MnPAVE - Your Guide to Better Pavement Design

Minnesota Department of Transportation

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

Mn/DOT
Office of Materials and Road Research

MINNESOTA DEPARTMENT OF TRANSPORTATION

Outline of Presentation

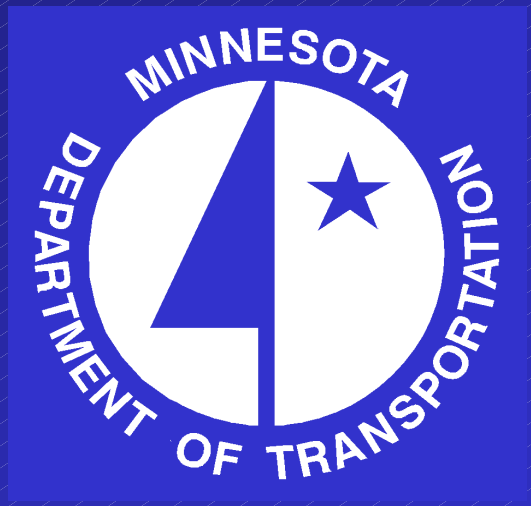
- **Background**
- **Overview of Development**
  - Structural model
  - Modulus testing
- **Beta Software Demo**

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

Minnesota Local Road Research Board



Motivation

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

Mechanistic-Empirical Design

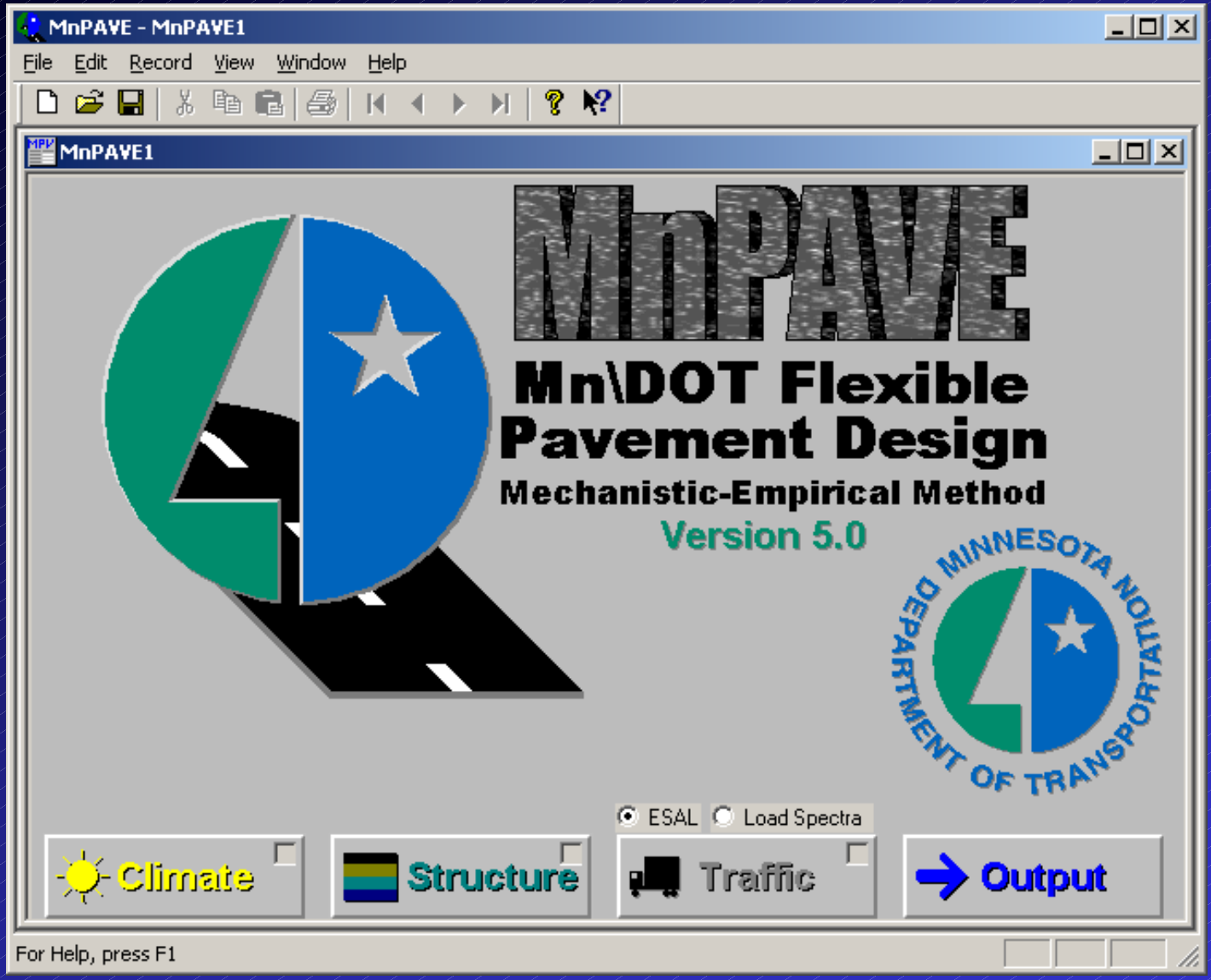
- **Potential of M-E methods:**
  - Ability to adapt to different distress modes
  - Allow better materials tests and characterization
    - Quantify and show benefit of improved materials and specifications
  - Adapt to changing load limits and configurations
  - Achieve agreement between structural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

Project Timeline

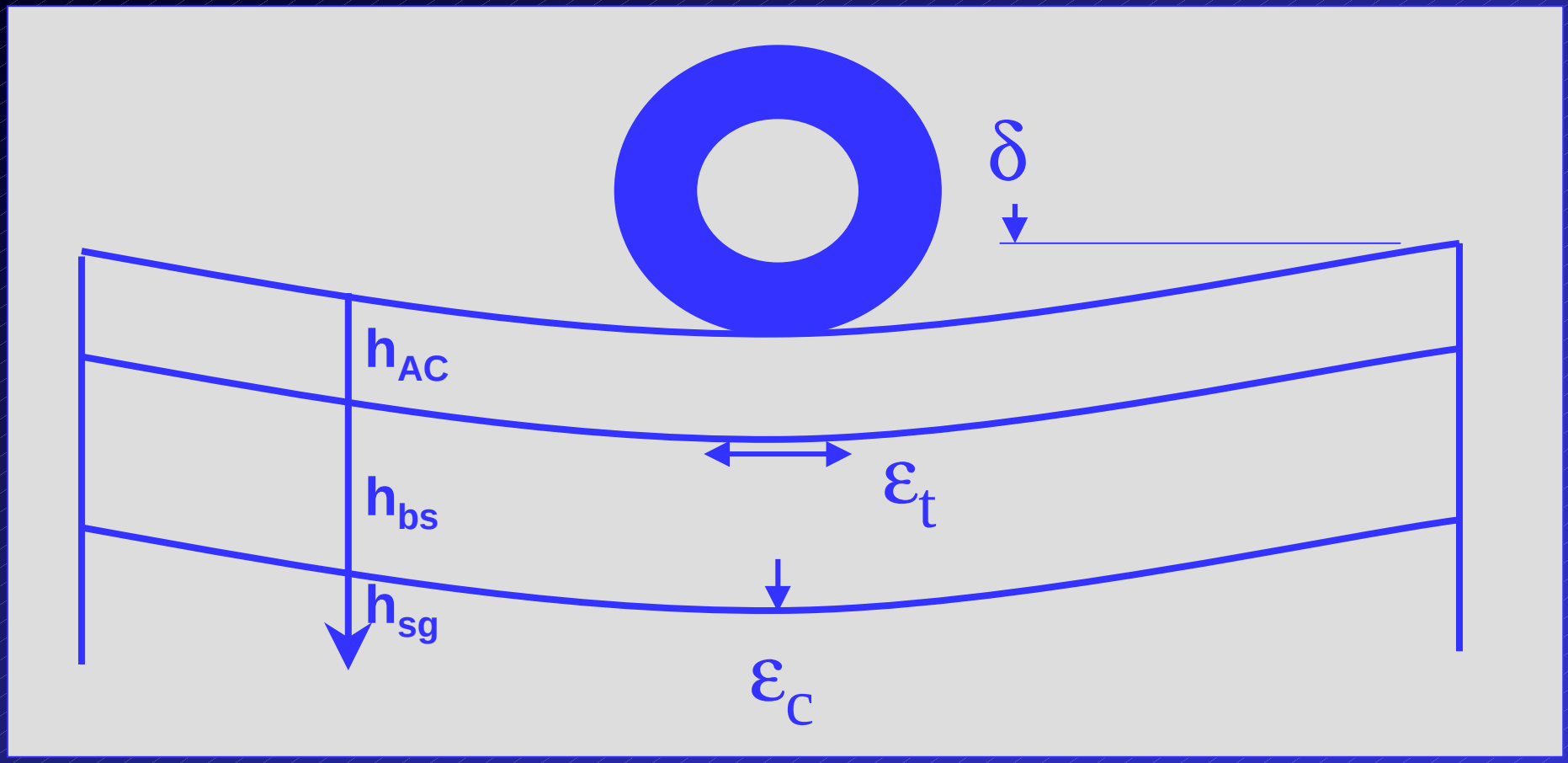
- **Timeframe for completion, implementation**
  - Fully operational MnPAVE software — Mar 2001
  - User training starts — Jun 2001
  - Incorporate user feedback, calibrated MnPAVE — Dec 2001
  - M-E design adopted as Mn/DOT's procedure — Dec 2002
  - Evaluate AASHTO 2002 procedure, incorporate features 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**

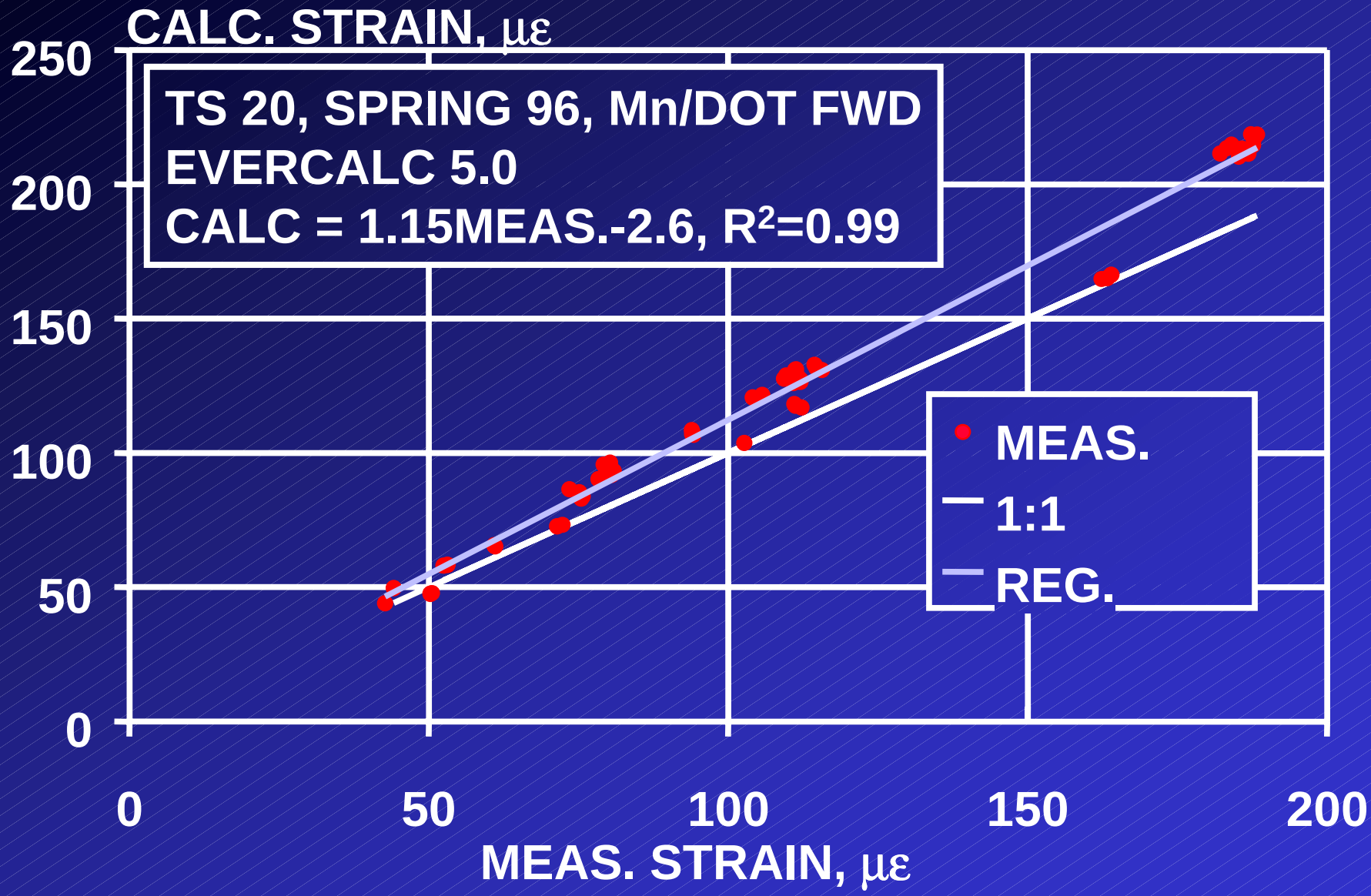

MnPAVE - MnPAVE1
File Edit Record View Window Help
MnPAVE1
MnPAVE
Mn\DOT Flexible Pavement Design
Mechanistic-Empirical Method
Version 5.0
MINNESOTA DEPARTMENT OF TRANSPORTATION
ESAL
Load Spectra
Climate
Structure
Traffic
Output
For Help, press F1

Structural Model

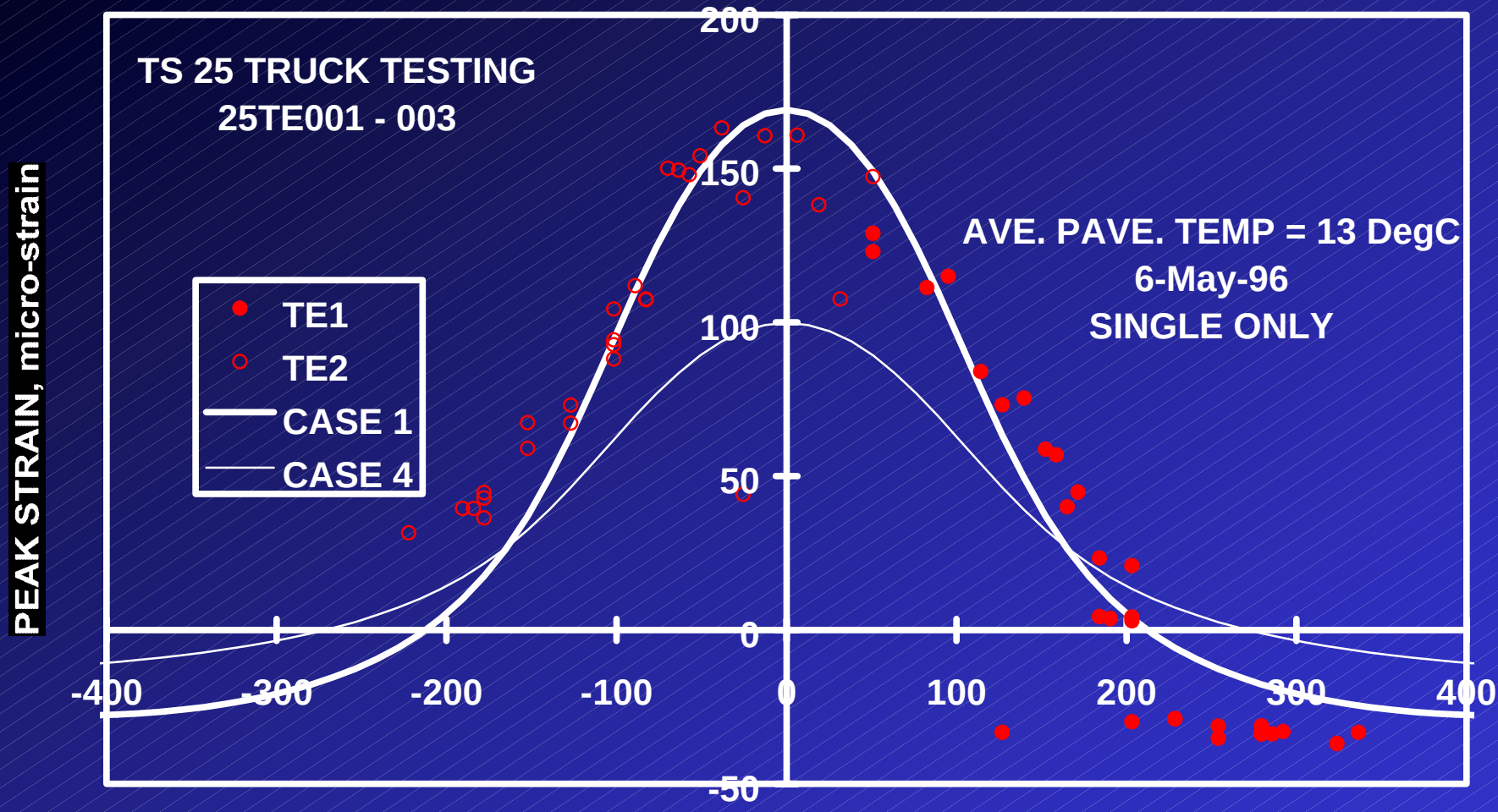


Based on the assumption that pavement can be modeled as a multi-layered elastic structure.

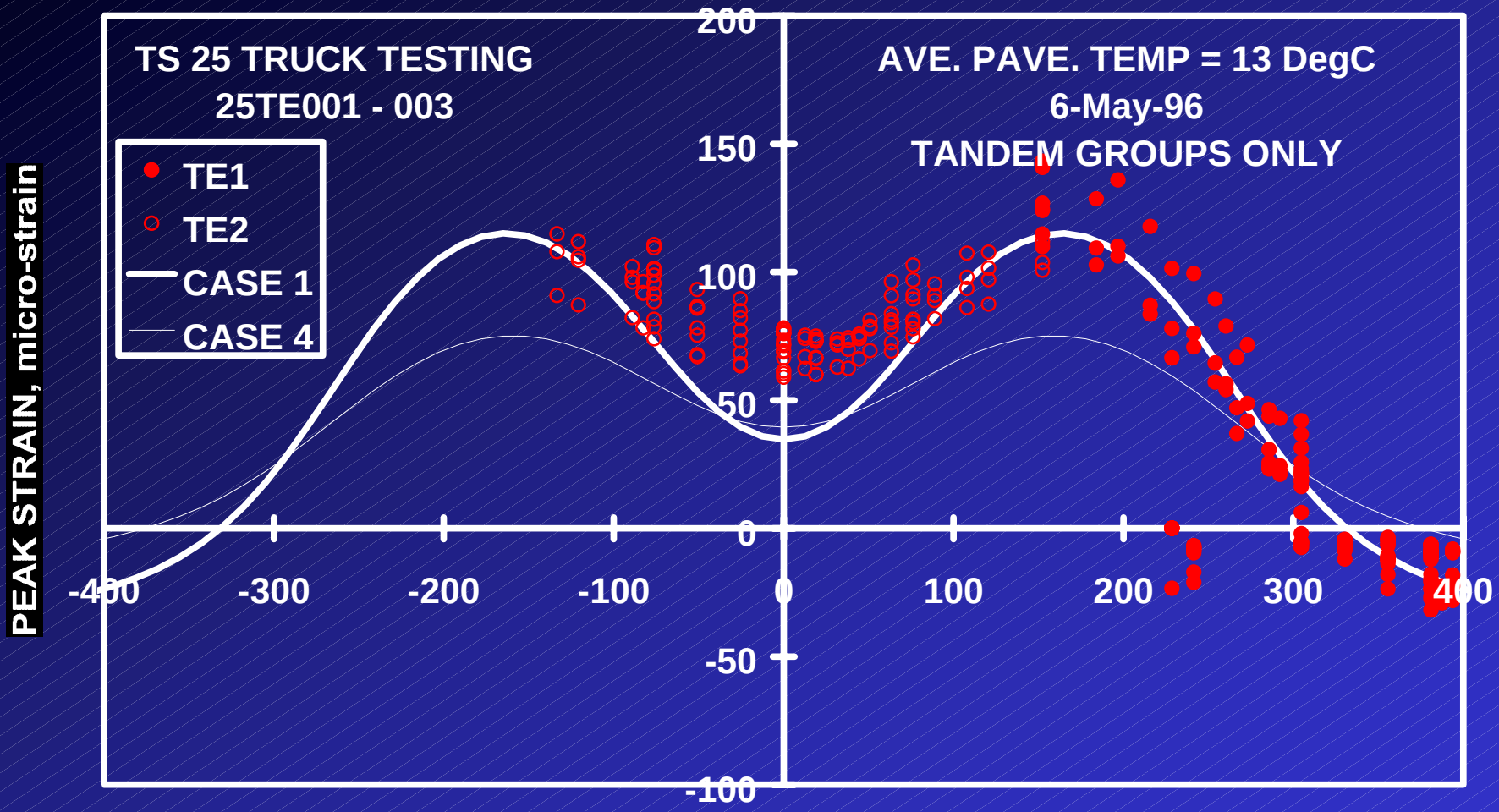
CALCULATED vs. MEASURED STRAINS



DISTRIBUTION OF STRAINS



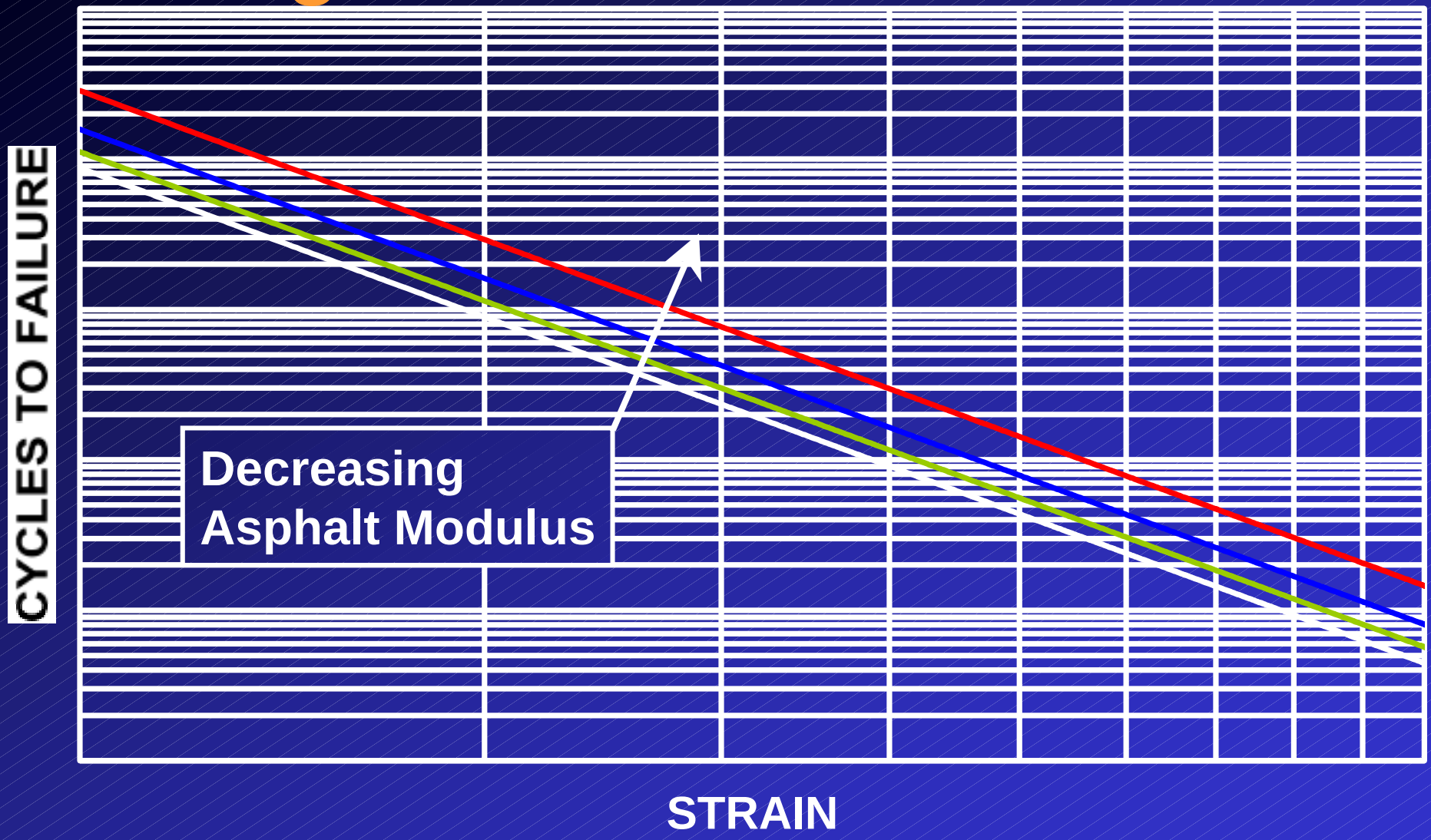
DISTRIBUTION OF STRAINS



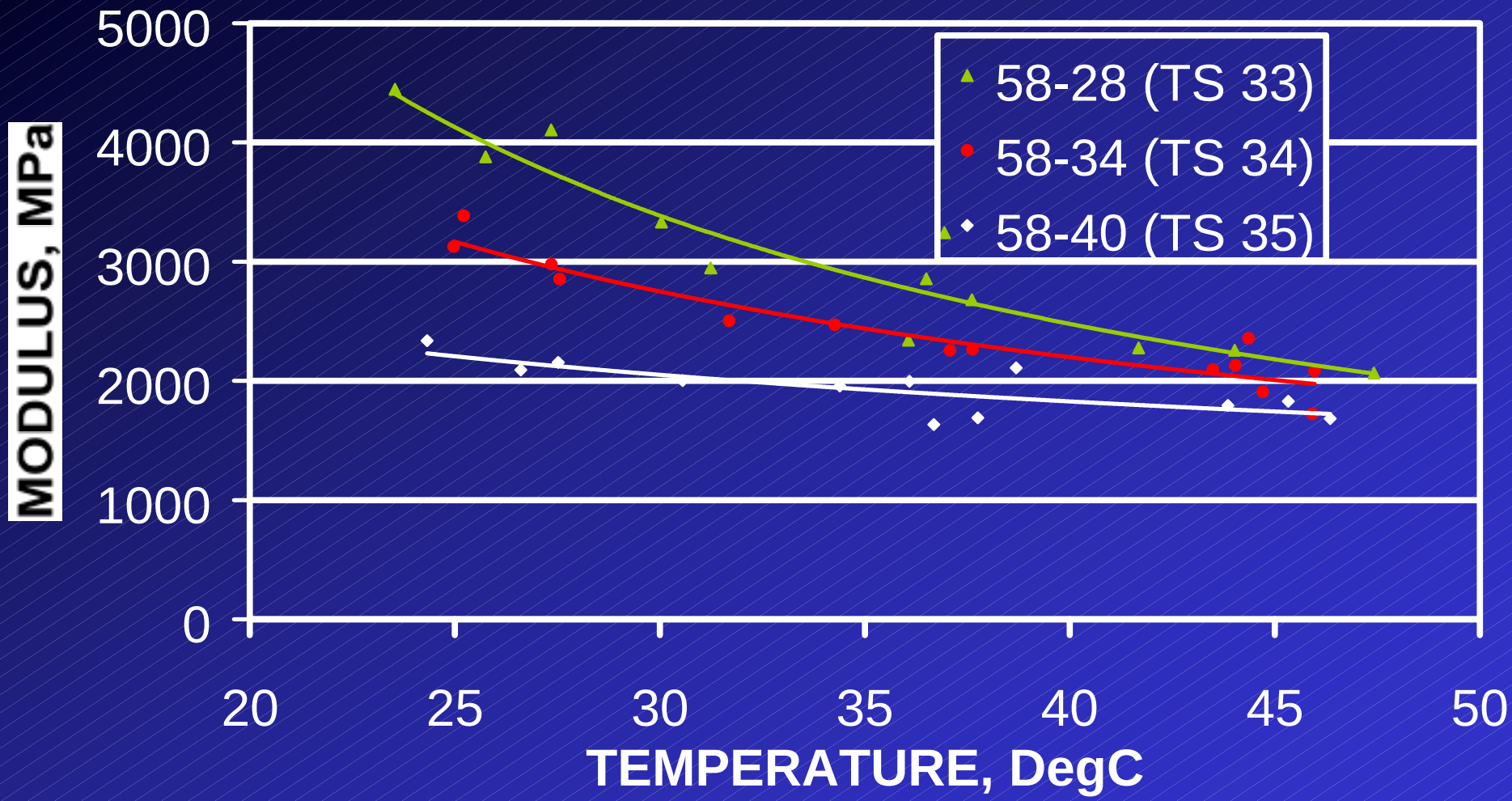
Transfer Functions

- **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

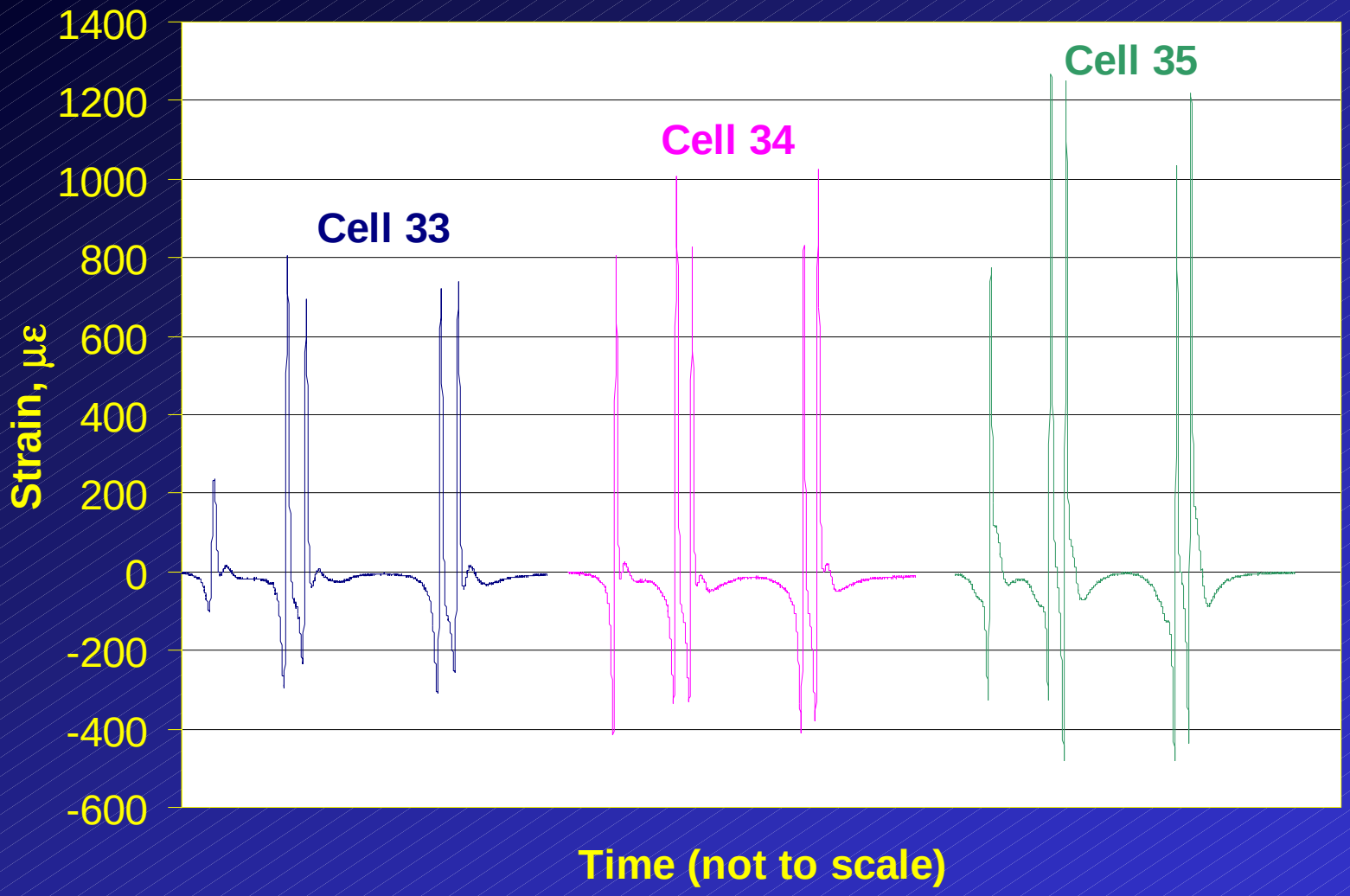


HMA MODULUS vs. TEMPERATURE



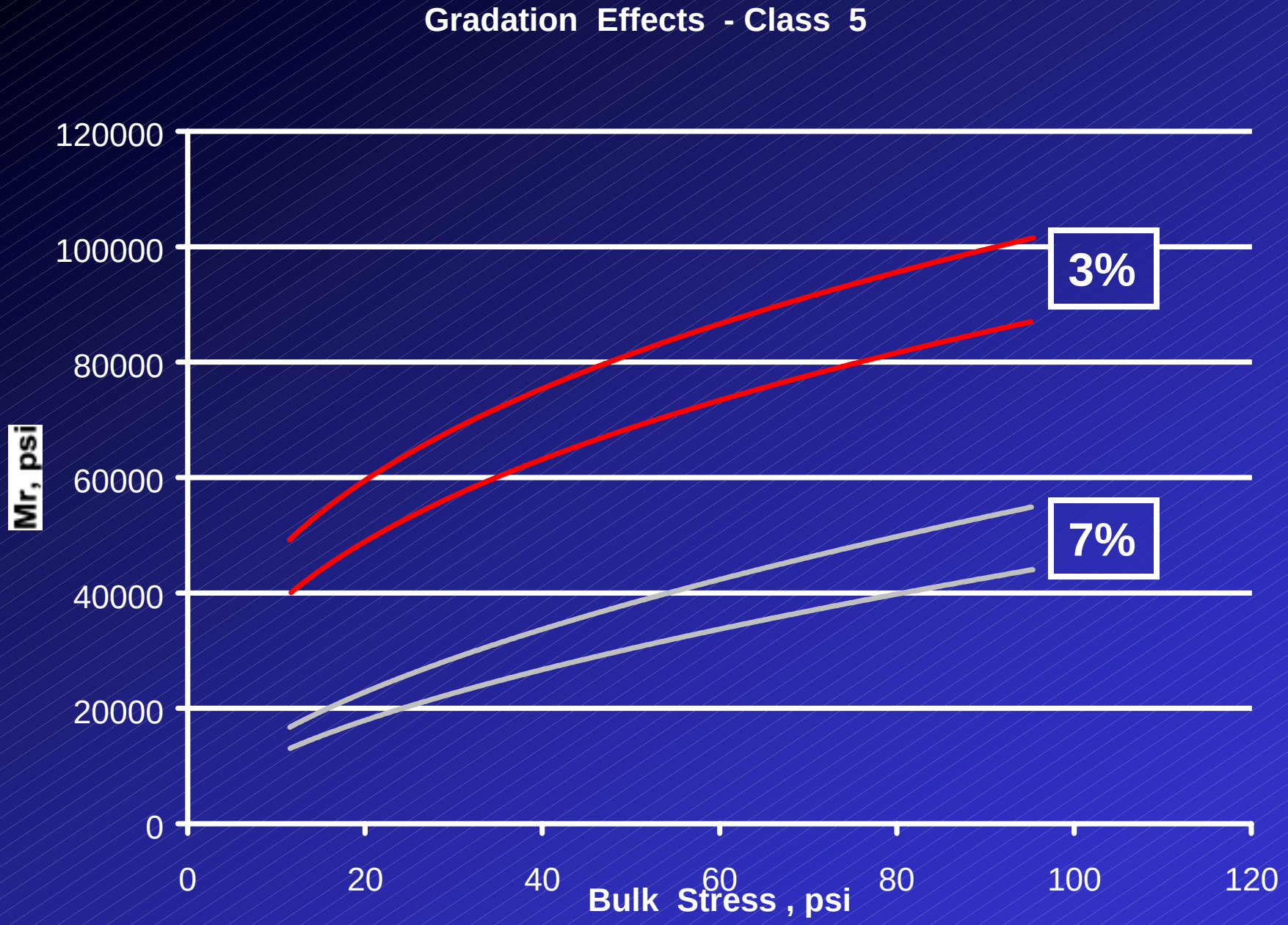
Longitudinal Strain in Mn/ROAD Superpave Cells

May 22, 2000 1:00 p.m.

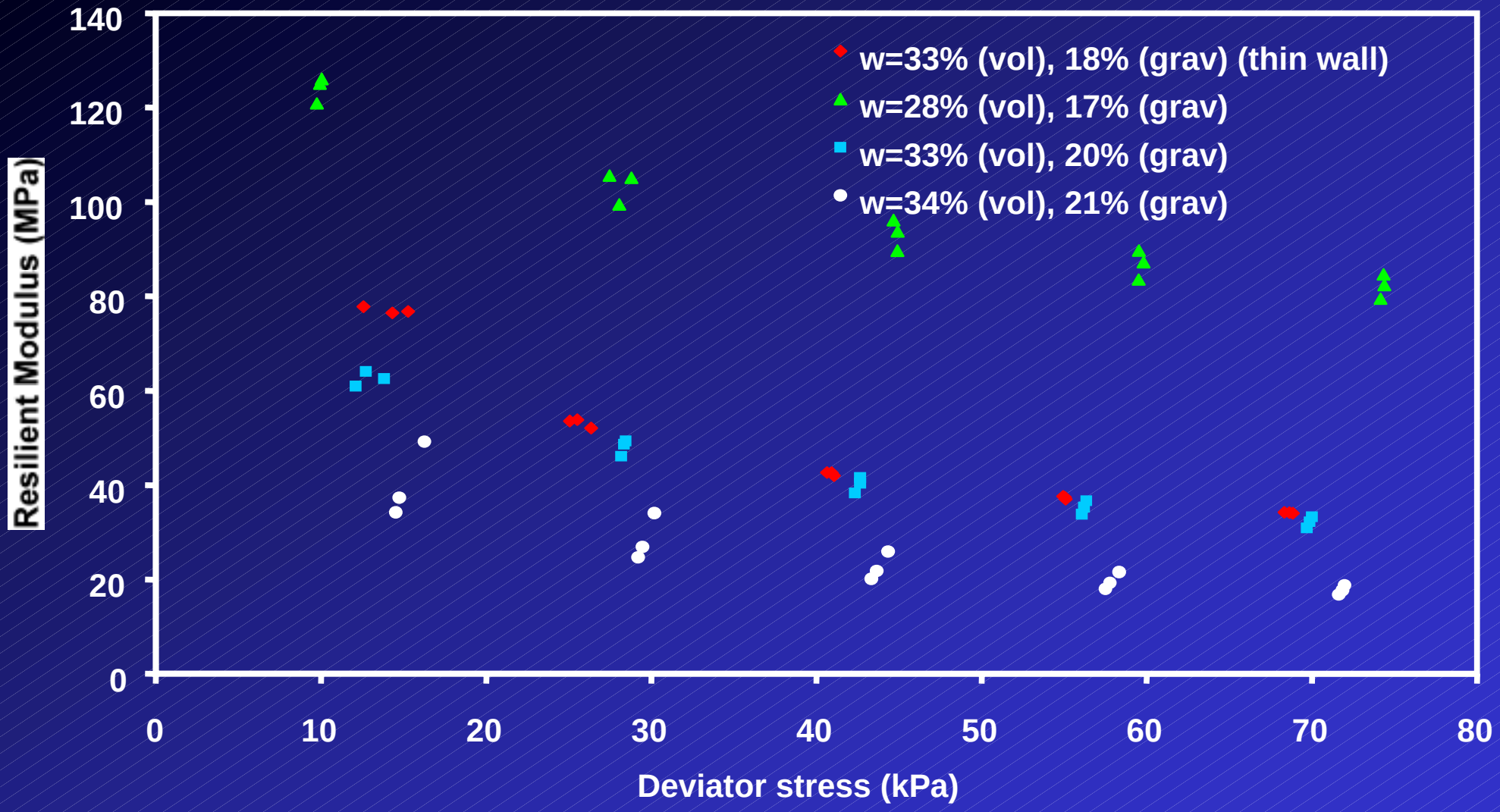


Triaxial Testing System

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


Gradation Effects - Class 5
120000
100000
80000
60000
40000
20000
0
Mr, psi
3%
7%
0
20
40
60
80
100
120
Bulk Stress , psi

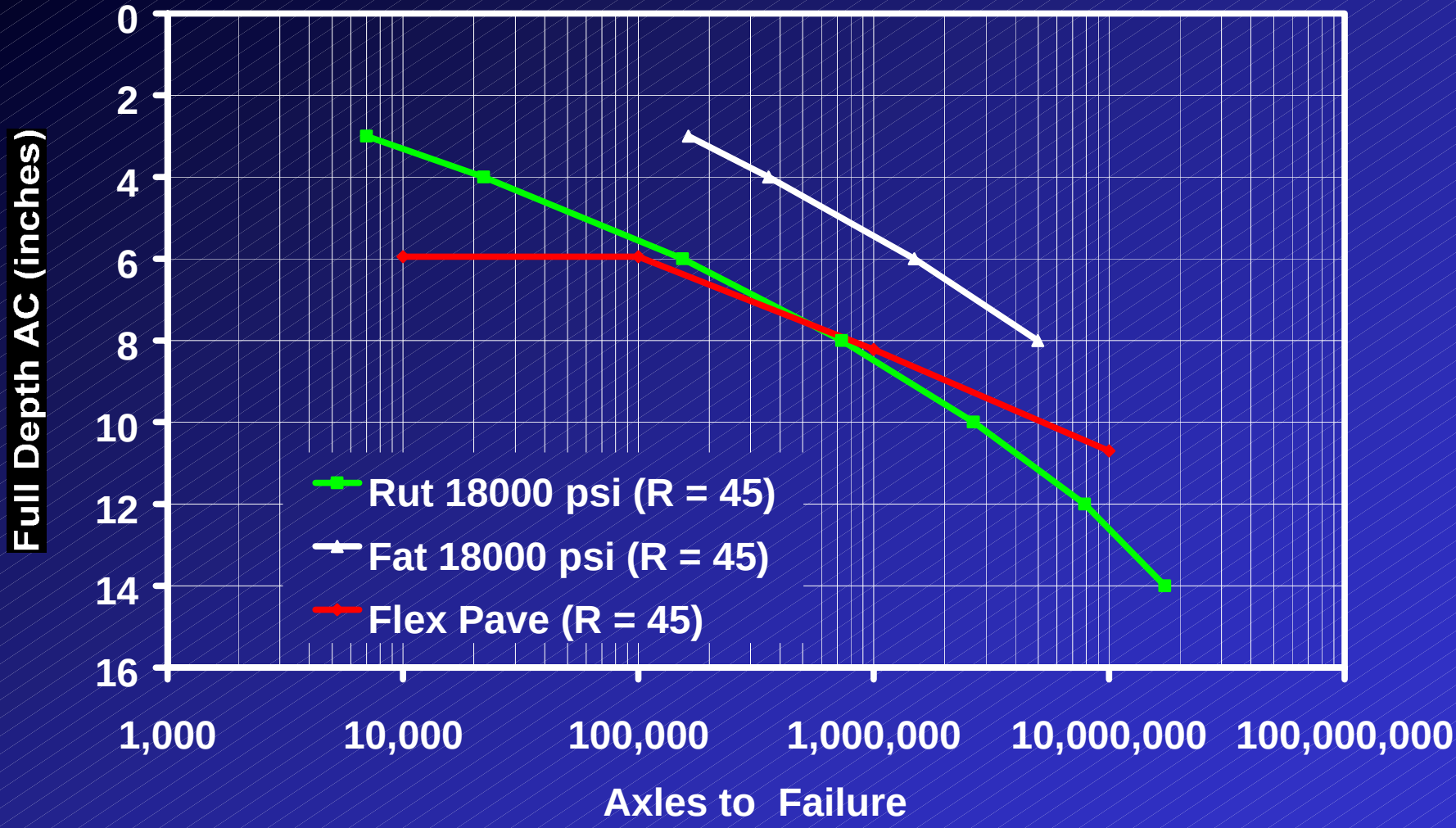
Effect of Moisture and Density on Soil Modulus



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
  - Bruce Tanquist 651-366-5422
  - Ruth Roberson 651-296-7349