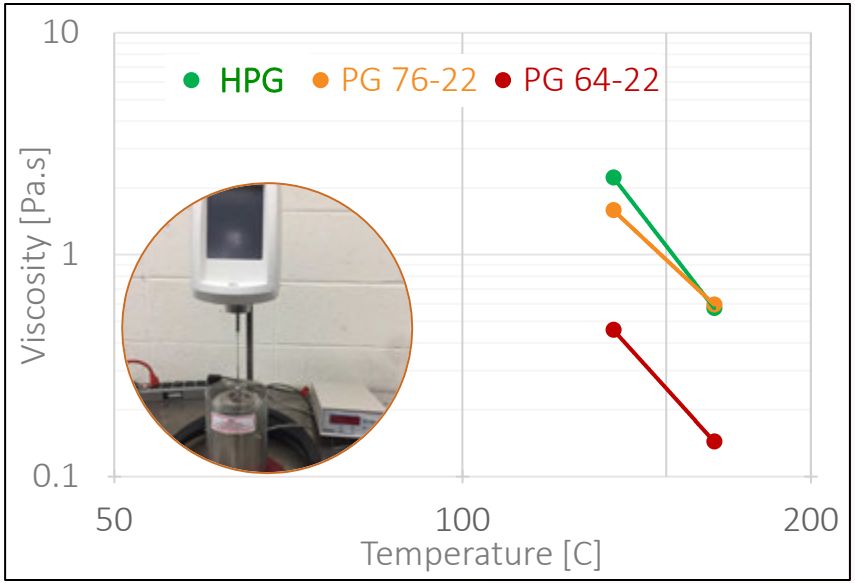


Fig. 1. Rotational Viscosity

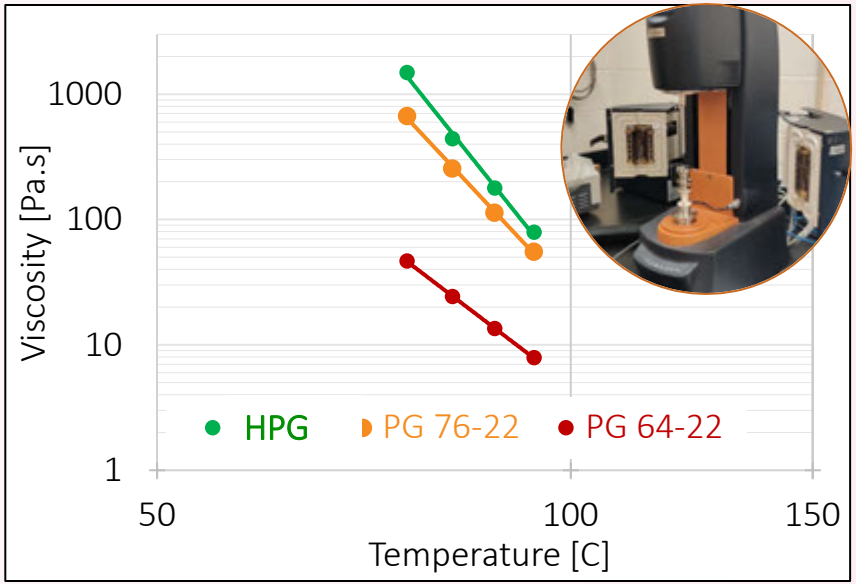


Fig. 2. DSR Viscosity

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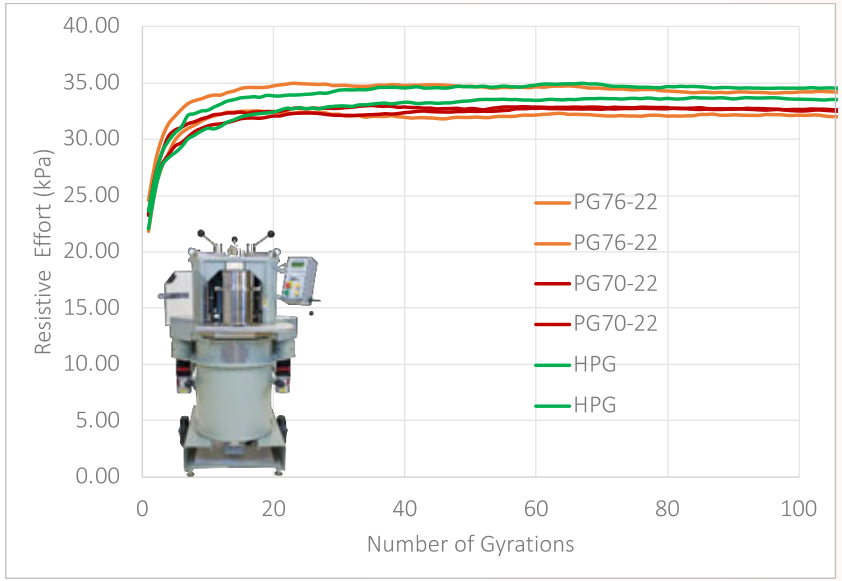


Fig. 1. PFC Workability

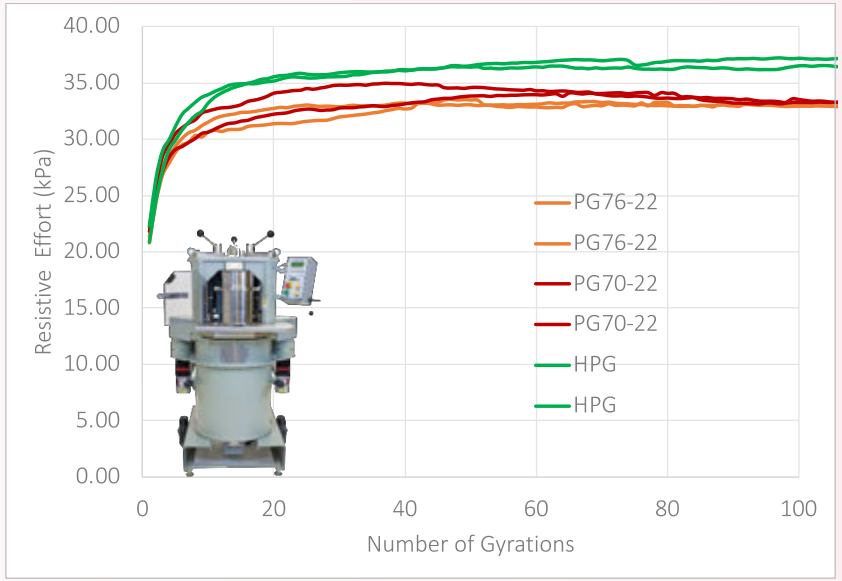


Fig. 2. SMA Workability

# Workability – Lab Binder Lab Mix Field Construction

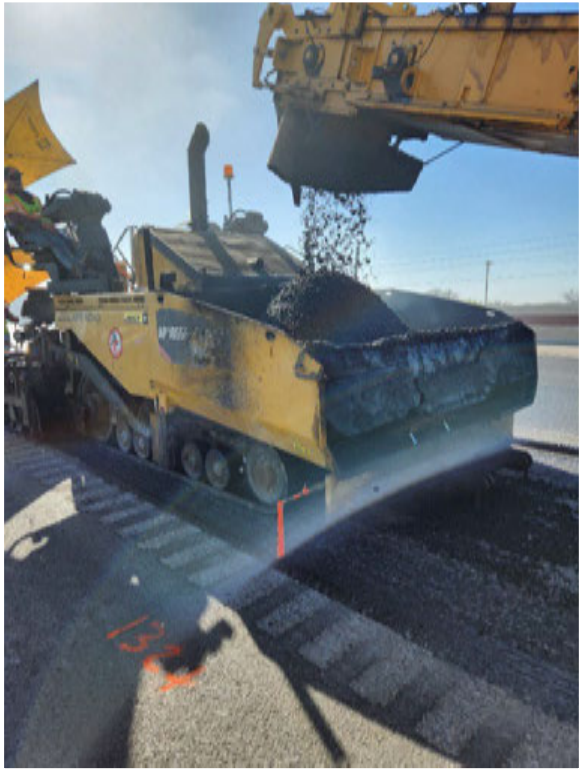

Fig. 1. Placement

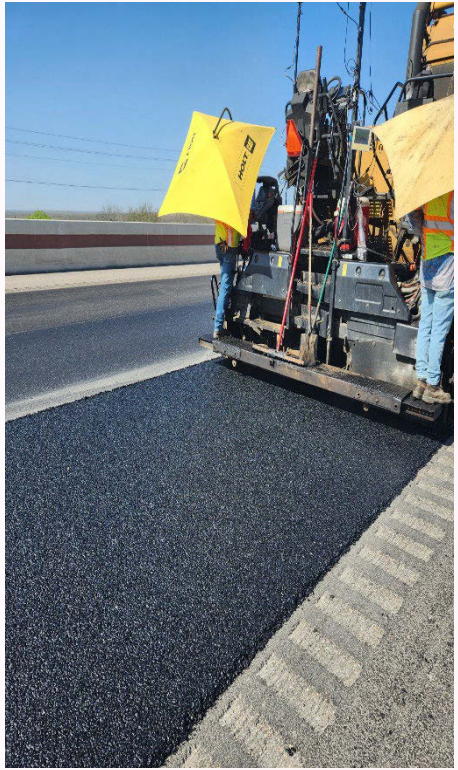

Fig. 2. Compaction

## SMA Site 1:

- 3 inch SMA
- Windrow temperature = 320F
- No problem with laydown or compaction

# Workability – Lab Binder Lab Mix Field Construction

Fig. 1. Placement



Fig. 2. Compaction

## SMA Site 2:

- 3 inch SMA (mill and replace)
- Temperature started at 350 F and no issues with placement or compaction
- Some issues when temperature hit 305 F; construction delay caused some issues when temperature fell to 225F

# Workability – Lab Binder Lab Mix Field Construction

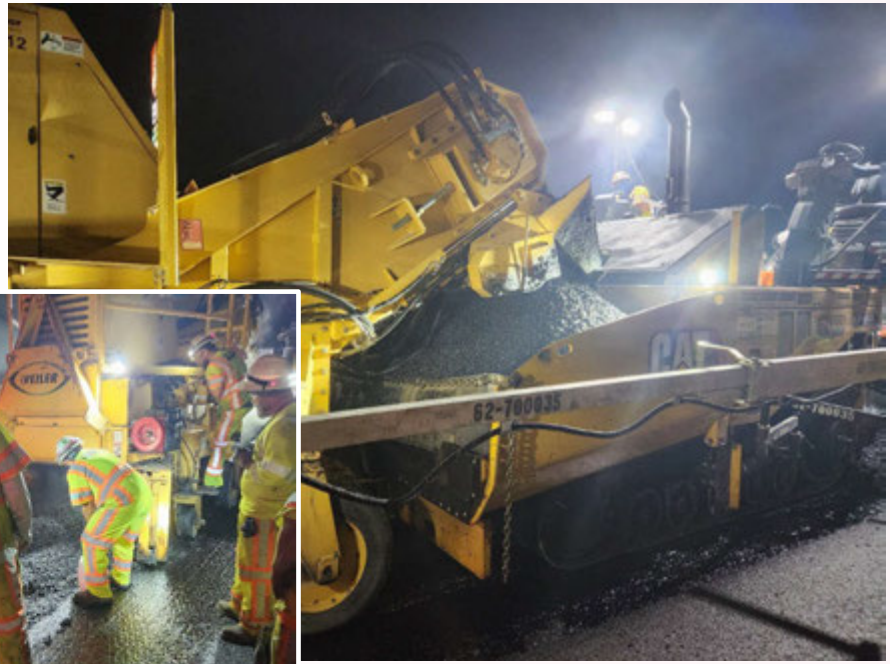

Fig. 1. Placement

Fig. 2. Placement

## SMA Site 3:

- 2 inch SMA (mill and replace)
- Initially temperature was 275 F and some pick up issues
- Successive mixes at 325 F went smoothly without any issues

# HPG Binder Properties

# Performance Grade (PG)

# Poker Chip Ductility

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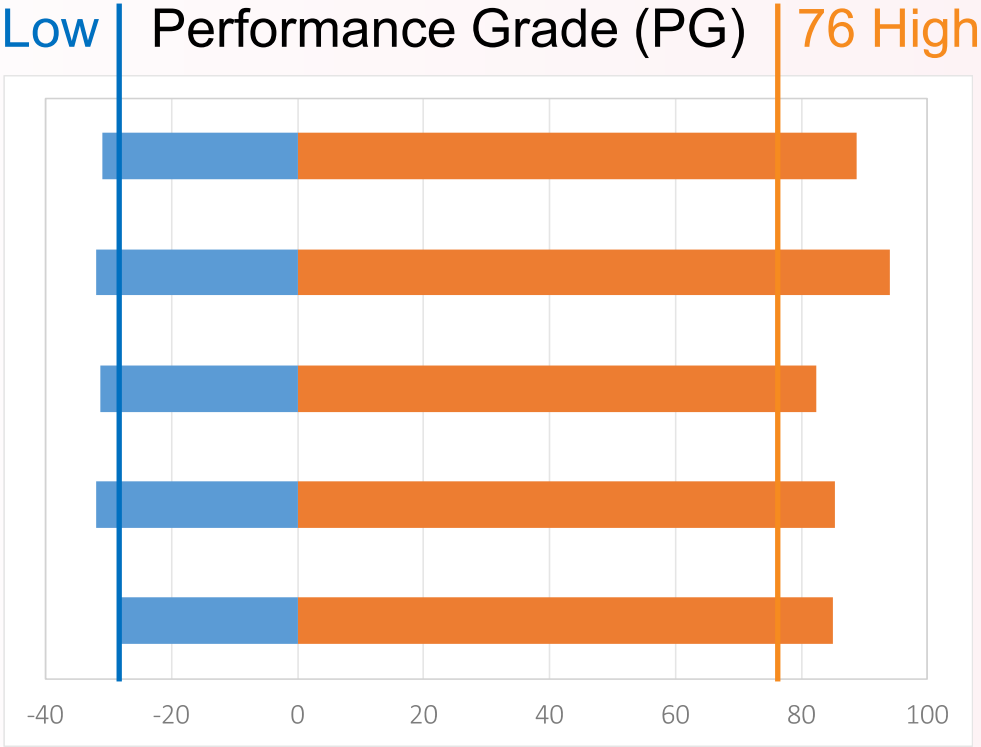
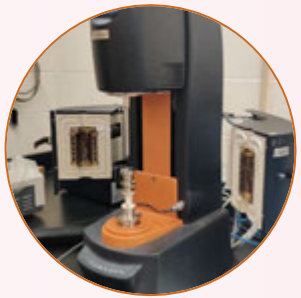
**Performance Grade (PG)** | Poker Chip Ductility

BBR



DSR

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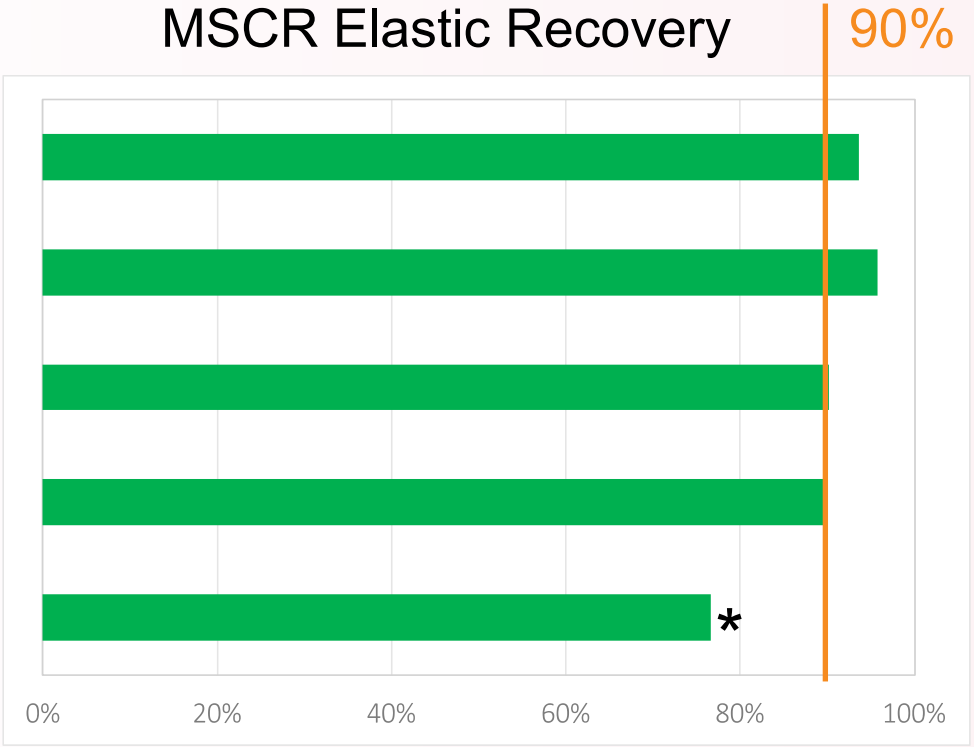
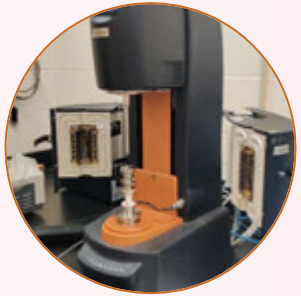


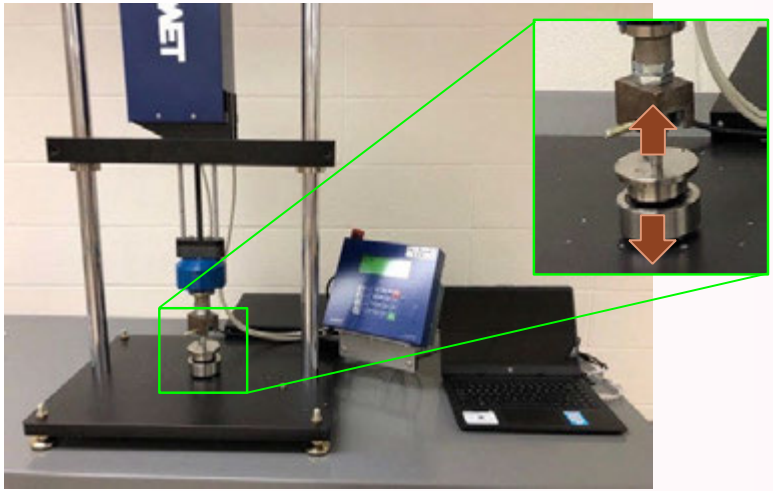
DSR

* A binder substitution had to be made.

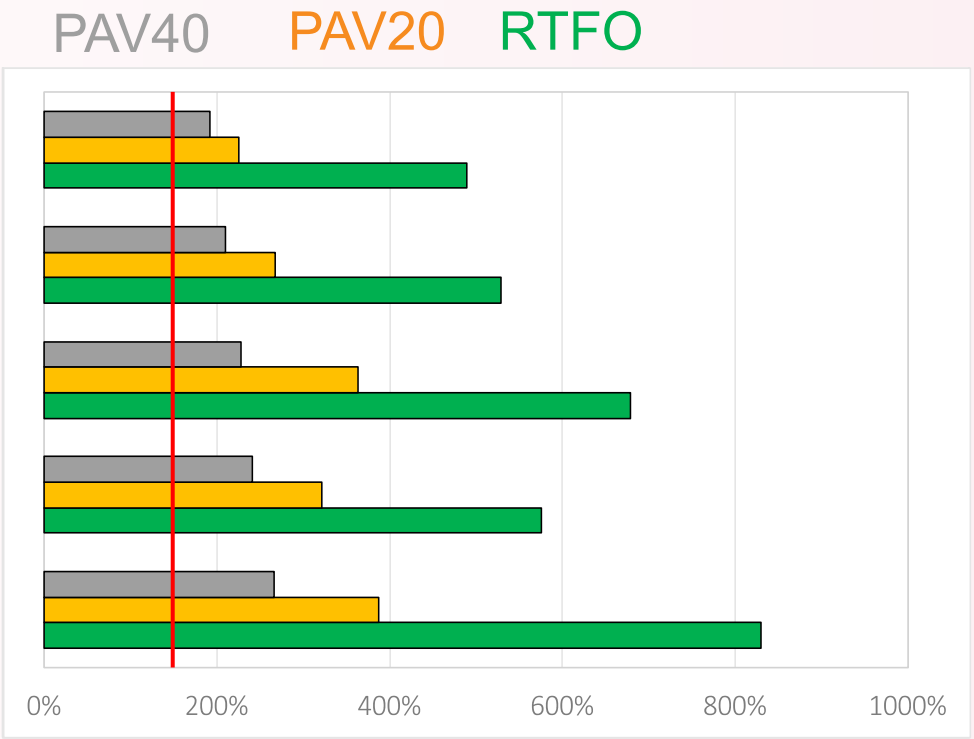
# HPG Binder Properties

Performance Grade (PG)

**Poker Chip Ductility**



Poker Chip Instrument



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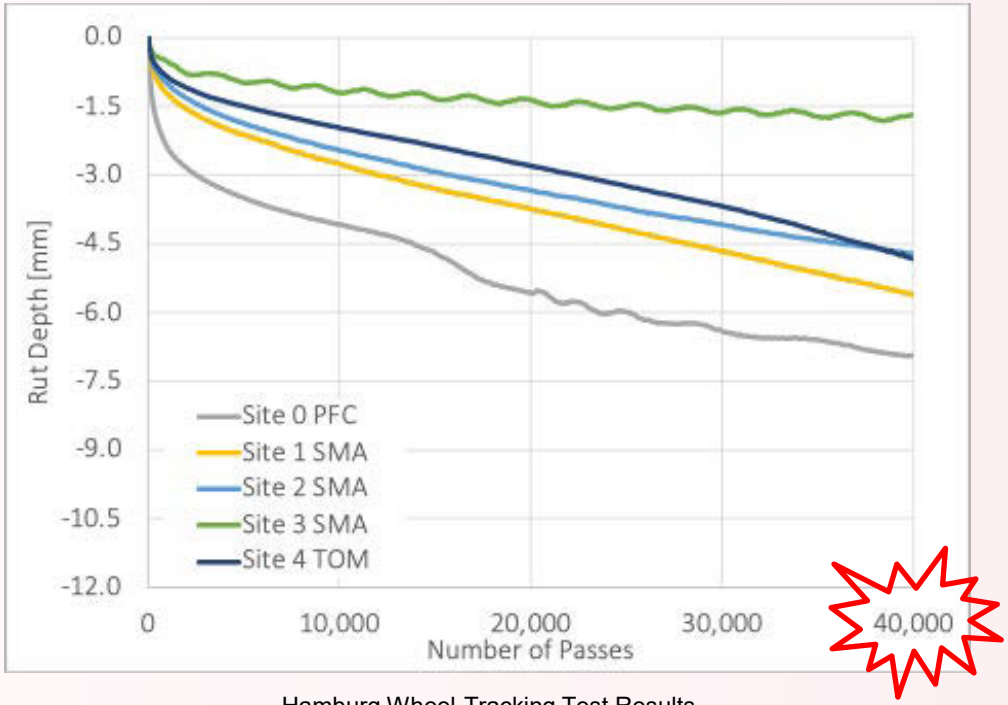
Hamburg Wheel-Tracking Test Setup




Hamburg Wheel-Tracking Test Results

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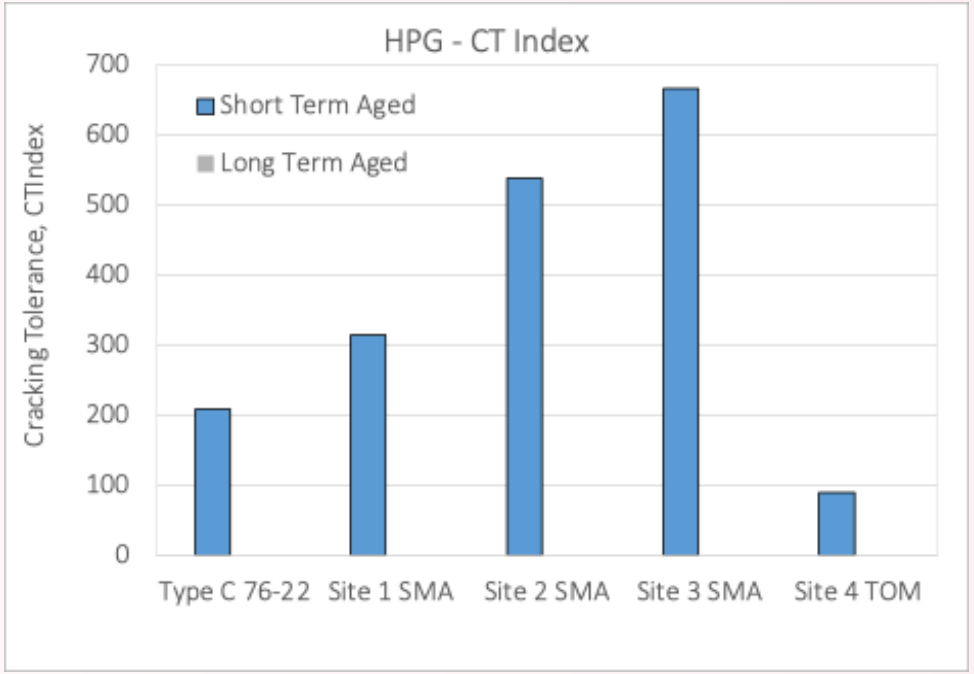
IDEAL-CT Test Setup




IDEAL-CT Test Results

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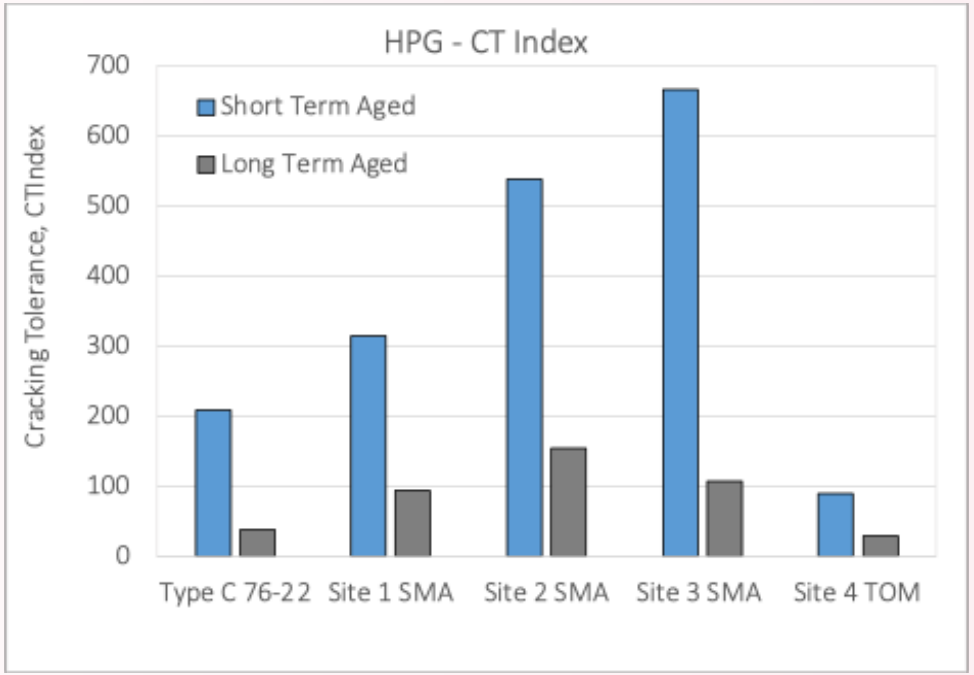


IDEAL-CT Test Results

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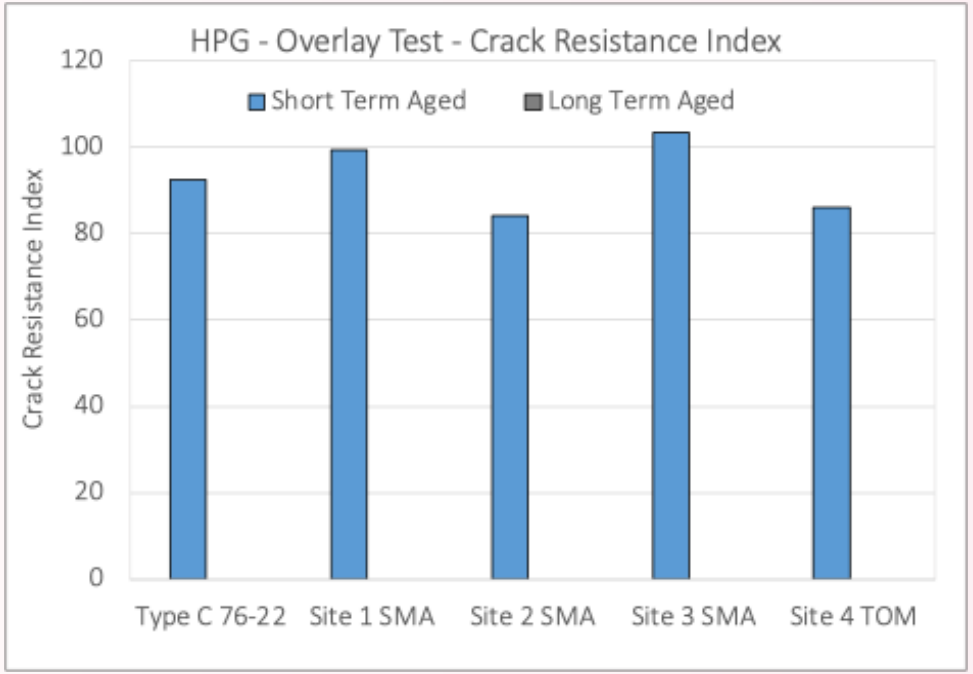
Overlay Cracking Test Setup

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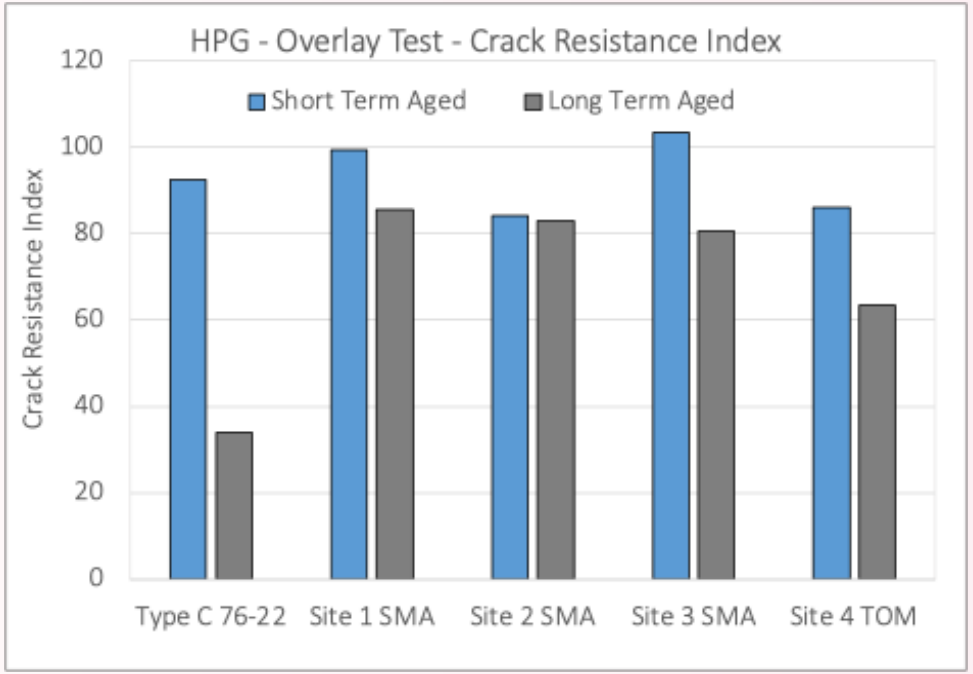


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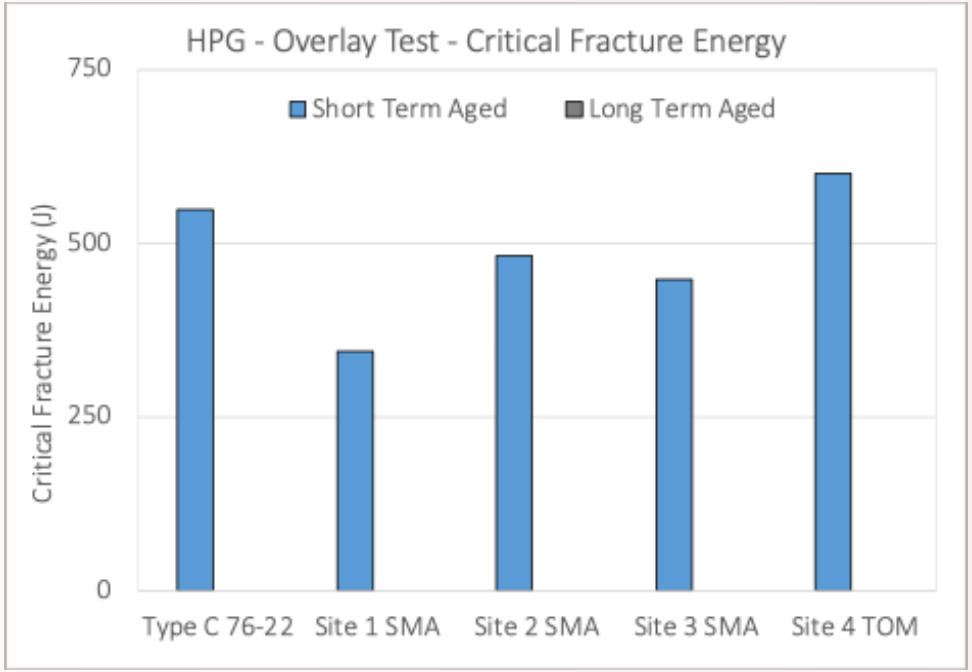


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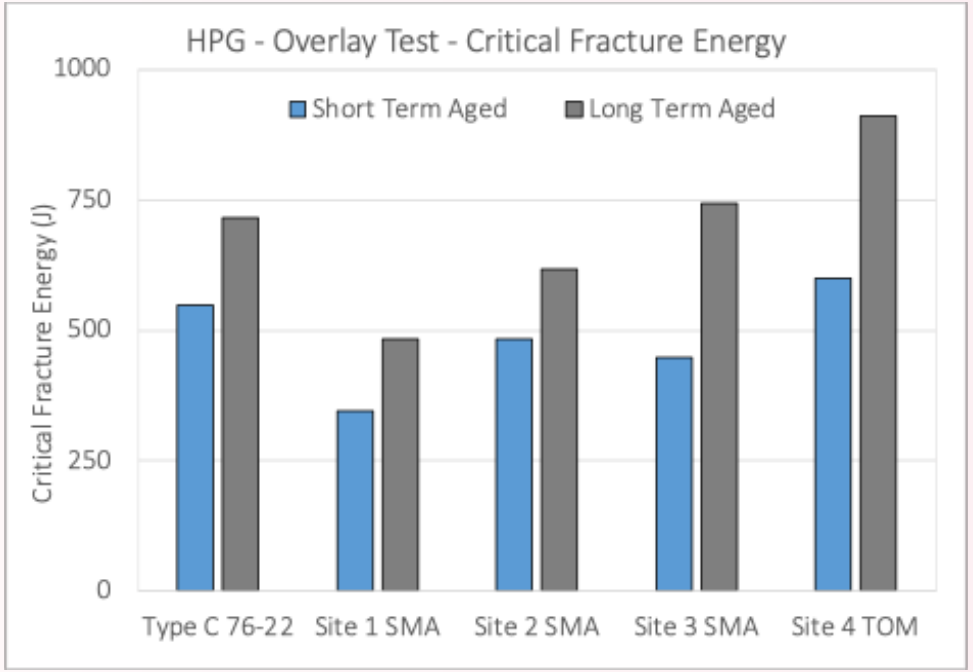


Overlay Cracking Test Results

# Next Steps

- Continue to monitor long-term performance.
- Continue to provide support to districts.
- Phase 2 lab study → constant mix design + HPG with different modifiers

# Acknowledgements


- MTD, TxDOT
  Ryan Barborak, Enad Mahmoud, Travis Patton, Melissa Benavides

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- CTR, UT Austin
  Darren Hazlett, Angelo Filonzi, Tyler Seay, David Chen, Satyavati Komaragiri

# Questions

## Contact:

TxDOT / MTD

MTD-Asphalt-Engineering@txdot.gov

CTR / UT Austin

bhasin@utexas.edu