Performance Testing: A Path to Implementation

Douglas Hanson • November 15, 2011

Why do we need performance Tests

- For Research Purposes
  - To evaluate new materials or design strategies
- As Part of Mix Design Process
  - To identify mixtures prone to performance problems
  - To gain confidence on Warranty and Design-Build projects

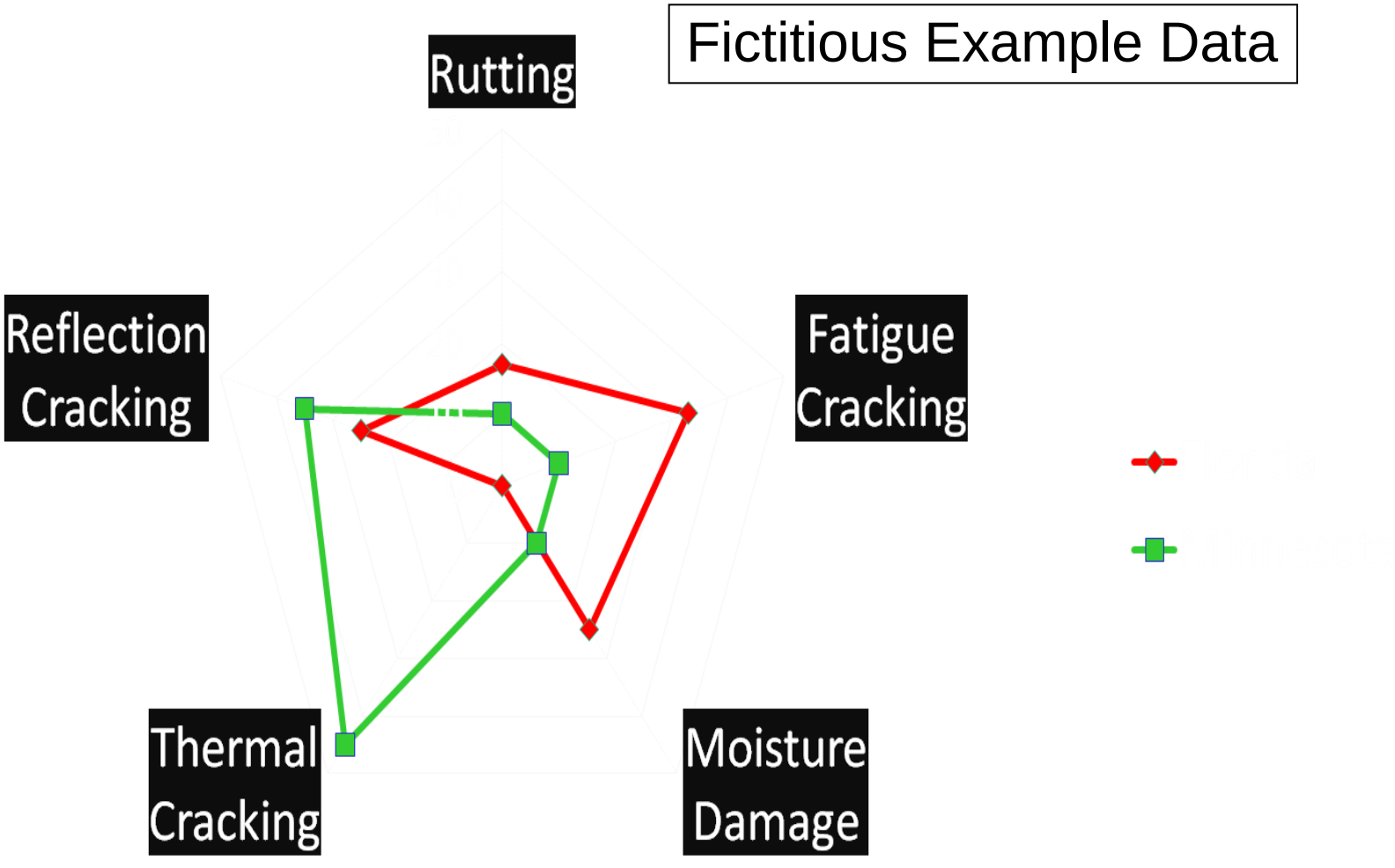
Why do we need performance Tests

- For Quality Assurance Purposes
  - To assess how plant mix could impact performance and use in pay adjustment factors

Who's on First?

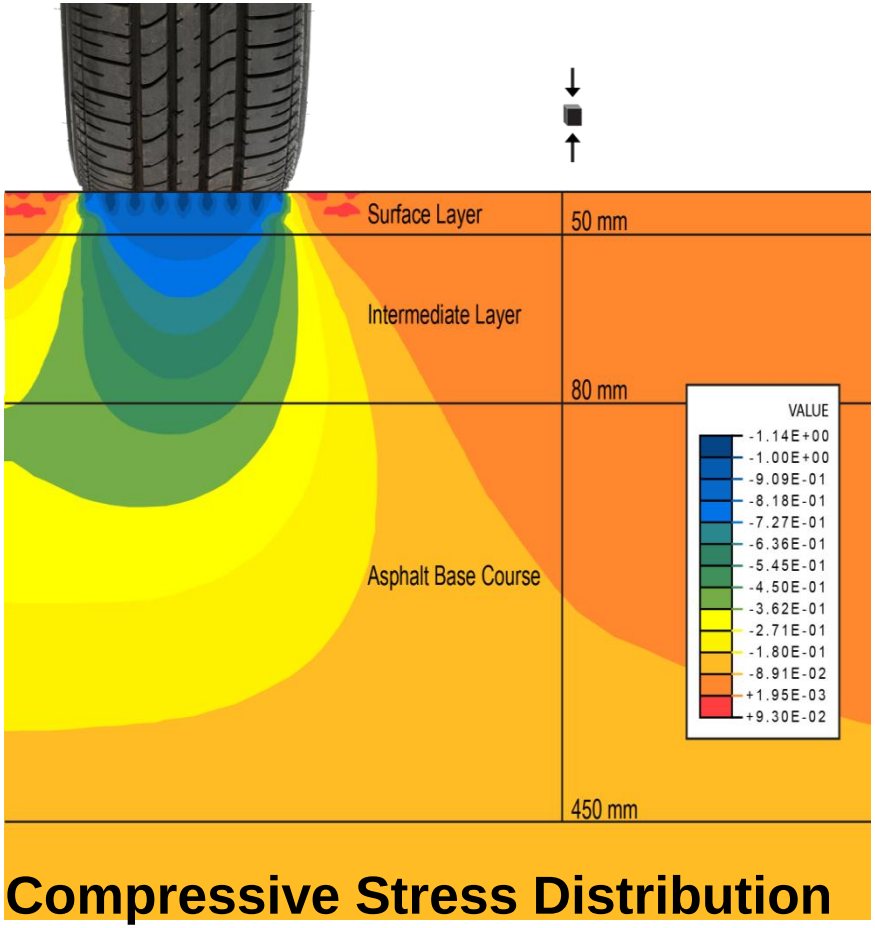
What are the Most Critical Needs?

What Are the Primary Modes of Distress?

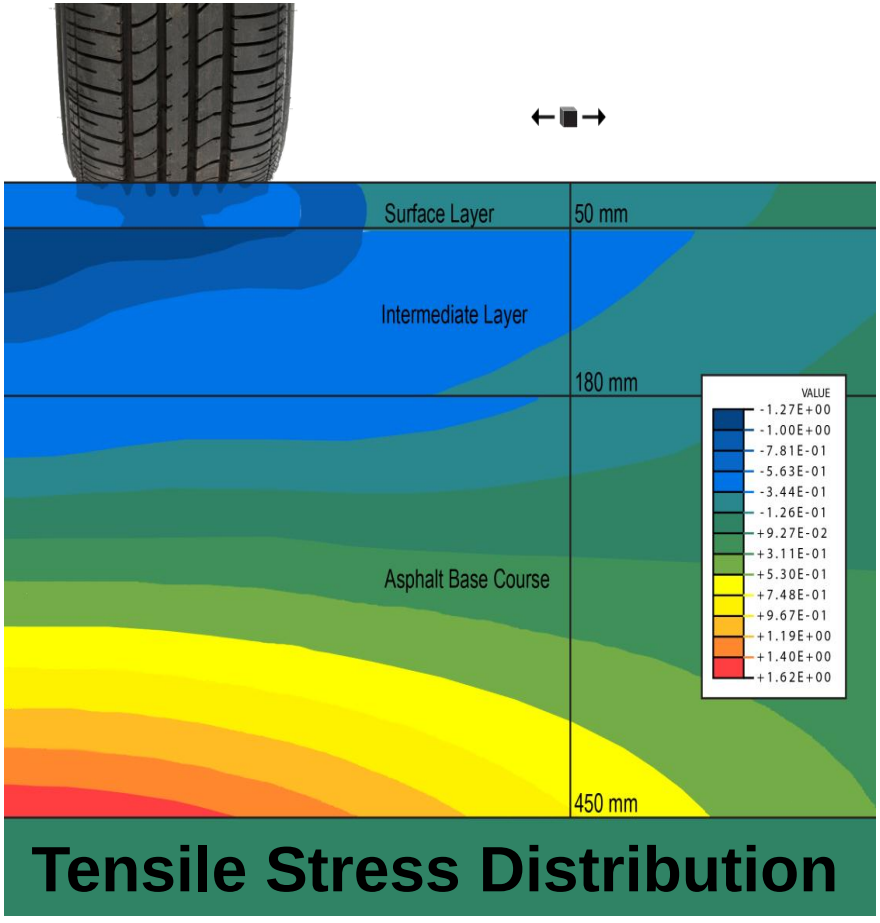


It's Like an Onion

Stress Distributions in a Pavement



Compressive Stress Distribution



Tensile Stress Distribution

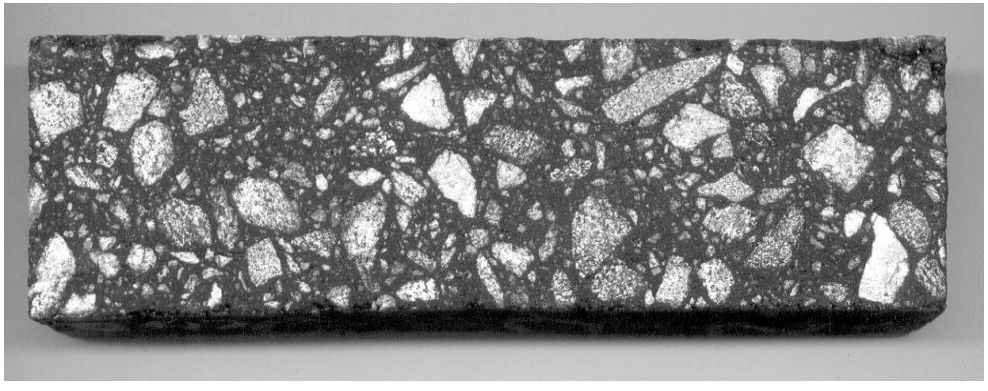
Each Layer in an Asphalt Pavement has Different Critical Stresses

It's a Snapshot in Time

How to Deal with Aging?

Healing ?

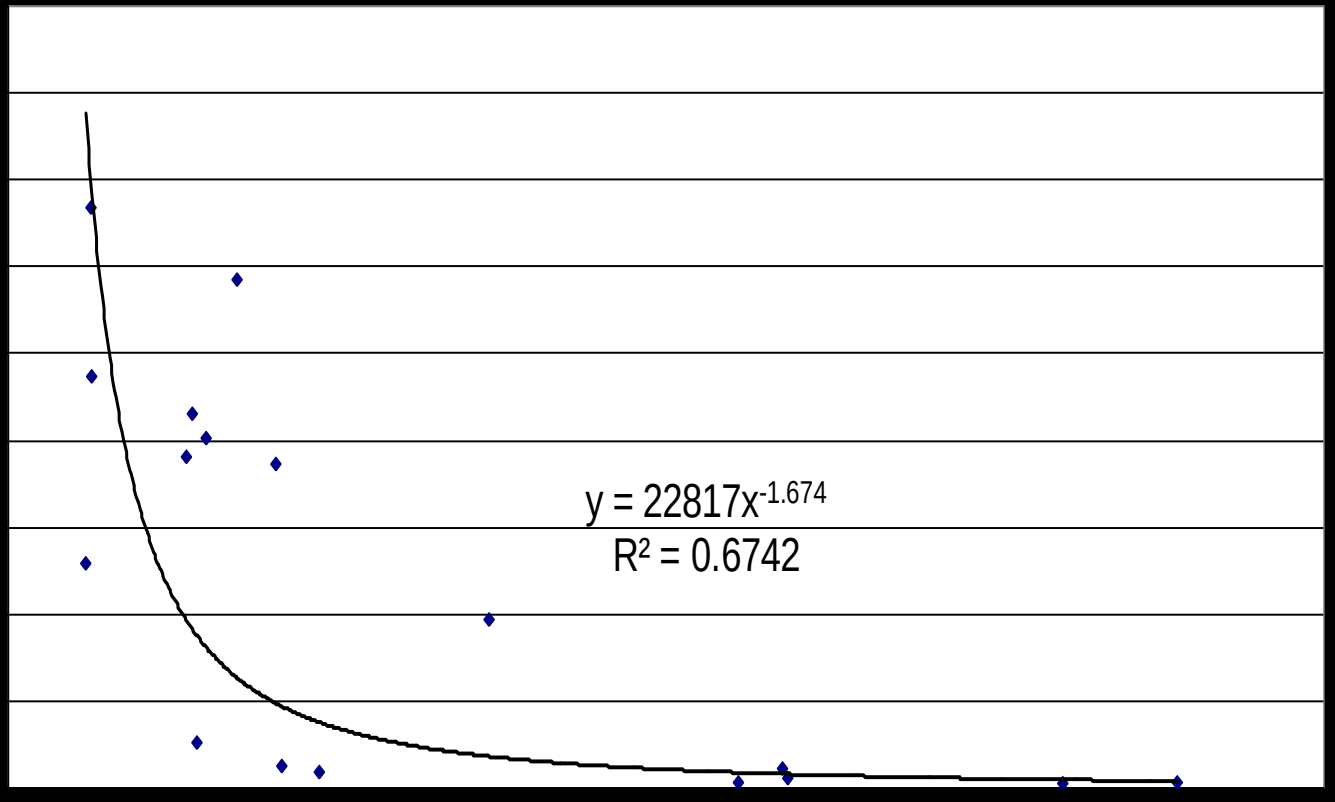
Changes in asphalt properties with time



Proof's in the Pudding

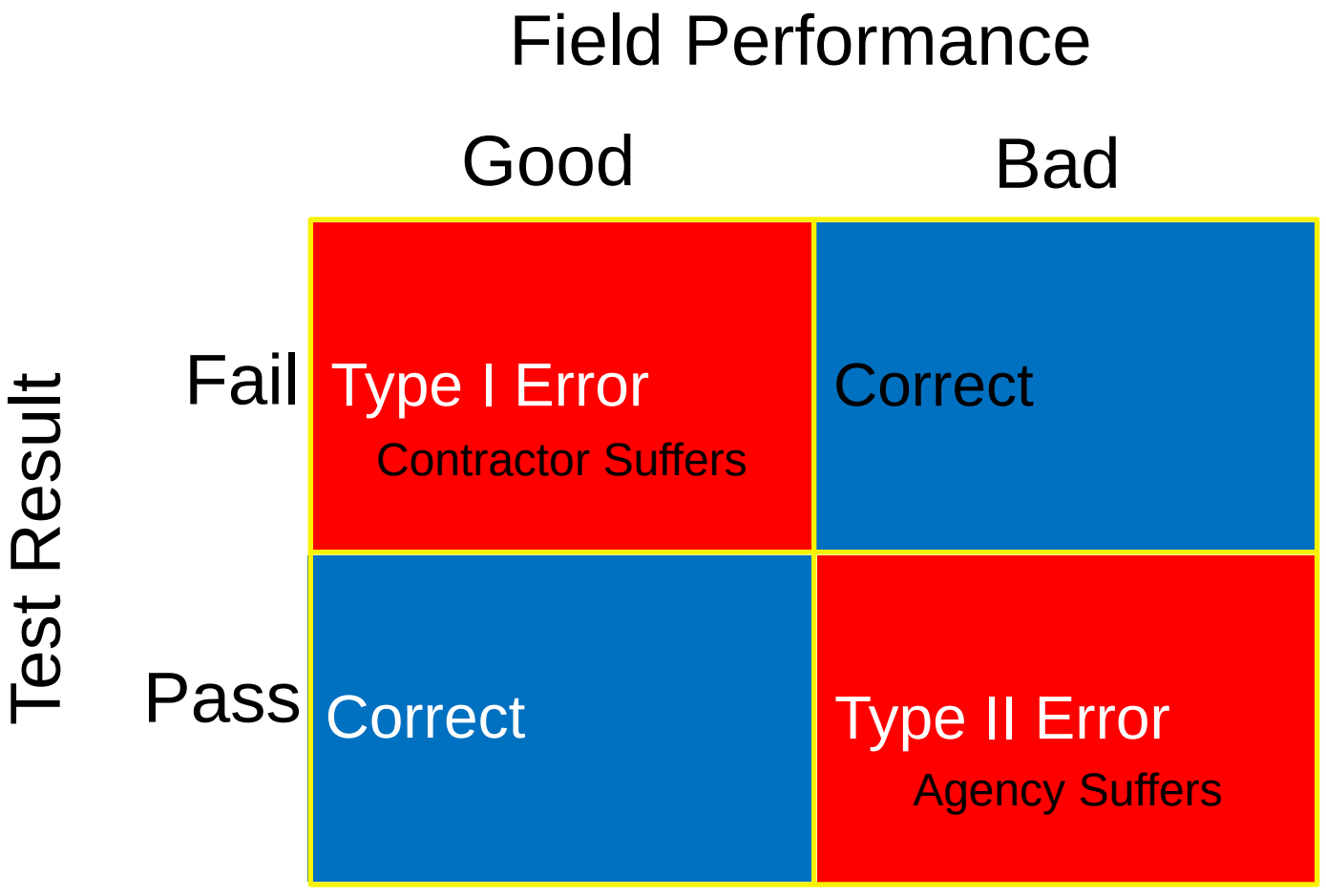
NCAT TEST TRACK

Performance Correlations

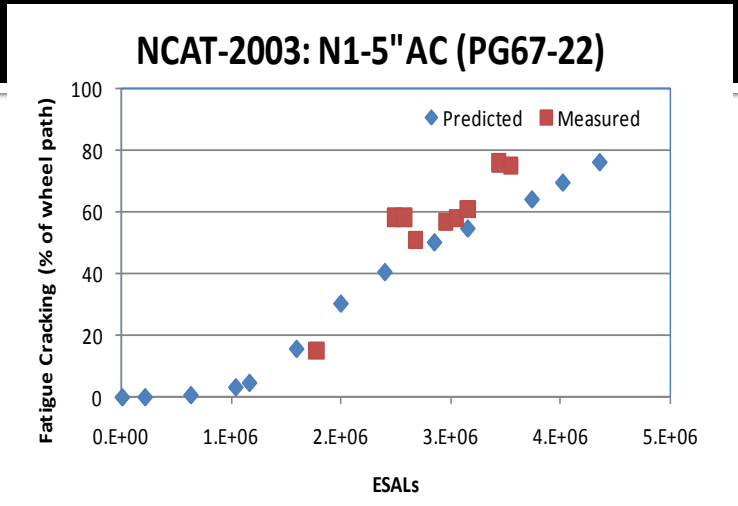


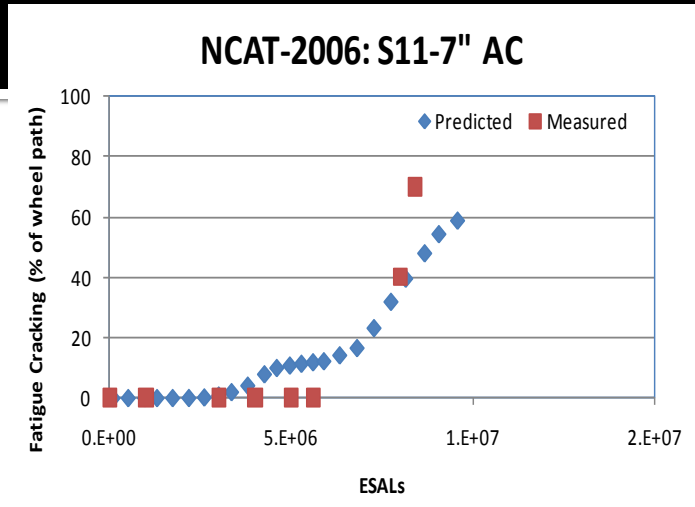
FLOW NUMBER vs RUTTING RATE

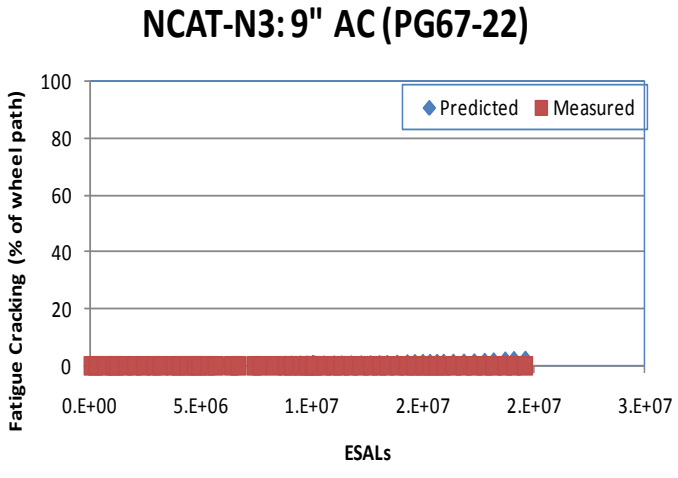
Relationship to Performance

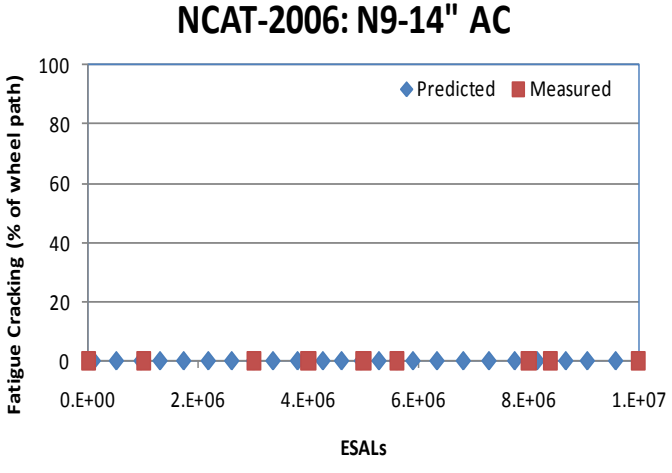


Using Mix Properties in Performance Models









Calibration of TX-ME Fatigue Model Using the NCAT Test Track

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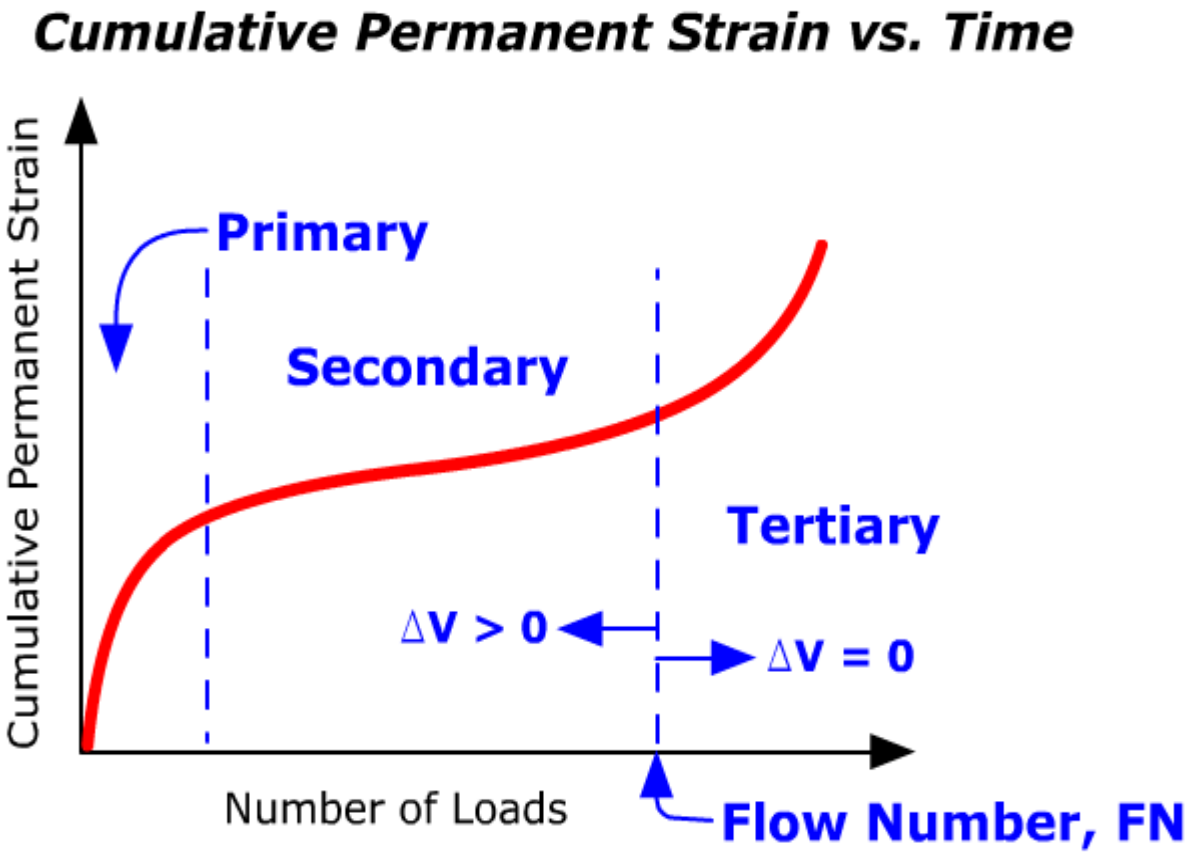
Performance Tests

Rut Resistance
Flow Number (F_N) Test

- Air voids (7%)
- Deviator stress (70 – 100 psi)
- Confining pressure (0 - 10 psi)

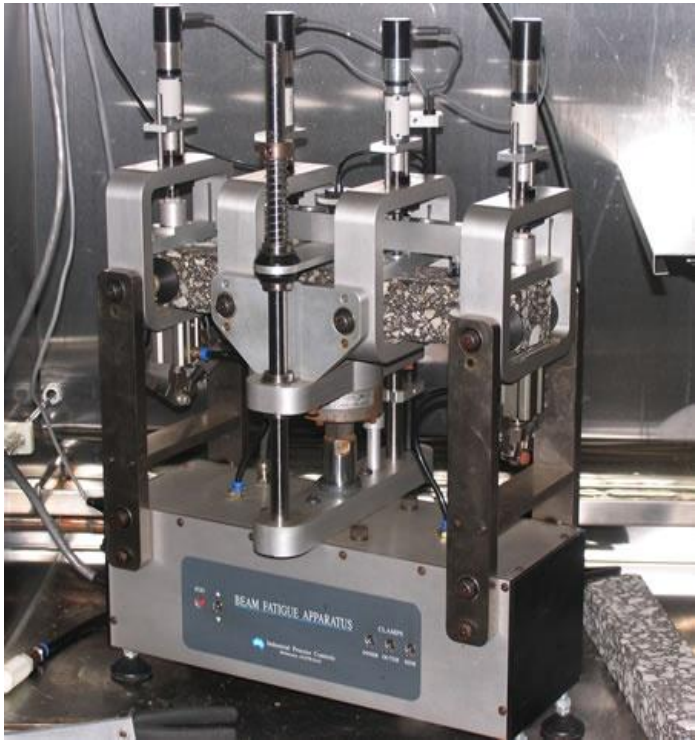
Flow Number Test (cont.)

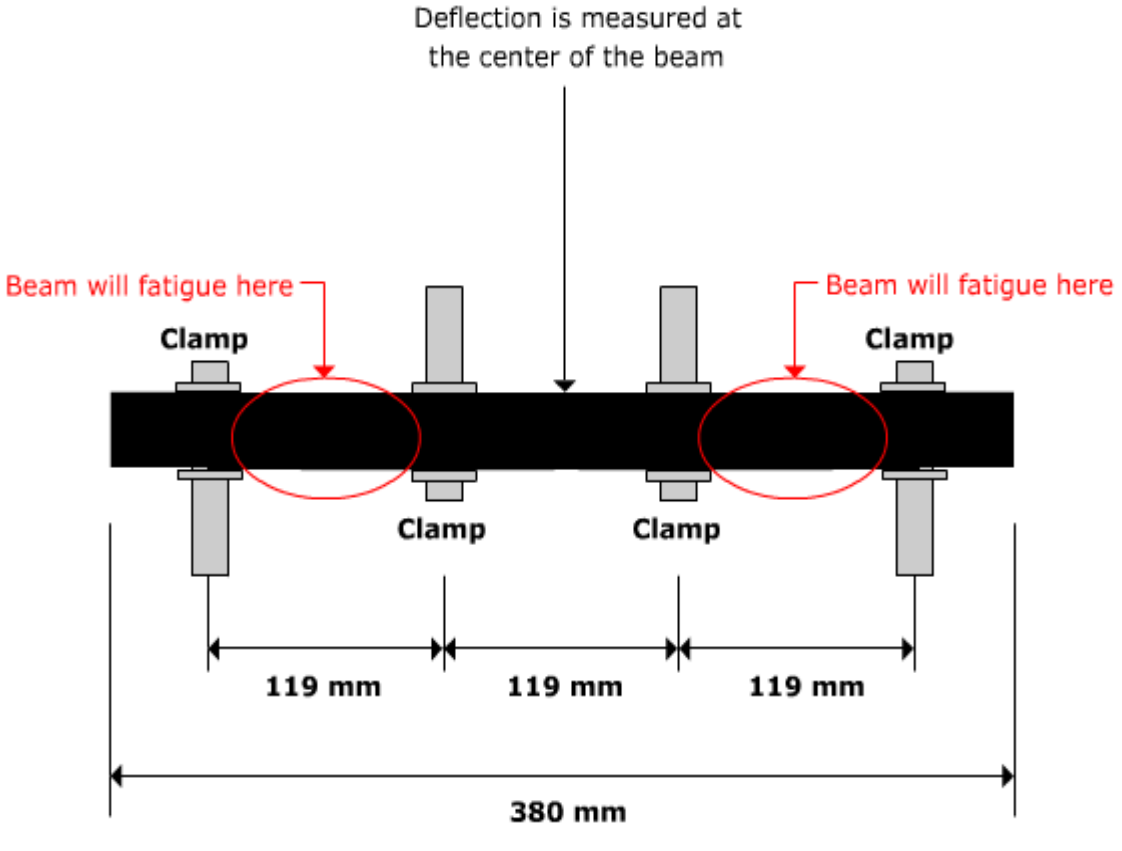


- Primary: strain rate decreases with loading time
- Secondary: strain rate is constant with loading time
- Tertiary: strain rate increases with loading time
- Lower flow number should correspond to greater rutting

Asphalt Pavement Analyzer

Bending Beam Fatigue Test





Moisture Damage Susceptibility

Small pothole with flushed binder on the surface – a sign of moisture damage

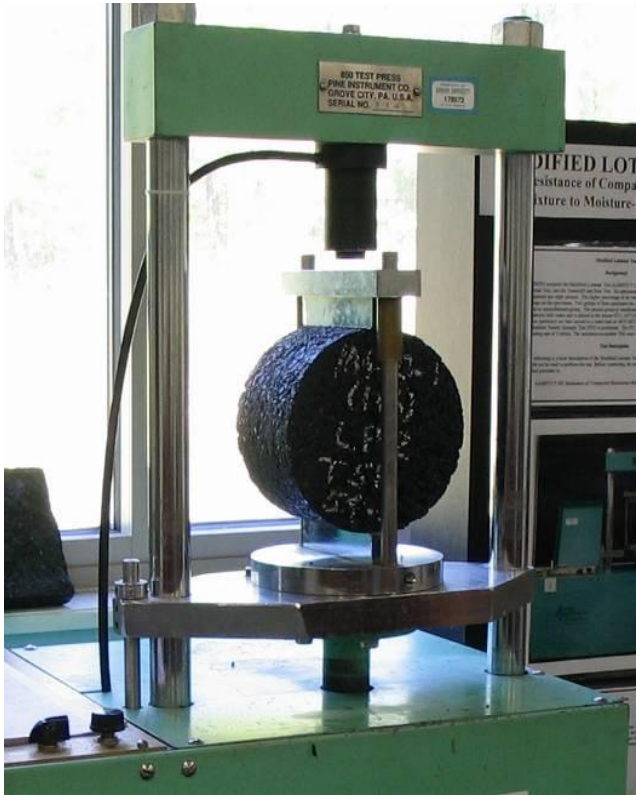
A 1.5” overlay less than one year old that was placed on a layer that was weakened by moisture damage.

Moisture Damage Susceptibility

Cores showing moisture damage (stripping) in an underlying layer

Severe stripping – the asphalt binder is gone

Moisture Damage Susceptibility Tests



AASHTO T 283, Tensile Strength Ratio

AASHTO T 324, Hamburg Wheel Tracker

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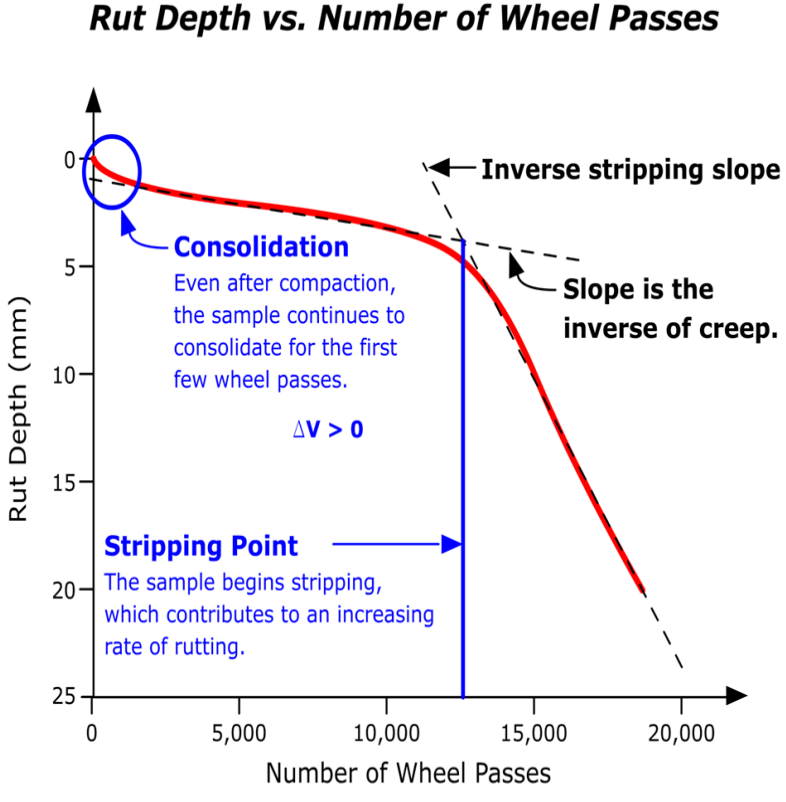
Hamburg Wheel Tracking Test

Hamburg Wheel Tracker capable or running two sets of specimens simultaneously

- **Test combines rutting assessment with moisture susceptibility**



Moisture Damage Susceptibility Testing

AASHTO T 283, TENSILE STRENGTH RATIO

- Procedure is well established for mix design approval and verification of plant mix
- 1 week to complete the test
- Precision statistics unknown, suspected to be poor
- Pass/Fail criteria on TSR
- Some states also have minimum conditioned tensile strength

AASHTO T 324, HAMBURG WHEEL TRACKING TEST

- Specified by a few states and used by numerous researchers
- 1 to 2 days to complete test
- $60,000 equipment cost
- Precision statistics unknown, suspected to be poor
- Pass/Fail criteria on SIP

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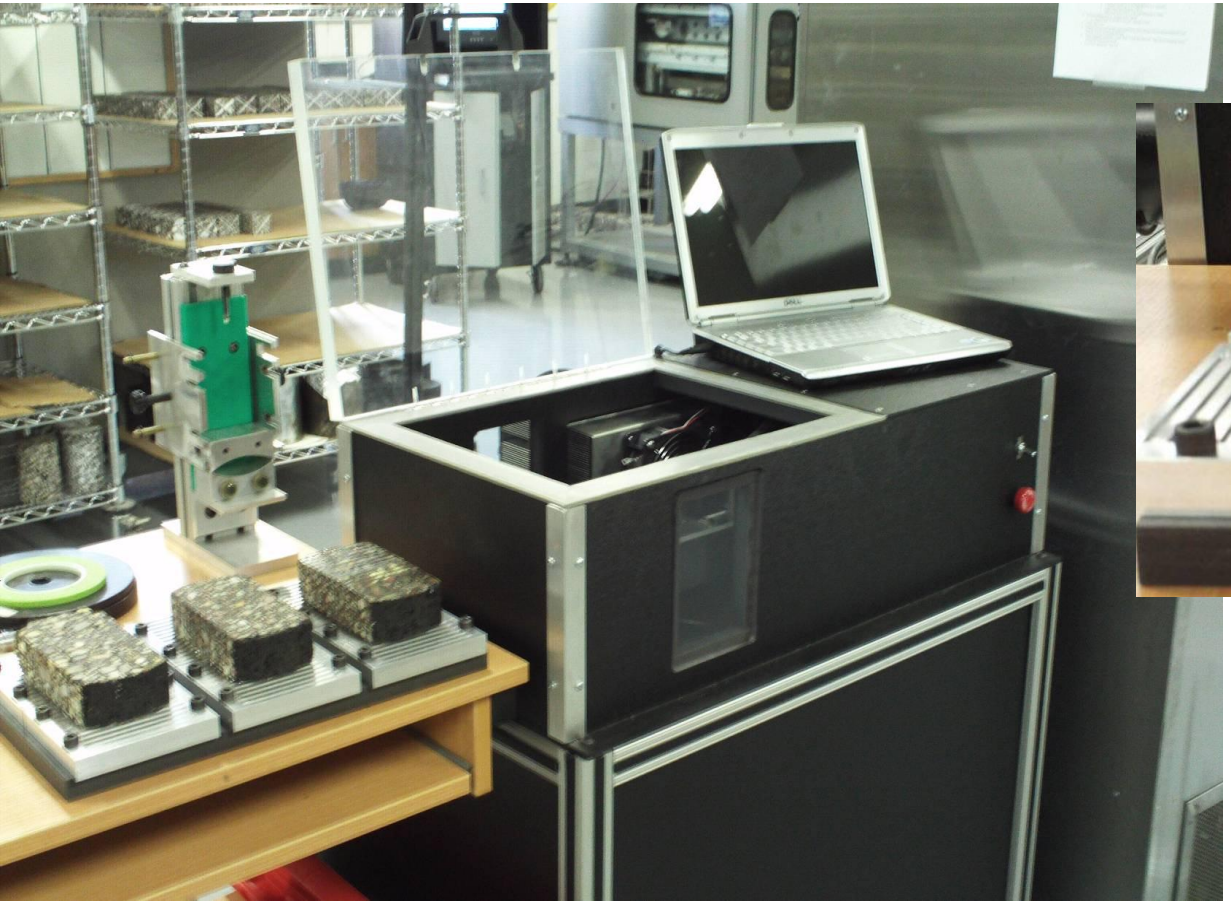
Reflection Cracking

Many cracks that are evident on the surface are caused by cracks or joints in the underlying pavement

See what the asphalt did to that concrete!

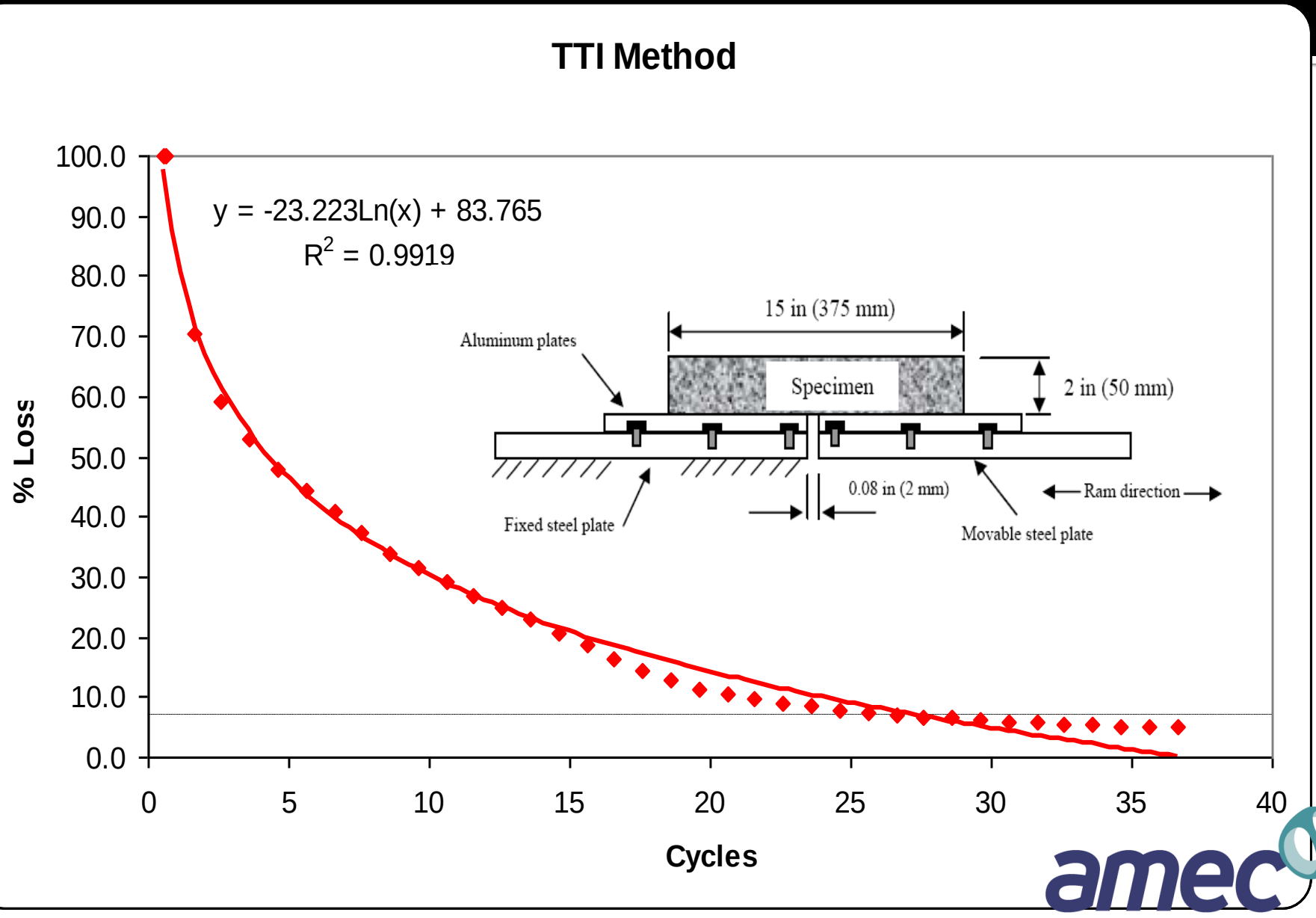
Texas Overlay Tester



Specimens prepared for testing

The Texas Overlay Tester is a self contained device

Texas Overlay Tester

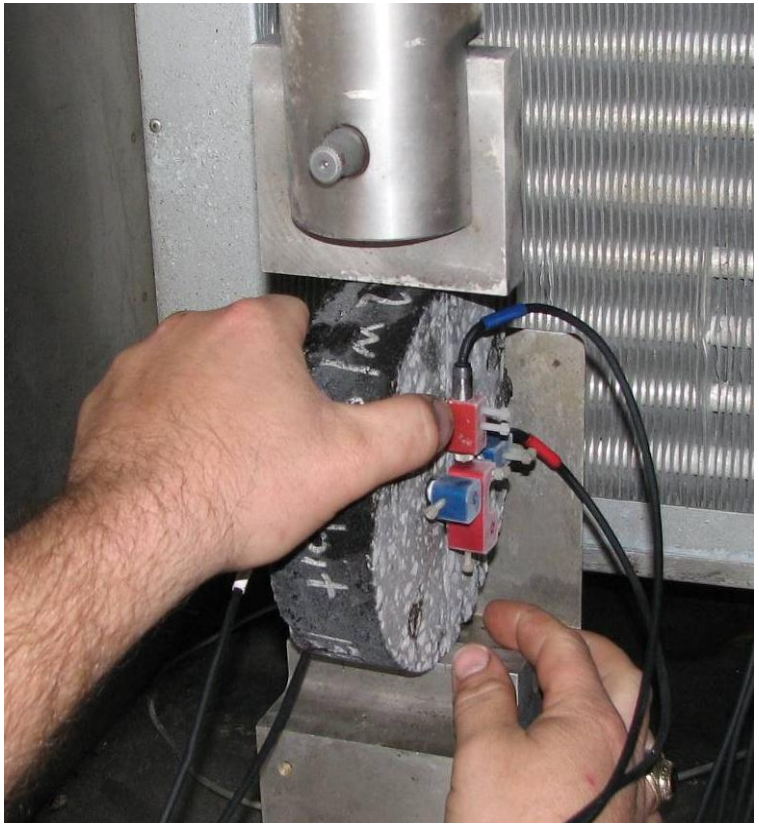


Thermal Cracking

- The most prevalent form of distress in cold weather climates
- Caused by contraction during temperature drops
- Cracking begins at the surface

Thermal cracks typically go across the pavement

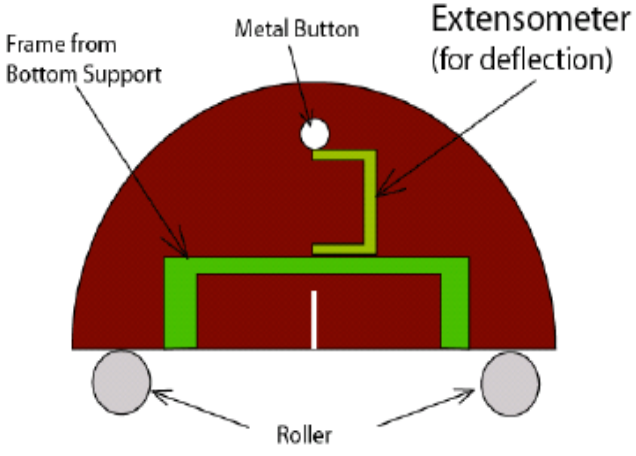
Indirect Tensile Creep Compliance and Strength Test (AASHTO T 322)



Setting up a specimen for the IDT Creep Compliance Test

- Specimens cut from SGC cylinders
- 0°, -10°, -20° C
- Creep test: apply constant load for 1000 sec., measure strain
- Compliance is the inverse of stiffness
- Strength Test: vertical displacement

Semi-Circular Bend (SCB) Test

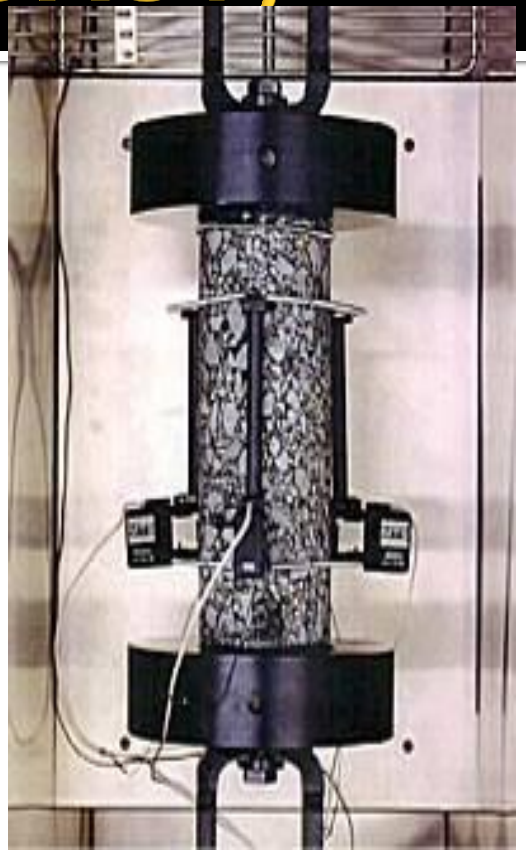


- Recommended by Univ. of Minnesota in TPF-5(080) & TPF-5(132) Pooled Fund Studies
- Two parameters are generated: fracture toughness and fracture energy

Thermal Stress Restrained Specimen Test (TSRST)

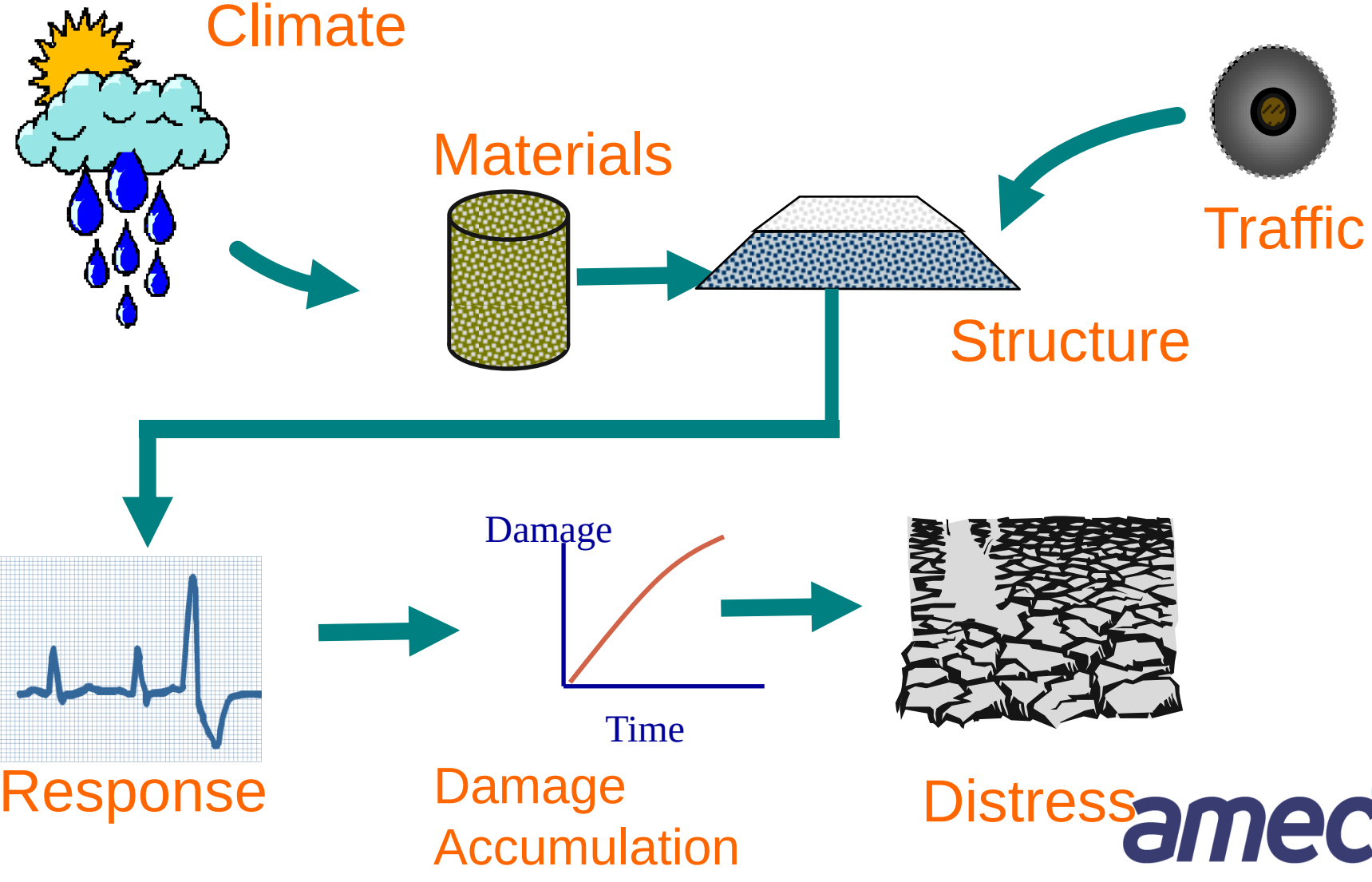
Specimen with acoustic emission sensors

TSRST test system



Specimen with strain extnsometers

M-E Pavement Design



Dynamic Modulus (|E*|)

Specimen for E* Test

150 mm by 100 mm,
cored from SGC specimen

Summary

- Numerous “performance tests” are available for each type of asphalt pavement distress
- More research is needed to validate tests and establish their repeatability
- Implementation of performance tests will require substantial investments in equipment and training

Performance testing

Is the art of molding materials we do not wholly understand into shapes we cannot precisely analyze, so as to withstand forces we cannot assess, in such a way that the community at large has no reason to suspect our ignorance.

Source: Unknown

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THANK
YOU