PERFORMANCE. RELIABILITY.

Enhancing Pavement Quality and Longevity – Simple Solutions to Common Infrastructure Problems
QAW 2020

Grover Allen, Ph.D., P.E.

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Unsolved Infrastructure Problems

1. Poor Interlayer Bonding
2. Low-quality RAP Binder in New Roads
3. OGFC Aging Rate (High Voids)
4. Poor Maintenance of Road Surfaces

Unsolved Infrastructure Problems

1. **Poor Interlayer Bonding**
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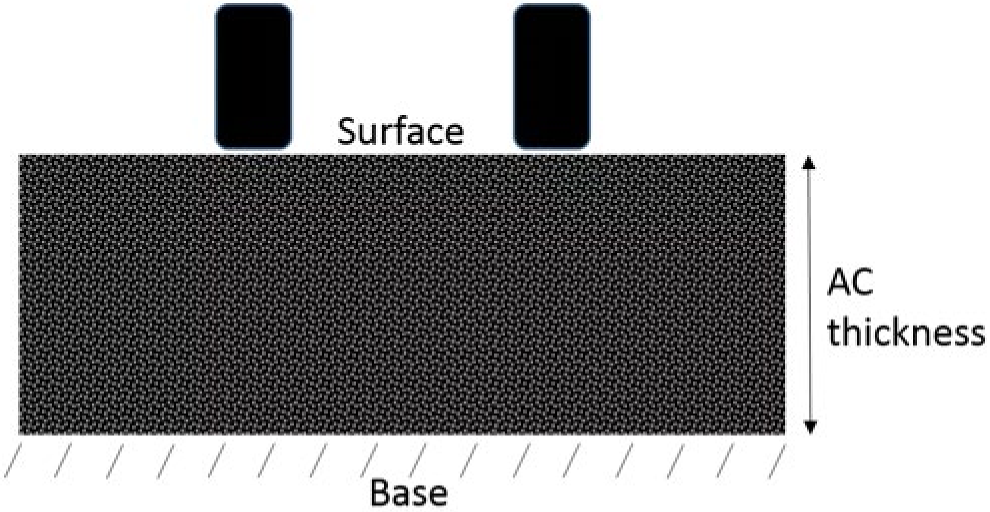
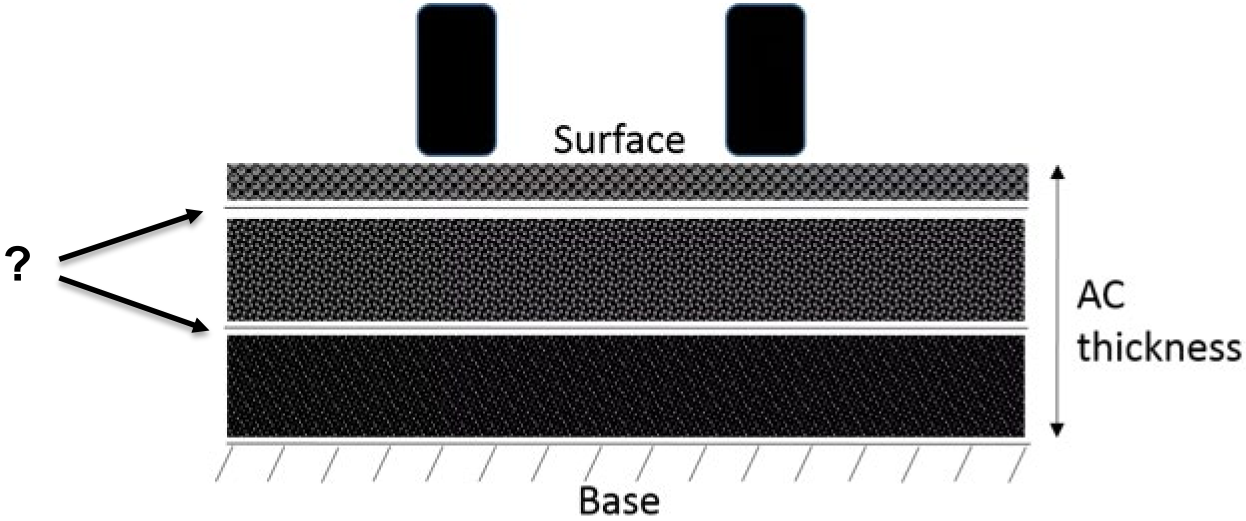
Consider Two AC Pavement Structures





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Tack Coat

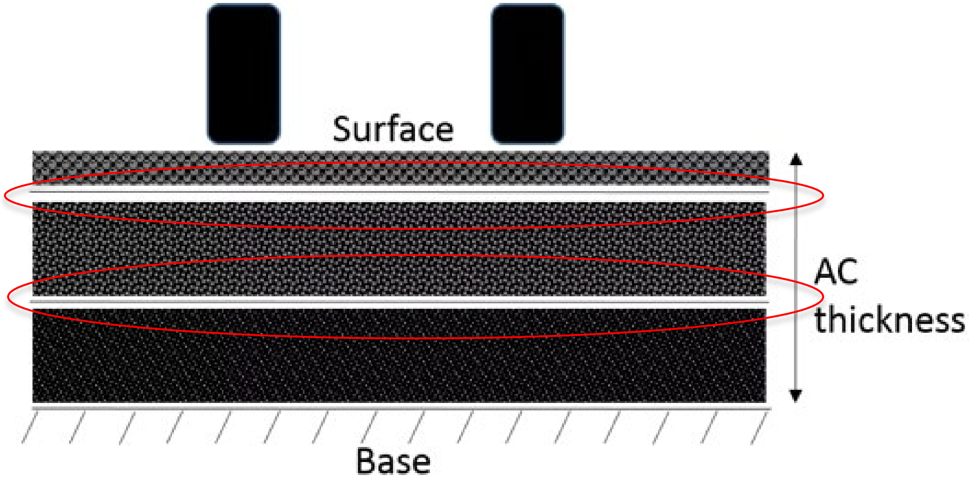
A light application of asphalt or asphalt emulsion

Used to promote the bond between pavement layers

Essential to overall pavement performance

Interface Failures

AI/FHWA Tack Coat Best Practices 2015 – Dave Johnson, P.E.



Forensics Case – IH-35 San Antonio

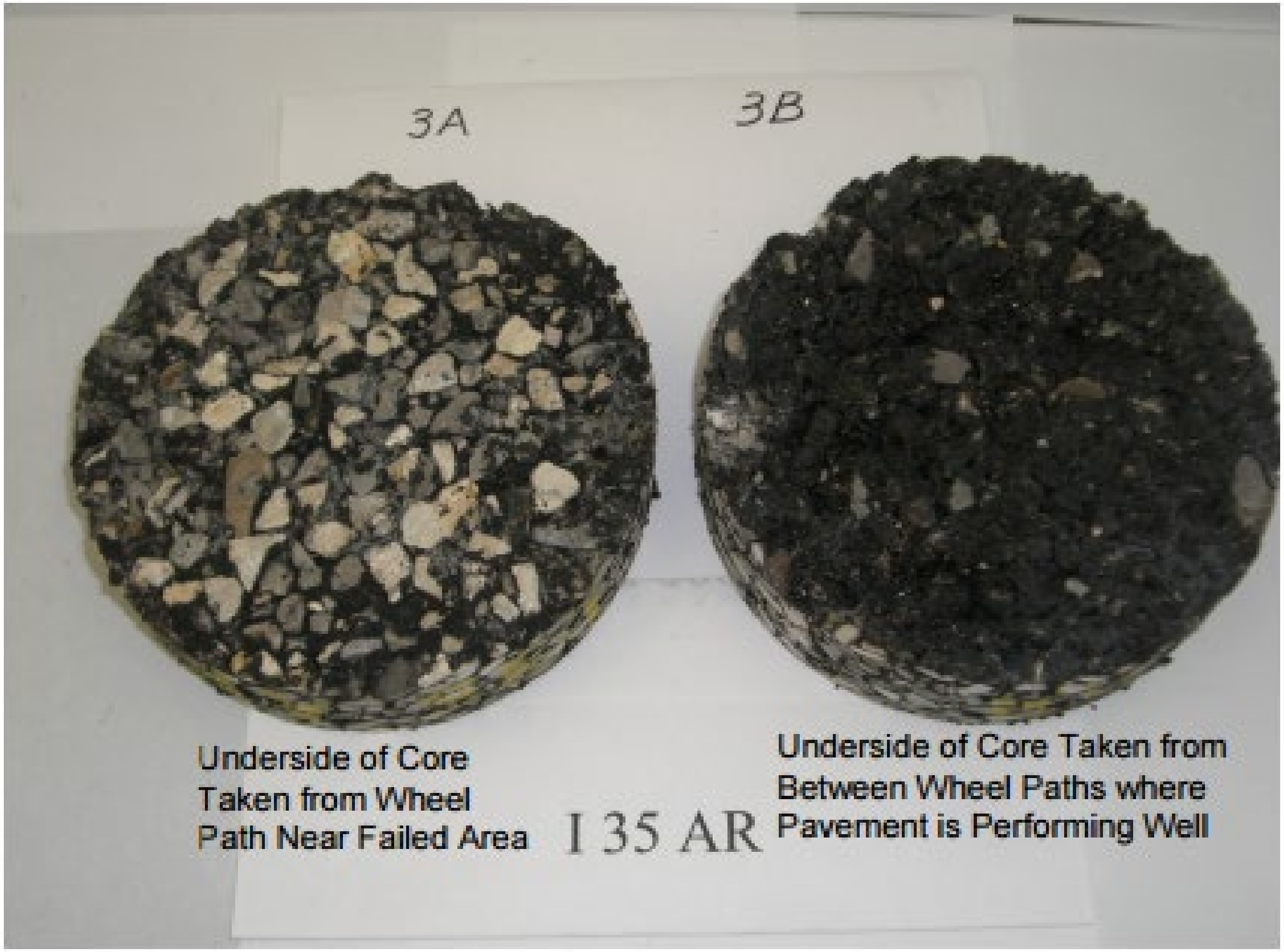


Figure 97. Cores Taken from Distressed PFC on IH-35 in San Antonio.

Performance and Cost Effectiveness of Permeable Friction Course Pavements – FHWA/TX-12/0-5836-2, TTI, 2013

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Adhesive Removal (Tracking)

Gierhart D (2015).
AI - Tack Coat Best Practices.

Adhesive Removal (Tracking)

Tashman L, Nam K, Papagiannakis T (2006).
Evaluation of the Influence of Tack Coat Construction Factors on the Bond Strength Between Pavement Layers, WA-RD 645.1.

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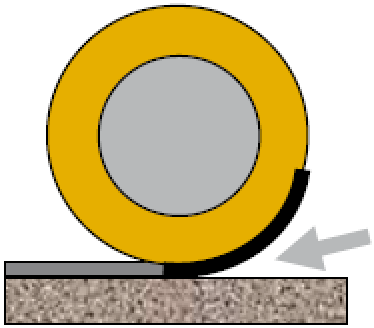
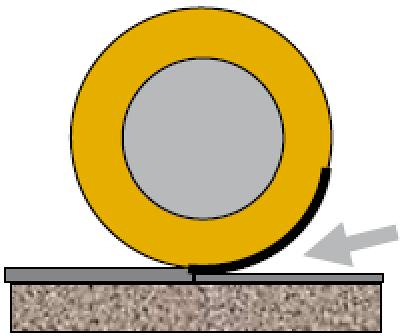
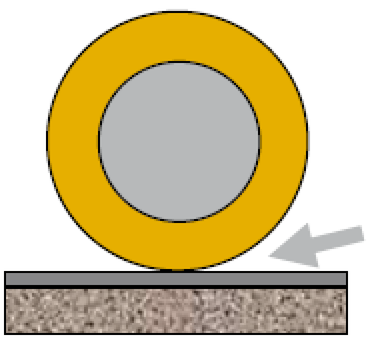
What Causes Tracking?



Tracking: Adhesion to Tire >> Adhesion to Road



Tracking: Adhesion to Tire >> Cohesion of Binder



Trackless: Adhesion to Tire << Adhesion and Cohesion

Gorsuch, C (2014).
Emulsions of High Softening Point Bitumens and Their Potential Uses in Road Construction and Maintenance.

How Important is Tack Coat Coverage/Removal?

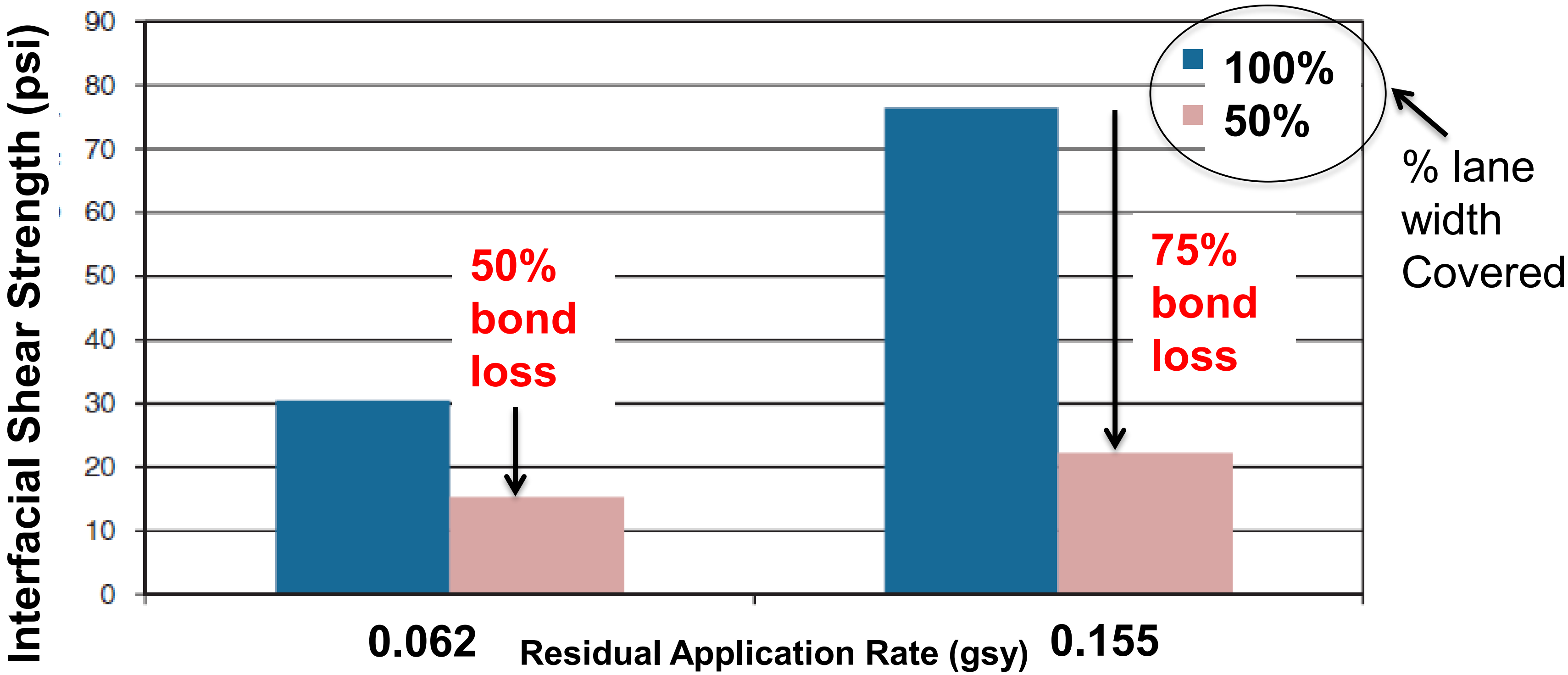


Figure 66. Effect of tack coat coverage on ISS.

Mohammed LN, Elseifi MA, Bae A, Patel N, Button J, Scherocman (2012). NCHRP Report 712 Optimization of Tack Coat for HMA Placement.[5]

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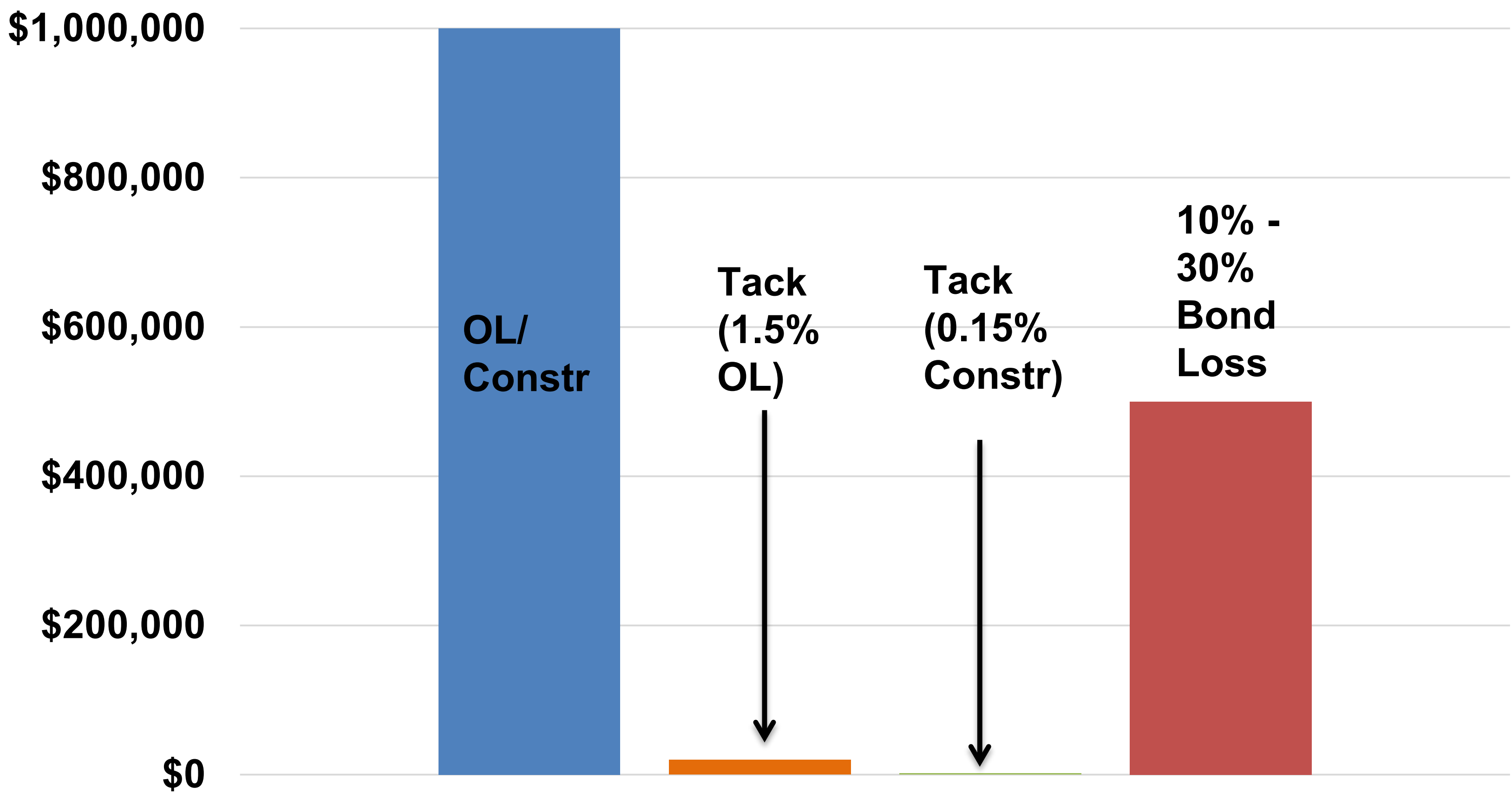
Cost of Tack Compared to Cost of Bond Loss

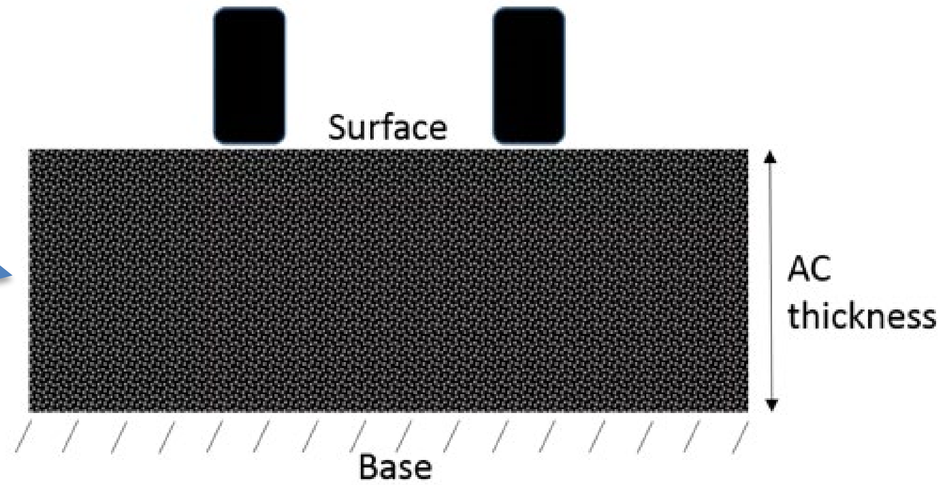


AI/FHWA Tack Coat Best Practices 2015 – Dave Johnson, P.E.

Cost of tack is insignificant to the project. Why not use a proven, high-quality solution?

Designing Pavements Like Its 1958

<u>Monolithic Structure</u>
Valid assumption for pavement design?



The 1958 AASHTO design methodology—
*Still used to this day by almost 80% of agencies and engineers…

Method assumes a <u>very conservative</u> (low) strength value.

NCAT studies in [2009](#) and [2014](#) calibrated the strength values.

- Findings:
  - Lack of bond <u>requires</u> thickness overdesign
  - **Ensuring bond reduces thickness requirement by roughly 20%**

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Starting with Aged Binder (20% average RAP)

QIP-129 (NAPA 2015)

Multi-source RAP pile (RAP Best Practices. NCAT 2010.)

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Re-using Aged Asphalt

New Pavement

+

Aged Pavement

≠

New Pavement

👌

New Pavement

+

Aged Pavement

=

New Pavement?

Regenerate Aged Asphalt Binder

Currently approved in most states to replace up to 20% of required binder in mix.

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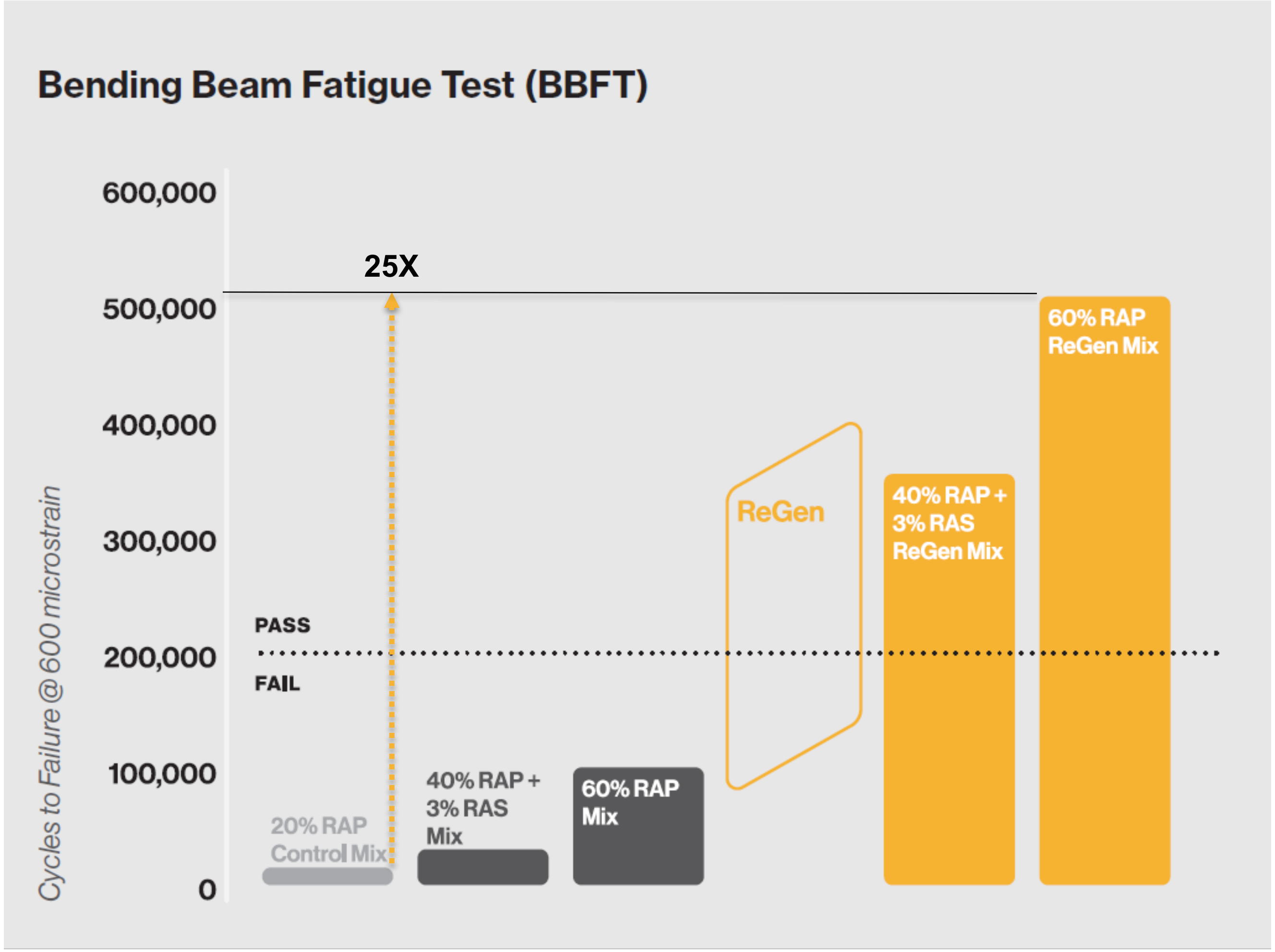
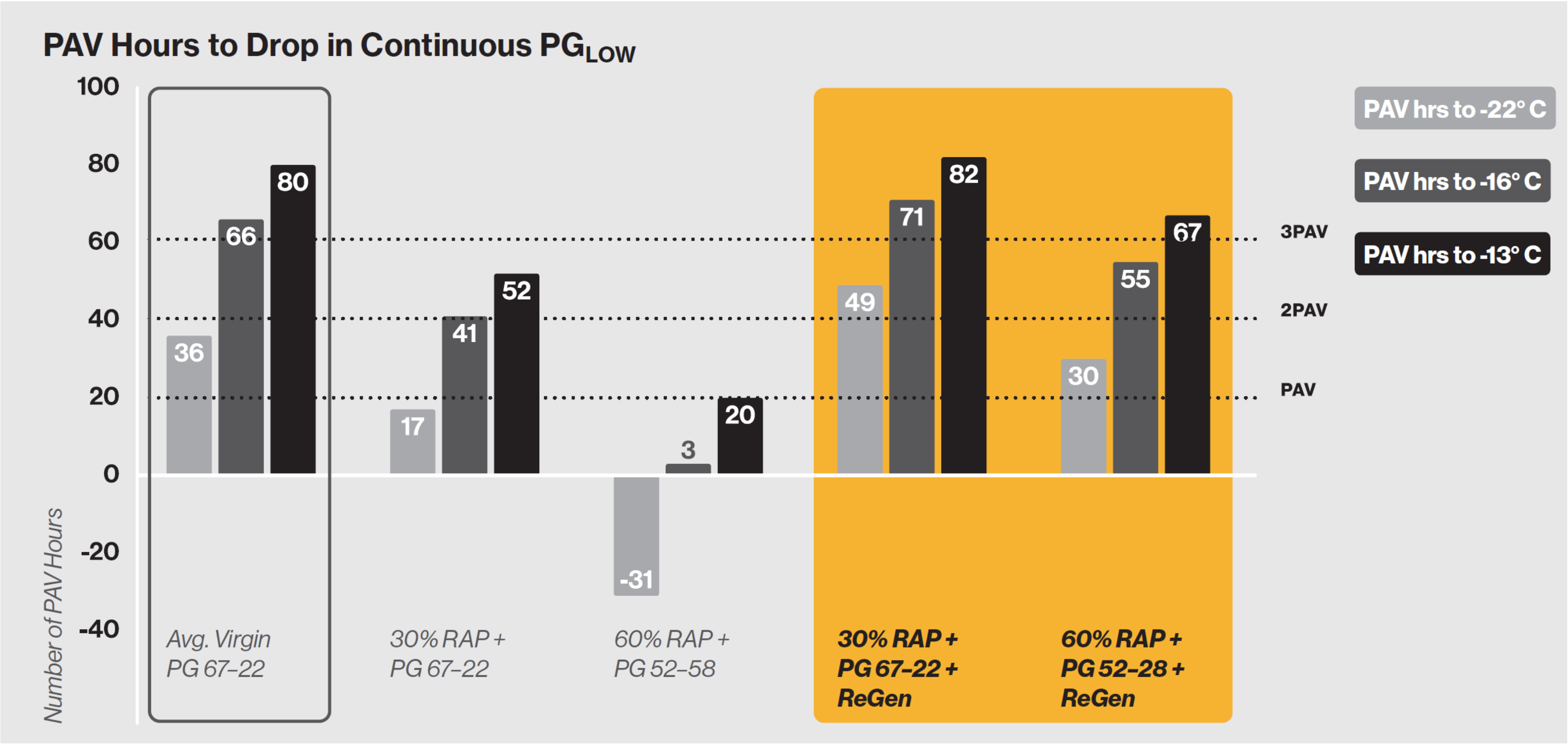
Superior Mix Fatigue Resistance (Fatigue-Resistant Bottom AC Layer)



Sustained Age-Resistance



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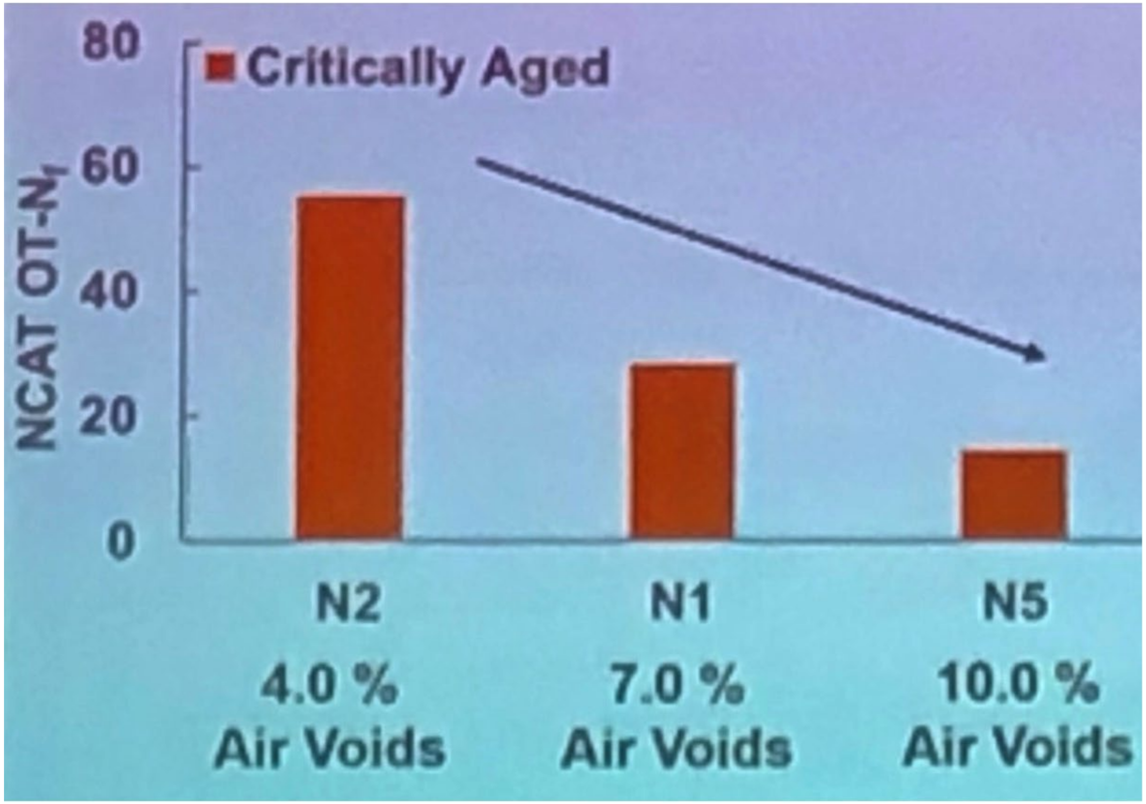
OGFC Aging vs Dense Mixture Aging



<u>Decreased</u> Expected Life
(similar cost of construction)

OGFC: 8 years
Dense: 13 years

Arambula et al. (2013). Performance and Cost Effectiveness of Porous Friction Courses

D'Angelo et al. (2019)

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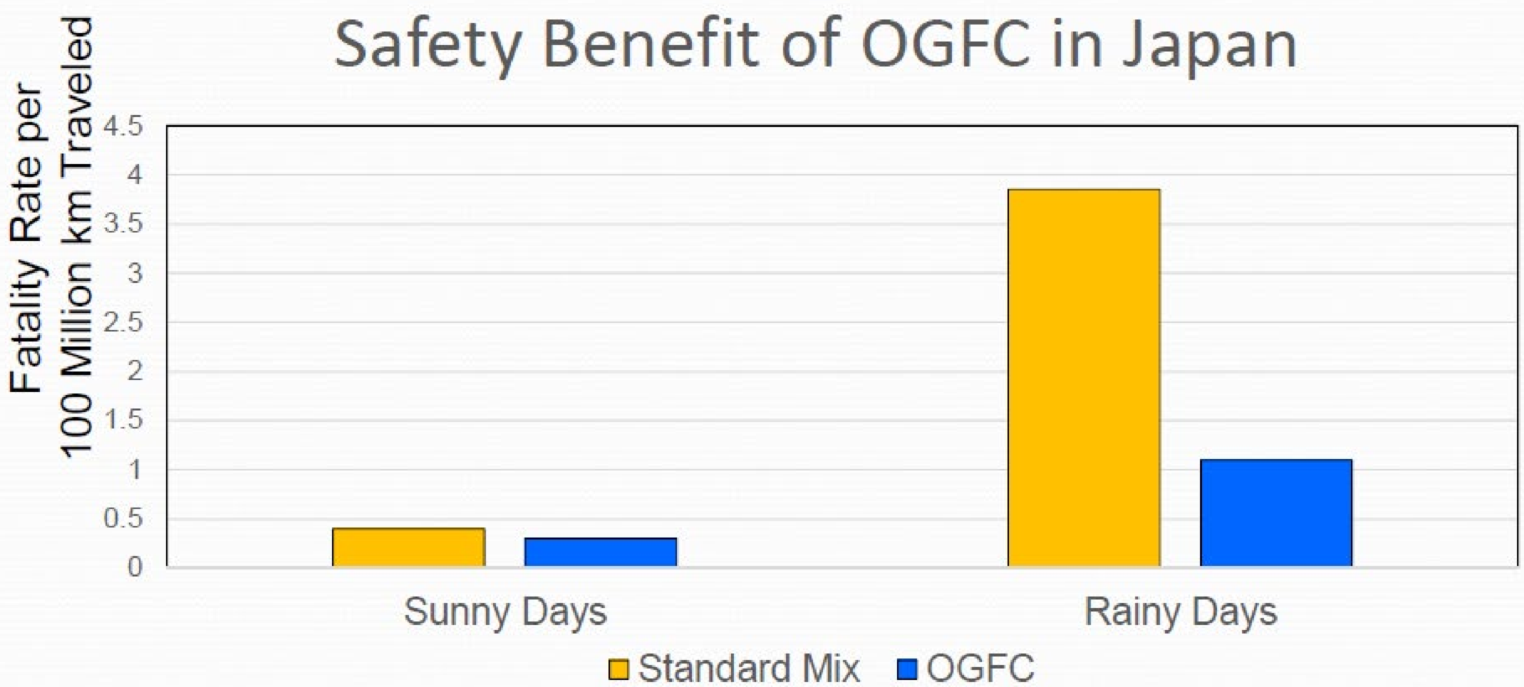
Fatality Reduction on Rainy Days



Source: Shimeno & Tanaka, 11th International Conference on Asphalt Pavement, 2010

National Center for Asphalt Technology NCAT at AUBURN UNIVERSITY

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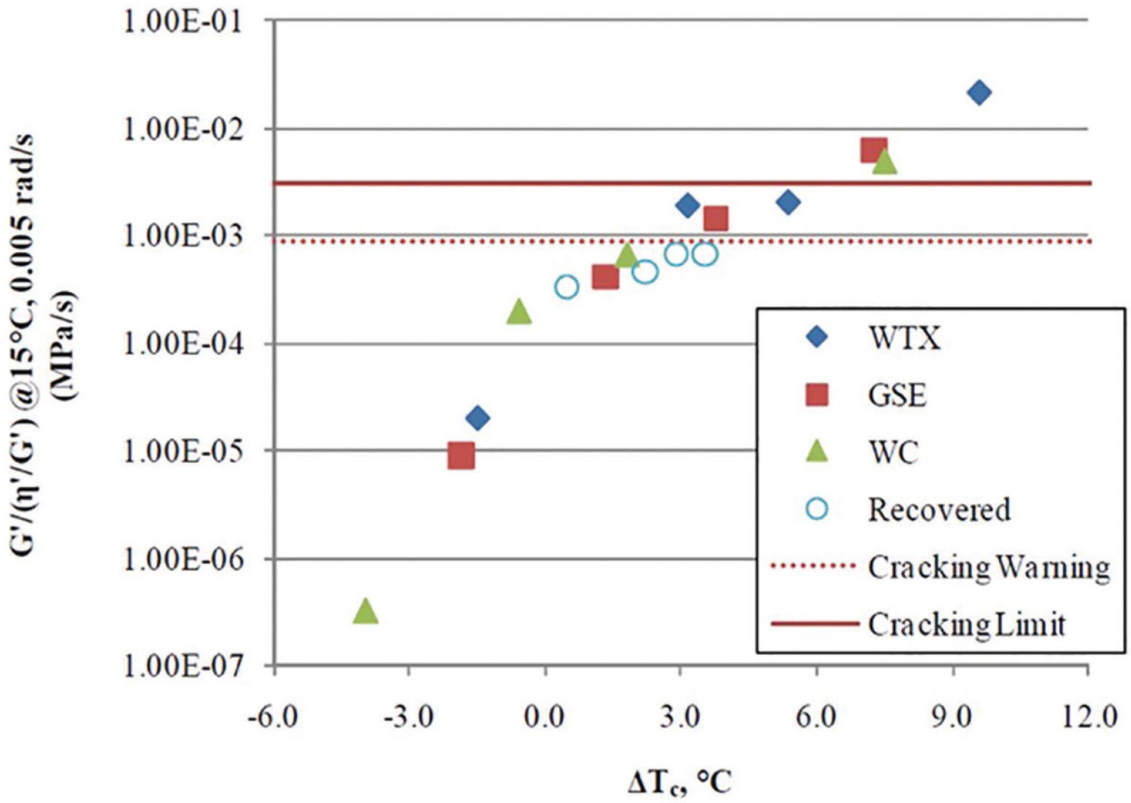
Enter ΔTc

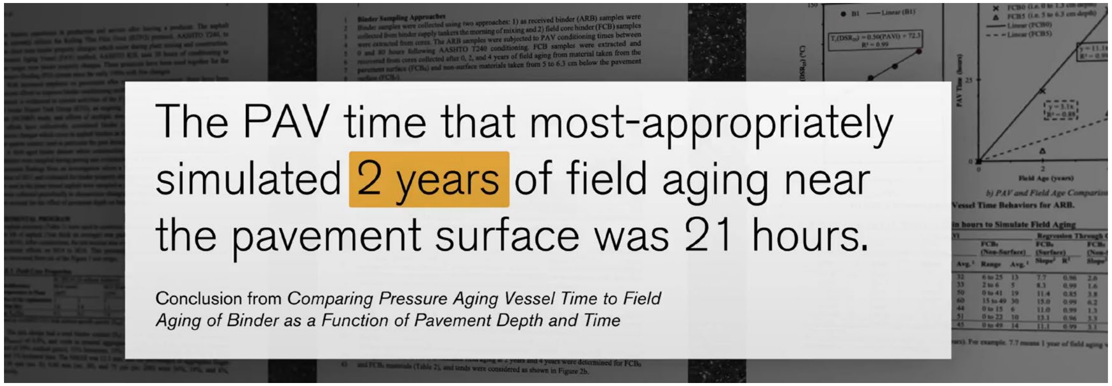
FIGURE 6. Relationship Between (G'/(η'/G') and ΔT_c Taken from (Anderson, 2011)



In research published in 2011 Anderson, et al (Anderson, 2011) investigated the rheological and ductility characteristics of PAV aged binders and binders recovered from aged air field cores to understand the relationship of those rheological properties to the level of non-load associated pavement distress. Key findings from that research suggested a cracking warning limit based on the difference between the BBR m-value critical temperature and the BBR S value critical temperature (defined as ΔT_c) at a ΔT_c value of +2.5°C and a cracking limit at a ΔT_c of +5°C. This concept is shown in FIGURE 6, taken from the Anderson, et. al paper. FIGURE 6 shows the relationship between the Glover parameter of (G'/(η'/G') and ΔT_c. Based on this work the authors concluded that a ΔT_c value of 5°C corresponded to a value beyond which the binder ductility would have decreased to a point where durability had been lost.

PAV Aging

- **IGNORES <u>long-term</u> aging-resistance of binder**



[1]Smith B et al. (2018). *Comparing Pressure Aging Vessel Time to Field Aging of Binder as a Function of Pavement Depth and Time.* Transportation Research Board 97th Annual Meeting, Washington, D.C.

- **Allows for binders with <u>very different aging susceptibility</u> to seem equal**

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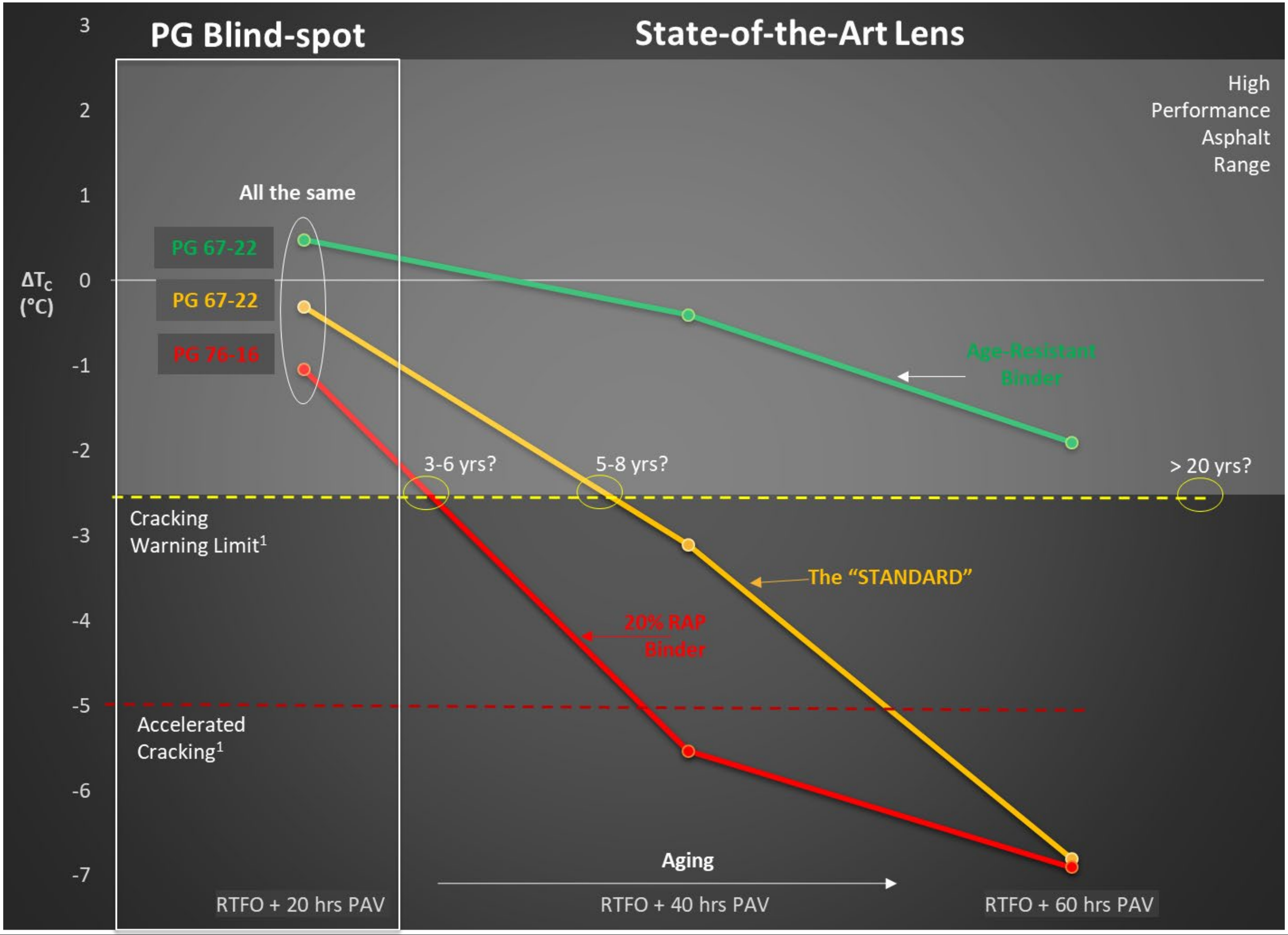
Look Beyond the PG "Blind Spot"



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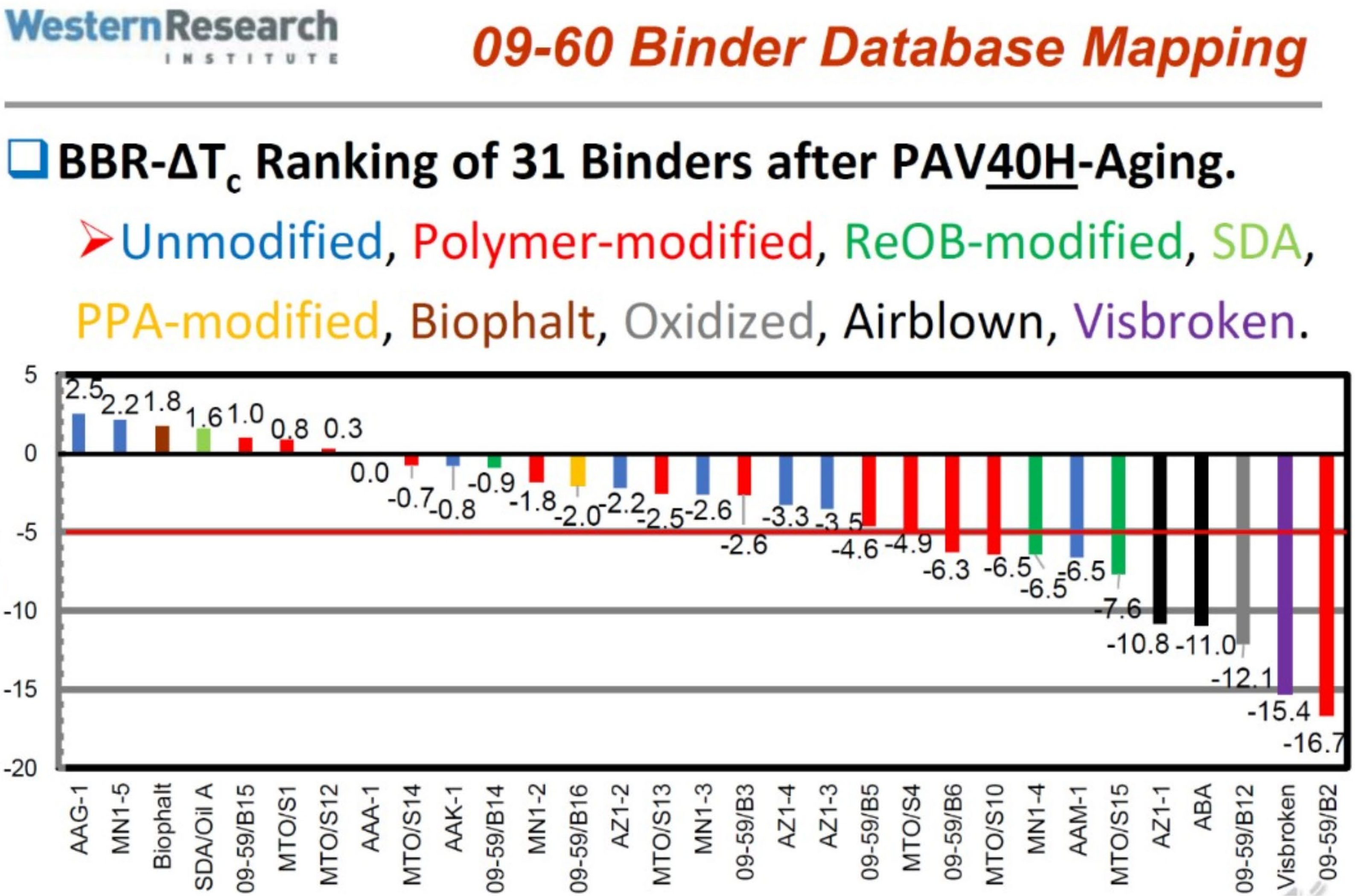
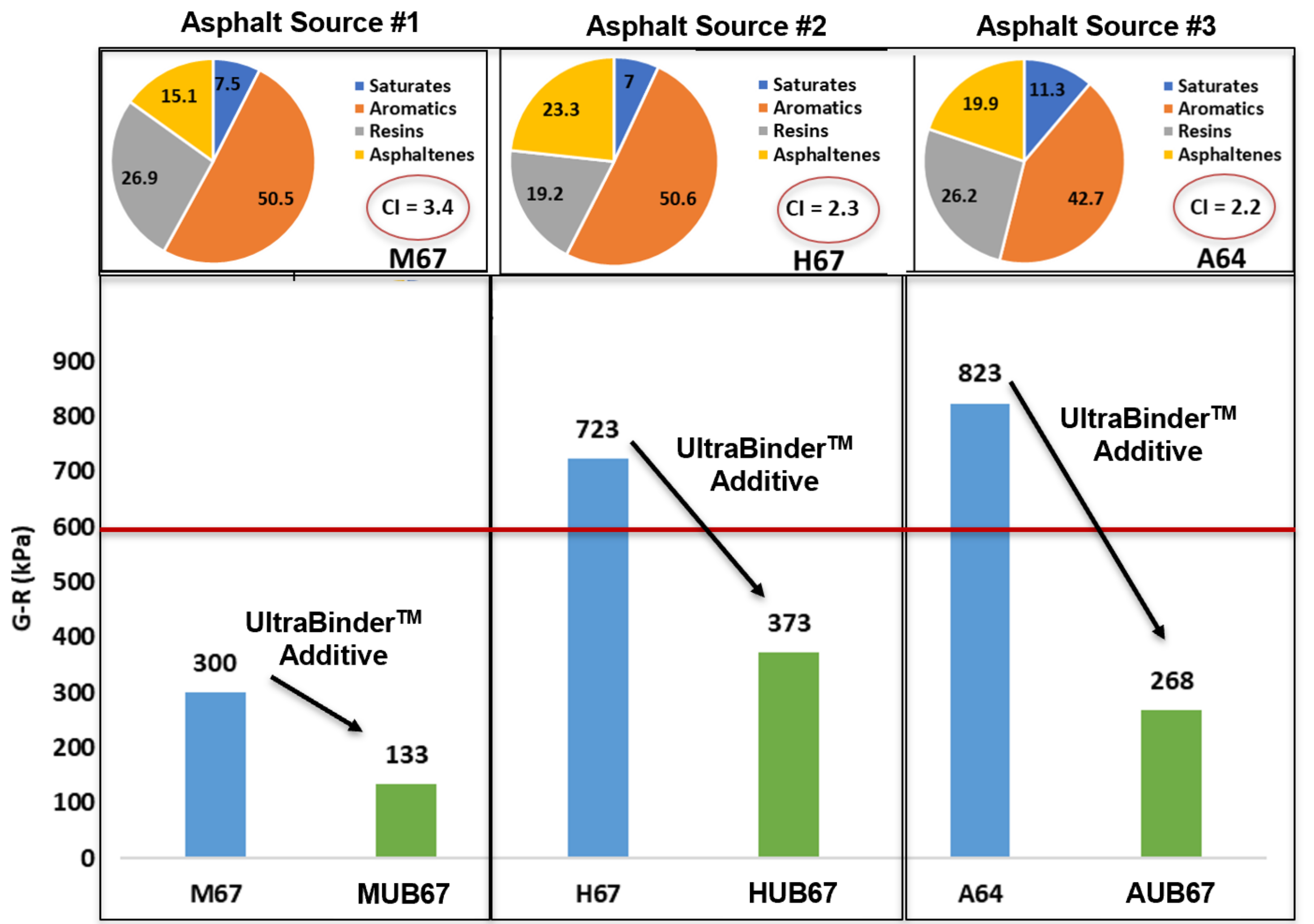
Effect of Conventional Modifiers against Aging (ΔTc)



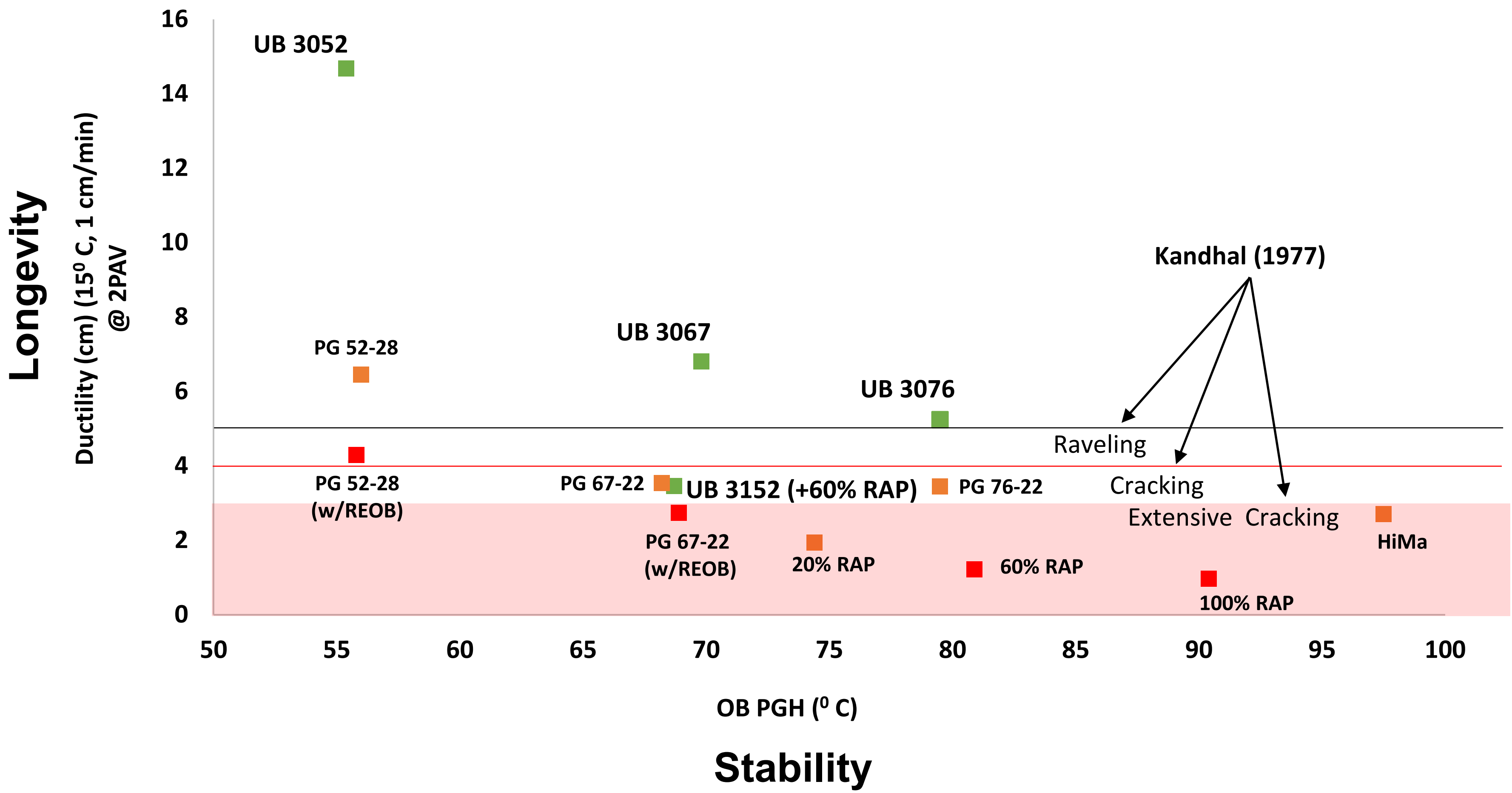
Extended Aging (40-HR PAV) G-R Values

CI = ((NA+PA)/(S+A))



40-HR (2PAV)

L:S
Longevity:Stability



Effects of PAV Aging on Binder Ductility

PG

“UltraBin

All Specimens: TRIPLE PAV-AGED (60-hr) before testing

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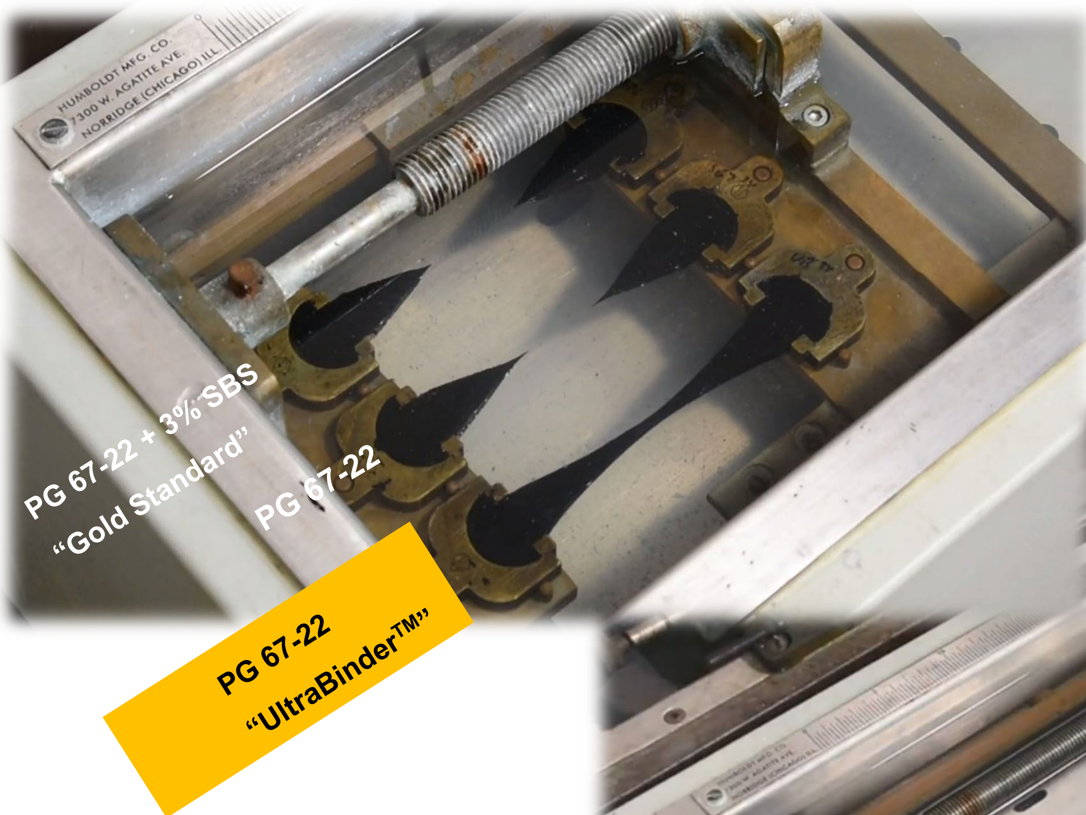
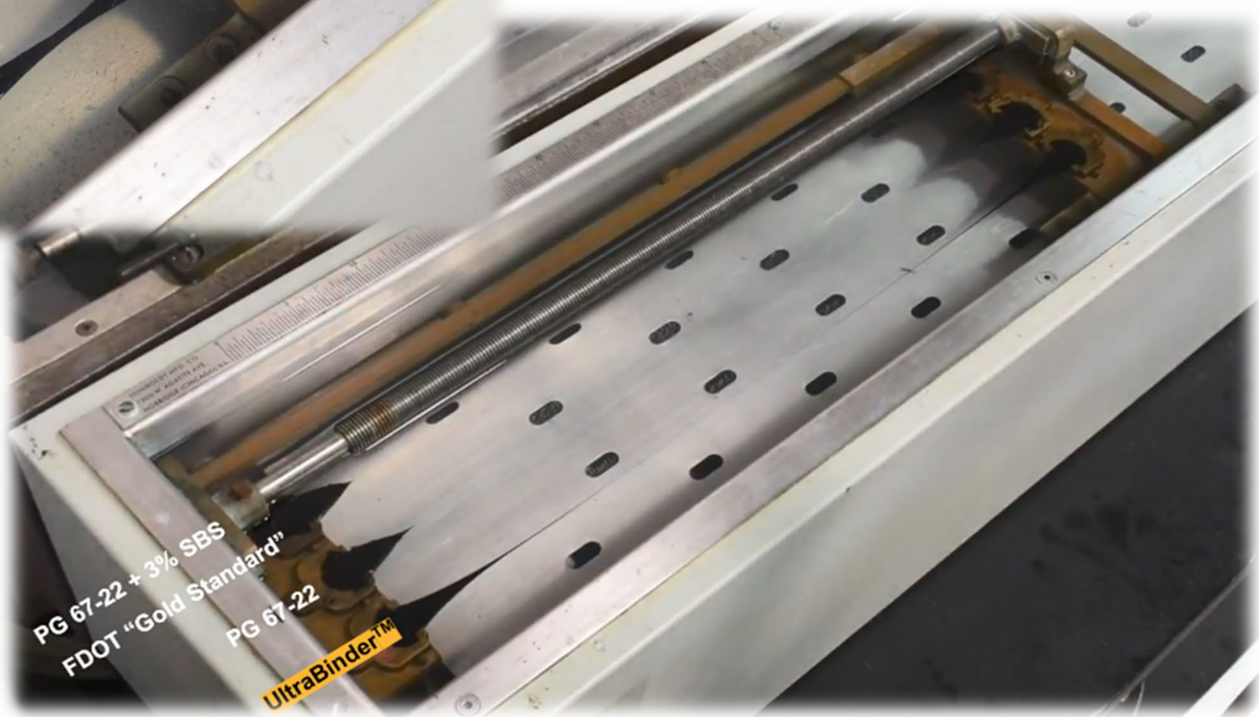
Effects of PAV aging on Binder Ductility



Comparison

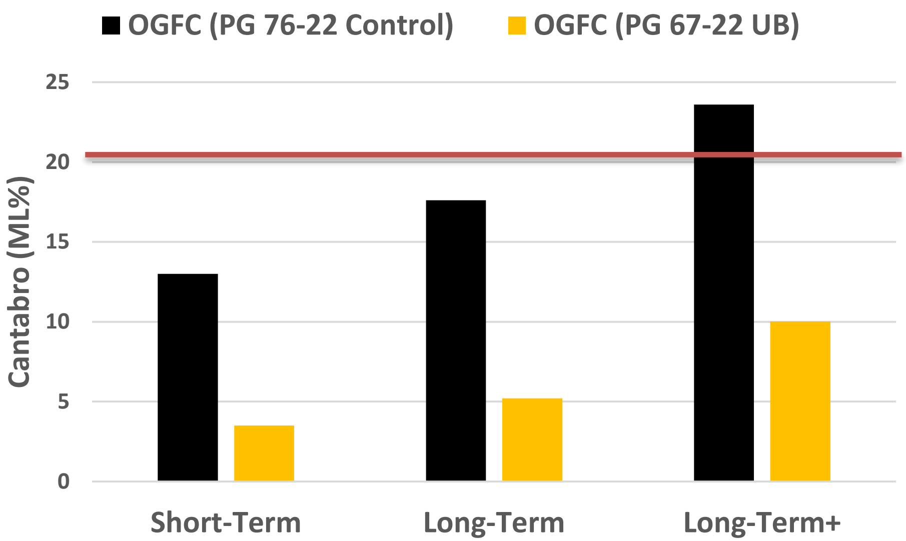
1. PG 67-22 + 3% SBS (FDOT "Gold Standard" PG 76-22)
2. PG 67-22
3. PG 67-22 (UltraBinder™)



All Specimens: <u>TRIPLE</u> PAV-AGED (60-hr) before testing

UltraBinder – OGFC Aging Defense

Figure 13. Cantabro Abrasion Mass Loss (Left) LA Abrasion Machine, (Middle) sample prior to testing, (right) sample after testing



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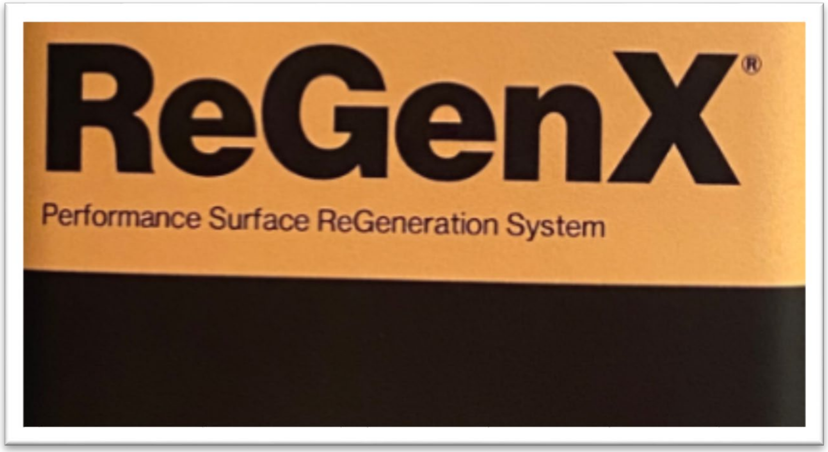
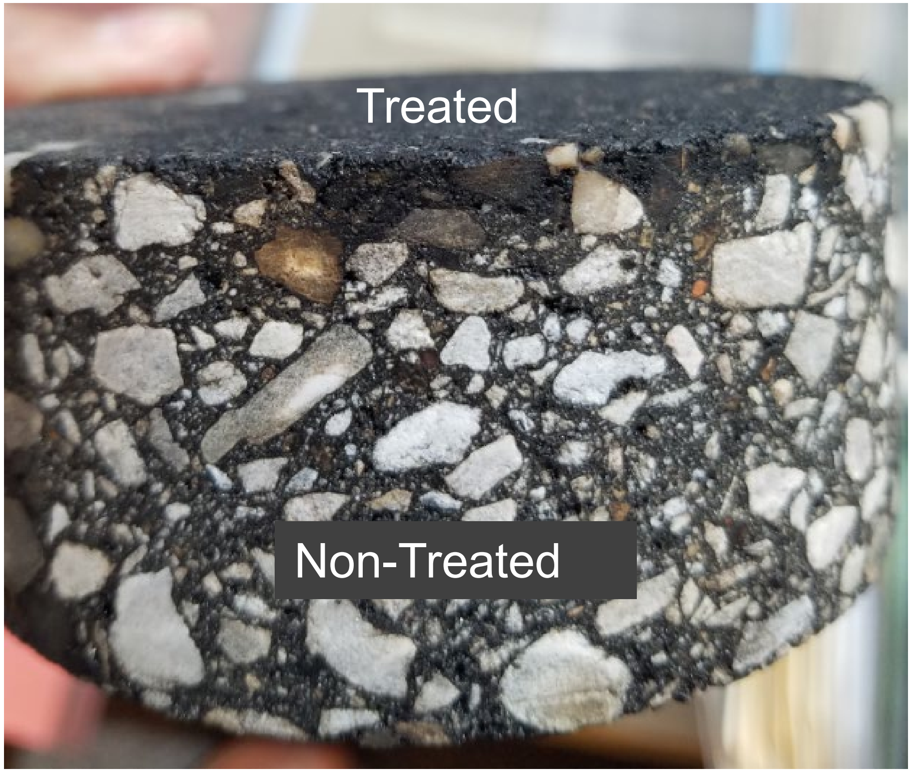
Routine Maintenance

Pavements also require maintenance to delay major rehabilitation or replacement.

Delay Surface Deterioration





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Asphalt Technology News

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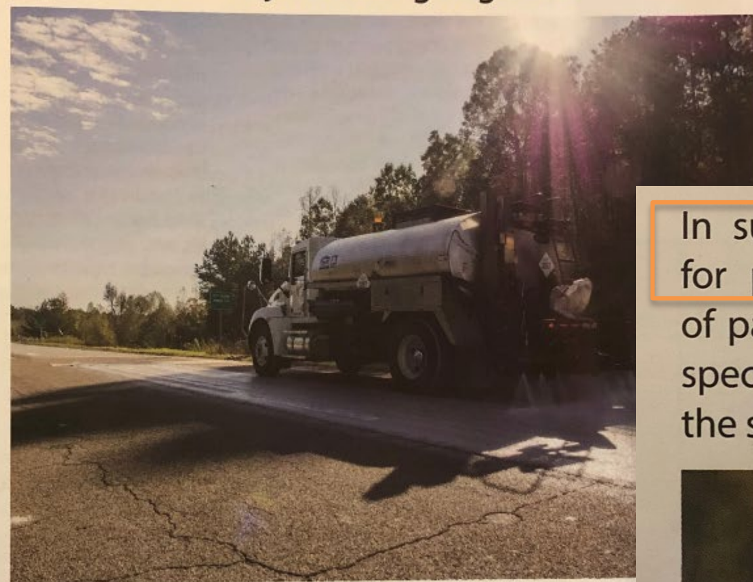
National Center for Asphalt Technology
NCAT
at AUBURN UNIVERSITY

Evaluation of Rejuvenating Fog Seals



Delta Mist™ rejuvenator is applied to Section S3 of the NCAT Test Track.

A rejuvenating fog seal is a type of pavement preservation treatment applied to an existing asphalt pavement surface to preserve its functional and structural integrity and delay a more costly rehabilitation treatment in the near future.

A fog seal consists of a slow setting asphalt emulsion (e.g., SS-1, SS-1h, CSS-1 and CSS-1h) diluted with one to four equal parts of water and applied at rates between 0.06 - 0.13 gal/yd² on an existing pavement surface without a cover aggregate. It is intended to penetrate into the surface pores of the pavement to seal very small cracks and surface voids as well as coat surface aggregate particles. Pavement surfaces with high void contents are more susceptible to oxidative agi exposure of the binder t temperatures. The asphalt stiffer, and consequently, m oxidation, leading to deteri

Rejuvenators can be added raveled and aged paveme penetration into the pave the flexibility of the aged bi are petroleum or bio-base and physical characteri restore properties of the a in the surface layer. Addi a fog seal reduces the lik failure within the asphalt slow the rate of aging caused by oxidation. For

Surface Treatment Product
BioRestor®
RePlay™
Regen-X™
Delta Mist™
Reclamite®
CMS-1PF
RejuvaSeal

In summary, rejuvenating seals are a low-cost option for preventing or retarding the surface deterioration of pavements, practical in use since they do not require specialized equipment, and can be effective for restoring the surface condition of an existing pavement.

For more information, contact Raquel Moraes at moraes@auburn.edu

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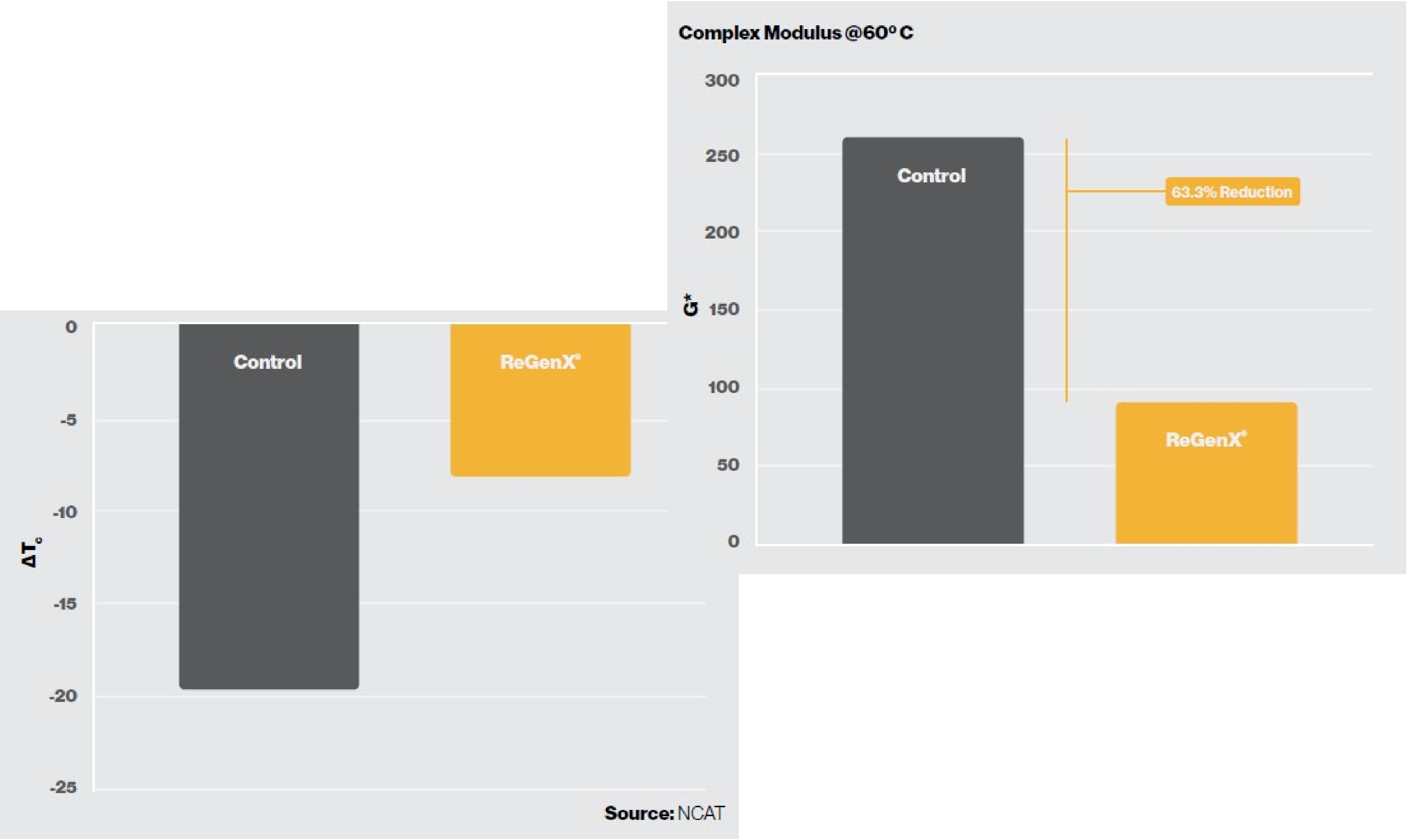
ΔTc and Complex Modulus – ReGenX Surface Treatment



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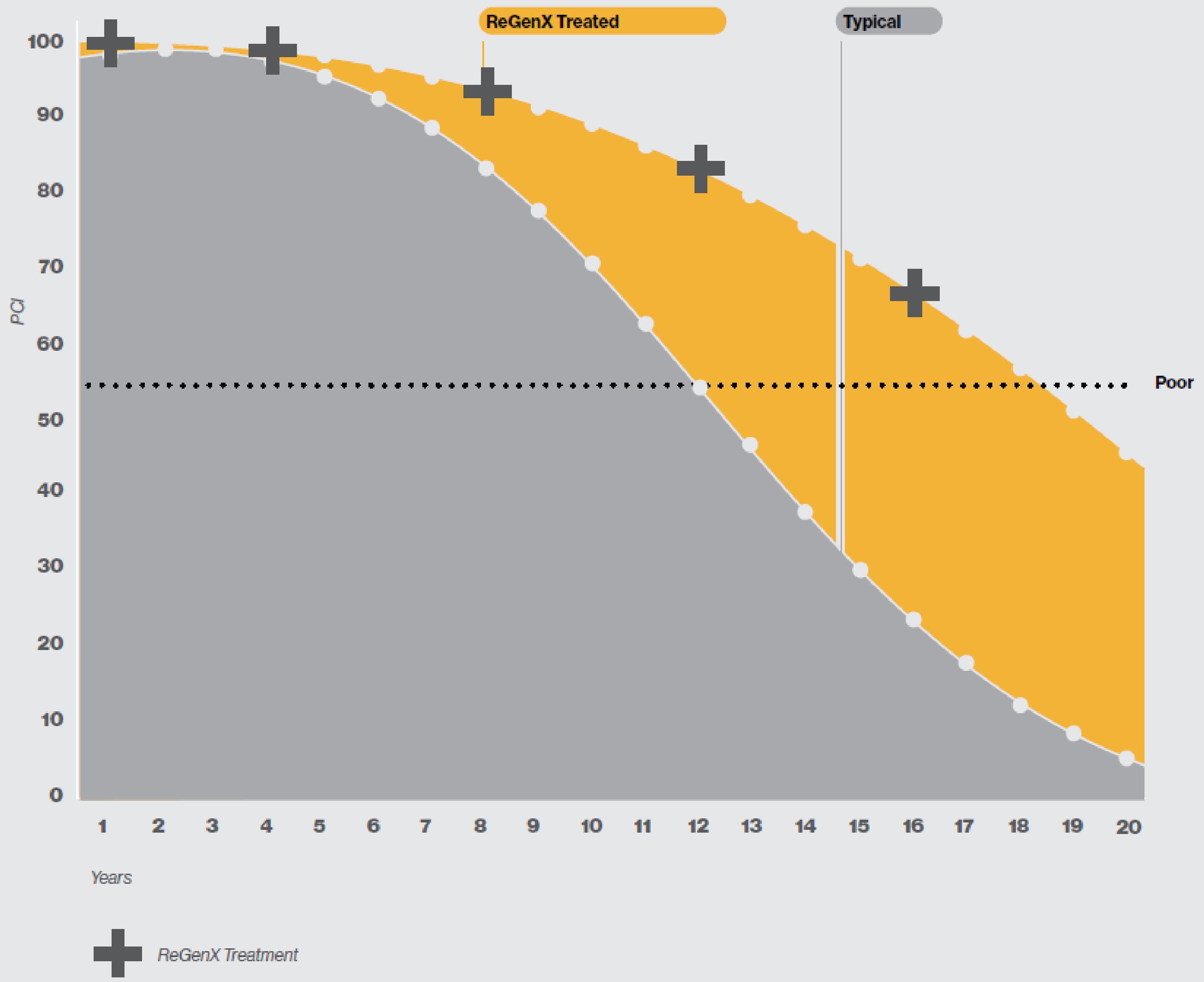
Delay Surface Deterioration with ReGenX

Pavement Condition Over Time

Applying ReGenX every 4-5 years in a routine maintenance progam will extend the life of your pavement investment by many years.



Mixtures contained 20% RAP + antistrip

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Quality Construction

High-Quality Materials (Bond/Age-Resistance)

Proper Maintenance (Delay Deterioration)

Huber, AMAP 2019

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Thank You!