What is on the Horizon in HMA

John D'Angelo
Federal Highway Administration


Binders

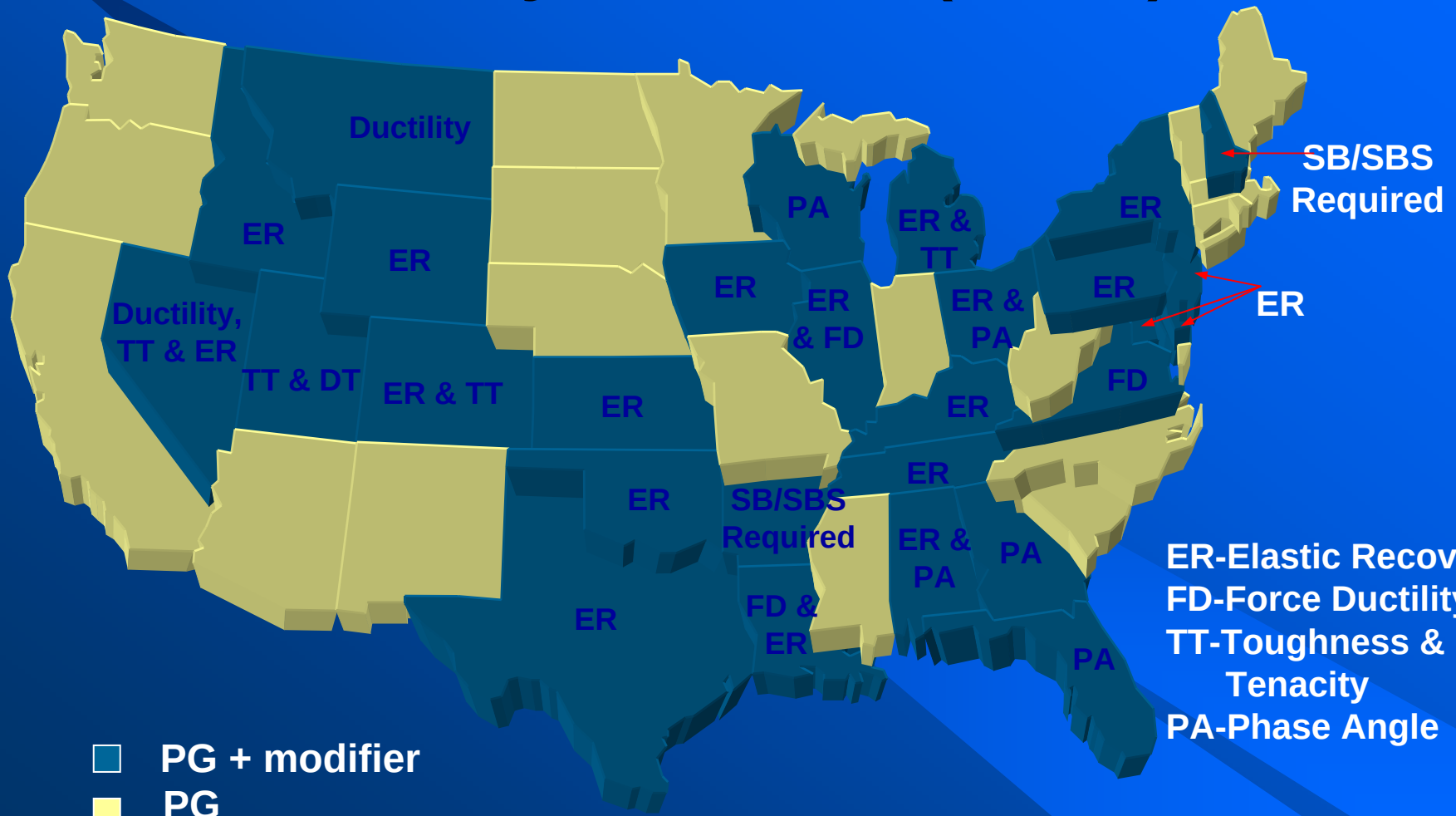
Development of Standard Practice for Superpave Plus Specifications

Use of DSR in Place of ER and Ductility

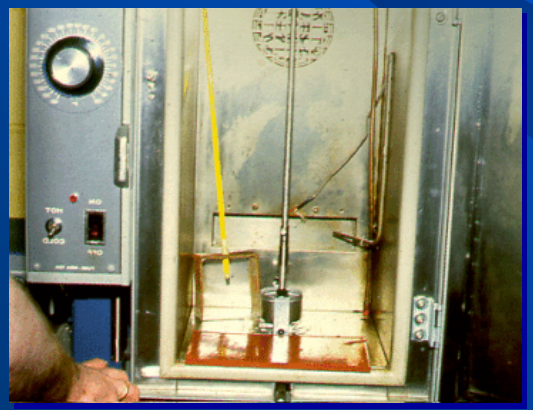
Why Superpave Plus Specs.

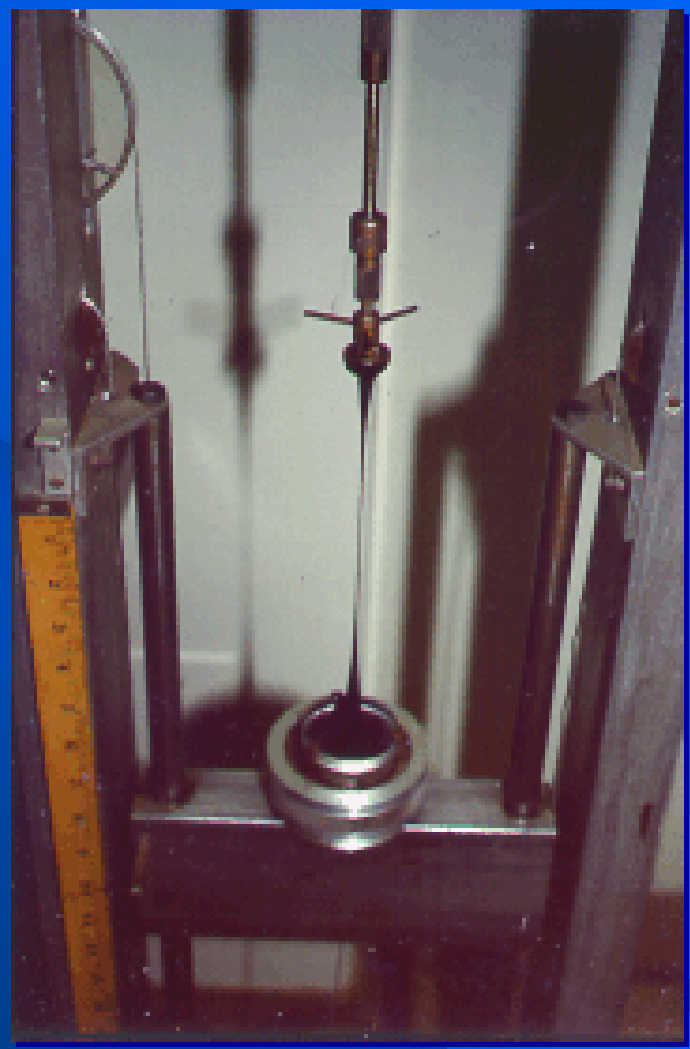
- The existing specifications do not identify the performance characteristics of modified binders.
- The existing specifications do not have a criteria for fatigue or durability.
- Agencies look to other tests to identify modifiers
  - Elastomeric polymer modifiers are desired

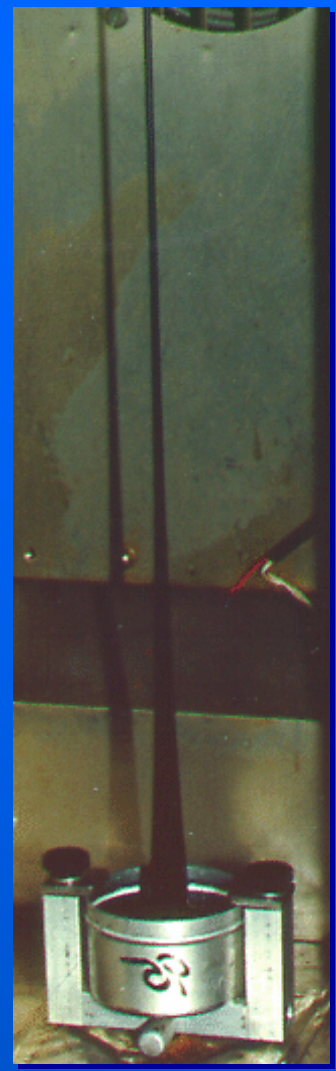
State DOT's Specifying Polymer PG (PG+)



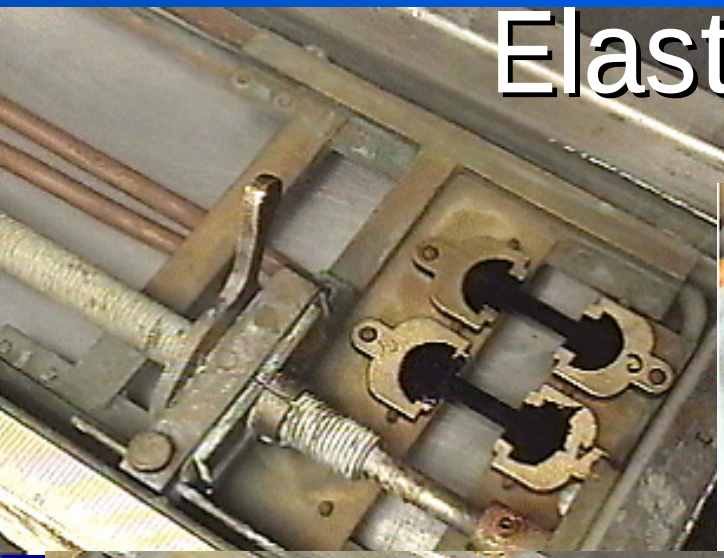
Toughness & Tenacity

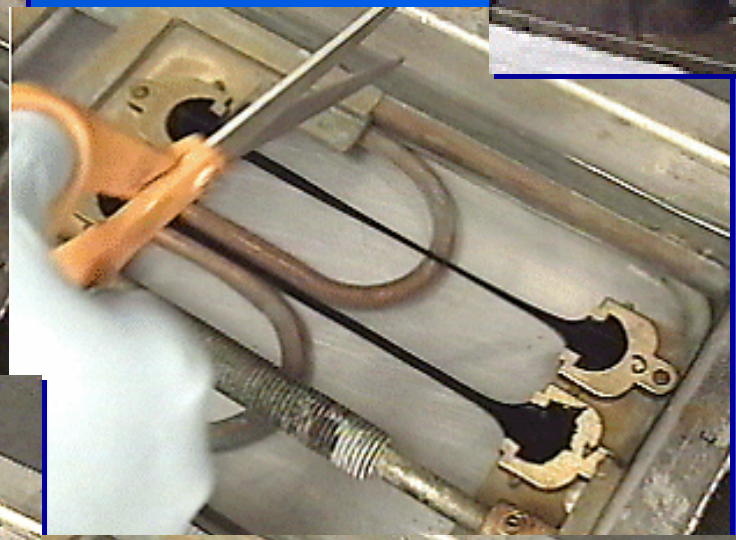


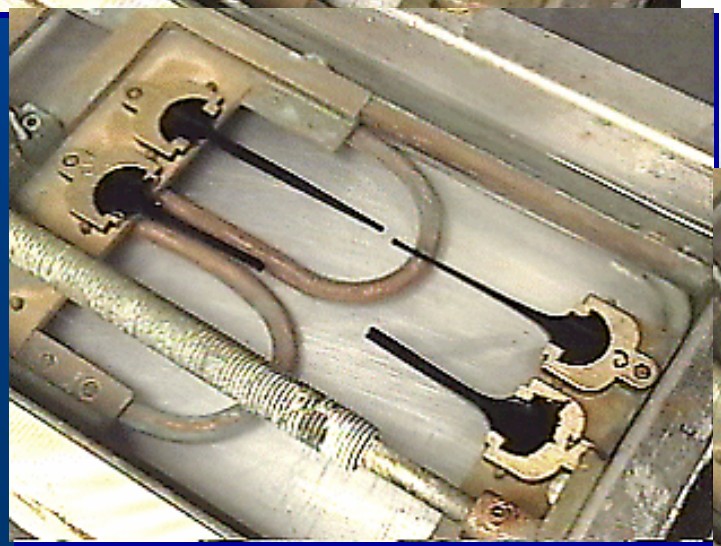


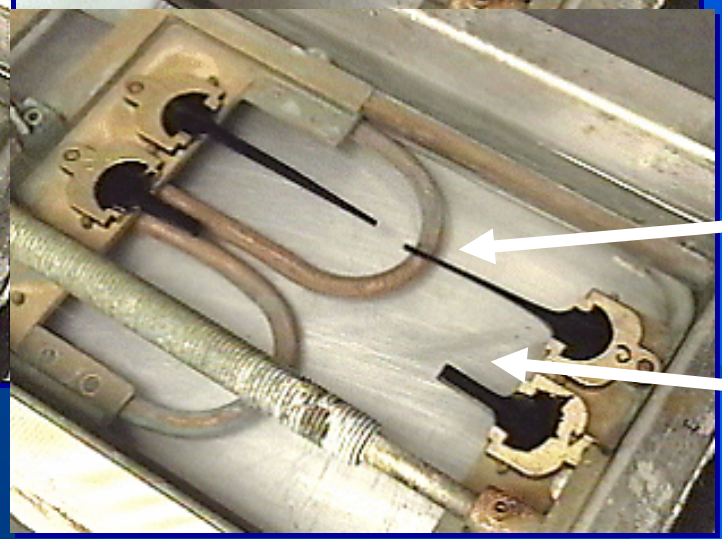


Elastic Recove





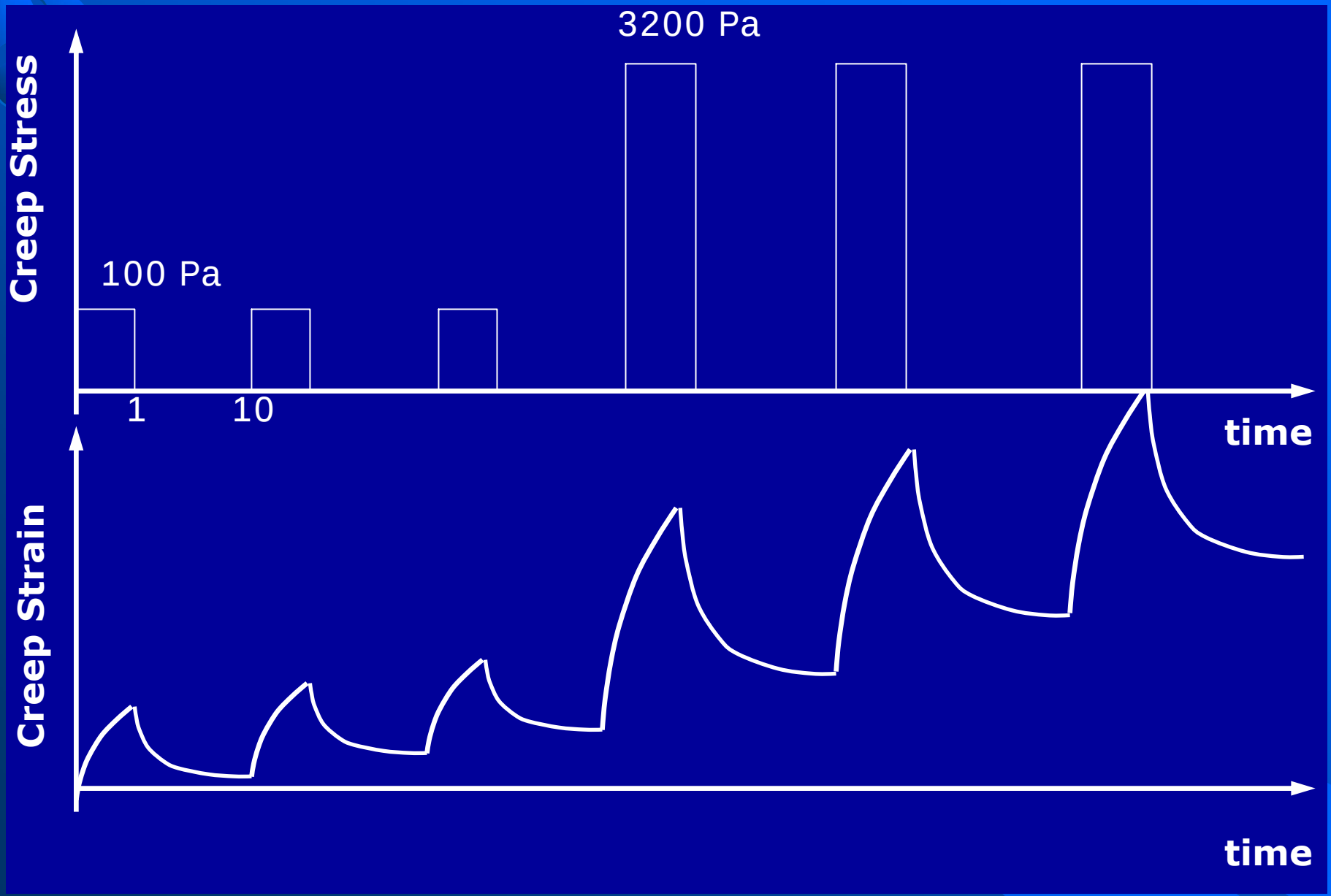




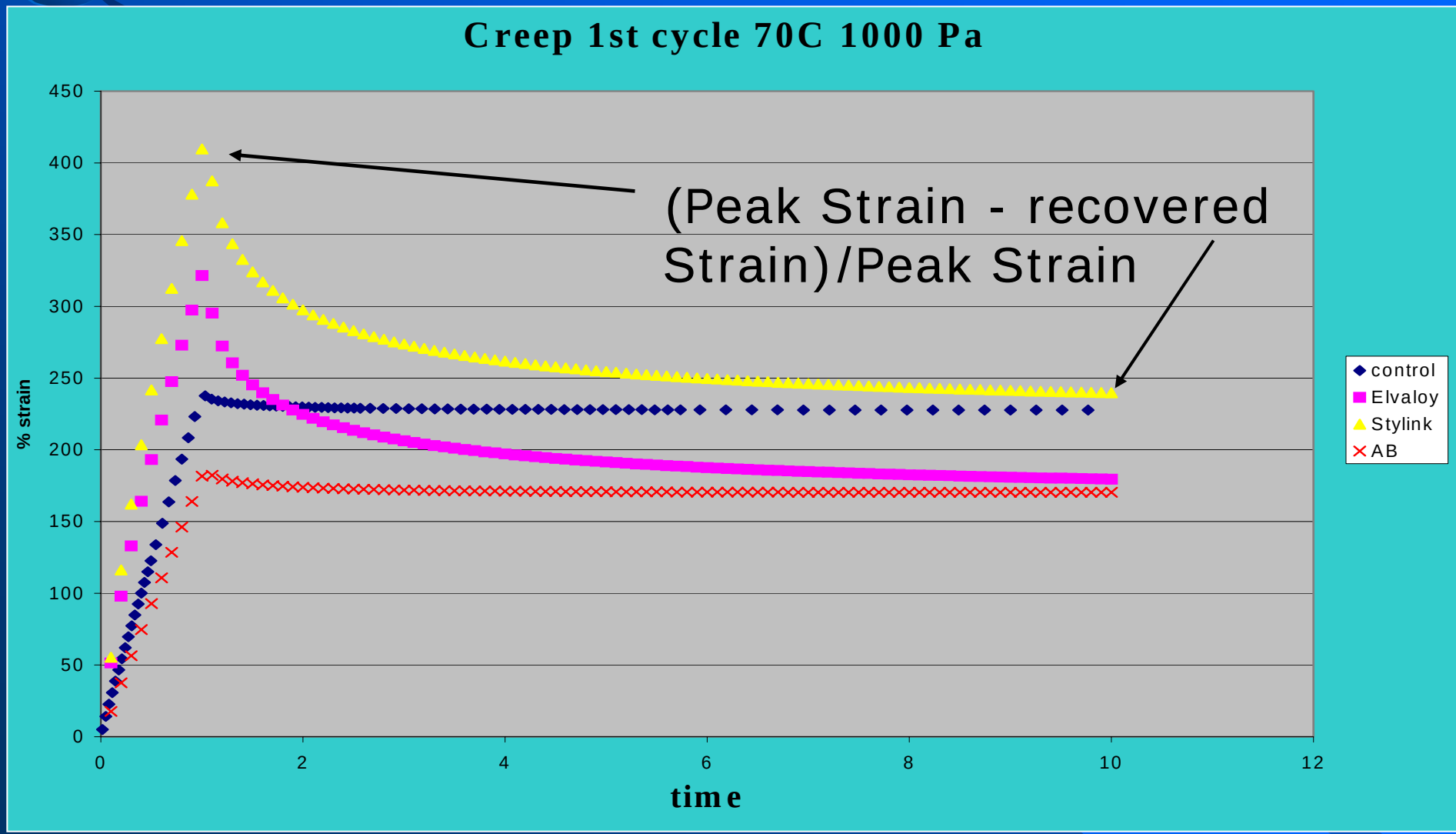
AC doesn't recover

SB modified AC recovers

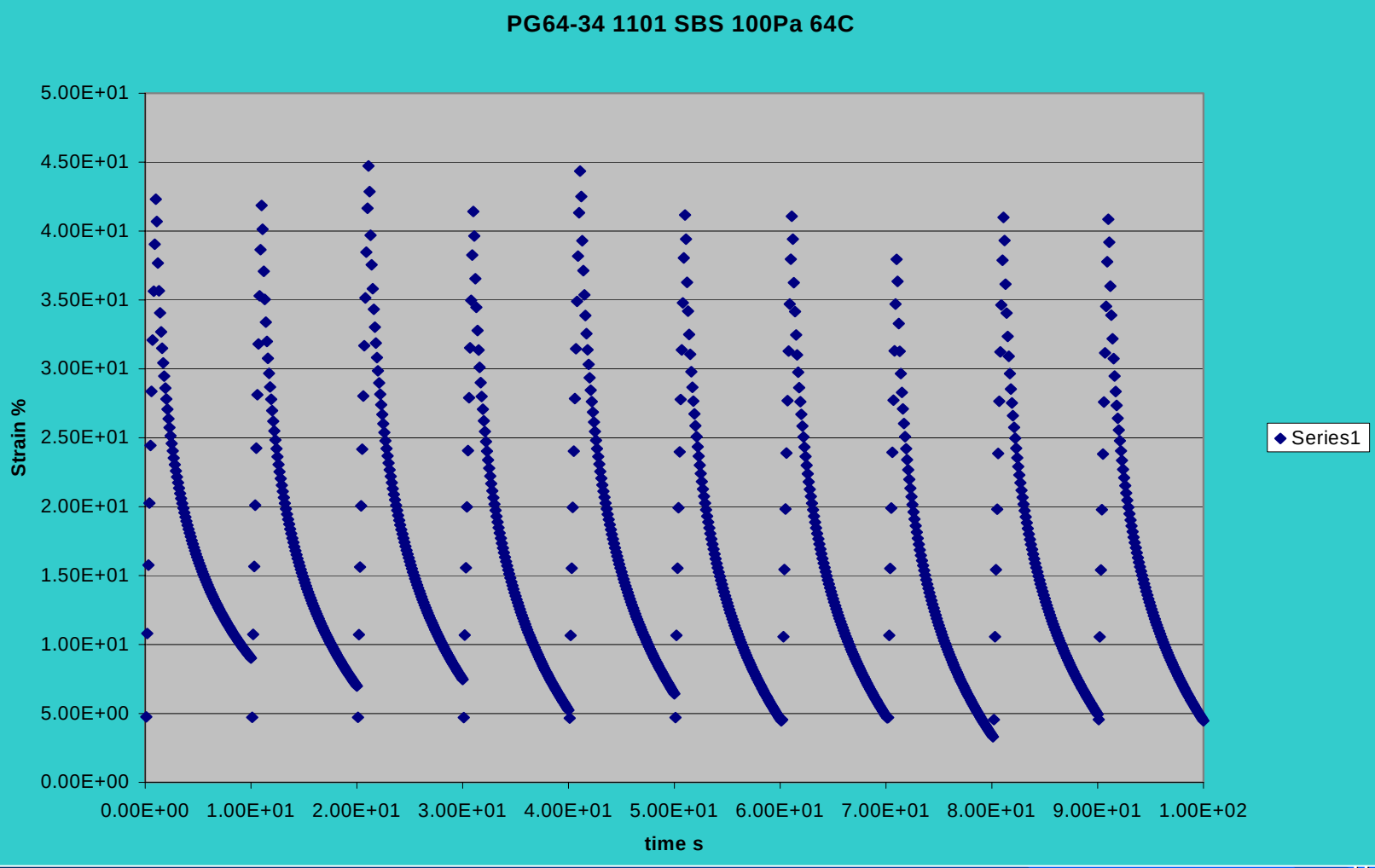
Proposed MSCR TEST Protocol



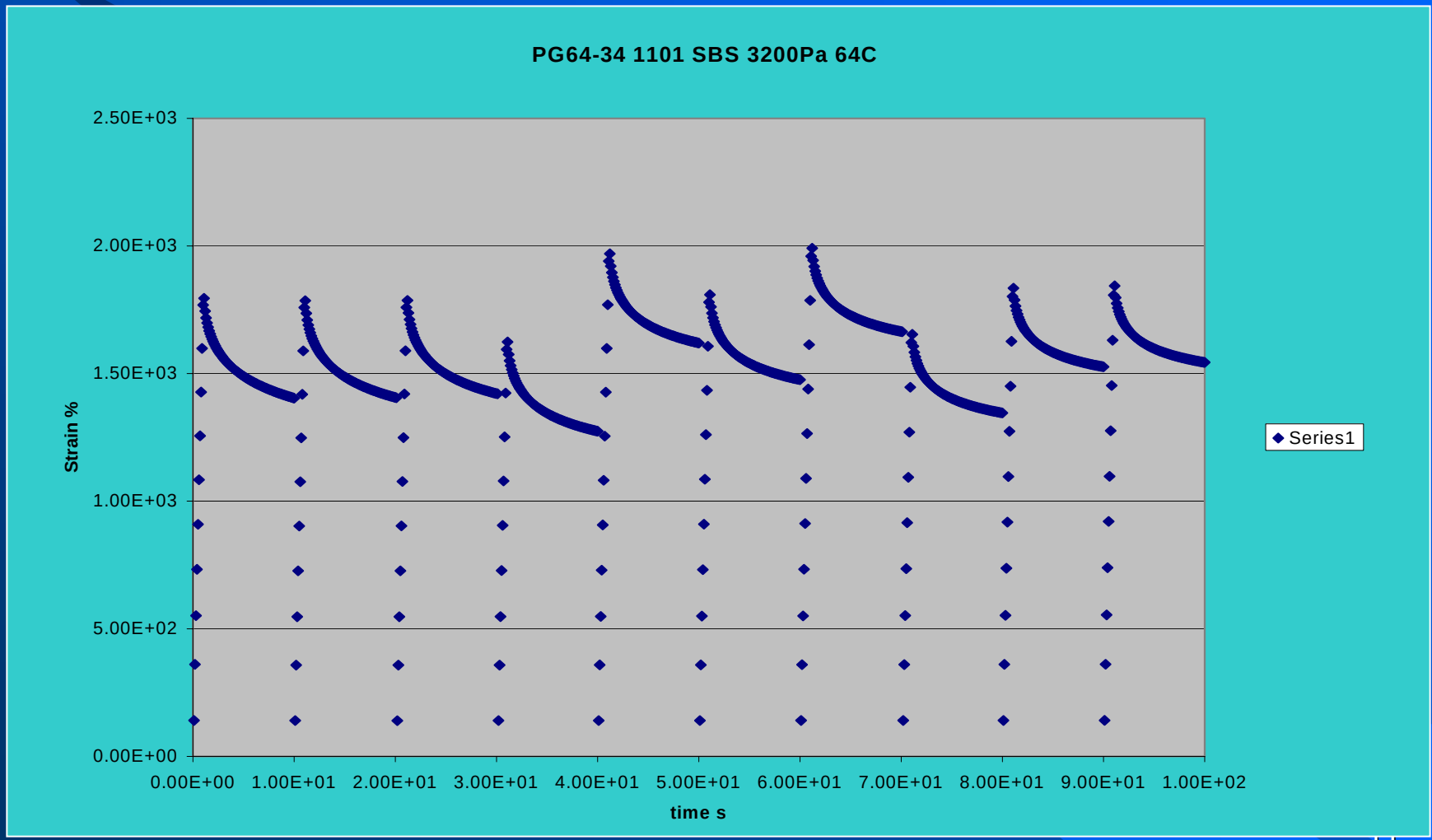
What criteria? % recovered strain



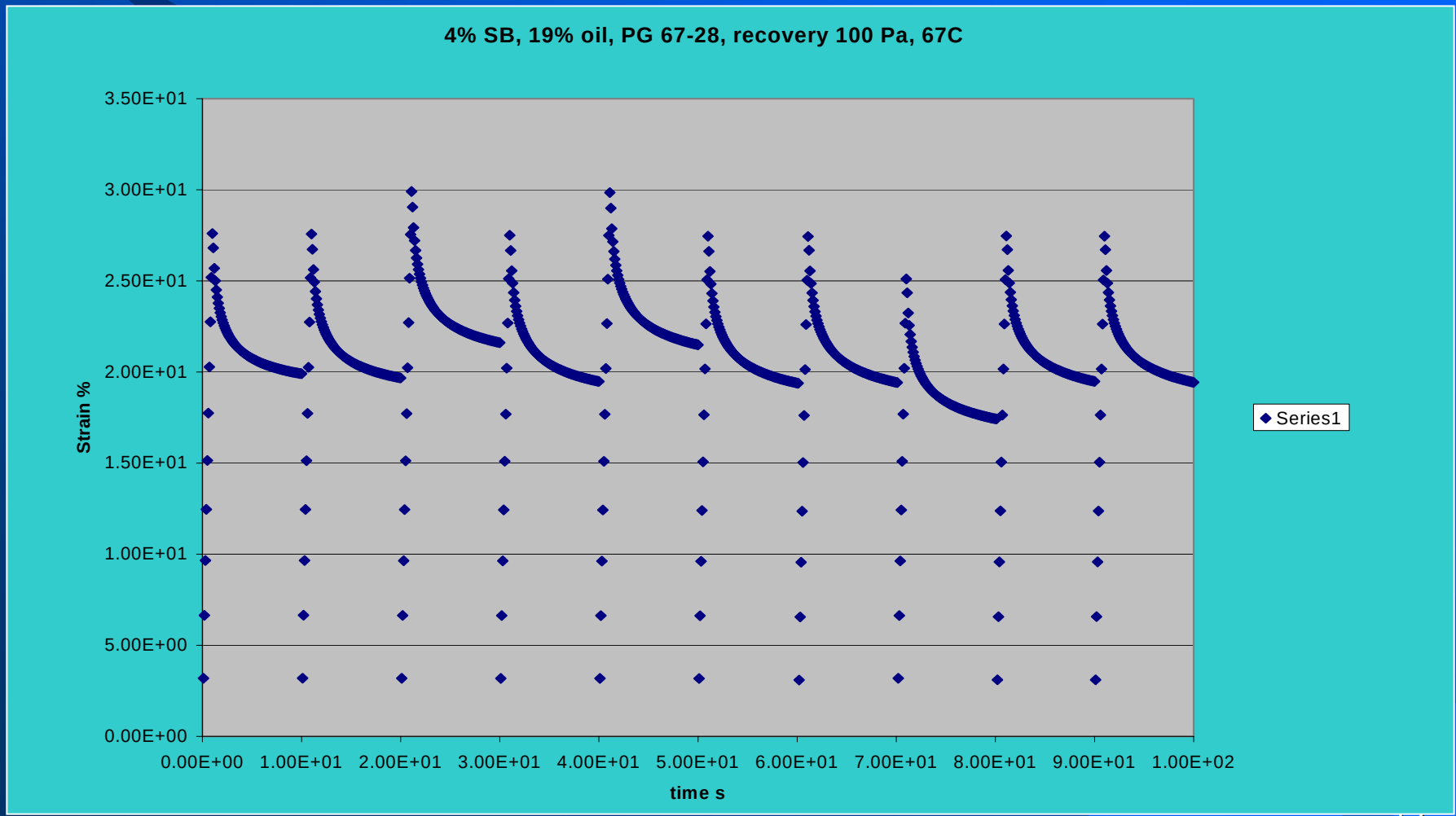
PG 64-34 1101 SBS 83% recovery 100Pa



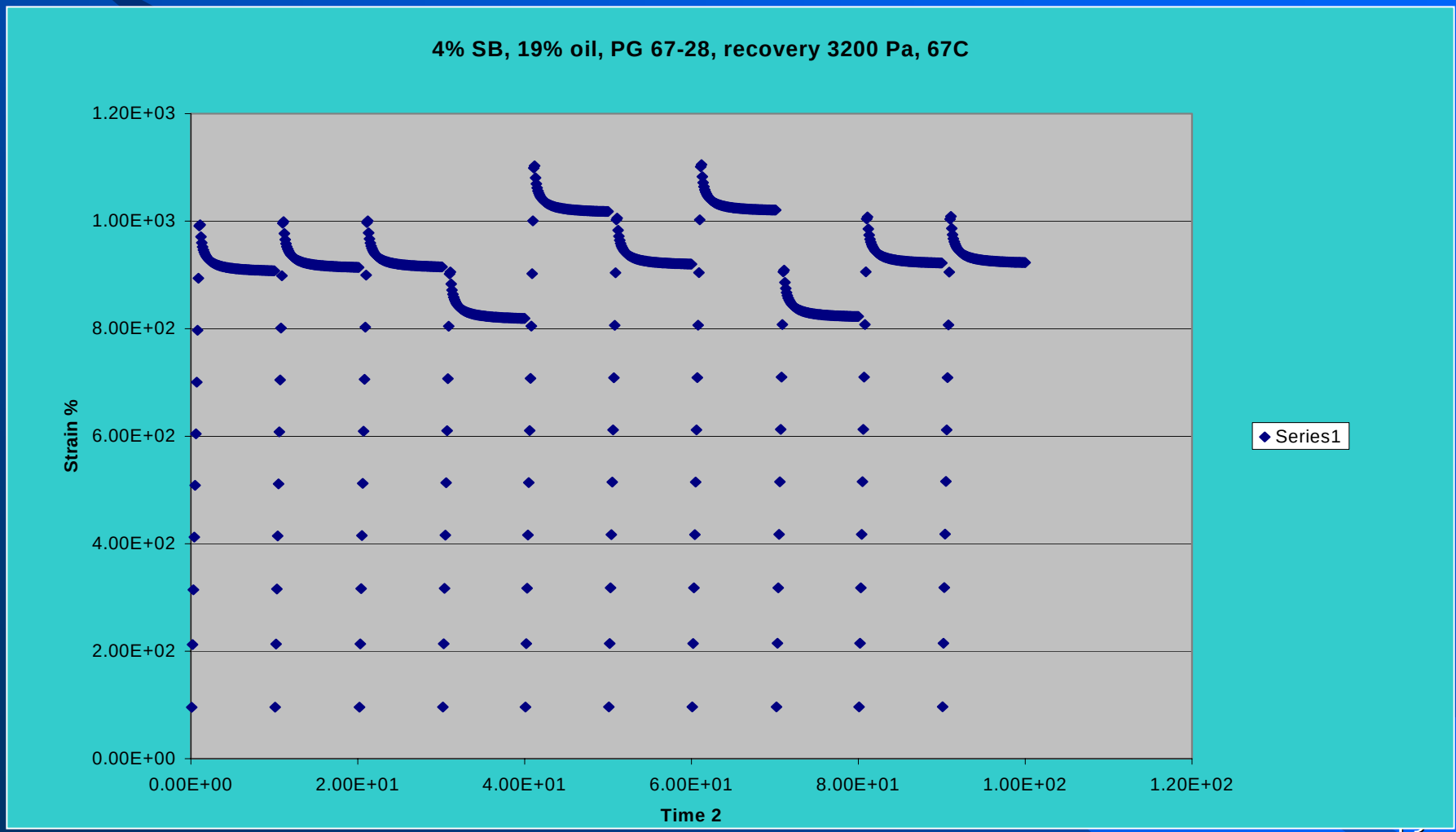
PG 64-34 1101 SBS 21% recovery 3200Pa



67-34 28% recovery 100Pa



67-34 9% recovery 3200Pa, 75% ER



Findings to date

- The DSR MSCR percent strain recovery criterion can replace the FD, ER, or T&T.

Future Steps

- Analyze available MSCR percent recovered strain data to finalize creep stress level and test protocol
- Where available, show relationships with existing ER, FD, Duct., and T&T data


Mixture

Superpave Gyratory Compactor Calibration

Making Superpave Consistent


Eight Different Models




Standard Method of Test for

Preparing and Determining the Density of Hot-Mix Asphalt (HMA) Specimens by Means of the Superpave Gyratory Compactor

AASHTO Designation: T 312-03

4. APPARATUS

4.1 *Superpave Gyratory Compactor* – ... The compactor shall tilt the specimen molds at an external angle of 1.25° ±0.02° **or** an average internal angle of 1.16° ± 0.02° in accordance with AASHTO. The compactor shall gyrate the specimens mold at a rate of 30.0 + 0.5 gyrations per minute...

Internal Angle of Gyration

- Internal Angle of Gyration
  - Development of the FHWA Dynamic Angle Validator (DAV)
    - Wireless Unit
    - Drop into mold either before or after adding mix

Average Dynamic Internal Angle

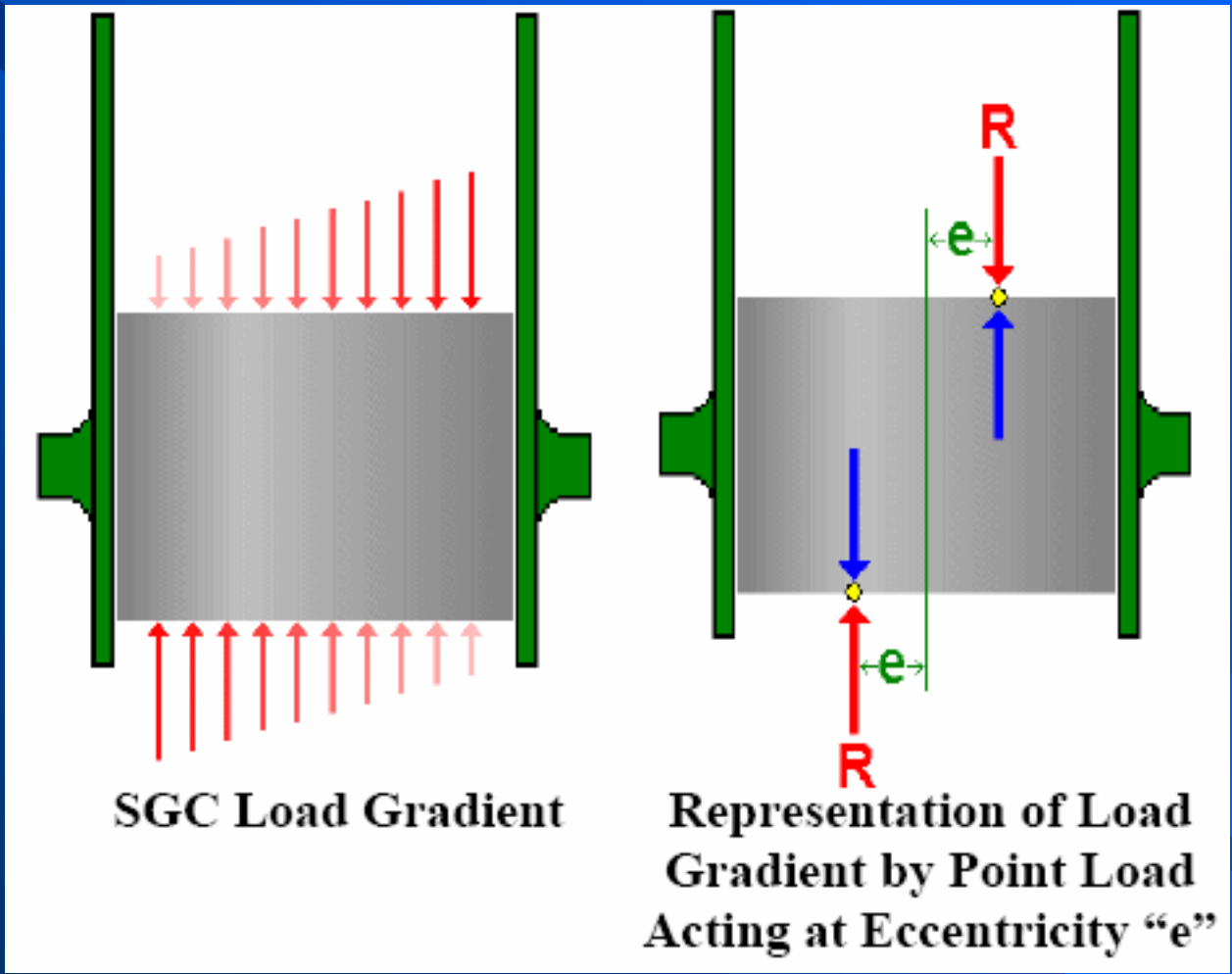
DAV on Top
to measure α_T

DAV on Bottom
to measure α_B

Internal Angle of Gyration

- DAV
  - Validate Differences in SGCs
    - Demonstrated that internal angle of gyration could be different even though external angle was the same.
  - Calibration
    - Potentially time-intensive
      - Up to 1 day for a calibration
    - Affected by mixture stiffness
      - Requiring recalibration for different mix types

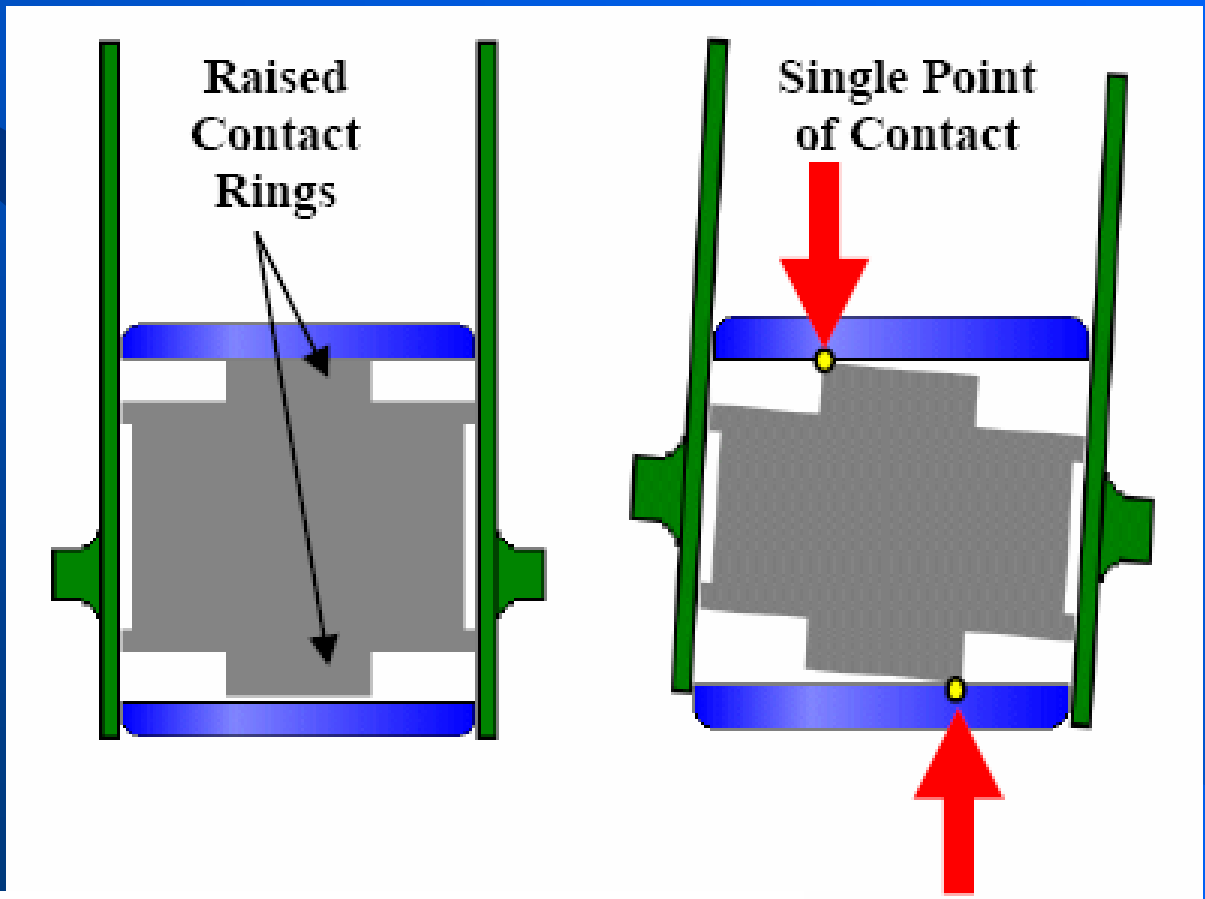
Forces Acting in a Mold During Gyratory Compaction



Mechanical Simulation of an Asphalt Mixture – RAM

RAM – Rapid Angle Measurement Device (Pine)

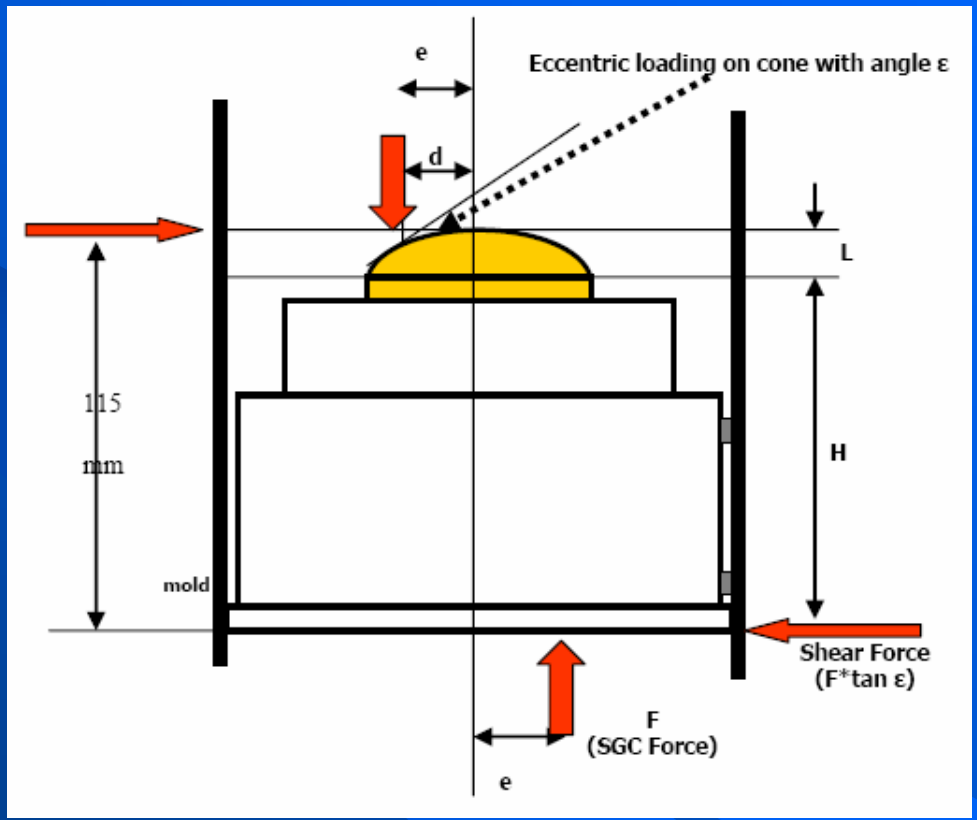
RAM Operations



Increasing Ring Diameter =

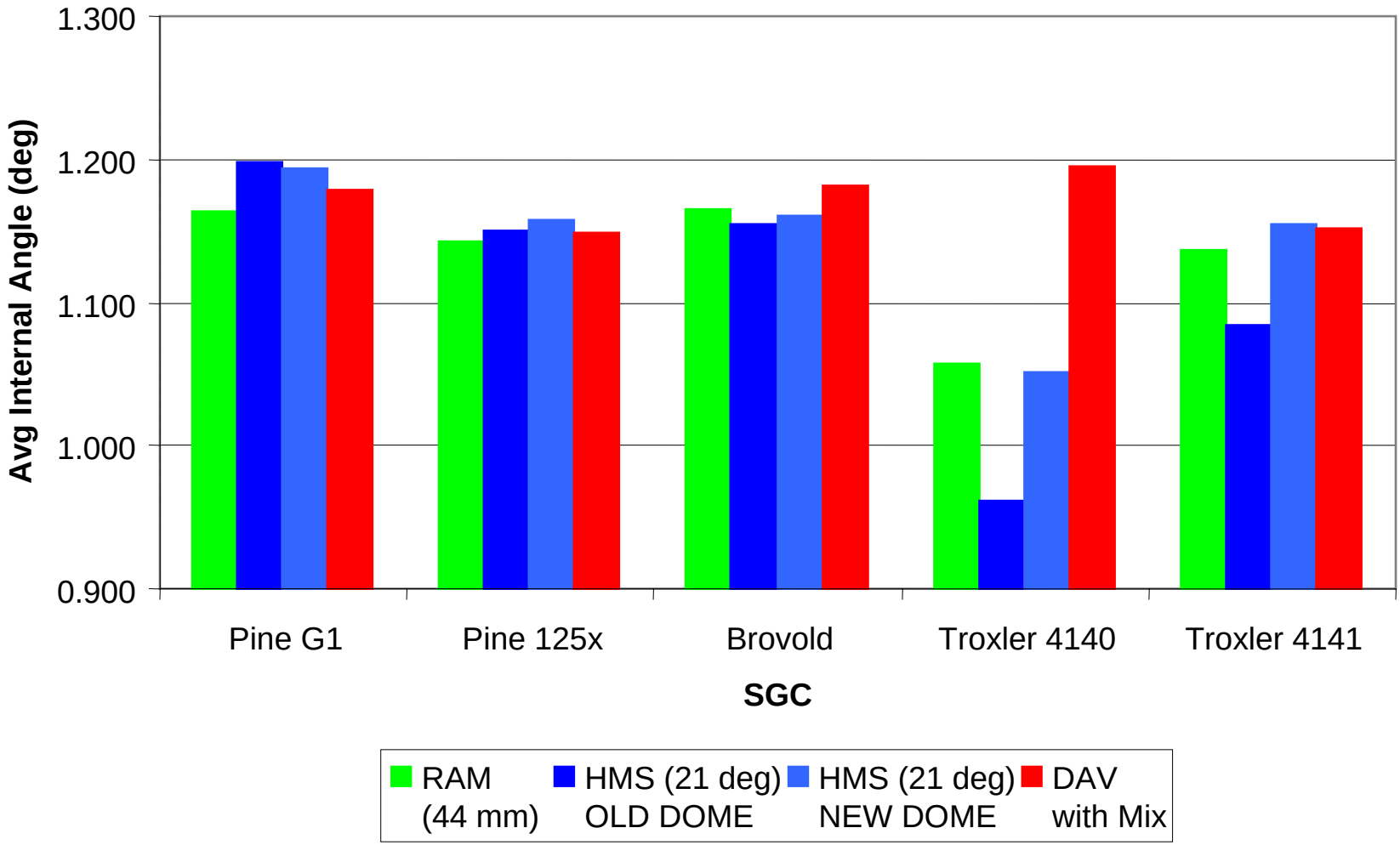
Increasing Mix Eccentricity/Stiffness

Mechanical Simulation of an Asphalt Mixture – HMS



HMS – Hot-Mix Simulator (TestQuip)

Comparison of Internal Angle Using Mechanical Mix Simulation Devices



Conclusions

- Recommend 22-mm (233 N-m) to set angle
  - Difference at higher eccentricity limit no greater than 0.025 degrees for most SGC models
  - Use 25-mm (265 N-m) to set angle for other model?
- No consistent significant difference in internal angle as a function of mold temperature
- Initial results showed no consistent relationship between internal angle measured with RAM and HMS
  - Modification to HMS dome has significantly improved relationship

National Cooperative Highway Research Program

9-29: *Simple Performance Tester for Superpave Mix Design*

- **Evaluation of 1st-article SPTs from Shedworks/IPC and Interlaken complete.**
- **Single-replicate measurement COV: dynamic modulus 13%, flow time 33%.**

Advanced Asphalt Technologies (November 2005)

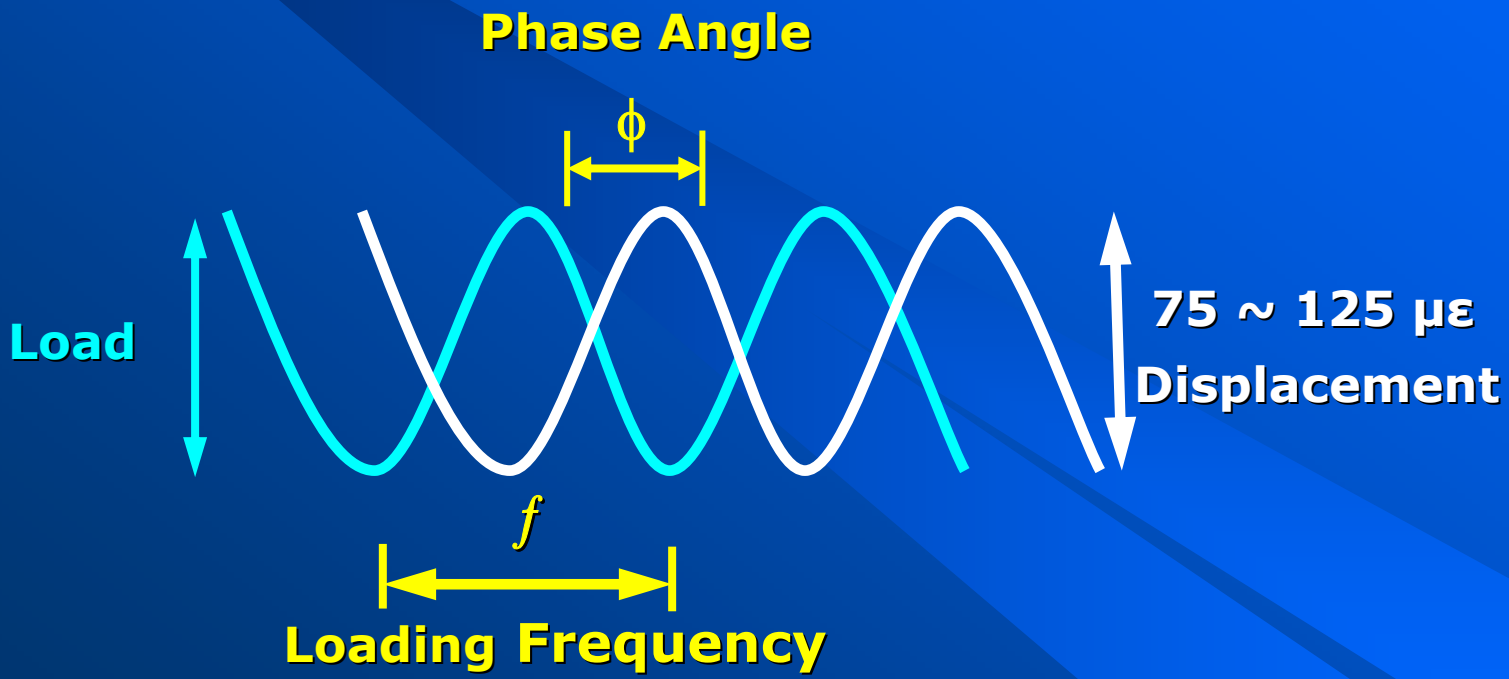
Performance Tester

Dynamic Modulus E*

σ_0 = dynamic stress

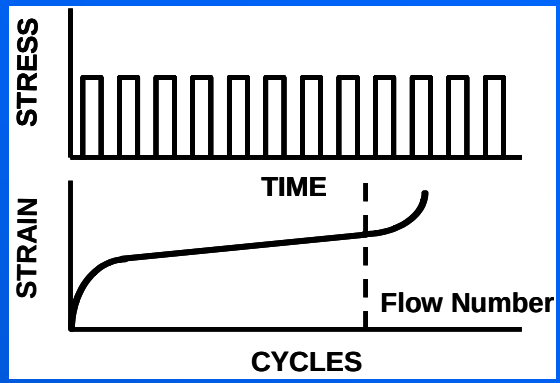
ε_0 = recoverable axial strain

$$|E^*| = \frac{\sigma_0}{\varepsilon_0}$$



Flow Number Test (Fn)

Dynamic Creep – Repeated Load

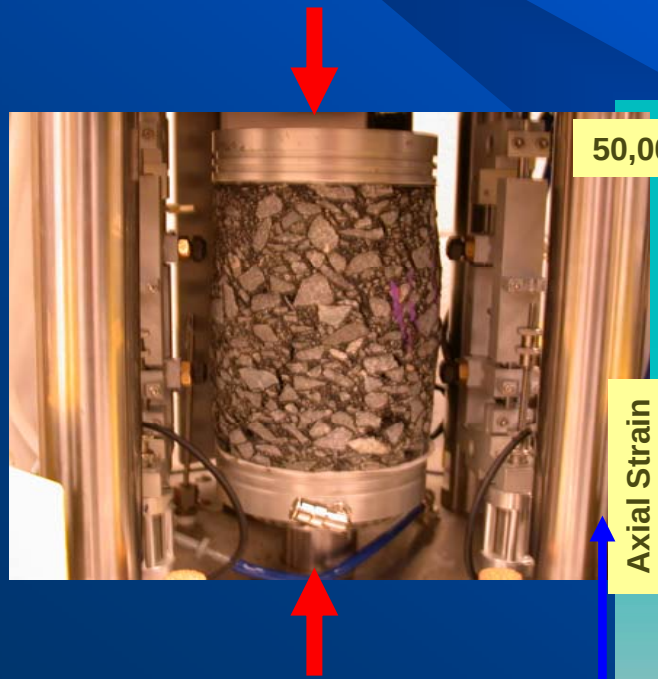


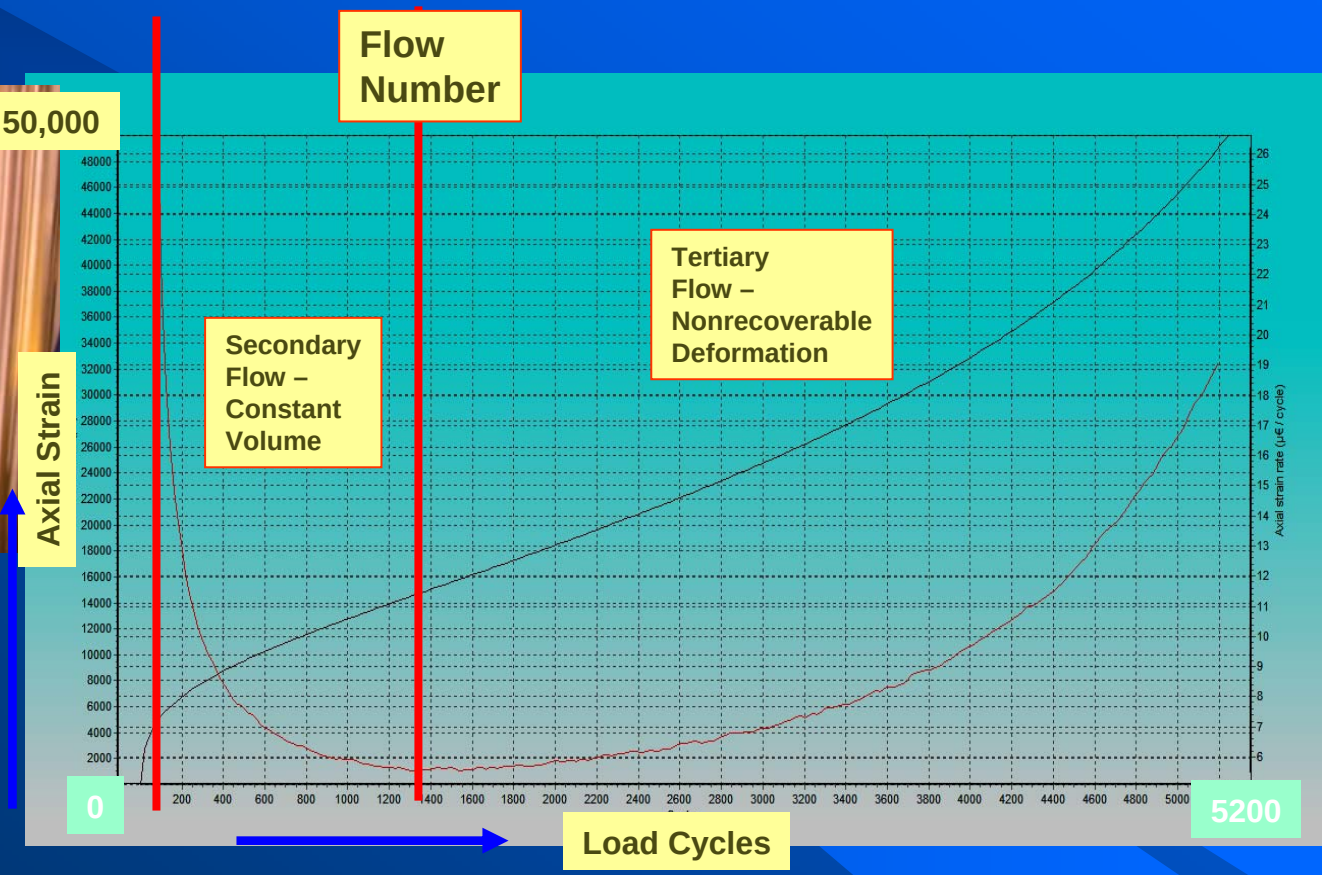
Applied Stress (kPa)	600 (87 psi)
Temperature (°C)	54
Failure limits	10,000 cycles or 5% strain

Flow Number: number of load repetitions at which shear deformation occurs under constant volume

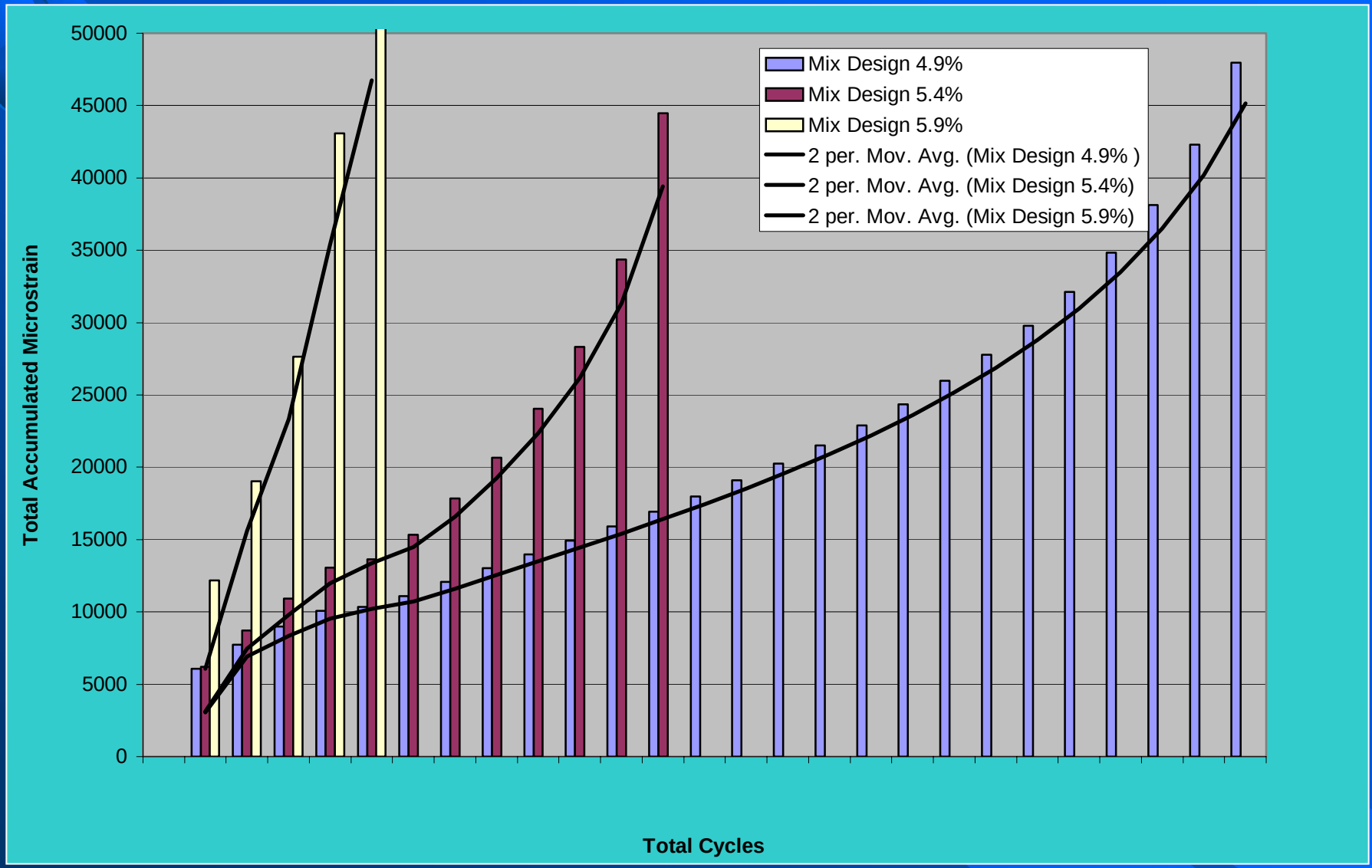
Flow Number Test (Fn)

Load “on” for 0.1 sec, “off” for 0.9 sec





Slope of Accumulated Microstrain Curves



Slope of curve indicates progression of material into Tertiary Flow

9-33: *A Mix Design Manual for Hot Mix Asphalt*

Update method in AI Manual SP-02:

- **Simple performance test(s).**
- **As-delivered M-E design guide performance models and software.**
- **New volumetric criteria.**
- **Framework for integrated mix and structural design.**

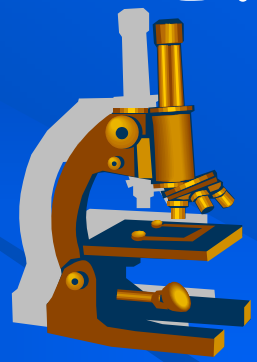
Advanced Asphalt Technologies, LLC (August 2006)

1-40:Facilitating the Implementation of the Guide for the Design of New and Rehabilitated Pavement Structures

- Conduct a thorough review of the Guide
- Organize and convene workshops
- Develop a concise user's guide
- Provide technical support

FHWA Design Guide Implementation Team (DGIT)

To support & educate State highway agencies and industry in development & implementation of Mechanistic-Empirical Pavement Design



Facilitating Implementation of Mechanistic-Empirical Pavement Design

FHWA DGIT Workshops

*Webcast available

Past Workshops

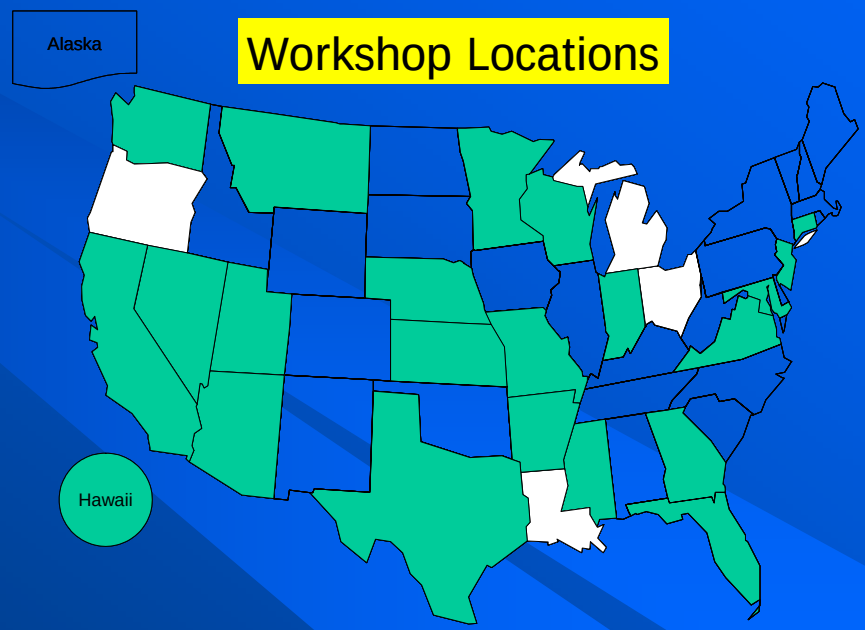
- ✓ Introduction to the DG – 8*
- ✓ Traffic – 2

Current

- ➢ Materials – 11*
- ➢ Traffic – 2

Future

- ➢ Climatic Inputs – 4
- ➢ Local Calibration



Additional Workshops Planned

- 1-Day Climatic Inputs for M-E Pavt Design
  - Under development by DGIT
  - Pilot: February 2006
  - Purpose: educate Pavt Designers on obtaining climatic inputs through EICM
- Local Calibration for M-E PDG models
  - Awaiting deliverables from NCHRP 1-40 A,B
  - Planned for Winter 2007
  - Purpose: discuss Sensitivity of inputs & calibration, educate Pavt Designers & Pavement Managers


Construction

Intelligent Compaction

GPS antenna

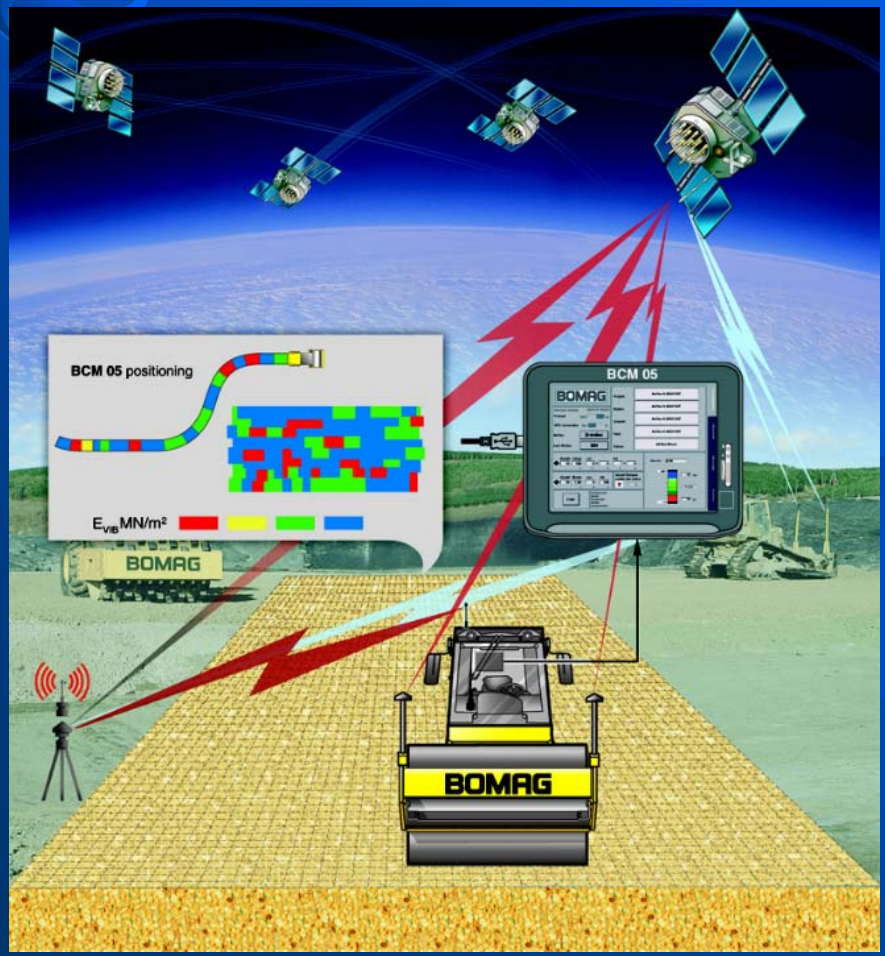
GPS reference station (Trimble)

BW 174 Asphalt Manager equipped with BCM05 and GPS

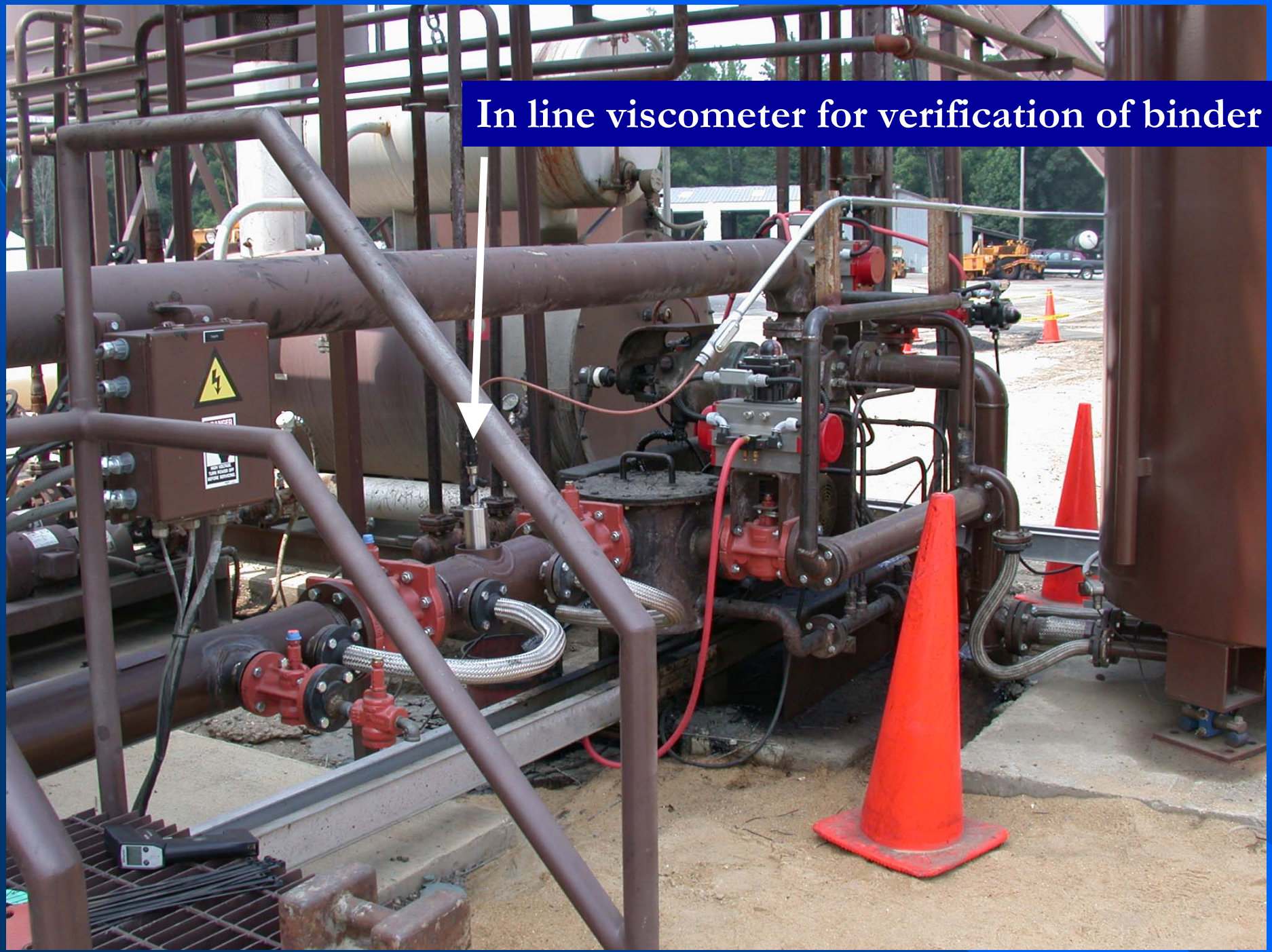
What is intelligent compaction?

- Automatic adjustable compaction equipment
- Usage of Continuous Compaction Control, CCC
- Selection of the most suitable equipment

GPS / positioning with reference station



At the mix plant are there other process that can be part of a QA program?


In line viscometer for verification of binder

Computer recordation

QA of the Future

- The QA will all be tied to Internet.
  - Direct down load of info to the owner.
  - Posting of data immediately to all parties.
  - Faster review and resolution of discrepancies.

Questions