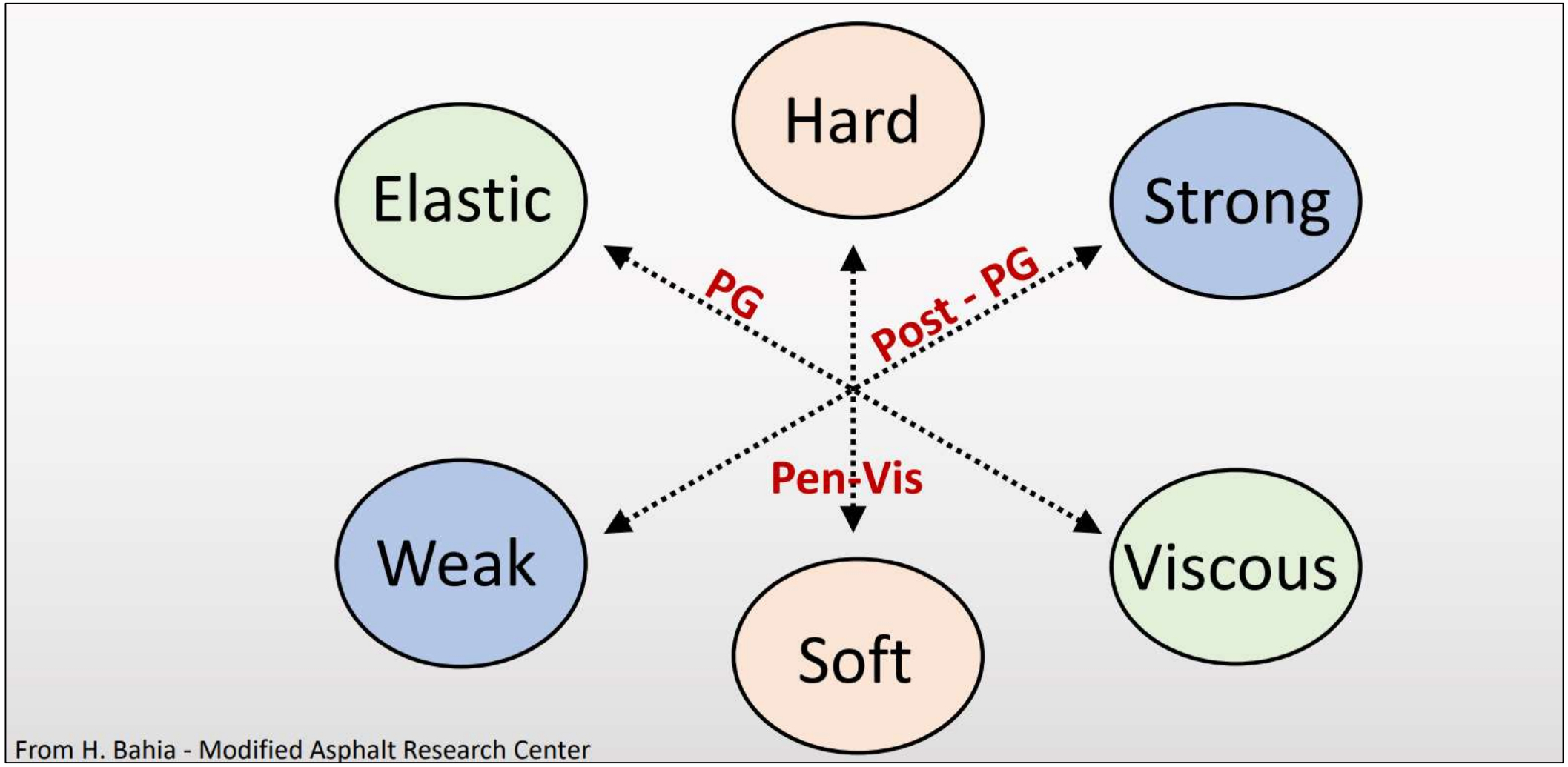
BAKELITE
SYNTHETICS

Next Generation Synthetics

Binder Selection for the 21st Century

Evolution of Asphalt Specifications



Thermal Cracking

- Correlates most significantly with the binder properties

Rutting

- More related to mixture shear strength
- Binder can still contribute

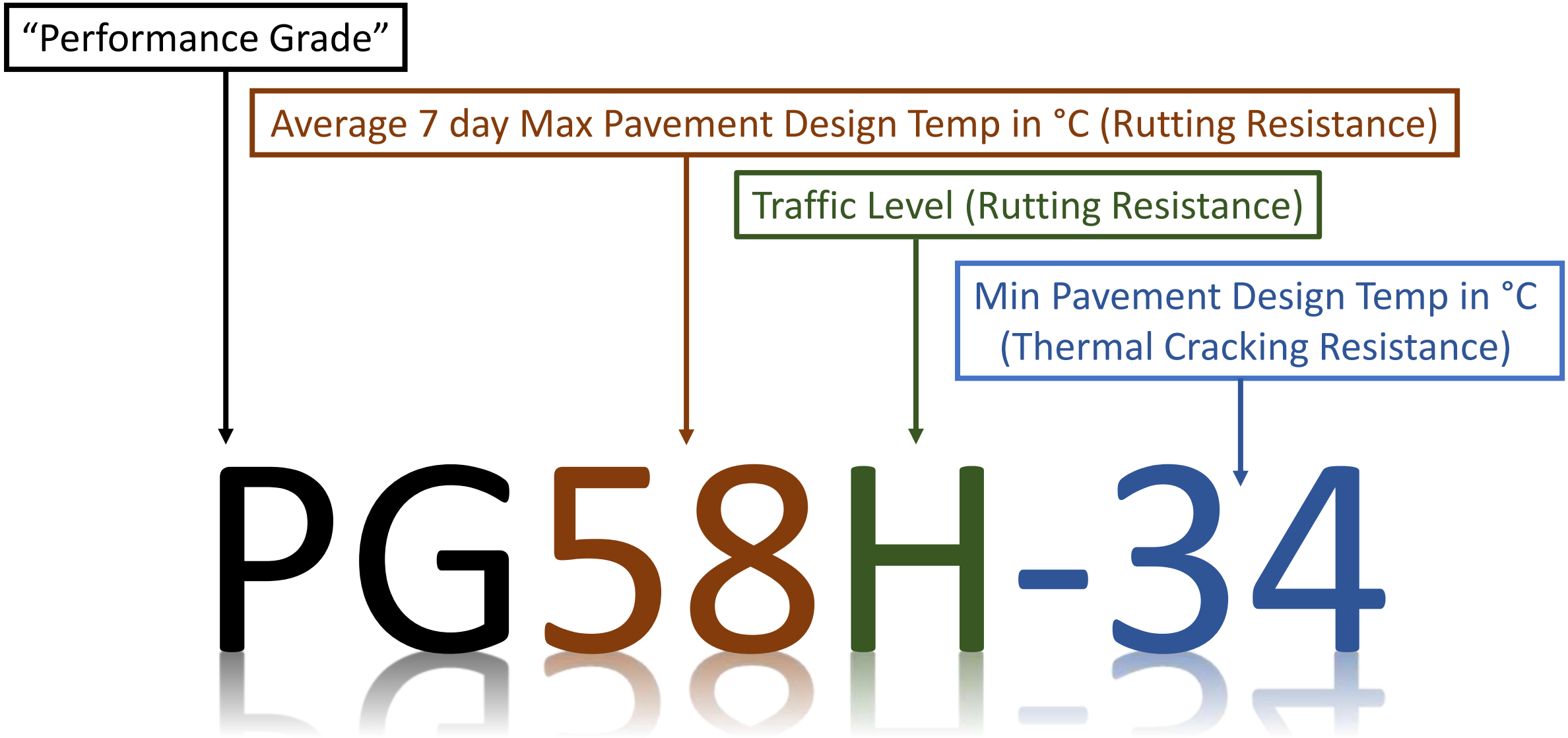
Fatigue Cracking

- Affected by pavement structure and traffic
- PG Specs promote compliant/elastic binders

Photos from the MnDOT Website & Maintenance Manual

Consider pavement distresses in Binder Selection

MSCR: What do the Numbers & Letters Mean?



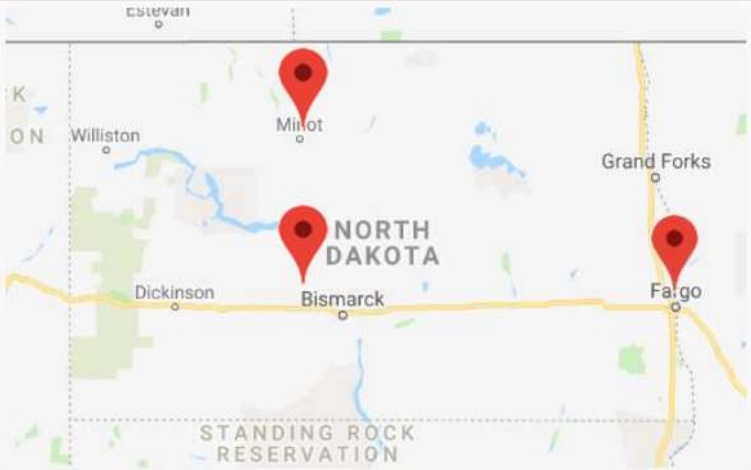
LTPPBind Online – High Temp

- FHWA web-based tool to help select the asphalt binder PG for a particular site.
- Uses climate data collected by NASA

	Fargo	Bismarck	Minot
High Air Temperature of high 7 days:	34.27	34.29	33.11
Standard Dev. of the high 7 days:	2.9	2.36	2.36
High Avg Pavement Temp of 7 Days 50%:	55.12	55	53.73
High Avg Pavement Temp of 7 Days 98%:	59.72	59.34	58.08

LTPPBind Online – Low PG

- FHWA web-based tool to help select the asphalt binder PG for a particular site.
- Uses climate data collected by NASA



	Fargo	Bismarck	Minot
Lowest Yearly Air Temp, ºC:	-43.1	-40	-42
Low Air Temp Standard Dev, ºC:	5.11	4.75	5.06
Low Pavement Temp 50% Reliability:	-32.49	-30.44	-32.26
Low Pavement Temp 98% Reliability:	-41.2	-38.7	-40.9

Traffic Level

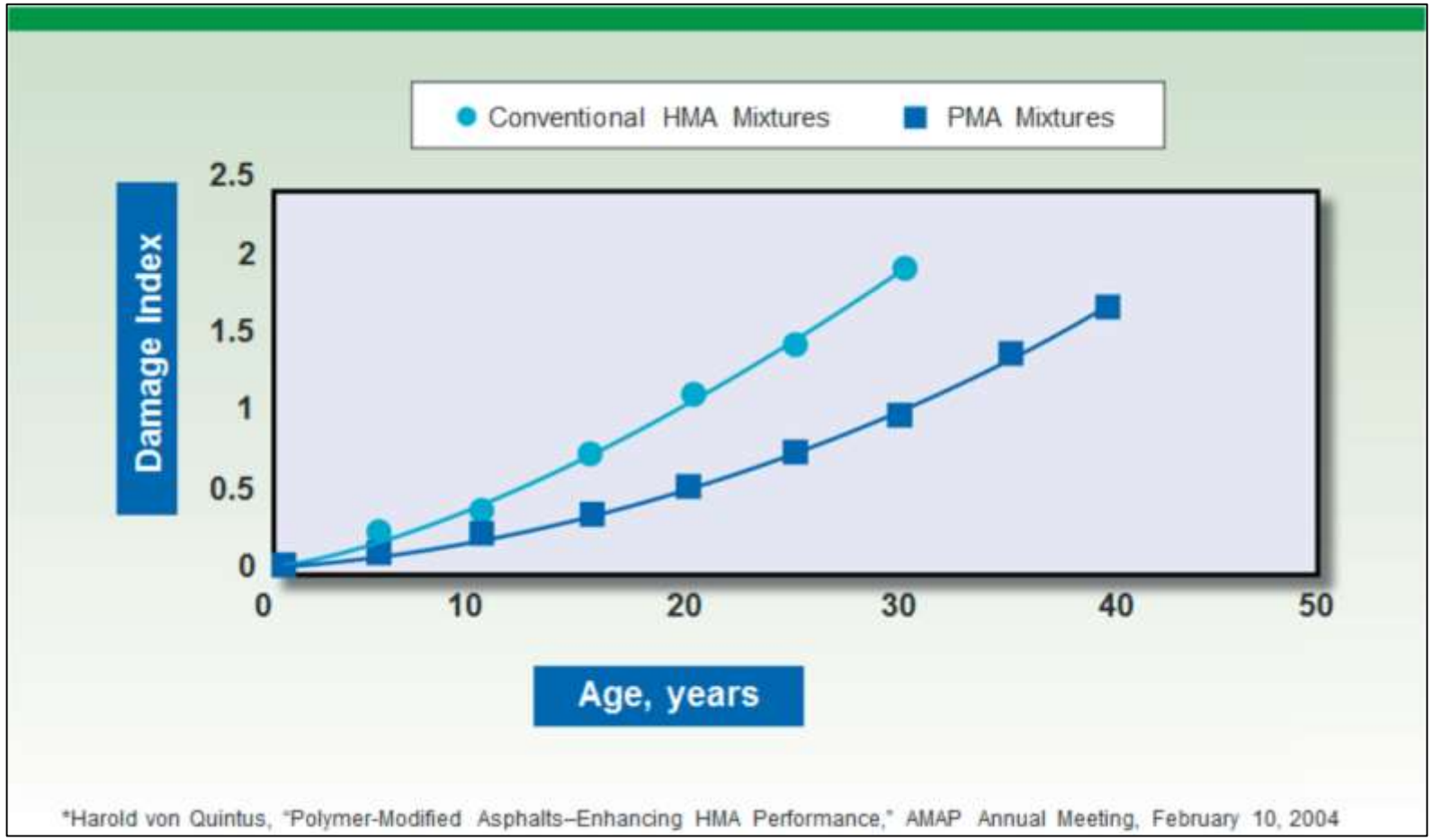
PG 58S-34 → Standard Traffic (0% Recovery)

PG 58H-34 → Heavy Traffic (30% Recovery)

PG 58V-34 → Very Heavy Traffic (55% Recovery)

PG 58E-34 → Extremely Heavy Traffic (75% Recovery)

Why % Recovery? Elastomeric Polymer…That's Why!



*Harold von Quintus, "Polymer-Modified Asphalts–Enhancing HMA Performance," AMAP Annual Meeting, February 10, 2004

Why Elastomeric Polymer?

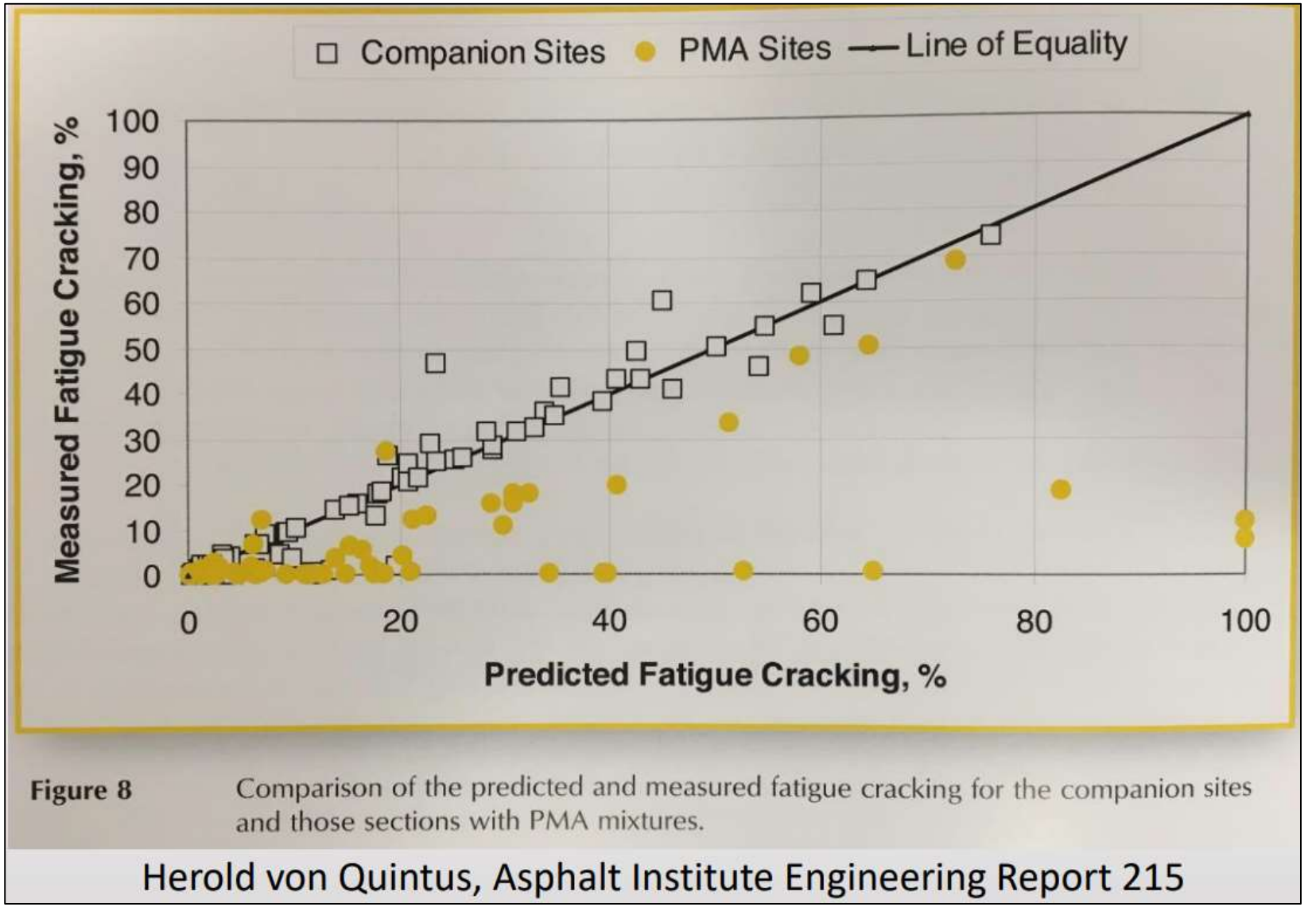


Figure 8 Comparison of the predicted and measured fatigue cracking for the companion sites and those sections with PMA mixtures.

Herold von Quintus, Asphalt Institute Engineering Report 215

What About RAP?

- Recycled Asphalt Pavement (RAP) contains aged asphalt binder
  - Asphalt binders become stiffer and more brittle with age
  - Cracking is more dependent on the aged condition of asphalt
  - Asphalts that are less durable tend to age faster

Grade Dropping

PG 58H – 34 

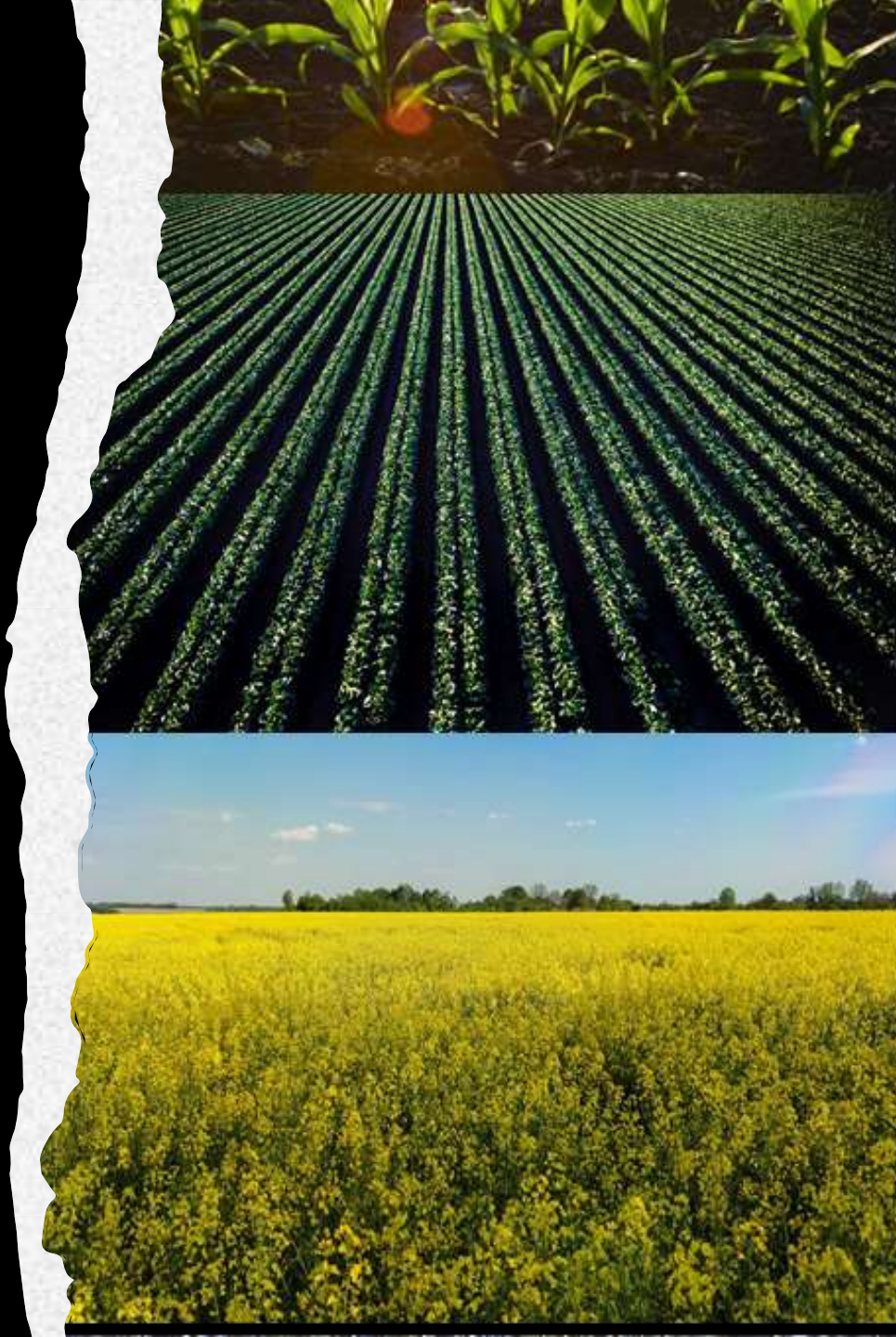
PG 52H – 40

How do we get -40? Suppliers don't offer that grade currently?

Bio-based oils can be used to manufacture PG XX-40, but they can work with other grades just as well.

Bio-Based Oils for RAP Mixes

- Agricultural or Plant based (“Organic Material”)
  - Fatty acid-based chemistries
  - Nonvolatile vegetable oils
  - Reacted bio-based oils
  - Tall oils
- Can be compatible additives to asphalt
  - Storage stable
  - Phase stable
- Lower asphalt stiffness (reduces high and low PG)
- Restore properties of aged asphalt



Asphalt Parameters That Indicate Durability and Brittleness

Glover-Rowe

Cross-over Temperature

R-value

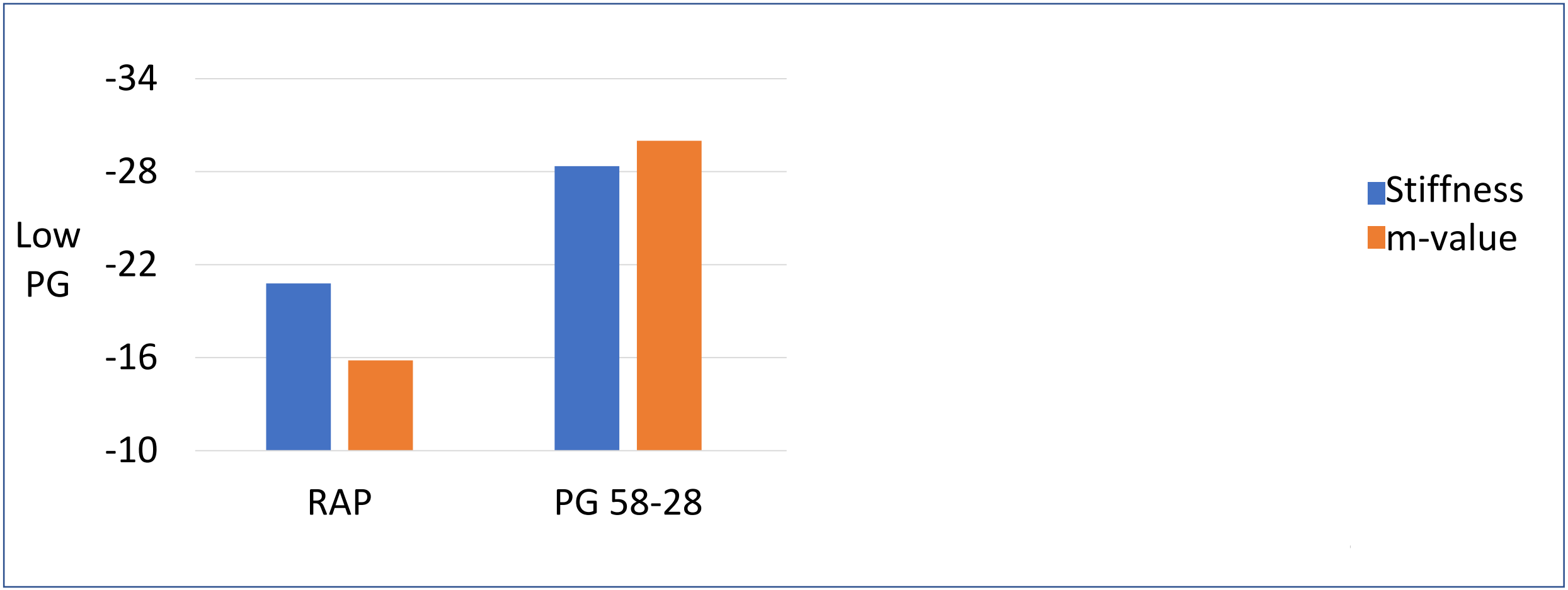
Phase Angle

ΔTc

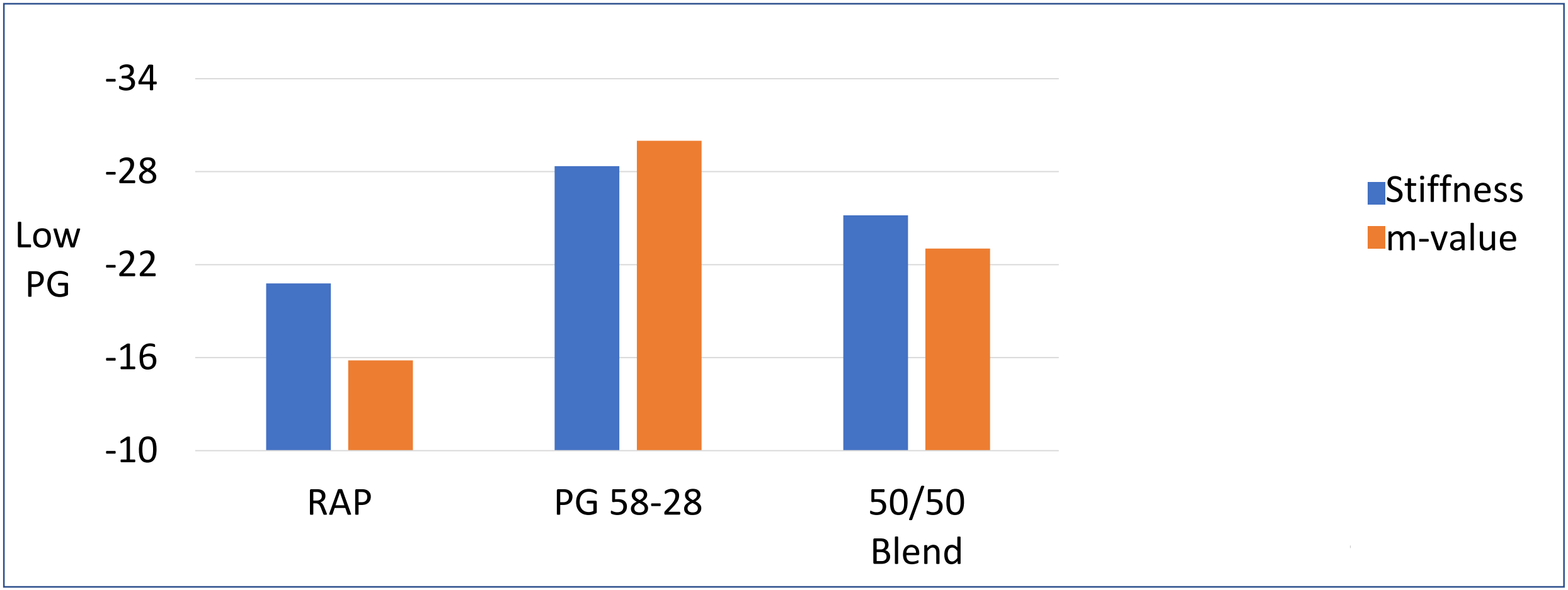
What Research Tells Us About ΔTc

- As binders age, they lose ductility and ΔTc decreases
- ΔTc reaching -5.0 may be the tipping point for age-related cracking
- Measuring ΔTc after more severe laboratory aging gives us the tools to evaluate durability
  - 40hrs PAV is helpful for research and forensic analysis

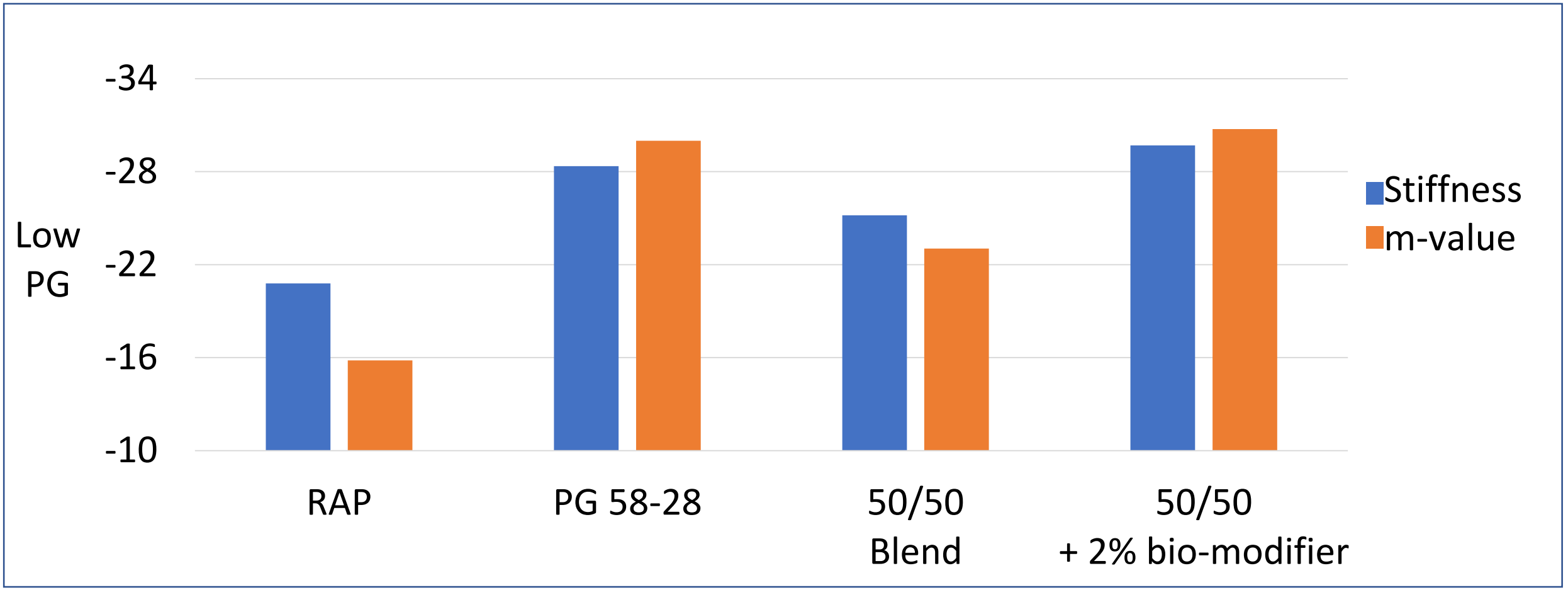
Continuous PG	PG 95-16
40hr PAV ΔTc	-6.8



Continuous PG	PG 95-16	PG 60-28
40hr PAV ΔTc	-6.8	-1.1



Continuous PG	PG 95-16	PG 60-28	PG 77-23
40hr PAV ΔTc	-6.8	-1.1	-3.8



Continuous PG	PG 95-16	PG 60-28	PG 77-23	PG 63-30
40hr PAV ΔTc	-6.8	-1.1	-3.8	-1.2

Softened + "Rejuvenated"

Using Bio-based Modifier Oils

- Supplier Terminal blended
  - Tank or In-line Blending
  - Ability for supplier to product XX-40 binders
  - Final binder certification to specification by supplier

- Hot Mix Plant blended
  - Blended into binder storage tank at plant site, properly circulated
  - In-line blended with oil into plant during HMA production
    - Alleviates contractor binder storage constraints
    - Contractor can maximize RAP usages, reduce amount of virgin binder and aggregate used
    - Easily switch between mix designs and RAP usage levels

Conclusions

- Select PG 58 to resist rutting distress on pavement
- Select -34 to protect from thermal cracking distresses
- Select appropriate traffic level H, V, or E to improve pavement performance through the use of polymer modified binders
- Utilize bio-based modifier oils to optimize RAP content in mixes

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