

How Do Asphalt Specifications Impact Quality Expectations?

**Amma Agbedor, Ph.D., P.Eng.
Regional & Research Engineer
Asphalt Institute**

What are the quality expectations of
asphalt pavement?

Performance Characteristics of Asphalt Pavement

Excellent resistance to **cracking**, **rutting**, and **fatigue**.

Should perform well under varying **temperatures** and **traffic loads**, maintaining its structural integrity **over time**.



Asphalt Mix Components



Asphalt characteristics change with:



Temperature



Time of Loading



Aging (properties change with time)

Permanent Deformation

- **High in-service temperature**
 - Desert climates
 - Summer temperatures
- **Sustained loads**
 - Parked vehicles
 - Rest parks, Weigh Stations
 - Slow-moving truck traffic
 - Intersections, Ramps
- **New pavements**



We want a ***stiff, elastic*** binder to contribute to mix rutting resistance

Addressing Asphalt Binder Contribution to Rutting

- Most widely used specification: **AASHTO M320** for Performance-Graded (PG) Asphalt Binder
 - Based on a study of neat (**unmodified**) binders
 - May not properly characterize **polymer modified** binders
- **AASHTO M332** allows for better characterization of the high temperature, performance-related properties of asphalt binders

PG 67-22 unmodified, 15mm rut

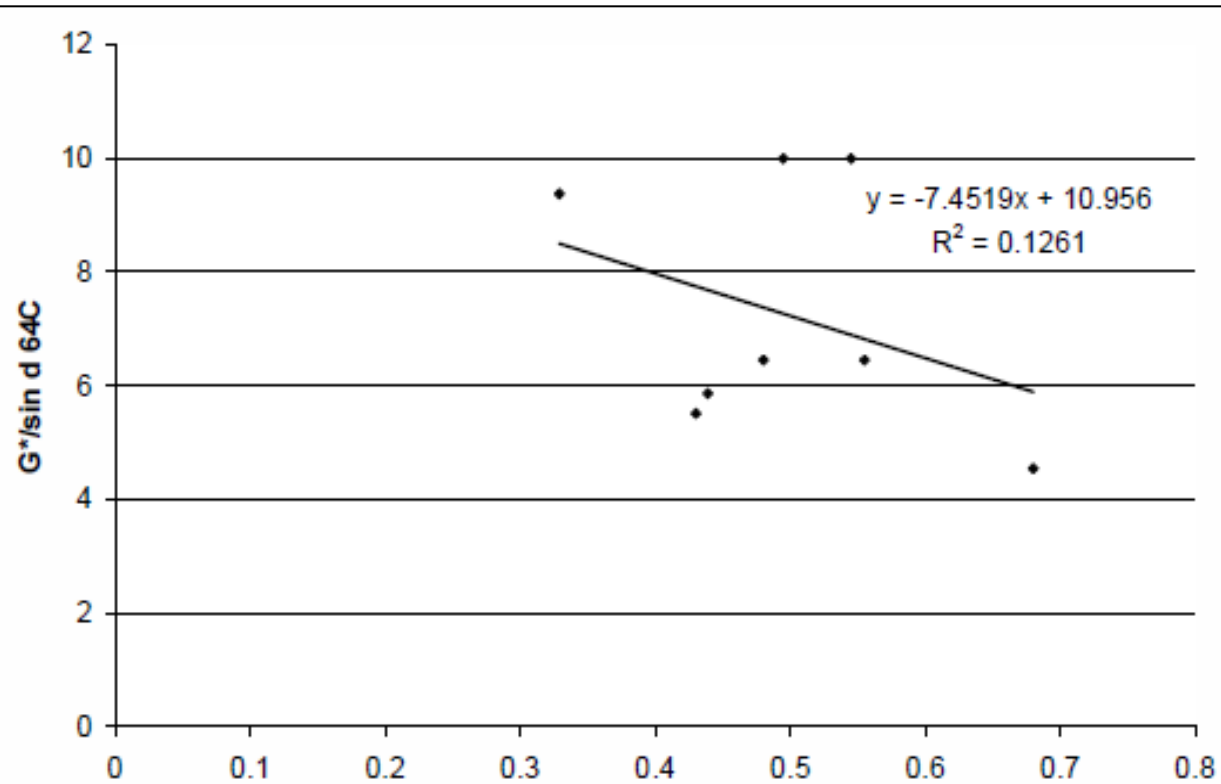


PG 64-22 modified, no rutting

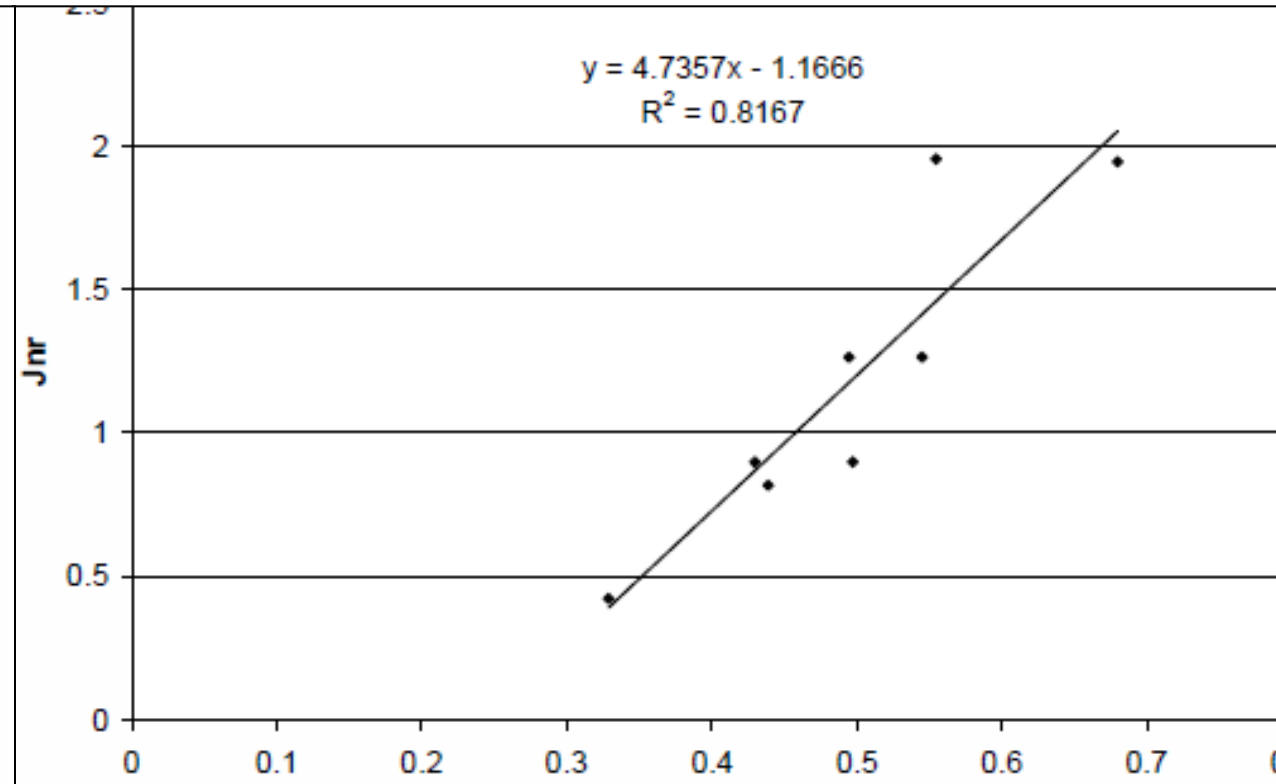


FHWA Accelerated Loading Facility – AASHTO M 320 vs. M 332

AASHTO M 320
 $R^2 = 0.13$



AASHTO M 332
 $R^2 = 0.82$



Addressing permanent deformation (rutting)

i.e. PG 64E-22

MSCR Jnr on RTFO aged binder:

Four traffic levels

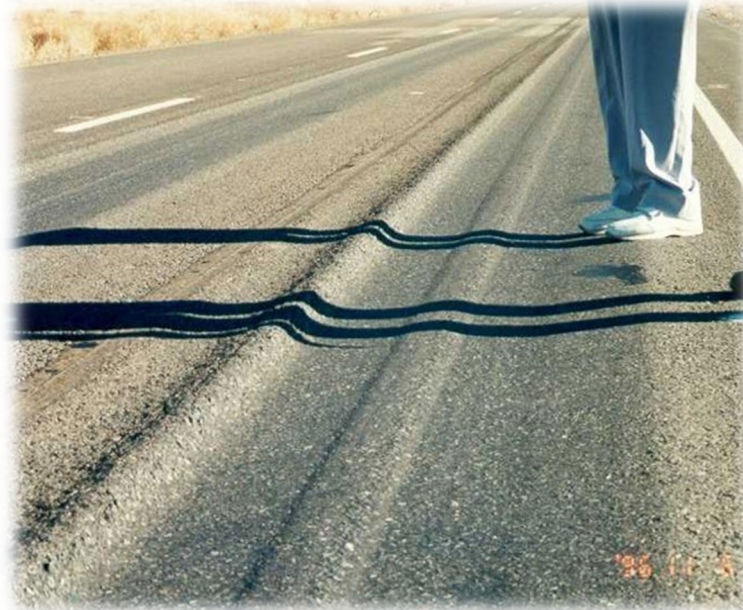
S = Standard:	< 10 million ESALs <u>and</u> standard traffic loading	$\leq 4.5 \text{ kPa}^{-1}$
H = Heavy:	10 – 30 million ESALs <u>or</u> slow-moving traffic loading	$\leq 2.0 \text{ kPa}^{-1}$
V = Very Heavy:	> 30 million ESALs <u>or</u> standing traffic loading	$\leq 1.0 \text{ kPa}^{-1}$
E = Extra Heavy:	> 30 million ESALs <u>and</u> standing traffic loading	$\leq 0.5 \text{ kPa}^{-1}$

Quality Expectations: Other Contributors to Rutting



Rutting caused by **soft subgrade**. Note the cracks in the bottom of the rut. No humps on either side of the rut.

Nothing wrong with the binder or mix.



Rutting most likely caused by a **mix volumetrics issue**. Less likely, but possibly a binder issue. Mat has humps on either side of the rut. Shows plastic movement in the mix.



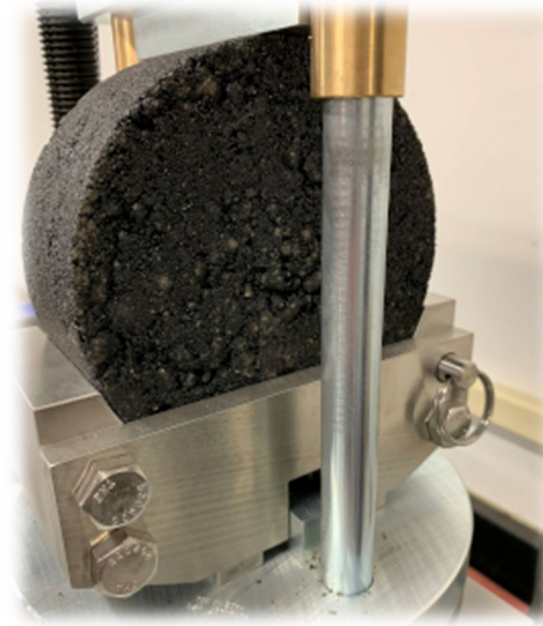
Ruts only where there is a substantial **time of loading** caused by parked cars.

The **aggregate structure** provides load-bearing capacity, not asphalt binder!

Common Asphalt Mix Rutting Tests



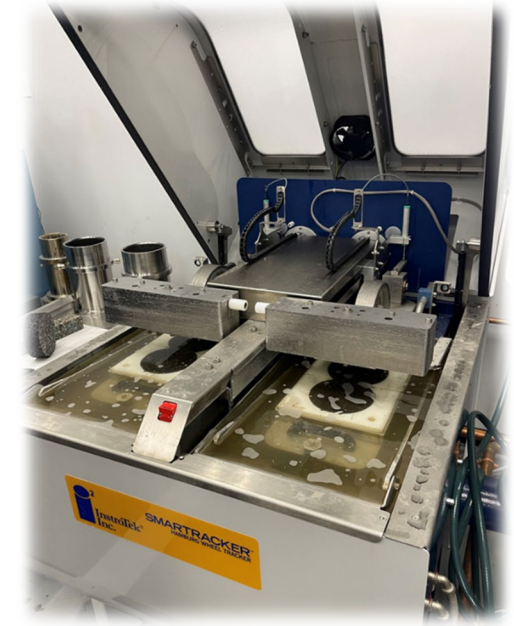
Asphalt
Pavement
Analyzer



IDEAL
Rutting
Test



Asphalt Mix
Performance
Test



Hamburg Wheel
Tracking Test

Low Temperature Behavior Most Prevalent When

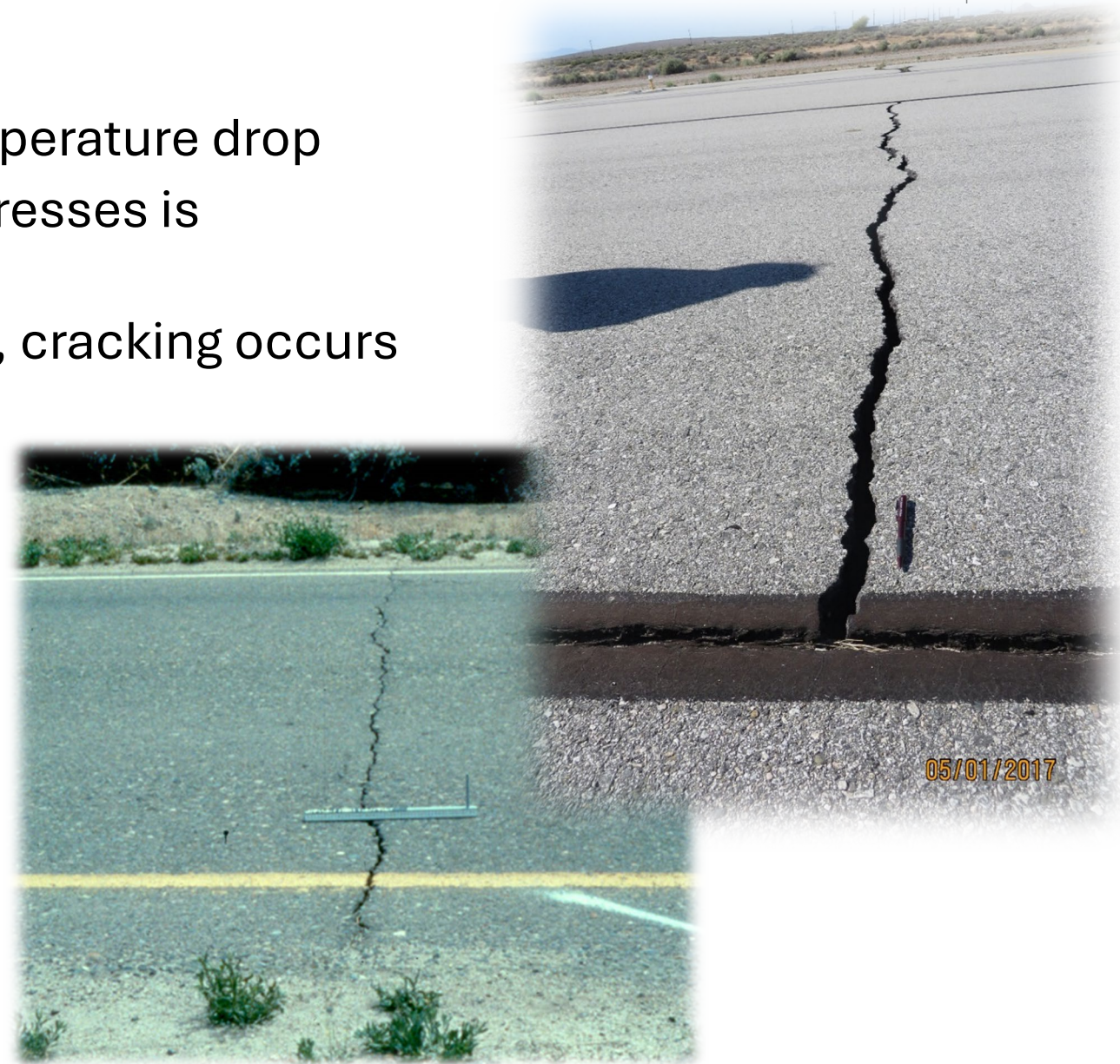
- **Low Temperature**
 - Cold climates
 - Winter
- **Binder is Oxidized**
 - Aged
 - Low effective AC content
 - Poorly compacted



Stiffer and more brittle behavior of binder

Asphalt Pavements Behavior – Low Temperature

- Thermal Cracks (Low-temp cracking)
 - Internal stresses induced by rapid temperature drop
 - If binder is too brittle, ability to relax stresses is lessened
 - When stresses exceed capacity to flex, cracking occurs
 - Transverse, equal spacing, full width
- Depends on:
 - Asphalt binder (lots)
 - Mineral aggregate (little)
 - Volumetric proportioning (some)

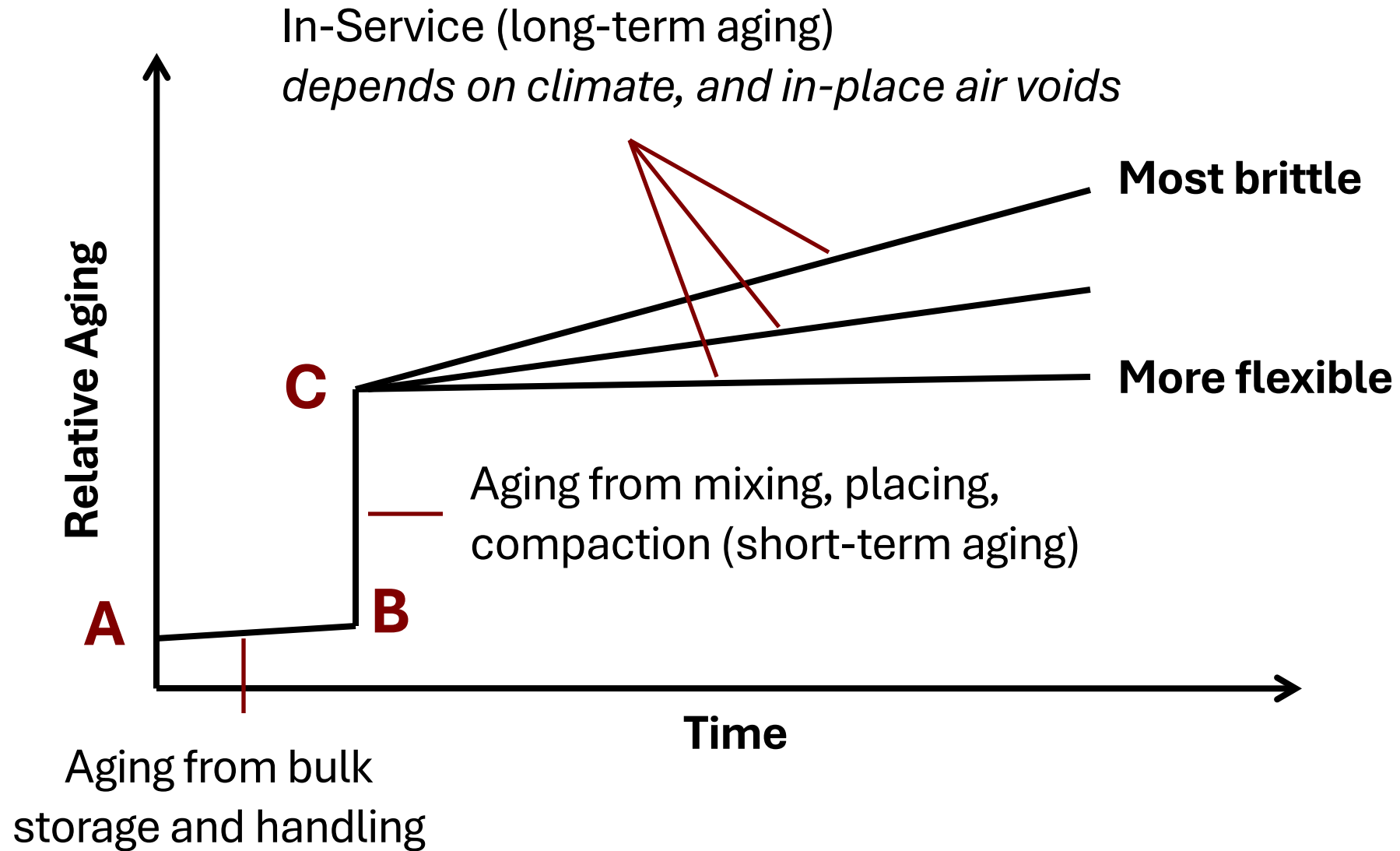


AASHTO M320 & M332:

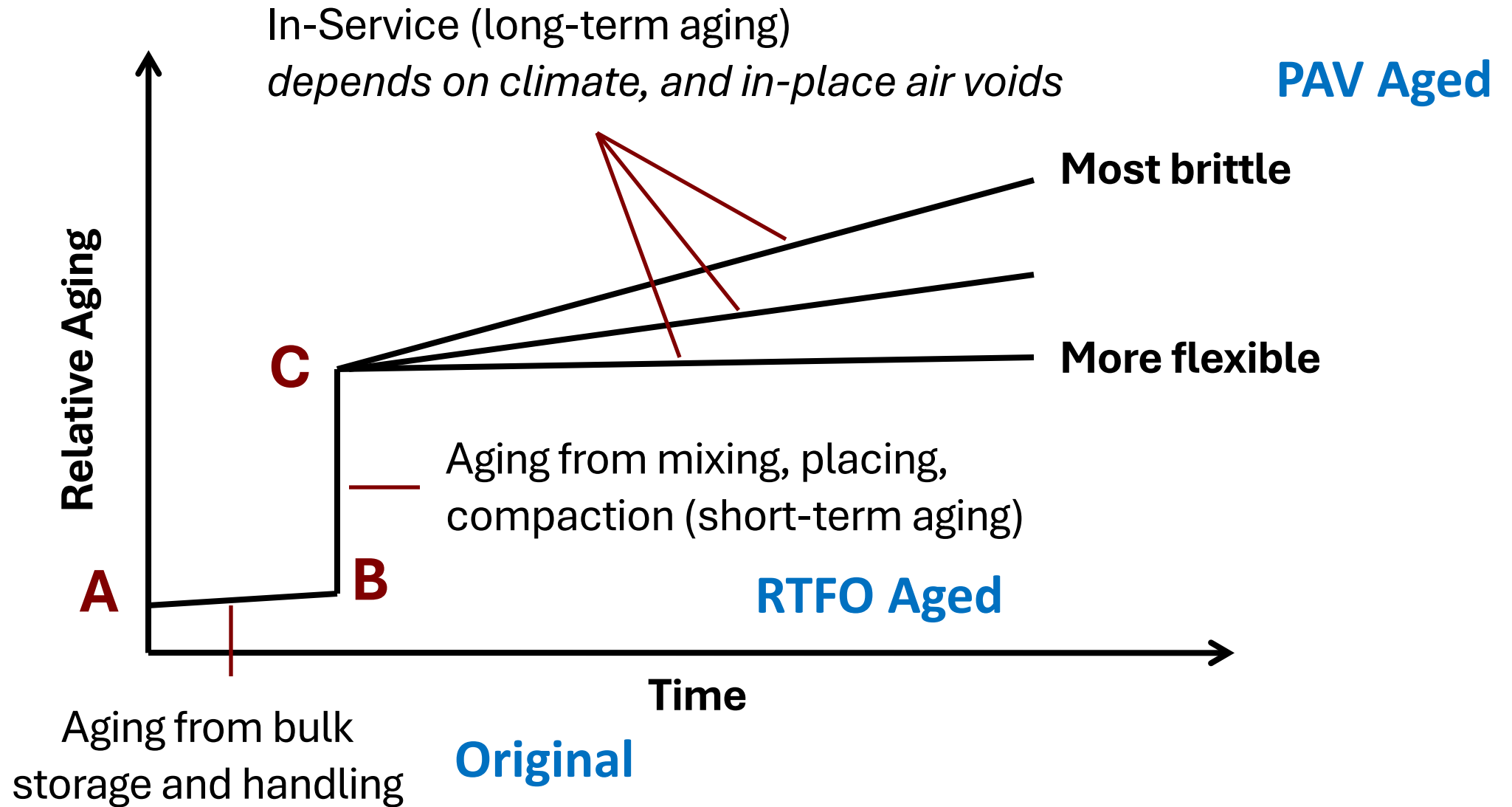
If the asphalt binder used in the mixture has the appropriate low temperature properties for the expected use, the expectation for conventional asphalt mixtures will be that they will have adequate laboratory thermal cracking performance.

PG 64V – 22

Asphalt Aging over the Pavement's Life



Testing Conditioning to Reflect Aging in the Pavement



Load-related:

- Fatigue cracking caused by repeated traffic loading which leads to microcracks followed by macrocracks
- Alligator cracking in wheel paths



Non-load-related:

- Loss of flexibility as the pavement ages and experiences temperature changes.
- Durability cracking – asphalt mix not able to relax stresses



Other Asphalt Tests

Delta T_c (ΔT_c)

- Derived Asphalt Property
- Difference between:
 - Stiffness Critical Temperature
 - M-value Critical Temperature
 - Both from BBR testing
- Targets Asphalt binder durability related to binder aging in the mix
- Insight to the relaxation properties of the binder
 - Non-Load related cracking
 - Age related embrittlement distresses



For More Information:
Asphalt Institute IS-240
*Use of the Delta T_c Parameter
To Characterize Asphalt Binder Behavior*

Quality Expectations: Other Effects of Aging

Prone to fatigue cracking



Weathering/ Raveling

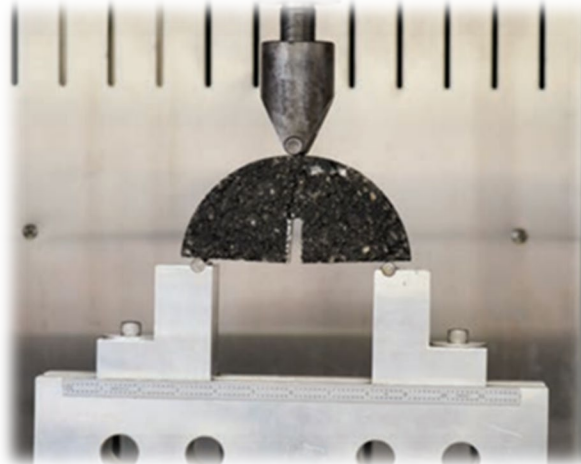


Both these can also be a sign of **insufficient binder content (mix design issue)**
Fatigue cracking often due to **inadequate tack bond** or **insufficient pavement thickness**

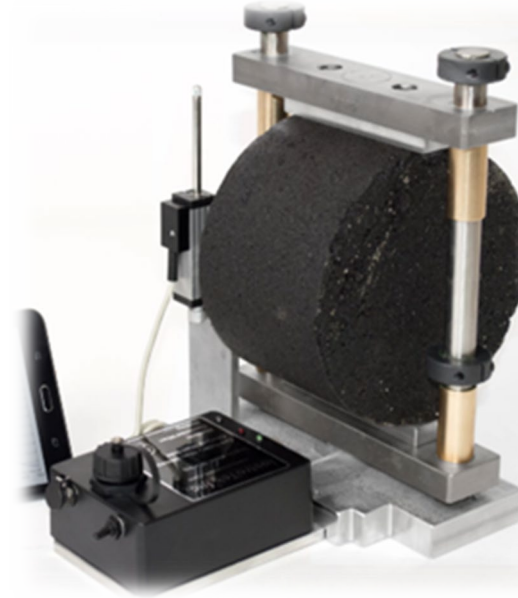
Common Asphalt Mix Cracking Tests



Texas Overlay Test



Semi Circular
Beam Test



IDEAL
Cracking Test

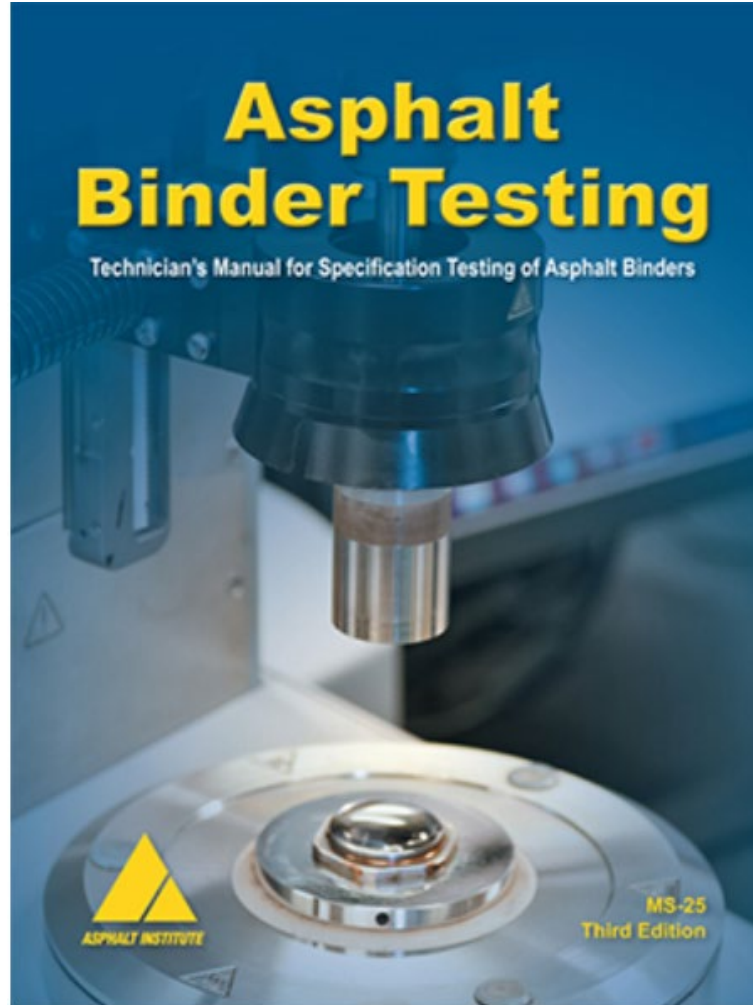


Disk-Shaped
Compact
Tension Test

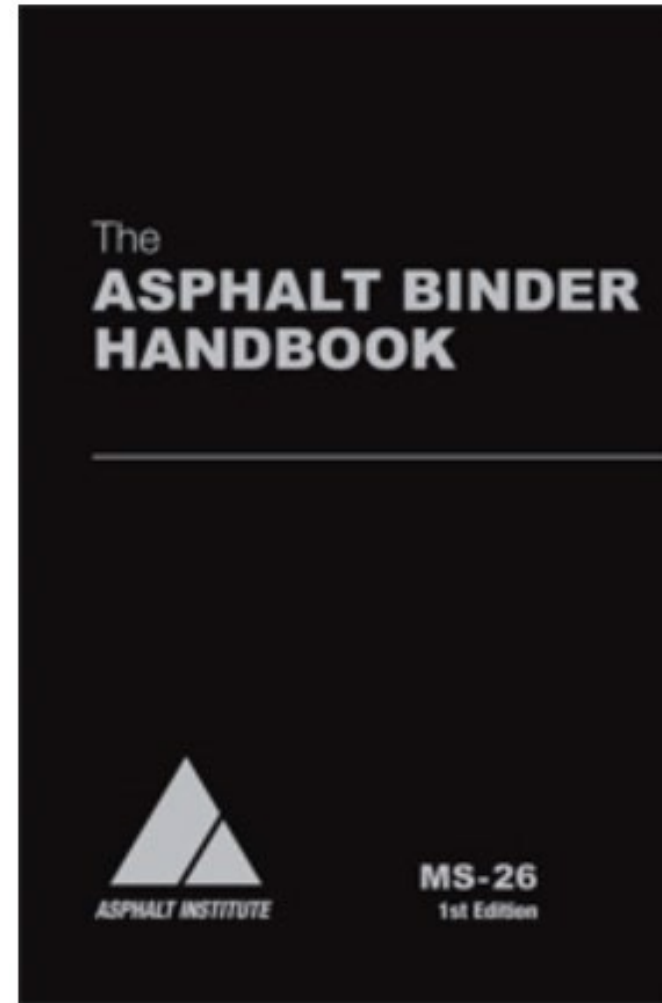
Remember . . .

- Not all pavement distress is related to inherently poor asphalt binder or mixture quality
- Excellent materials can be combined with poor volumetrics resulting in poor performance
- Rutting could be caused by a soft/unstable subgrade
- Fatigue cracking often a sign of inadequate pavement thickness or inadequate bond between lifts
- Reflective cracking caused by overlaying working cracks
- Edge cracking caused by unstable edge support
- Thermal cracking could still occur because of low P_{be} , even with proper environmental binder grade
- Great materials will still fail with poor production, placement, and/or compaction

For More Binder Information



MS-25



MS-26

Resource for Additional Learning

- **Course Outline**

- Module 1: Inspector's Authority and Responsibility
- Module 2: Materials
- Module 3: Mixtures and Mix Design
- Module 4: Plants & Production
- Module 5: Transportation, Delivery, & Preparation
- Module 6: Placement
- Module 7: Compaction
- Module 8: Acceptance and Testing

- **Each module roughly 90-120 mins**

- **Modules consist of ppt slides with audio, exam**

<http://www.asphaltinstitute.org/training/seminars/paving-inspector-certification-pic/>



Thank you.

