Basic Pavement Design/Basic Concepts

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What are the main pavement design parameters?

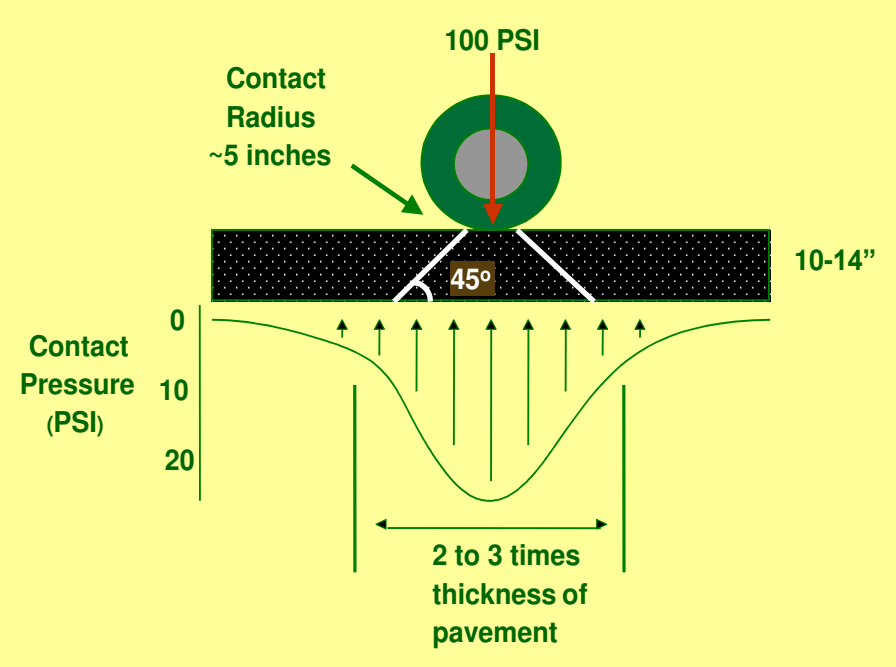
- Two broad categories:
  - Structural
  - Functional

Functional Pavement Aspects

- Ride
- Friction
- Rutting
- Noise

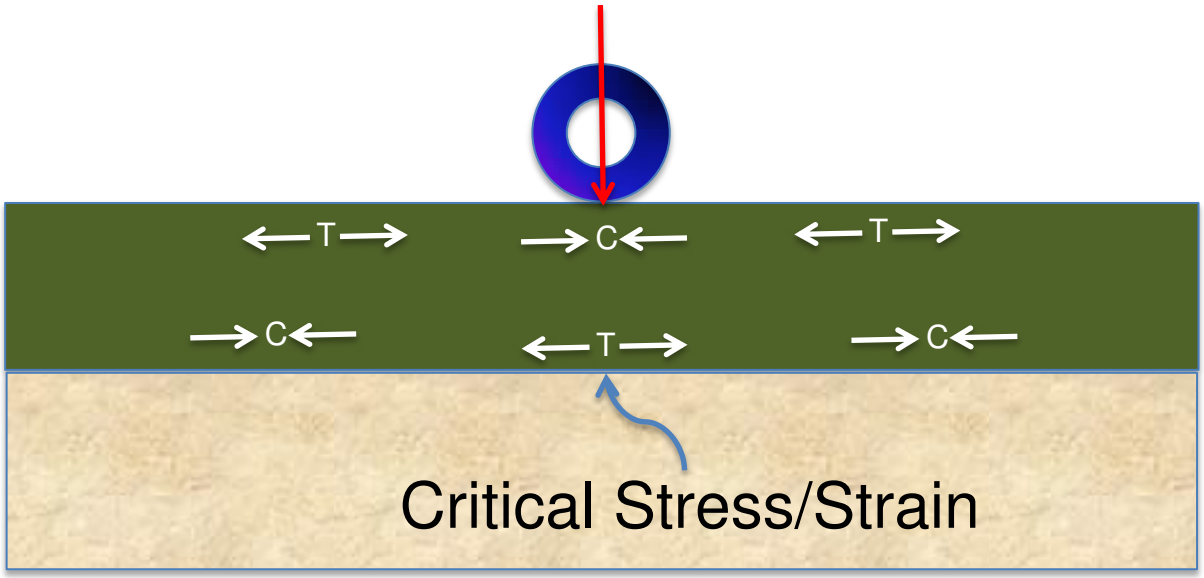
Structural Pavement Aspects

- Protect subgrade from permanent deformation



Structural Pavement Aspects

- Resist fatigue damage from repeated traffic loading



Pavement Design

- For most pavements consisting of bound materials, fatigue damage is the controlling factor.
- The larger the stress or strain at the critical point, the fewer load repetitions to failure.
- The relationship between material response and damage is referred to as a transfer function.

Pavement Design

- At one extreme, a pavement can fail in one load repetition. This is a consideration for airfield pavement, but not so much for highways.
- At the other extreme, the load-induced response in the pavement can be so low that the fatigue life is “infinite”.


Wow!
I'll take INFINITE, please.

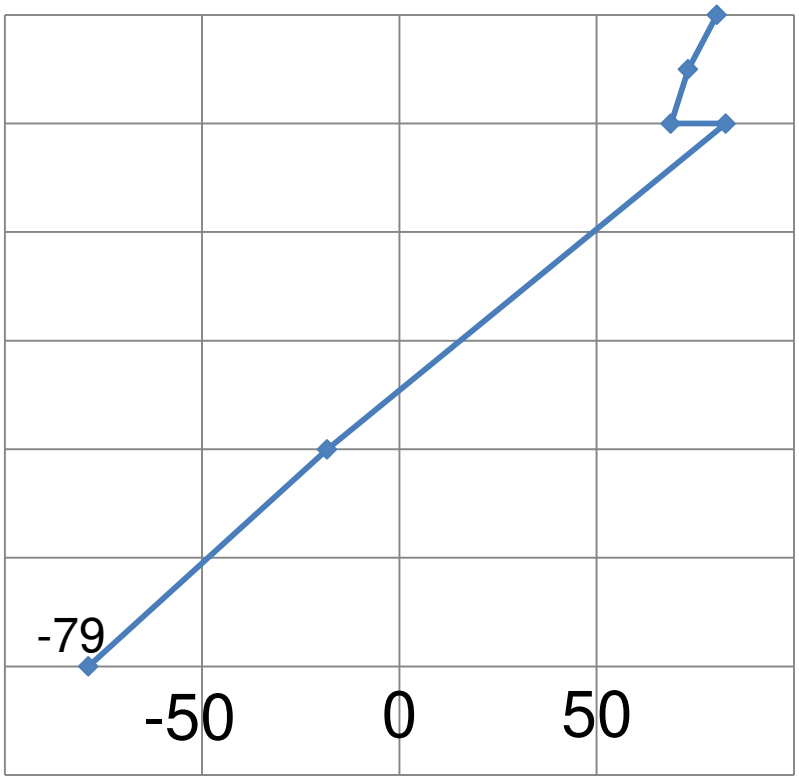
Pavement Design

- For asphalt, the "infinite" condition is determined by the endurance limit and expressed in microstrain.
- Researchers differ somewhat on what the endurance limit is, but the range is generally 70 to 150 microstrain and depends on the mix design.

Pavement Design

- For concrete and cement-treated bases, the fatigue life is generally expressed as the ratio of horizontal stress to the modulus of rupture.
- It is often assumed that if the ratio is less than 0.45 to 0.50, the fatigue life is also infinite.

Sample Pavement Structure



Horizontal Stress (psi)

Negative = Tension
Positive = Compression

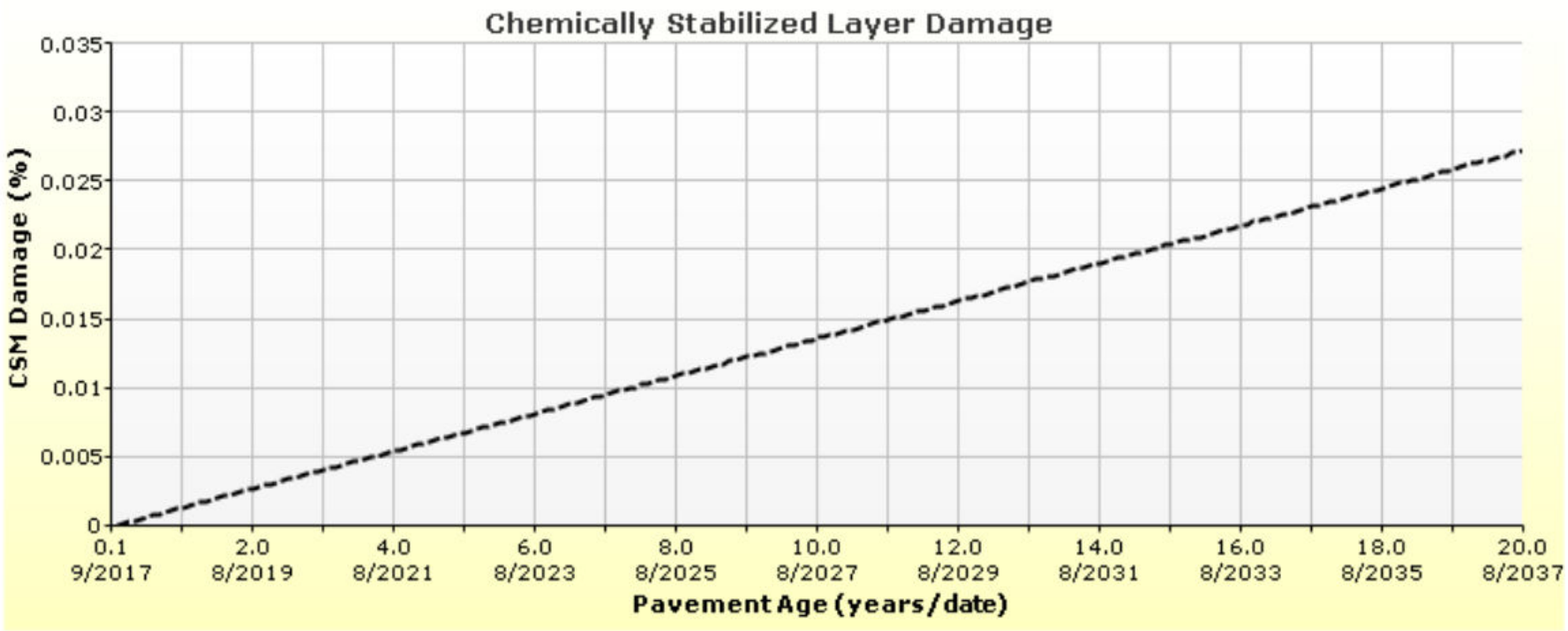
Sample Pavement Structure

- Assume FDR has a lab compressive strength of 600 psi at 8 days.
- Assume field strength of FDR is 75% of lab strength, 450 psi.
- Assume 8 day strength is 60% of long term strength. This makes the long term strength 750 psi.

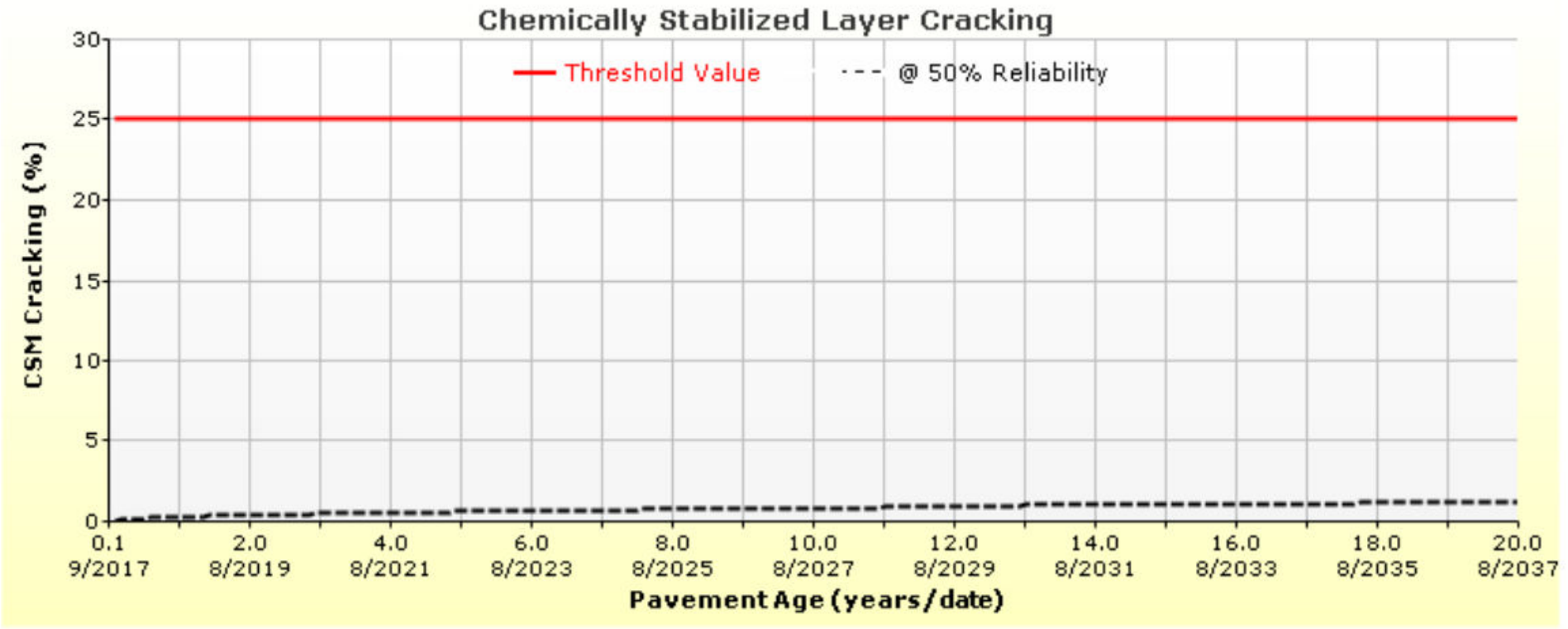
Sample Pavement Structure

- A compressive strength of 750 psi is assumed to have a modulus of elasticity of 865,000 psi and a modulus of rupture of 173 psi.
- Estimated stress in our example is 79 psi, for a ratio of 0.46.
- Using AASHTO MEPDG transfer function, this would give 22.5 million repetitions to failure.
- Estimated asphalt strain is 57 microstrain, well below typical endurance limits for fatigue.

AASHTO PavementME Results



AASHTO PavementME Results



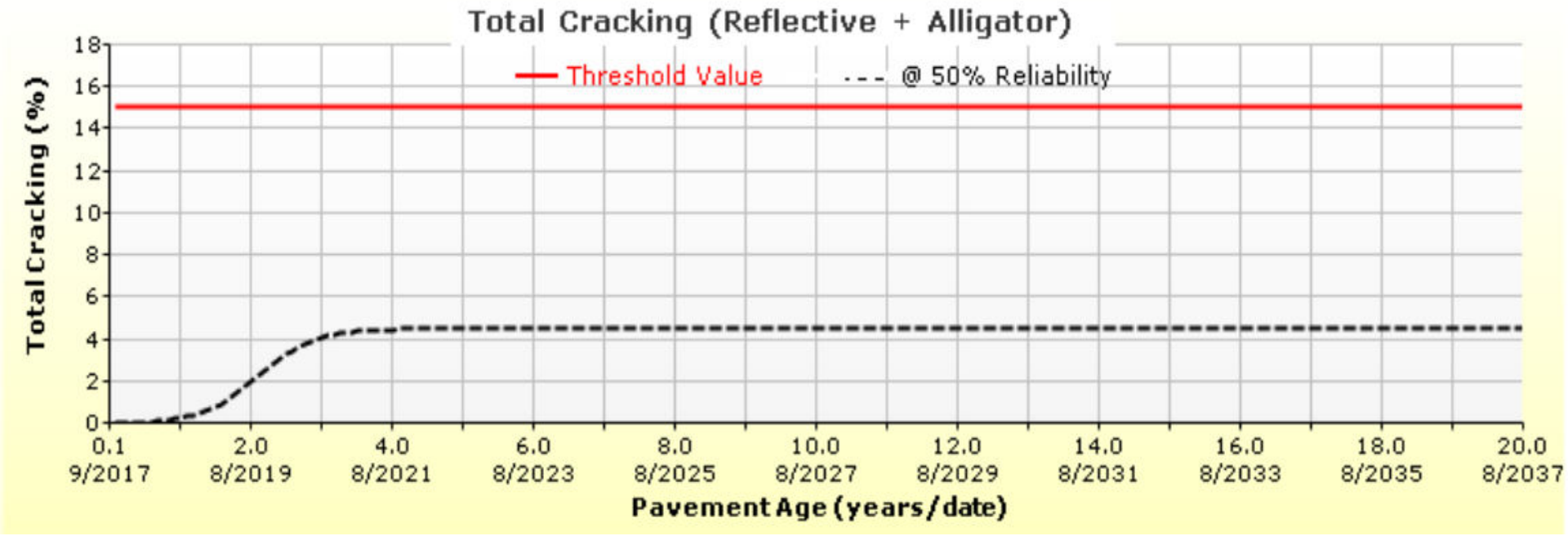
What's the catch?

- Reflective cracking:
  - When Portland cement and water cure, the resulting product has a slightly lower volume than what went in.
  - The pavement is restrained by friction to its original length. It wants to shrink, but can't.
  - This creates tensile stresses in the pavement.
  - If the tensile stresses exceed the tensile strength at a given point in time and space, the pavement will crack.

What's the catch?

- Reflective cracking:
  - These cracks are NOT the same as fatigue cracks and have high load transfer efficiency.
  - Concern is that these cracks will lose their LTE over time, water will get into pavement and subgrade. This water could lead to softening of the subgrade and damage.
  - Also the cracks reflect through the asphalt overlay and may allow water damage.

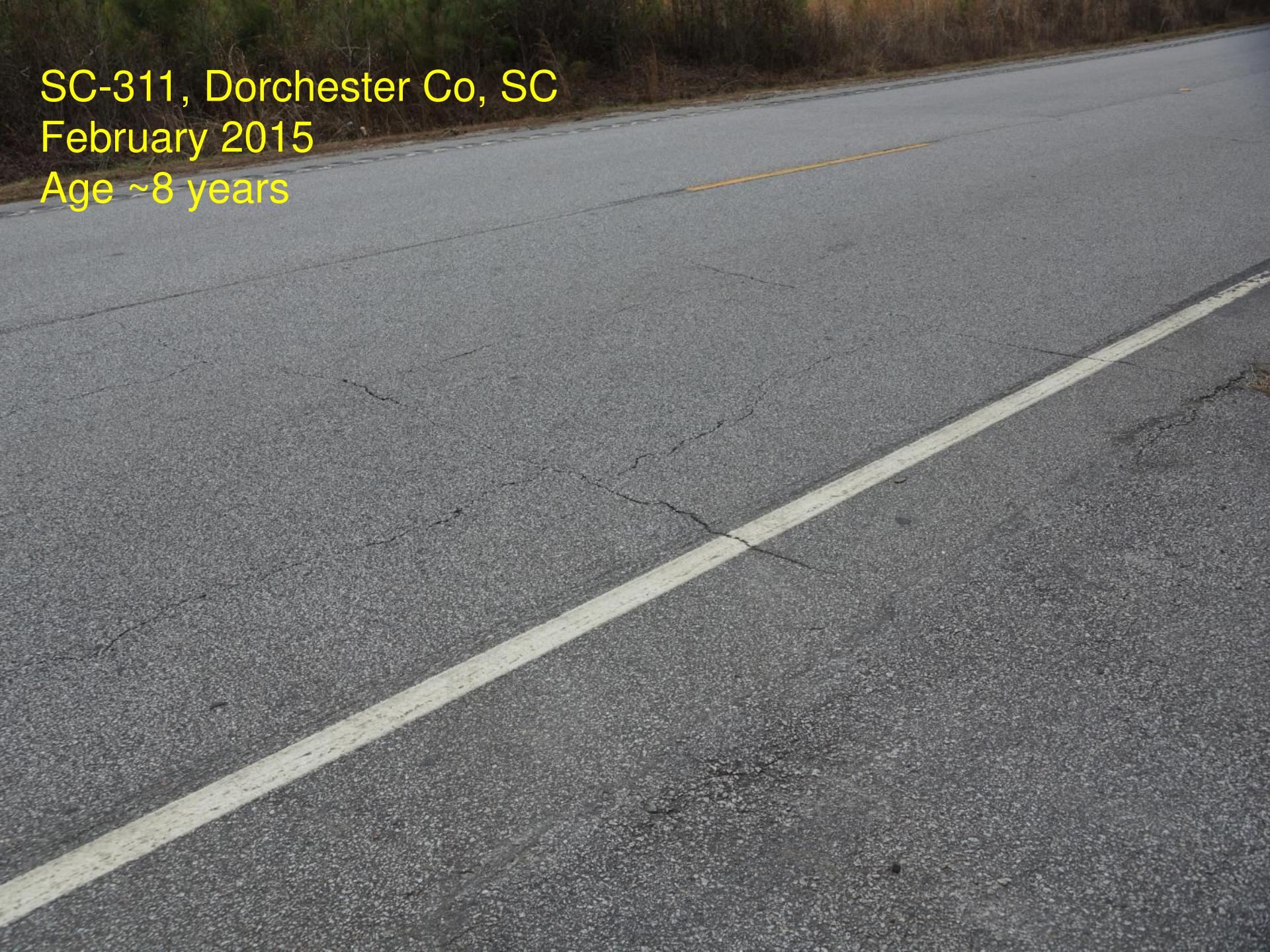
AASHTO PavementME Results



Dealing with reflective cracking

- Several strategies available
  - Stress absorbing interlayer
  - Geosynthetics
  - Pre-cracking/microcracking
  - Crack sealing
  - Use lower cement content/greater depth
  - Don't worry about it…


SC-311, Dorchester Co, SC
February 2015
Age ~8 years


SC-311, Dorchester Co, SC
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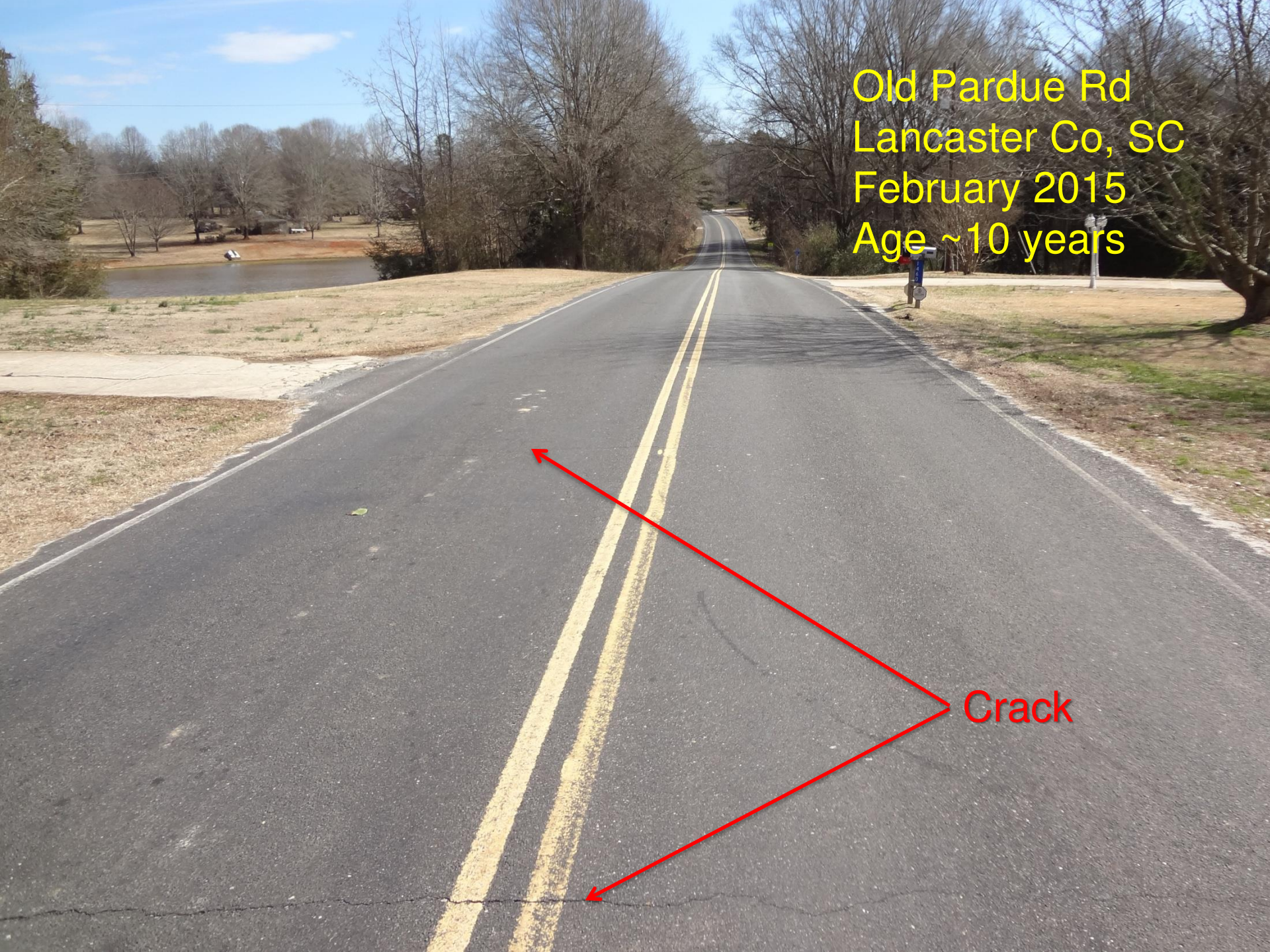
Old Pardue Rd
Lancaster Co, SC
February 2015
Age ~10 years
Crack


Crack Sealing ?

Cracking is not limited to FDR

- Patching, milling, and overlay can also develop reflective cracking over patch boundaries and existing cracks.
- Unlike FDR-related shrinkage cracking, the reflected cracks are often promptly structural in nature.
- Need to consider the FDR cracking behavior in perspective with the alternatives.

Other issues

- Rideability
  - Good smoothness is achievable.
  - Technology is improving the grade control capabilities of the FDR process.
  - Motor grader operator skill is essential to getting a smooth ride.

Conclusions

- FDR can provide a very long-lasting base, even under high traffic conditions.
- In mild climates, like South Carolina, reflected shrinkage cracks are primarily an aesthetic issue.
- Shrinkage cracking may be mitigated by a variety of means, if necessary.

Questions?

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