

MnPAVE - Your Guide to Better Pavement Design

*Minnesota Department of
Transportation*

Mn/ROAD, The First Six Years –
A Workshop
February 21, 2001

Outline of Presentation

- **Background**
- **Overview of Development**
 - ◆ Structural model
 - ◆ Modulus testing
- **Beta Software Demo**



Previous Work

■ Mn/DOT - Research at Mn/ROAD

- ◆ In-place properties, seasonal testing, performance monitoring (1991-present)
- ◆ SLR work

■ U of Mn -

- ◆ ROADENT, Reliability projects (1999)
- ◆ Seasonal Study (2000)
- ◆ Low-Volume Road Best Practices (in progress)

■ U of Illinois -



Acknowledgements



Motivation

- **Why Mechanistic-Empirical Design?**
 - ◆ Our current procedures cannot adequately address issues facing us today



Mechanistic-Empirical Design

■ Potential of M-E methods:

- ◆ Ability to adapt to different distress modes
- ◆ Allow better materials tests and characterization
 - ◆ Quantify and show benefit of improved materials and specifications
- ◆ Adapt to changing load limits and configurations
- ◆ Achieve agreement between structural and materials design



Project Timeline

■ Timeframe for completion, implementation

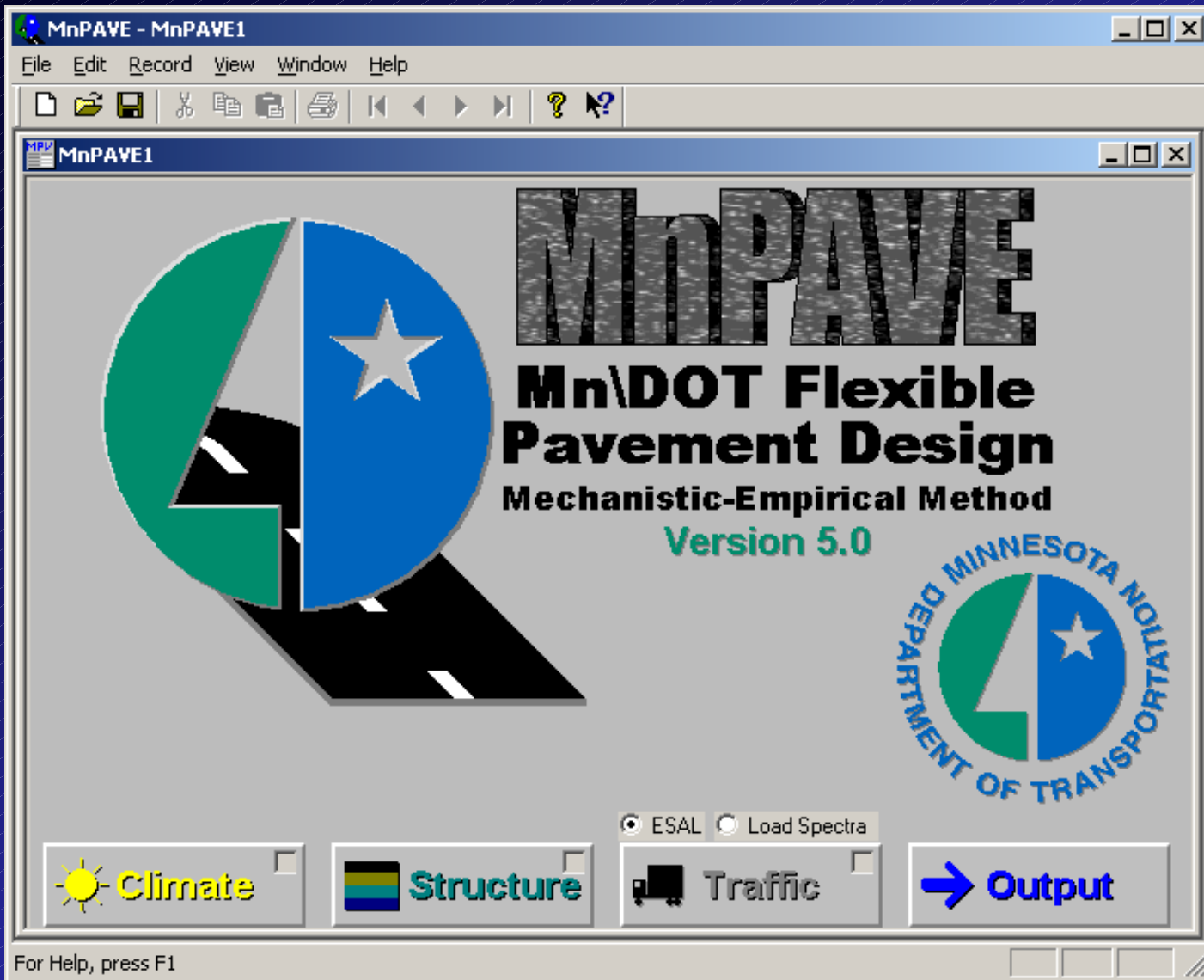
- ❖ Fully operational MnPAVE software Mar 2001
- ❖ User training starts Jun 2001
- ❖ Incorporate user feedback, calibrated MnPAVE Dec 2001
- ❖ M-E design adopted as Mn/DOT's procedure Dec 2002
- ❖ Evaluate AASHTO 2002 procedure, incorporate features as needed Dec 2003



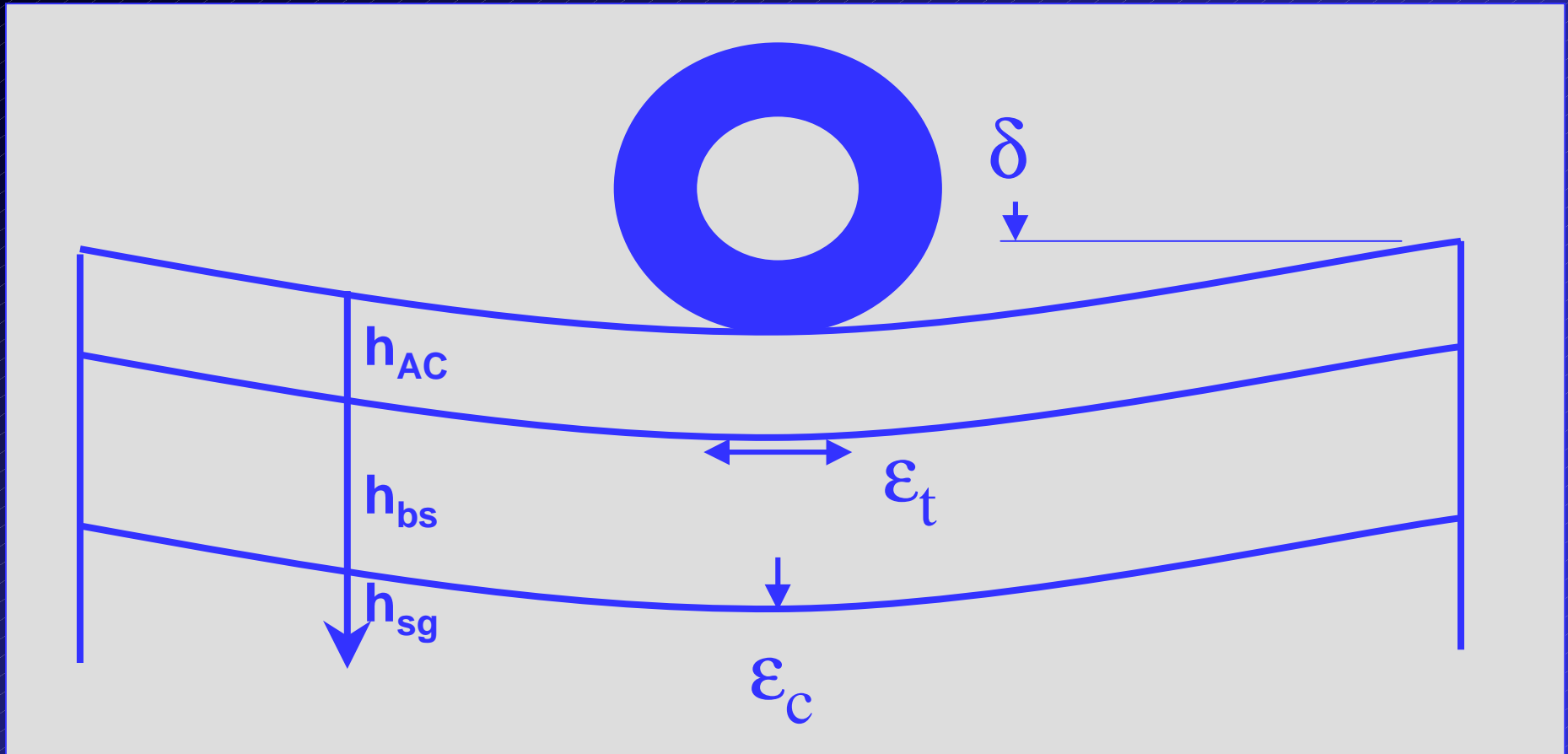
Basic Elements

- **Structural model**
- **Design Levels**
- **Input data**
 - ◆ Project location, climatic data
 - ◆ Materials properties, layer thickness, variability
 - ◆ Test results, if required
 - ◆ Traffic
- **Output**
- **Transfer functions**



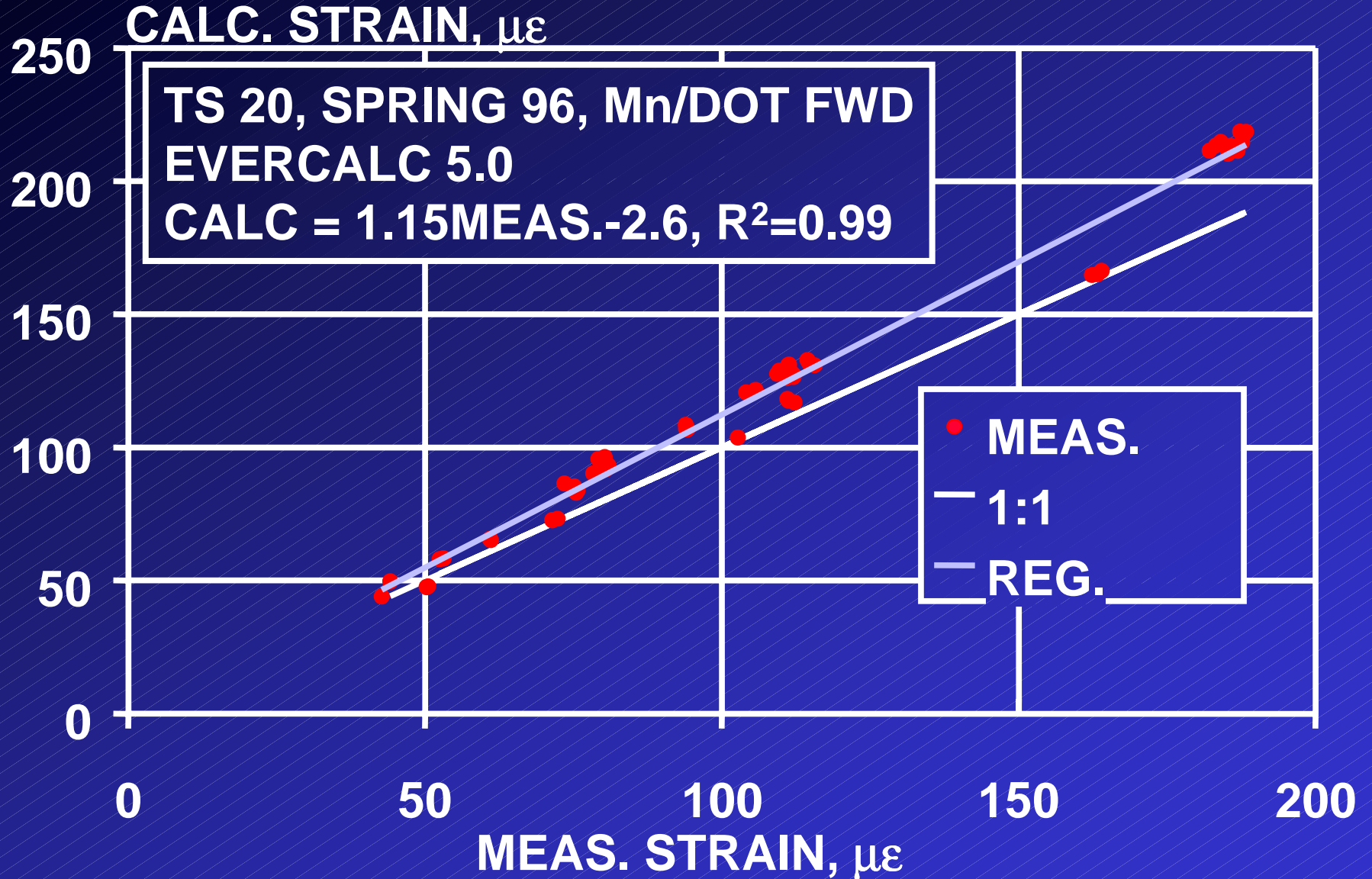


Structural Model

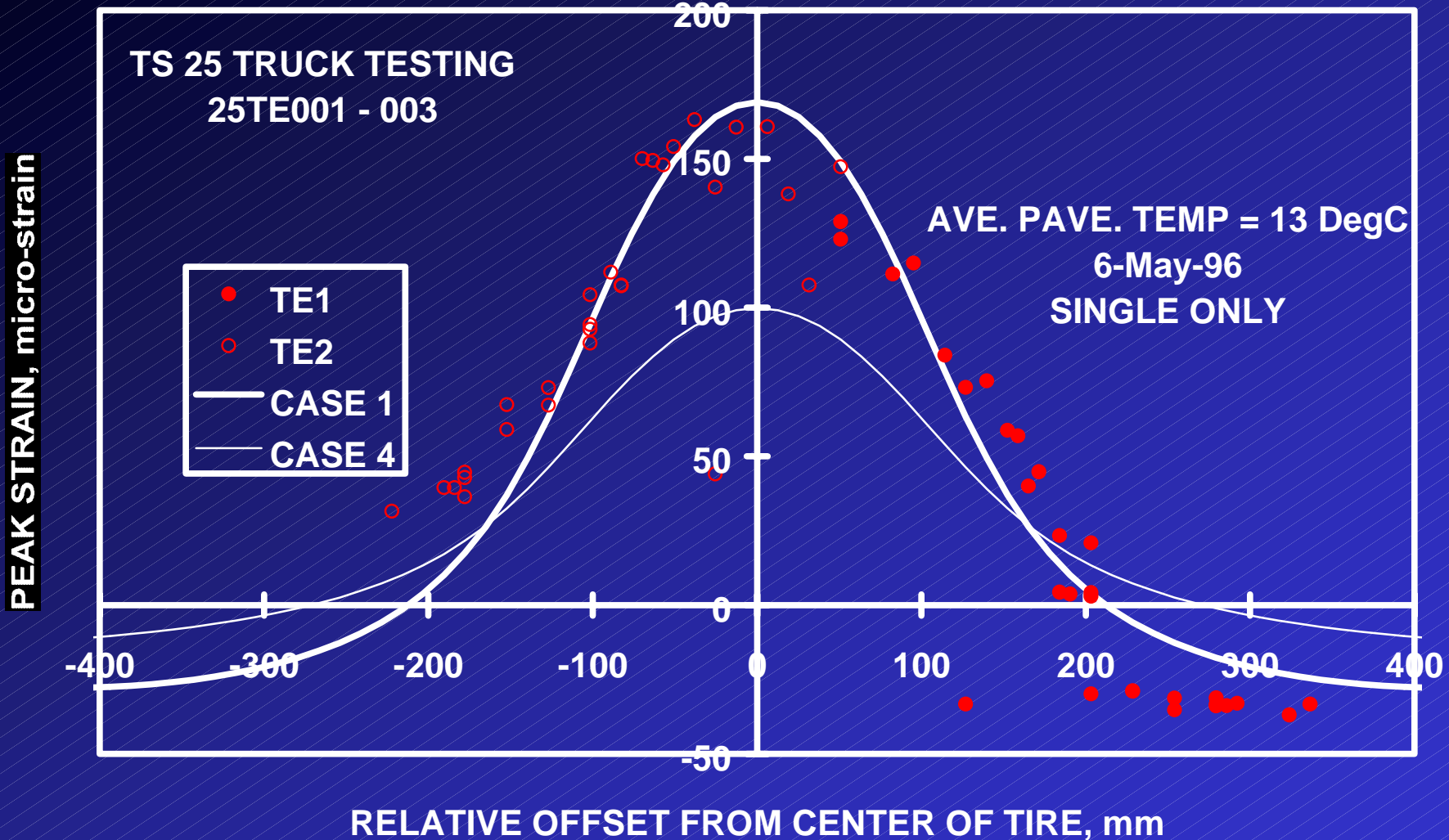


Based on the assumption that pavement can be modeled as a multi-layered elastic structure.

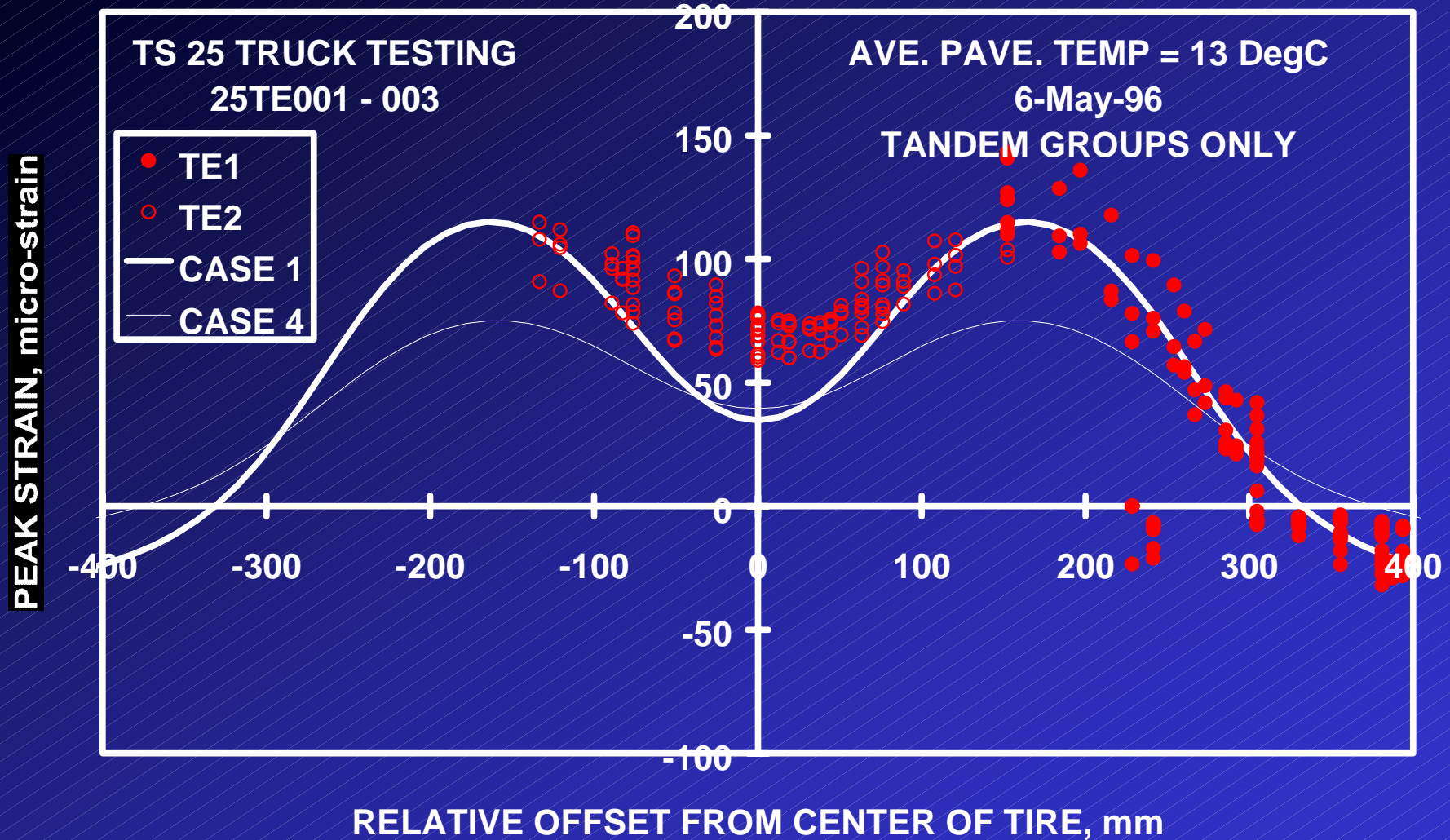
CALCULATED vs. MEASURED STRAINS



DISTRIBUTION OF STRAINS



DISTRIBUTION OF STRAINS

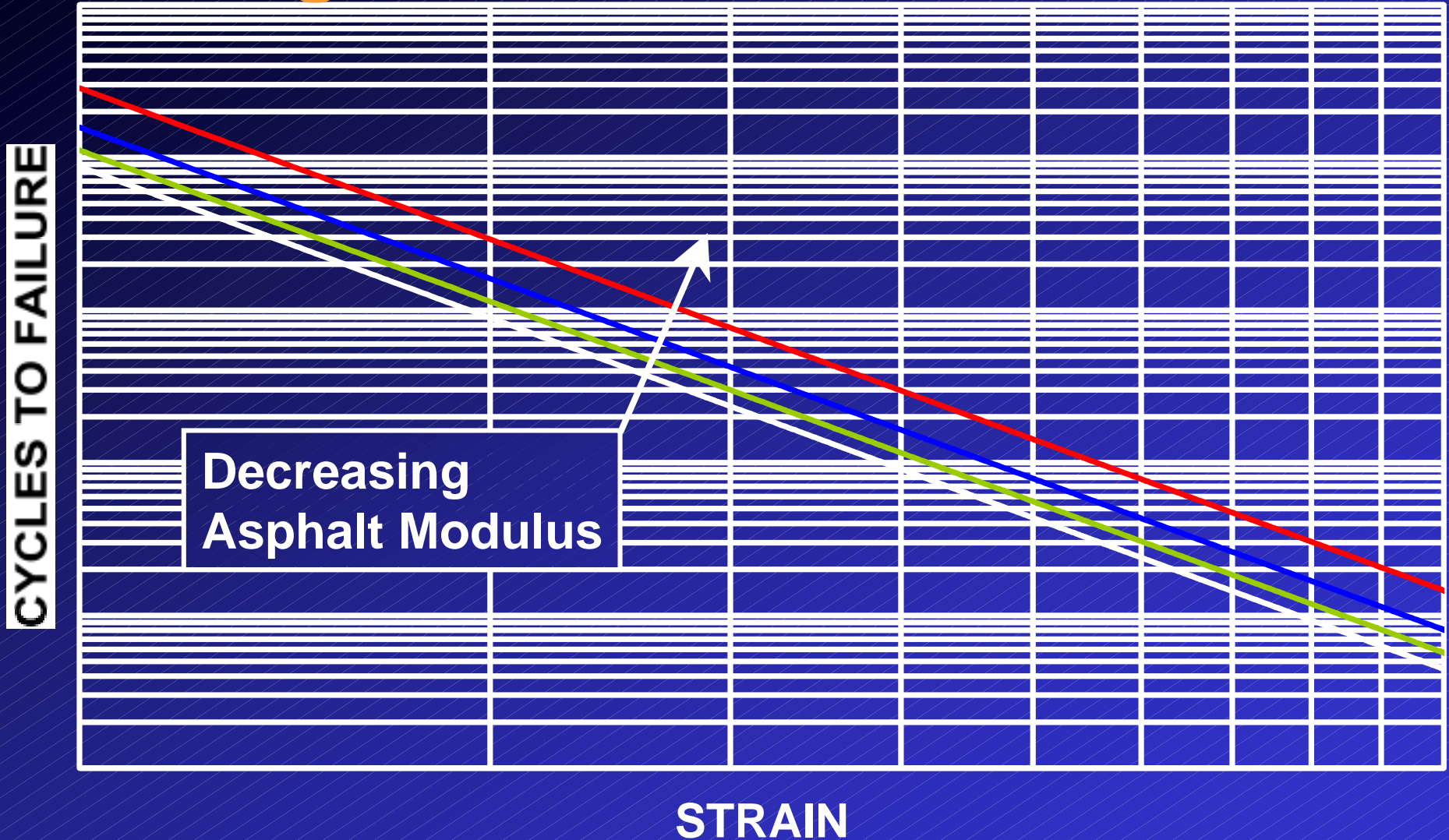


Transfer Functions

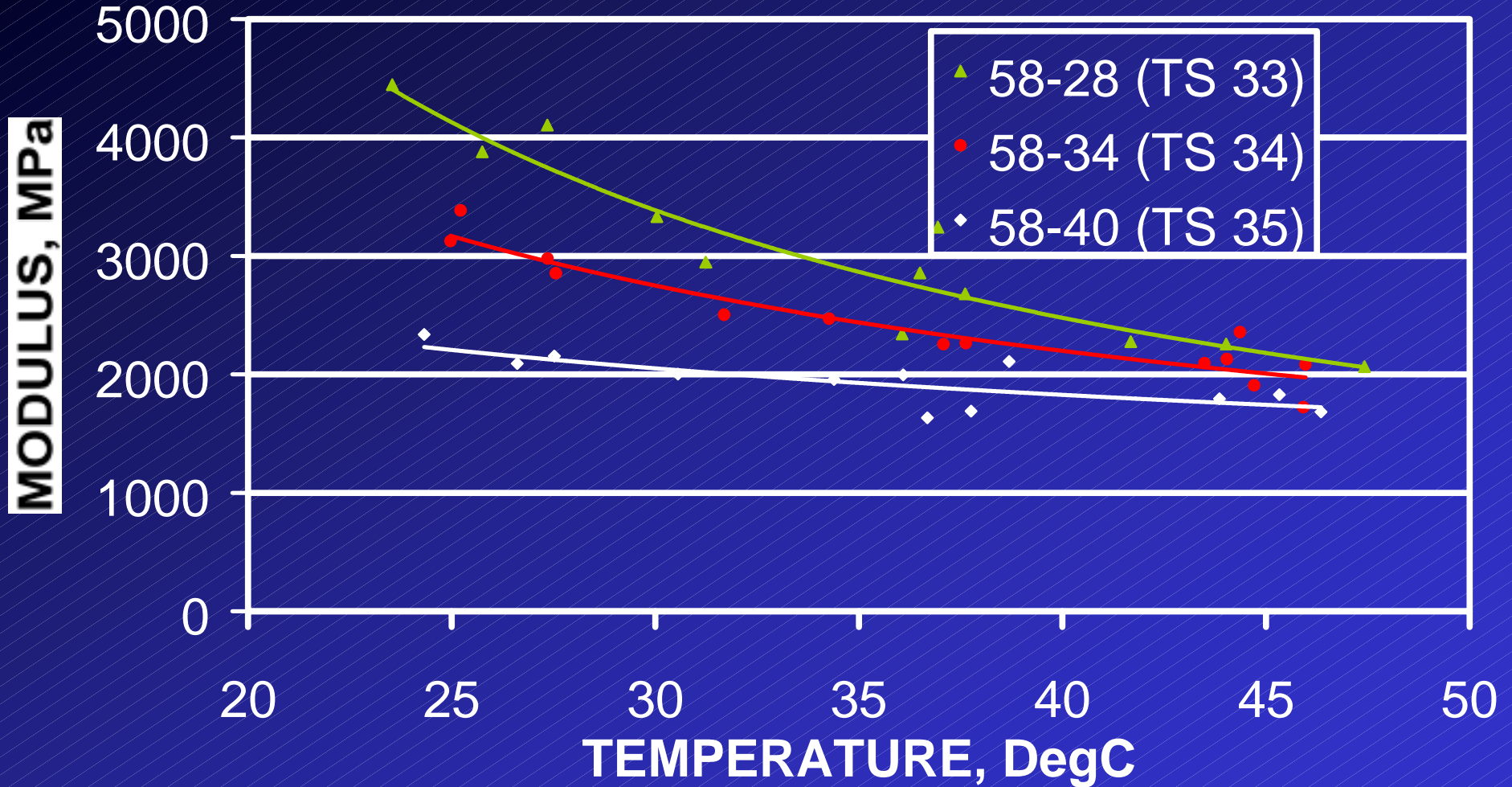
- **Transfer functions relate load repetitions to onset of distresses**
 - ◆ Rutting, Fatigue
 - ◆ Other?
- **Transfer functions have limitations**
 - ◆ Developed for specific conditions
 - ◆ Need to be verified, tested for reasonableness, calibrated



Fatigue transfer function



HMA MODULUS vs. TEMPERATURE



Longitudinal Strain in Mn/ROAD Superpave Cells

May 22, 2000 1:00 p.m.

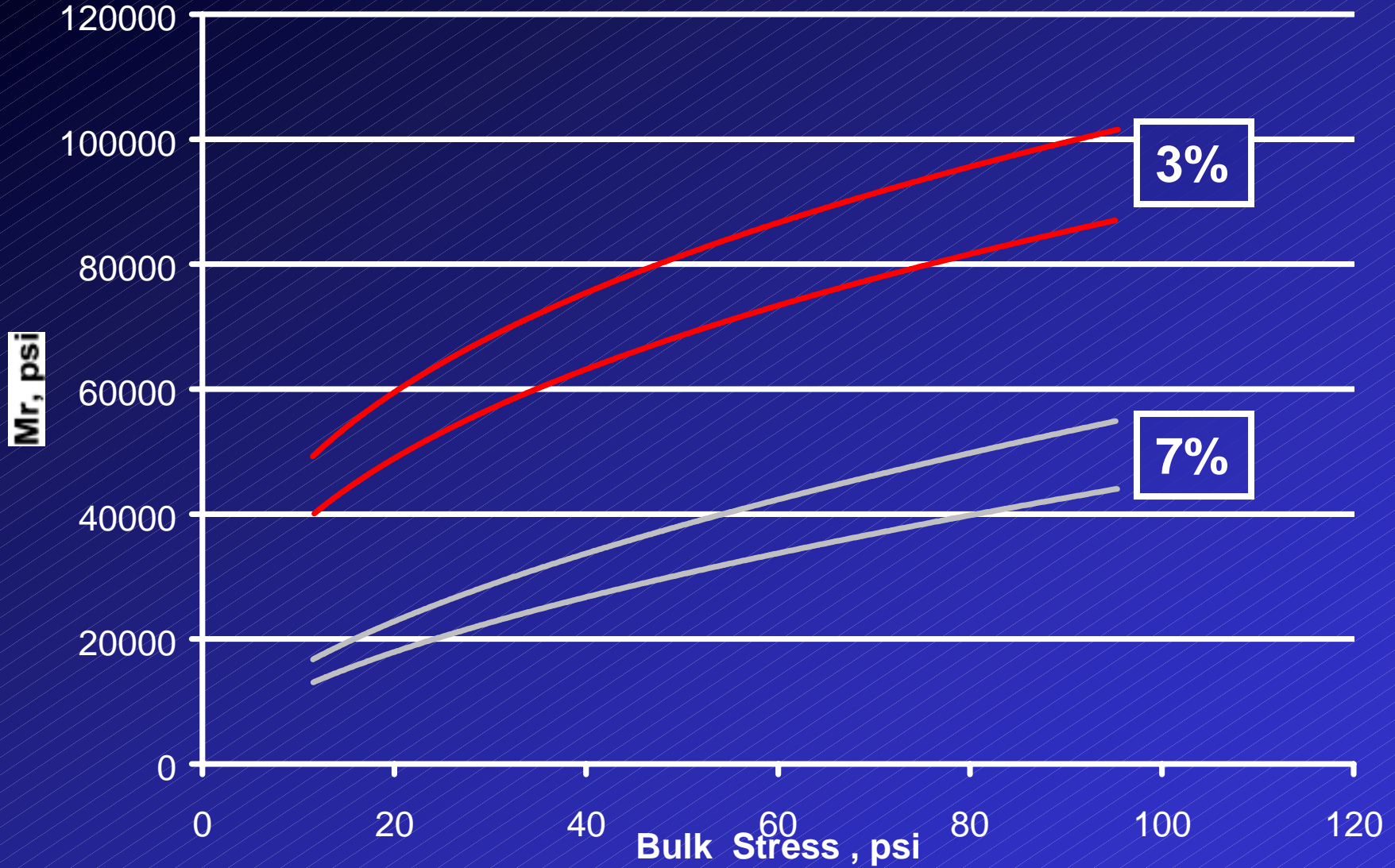


Triaxial Testing System

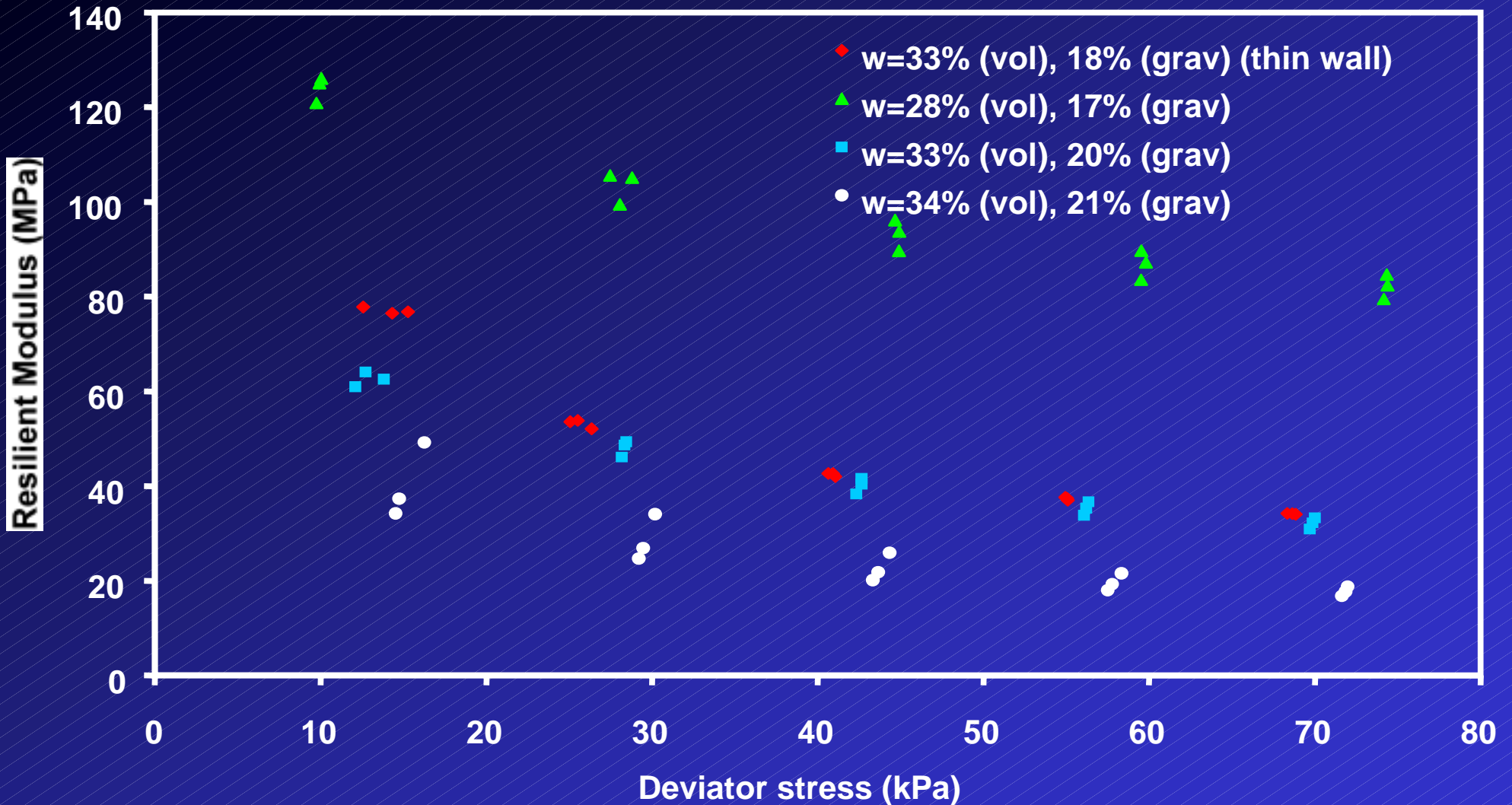
- Purchased 1990
- 22 kip load frame
 - ◆ Closed-loop, computer-controlled system



Gradation Effects - Class 5



Effect of Moisture and Density on Soil Modulus

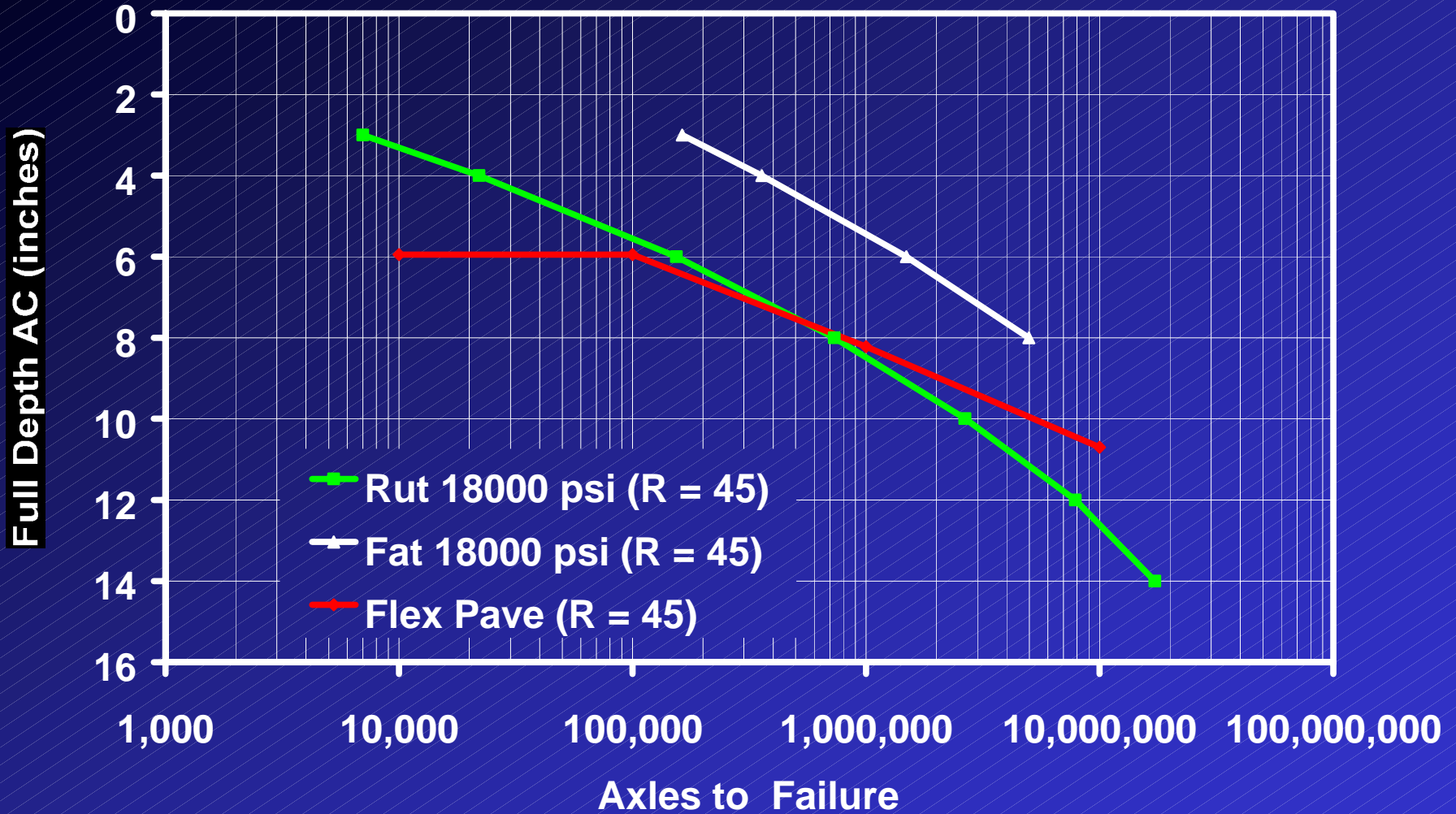


Validation/Calibration Process

- **Compare MnPAVE output with current procedure and experience**
 - ◆ Run pavements consistent with current design standards from all levels of traffic, material quality through MnPAVE
- **Verify reasonableness of output, adjust if necessary**



Mn/DOT Full Depth vs. M-E MnPAVE (beta) Designs



Immediate Challenges

■ Laboratory testing procedures

- ◆ Soils – production mode
- ◆ Aggregate base, HMA - develop

■ Training

- ◆ Local agencies
- ◆ Mn/DOT
- ◆ Consultants



Future Work

- Refine transfer functions
- Expand procedure to cover rehabilitation
 - ◆ Overlays
 - ◆ CIR
 - ◆ Rubblization
- Performance specifications
- Further work needed to characterize modified base gradations, select granular, Superpave, etc.



Summary

- **Inputs that represent in-service conditions are needed**
- **Procedure has flexibility in methods used to derive inputs**
- **Must account for construction practices**
 - ◆ Subgrade preparation (subcut, compaction)
 - ◆ Testing



Summary, cont.

- M-E is coming soon and is needed to address pavement issues facing us today
- The process does present challenges but potential benefits outweigh these
- Since M-E is mechanics-based, it is more easily adaptable to new conditions, loads, and materials



For More Information:

■ Office of Materials and Road Research

- ◆ <http://www.dot.state.mn.us/mnroad>

■ Road Research Section

- ◆ John Siekmeier 651-366-5417
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