# What is on the Horizon in HMA

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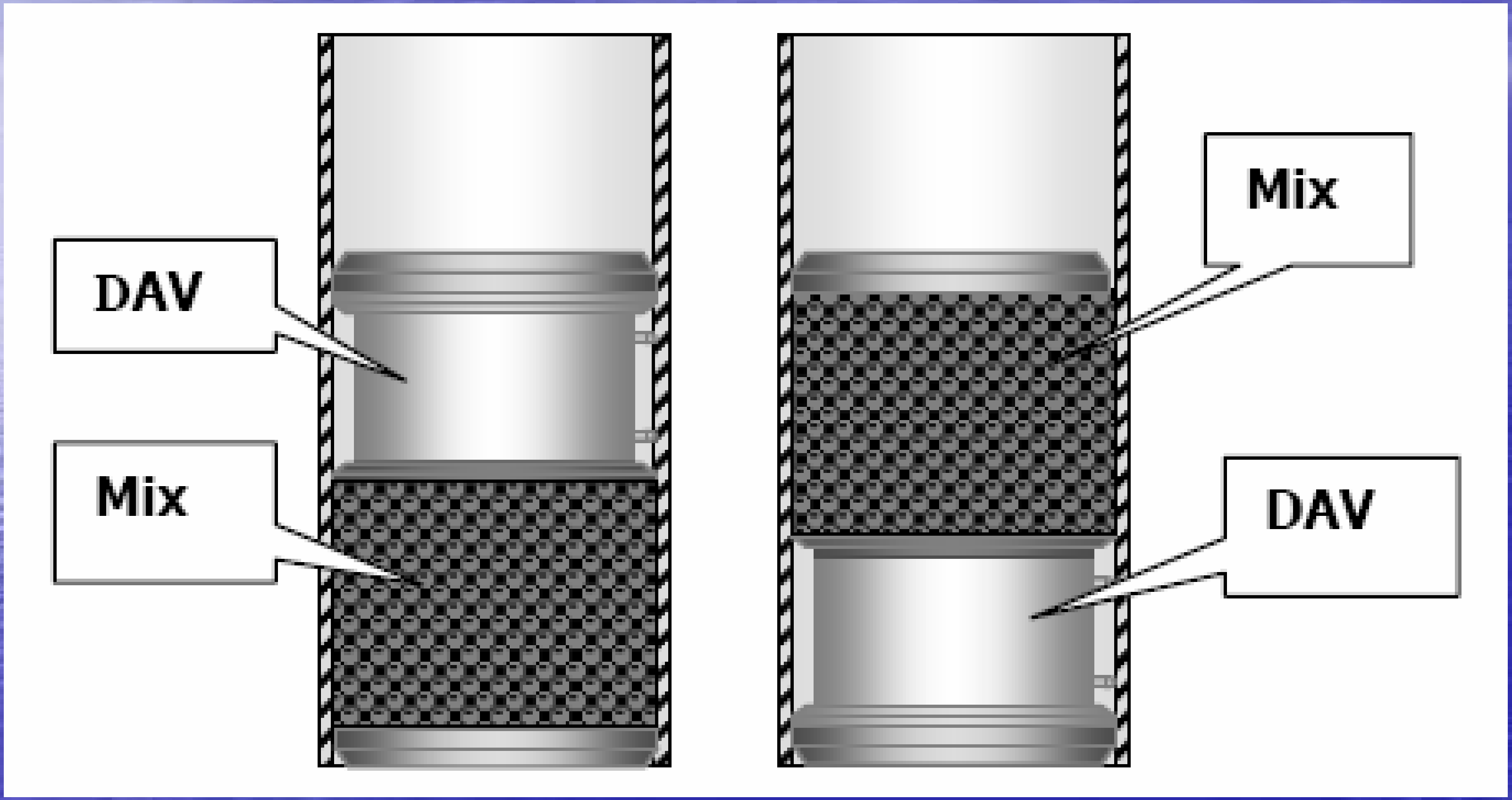
Federal Highway Administration

# Are they all the same?

# Internal Angle of Gyration

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

# Dynamic Angle Validator

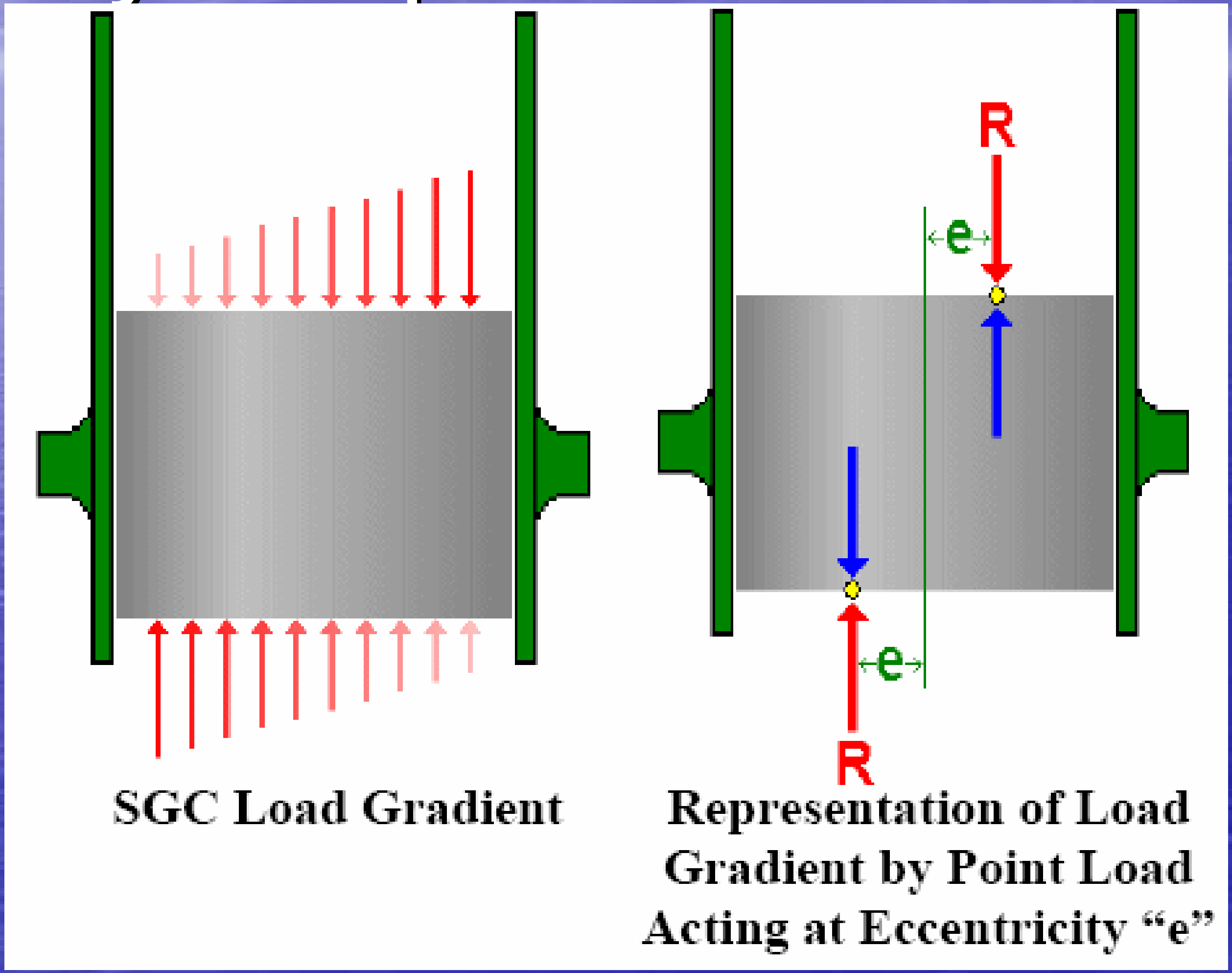



Dr. Kevin Hall, “Evaluating the Superpave Gyratory Compactor Internal Angle of Gyration Using Simulated Loading”, submitted to AAPT2005

# 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

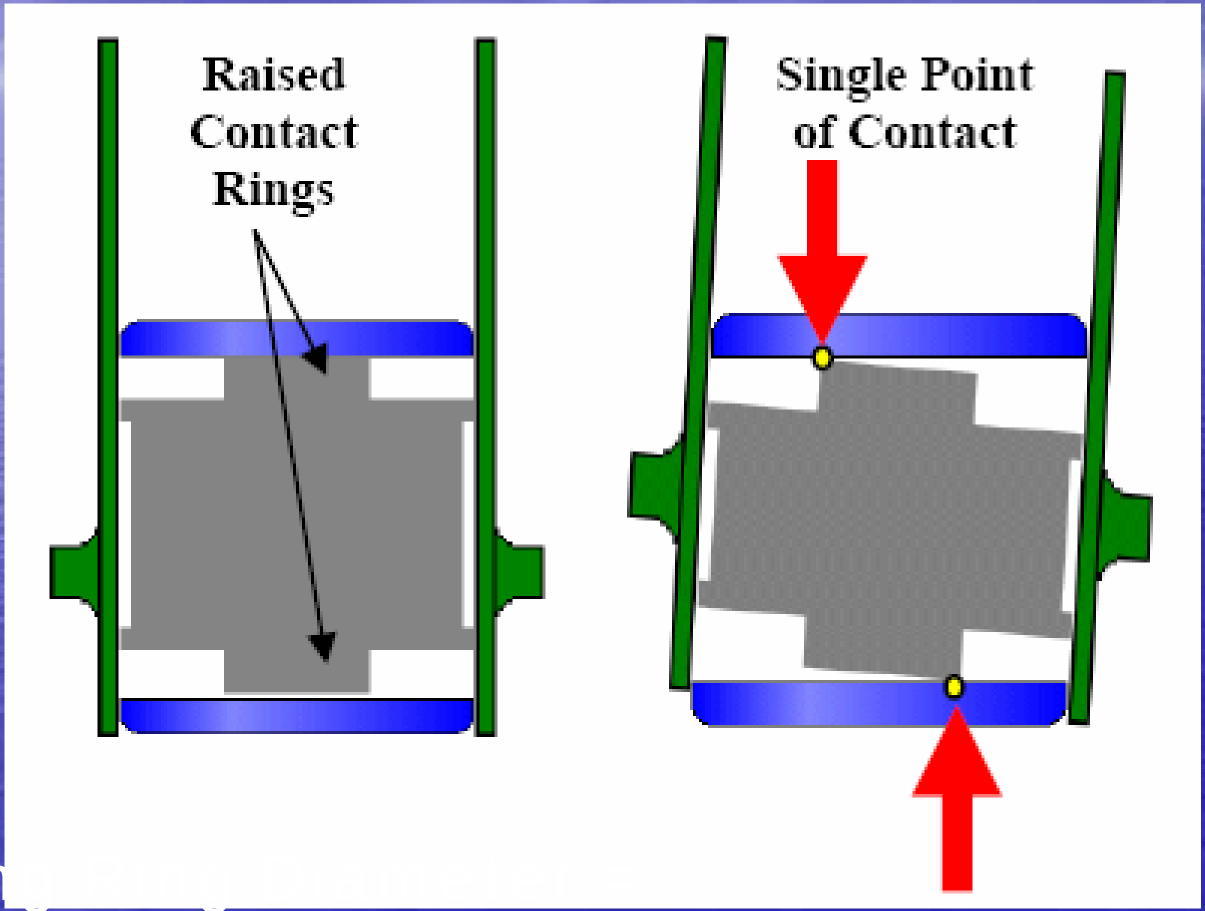
# Forces Acting in a Mold During Gyratory Compaction



# Mechanical Simulation of an Asphalt Mixture – RAM

RAM – Rapid Angle Measurement Device (Pine)

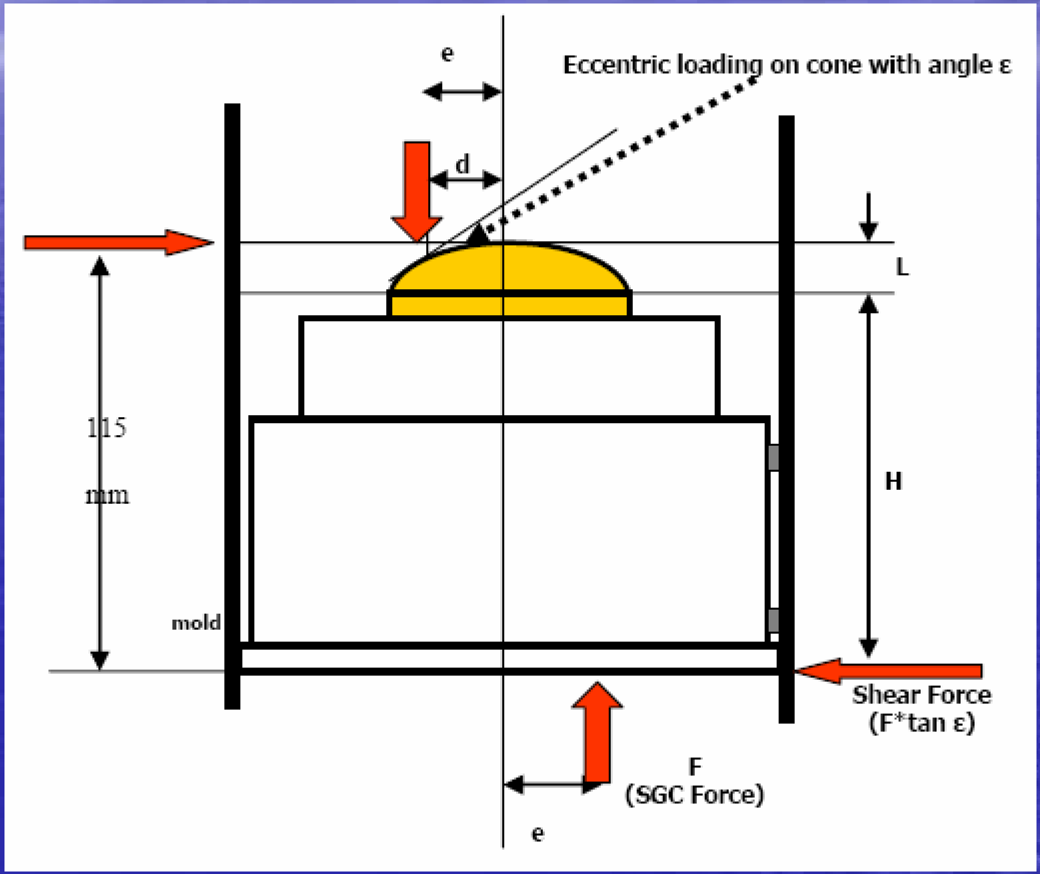
# RAM Operations




Increasin

Increasing Mix Eccentricity

# Mechanical Simulation of an Asphalt Mixture – HMS



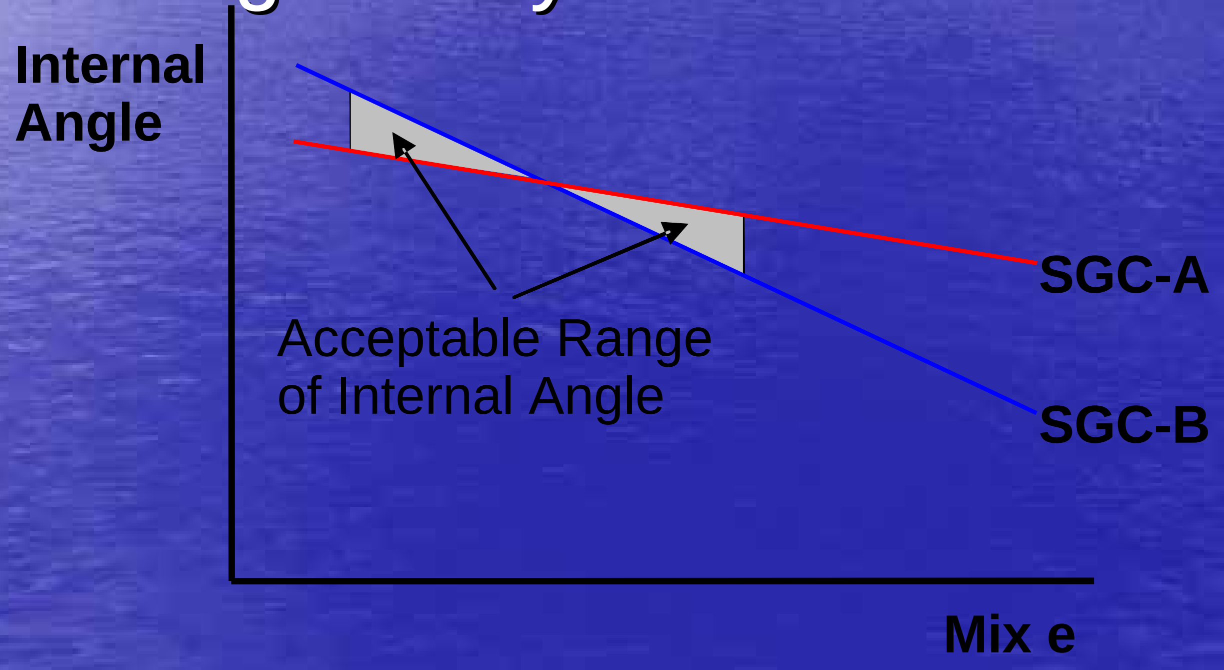

HMS – Hot-Mix Simulator (TestQuip)

# Purpose of Research

- Objectives
  - Improve the determination and calibration of the dynamic internal angle of gyration for the Superpave gyratory compactor using mechanical mixture simulation devices
    - Reduce time for calibration
    - Improve reproducibility between different labs
    - Recommend revisions to AASHTO T312

# Research Plan – Task 1

- Determine the Effect of Mix Eccentricity on Internal Angle of Gyration



# Research Plan – Task 2

- Using a Wide Variety of Mixtures...
  - What is the relationship between mixture eccentricity and stiffness?
  - What is an "average" or representative mixture eccentricity?
  - Is there a standard mixture eccentricity that can be used to minimize variation in the percentage of air voids in specimens produced by different SGCs?

# Research Plan – Task 3

- Using Mechanical Simulation Devices in the Calibration Process
  - Issues
    - Necessity of heated molds?

# Frame Stiffness Measures – RAM only

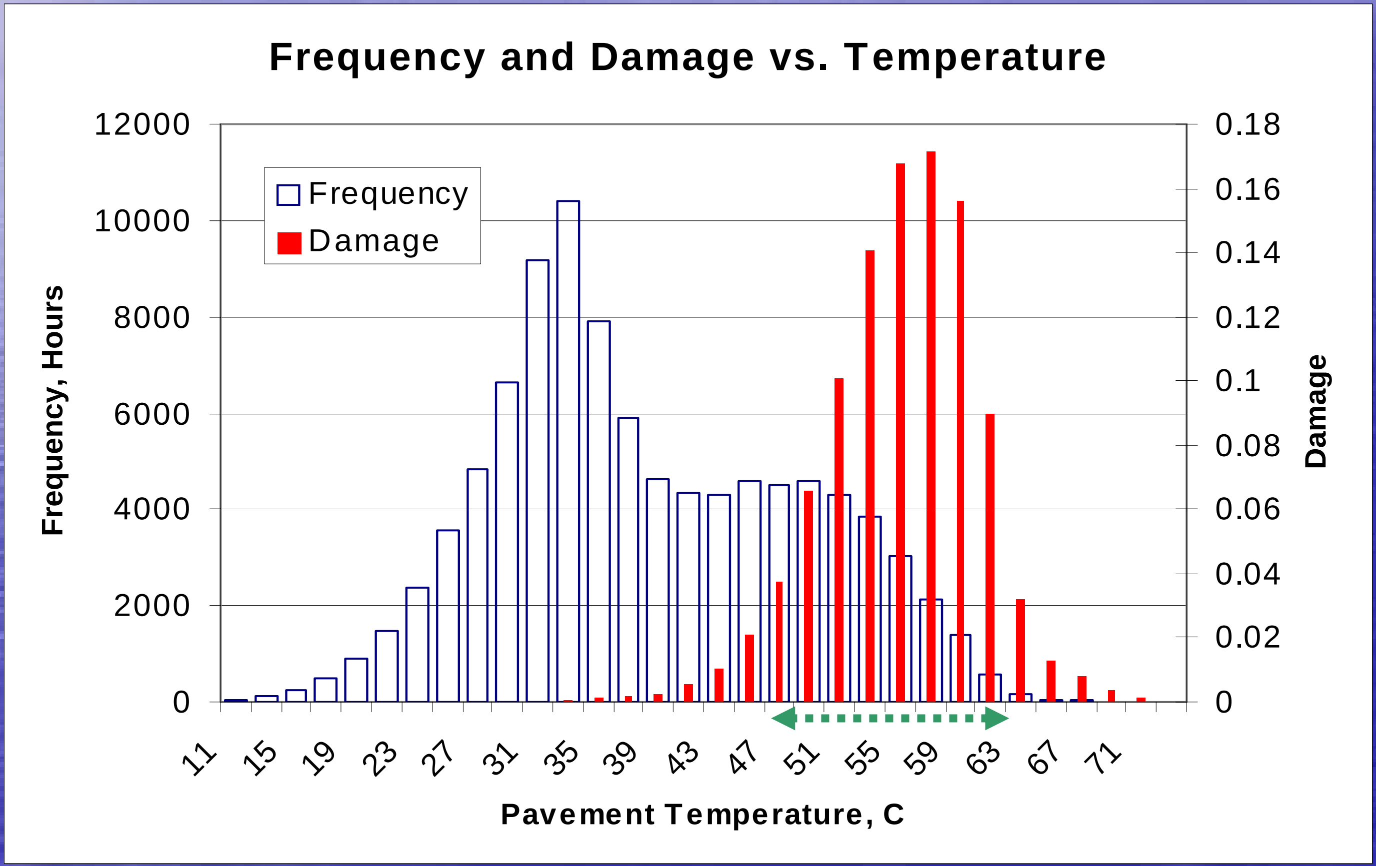
| Testing Agency | Frame Stiffness (Deg / N-m) | | | | | |
|---|---|---|---|---|---|---|
| | Superpave Gyratory Compactor (SGC) Model | | | | | |
| | Pine AFG125x | Pine AFG1 | Pine AFGB1 (Brovold) | Troxler 4140 | Troxler 4141 | ServoPac |
| **Univ. of Arkansas** *(Stiffness Study)* | 0.00031 | 0.00034 | 0.00036 | 0.00109 | 0.00063 | |
| **Univ. of Arkansas** *(RAM ILS)* | 0.00046 | | 0.00025 | 0.00139 | 0.00058 | |
| **Univ. of Arkansas** *(RAM-DAV/HMS Study)* | 0.00037 | 0.00047 | 0.00031 | 0.00127 | 0.00054 | |
| **Florida DOT** *(used by permission)* | 0.00033 | | 0.00041 | 0.00172 | | 0.00041 |
| **InstroTek** *(used by permission)* | 0.00047 | 0.00050 | 0.00055 | 0.00176 | 0.00180 | |
| | | | | 0.00136 | 0.00122 | |
| | | | | 0.00132 | | |
| **Mean Value** | 0.00039 | 0.00044 | 0.00038 | 0.00142 | 0.00095 | 0.00041 |
| **Standard Deviation** | 0.000074 | 0.000085 | 0.000114 | 0.000242 | 0.000548 | N/A |
| **Coefficient of Variation (%)** | 19.0 | 19.5 | 30.3 | 17.1 | 57.5 | N/A |

# Binders

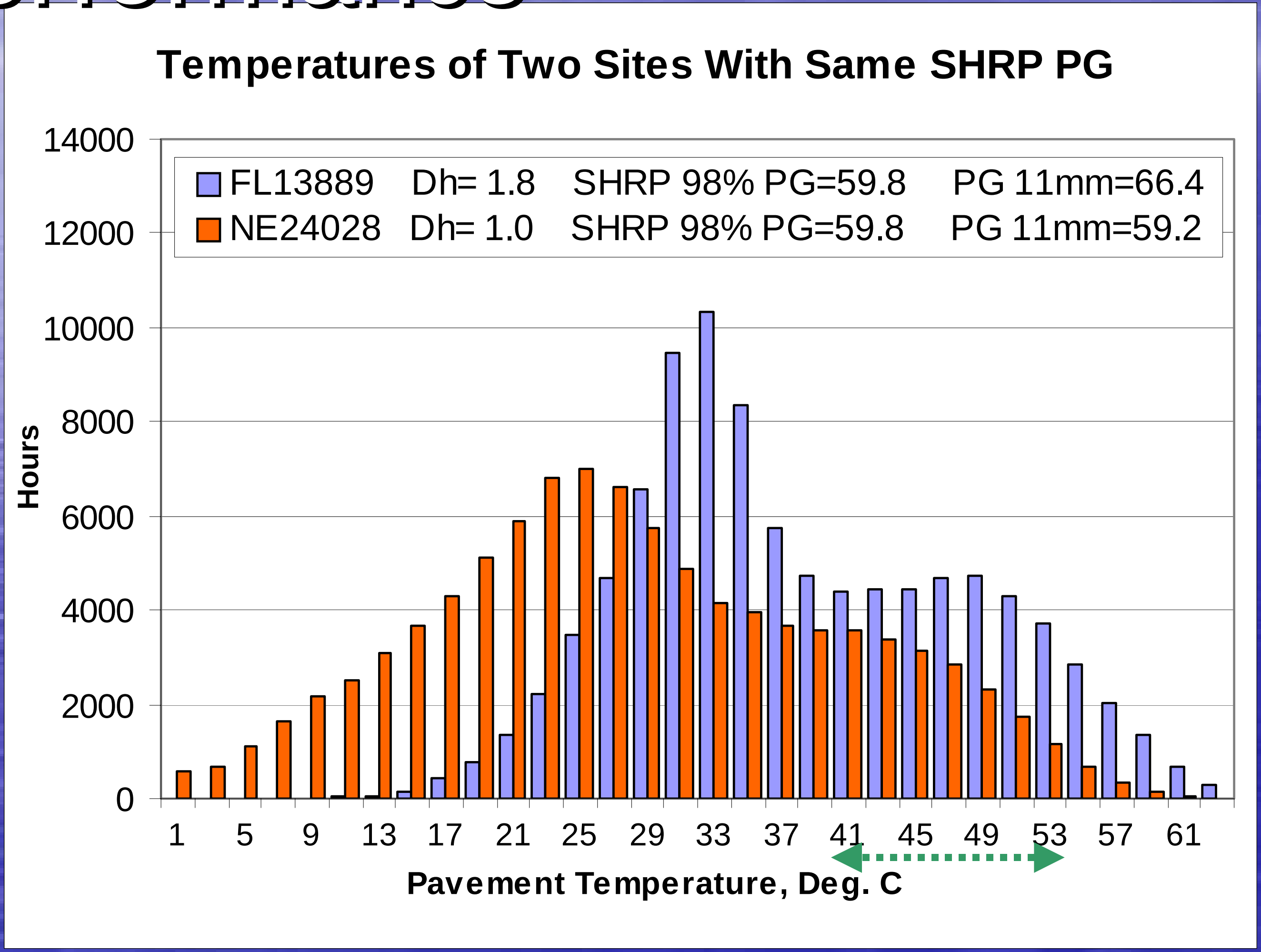
# Is the current binder selection based on pavement temp. correct?

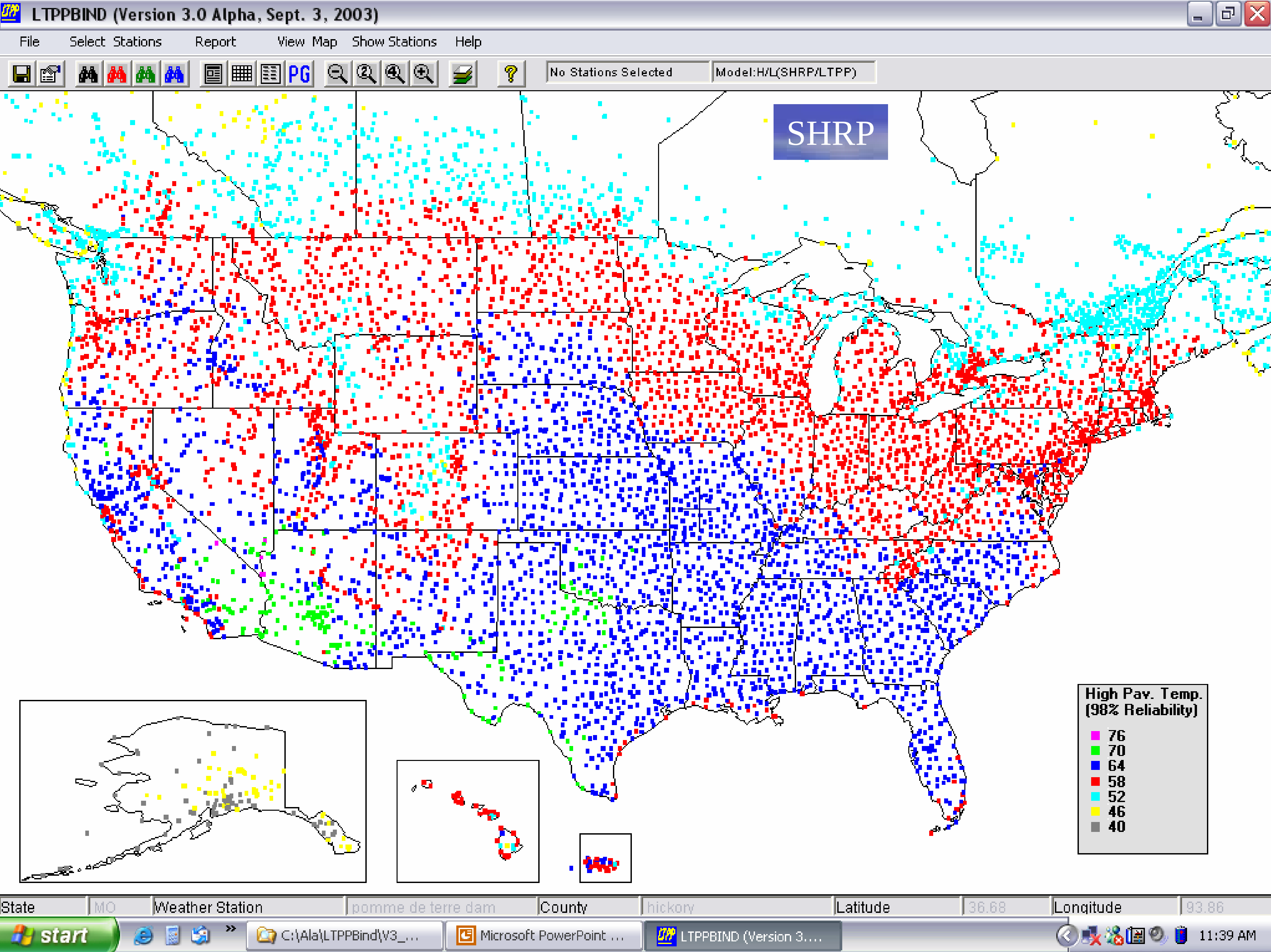
- Is a PG 58 in Florida the same as a PG 58 in Idaho?
- Is the average 7 day high temp the best measure of pavement rutting?

# Most Damage is at Many Hours of High Temperatures, not Highest Temperatures



# Same SHRP PG, Different Performance




LTPPBIND (Version 3.0 Alpha, Sept. 3, 2003)
File
Select Stations
Report
View Map
Show Stations
Help
PG
No Stations Selected
Model:H/L(SHRP/LTPP)
SHRP
High Pav. Temp.
(98% Reliability)
76
70
64
58
52
46
40
State
MO
Weather Station
pomme de terre dam
County
hickory
Latitude
36.68
Longitude
93.86
start
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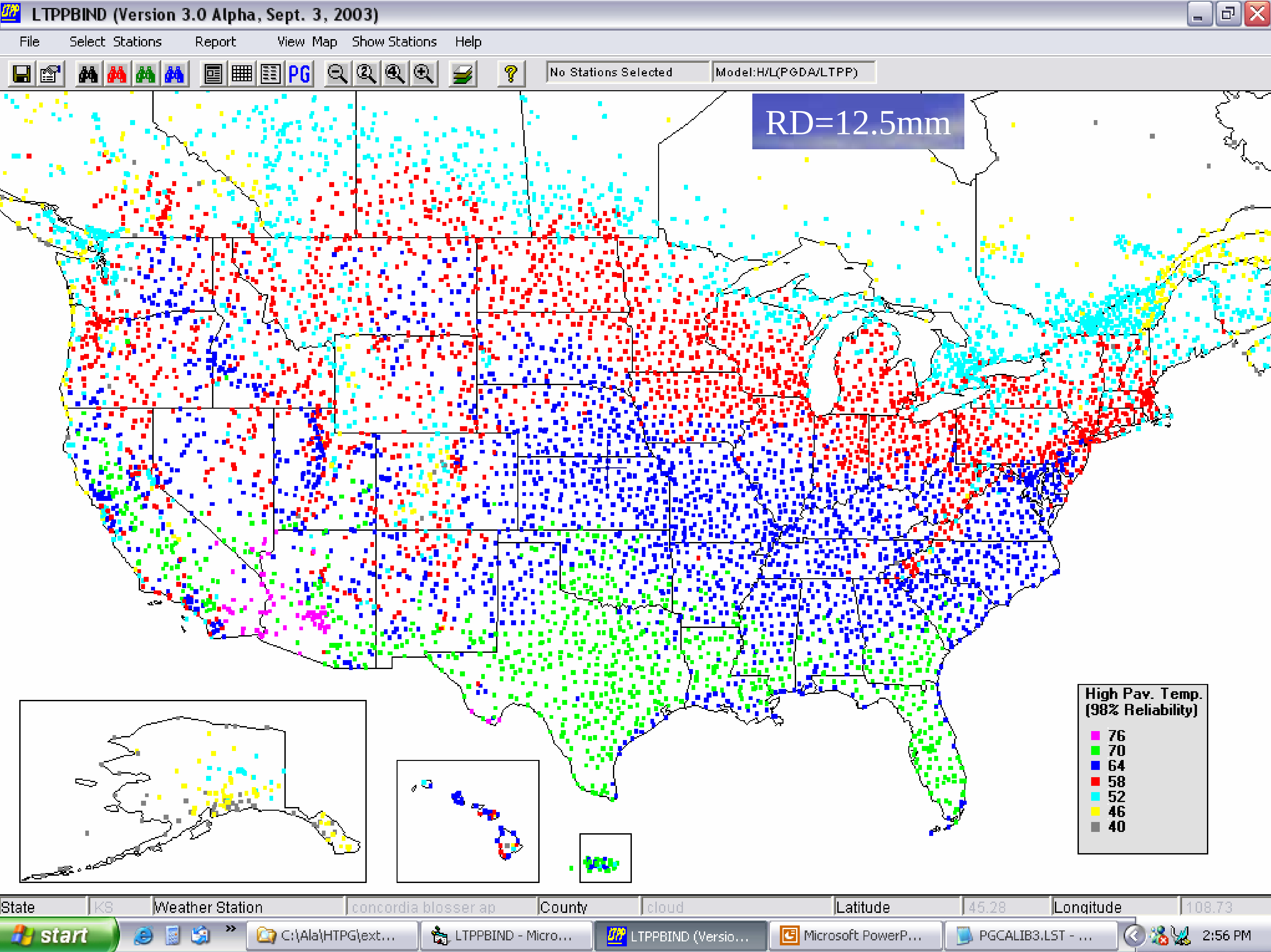
LTPPBIND (Version 3.0 Alpha, Sept. 3, 2003)
File
Select Stations
Report
View Map
Show Stations
Help
PG
No Stations Selected
Model:H/L(PGDA/LTPP)
RD=12.5mm
High Pav. Temp.
(98% Reliability)
76
70
64
58
52
46
40
State
KS
Weather Station
concordia blosser ap
County
cloud
Latitude
45.28
Longitude
108.73
start
C:\Ala\HTPG\ext...
LTPPBIND - Micro...
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PGCALIB3.LST - ...
2:56 PM

# Grade Bumping by Base PG and Speed for All Rut Depths

| | | ESAL, Millions | | | |
|---|---|---|---|---|---|
| **Speed** | **Base Grade** | **<3** | **3-10** | **10-30** | **30+** |
| **Fast** | **52** | 0 | 10.3 | 16.8 | 19.3 |
| | **58** | 0 | 8.7 | 14.5 | 16.8 |
| | **64** | 0 | 7.4 | 12.7 | 14.9 |
| | **70** | 0 | 6.1 | 10.8 | 12.9 |
| **Slow** | **52** | 3.1 | 13 | 19.2 | 21.6 |
| | **58** | 2.9 | 11.2 | 16.8 | 19 |
| | **64** | 2.7 | 9.8 | 14.9 | 17 |
| | **70** | 2.5 | 8.4 | 12.9 | 14.9 |

# LTPPBind 3 new software

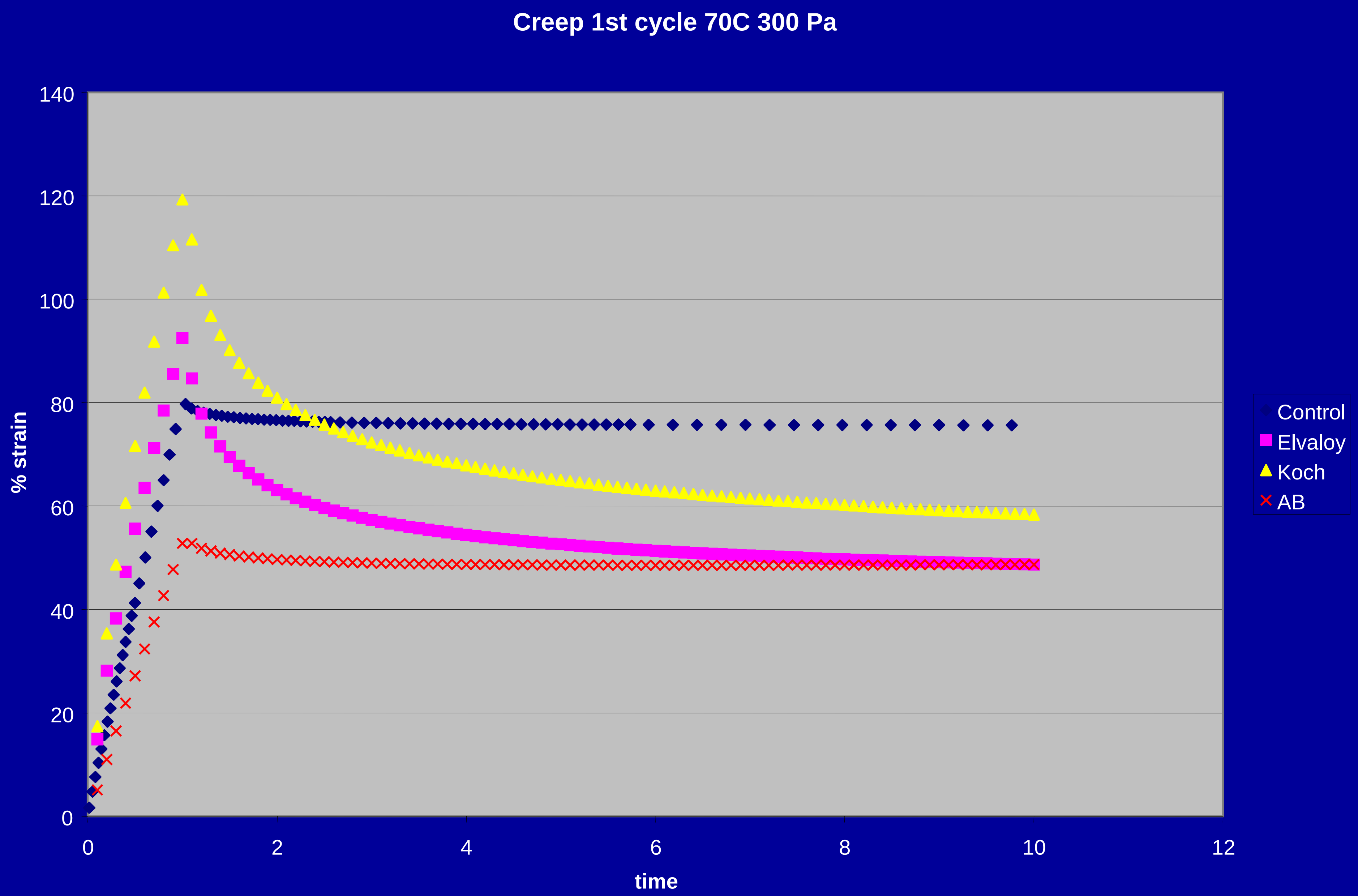
- Web site
- http://ltppbind.com/

# Modified Binders Affect Performance

- Study same mix different binders.

PG 63-22 mod. no rutting

PG 67-22 unmod. 15mm rutting


Creep 1st cycle 70C 300 Pa
% strain
time
140
120
100
80
60
40
20
0
0
2
4
6
8
10
12
Control
Elvaloy
Koch
AB

***N*ational**

***C*ooperative**

***H*ighway**

***R*esearch**

***P*rogram**

# 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)*

# 9-27: *Relationships of HMA In-Place Air Voids, Lift Thickness and Permeability*

**Determine in-place air voids and minimum lift thicknesses needed to achieve durable, impermeable HMA pavements.**

*NCAT (April 2004)*

# Factors Affecting In-Place Air Voids

- Recommended thickness/NMAS ratios for adequate in-place density:
  - $\geq$ 3 for fine-graded mixes
  - $\geq$ 4 for coarse-graded mixes
- Lower ratios will require more field compactive effort to achieve adequate density.

# Factors Affecting HMA Permeability

- No significant difference in lab permeability between fine- and coarse-graded mixes.
- Satisfactory permeability at 7±1% AVC at t/NMAS = 2, 3, or 4.
- Permeability increases as air voids and coarse aggregate ratio increase, decreases as VMA increases.

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

**Update method in AI Manual SP-02:**

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

***Advanced Asphalt Technologies, LLC (August 2006)***

# *9-39: Determining the Mixing and Compaction Temperatures of Superpave Asphalt Binders in HMA*

- **Reliable, user-friendly method.**
- **Equally applicable to modified and unmodified binders.**
- **Simple and quick to use.**
- **Suitable for routine specification use.**

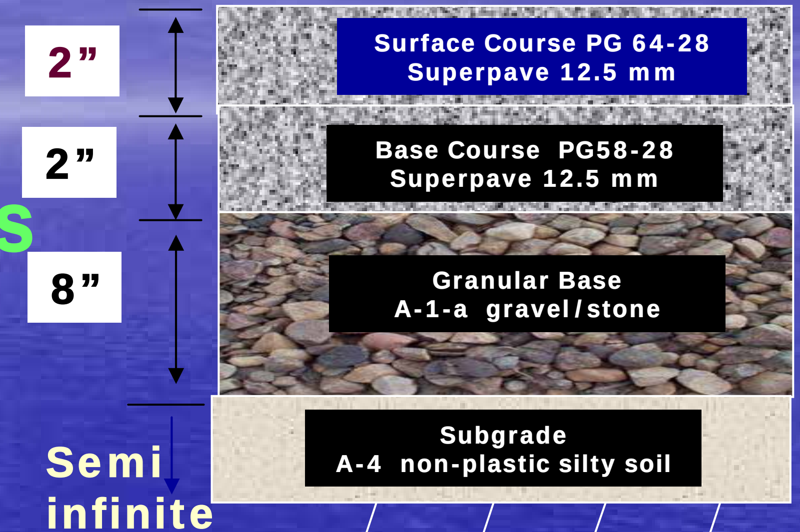
*(RFP anticipated December 2004)*

# 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

# Benefits of M-E Pavement Design

- Wide Range of Pavement Structures
  - New
  - Rehabilitated




## Direct Consideration of Major Factors

Traffic – Direct Consideration of Overweight Trucks

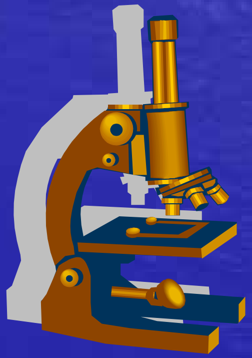
Climate

Materials – Different HMA/Aggregate Materials

Support – Foundation & Existing Pavement

# 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***

# Increase Understanding

## Materials/Design Engineers 2-day Workshops

- Objective: Educate M/D engineers on requirements for obtaining materials characterization inputs in common forum
  - Asphalt materials inputs
  - Concrete materials inputs
  - Soils/Unbound Granular materials inputs
  - Rehabilitation inputs
- Workshop, Laboratory & Software Modules

# 2005 Workshop Schedule

| Month | Location |
| --- | --- |
| January 27-28 | Turner-Fairbank (Pilot) |
| February 15-16 | Salt Lake City, UT |
| March 30-31 | Rocky Hill, CT& Webcast |
| April 5-6 | Thornburg, VA |
| April 20-21 | Jefferson City, MO |

Thanks!