

Perpetual Pavement Design with PerRoad

PerRoad 3.3

PerRoad

PerRoad3.3.exe

Functional Classification: **Urban Collector**

Truck/AADT: 1000 (500 to 1000)

STraffic: 1 (1 to 25)

SSrowth: 1 (0 to 3)

Design Trucks: 33462 (Total Trucks in 30 Years)

Design ESALs: 10017 (Total ESALs in 30 Years)

AGGHTD Soil Classification: A-1-a

Soil Modulus: 2500 (10,000 to 30,000 psi)

Aggregate Base Thickness: 4 (0 to 10 in.)

HMA Modulus: 400000 (400,000 to 1,000,000 psi)

Calculated HMA: in. Calculated Thickness rounded up to nearest 0.25"

Design HMA: in.

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What is a Perpetual Pavement?

- A pavement designed so there are no distresses deep in the pavement structure

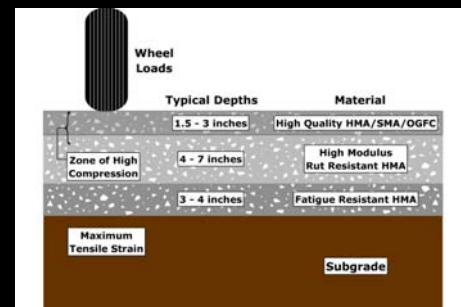


Goal of Perpetual Pavement Design

- Design so there are no deep structural distresses
 - Bottom up fatigue cracking
 - Structural rutting
- All distresses can be quickly remedied from surface
- Result in a structure with 'Perpetual' or 'Long Life'

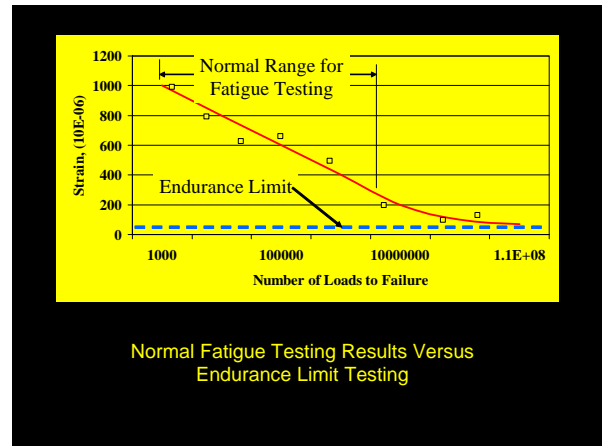
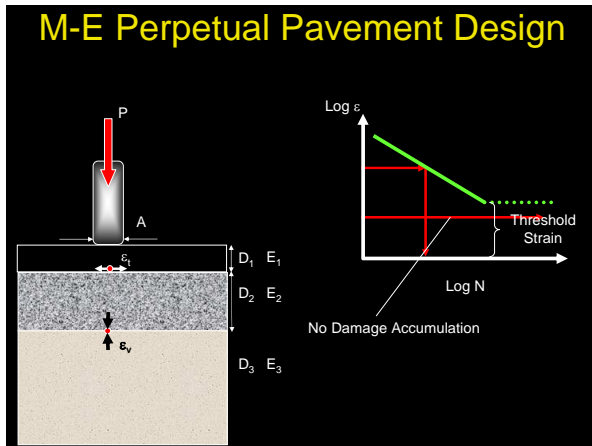


Designing Perpetual Pavements



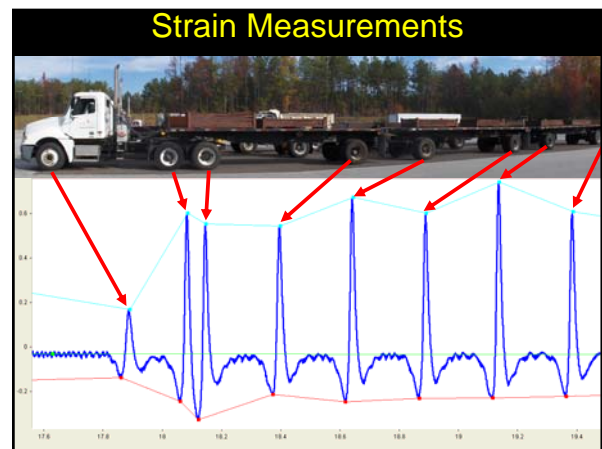
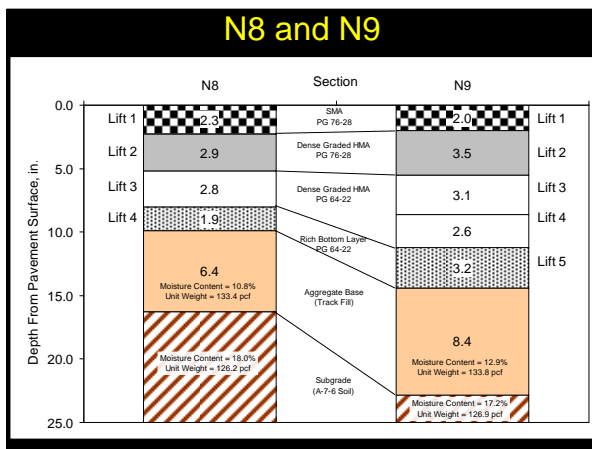
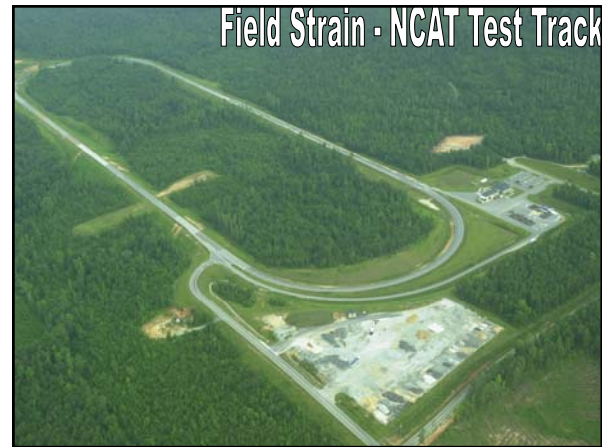
Newcomb, 2001

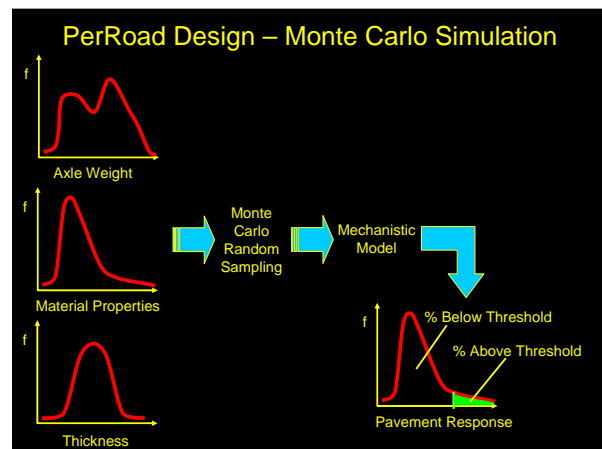
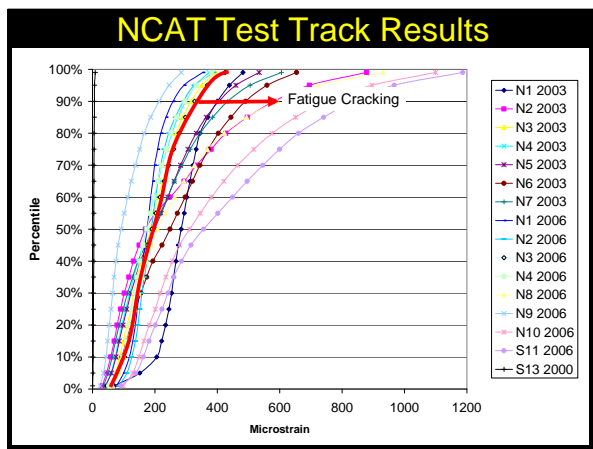
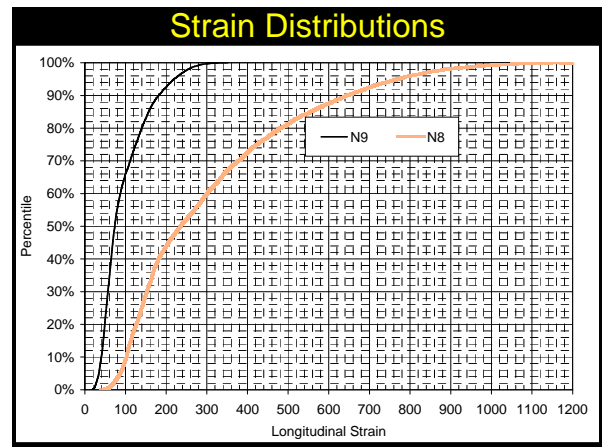
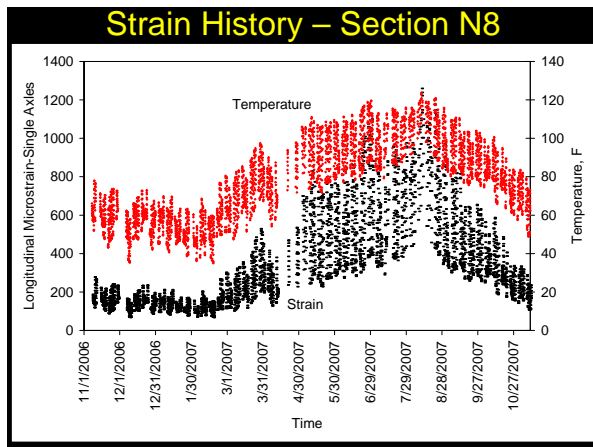
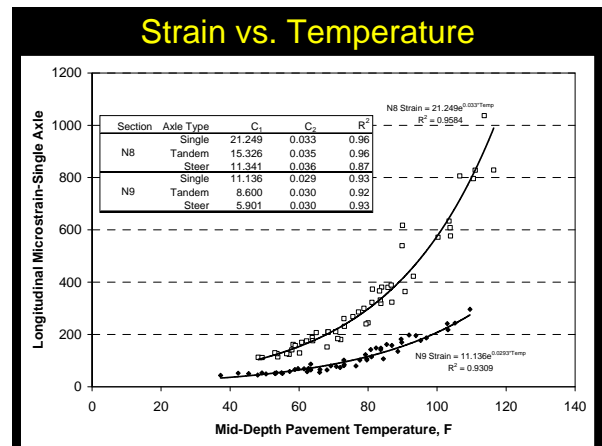
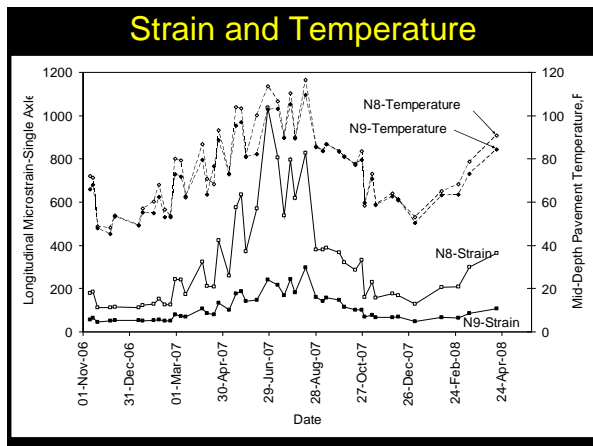
M-E Perpetual Pavement Design



What is the Endurance Limit for HMA?

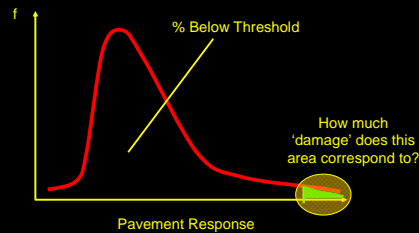
- 1972 – Monismith estimates about 70 $\mu\epsilon$
- 2001 – I-710 designed at 70 $\mu\epsilon$
- 2002 – 70 $\mu\epsilon$ used by APA
- 2007 – NCHRP 9-38 Lab Study
 - 100 $\mu\epsilon$ for unmod binders
 - 250 $\mu\epsilon$ for mod binders
 - More severe than field
- 2007 – MEPDG uses 100 to 250 $\mu\epsilon$
- 2008 – Field measurements show higher strains





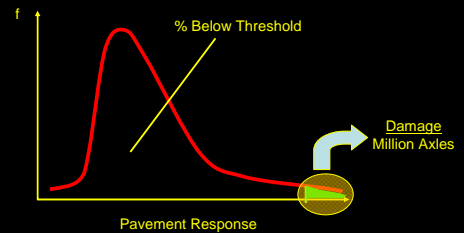
% Below Threshold

- Design should have high % below threshold



'Damage Computation'

- For responses exceeding threshold, compute N using transfer function
 - User defined
- Calculate damage accumulation rate
 - Damage / Maxles

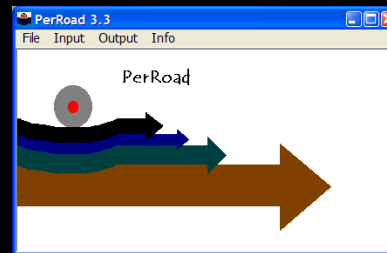


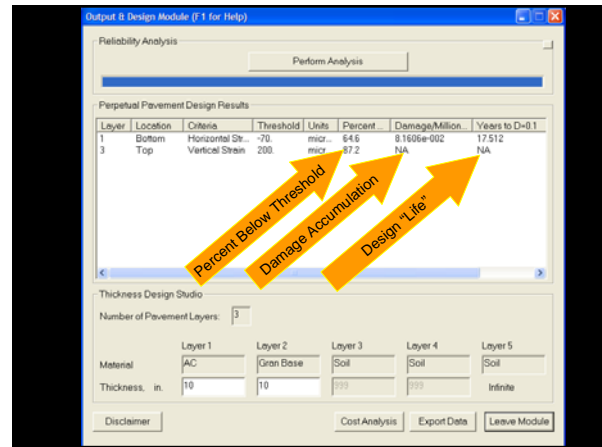
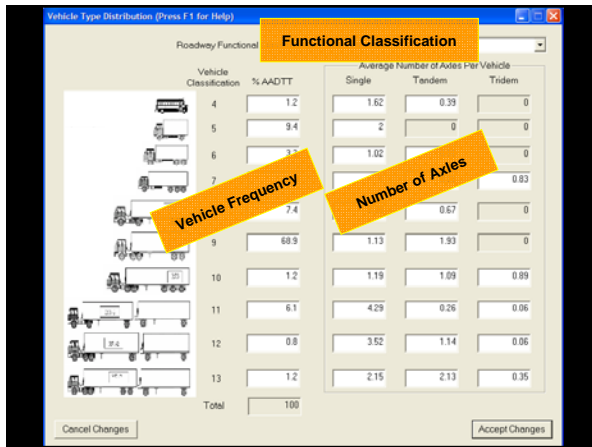
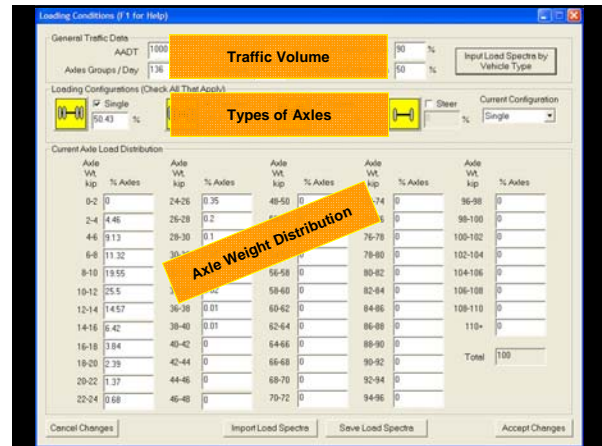
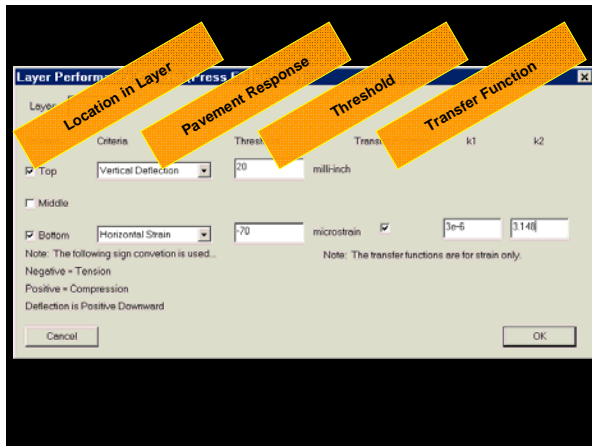
Estimated Long Life

- Convert damage rate into an estimated time
 - Use traffic volume and growth
 - Calculate when damage = 0.1

PerRoad 3.3

- Sponsored by APA
- Developed at Auburn University / NCAT
- M-E Perpetual Pavement Design and Analysis Tool





- ### Methodology - Overview
- Develop a set of boundary conditions
 - Execute PerRoad analysis to determine required thickness for each "design"
 - Develop design regression equations
 - Guiding Principles
 - Limit number of required inputs
 - Make design procedure simple/efficient

Traffic Parameters

- Rural (Local) Collector vs. Urban Collector
- Volume
 - 500, 1000 and 5000 AADT
 - 0%, 1% and 3% Growth
 - 1%, 5%, 10% and 20% Trucks
- Distribution Factors
 - Assume 2-lane facility
 - 100% Trucks in design lane
 - 50% directional distribution
- Loadings
 - Default Load Spectra in PerRoad

Volume Range (over 30 years)
27,375 to 8,577,500 trucks

Structural Cross Section

	Layer Stiffness	Poisson's Ratio	
HMA	400,000 to 1,000,000 psi	0.35	Variable
Aggregate Base	20,000 psi	0.40	0-10 in.
Subgrade Soil	10,000 psi to 30,000 psi	0.45	Infinite

Performance Criteria

- Limit damage accumulation to 0.1 after 30 years
- Mn/ROAD-based Transfer functions
 - Fatigue and Rutting
- Perpetual Pavement Thresholds
 - Fatigue: -70 $\mu\epsilon$
 - Rutting: 200 $\mu\epsilon$

Number of Simulations

Simulations =

- 2 Highway Classifications
- X 3 Traffic Volumes
- X 3 Growth Rates
- X 4 Percent Trucks
- X 3 Soil Stiffnesses
- X 3 HMA Stiffnesses
- X 3 Base Thicknesses

1,944 Pavement Designs

Design Equation

HMA = $C_0 + C_1 * AADT + C_2 * \%Trucks + C_3 * \%Growth + C_4 * Soil\ Stiffness + C_5 * Base\ Thickness + C_6 * HMA\ Stiffness$

Parameter	Urban Collector	Rural Collector
C ₀ (Intercept)	10.1587	10.8162
C ₁ (AADT)	6.281E-04	6.396E-04
C ₂ (%Trucks)	0.1817	0.1861
C ₃ (%Growth)	0.2264	0.2222
C ₄ (Soil Stiffness)	-9.437E-05	-9.915E-05
C ₅ (Base Thickness)	-0.0780	-0.0743
C ₆ (HMA Stiffness)	-5.098E-06	-5.365E-06
R ²	0.90	0.90

PerRoad XPress

