Putting the Puzzle Together On Our National Asphalt RD&T Activities

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Federal Highway Administration

National Cooperative Highway Research Program

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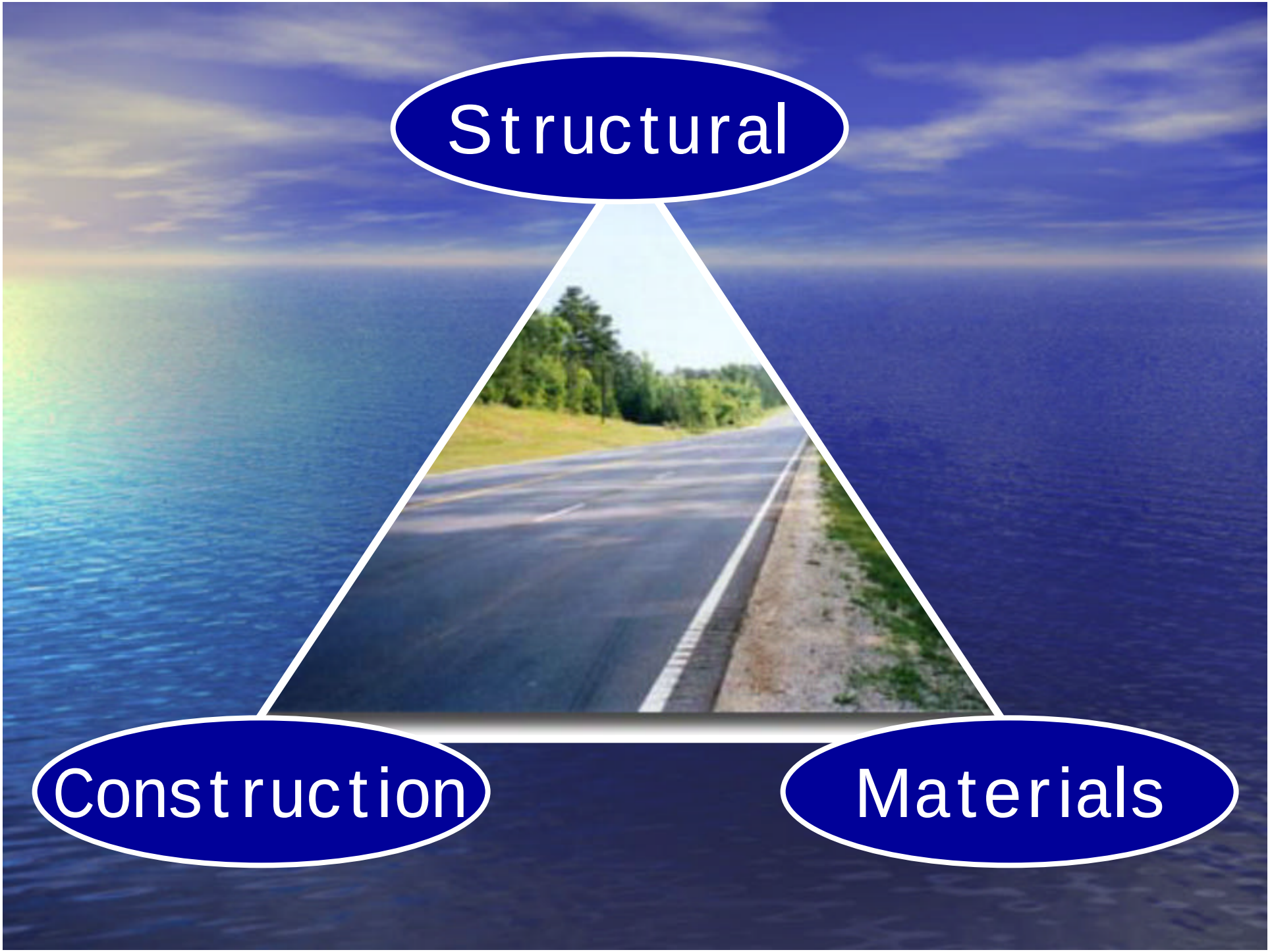
9-Series, Fall 2002

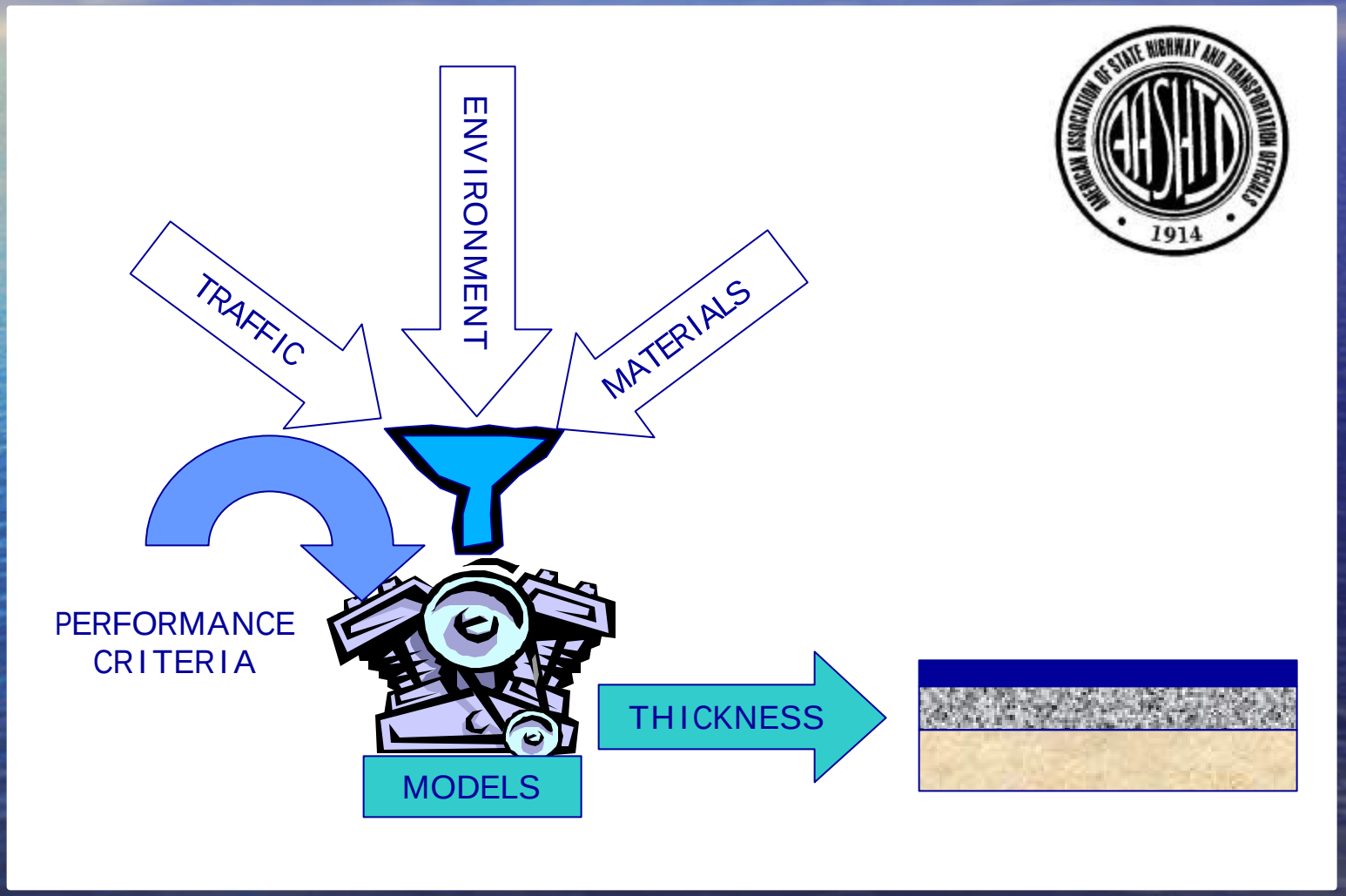
NAS - AASHTO's Research Program Since 1962

For Project Status Reports, Requests for Proposals, Online Documents, Products Developed for AASHTO Committees, and Other Information, Visit the Web at:

www4.trb.org/trb/crp.nsf/


Structural
Construction
Materials

NCHRP 1-37(A) Proposed AASHTO 2002 PDG...



Key Staff...


Principal Investigator
John P. Hallin
CO-PI (Marketing Training Implementation)
Kenneth McGhee
Flexible Pavement
Matthew W. Witczak
Rigid Pavement
Michael I. Darter

NCHRP 1-37(A)
July 2002 3...

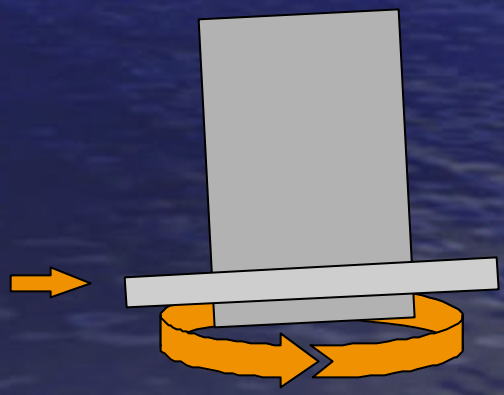
Develop and deliver a guide for design of new and rehabilitated pavement structures

- Based on mechanistic-empirical principles
- Accompanied by the necessary computational software
- For adoption and distribution by AASHTO

9-9(1): *Verification of Gyration Levels in the N_{design} Table…*

How well does densification at the N_{design} in PP28 match the field under traffic?

NCAT (August 2003)



9-9(1): *Verification of Gyration Levels in the N_{design} Table…*

Independent Variables:

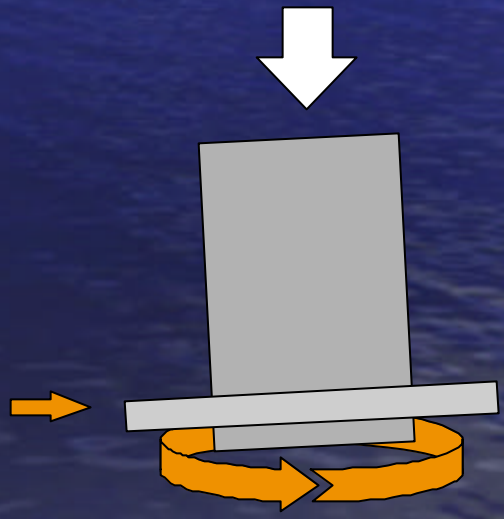
- **Gyration level**
- **Aggregate gradation, fine & coarse**
- **Binder grade “bump”**
- **Lift thickness to NMAS ratio**

9-9(1): *Verification of Gyration Levels in the N_{design} Table.*

- Average as-constructed air voids of 40 projects is 8.4 ± 1.9%
- At 1 year, average for 14 projects decreased from 8.5 ± 2.2% to 5.8 ± 1.9%
- No relationships yet apparent

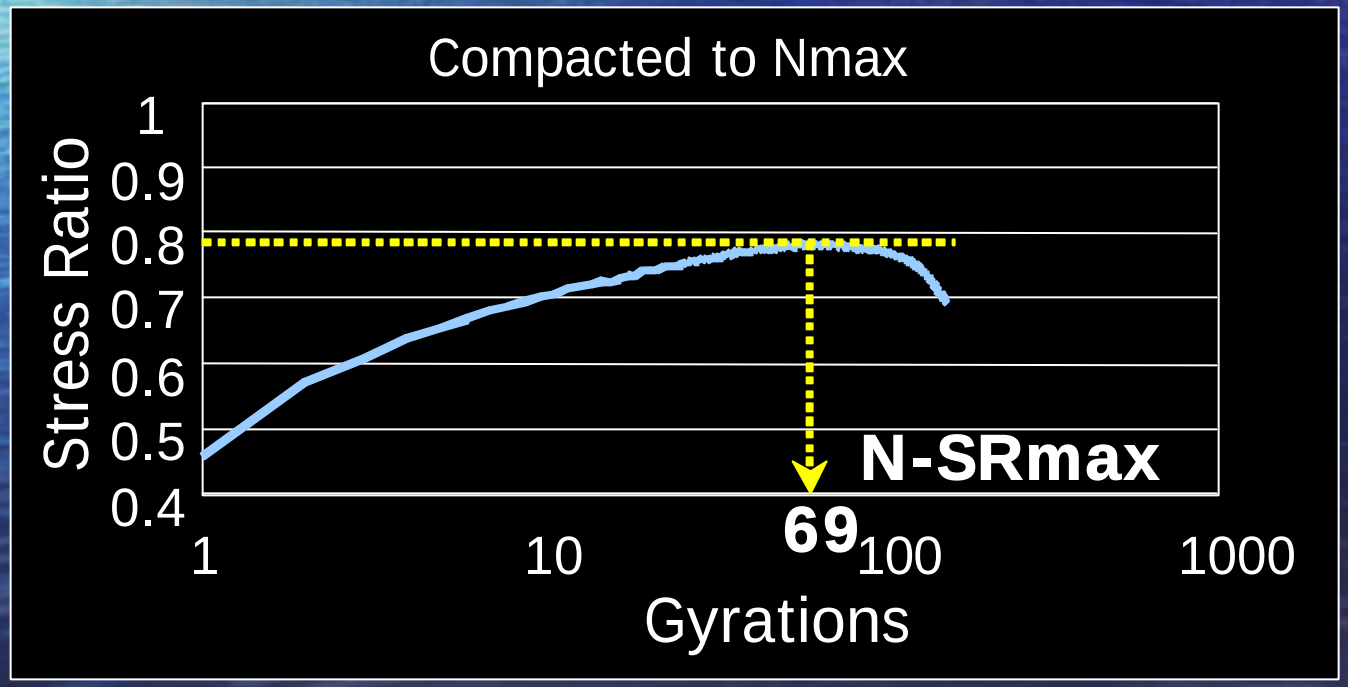
9-16(1): *Validation of 9-16 Findings for HMA QC…*

- **Validate the use of N-SR_{max} <u>**# of gyrations at max stress ratio**</u> measured with the SGC as a tool for field QC of HMA production.**



NCHRP 9-16 Issues...

- (1) N-SR_{max} is not a standard capability
- (2) Relatively insensitive to AC stiffness
- (3) Researchers have developed a new approach



Something New

- Dynamic Evaluation of Specification Compliance
- Determination of N-SR_{max}

Test Quip / Gilson
Pressure Response Indicator
(PRI)

9-19: *Superpave Support and Performance Models Management, Task C...*

Candidate simple performance tests:

- **Dynamic modulus: E* /sinF (PD/FC)**
- **Static creep: flow time (PD)**
- **Triaxial repeated load permanent deformation: flow number (PD)**

9-19: *Superpave Support and Performance Models Management, Task C.*

SPT Validation: Correlate test results with field performance of selected field sections - IN SPS-9, NV I-80, AZ I-10, NCAT Track (10), MnRoad, FHWA ALF, WesTrack

SPT Criteria: Develop with aid of performance models in the 2002 pavement design guide (1-37A)

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

- **First-article simple performance testers from Interlaken and ShedWorks/ IPC under evaluation by AAT and FHWA.**

Advanced Asphalt Technologies

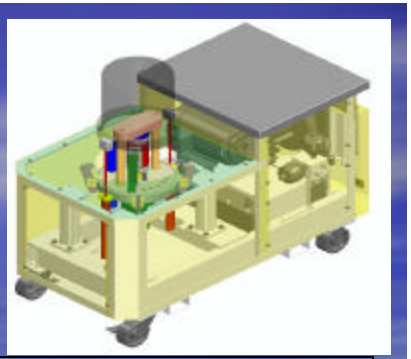
(April 2003)

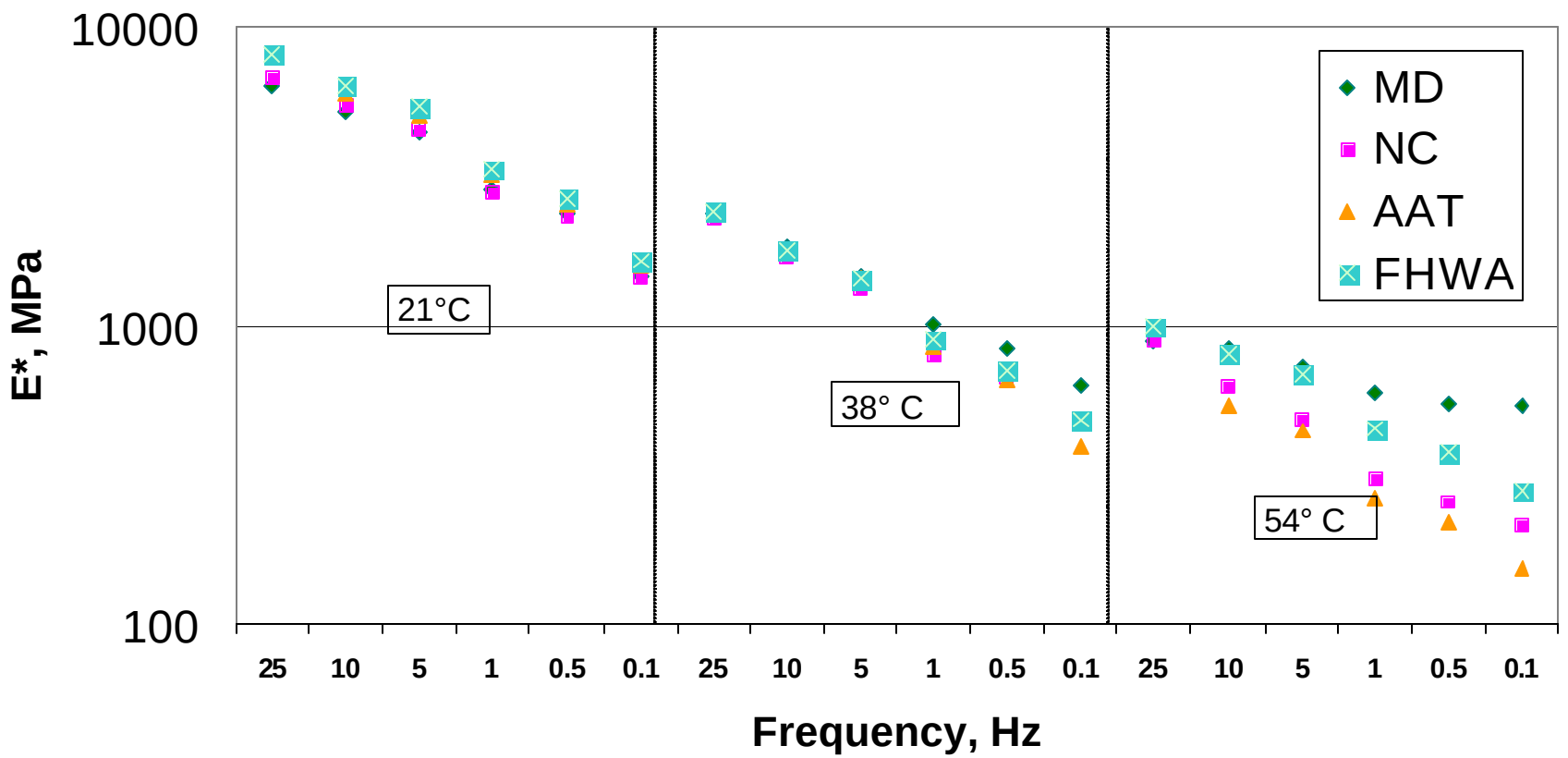
Simple Performance Test
First Articles (9-29)...

Shedworks

Interlaken

E* Pooled Fund Preliminary Results.





9-23: *Environmental Effects in Pavement Mix & Structural Design Systems…*

- **Validate the latest version of Integrated Climatic Model (ICM) developed in NCHRP Project 1-37A**
- **Verify the estimated period or rate of in-service aging simulated by AASHTO PP1 and PP2**

Arizona State University (August 2003)

9-23: *Environmental Effects in Pavement Mix & Structural Design Systems.*

- **All field work for ICM validation completed at 27 LTPP sites, MnRoad, and WesTrack**

- **Field samples obtained for verification of AASHTO PP1 & PP2**

9-22: *Beta-Testing and Validation of HMA PRS...*

In 2001, beta tested HMA SPEC v. 1.0 (done) and tested PRS as "shadow spec" on five field projects

Fugro-BRE, Inc. (December 2003)

Arizona, Colorado, Florida, Maryland, Illinois...

9-22: *Beta-Testing and Validation of HMA PRS.*

- **HMASpec V. 2.0: Incorporate requisite PRS elements and original WesTrack performance models into the 2002 Pavement Design Guide software program**

- **Preliminary LCC/PRS analysis of field projects complete.**

9-22: *Beta-Testing and Validation of HMA PRS...*

Project	Lots	Pay Factor
A	7	1.35 ± 0.26
B	7	1.17 ± 0.15
C	7	1.16 ± 0.21
D	9	0.85 ± 0.18
E	9	0.22 ± 0.20

LCCA based on Level I WesTrack models

9-25: *Requirements for Voids in Mineral Aggregate for Superpave Mixtures* +

Which volumetric design criterion best ensures adequate durability and performance: VMA, VFA, or calculated binder film thickness?

Advanced Asphalt Technologies (October 2003)

9-31: *Air Void Requirements for Superpave Mix Design…*

Should the design air void content vary with traffic loading and climatic conditions?

Advanced Asphalt Technologies (October 2003)

Advanced Asphalt Technologies, LLC

"Engineering Services for the Asphalt Industry"

9-25/9-31 Preliminary Findings.

- Defining optimum binder content at 4% air voids appears reasonable and effective in producing stable, durable HMA mixes
- Rut resistance increases with decreasing VMA, increasing compaction, increasing aggregate surface area
- Fatigue resistance is strongly correlated with binder content only

9-30: *Plan for Calibration and Validation of HMA Models*

Q. What does the validation of the HMA performance models in the 2002 Guide with laboratory-measured properties entail in time, money, and materials?

Fugro-BRE, Inc. (April 2003)

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

Update the 1993 method and manual:

- **Simple performance test(s).**
- **As-delivered 2002 design guide performance models and software.**
- **Spreadsheets for volumetric design, performance testing, and design optimization.**

(RFP Issue: April 2003 or later)

9-34: *Improved Conditioning Procedure for Predicting HMA Moisture Susceptibility*

Improved conditioning procedure based on the environmental conditioning system (ECS) for use with the validated SPT.

Pennsylvania Transportation Institute (March 2004)

9-35: *Aggregate Properties & Their Relationship to the Performance: A Critical Review* +

Identify consensus, source, and other aggregate properties that significantly impact HMA performance.

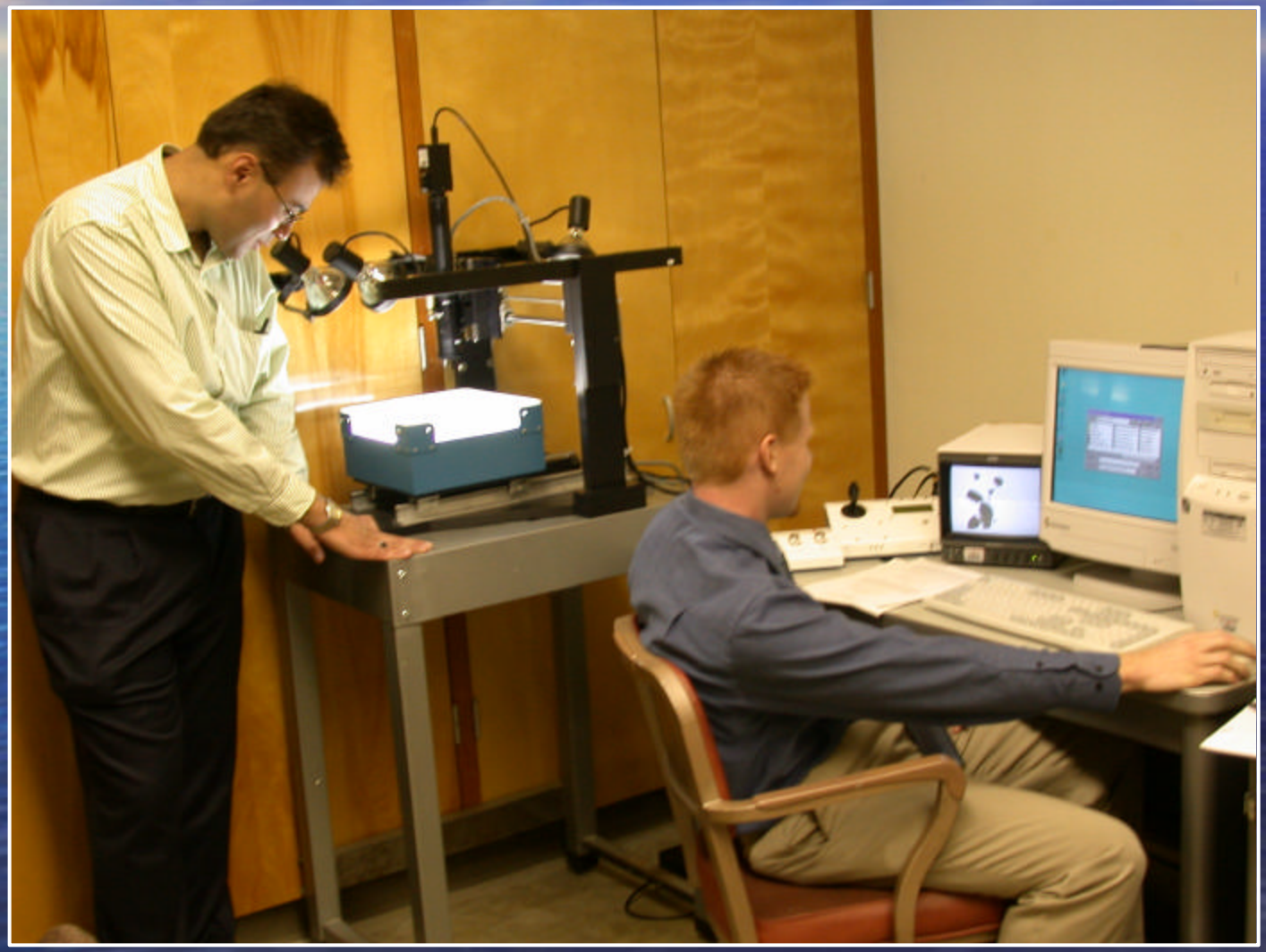
NCAT (June 2003)

4-30: *Improved Testing Methods for Critical Aggregate Shape/Texture Factors...*

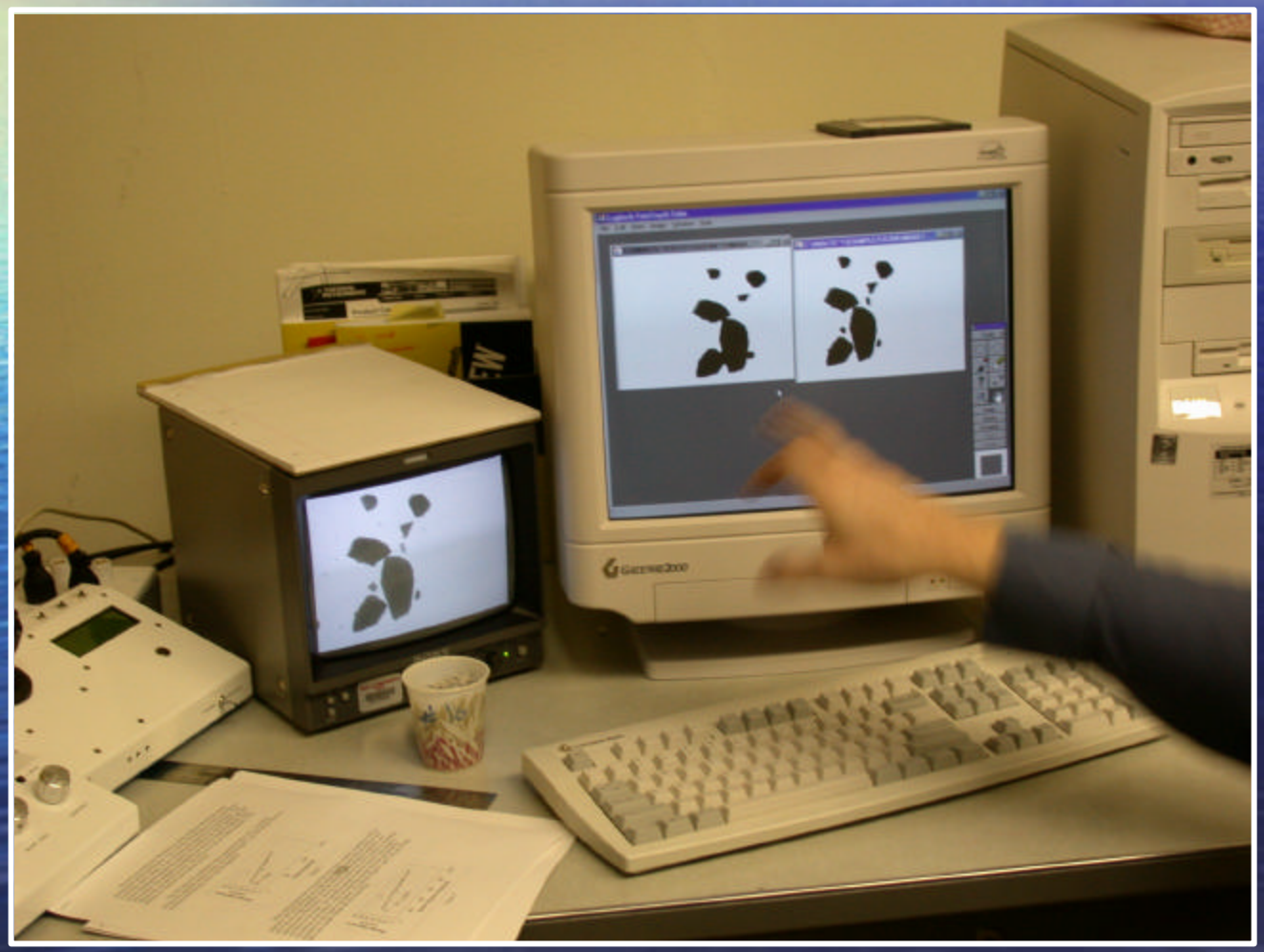
Identify or develop methods for measuring shape, texture, and angularity characteristics of aggregates used in hot-mix asphalt and hydraulic cement concrete

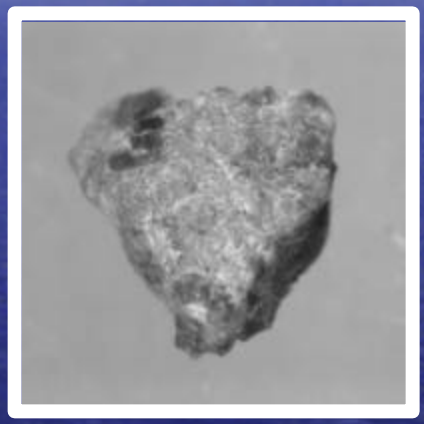
Washington State University (July 2004)

Aggregate IMaging System...



AIMS





9-36: *Improved Procedure for Laboratory Aging of Asphalt Binders in Pavements...*

Develop and validate a recommended procedure for short-term laboratory aging of asphalt binders usable in a purchase specification such as AASHTO M320: (1) neat and modified binders; (2) quantifies binder volatility; (3) extendible to long-term aging; (4) mimics PP2 mix aging

Agency Selection, December 2002

Superpave® Binder Specification

Short Term Aging

?

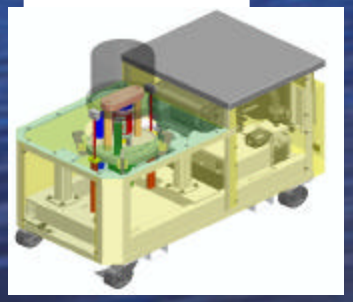
German Rolling Flask

TX DOT is adopting this technology

Issue: Within procedure post-aging handling practices

“The Puzzle”

1-37a PDG		9-19 Adv. Models	9-30 Models Calib.				
9-9 Ndes	9-16 N_{SRMax}	9-19 9-29 SPT	9-25 9-31 Voids (PRS)	9-33 Design Manual	9-34 H_2O	9-35 4-30 Agg.	9-36 Aging Binder
9-22 PRS							



A Few More Pieces To The Puzzle

NCHRP 90-series

Conducted by

FHWA

90-01: Mobile Asphalt Labs

- Provide “Hands-on” of Superpave System
  - Volumetric Mix Design
  - Field QC/QA Procedures, NCHRP 9-7
  - Dynamic Angle Validation (DAV)
  - Performance Related Specifications 9-22
  - Simple Performance Test 9-29

- 4 to 6 week visits
- Data used to support ETG’s

90-02: Binder lab

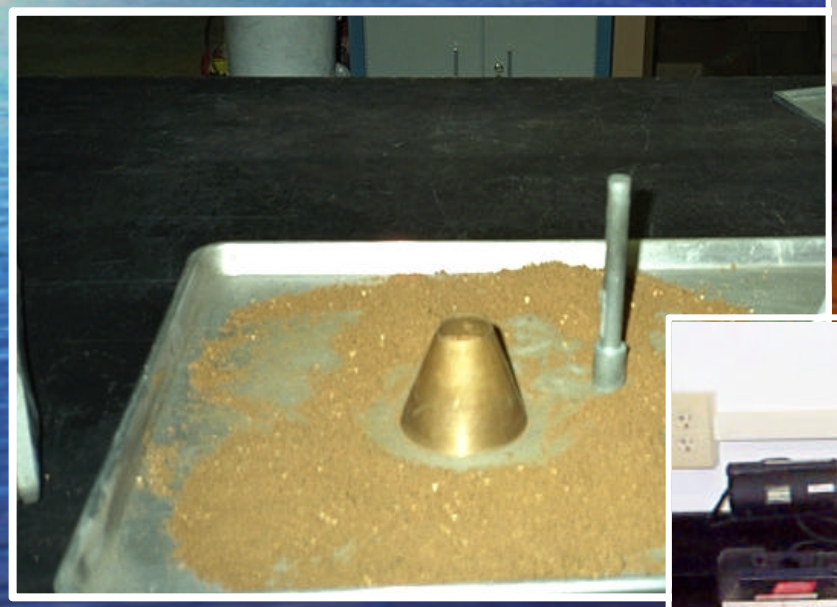
- Continuous support to the States:
  - Training / Ruggedness / Development / Validation
- Trouble shooting of binder problems
- Farther Development of the DT

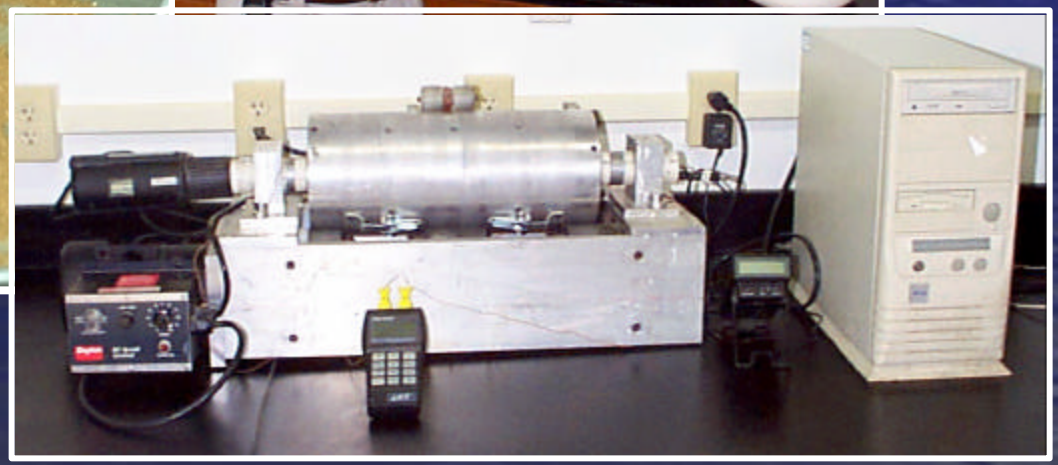
90-03 Mix Tenderness.

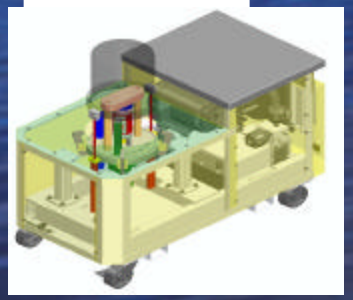
Producing Mix With High Moisture

90-05 Fine Aggregate Specific Gravity Test

- Issue:
  - VMA Field QC







Understanding the Performance of Modified Asphalts in Mixtures

NCHRP 90-07, TPF 5-(019)

Asphalt Pavement Team, R&D

REFINEMENT

Superpave™

Partnerships with Products

19 State DOT's & 11 Industry Sponsors

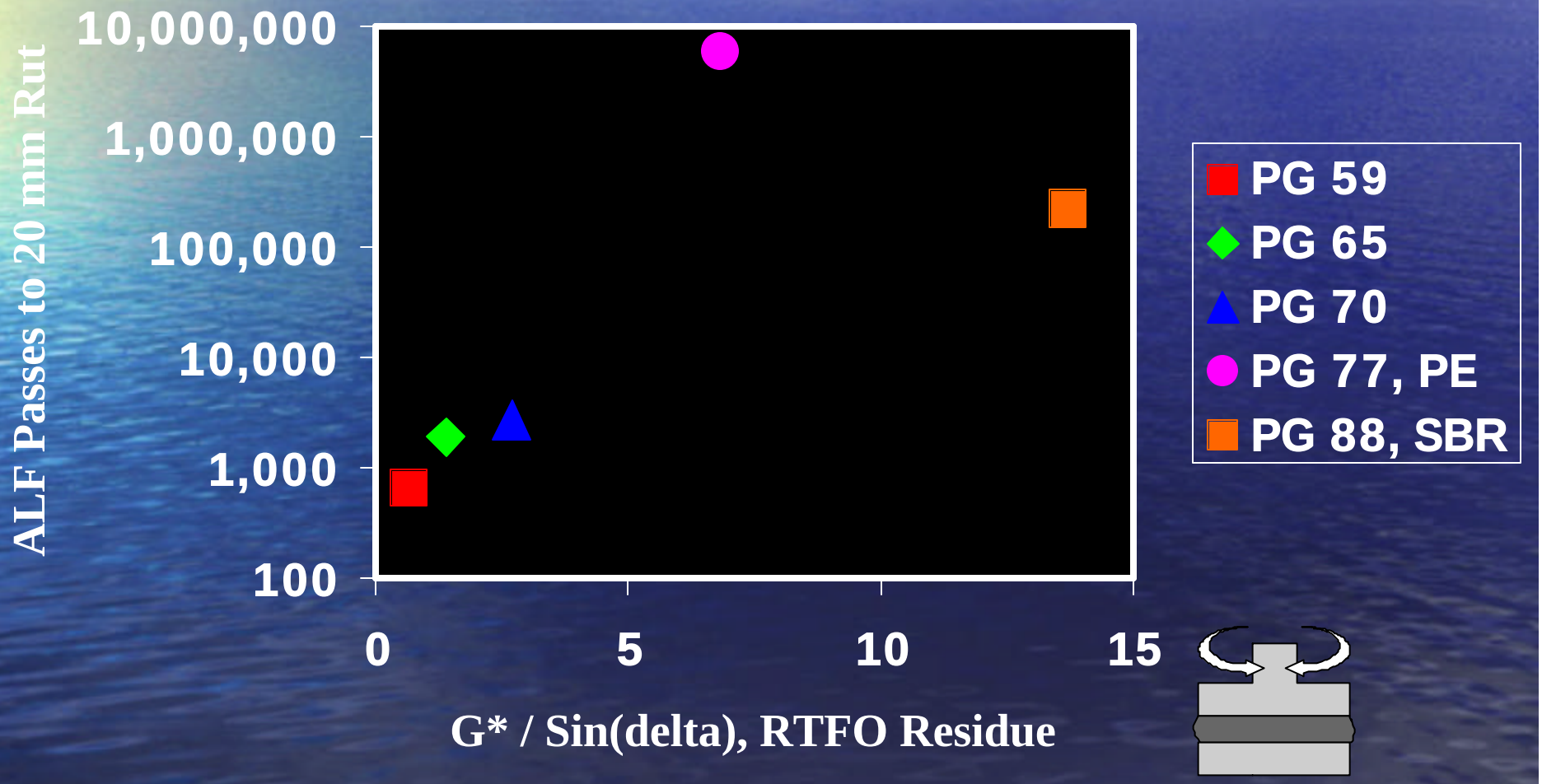
NCHRP 90-07, TPF 5-(019)
Accelerated Load Facility

Historical Perspective

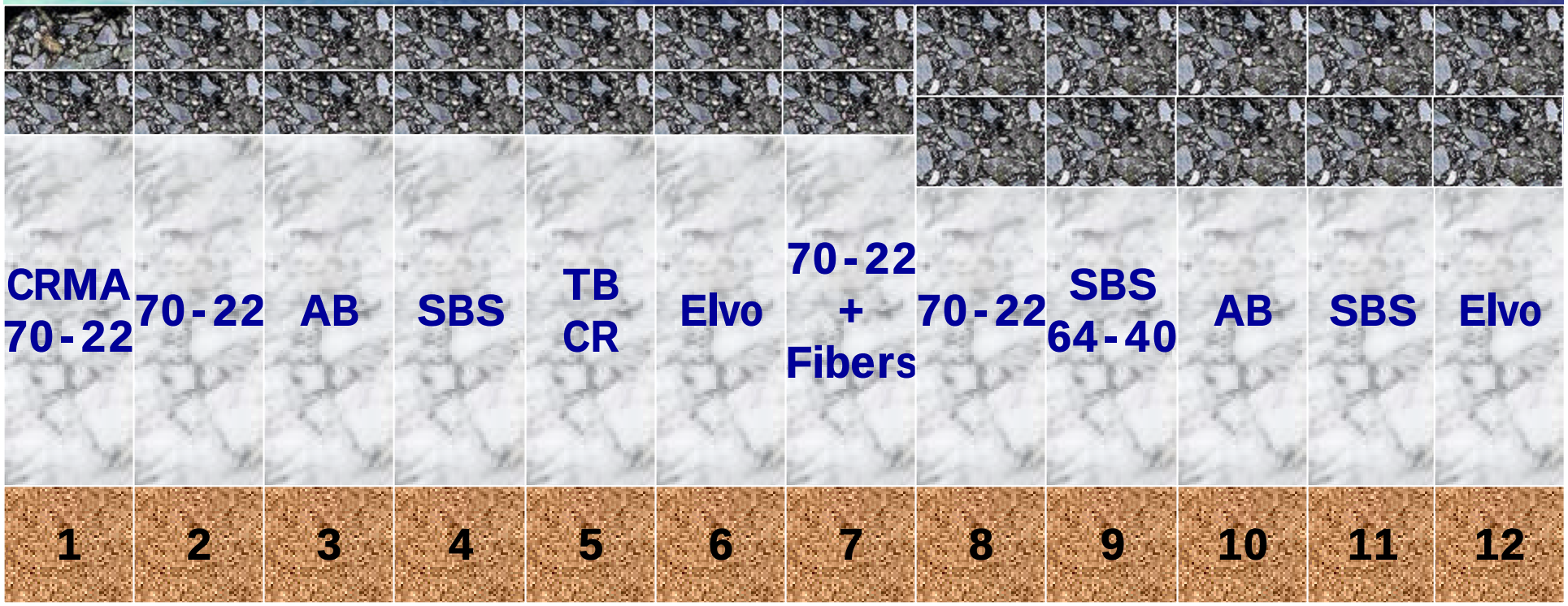
- ✓'86 Initial Trials
- ✓'89 WASHTO Field Tests
- ✓'90 Super Single Tire
- ✓'93 SHRP binder validation
- ✓'98 Ultra-Thin Whitetopping

FHWA ALF ’93 - Key Findings

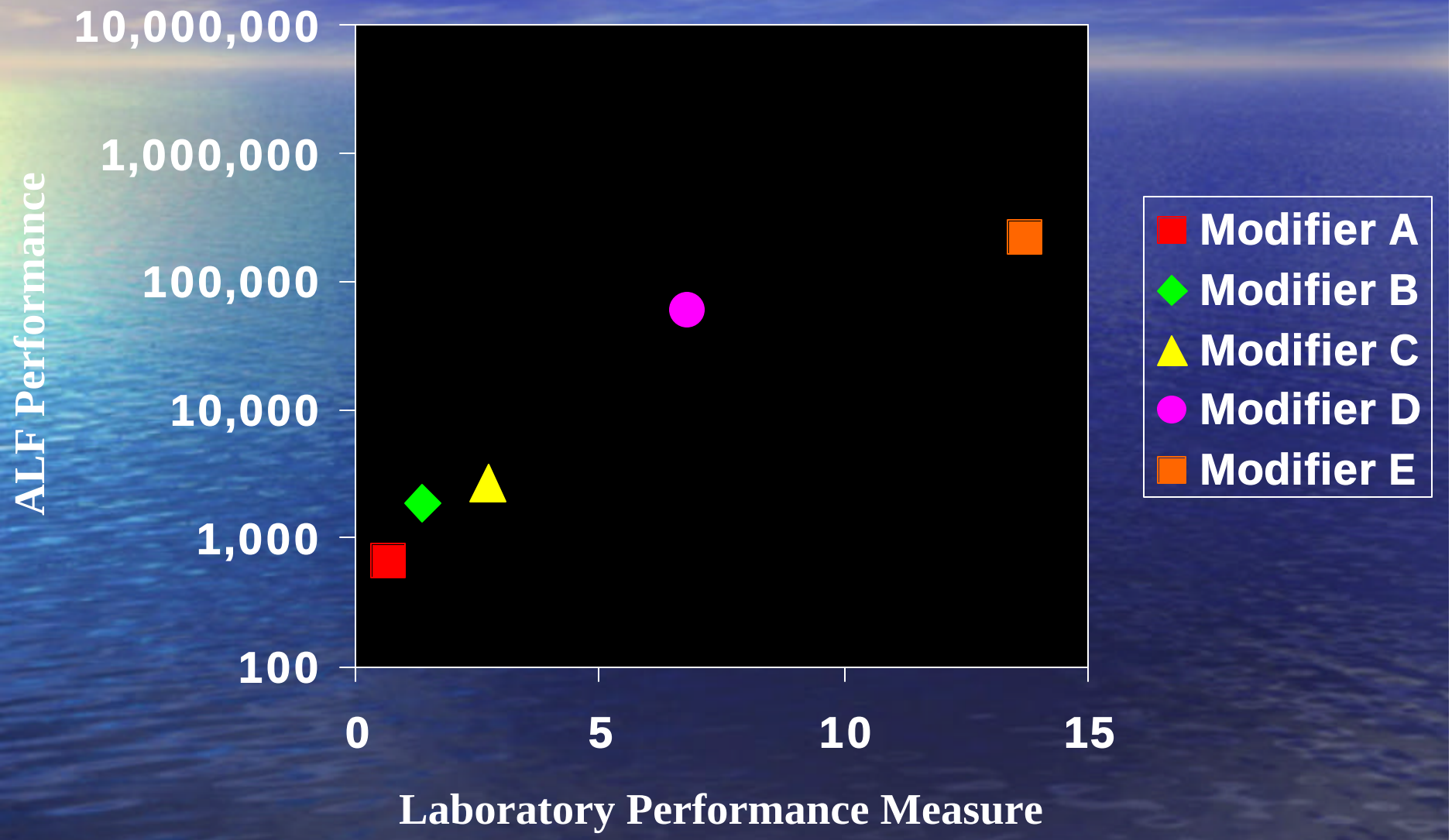
Tested at 58°C



Final Test Matrix



Analysis Goal



“So what?”

Superpave® Binder Specification

Rutting, Fatigue, and Low-Temp. Cracking

WHEN	WHAT	HOW	WHERE
Construction	Safety Pumpability Rutting	Flash Point Rot Visc $G^* / \sin \delta$	230 min 3 Pa-s max T(high)
Early *(RTFO)*	Rutting	$G^* / \sin \delta$	T(high)
Late *(+PAV)*	Fatigue Low Temp	$G^* \sin \delta$ BBR/DTT	T(inter) T_{CR}

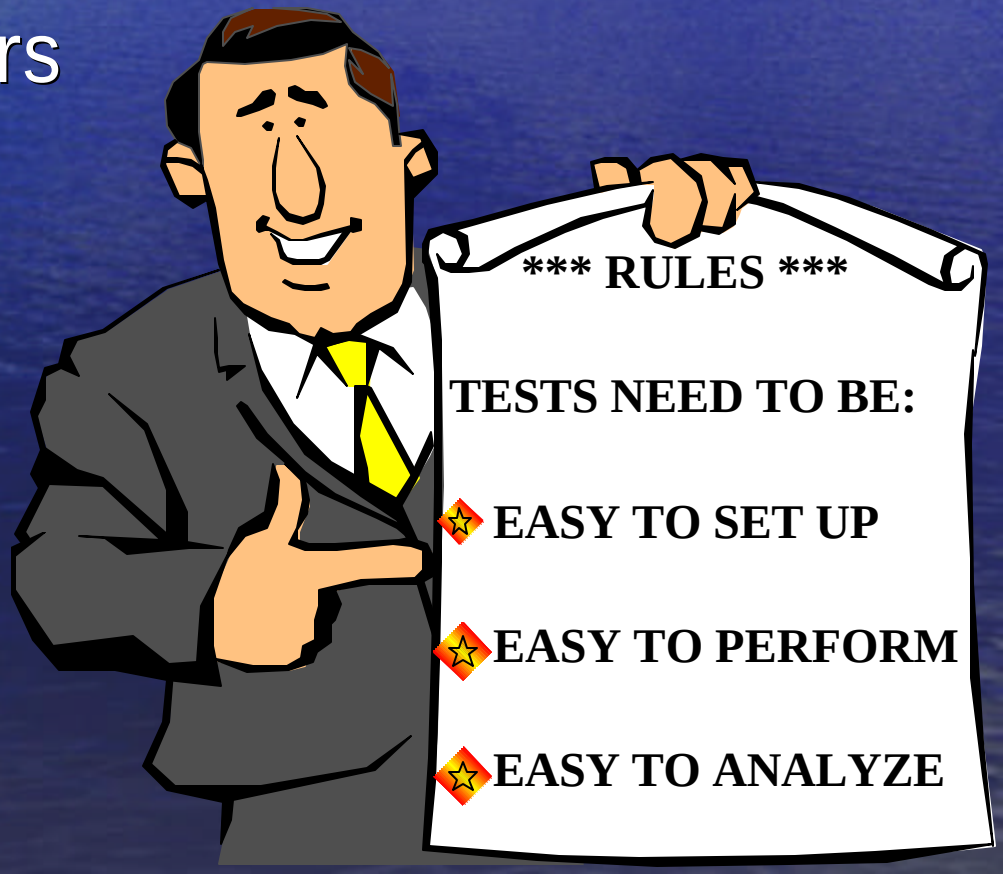
Superpave® Binder Spec. II

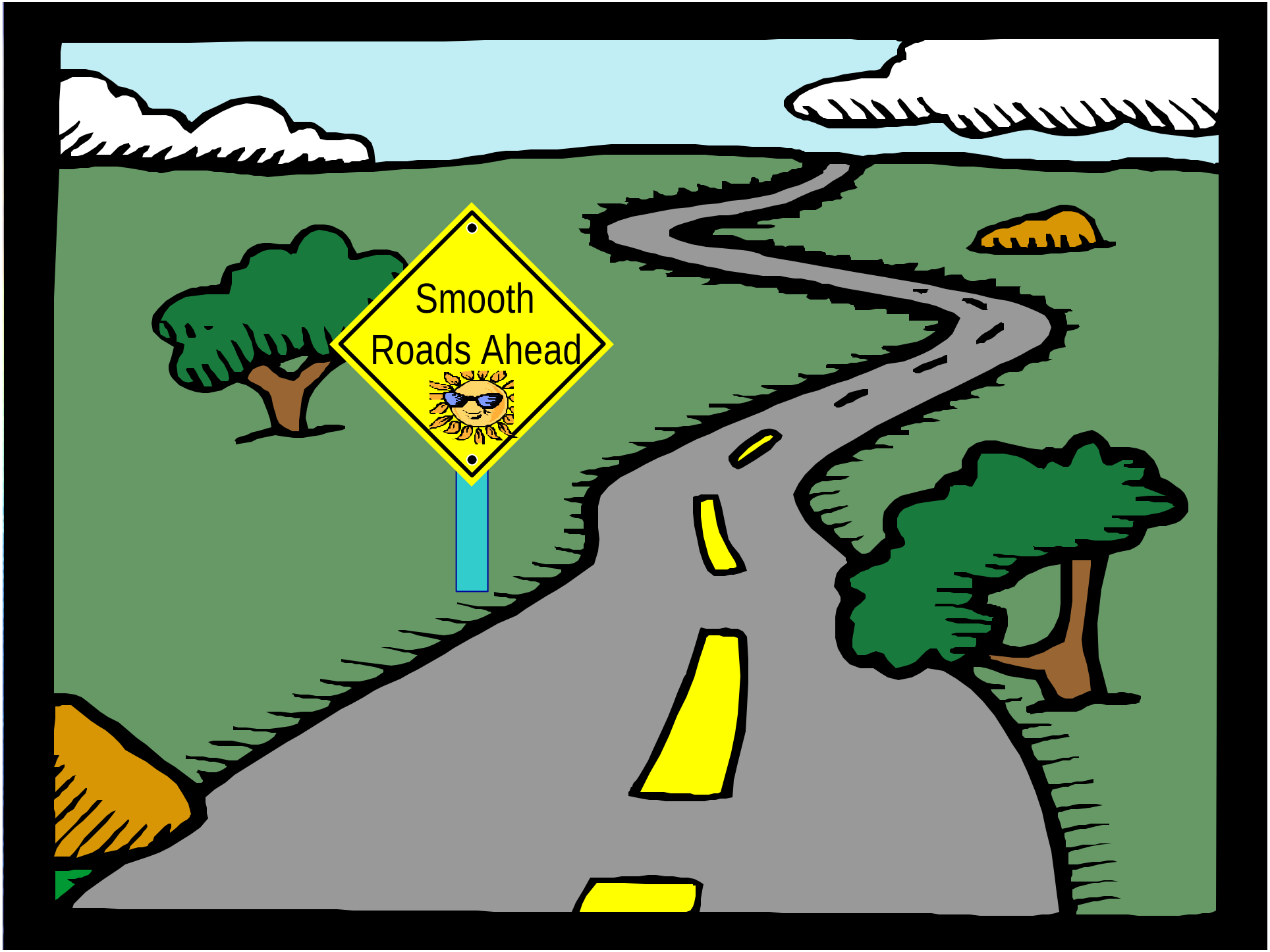
PG based on Degree Days

WHEN	WHAT	HOW	WHERE
Construction	Safety Pumpability Rutting	Flash Point Rot Visc $f(G^* \sin\delta)$ ZSV	230 min 3 Pa-s max T(high)
Early *Tx Device*	Rutting	$f(G^* \sin\delta)$ ZSV	T(high)
Late *(+MW)*	Fatigue Low Temp	$f''(G^* \sin\delta)$ DT DT / ABC	T(inter) T_{CR}

“So What?”

- To better handle neat asphalts
- To address modifiers
- To do it faster, better, and more economical!




Smooth
Roads Ahead