Superpave Support and Performance Models Management

NCHRP 9-19

Pursuit of the Simple Performance Test AC Rutting

AAPT Symposium Session

Tuesday 19 March 2002

Colorado Springs, Colorado

Simple Performance Tests

- ***Desired Fundamental Material Response Parameter***
- ***Another Type of Empirical Test Not an Option***

Candidate Simple Performance Tests

- **(12) Stiffness and Deformation/Strength Related Tests**

- *Rutting Stiffness*
  - *Dynamic (Complex) Modulus* - *ASU*
  - *Dynamic (Wave Propogation) Modulus* - *ASU*
  - *Predicted Stiffness from Material Properties* - *ASU*
  - *SST-G* Complex Modulus* - *AAT*
  - *G*-Field Shear Tester* - *UMD*
- *Rutting Deformability*
  - *Triaxial Shear Strength* - *ASU*
  - *Repeated Load Permanent Deformation (Triaxial)* - *ASU*
  - *Repeated Shear Permanent Deformation* - *Hertiage*
  - *Static Creep / Flow Time* - *ASU*
- *Cracking*
  - *Indirect Tensile (Strength, Creep, Fatigue)* - *ASU*
  - *Dynamic (Complex) Modulus* - *ASU*

- **Over 80 Test Response Parameters**

Experimental Sites
18 AC Mixtures Evaluated

MnRoad

WesTrack

FHWA-ALF

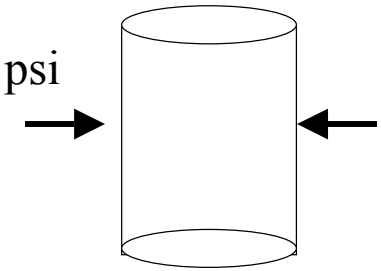
NCHRP 9-19 SPT Study Results

- ***Ancilliary Studies***
  - Specimen Size-Geometry
  - Optimal Instrumentation Set-up
  - Impact of Specimen Diameter
  - Sensitivity Studies
  - E*(uniaxial) versus E*(flex)
  - Flow Measurement Systems (Vert; Radial;Actuator)
- ***Top AC Rutting Candidate Tests***
  - E* Complex Modulus
  - Fn Flow Number
  - Ft Flow Time

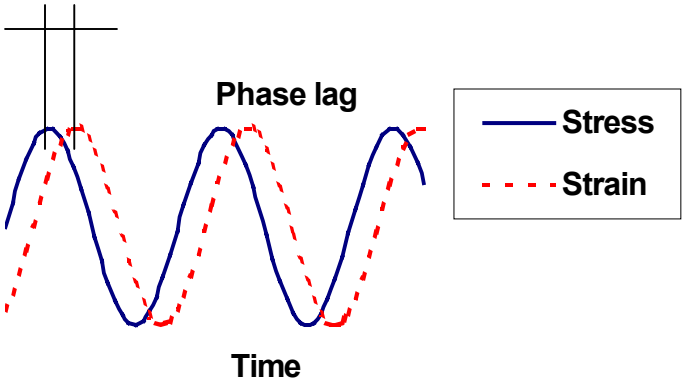
E -- Triaxial Complex Modulus Testing*

3 to 200 psi

0, 20,30 psi

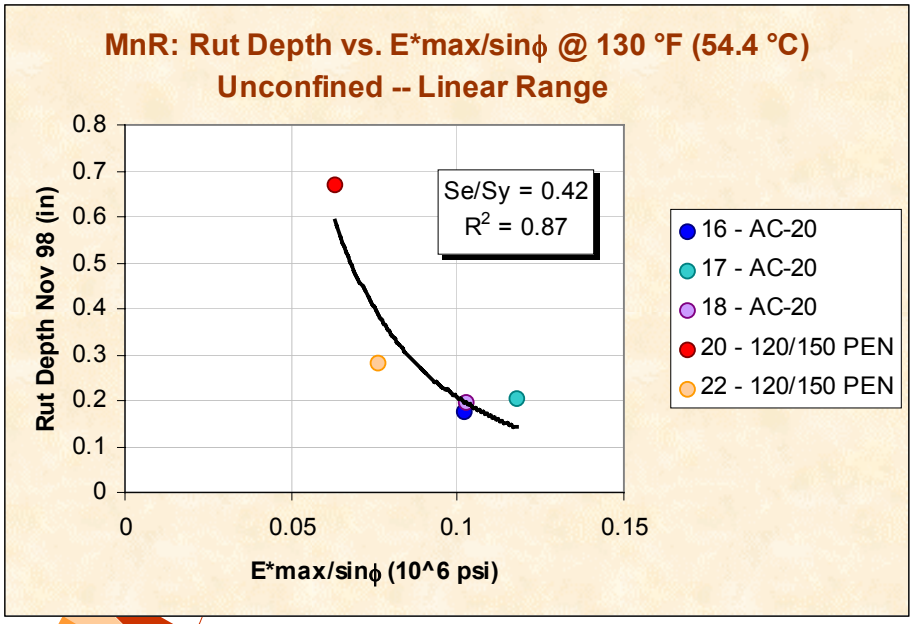


Phase Lag in Dynamic Loading



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

$E^*_{max}/\sin\phi$ Linear Range



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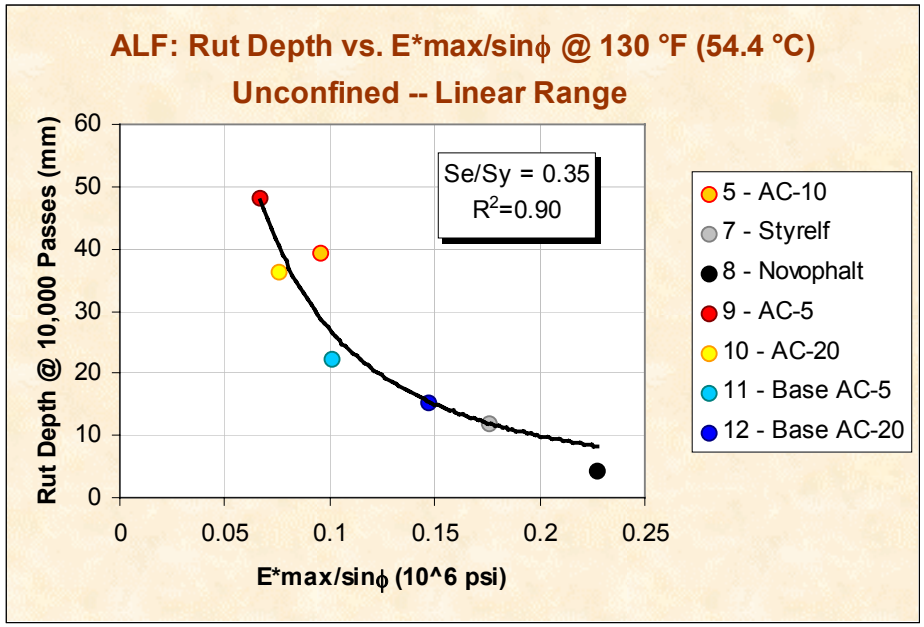
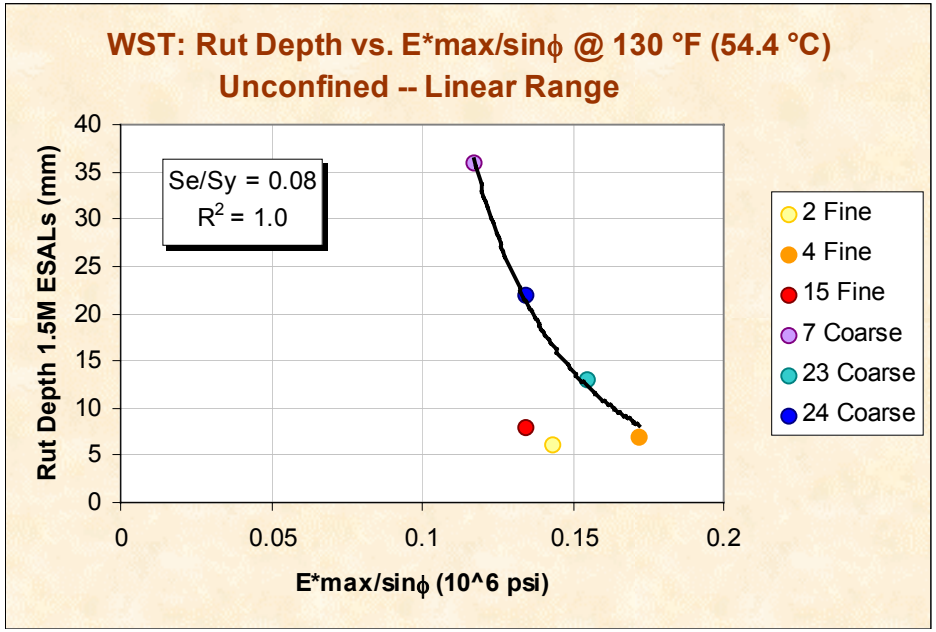
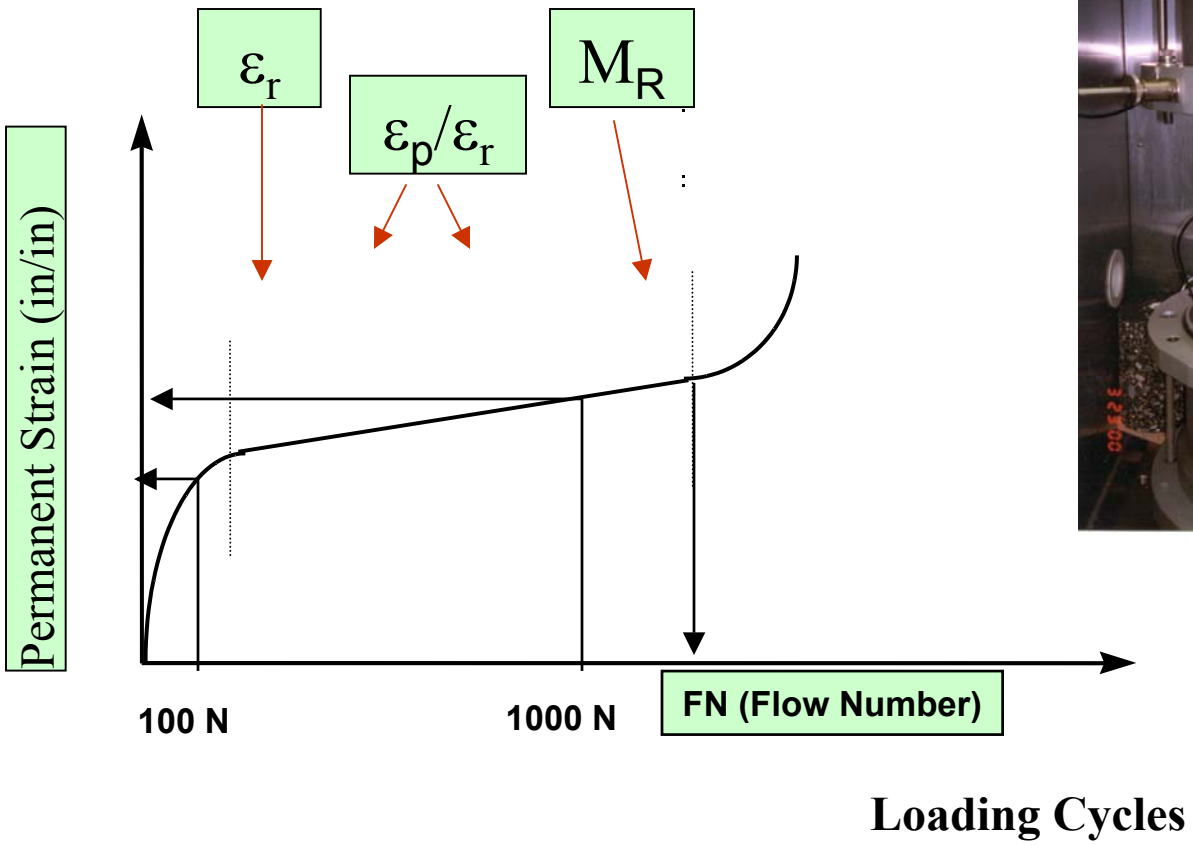


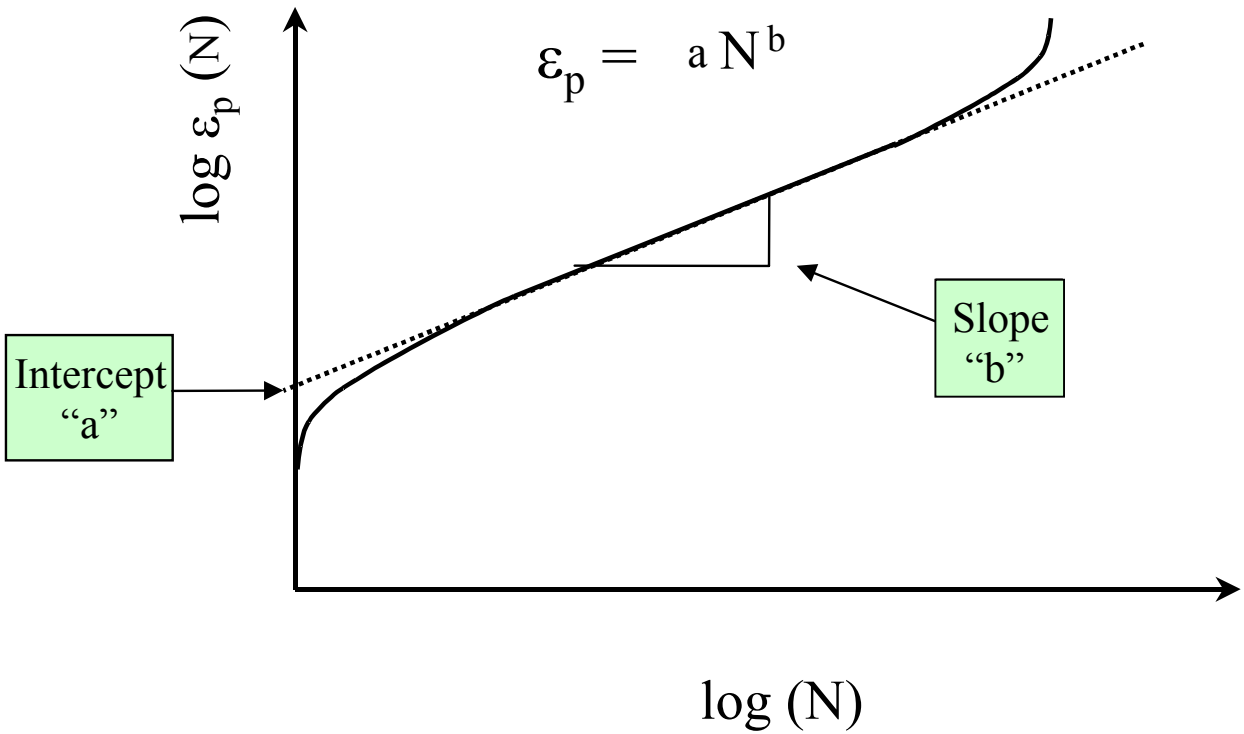
$E^*_{max}/\sin\phi$ Linear Range



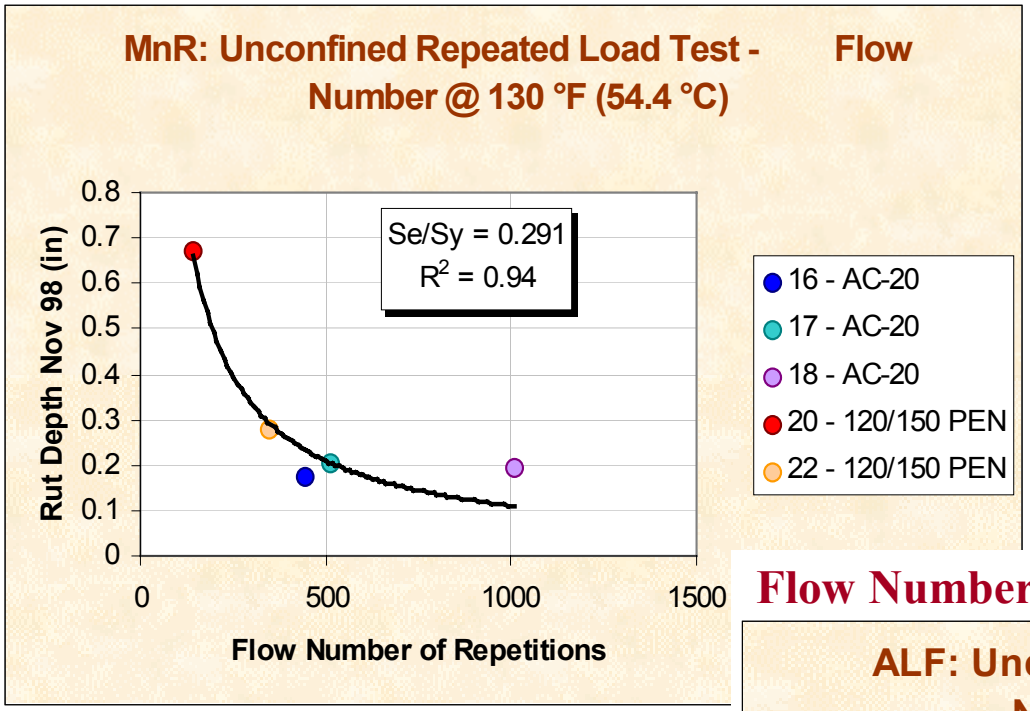
Repeated Load Permanent Deformation Test



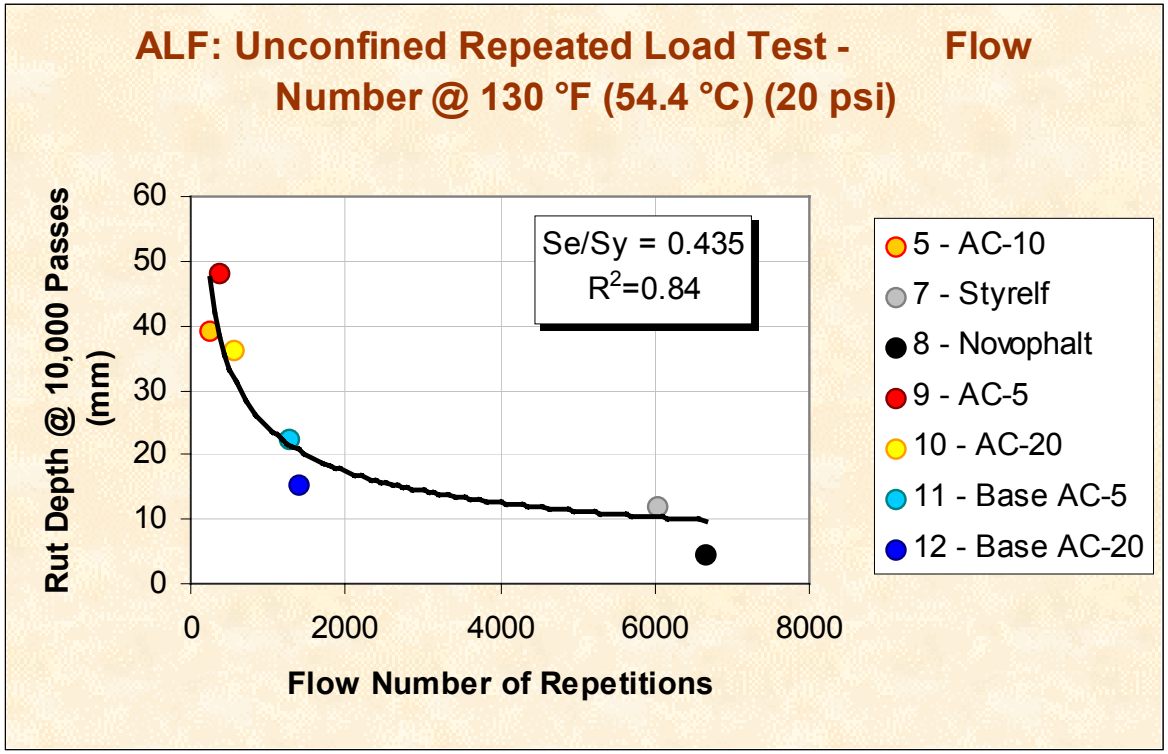
Permanent Deformation Test Parameters



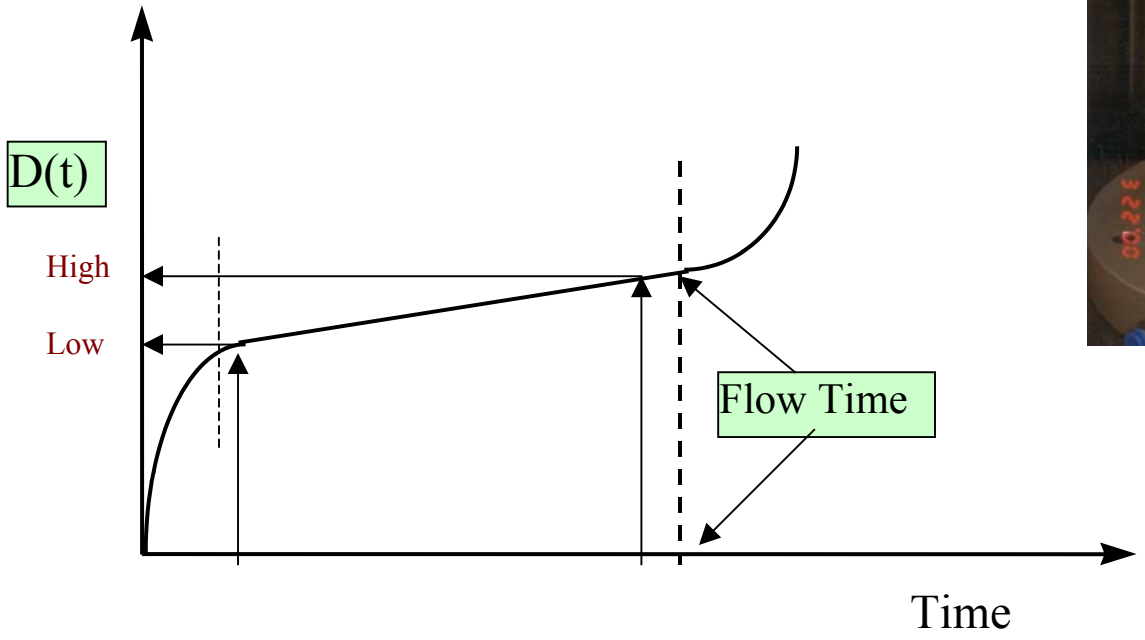
Flow Number



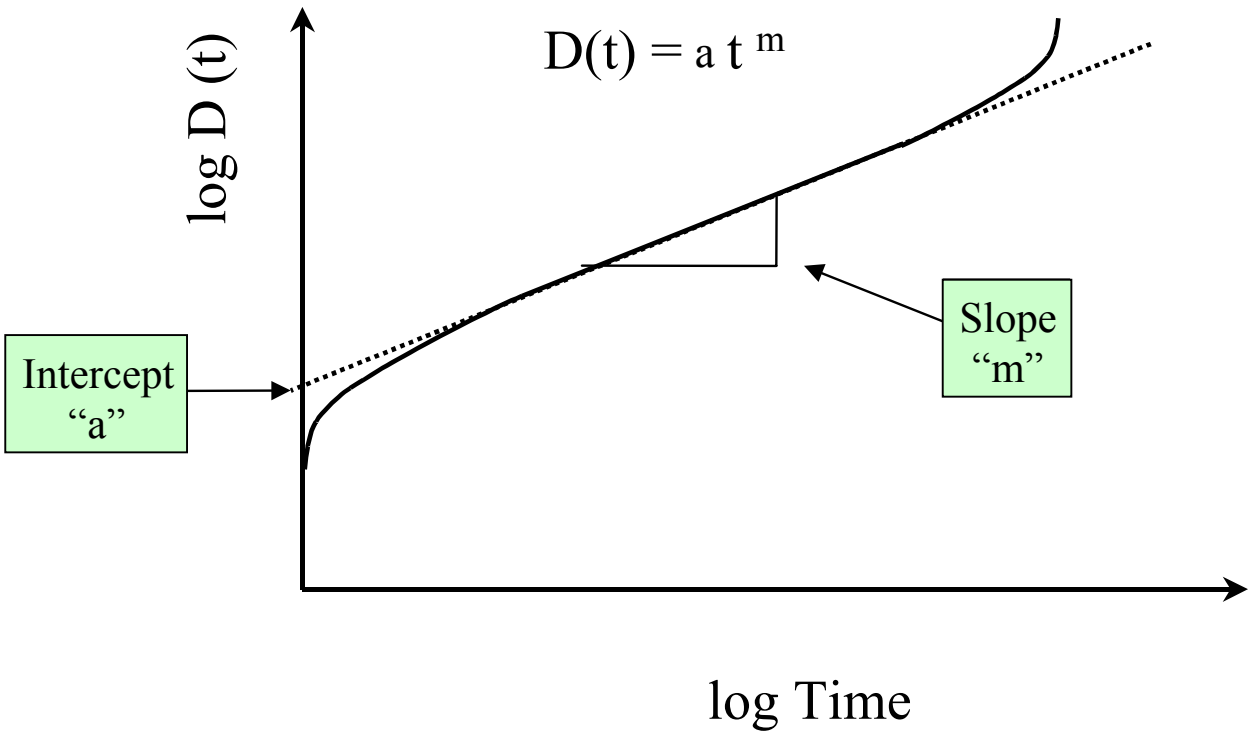
Flow Number



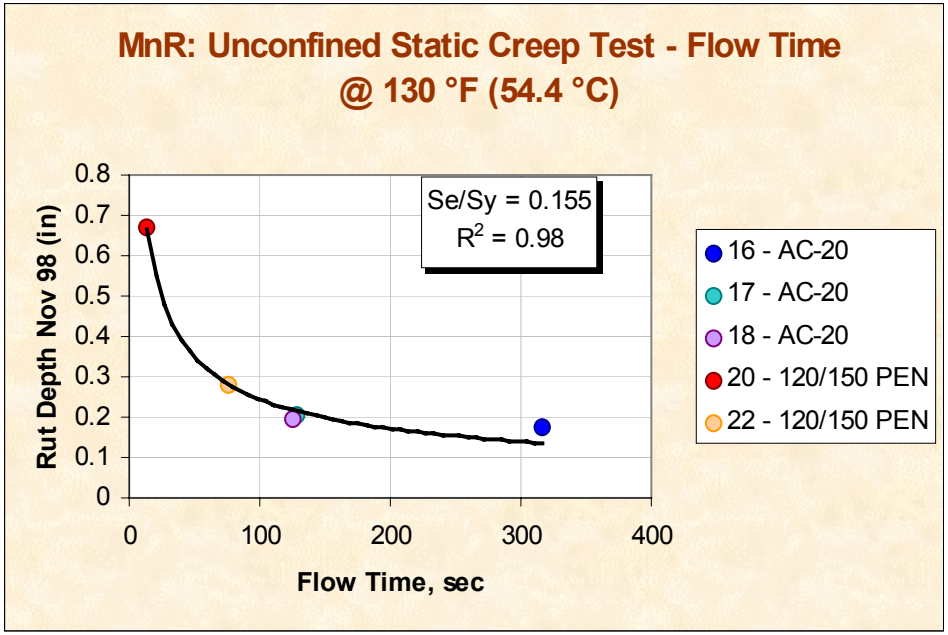
Creep - Flow Time Test



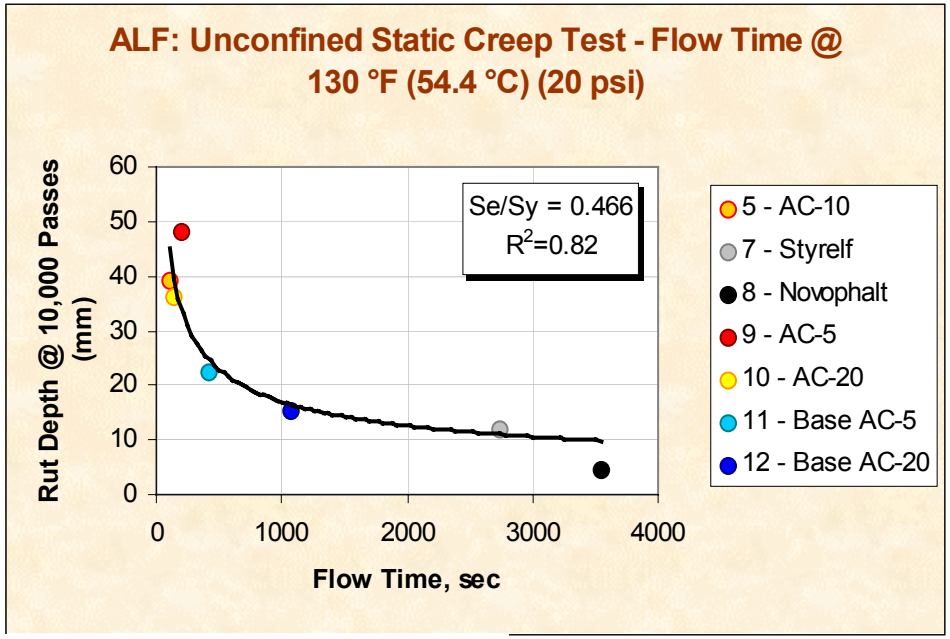
Creep Test Parameters



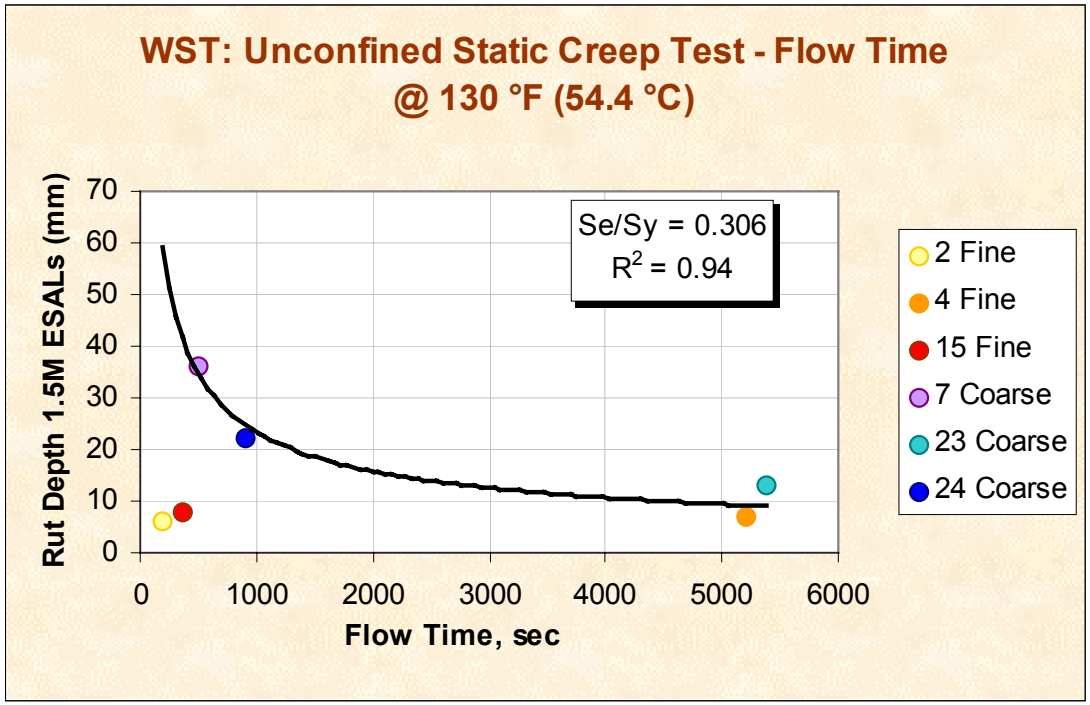
Flow Time



Flow Time



Flow Time



NCHRP 9-19 SPT Tests

- ***NCHRP 9-30 (Bonaquist et al)***
  - ***Developing prototype equipment for SPT***
  - ***Cost will be free market enterprise***
- ***MWW estimate***
  - ***$25-40 K Range***

Major Strength of NCHRP 9-19 SPT Research Approach

- ***Possible to Tie SPT Parameter Response to Accurate Estimate of Field Performance***
- ***Key Link is to Couple SPT Tests (NCHRP 9-19) to 2002 Design Guide (NCHRP 1-37A)***
- ***M-E 2002 Design Guide Distress Predictions***
  - ***Rutting (each layer material)***
  - ***Fatigue (surface down and bottom up)***
  - ***Thermal fracture***

USE OF SPT-E IN FIELD PERFORMANCE PREDICTION*

E* ⟶ Master Curve ⟶ Pavement Performance Model

yields σ, ε, δ of Pavement System

<u>AC Rutting Model</u> (2002 Design Guide)

$$\frac{\varepsilon p}{\varepsilon r} = \beta_{r_1} r_1 \, N^{\beta r_2 r_2} \, T^{\beta r_3 r_3}$$

where $\beta_{r1} r_1 = c_1$

$\beta_{r_2} r_2 = c_2$

$\beta_{r_3} r_3 = c_3$

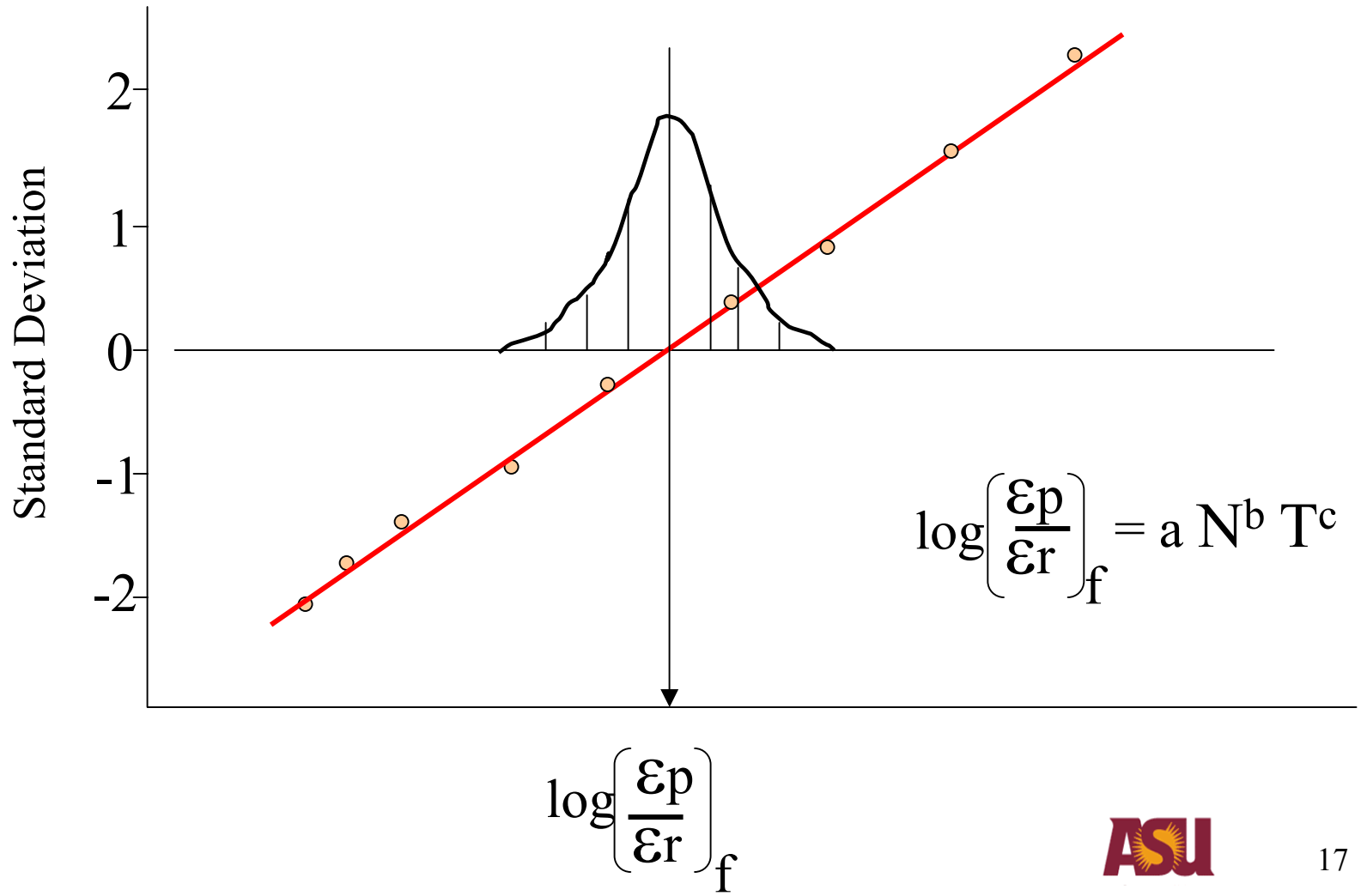
Nationally calibrated AC Permanent Deformation Model Constants

$$\varepsilon p = \varepsilon r \left[c_1 N^{c_2} \, T^{c_3} \right]$$

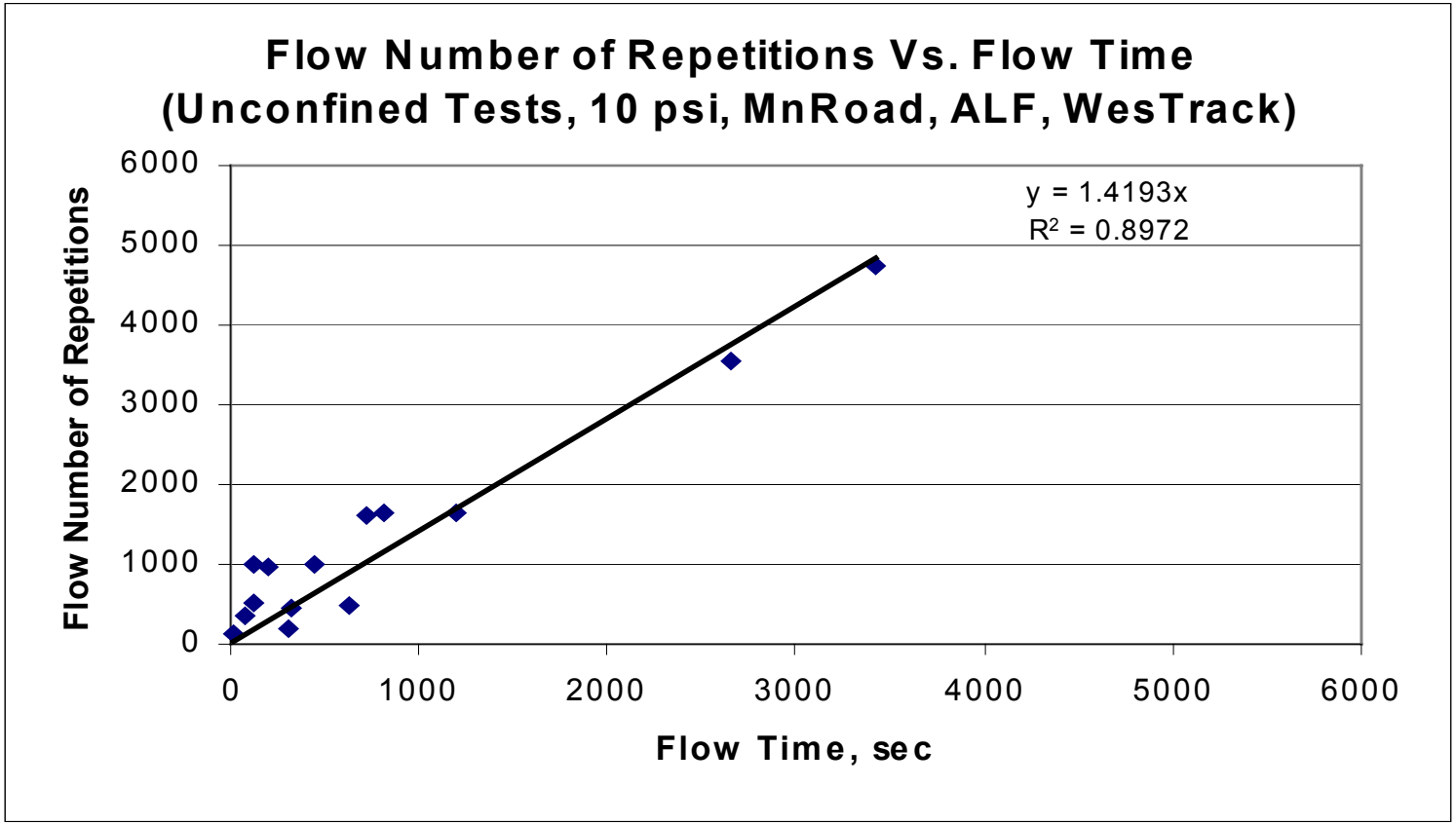
$$RDac = \int_{Z=Z_1}^{Z_2} \varepsilon p \, dz$$

Numerical Integration

USE OF SPT-Fm IN FIELD PERFORMANCE PREDICTION



USE OF SPT-Ft IN FIELD PERFORMANCE PREDICTION



Relationship between Fm and Ft will allow Fm Field Performance Methodology to be Directly correlated to Ft – Flow Time

SUMMARY AND CONCLUSIONS OF NCHRP 9-19 STUDY

- ***Top SPT Candidates Appear to Have Potential to Tie Mix Design Directly to Structural Field Performance Through 2002 Design Guide***

- ***Final Feasibility , Recommended Approach, Final Test Protocol and Implementation Criteria Should be Finished by December 2002***