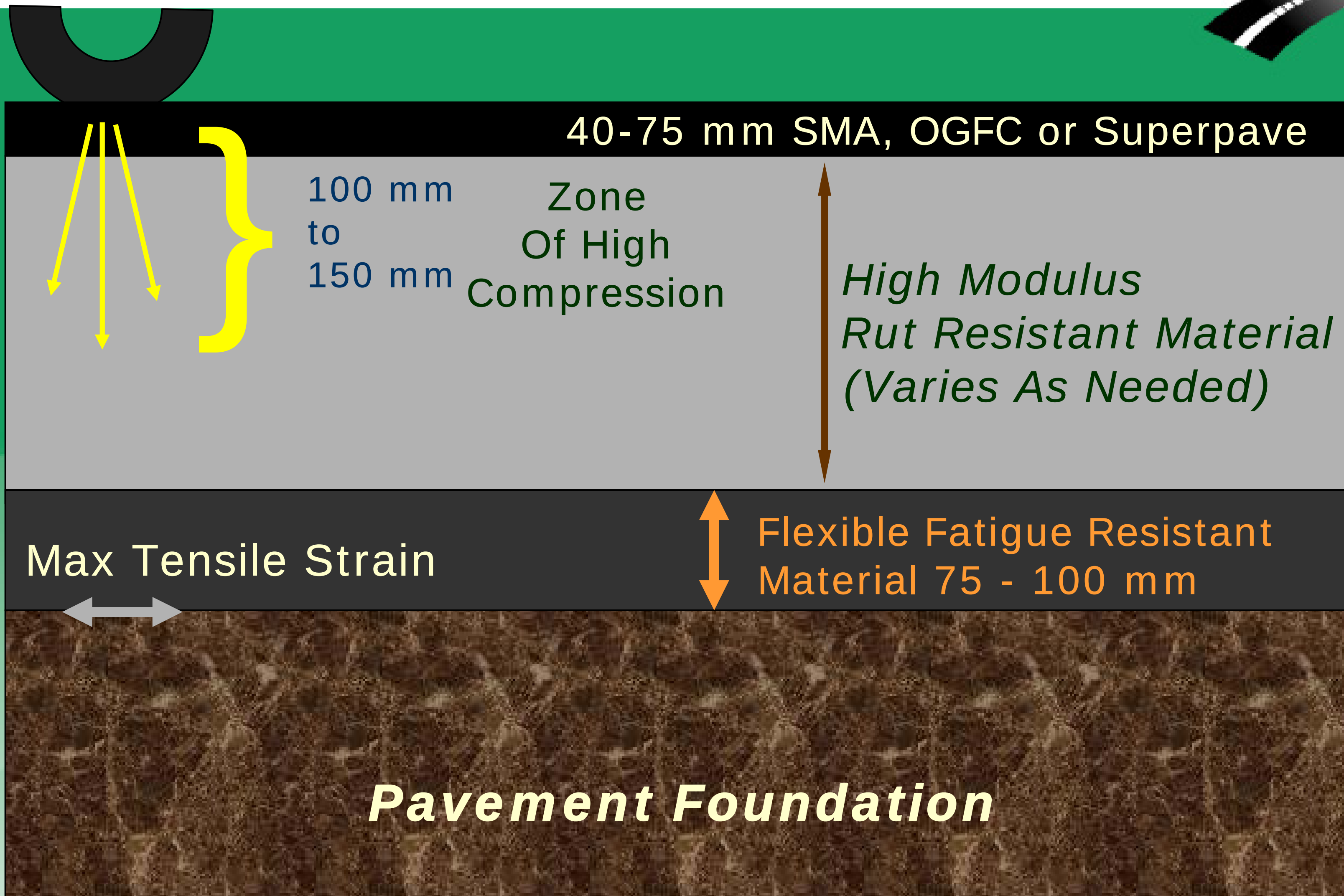
Perpetual Pavements

www.AsphaltAlliance.com

Perpetual Pavements



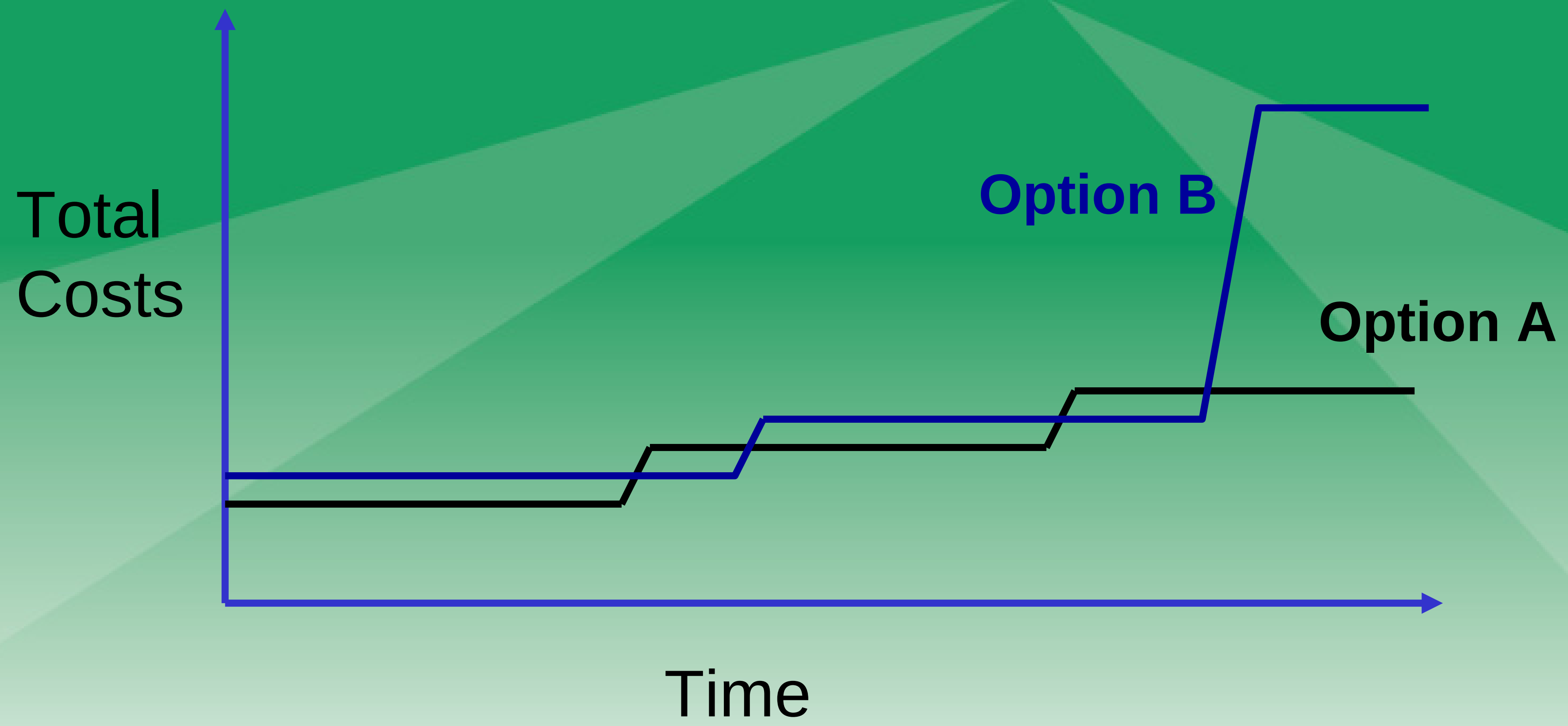
Value

Quality in a product or service is not what the supplier puts in. It is what the customer gets out and is willing to pay for. A product is not quality because it is hard to make and costs a lot of money, as manufacturers typically believe. This is incompetence. Customers pay only for what is of use to them and gives them value. Nothing else constitutes quality.

Peter Drucker

Perpetual Pavements

Economics

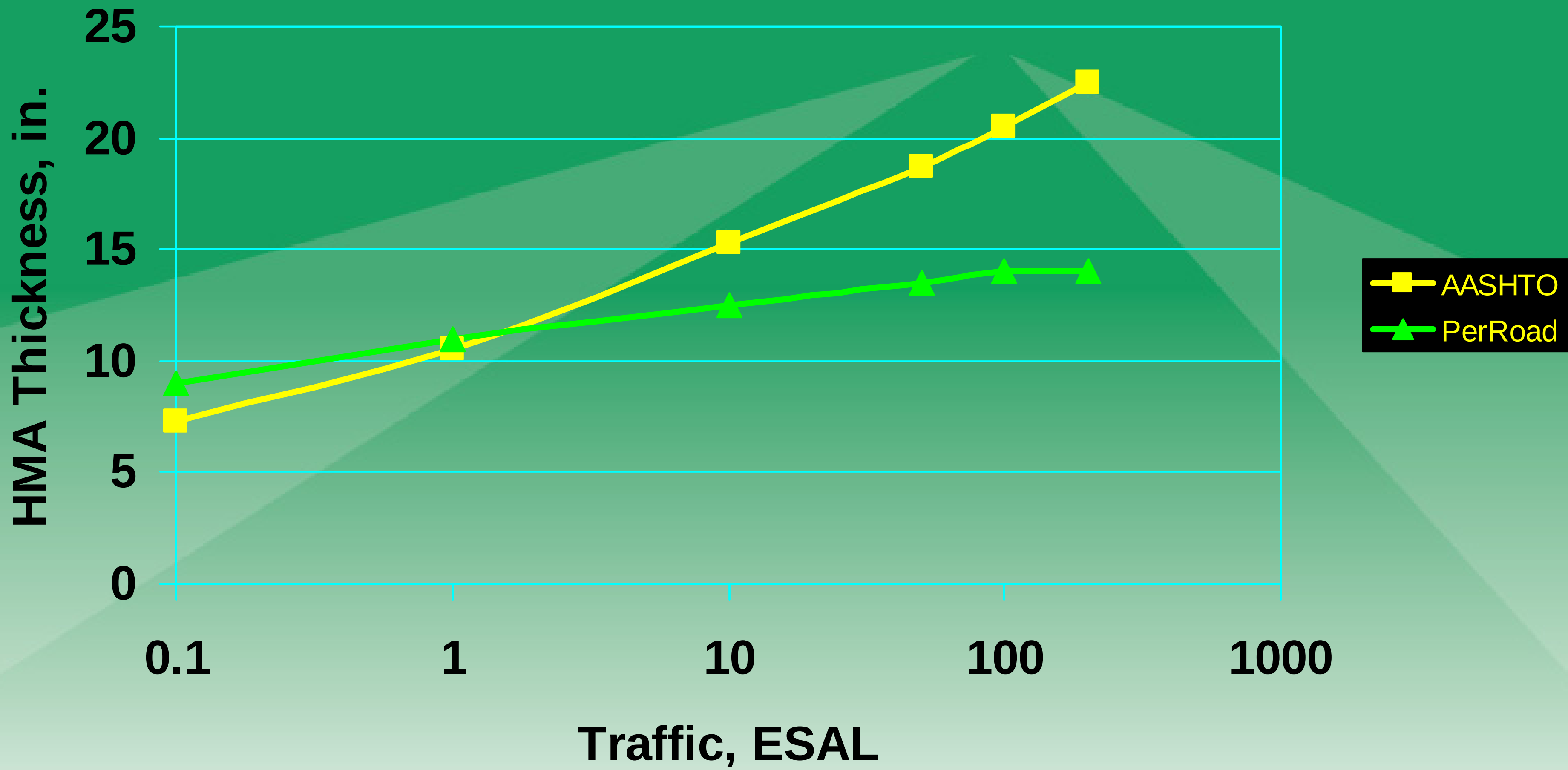


Why are Perpetual Pavements Important?

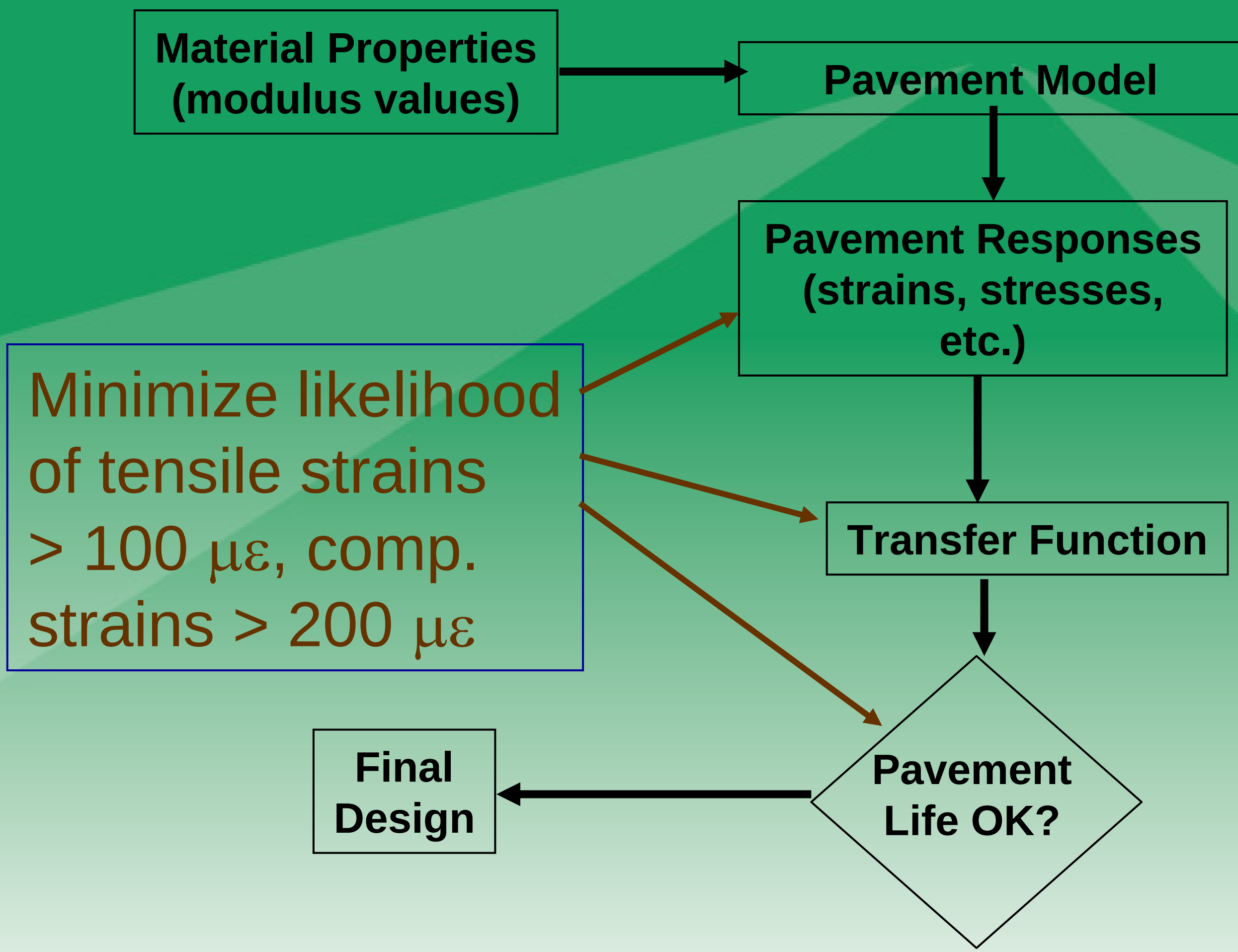
- Lower Life Cycle Cost
  - Better Use of Resources
  - Low Incremental Costs for Surface Renewal
- Lower User Delay Cost
  - Shorter Work Zone Periods
  - Off-Peak Period Construction

Perpetual Pavements

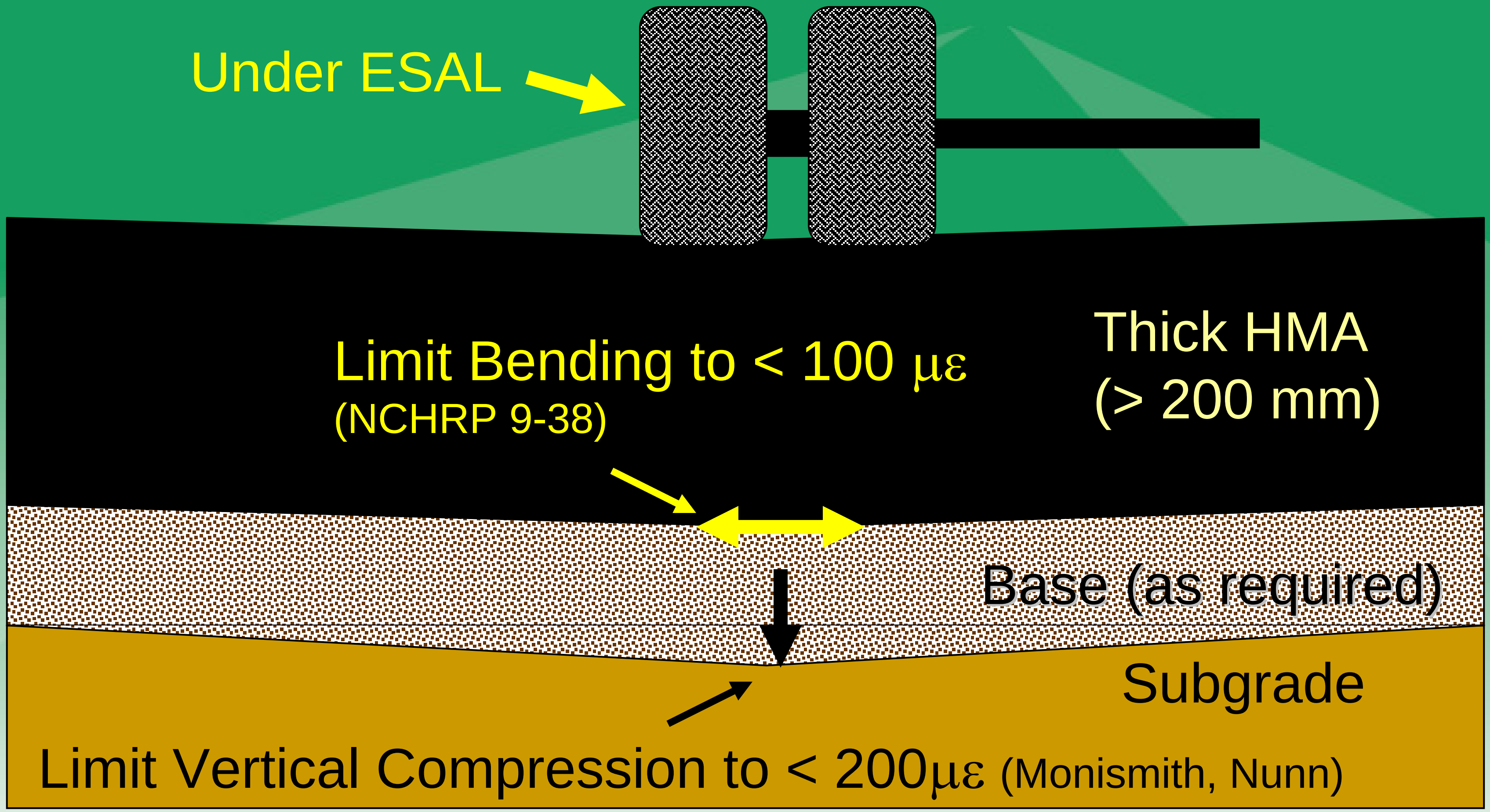
Perpetual Pavement versus Conventional Design



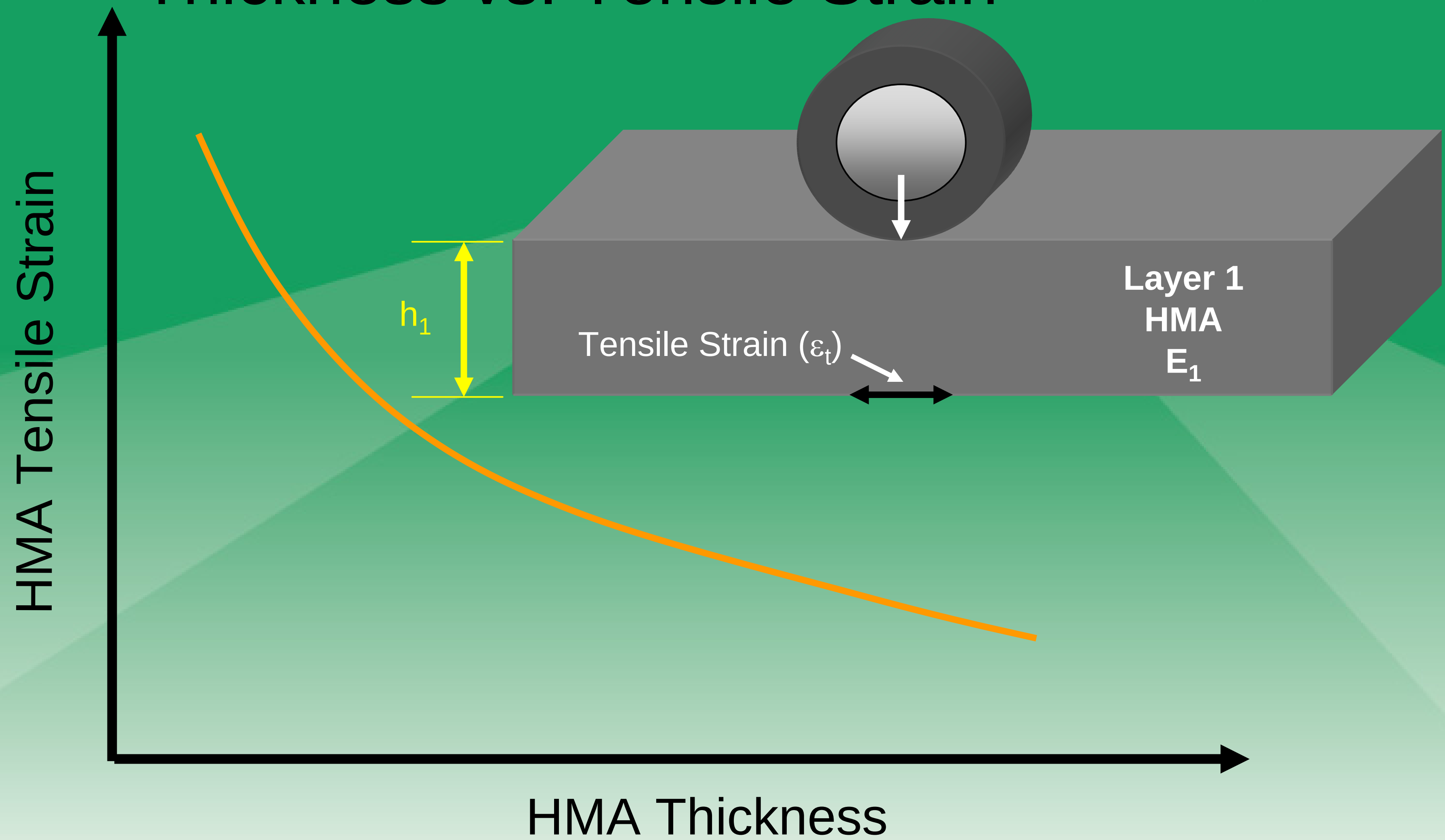
Mechanistic-Based Design



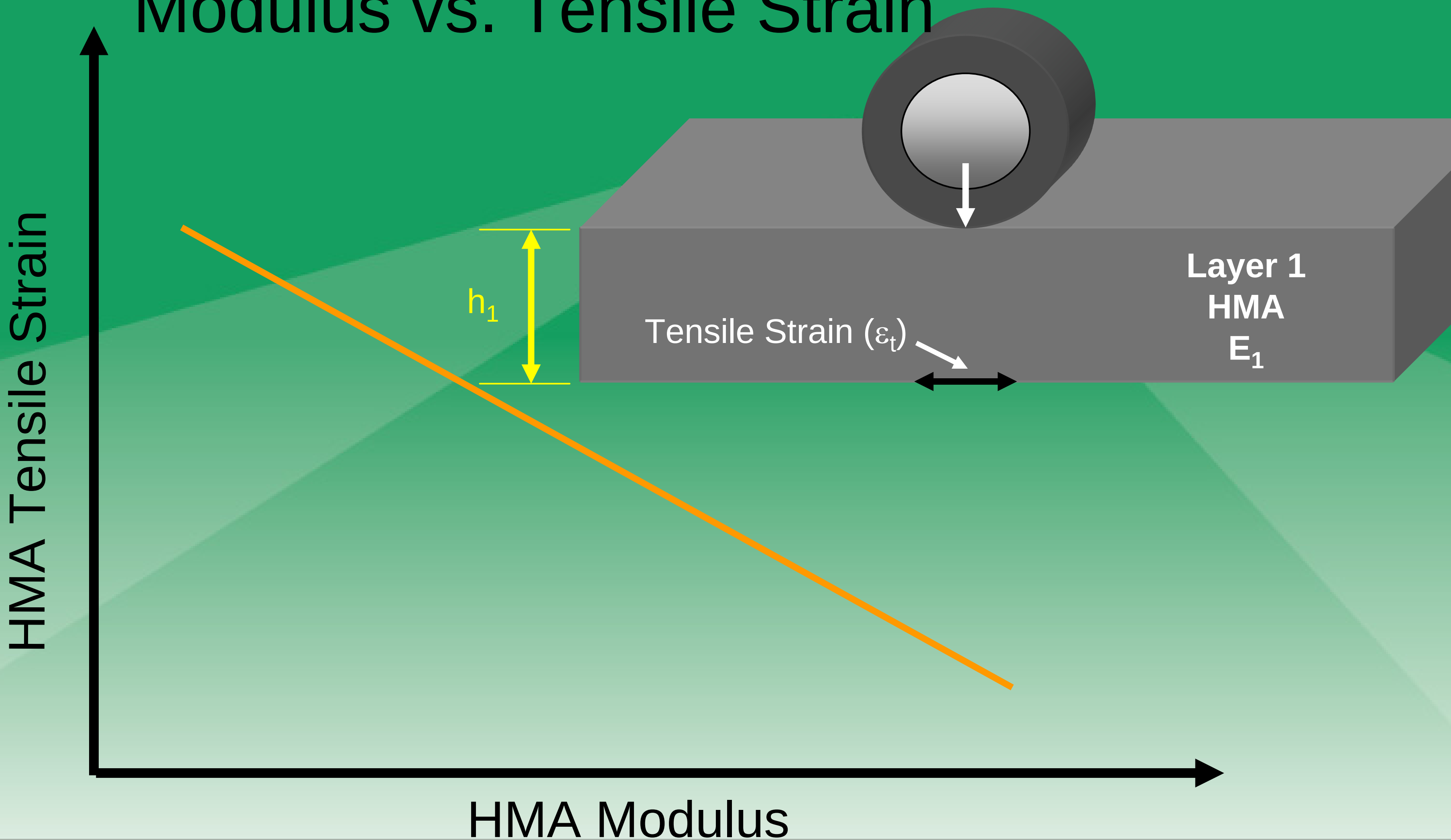
Mechanistic Performance Criteria



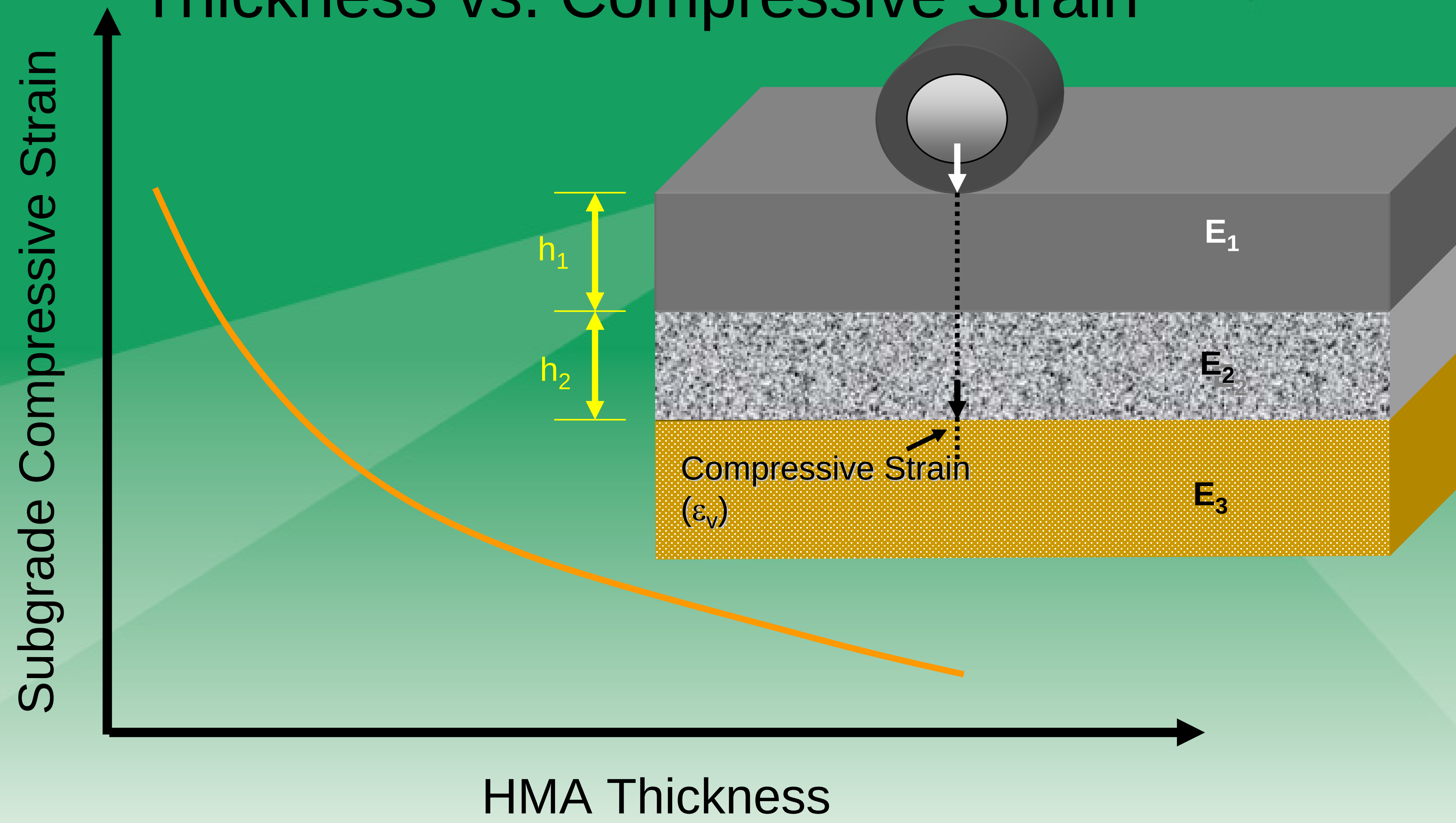
Thickness vs. Tensile Strain



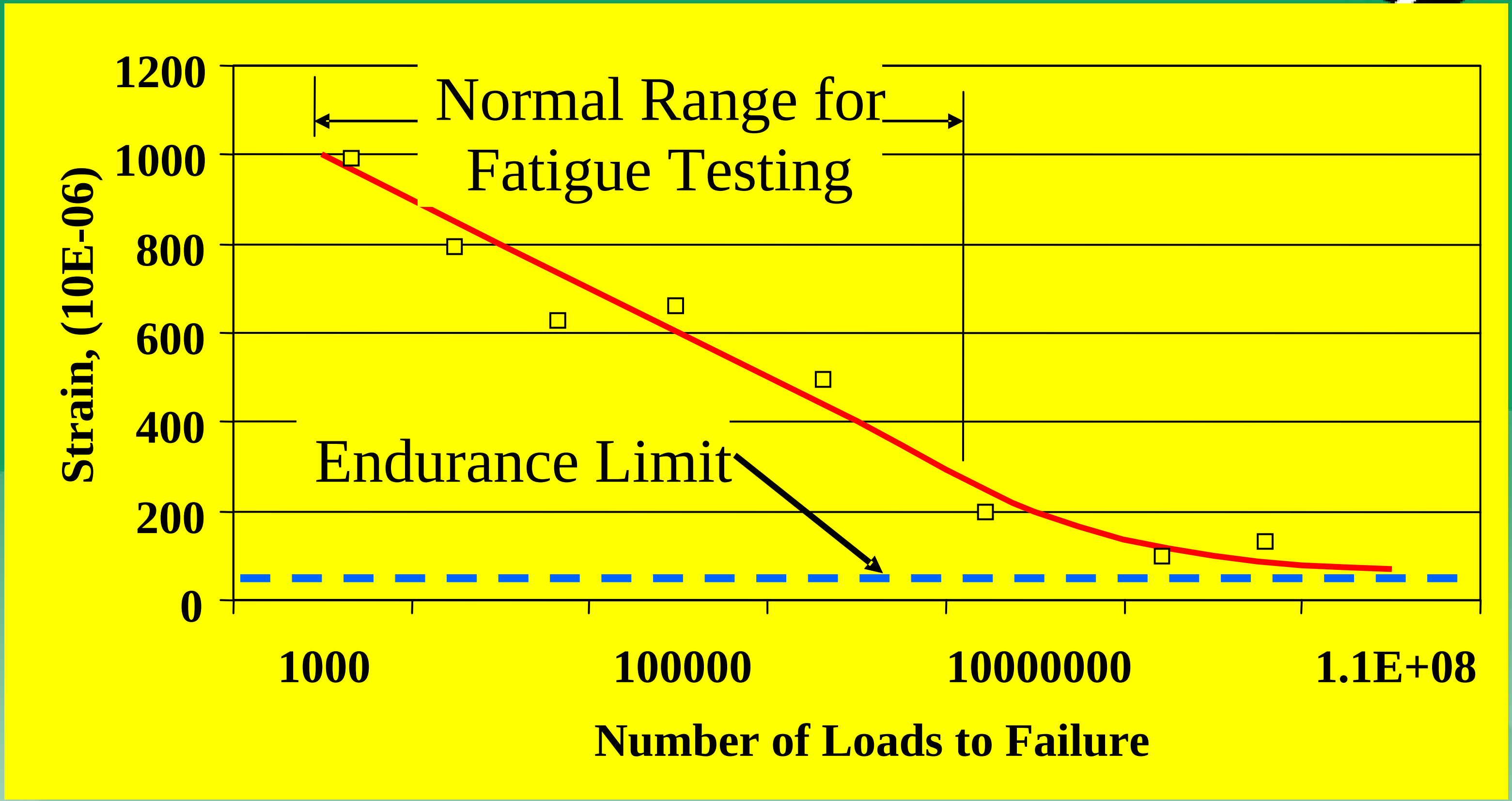
Modulus vs. Tensile Strain



Thickness vs. Compressive Strain

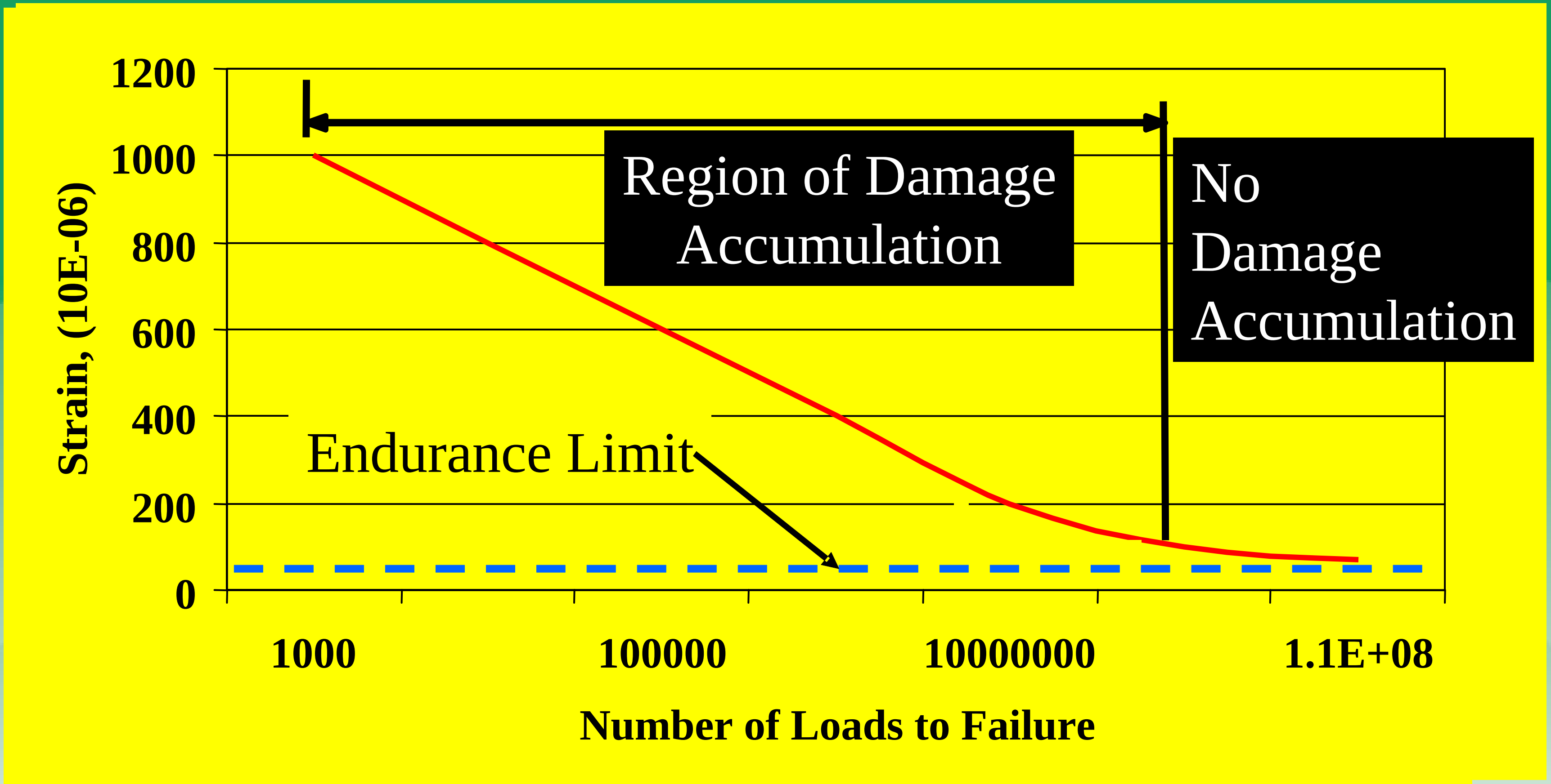


Perpetual Pavements



Normal Fatigue Testing Results Versus Endurance Limit Testing

Perpetual Pavements



Does the Endurance Limit Exist?

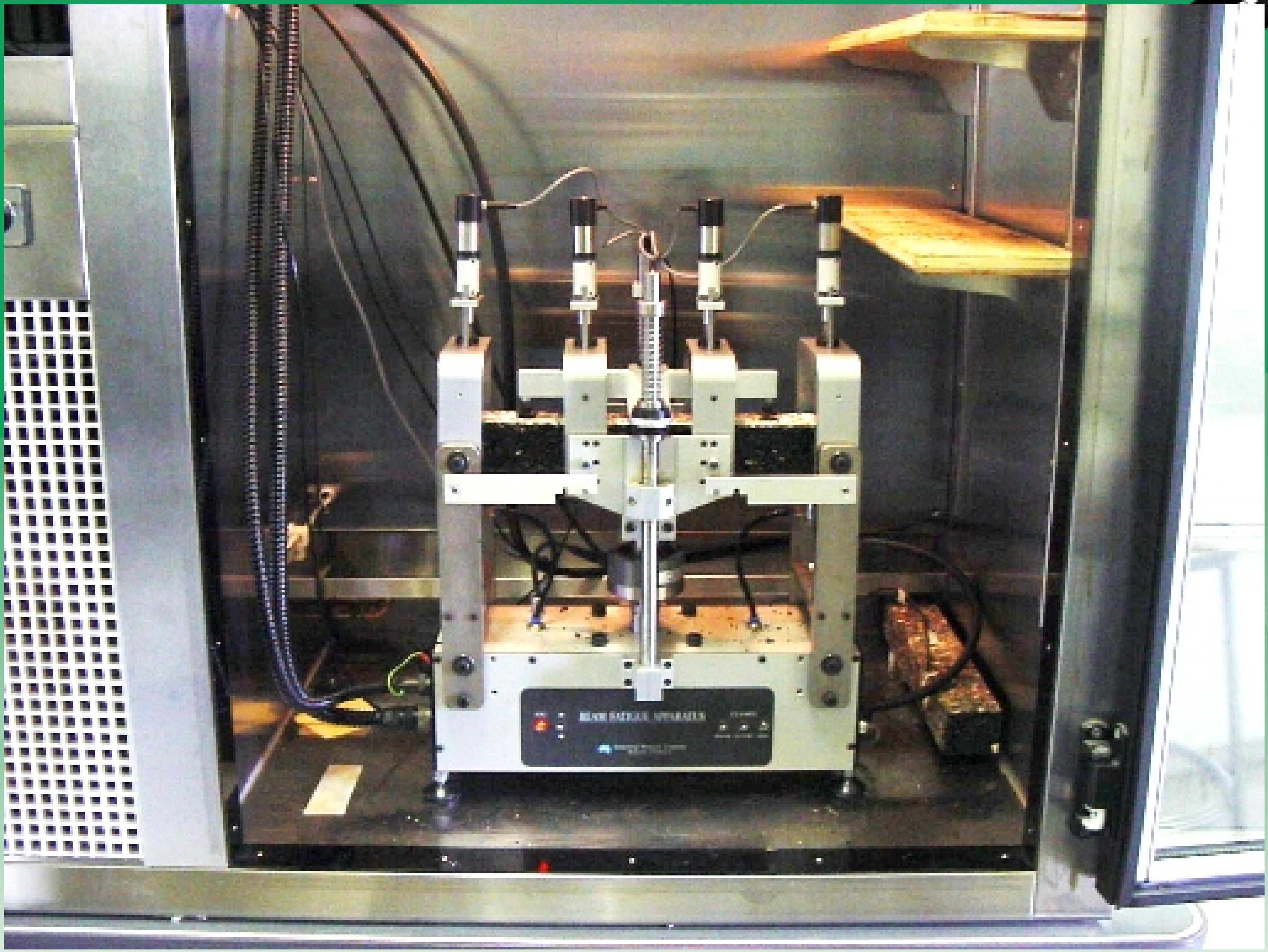
- University of Illinois Study
  - 70 με reasonable
- NCHRP Project 9-38
  - 100 με for unmodified asphalt
  - 250 με for modified asphalt
- NCHRP Project 9-44 – Validating the Endurance Limit
  - Endurance Limit Workshop
- In the new MEPDG to be adopted by AASHTO

Significance of Fatigue Endurance Limit

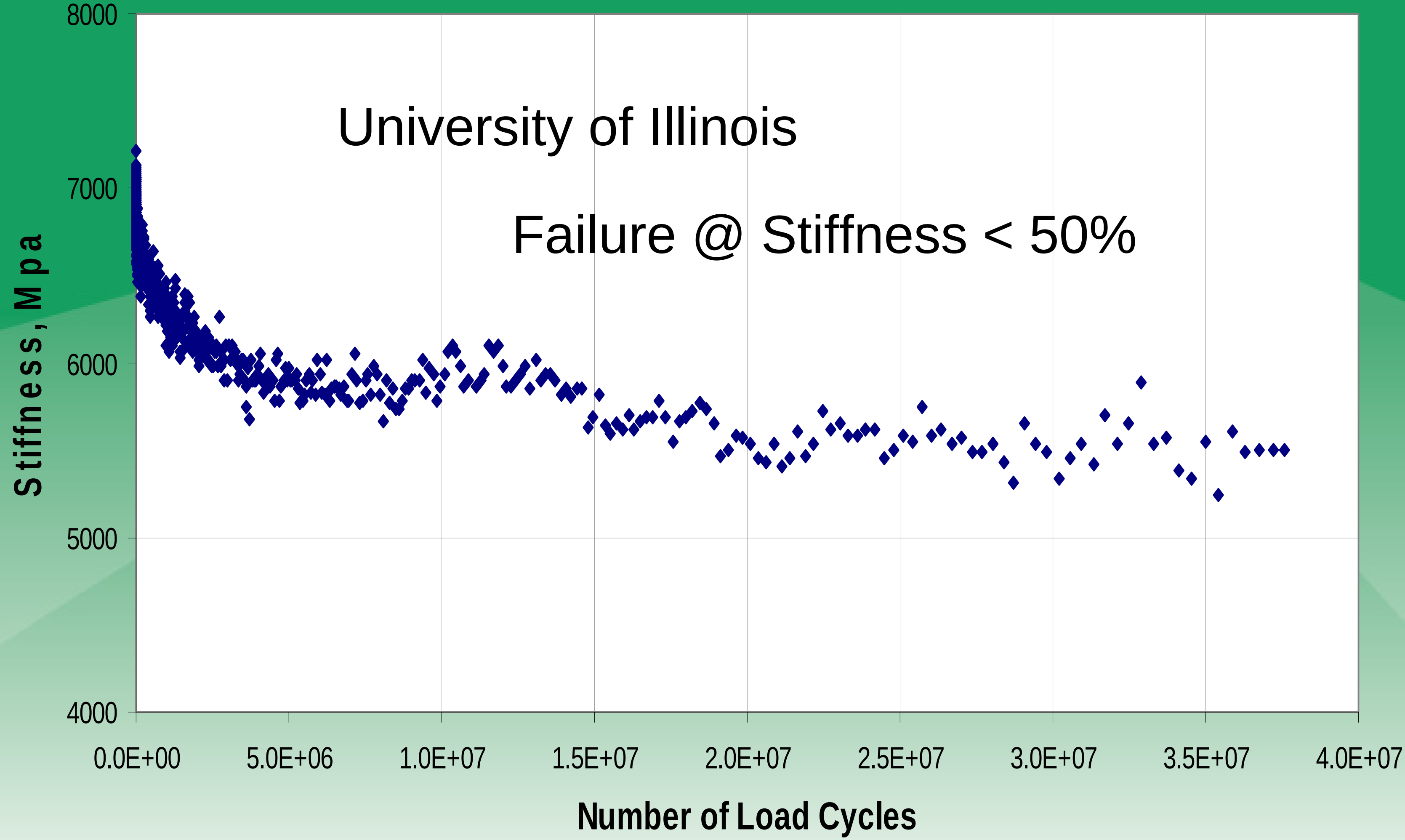
"….such a limit would provide a thickness limit for the pavement..Increasing the thickness beyond the limiting thickness…would provide no increased structural resistance to fatigue damage and represent an unneeded expense."

Prof. Carpenter

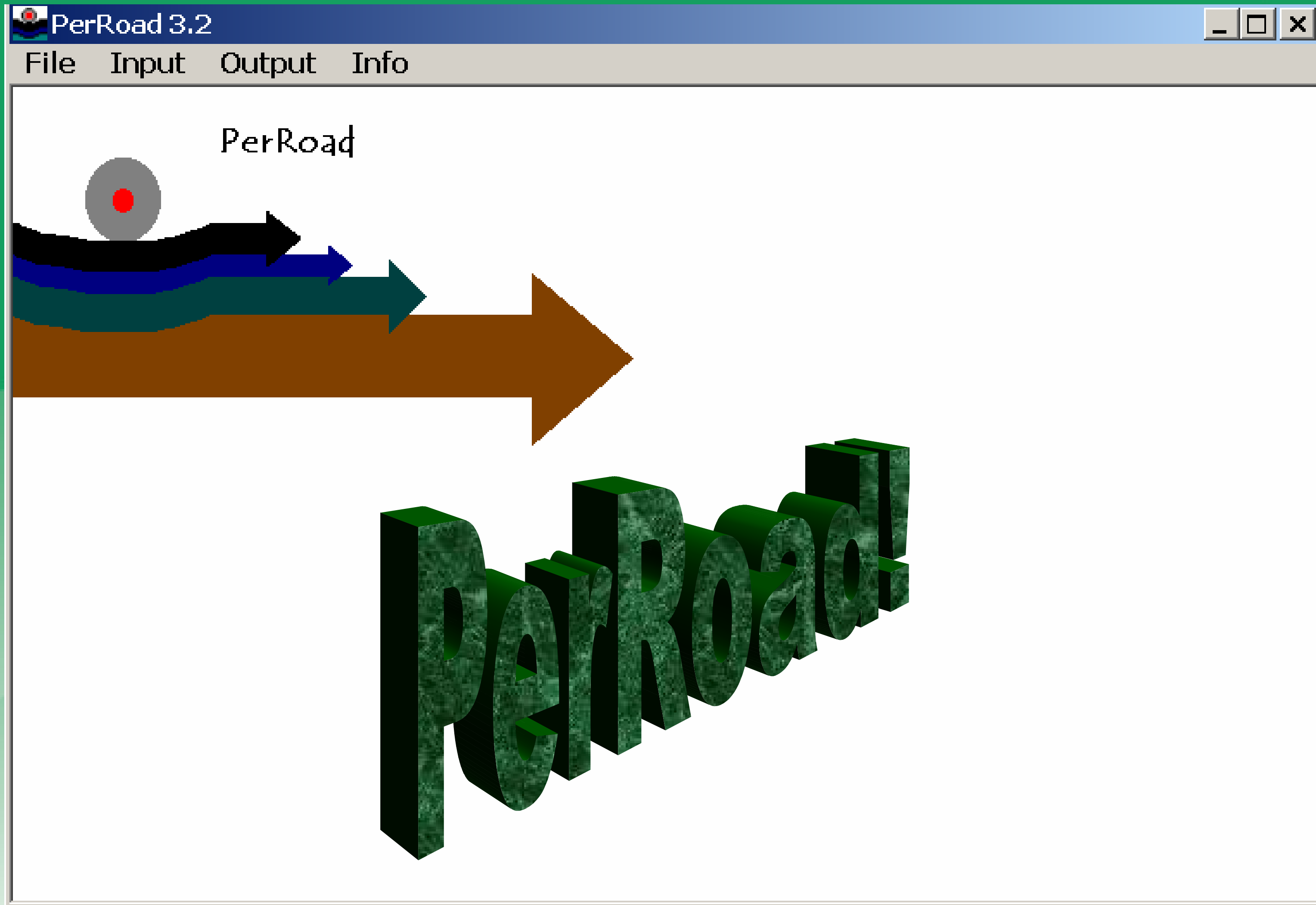
Perpetual Pavements



70 Micro Strain Test



Perpetual Pavements

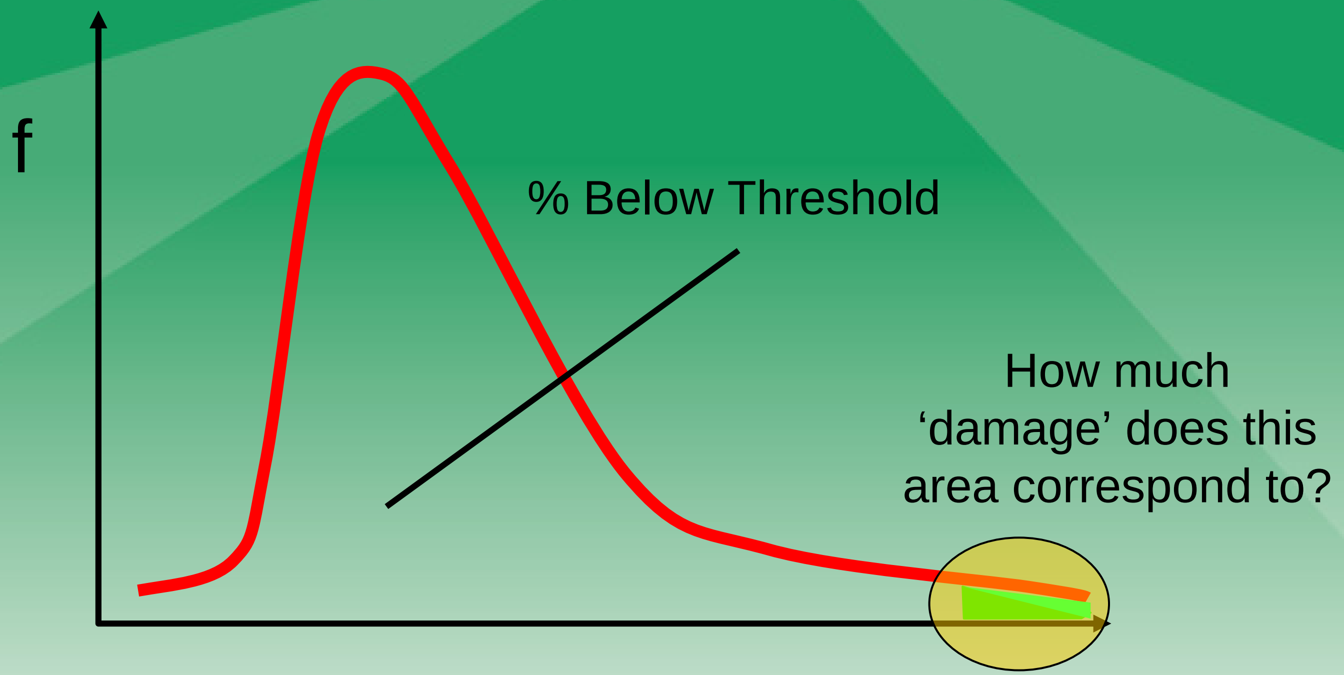


Analysis

- Program uses Monte Carlo simulation to model input distributions
  - Load, Materials, thickness
- A distribution of pavement response is determined
- Reliability = probability that response(s) below threshold, OR
- Damage/Million ESAL, OR
- Time to Damage = 0.1

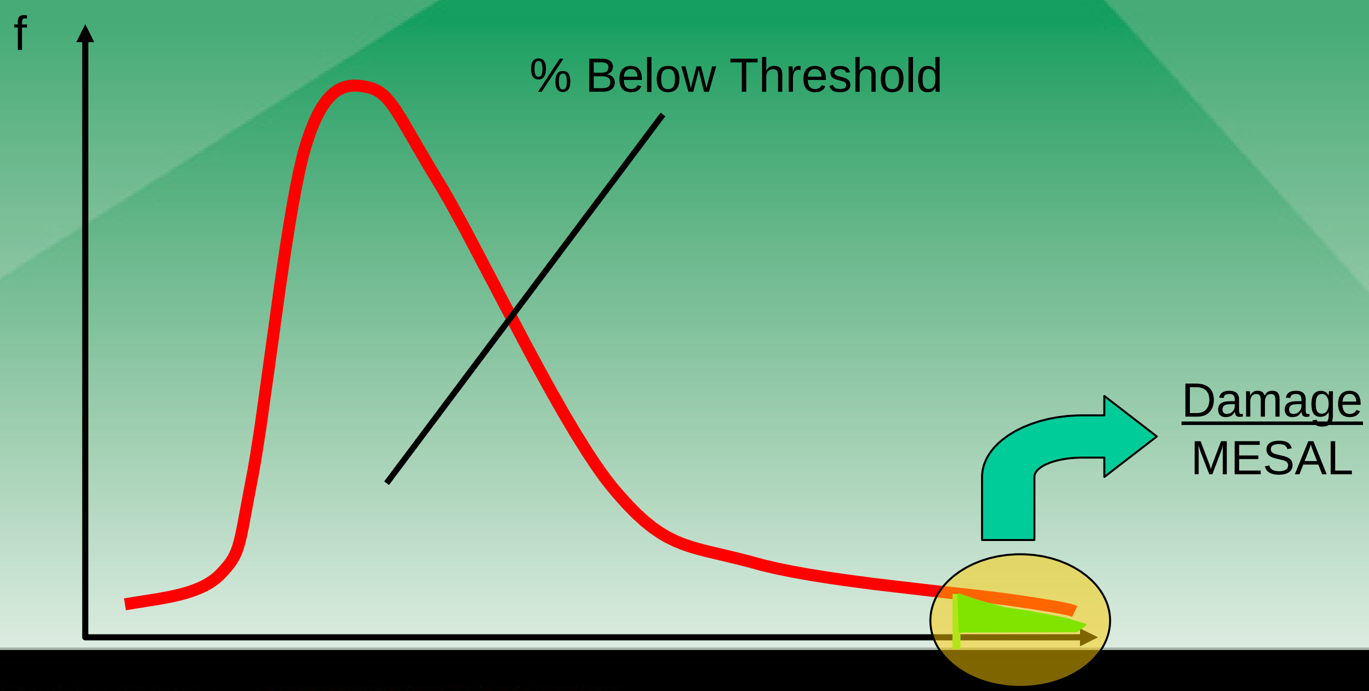
% Below Threshold

- Design should have high % below threshold



'Damage Computation'

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

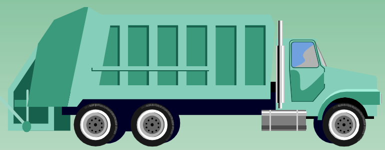


Estimated Long Life

- Convert damage rate into an estimated life
  - Use traffic volume and growth
  - Calculate when damage = 0.1
    - Use for Low Vol. Roads (t ~30 yrs.)

Low Volume Traffic

10 - 20/wk



3 - 5/wk

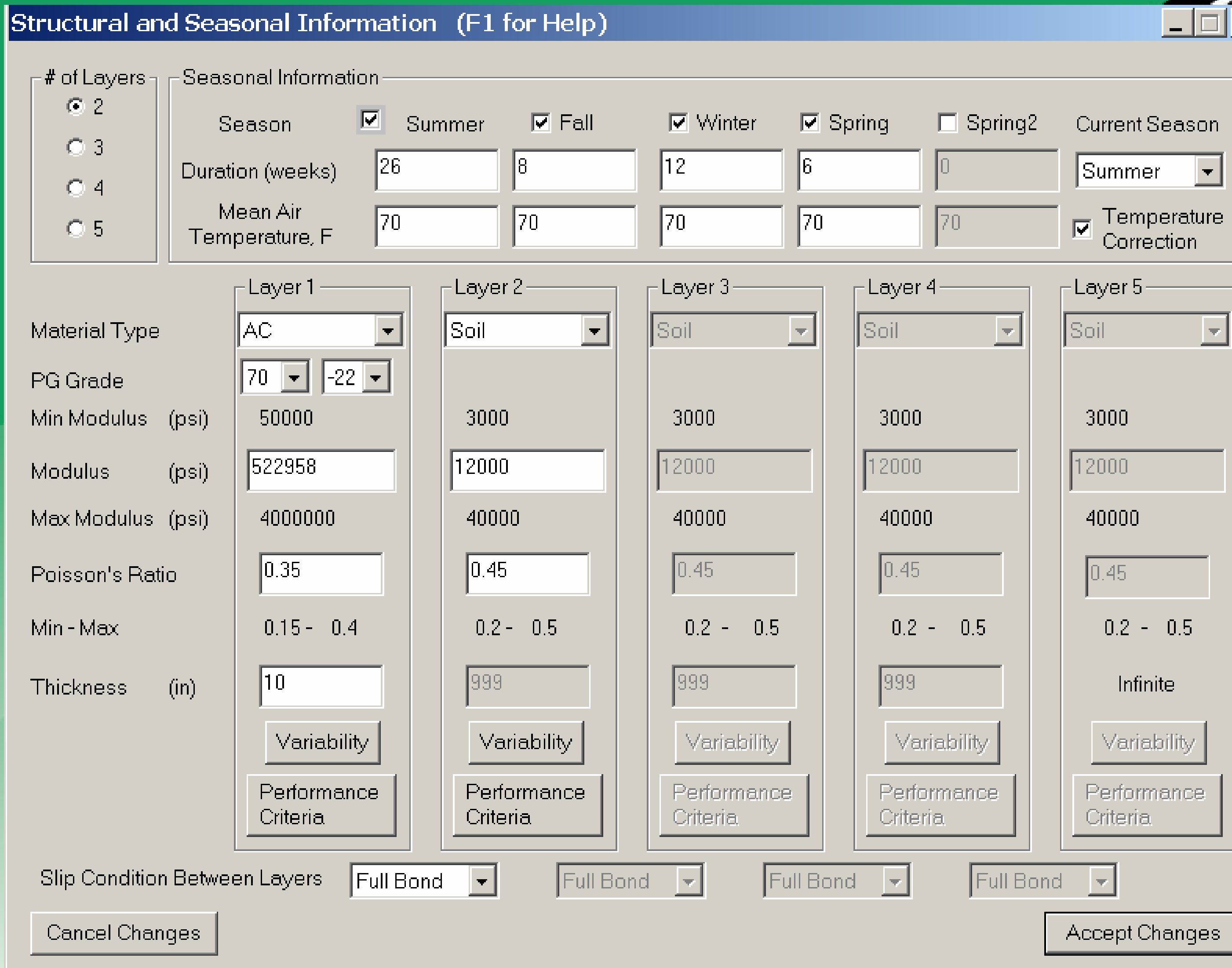
10 - 20/wk

Perpetual Pavements

Key Components

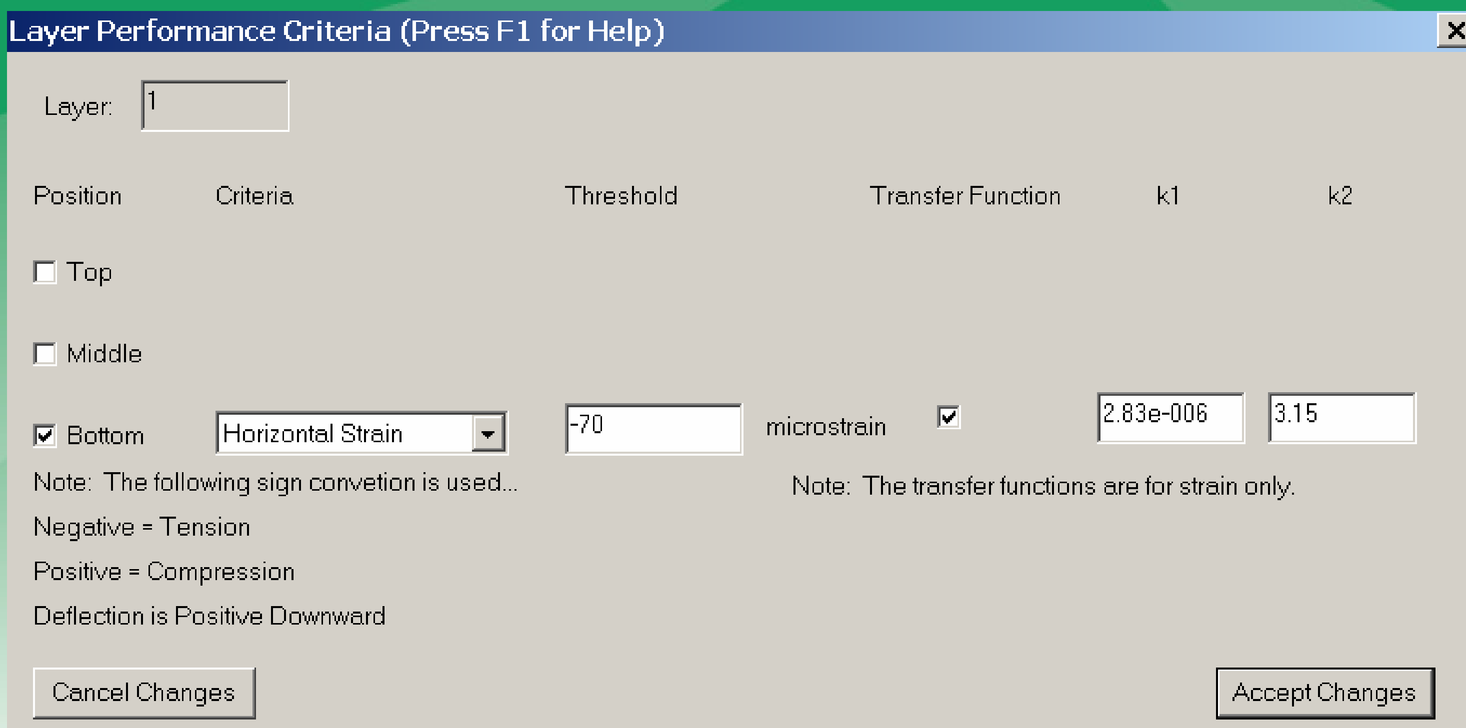
- Based on fully functional M-E design software
- Layered elastic analysis
- Incorporates
  - Seasonal effects
  - Thickness variability
  - Material property variability
  - Load Spectra or Traffic Count
  - Probabilistic analyses

Perpetual Pavements



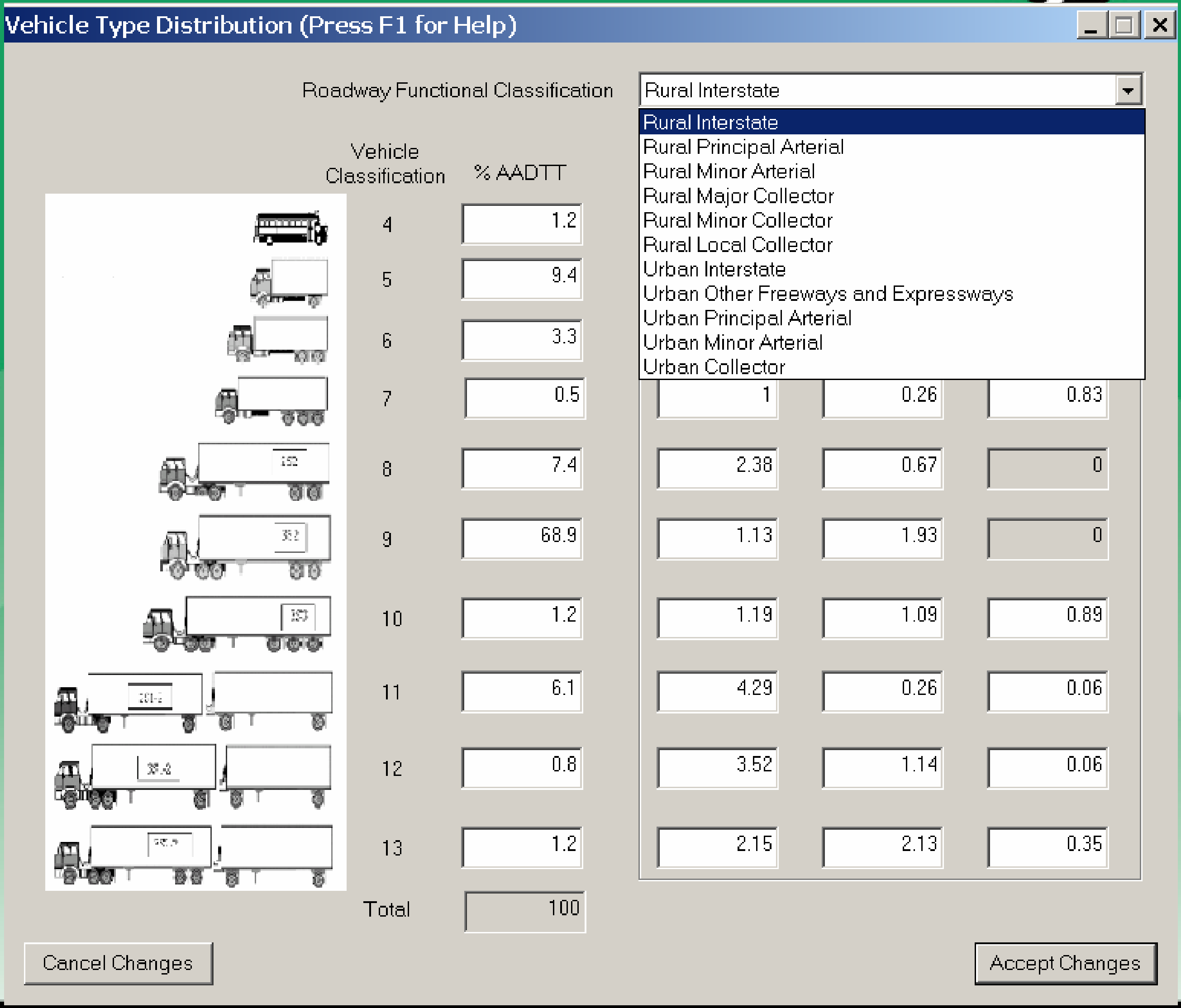
Perpetual Pavement Performance Criteria

- Designer selects location(s) in layer
- Type of criteria (stress, strain, deflection)
- Threshold value and transfer function

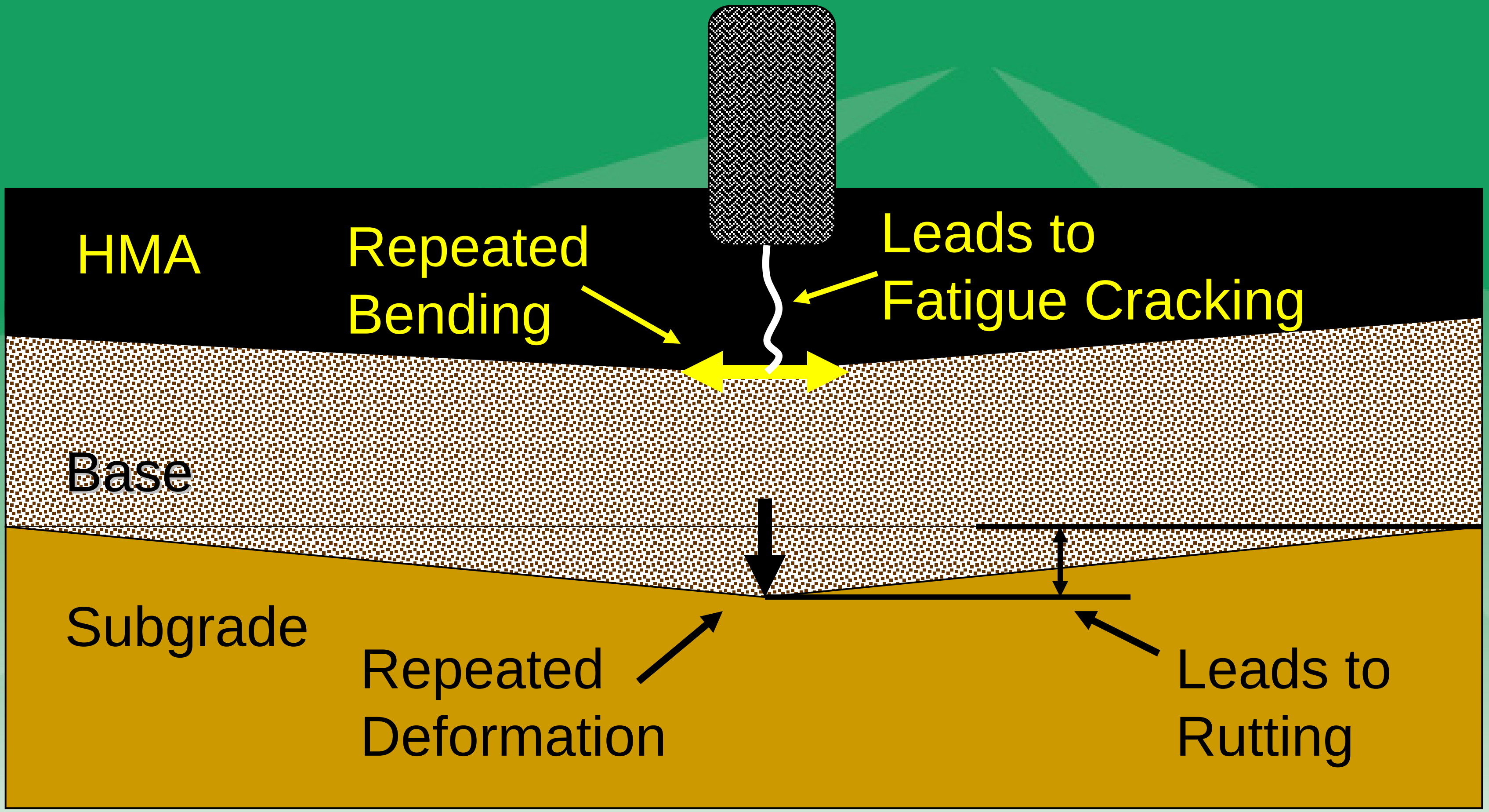


Perpetual Pavements

Traffic

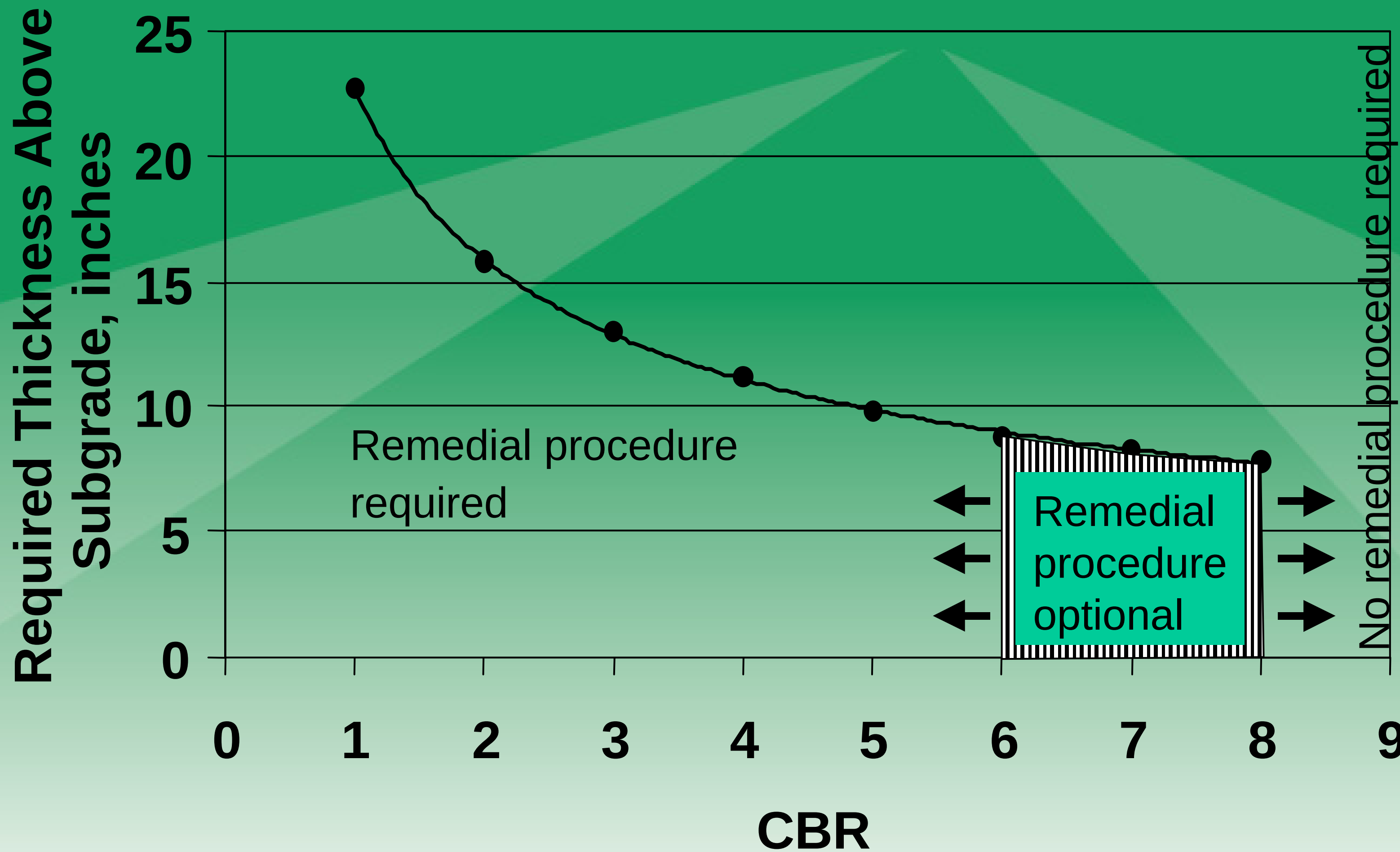


Performance Goals - Avoid These



Perpetual Pavements

Foundation - Illinois



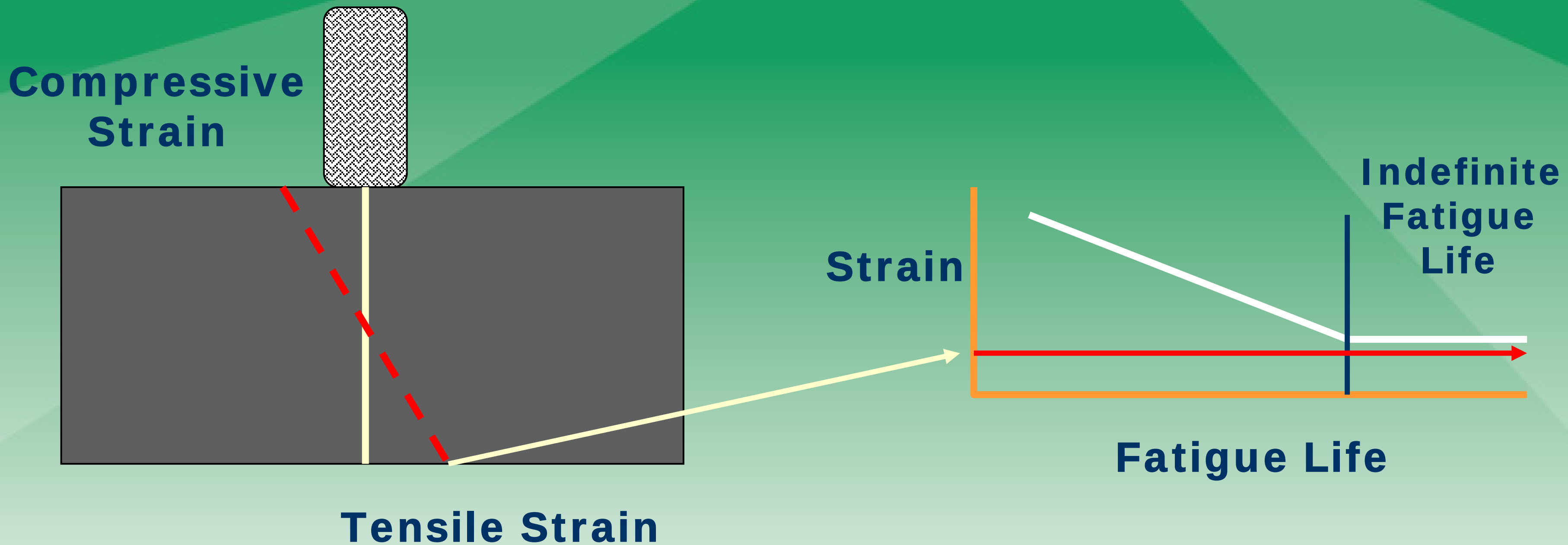
Perpetual Pavements

› Fatigue Resistant Asphalt Base

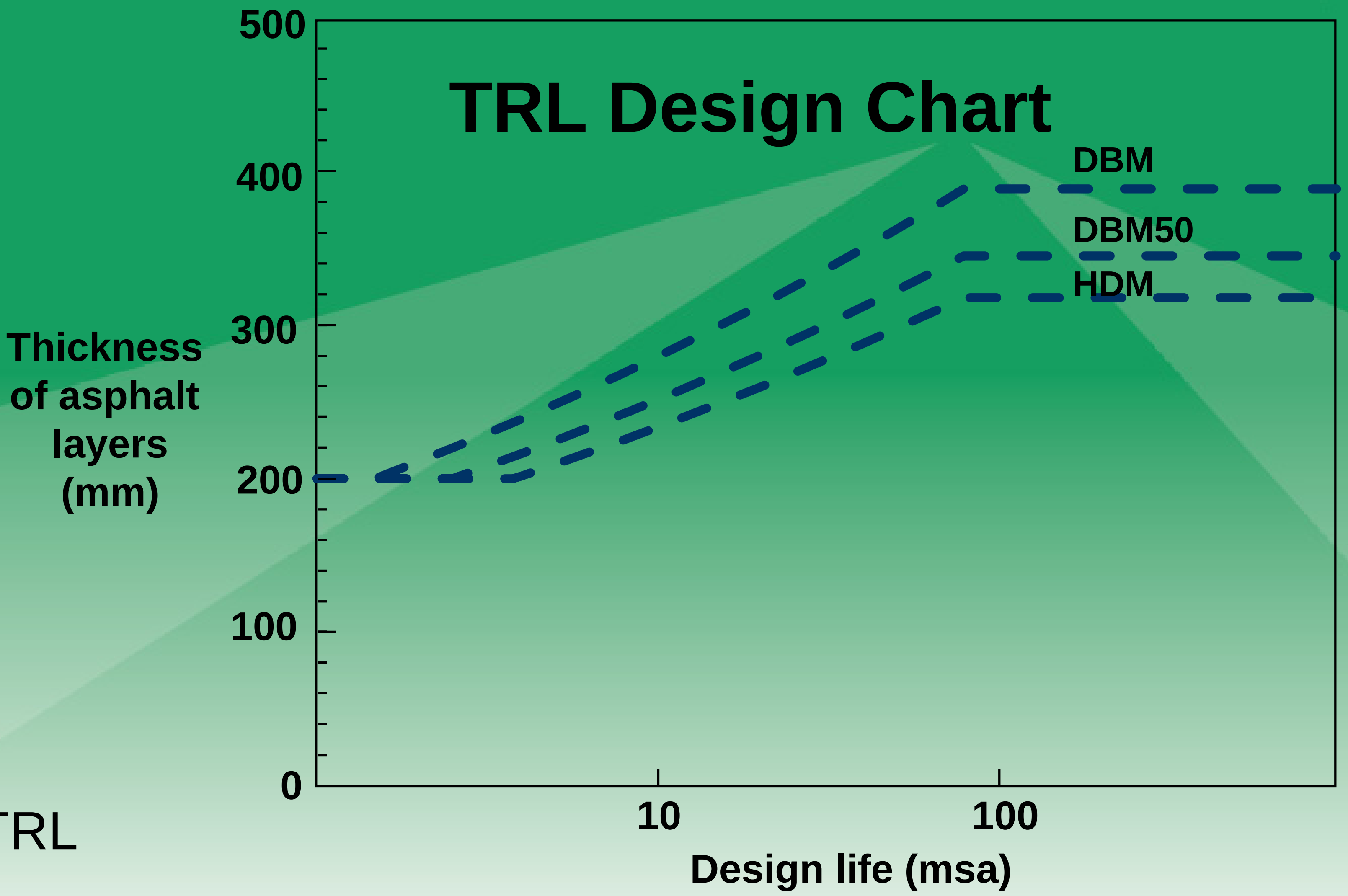
» Minimize Tensile Strain with Pavement Thickness

» Thicker Asphalt Pavement = **Lower Strain**

» Strain Below Fatigue Limit = **Indefinite Life**



Perpetual Pavements



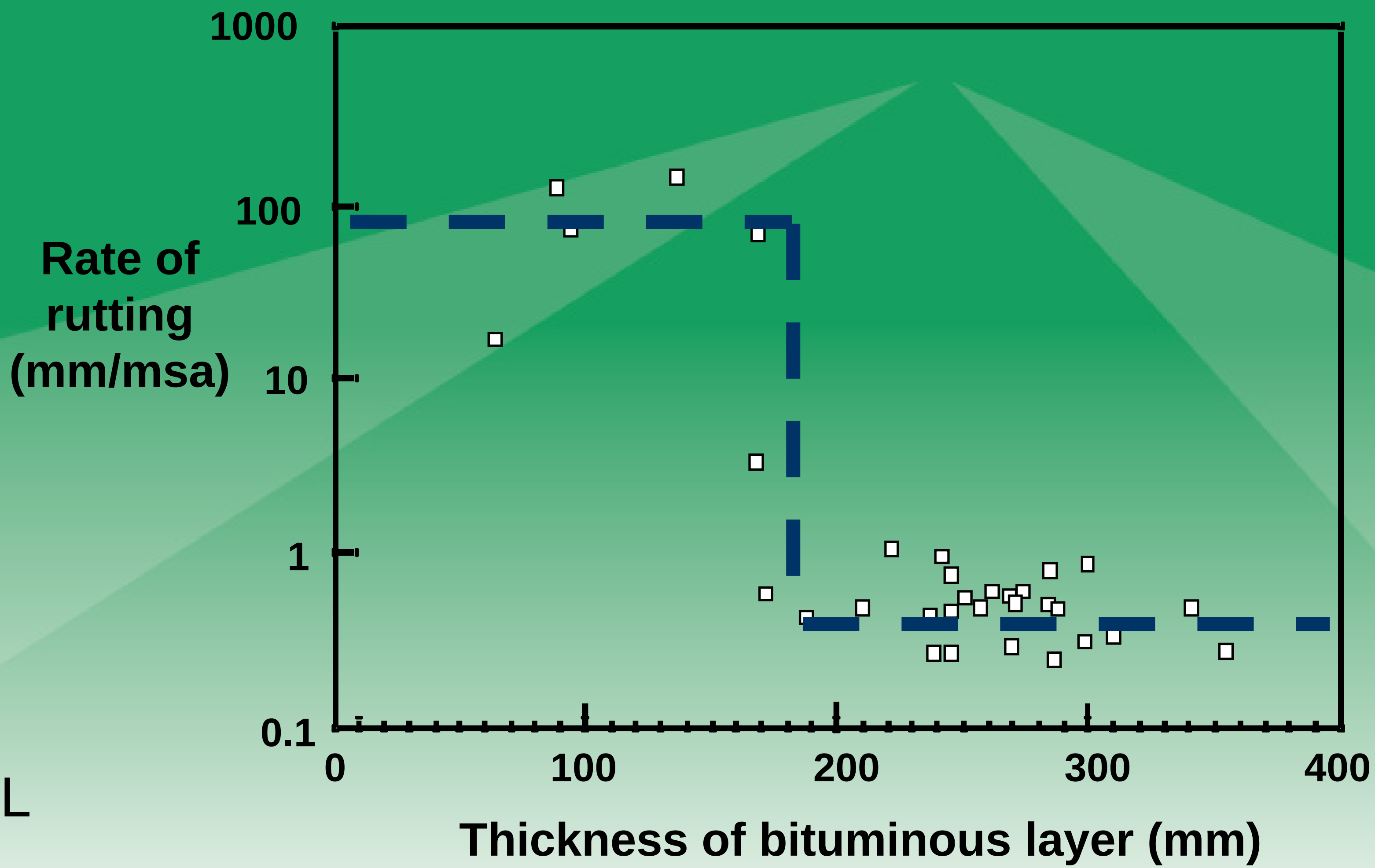
TRL

Perpetual Pavements

› Rut Resistant Upper Layers

- **Aggregate Interlock**
  - » ***Crushed Particles***
  - » ***Stone-on-Stone Contact***
- **Binder**
  - » ***High Temperature PG***
  - » ***Polymers***
  - » ***Fibers***
- **Air Voids**
  - » ***Avg. 4% to 6% In-Place***
- **Surface**
  - » ***Renewable***
  - » ***Tailored for Specific Use***

RATE OF RUTTING vs ASPHALT THICKNESS



TRL

Performance of Washington Interstate Flexible Pavements (based on 284 km)

Statistic	Time Since Original Construction (years)	Thickness of Original AC (mm (in.))	Time from Original Construction to First Resurfacing (years)
Average	31.6	230 (9.2)	12.4
Range	23 to 39	100 to 345	2 to 25

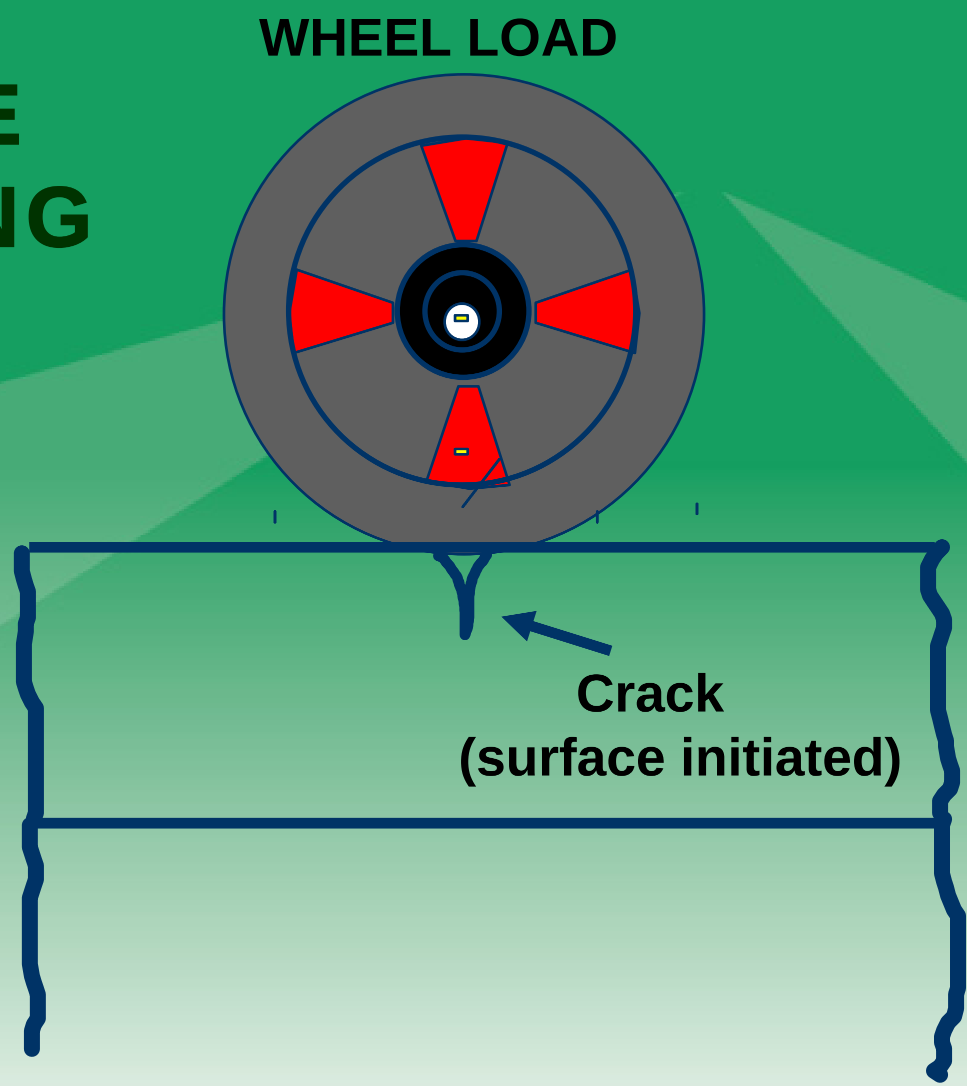
Ohio Study of Flexible Pavements

- Examined Performance on 4 Interstate Routes
  - HMA Pavements - Up to 34 Years without Rehabilitation or Reconstruction
  - "No significant quantity of work . . . for structural repair or to maintain drainage of the flexible pavements."
  - Only small incremental increases in Present Cost for HMA pavements.

FHWA - Data from Long-Term Pavement Performance Study

- **Data from GPS-6 (FHWA-RD-00-165)**
- **Conclusions**
  - *Most AC Overlays ≥ 15 years before Rehab*
  - *Many AC Overlays > 20 years before Significant Distress*
  - Thicker overlays mean less:
    - Fatigue Cracking
    - Transverse Cracking
    - Longitudinal Cracking

SURFACE CRACKING

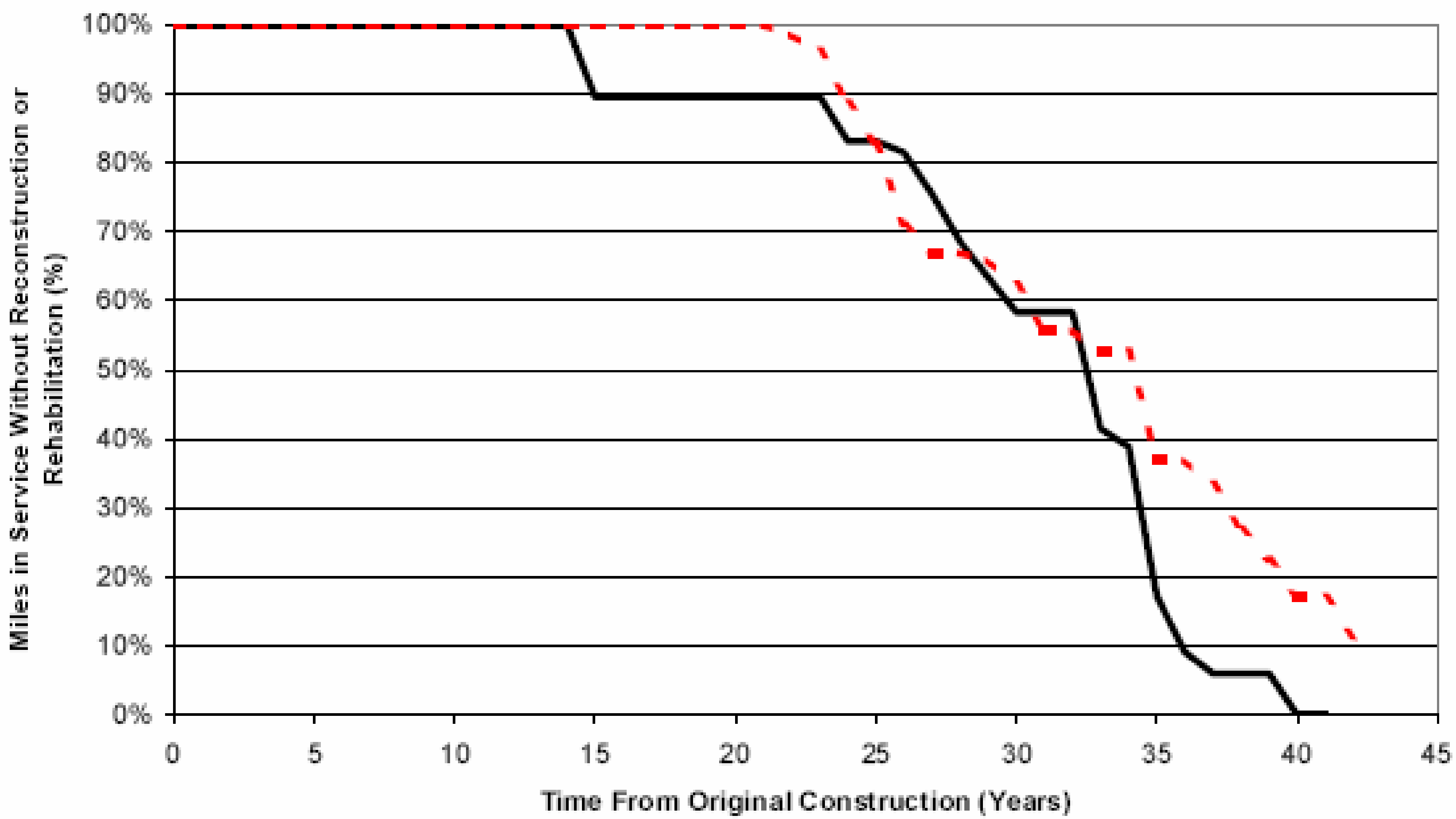


TRL

New Jersey I-287
Surface Cracking

Perpetual Pavements

Study of Kansas Interstates



Current Perpetual Pavement Efforts

- Europe
- California
- Colorado
- Illinois
- Kentucky
- Michigan
- Ohio
- Oregon
- Texas
- Wisconsin

Rehabilitation

APA ASPHALT PAVEMENT ALLIANCE

Possible Distresses

- ***Top-Down Fatigue***
- ***Thermal Cracking***
- ***Raveling***

Solutions

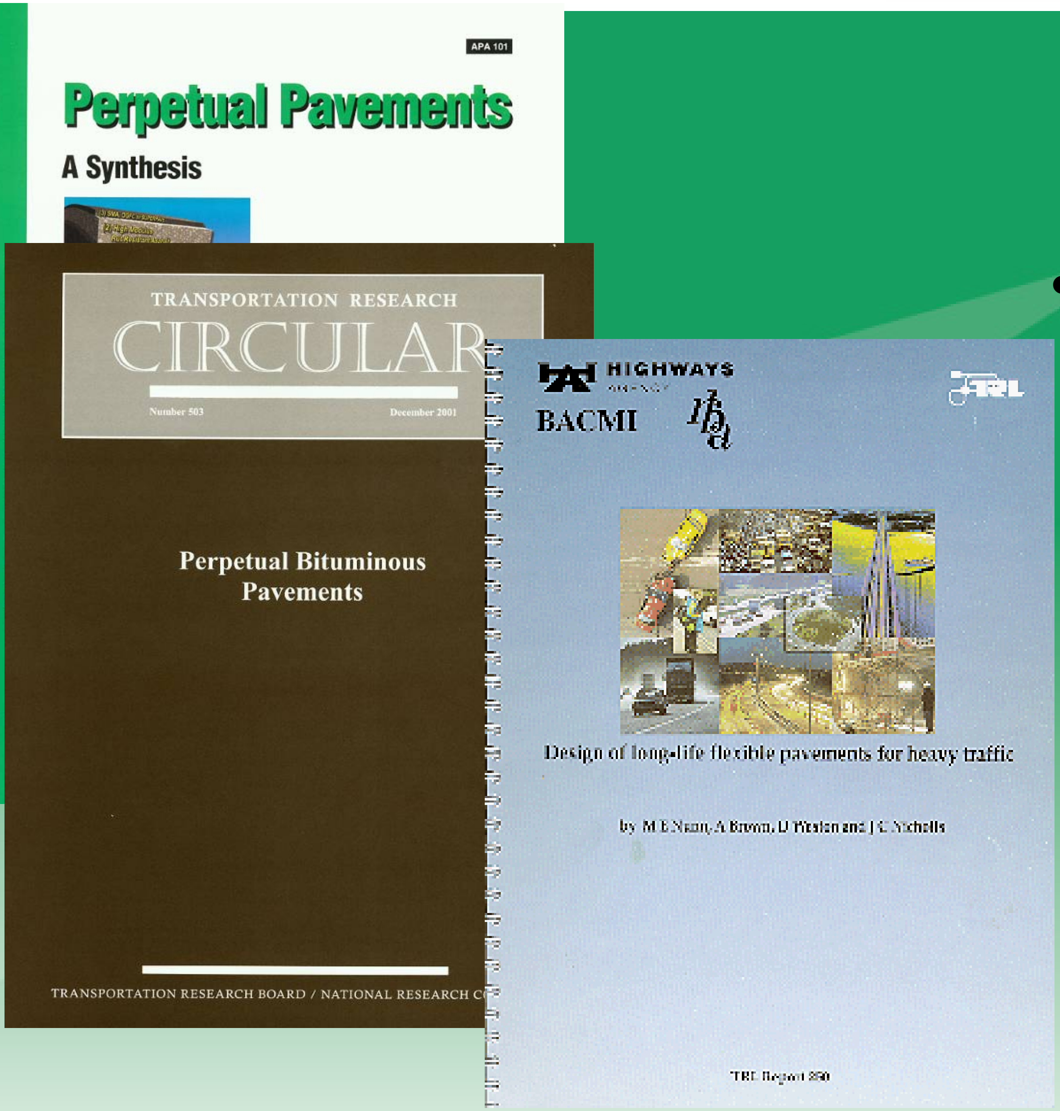
- ***Mill & Fill***
- ***Thin Overlay***

Perpetual Pavements

Perpetual Pavement

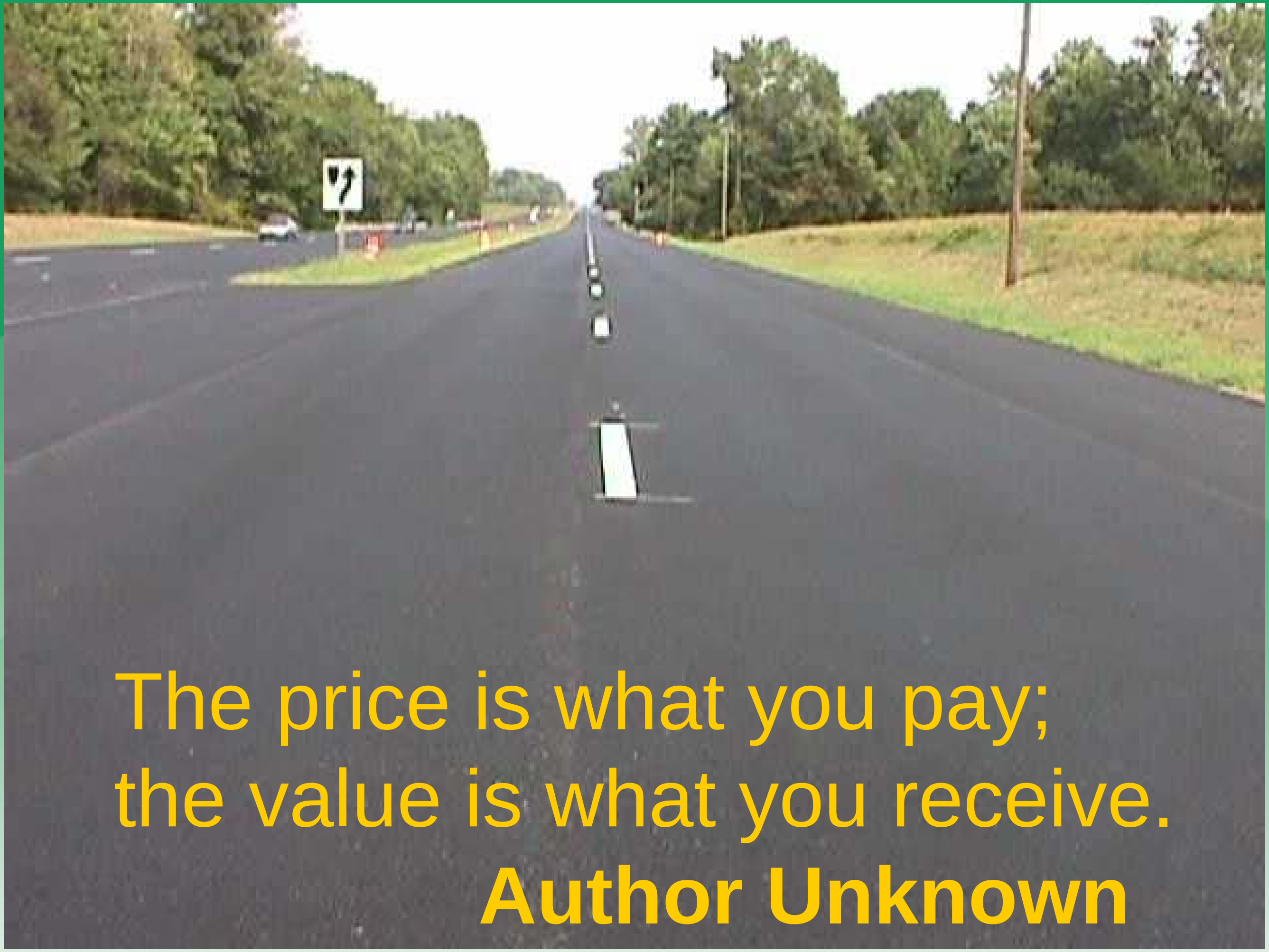
- Structure Lasts 50+ years.
  - Bottom-Up Design and Construction
  - Indefinite Fatigue Life
- Renewable Pavement Surface.
  - High Rutting Resistance
  - Tailored for Specific Application
- Consistent, Smooth and Safe Driving Surface.
- Environmentally Friendly
- Avoids Costly Reconstruction.

References



- Int’l Conferences on Perpetual Pavements
  - Int’l Soc. for Asphalt Pavements – 2004
  - Ohio – 2006

Value - Paraphrased



The price is what you pay;
the value is what you receive.

Author Unknown