NCHRP Projects 9-25 & 9-31: Volumetrics and Performance

NEAUPG Meeting

October 23, 2003

Advanced Asphalt Technologies, LLC

"Engineering Services for the Asphalt Industry"

NCHRP Project 9-25 and 9-31

- NCHRP Project 9-25
  - VMA, VFA, film thickness
  - Rutting, fatigue cracking, age hardening
- NCHRP Project 9-31
  - Air voids/Performance
  - Coordinated with 9-25
- Scheduled completion in March 2004

Superpave Problems…

- Surface cracking and raveling, especially for lean 12.5-mm mixes
- Rapid rutting in limited cases: Westrack—coarse gradations/high VMA
- High permeability and related problems

Purpose/Scope

- Variations in climate, traffic, materials and specifics of SHRP implementation
- Focus on effects of changes in volumetrics on performance-related properties
- Fatigue resistance, rut resistance and permeability

Laboratory Testing

- Four mixtures
- Coarse gradation & dense or fine
- Optimum, ±1 % binder
- PG 64-22, some PG 76-18, PG 58-28
- N-design 50, 75, 100, 125
- Wide range of volumetrics—often "outside the box"

Laboratory Testing

- Repeated shear at constant height
- Strength tests
  - Unconfined compression
  - Indirect tension
- Aggregate & mixture permeability
- Age-hardening: LTOA/FST
- Uniaxial fatigue at 20 C & 4 C

Summary of Findings

- Fatigue resistance increases with increasing voids filled (VFA)
- Rut resistance a function of aggregate fineness relative to VMA (resistivity)
- Permeability decreases with decreasing voids and increasing aggregate fineness
- Age hardening decreases with decreasing permeability

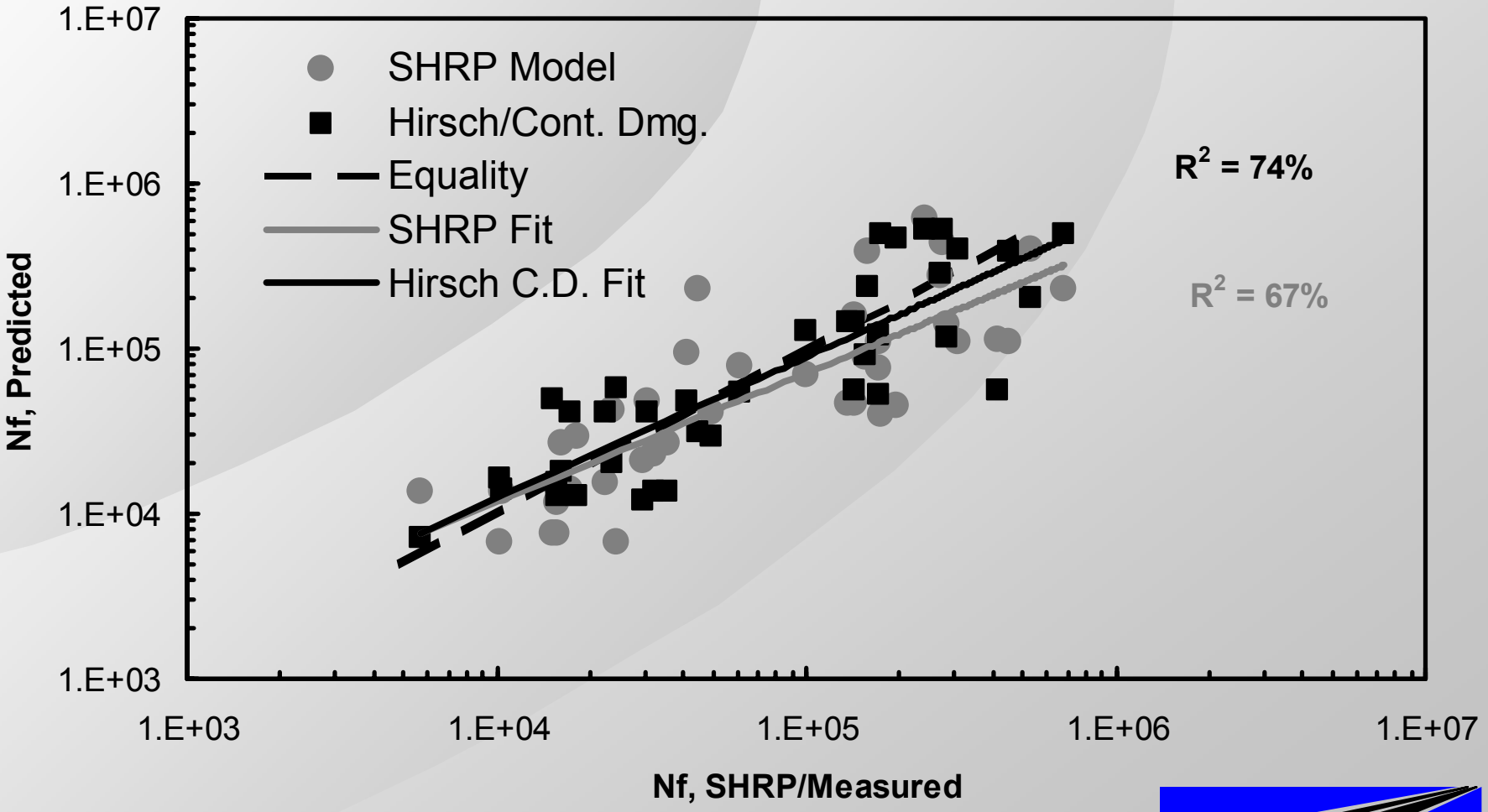
Performance/Volumetric Models

- Fatigue
  - Continuum damage testing & analysis
  - Simplify resulting relationship/verify
- Rutting
  - Resistivity: aggregate structure and binder viscosity
  - Verification
- Permeability: voids and aggregate fineness

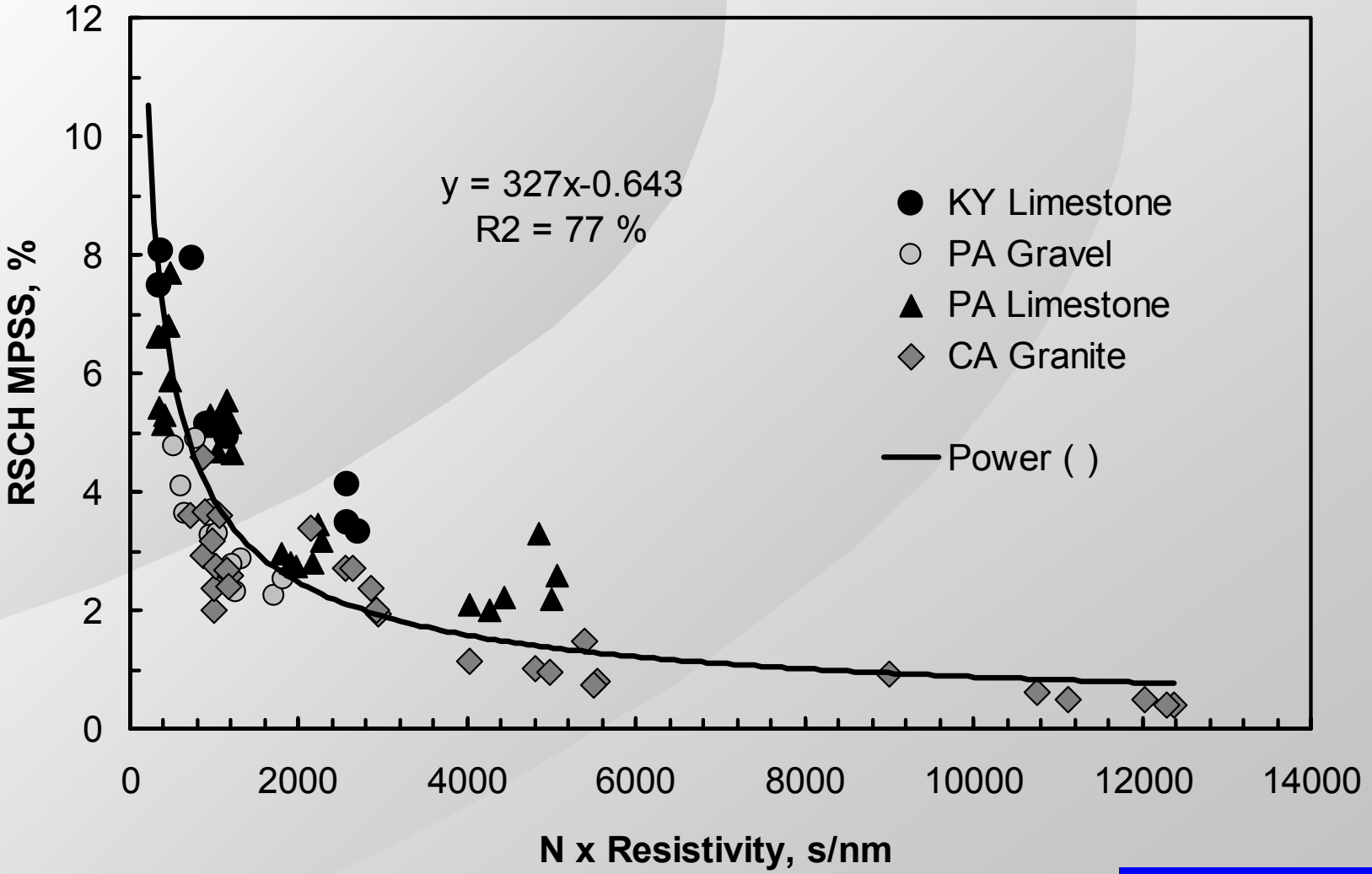
Equations

- $N_f = 0.035\ f\ \varepsilon_0^{-4}\ |E^*|^{-2.113}\ VFA^{1.728}\ R^{4.62}$
- $P = 2\eta\rho_a^2 SS^2 / VMA^3 \gamma_w$
- $K = 547\ (VTM\ /\ SS) - 656$

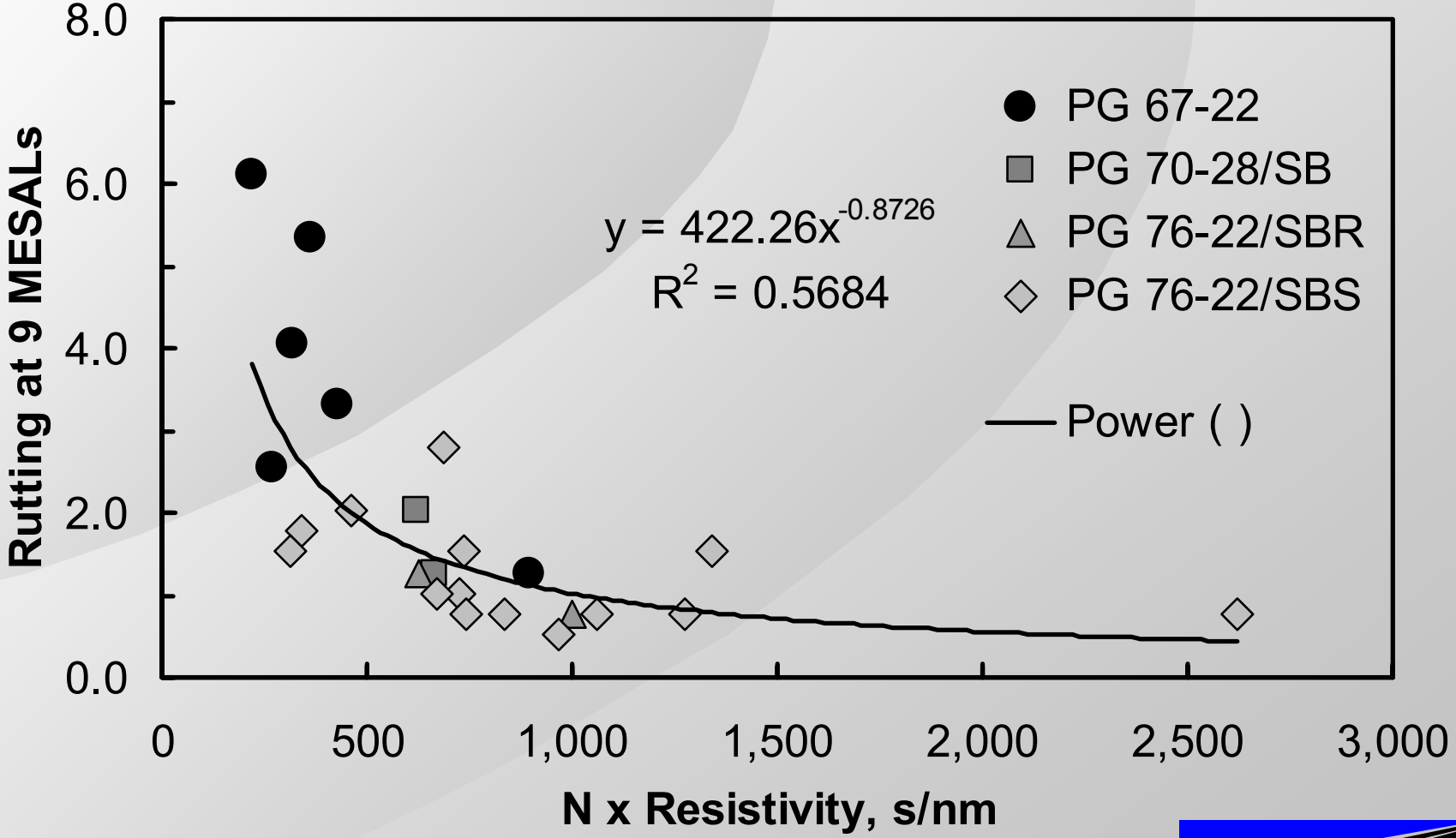
Fatigue Model Verification: SHRP Data



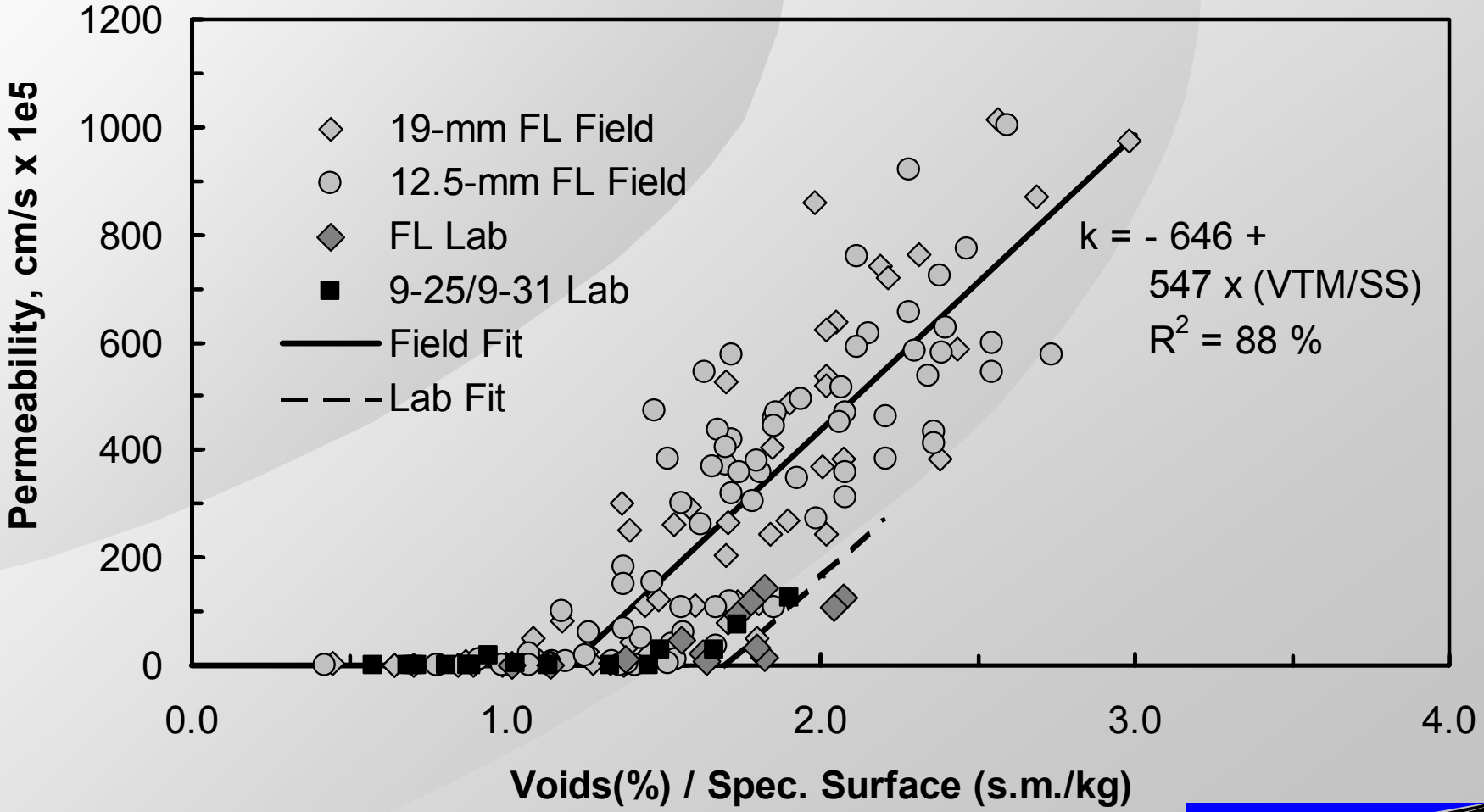
Resistivity and Rut Resistance



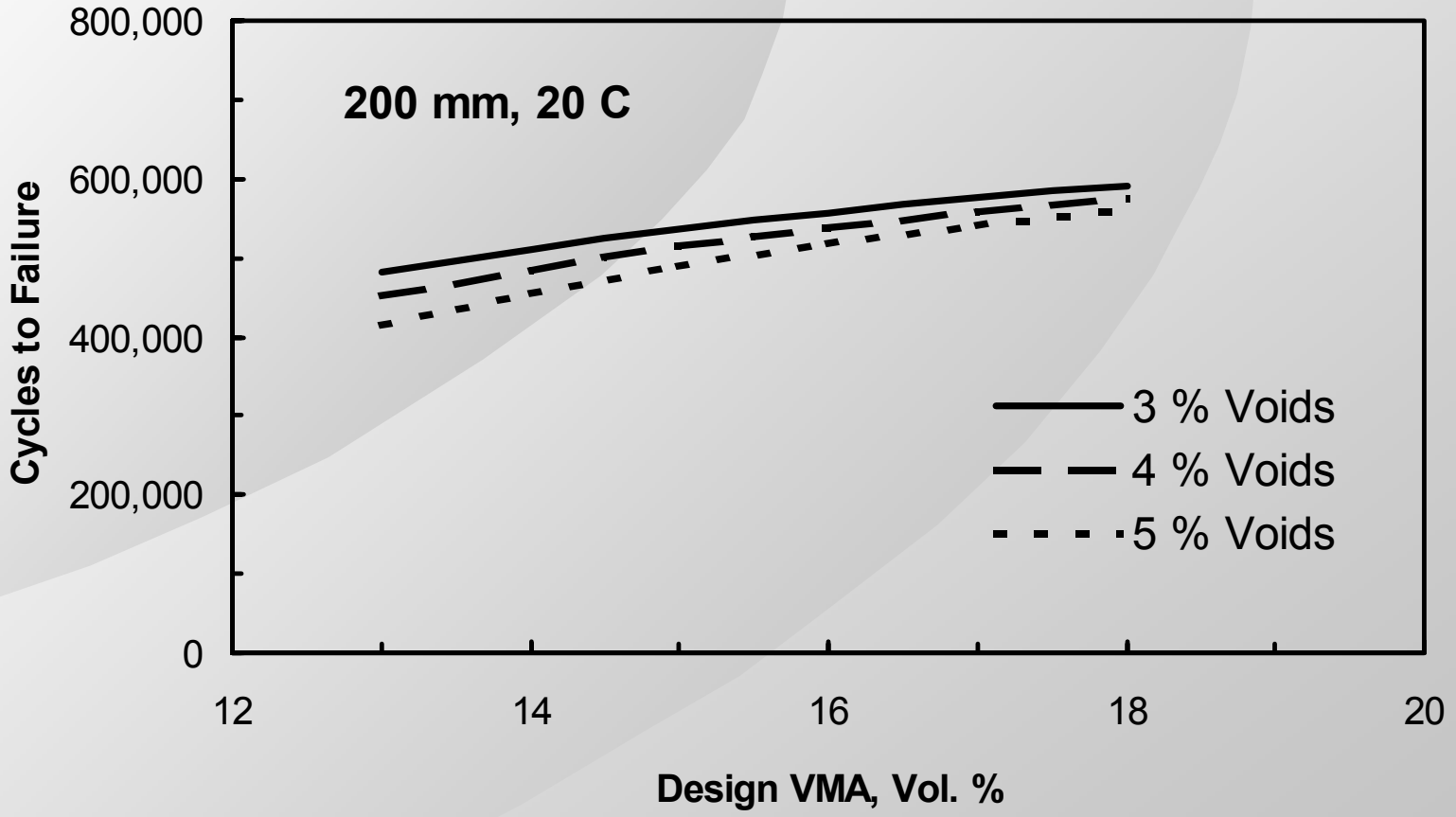
Resistivity Verification: NCAT Test Track



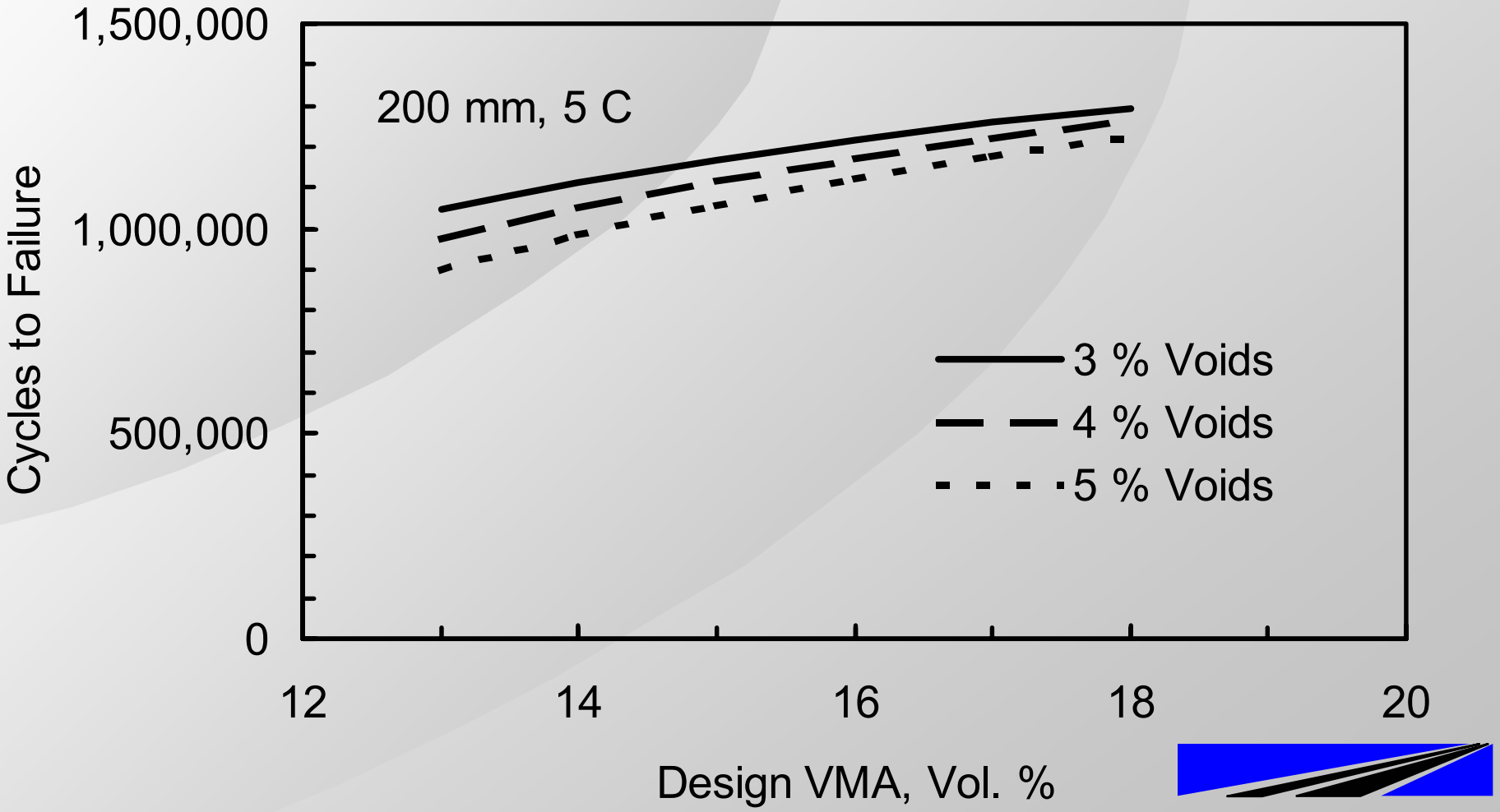
Permeability, Voids and Aggregate Fineness



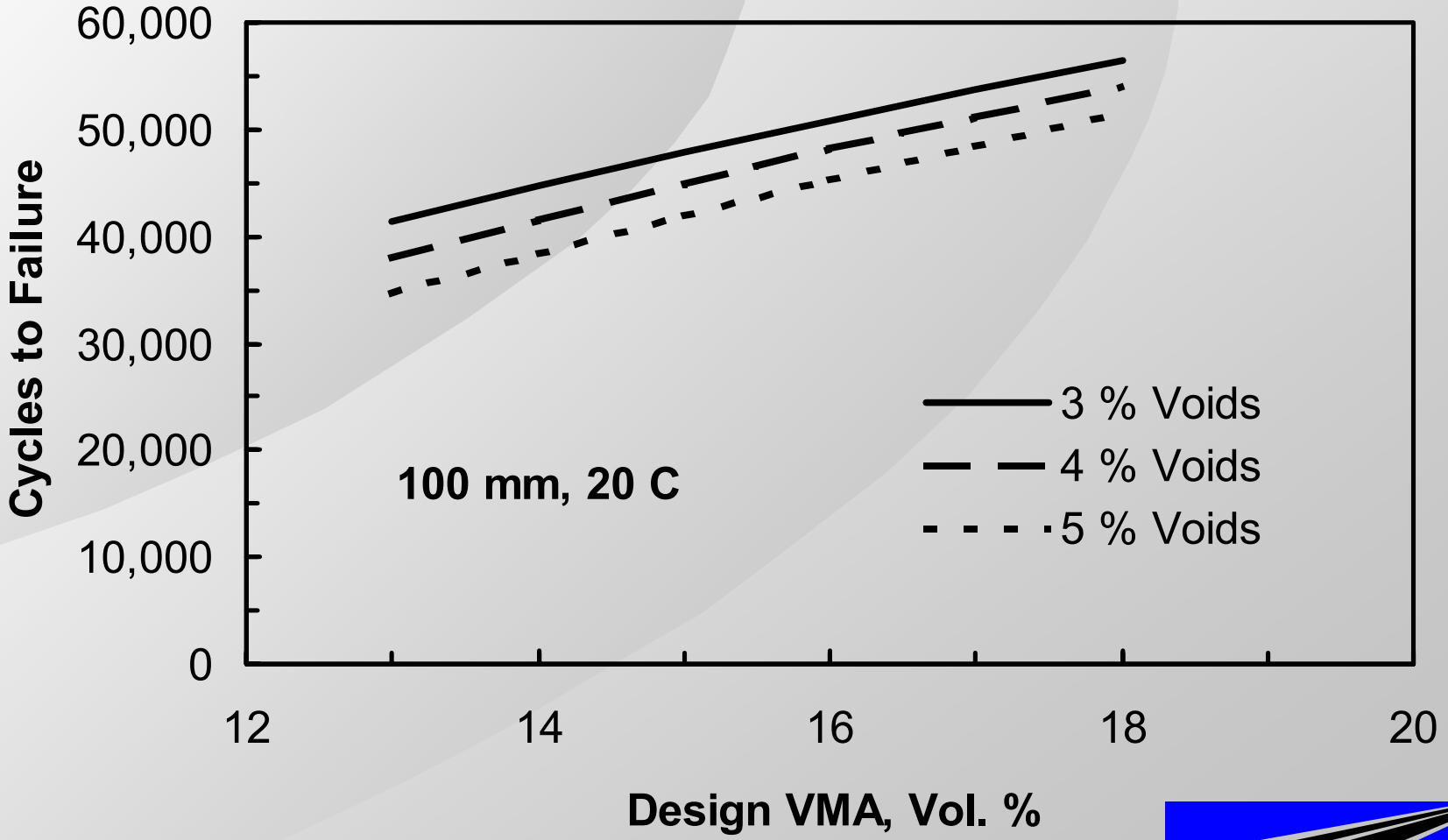
Fatigue and Volumetrics: Thick Pavement, 20 C



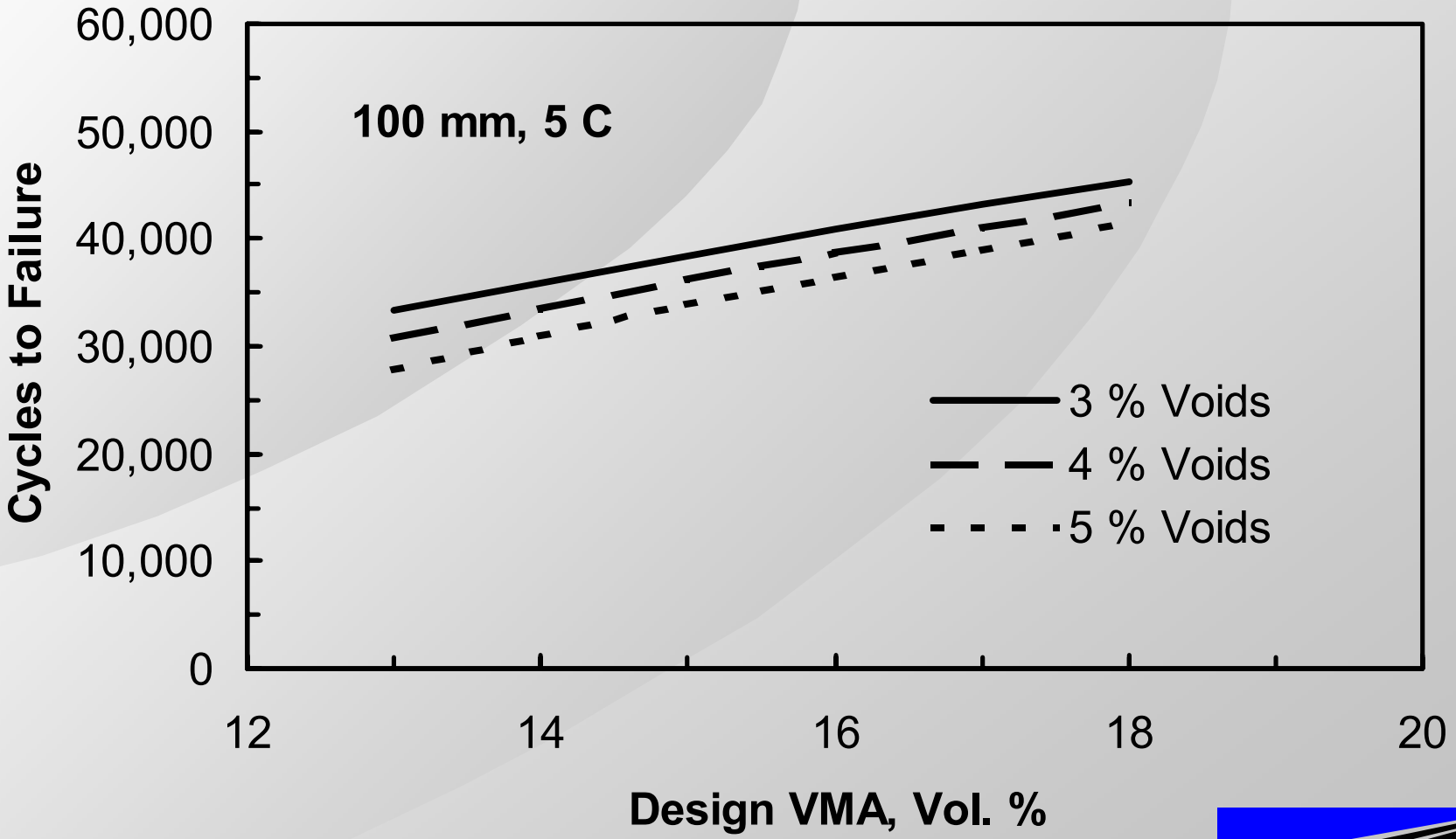
Fatigue and Volumetrics: Thick Pavement, 5 C



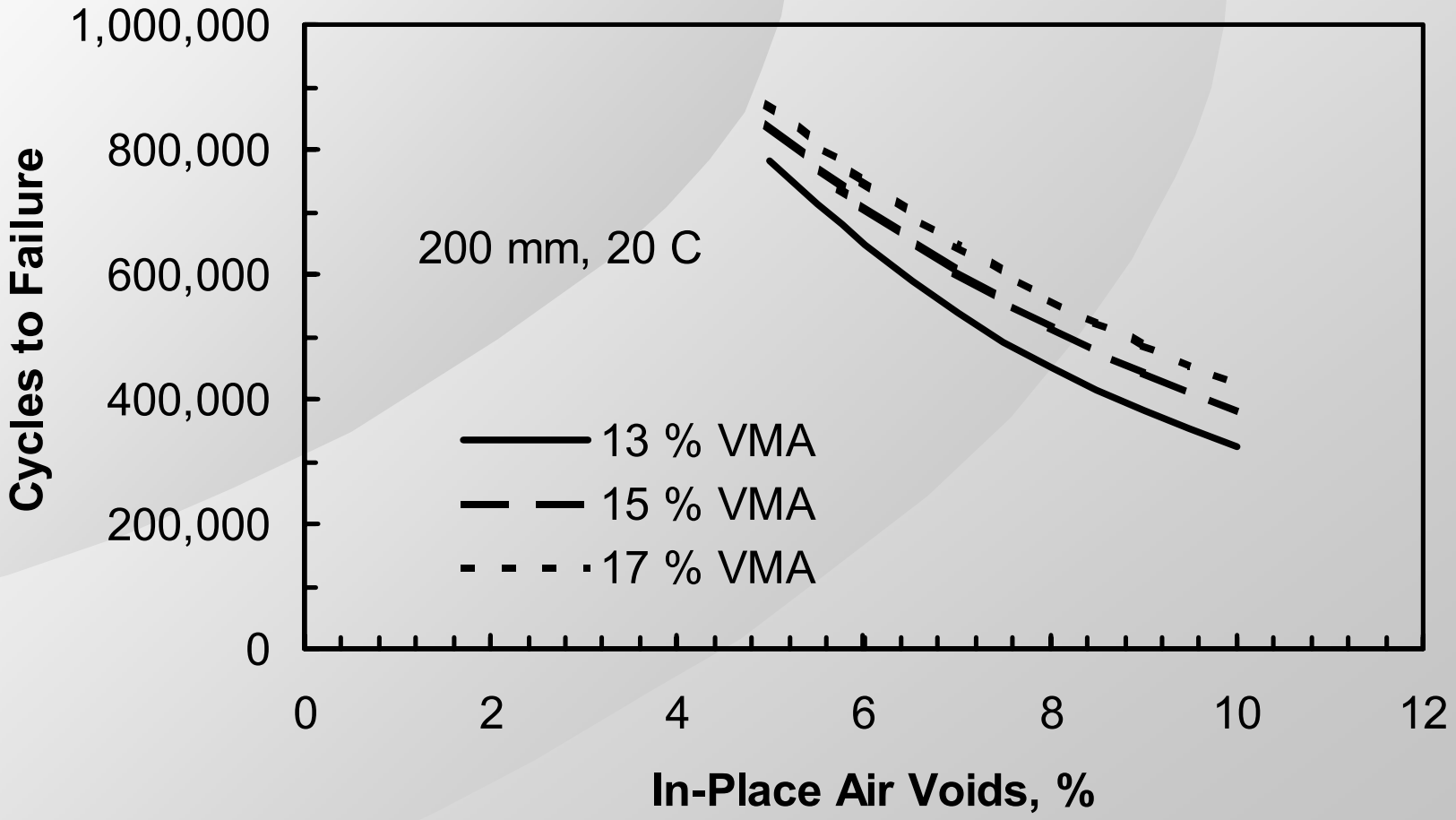
Fatigue and Volumetrics: Thin Pavement, 20 C



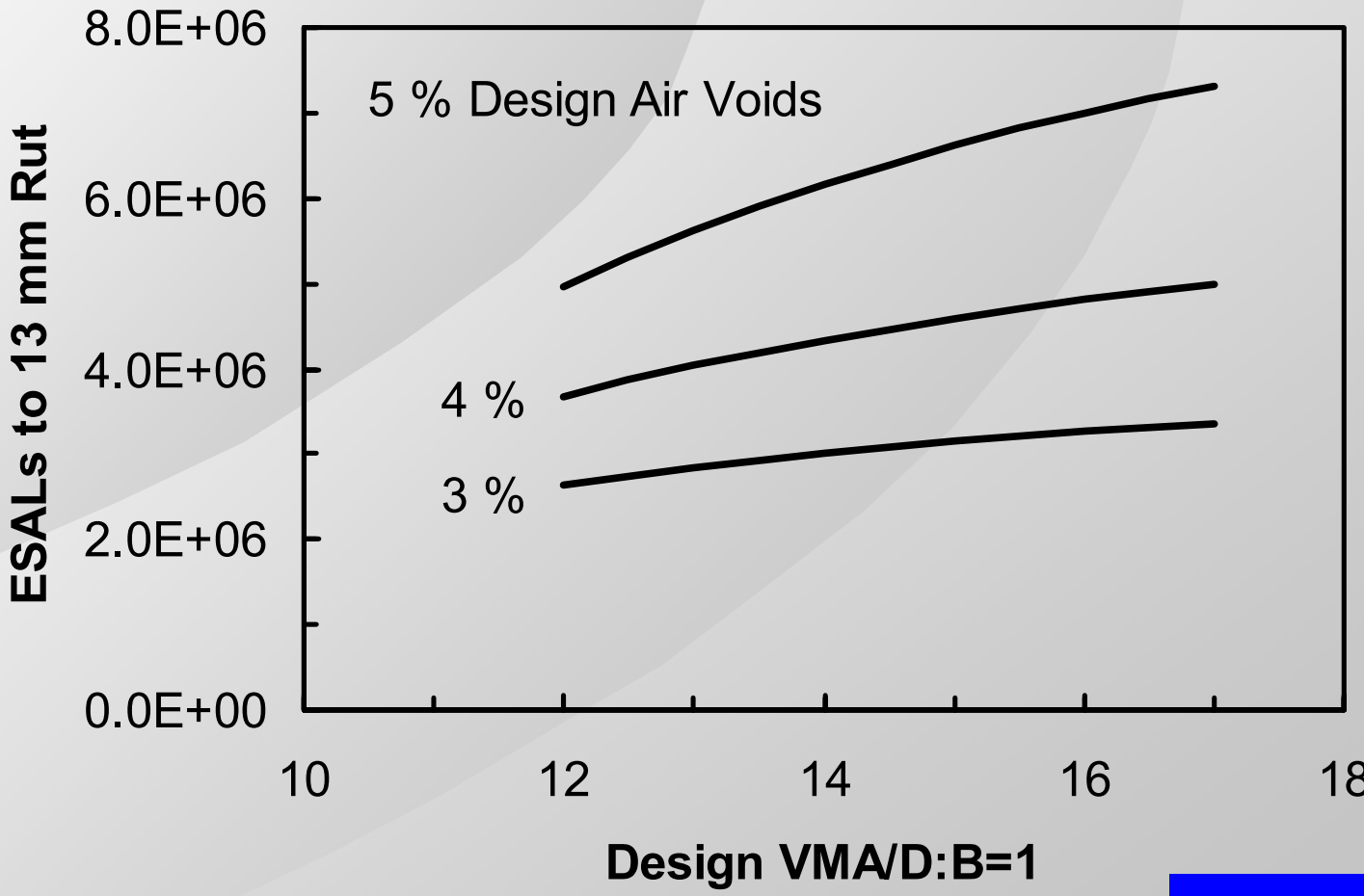
Fatigue and Volumetrics: Thin Pavement, 5 C



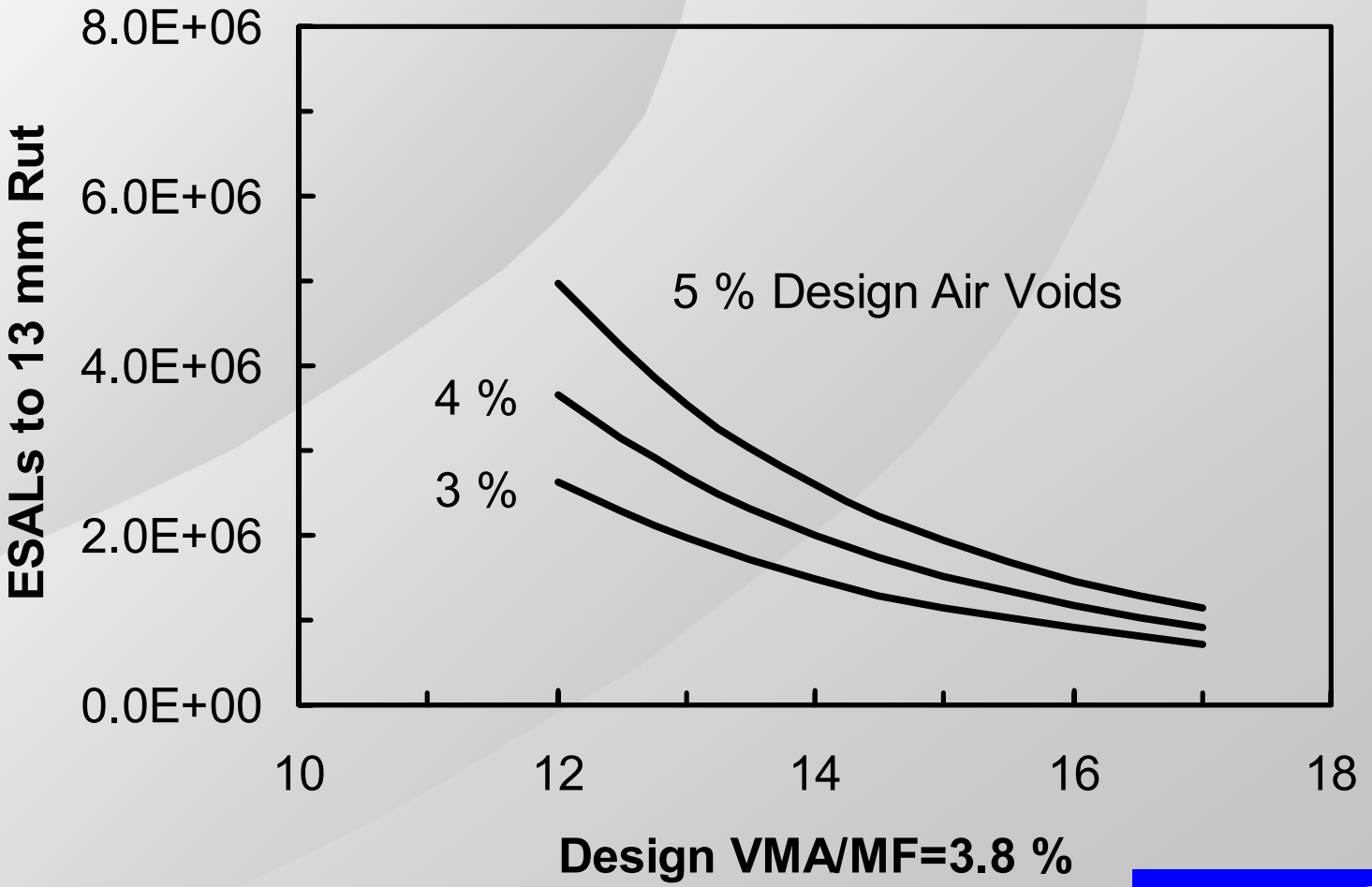
Fatigue and Compaction



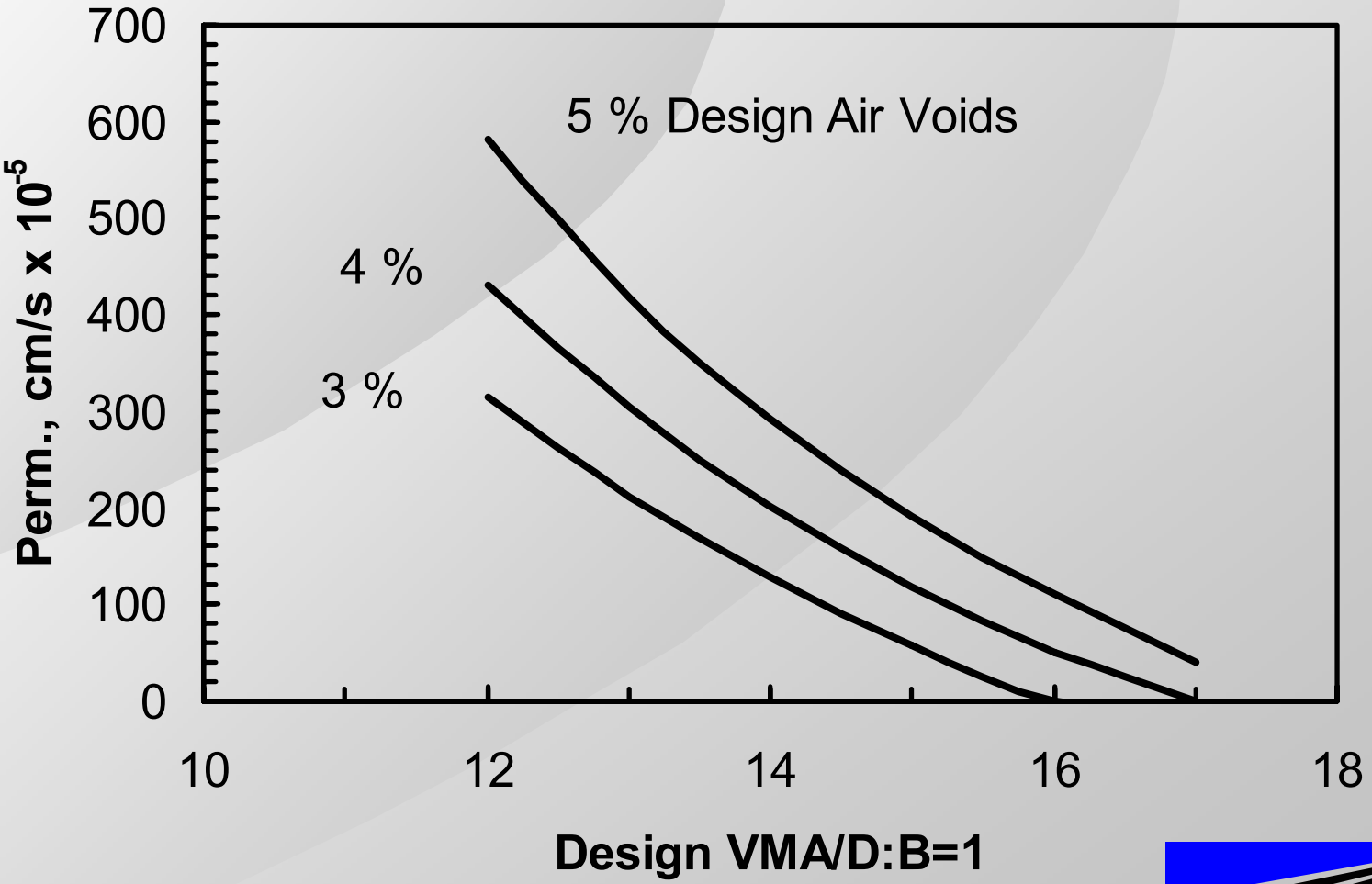
Rut Resistance and Volumetrics: Constant D/B Ratio



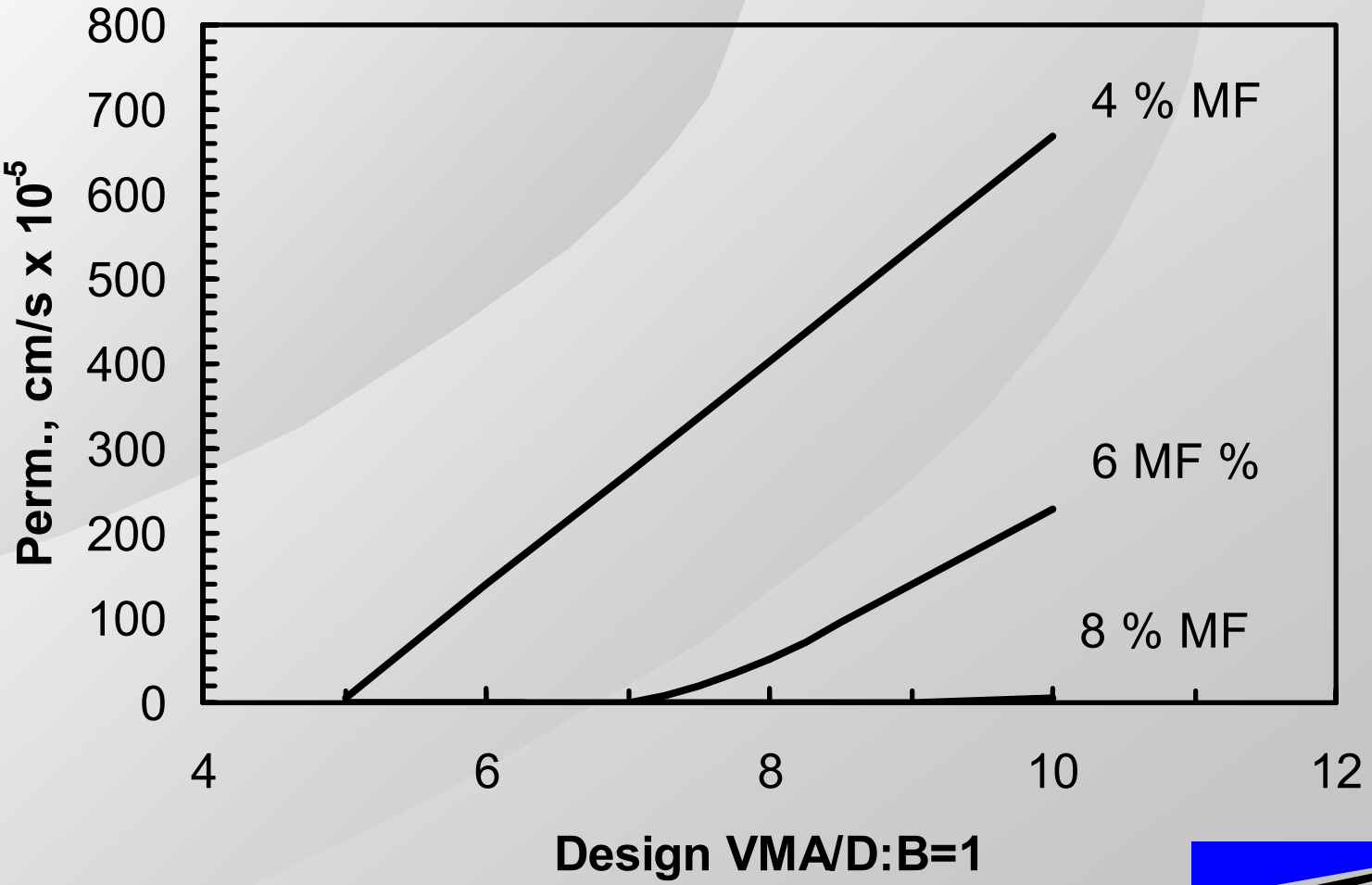
Rut Resistance and Volumetrics: Constant MF Content



Permeability and Volumetrics



Permeability and Compaction



Conclusion

- Volumetric specification probably OK
- Poor compaction?
  - Construction
  - Under traffic
- Healing?
- Increase design VMA and D/B
  - Improved compaction
  - decreased permeability
- Develop more workable mixes

Thanks!!!

- Those who stayed awake
- NEAUPG
- NCHRP, 9-25 & 9-31 Panels
- Lab guys
  - Kevin Knechtel
  - Don Jack