Future of the Asphalt Paving Industry

Association of Modified Asphalt Producers

Las Vegas, Nevada

February 1, 2005

Adam Hand

Granite Construction Inc.

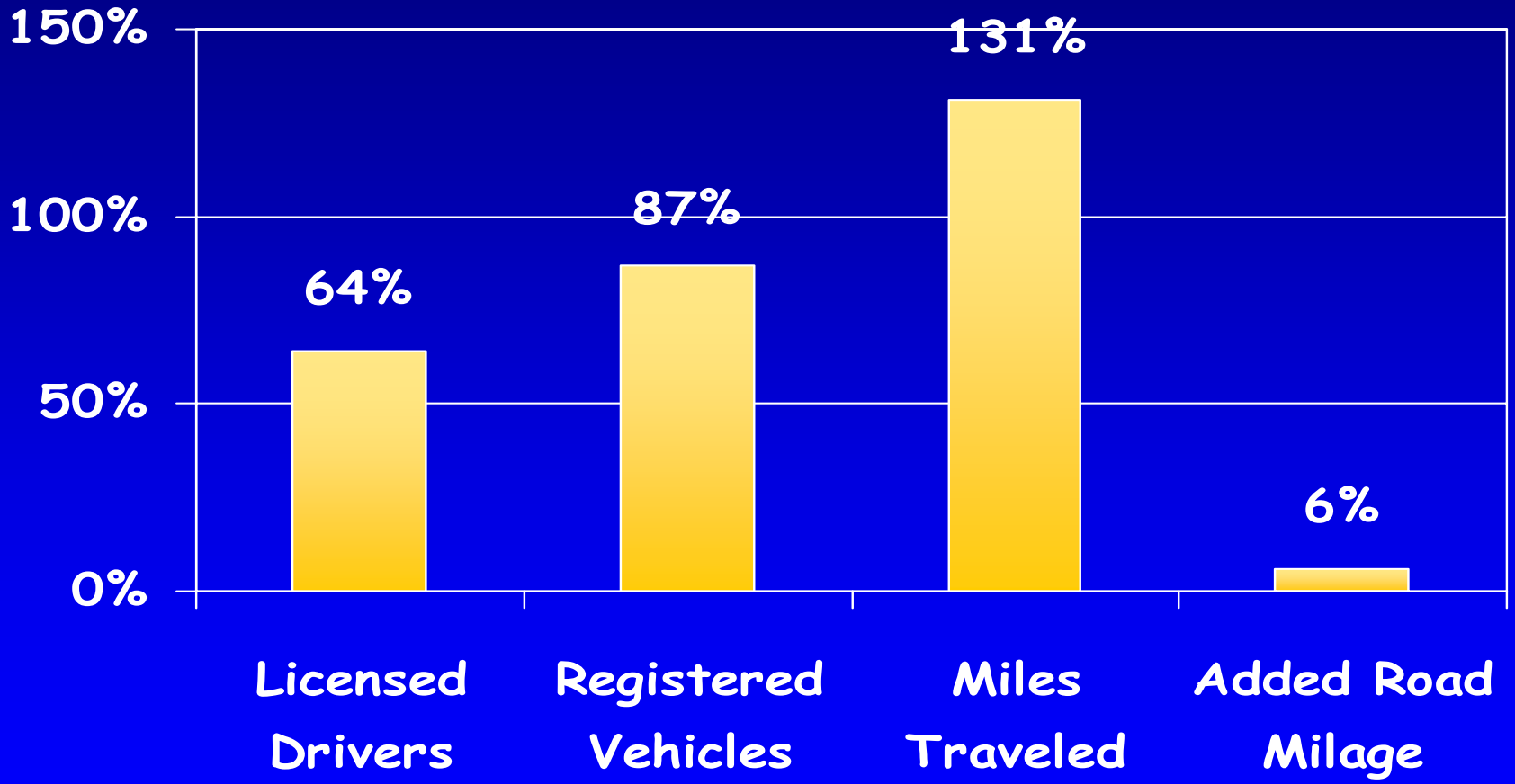
NAPA HMA Vision 2000 & Beyond

- Predictions from 1997-2000 Surveys
  - Industry
  - Agency
- Authors
  - Jon Epps
  - Matt Witczak
  - Dale Decker
  - Mike Acott

Major Issues Facing Industry

- Demand for Highways
- HMA Industry Change
- Funding
- Environmental, Safety and Health
- Quality

Increased Demand on Highways 1970-1997



3 Trillion Tons of Freight Annually

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HMA Industry Change

- Size
  - Increase in Size, but Decrease in Number
- Value
  - Increase
- Consolidation
  - Acquisitions and Mergers
- Structure
  - Vertical Integration

Change in DOT's

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Downsize

- 2/3 State DOT's Since 1997
- Next 5 Years
  - 30% Retire
  - Average Age 52 to 40

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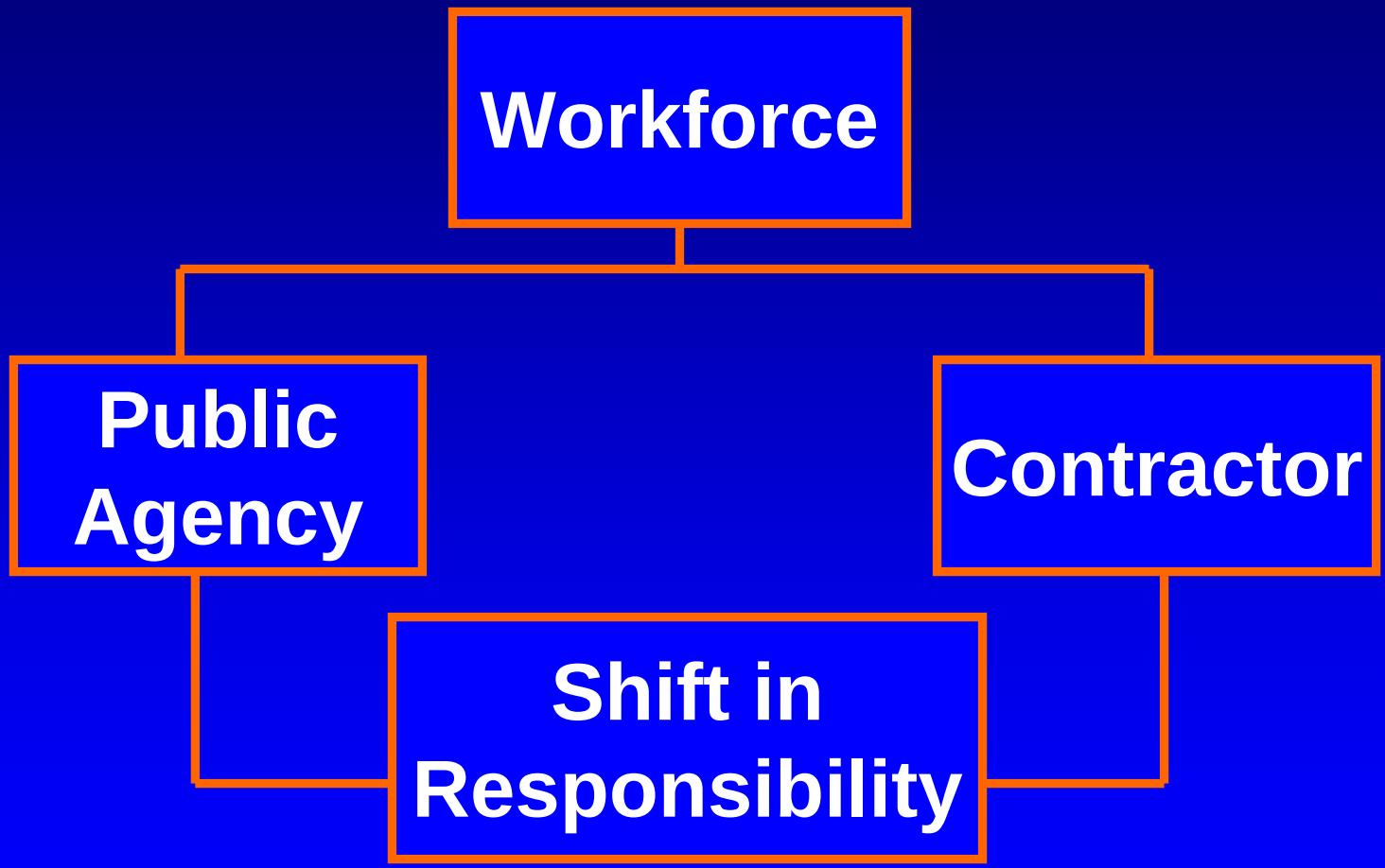
Conflict

- Reduced Workforce
- Increased Revenue
- Customer Demands

Shift in Responsibility



Transfer of Responsibility

- Design
- Construction Management
- Quality
- Maintenance
- Operation

What is Quality

- Meet Specification
- Customer Satisfaction
  - Road Users
    - Smoothness
  - Material Suppliers/Contractor
    - Consistency

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Innovative Contracting

- Low Bid Approach
- Reward Quality/Innovation
- Reduced Public Agency Workforce
- Transfer of Responsibility

Innovative Specifications

- QC/QA – 35 plus states
- End Result
- Warranty/Guaranty
- Design/Build
- Design/Build/Operate (maintain)

How Do Polymer Modified Asphalts Fit in the Future?

Must Understand Performance!

Ex. Warranties - History

- 1890's to 1920's
  - HMA patented
  - 10 or 15 year warranty
  - Material and workmanship
- 1920's
  - Patent protection lost
  - Warranties discontinued
- 1950's
  - Federal participation
  - State responsible for maintenance
  - Warranties not allowed

Ex. Warranties - History

- 1990
  - European asphalt study tour
  - FHWA Special Experimental Project 14
  - Innovative contracting methods (including warranties)

Ex. Warranties - History

- 1993
  - First pavement warranty project
- 1995
  - Three warranty projects
- 1996
  - Seven warranty projects
- 1997
  - More than 20 warranty projects
- 1998- Today
  - Many

Warranty Types

- Materials and Workmanship
- Performance

Materials and Workmanship Warranty

- Follow state specifications
- Define unacceptable performance
- If problem, forensic to determine if specifications were met

Performance Warranty

- Contractor sets specifications
- Define unacceptable performance
- If problem, contractor responsible for repair

Warranty Specification Details

- Acceptance criteria
- Performance criteria
- Size of elements
- Pavement evaluation
- Dispute resolution

Warranty Performance Criteria

- Engineering properties
  - Rutting
  - Cracking
  - Raveling
  - Ride
- User properties
  - Smoothness
  - Safety (hydroplaning in ruts)
  - Safety (friction number)

Warranty Pavement Evaluation

- What Performance Parameters
- How often?
- By who?
- Sample rate?
- Flow of information?

Benefits

- Definition of Success
- Balanced Risk
- Innovation Rewarded
- Non-confrontation Construction
- Improved Quality

Contractor Controls Own Destiny

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Question

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Must Understand Performance!

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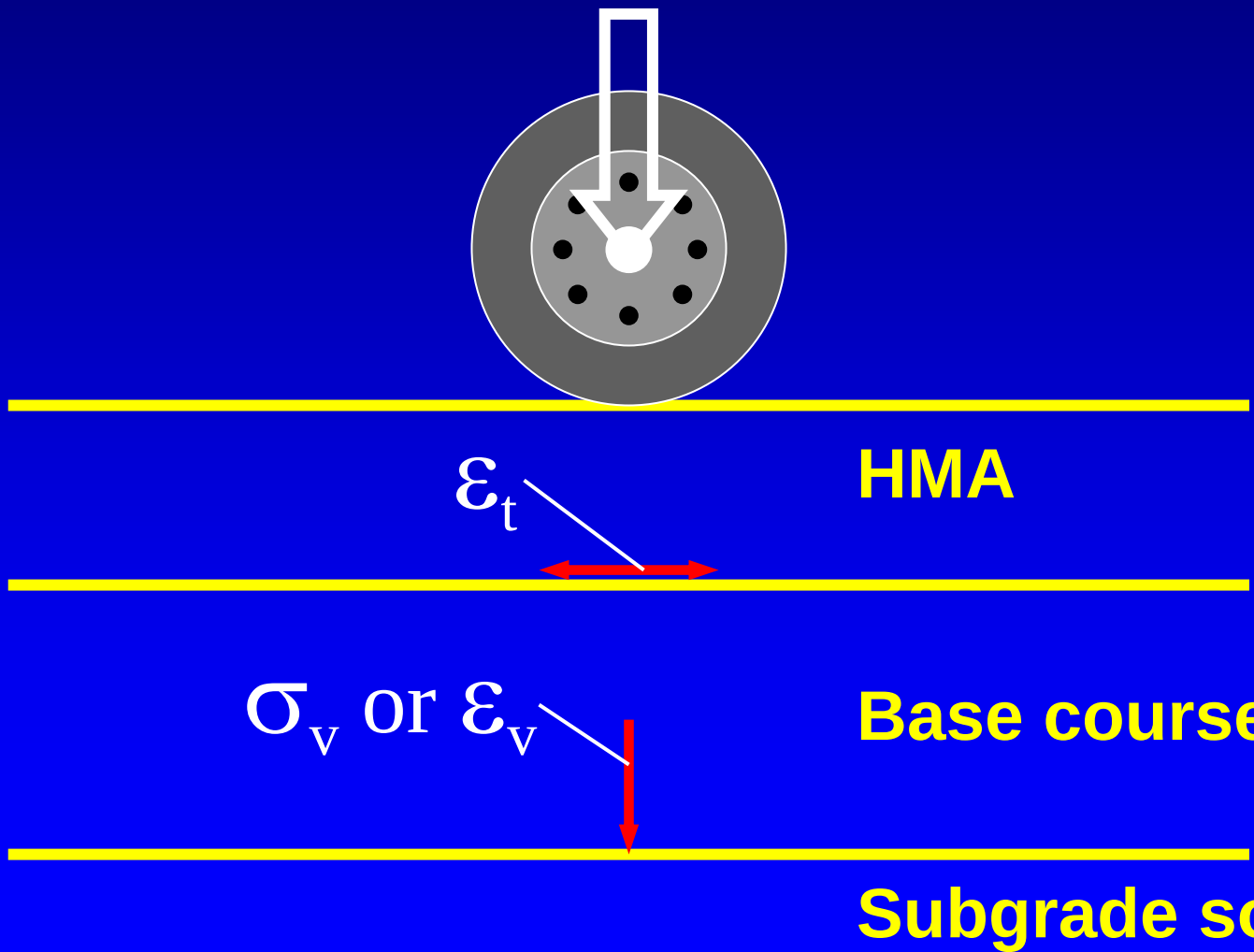
What is Performance?

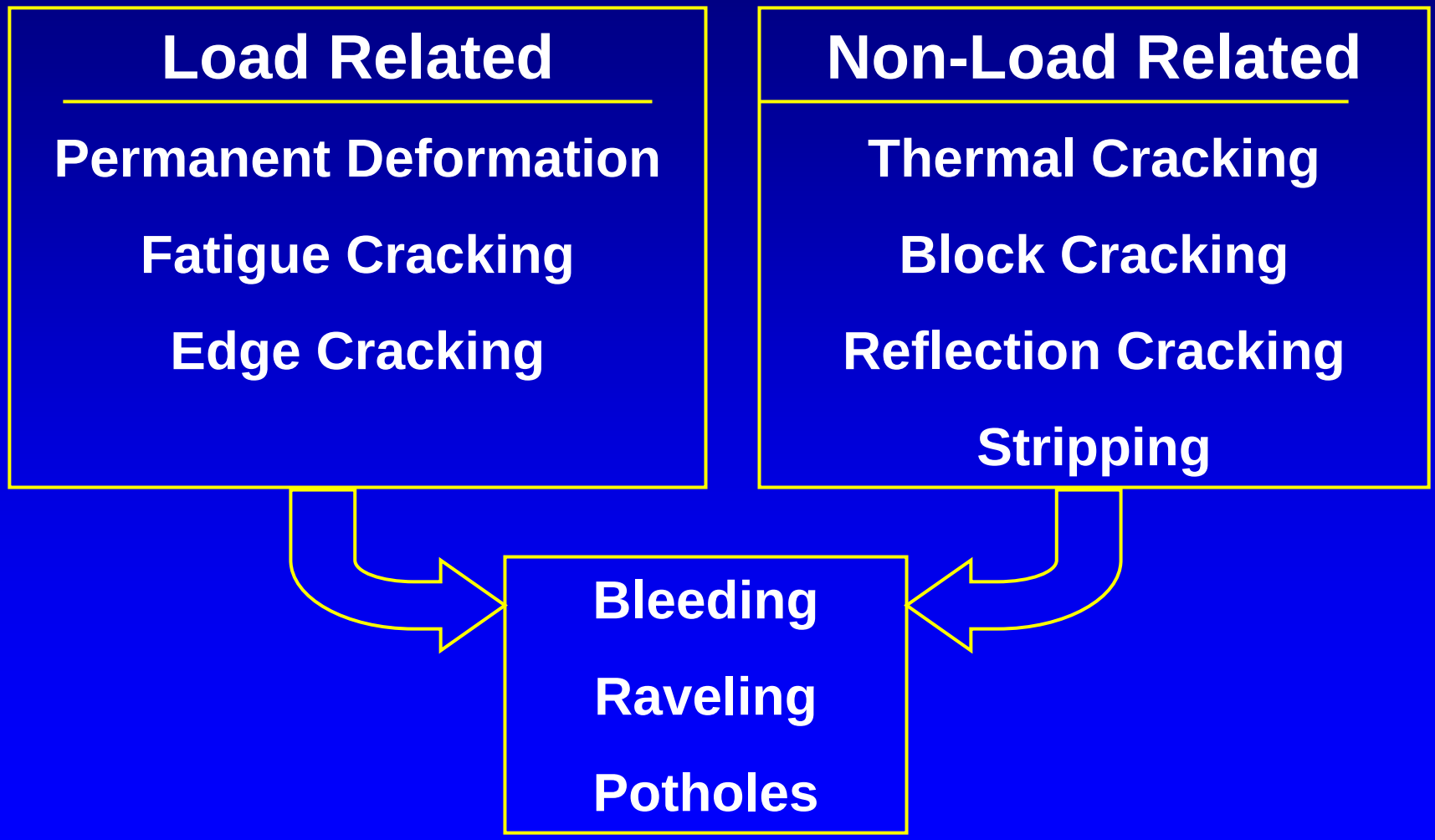
Structural Performance



Functional Performance

- Ride Quality
- Noise
- Friction
- Color

Modes of Failure

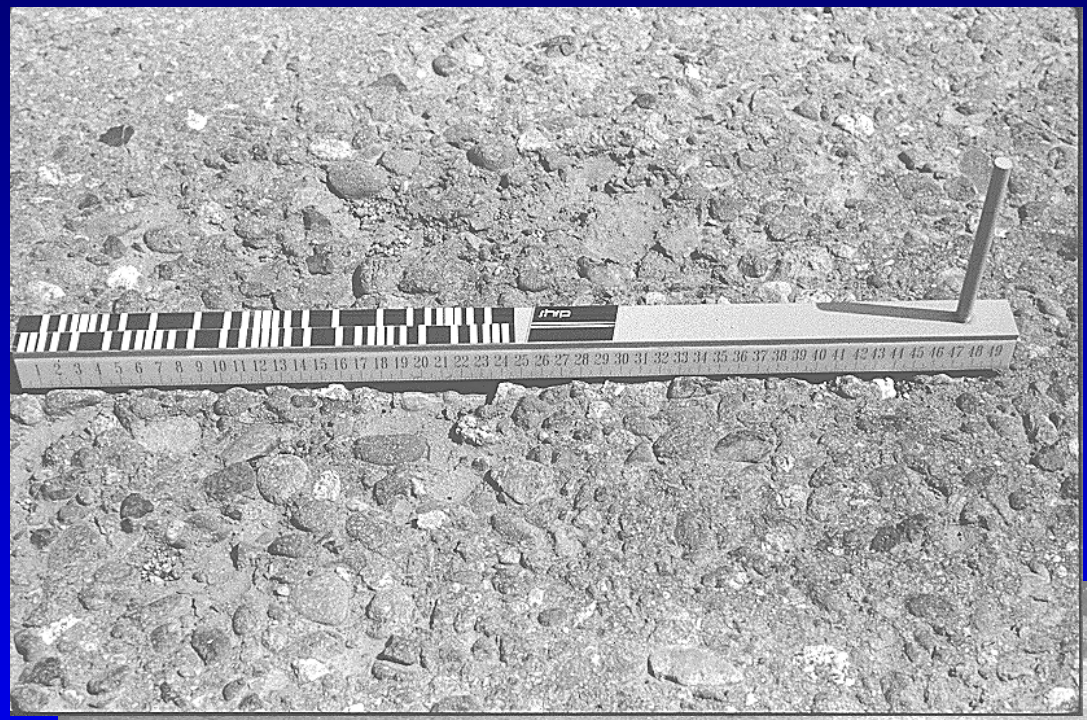


Rutting

Fatigue Cracking

Thermal Cracking

Durability



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Potholes

Question

How Do We Improve HMA Performance with Polymer Modified Asphalts

- **Materials**
- **Design**
- **Construction**

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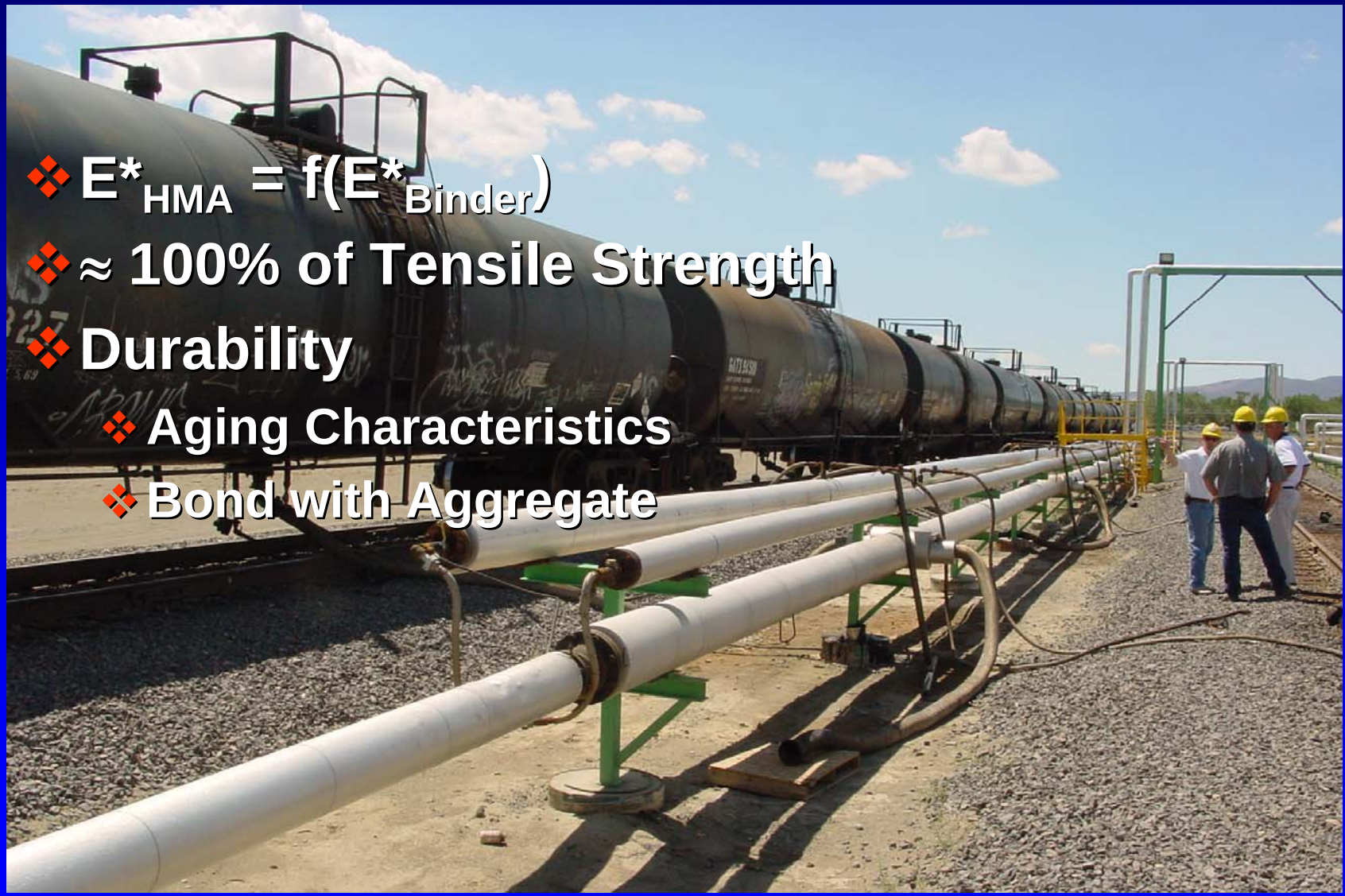
Asphalt Binder Contribution to HMA

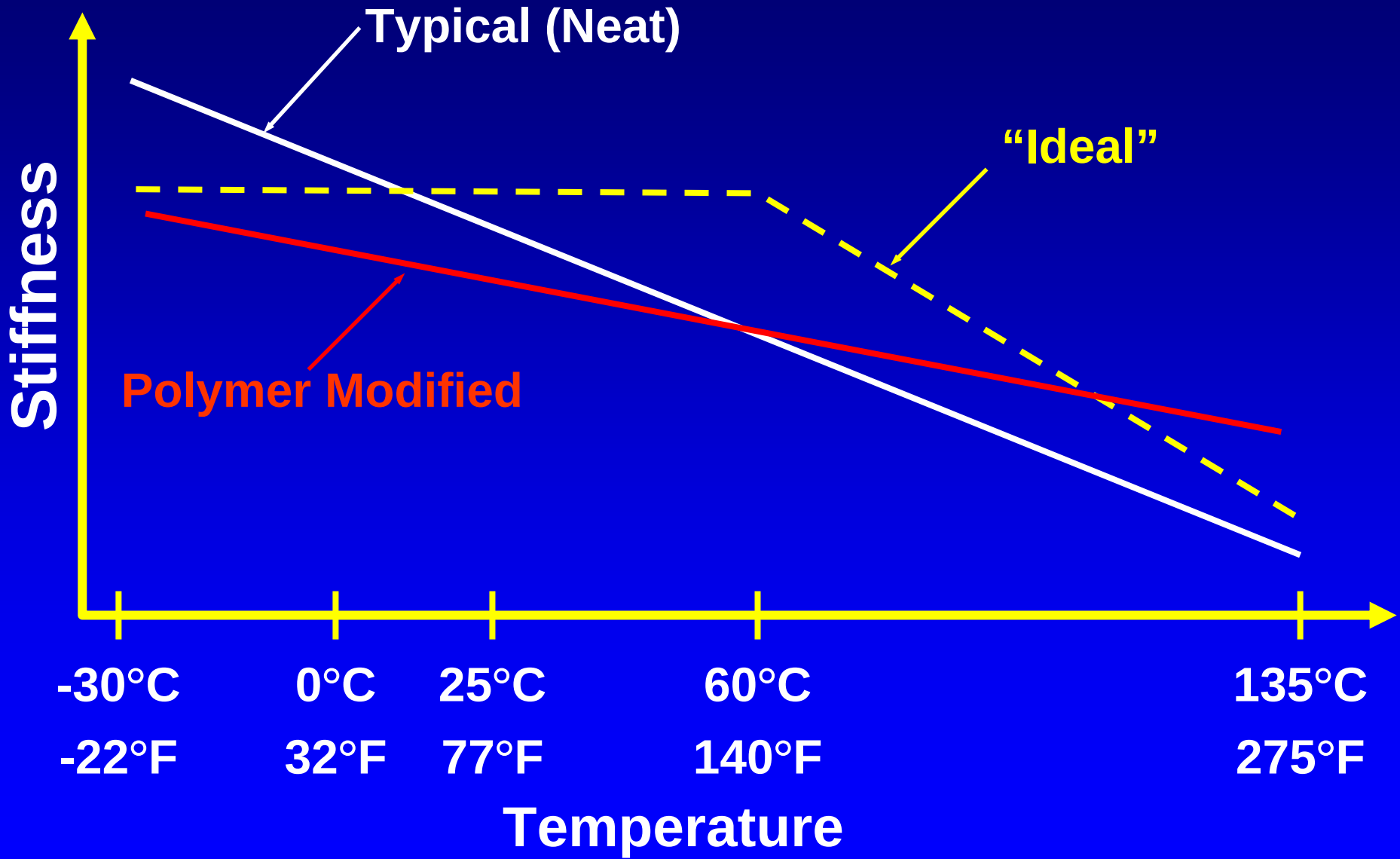


- $E^*_{HMA} = f(E^*_{Binder})$
- ≈ 100% of Tensile Strength
- Durability
  - Aging Characteristics
  - Bond with Aggregate

Materials - "Ideal" HMA Binder

- Low Stiffness at Construction Temps
- High Stiffness at High In-service Temps
- Low Stiffness at Low In-service Temps
- Excellent Long-term Durability

Asphalt Binder Behavior



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Reasons for PMA Use

- Increase High Temperature Stiffness
  - Rutting, Bleeding/Flushing Resistance
- Reduce Low Temp Stiffness
  - Thermal Cracking
- Improve Fatigue Resistance
- Improve Binder-Aggregate Bonding
  - Raveling, Stripping
- Improve Age Hardening Resistance
  - Durability
- Stiffen HMA Layers
  - Reduce Required Thickness
- Improve Overall Performance as Viewed by the Highway User

Superpave SPT (E*)

- Dynamic Modulus
  - E*/sinϕ
- Triaxial Creep
  - F_T= Flow Time
- Repeated Load Triaxial
  - F_N= Flow Number

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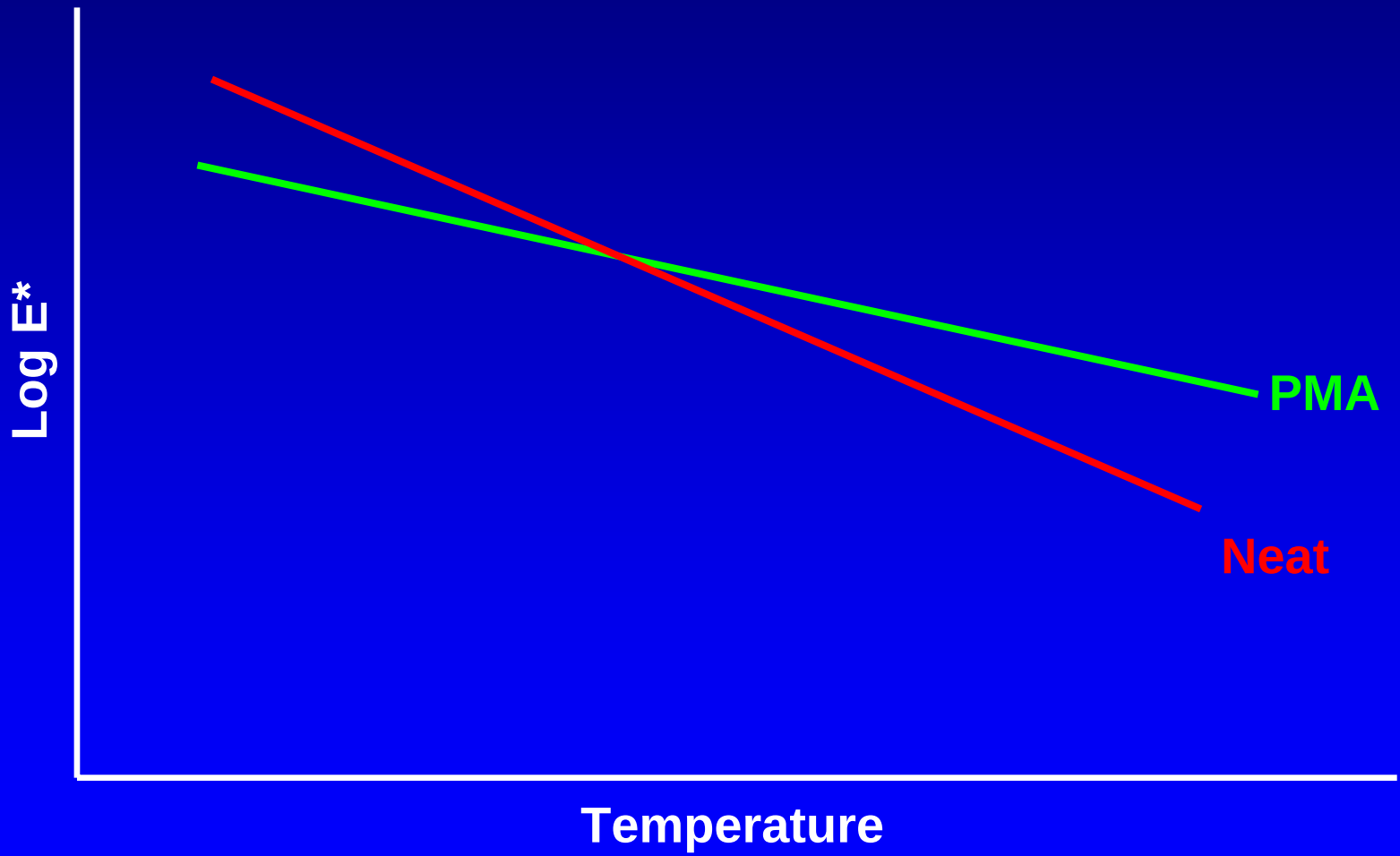
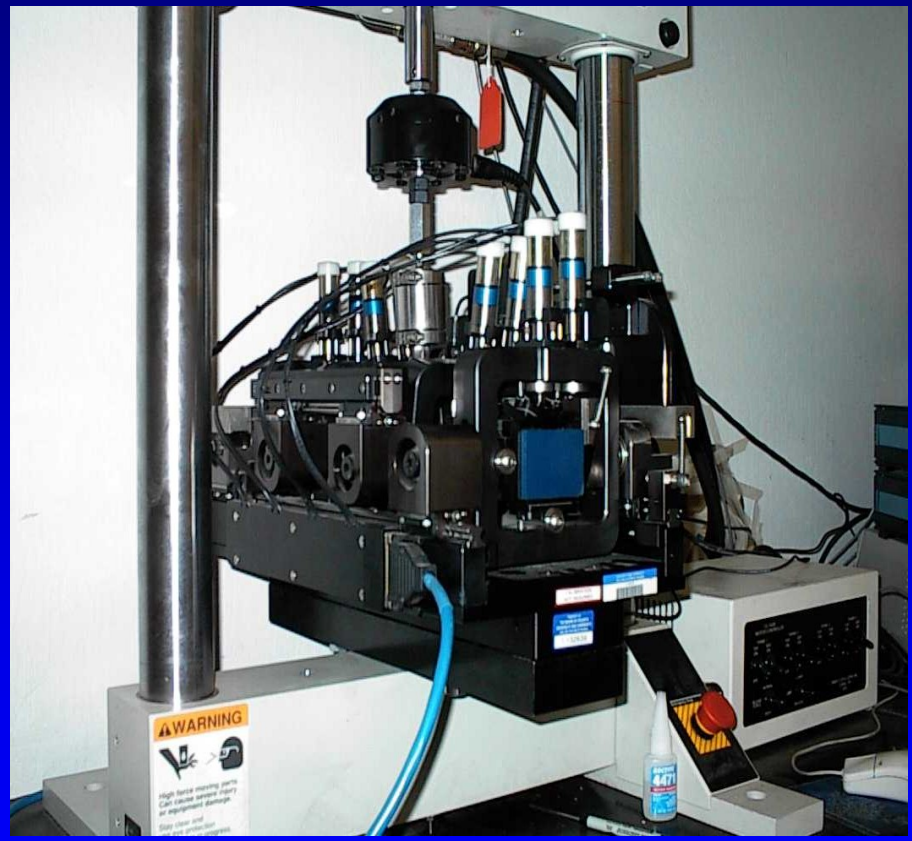
Rutting and Fatigue: E*



Flexural Fatigue



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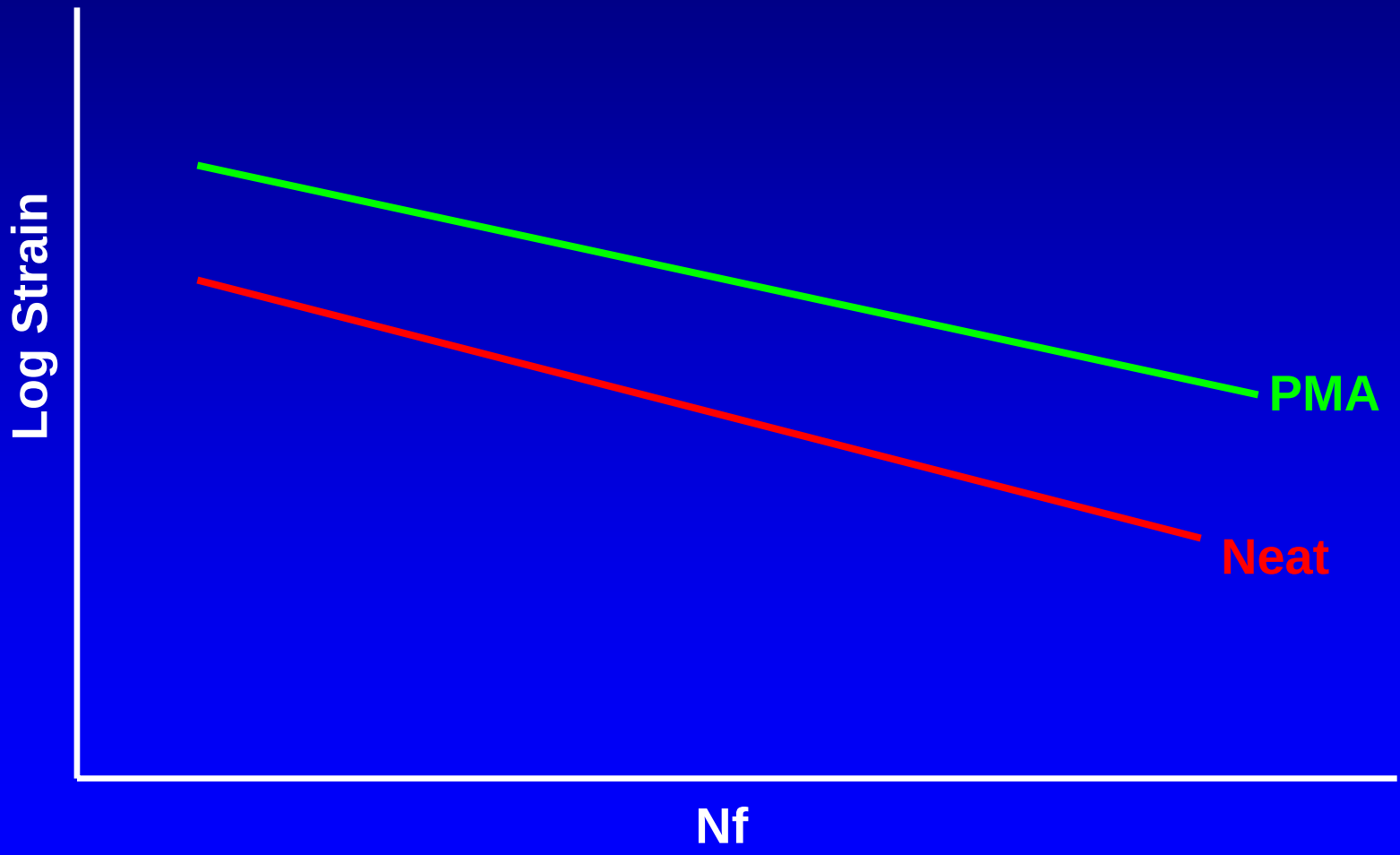
Fatigue



IDT/Durability

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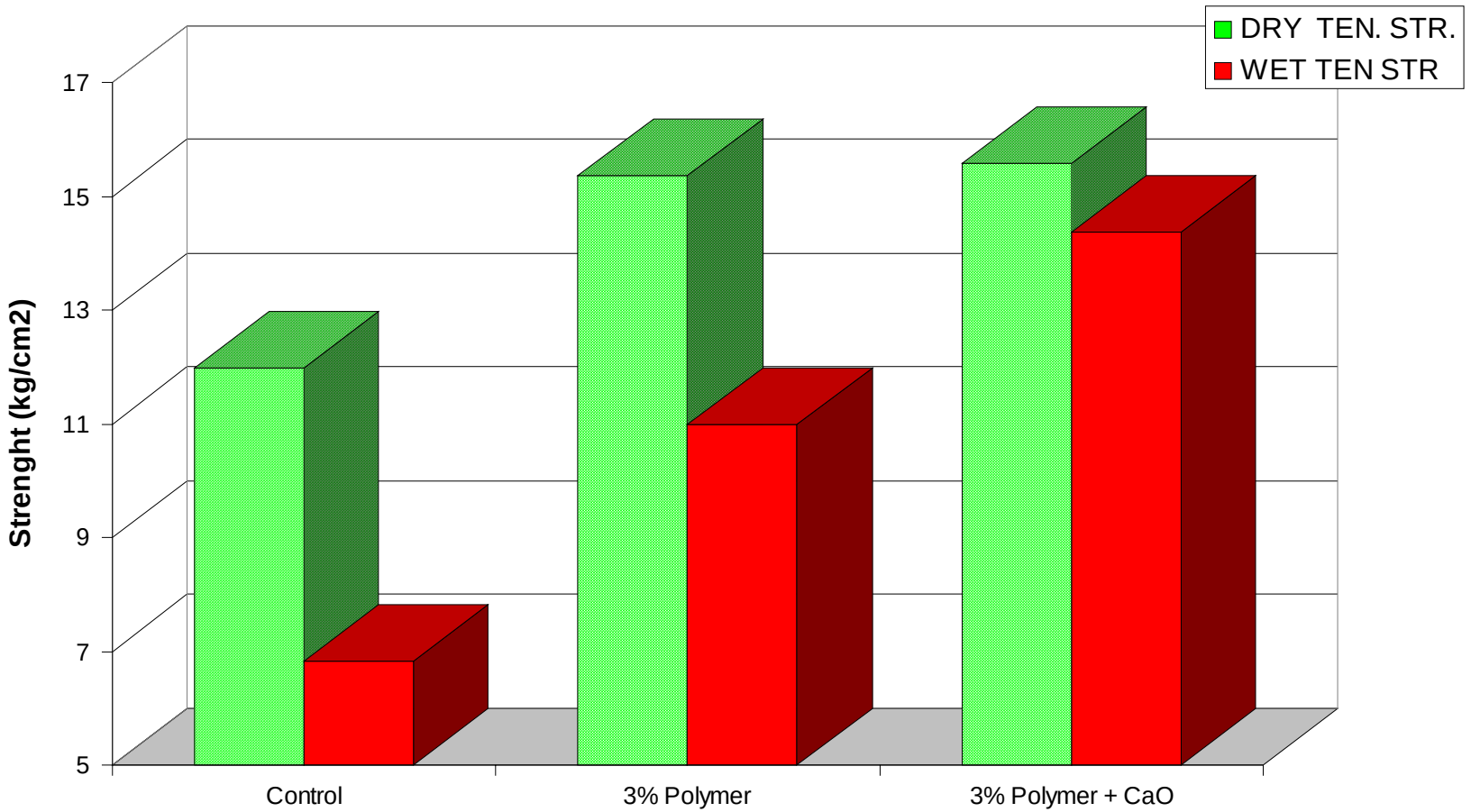
Lottman IDT Strengths



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Question

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- **Design**
- **Construction**

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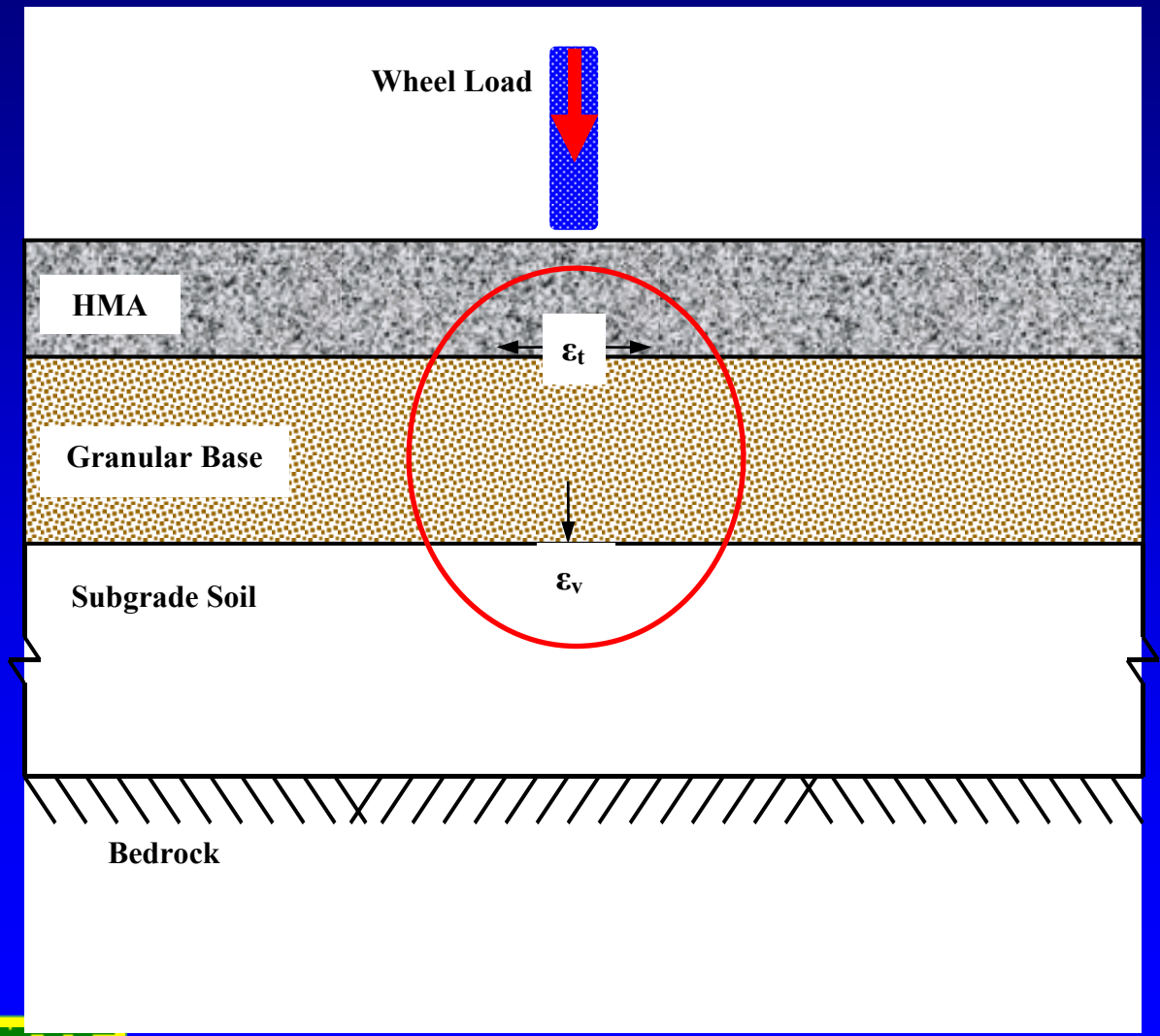
1993 AASHTO Structural Design Considerations



1993 AASHTO HMA Layer Coefficient (a_1)

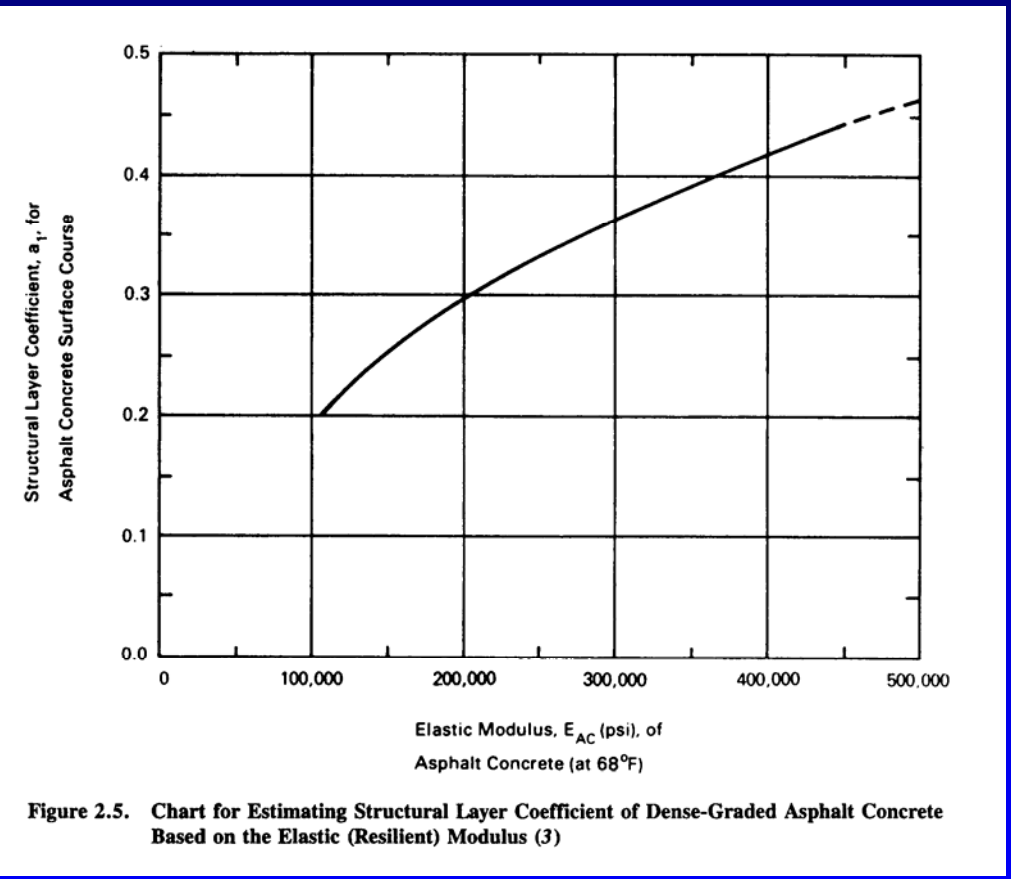
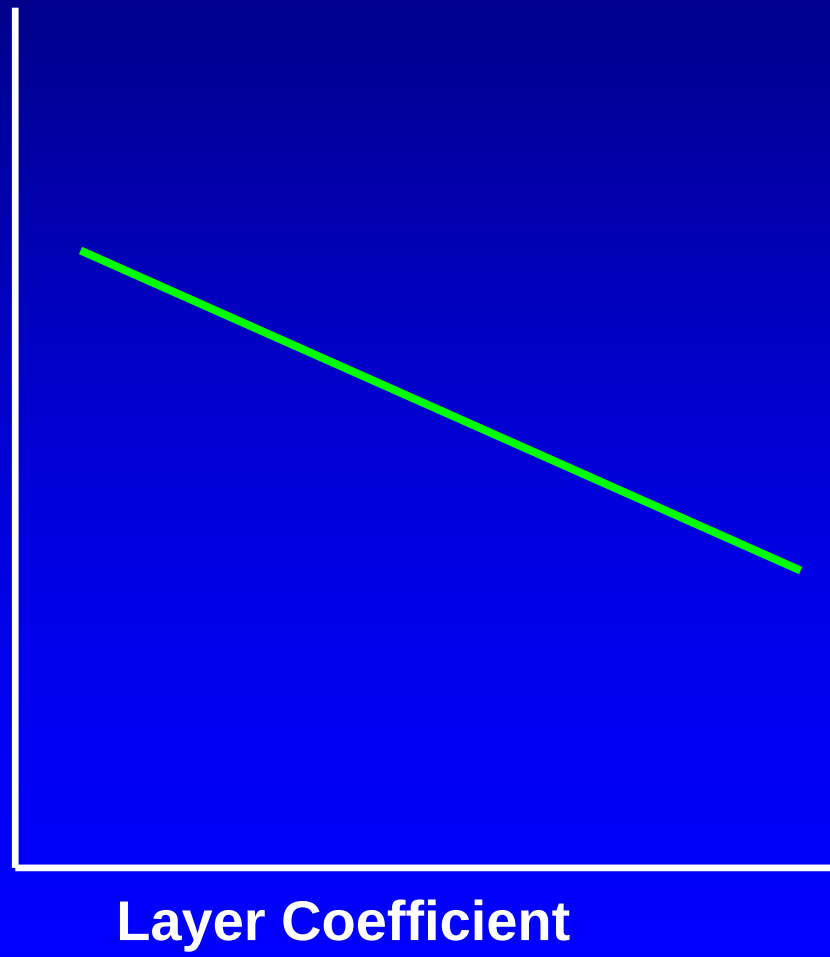


Figure 2.5. Chart for Estimating Structural Layer Coefficient of Dense-Graded Asphalt Concrete Based on the Elastic (Resilient) Modulus (3)



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Stiff Asphalt Layer Concept

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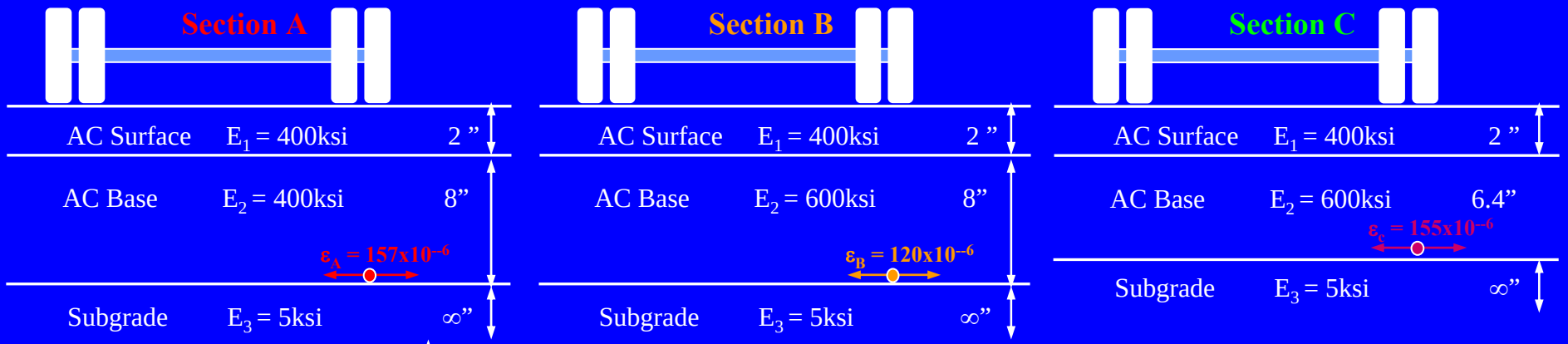
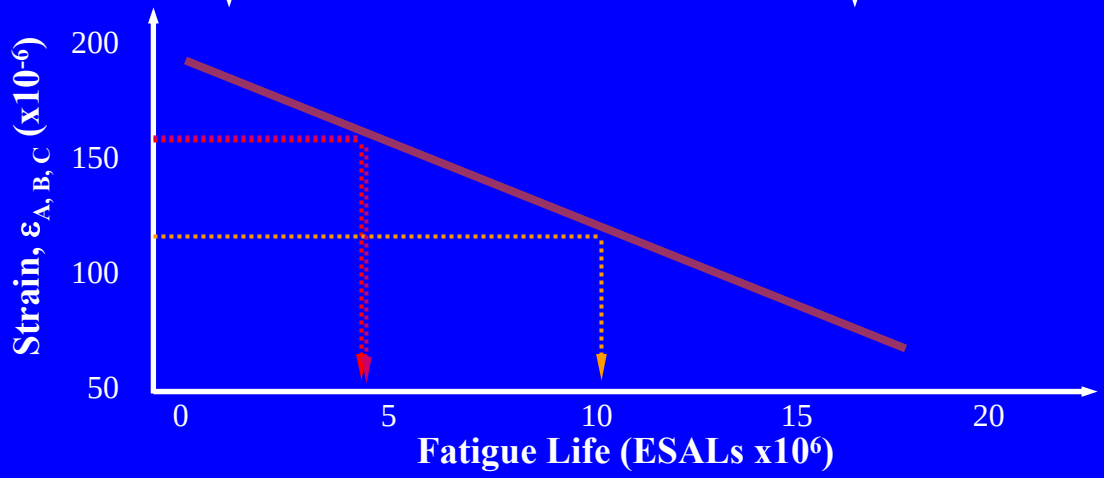
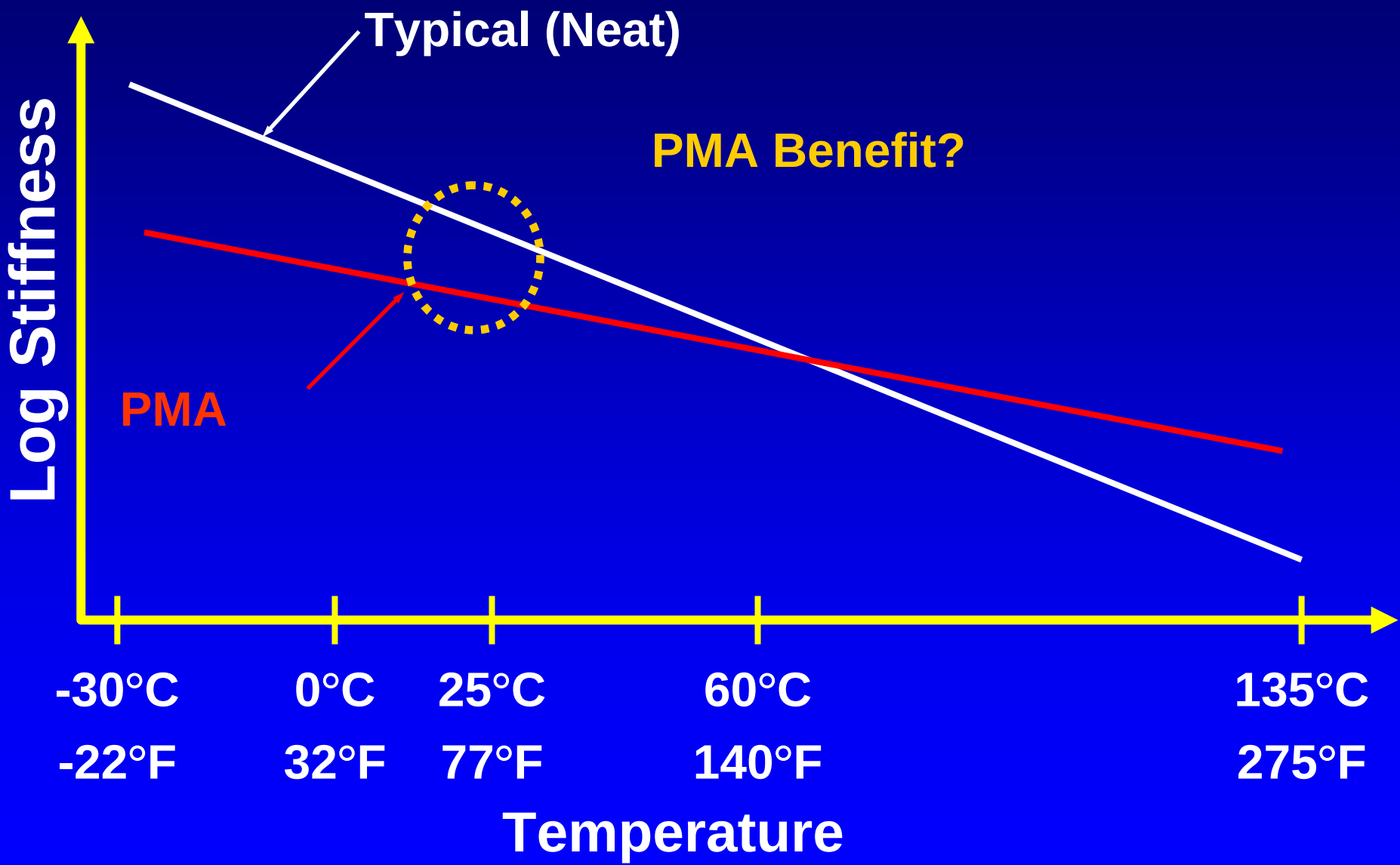




Section	Modulus (ksi)	Pavement Thickness (“)	Fatigue Life (ESALs x10⁶)	Cost Comparison	
A	400	10.0	4.5	100.0	100.0
B	600	10.0	10.5	108.0	116.0
C	600	8.4	4.5	90.4	96.8

Asphalt Binder Behavior



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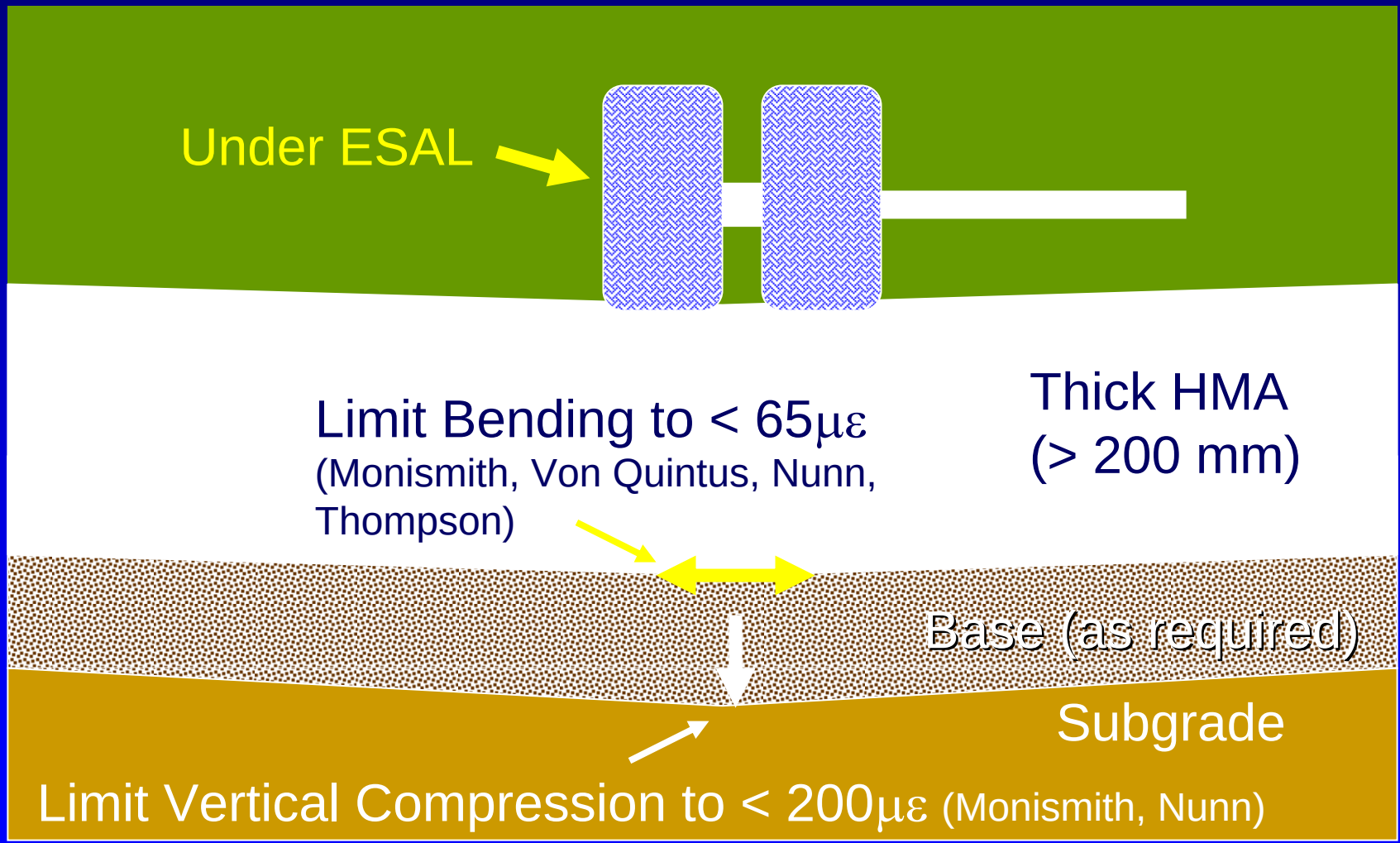
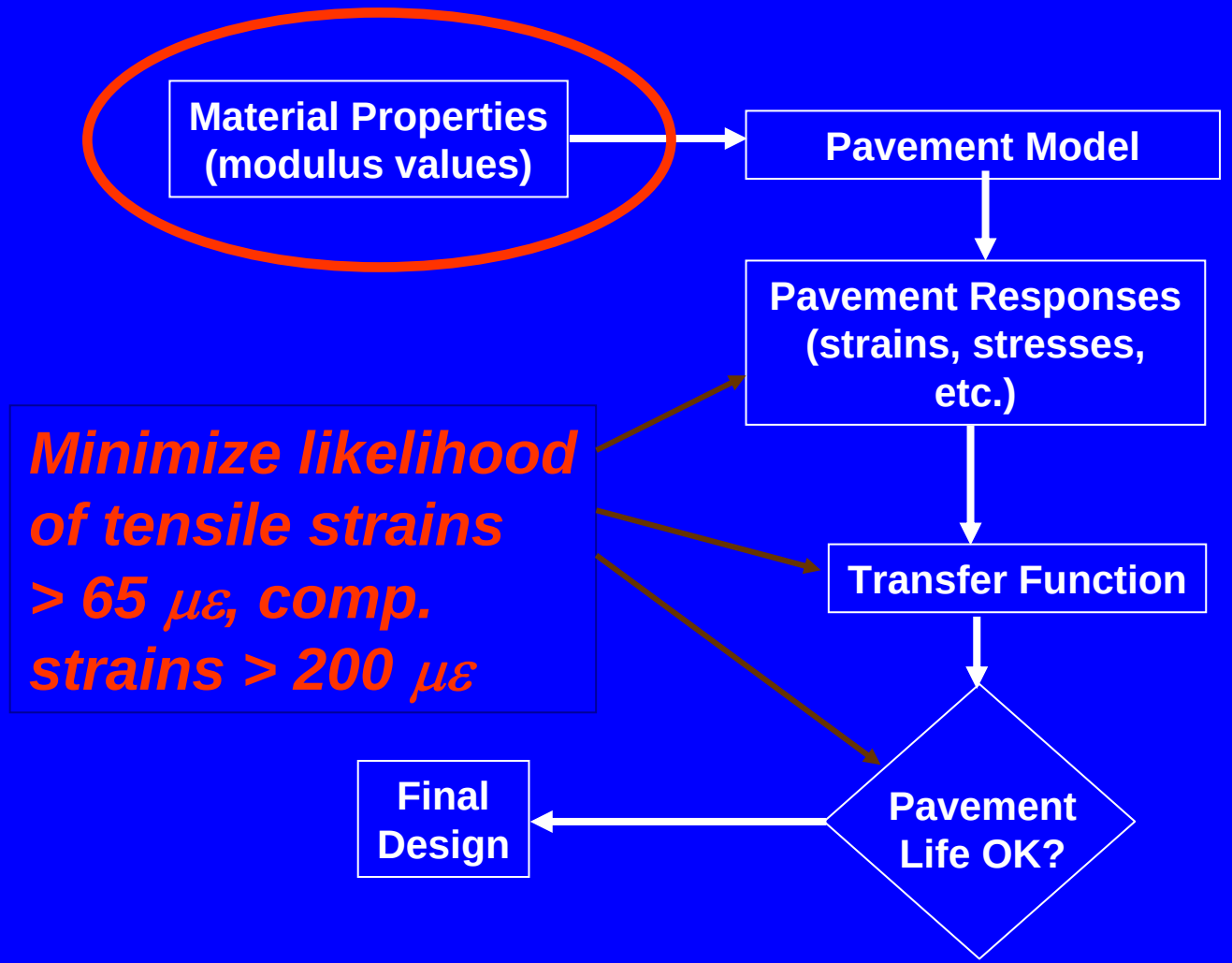
AASHTO 2002 Guide

- Idea/Framework from a 1996 Workshop
  - Public and Private Agencies, Industry, Academia
  - Considered: Traffic, Foundations, Materials, and Performance in suggesting techniques
- NCHRP Project 1-37A : *2002 Guide for the Design of New and Rehabilitated Pavement Structures*
- Develop and Deliver the "2002 Guide" by developing:
  - Guide based on existing Mechanistic-Empirical techniques including methodologies for calibration, validation and adaptation to local conditions
- Software Available for Download

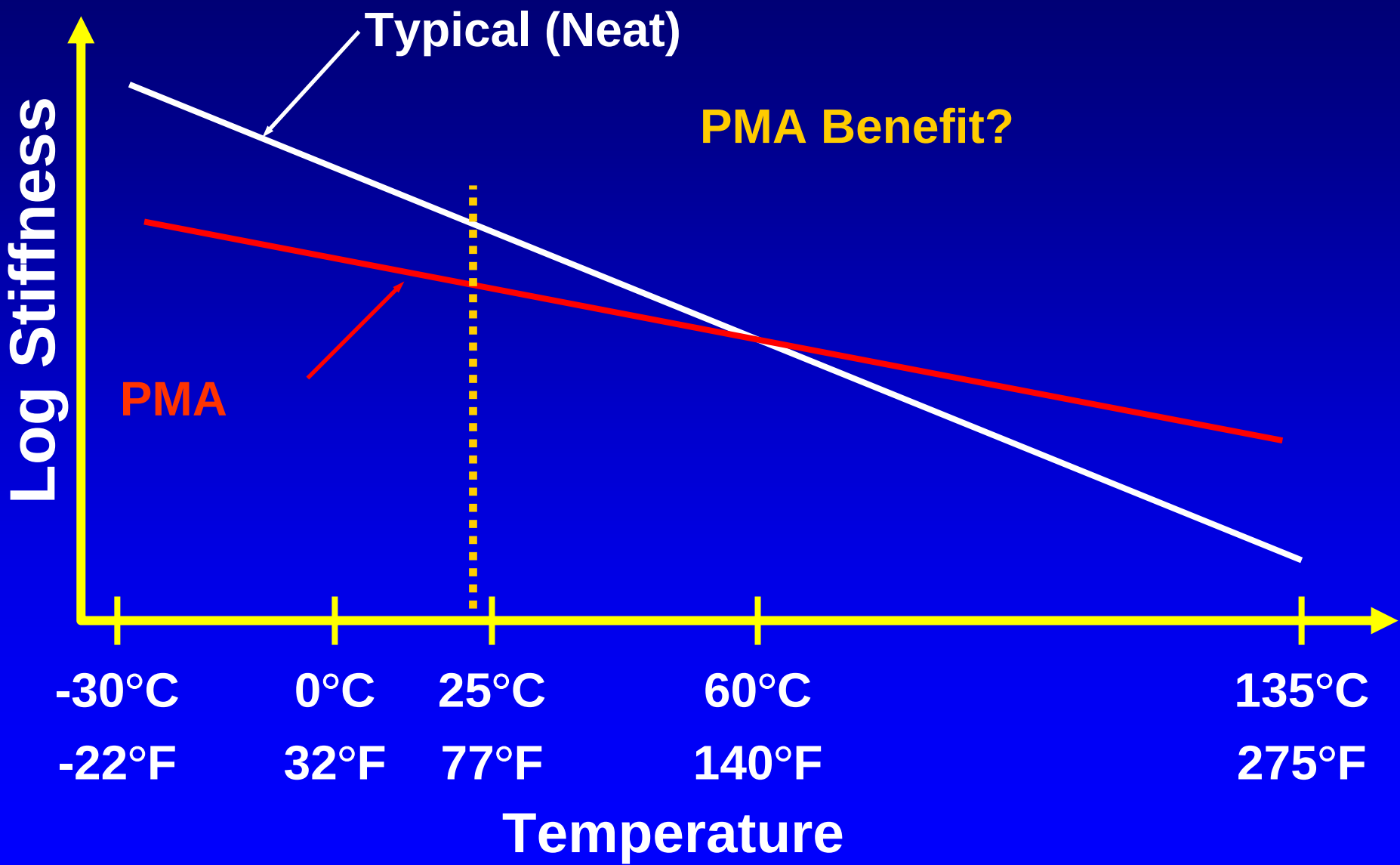
Mechanistic Performance Criteria



Mechanistic-Based Design



Asphalt Binder Behavior



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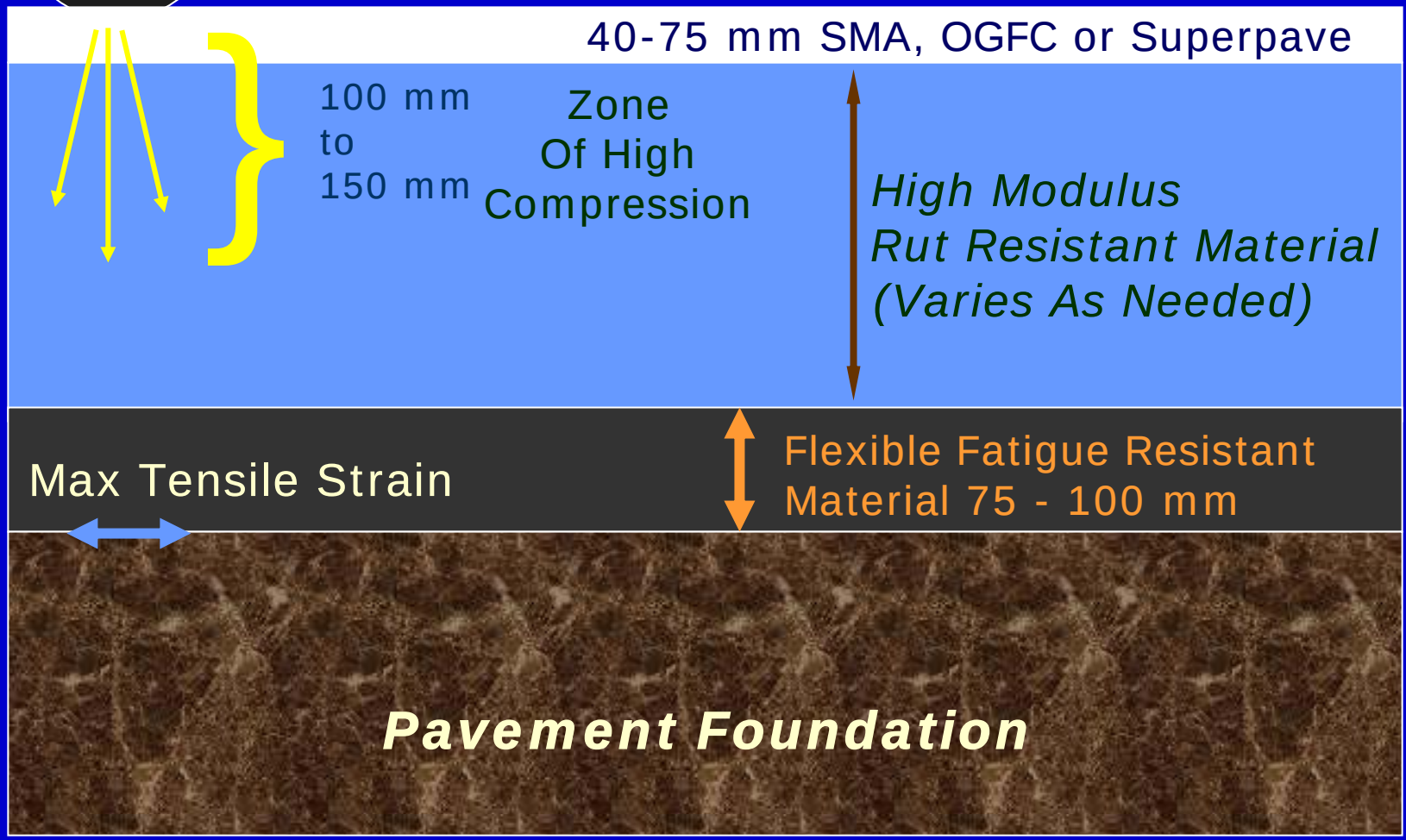
Perpetual Pavement



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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

Future Challenges to PMA Industry

1. Consistency for D/B & Warranty Projects
2. Prove Value in the Future using M-E Pavement Design Procedure?

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Consistency

- D/B, D/B/M and Warranty/Guarantee
- E* Constant
- Tight Binder Specifications
  - Binder Purchase Specifications

Binder Purchase Specifications

- Objective
  - Control Mixture E* with Binder E*
  - Statistically Based Purchase Specifications
  - Target Value = to Design Value
  - Allowable Tolerances
    - Test Method Variability Only?

Proving PMA Benefits

- Laboratory
- Accelerated Pavement Testing
- Long-Term Field Performance

Prototype Accelerated Pavement Testing

- FHWA ALF - Portable
- South African HVS - Portable
- TxDOT MLS – Quasi Portable
- InDOT/Purdue APT – Fixed
- Florida, Kansas, Ohio DOT - Fixed
- Many Many Others
  - Internationally Also

Full Scale Accelerated Pavements Testing

- US Examples
  - AASHO Road Test
  - MnROAD
  - WesTrack
  - NCAT Pavement Test Track
- Evaluation
  - Materials and Specifications
  - Design and Analysis Systems

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Summary

- Industry is Changing
- Shift in Responsibility and Technology
- Innovative Contracting Method
- Performance Knowledge
- 2002 M-E Design Guide
- Proof of PMA Beneficiation Proof