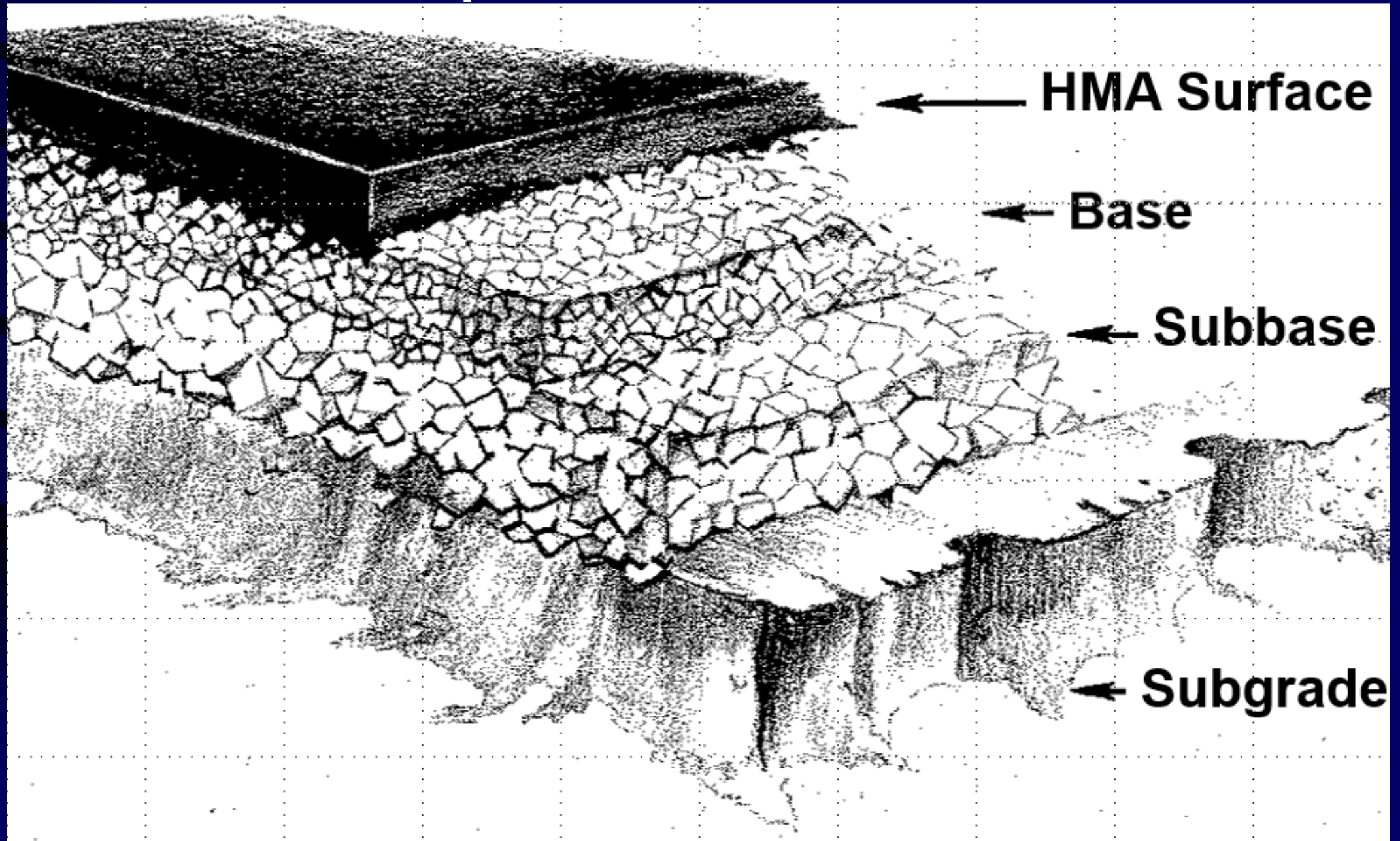


Design Concepts and Perpetual Pavement

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Asphalt Pavement



Why is it hard to design pavement?

- Hard to estimate service life
- Different load magnitudes, configurations & speeds
- Multilayer system
- Viscoelastic, non-linear materials
- Material properties are affected by environmental conditions
- Unconventional definition of failure

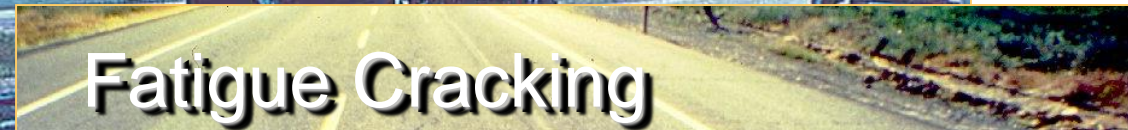
Distresses vs. Failure

When a distress or a combination of distresses reaches a certain unacceptable level it is considered failure

Rutting



Fatigue Cracking



Thermal Cracking



Roughness



Shoving

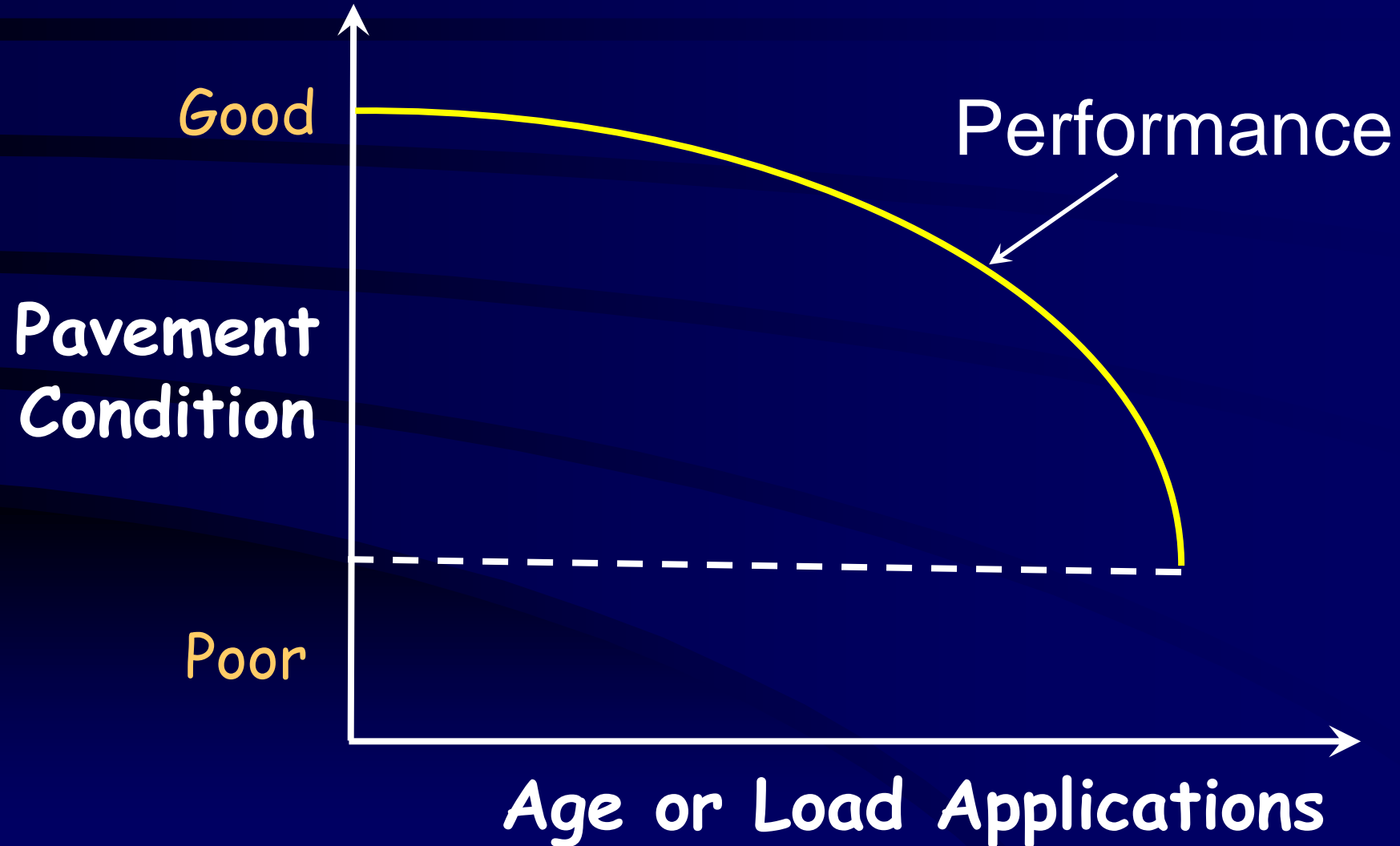


Bleeding/Flushing



Distresses in Asphalt Pavement

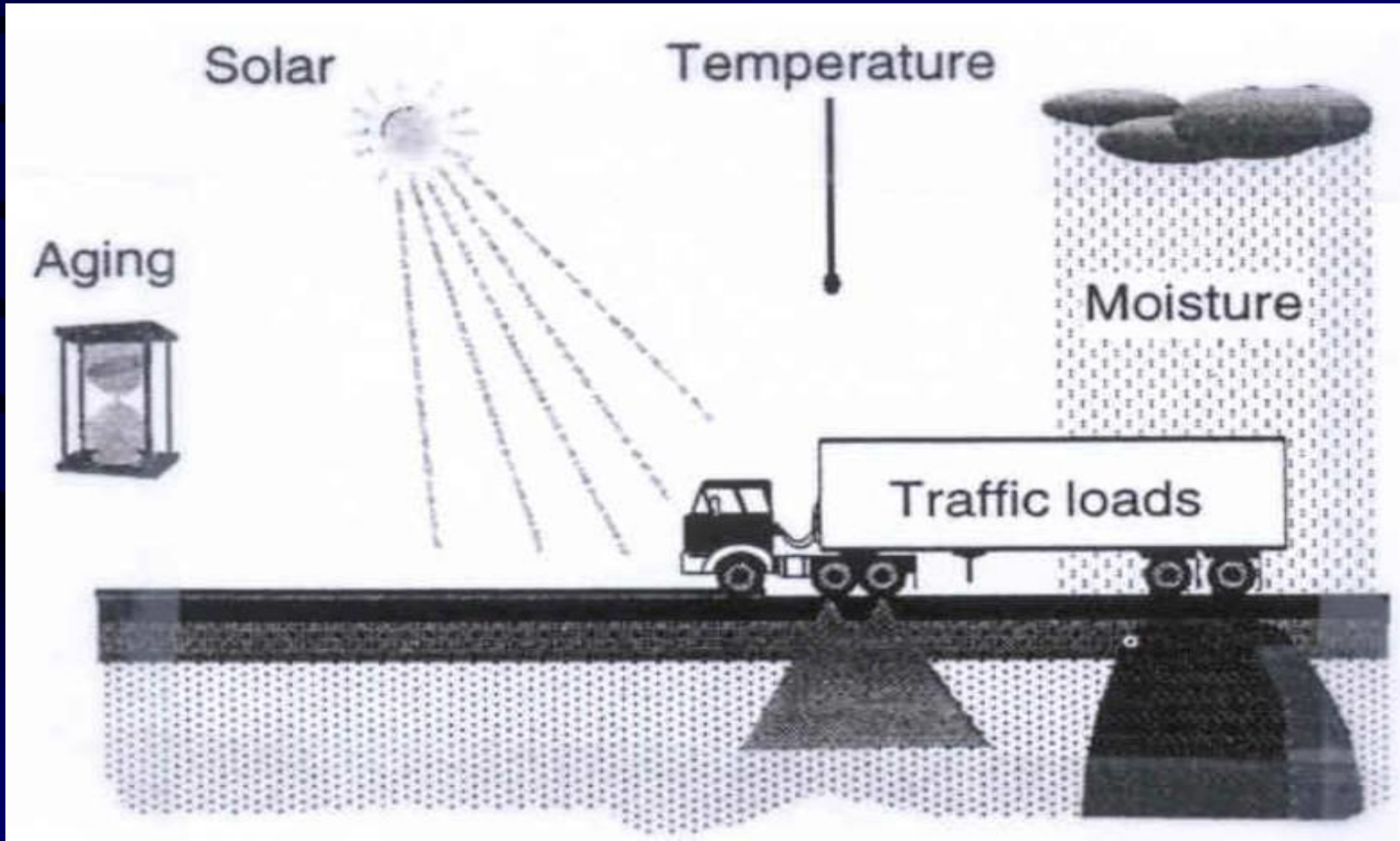
Empirical Nature of Pavement Design



Major Research Projects

- AASHO Road Test
- Strategic Highway Research Program (SHRP)
- Mechanistic-Empirical Pavement Design Guide (AASHTOWare Pavement ME Design)

Factors Affecting Pavement Performance



Factors Affecting Pavement Performance

1. Traffic

2. Soil and pavement materials

3. Environment

4. Construction and maintenance

Traffic

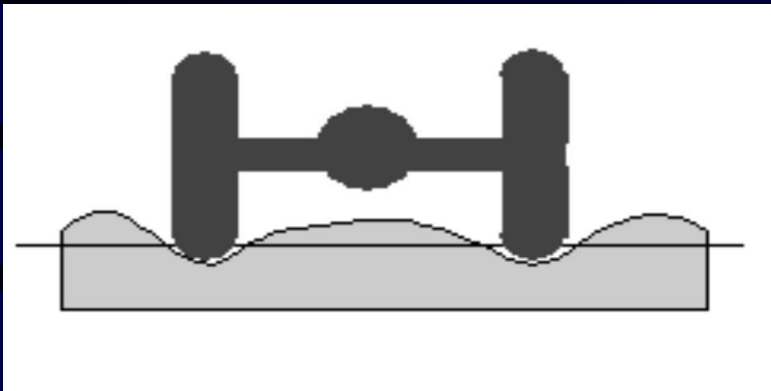
Traffic has a major effect on pavement performance

- Traffic volume
- Traffic load
- Tire pressure
- Rate of applying load

Severe Traffic Conditions



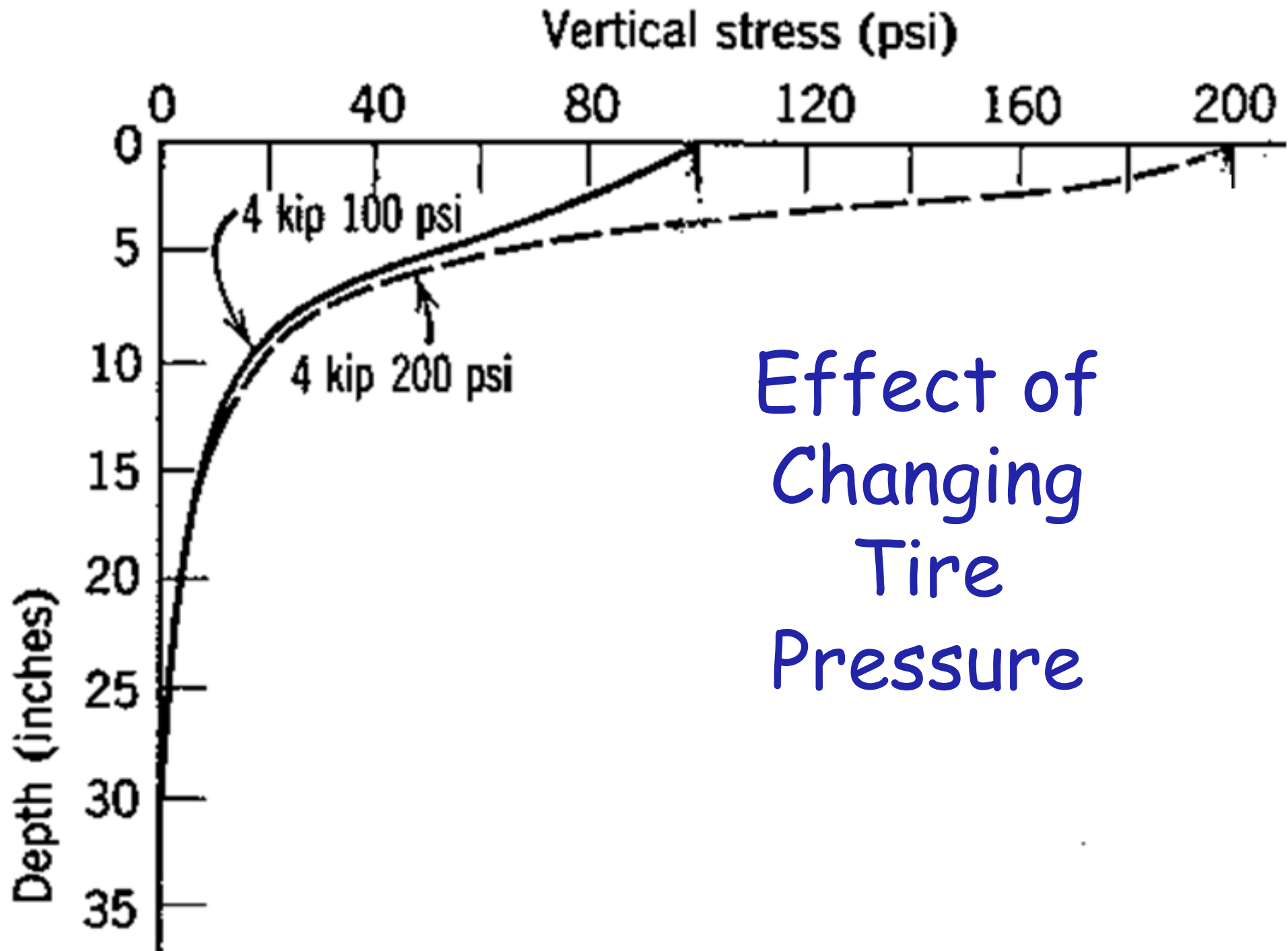
Heavy load and high traffic volume



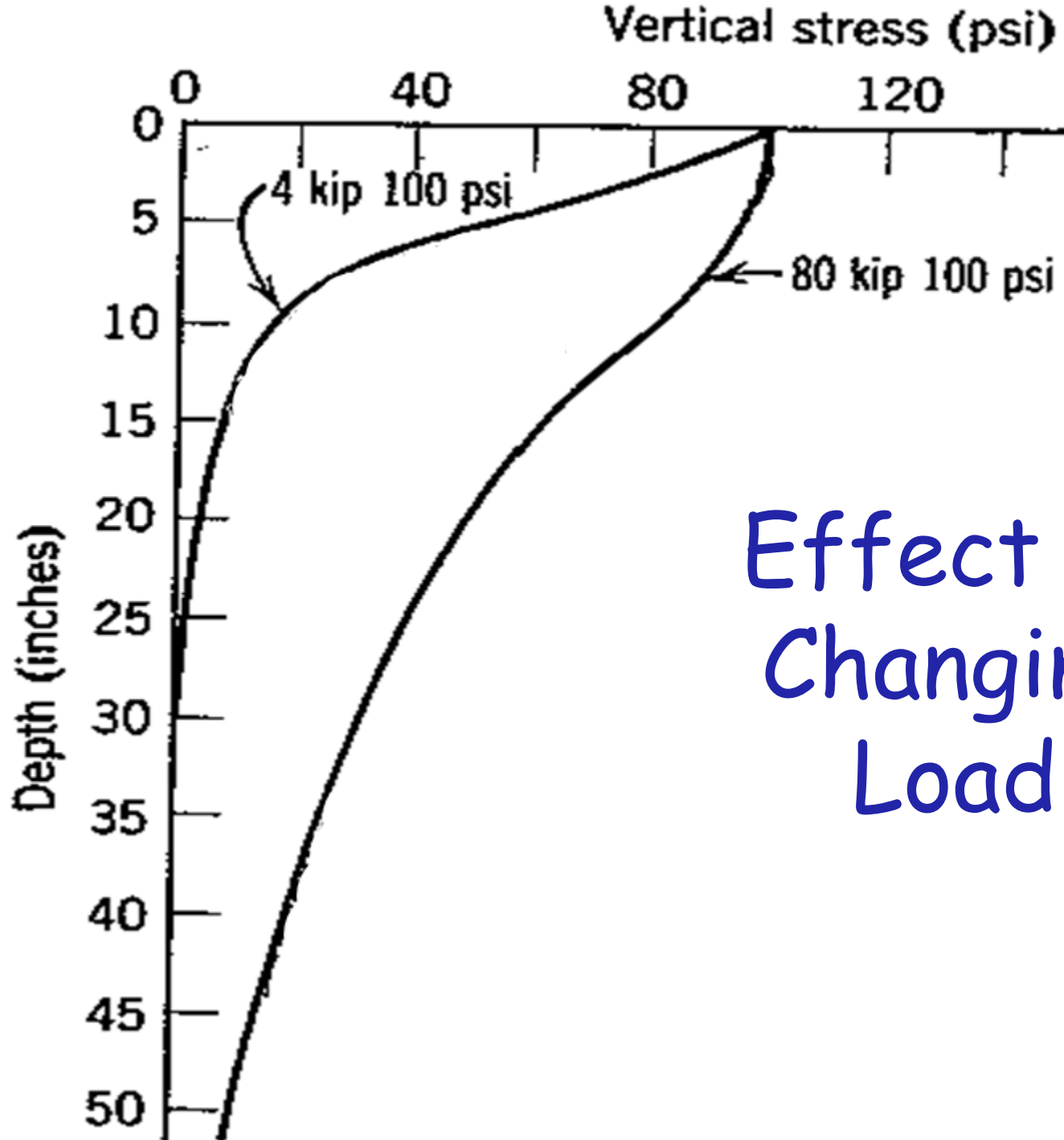
High tire pressure



Slow moving vehicles



Effect of
Changing
Tire
Pressure



Effect of
Changing
Load

Effect of Tire Pressure & Loads

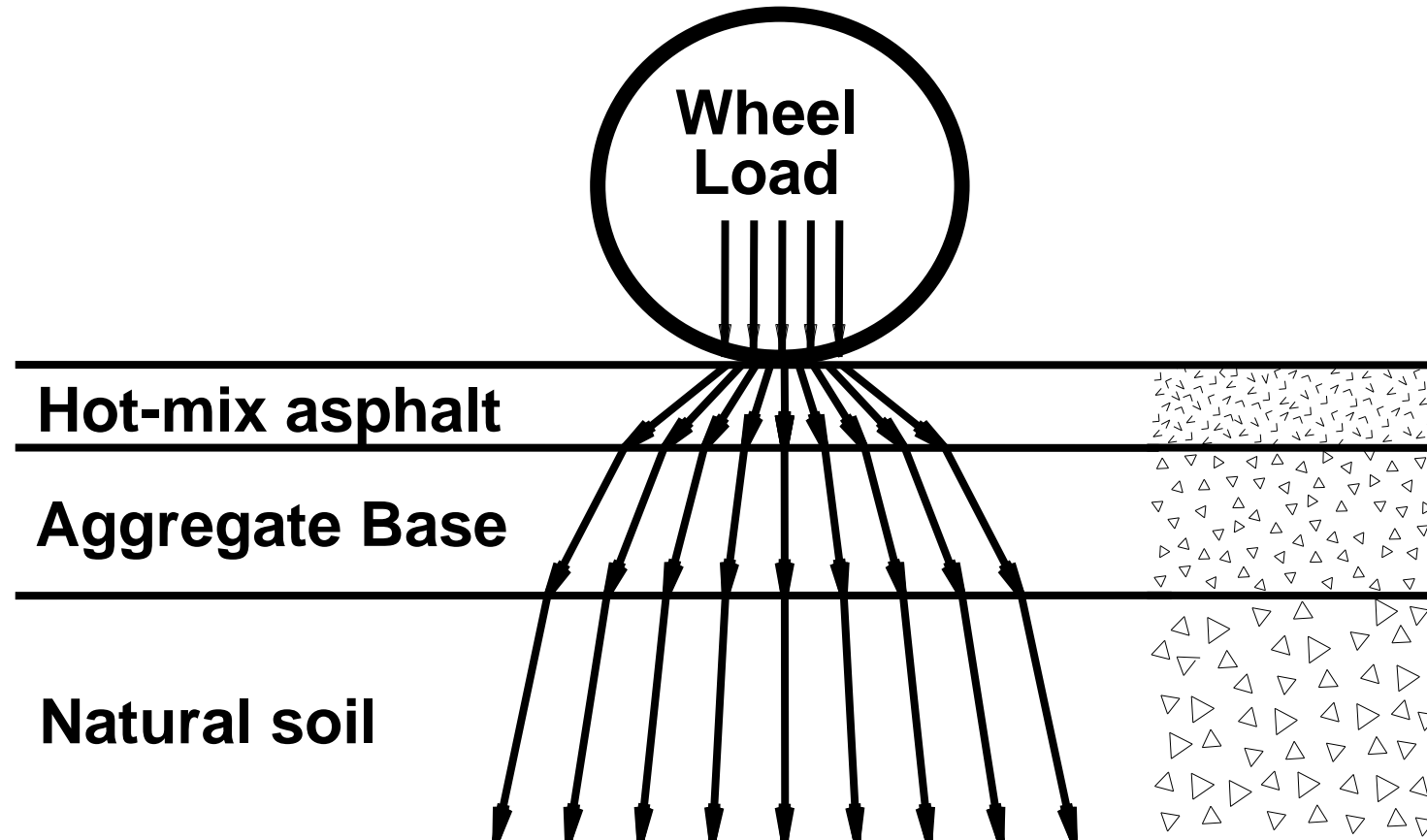
- Changing tire pressure affects upper layers
- Changing load affects deeper layers
- Required quality of surface is mostly determined by tire pressure
- Required pavement thickness is mostly determined by load magnitude



Factors Affecting Pavement Performance

1. Traffic
2. Soil and pavement materials
3. Environment
4. Construction and maintenance

Material quality affects performance



Factors Affecting Pavement Performance

1. Traffic
2. Soil and pavement materials
3. Environment
4. Construction and maintenance

Environmental Factors

- Moisture
- Temperature
- Freeze and thaw
- Aging

Factors Affecting Pavement Performance

1. Traffic
2. Soil and pavement materials
3. Environment
4. Construction and maintenance

Construction and maintenance

- Construction and maintenance practice largely affects performance

Design Objective

To determine the required layer materials and thicknesses so that the pavement would last for a certain design life before failure.

Pavement Design Approaches

1. Based on experience (ie., standard sections)
2. Based on simple strength tests or soil formula
3. Based on statistical evaluation of pavement performance (1993 AASHTO method)
4. Based on structural analysis of layered systems with some empirical relations (AASHTOWare ME design)

Concept of Perpetual Pavement

- Extended-life HMA pavement
- Limit distresses in the surface layer
- Has been used in Europe

Example of Perpetual Pavement

SMA 1.5" – 3"

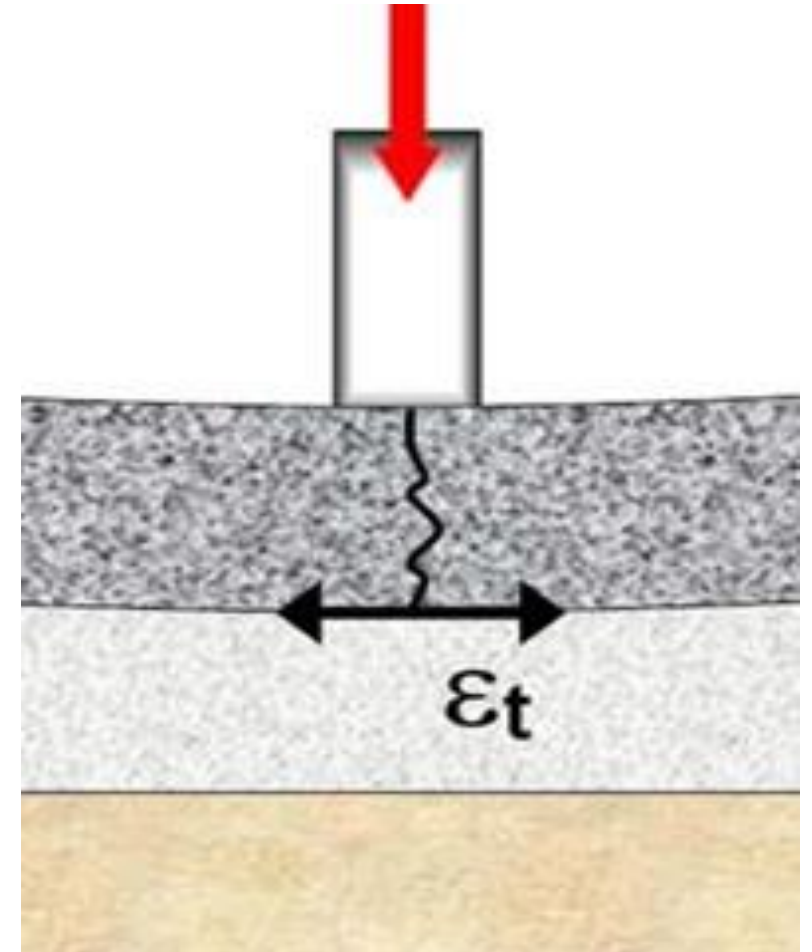
High Modulus
Rut Resistant Material
4" – 7"

Flexible Fatigue
Resistant Material 3" – 4"

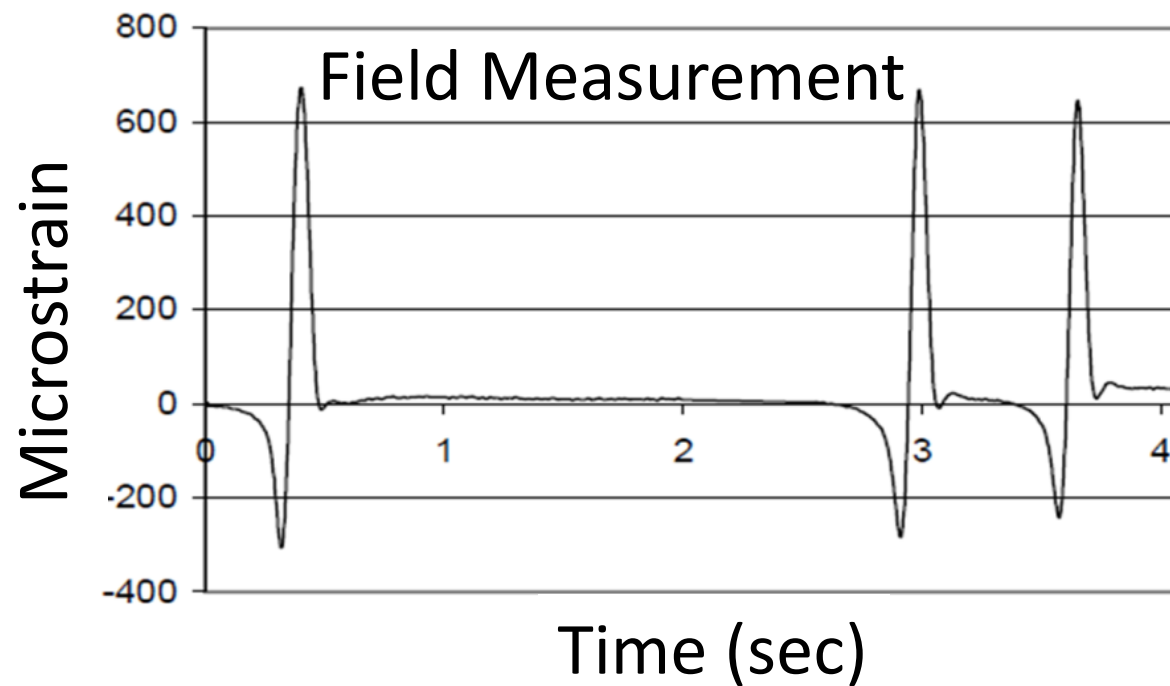
Pavement
Foundation

Endurance Limit

- Strain level below which HMA would endure indefinite load repetitions without accumulating fatigue cracks



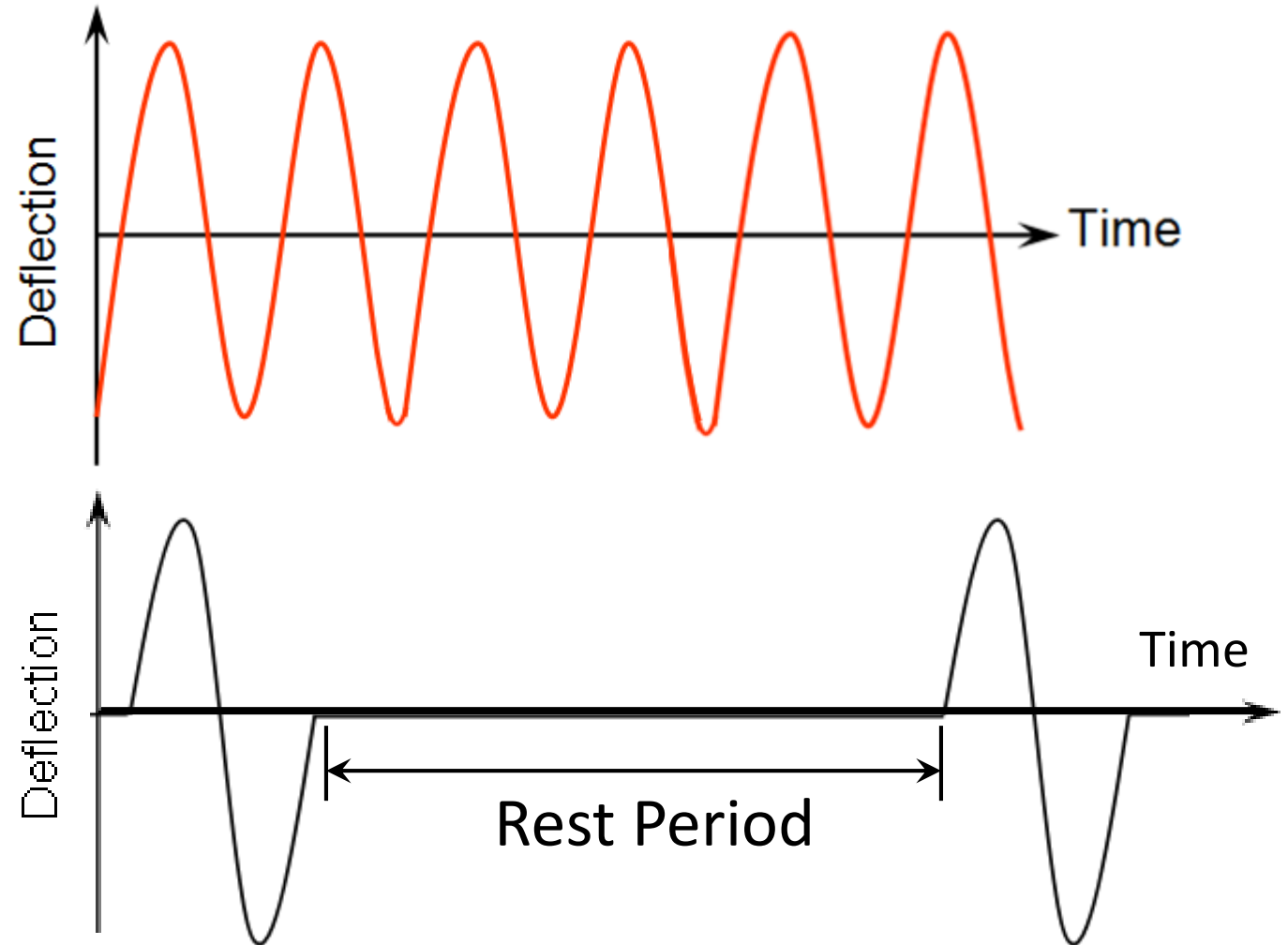
Healing Concept



- Capability of material to self-recover its stiffness or strength upon resting due to closure of cracks
- Traffic loads are separated by “rest periods” may allow for partial or full healing of damage
- It increases the number of load applications before failure

NCHRP Report 762

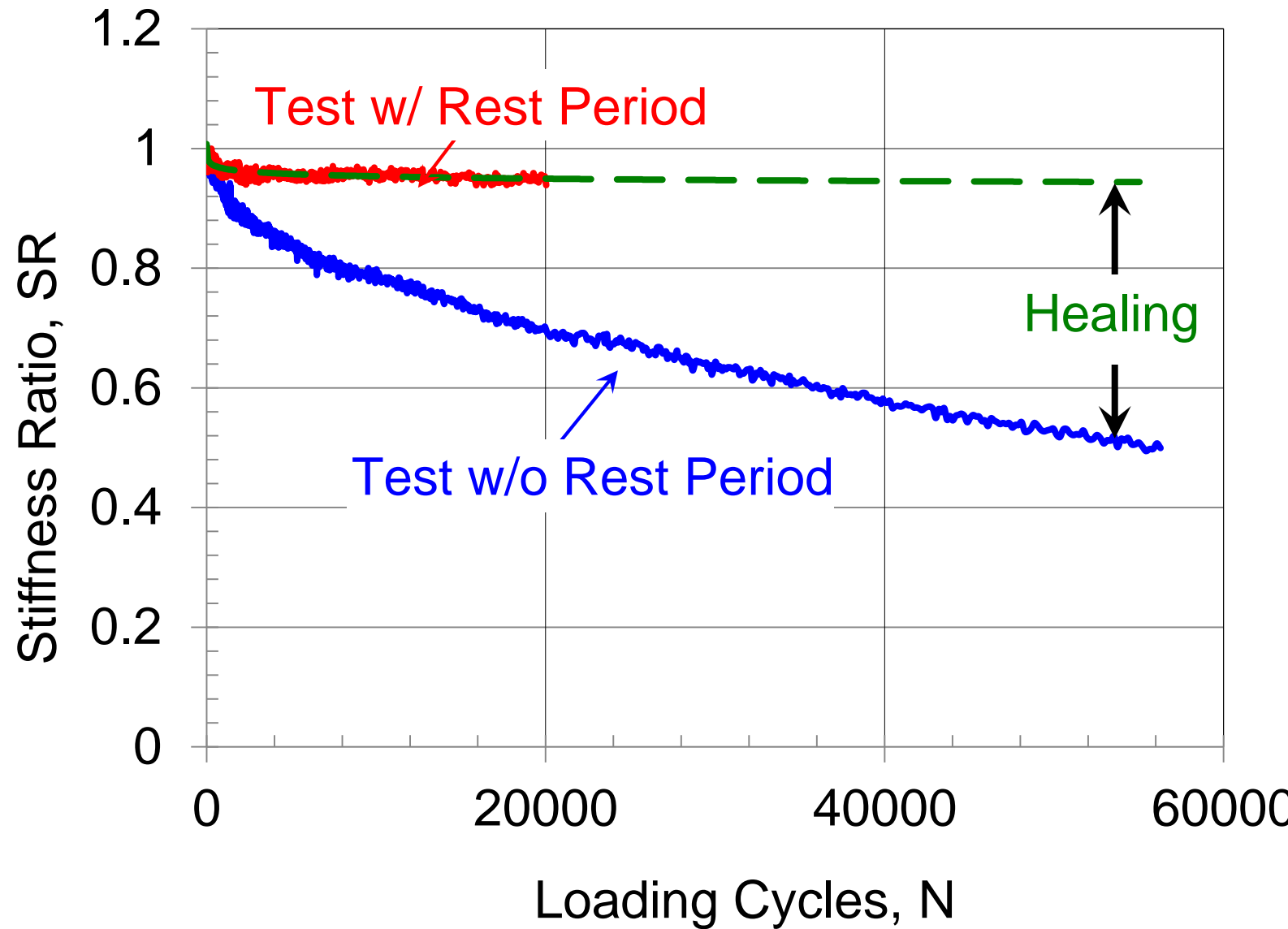
Tests w/ & w/o Rest Period



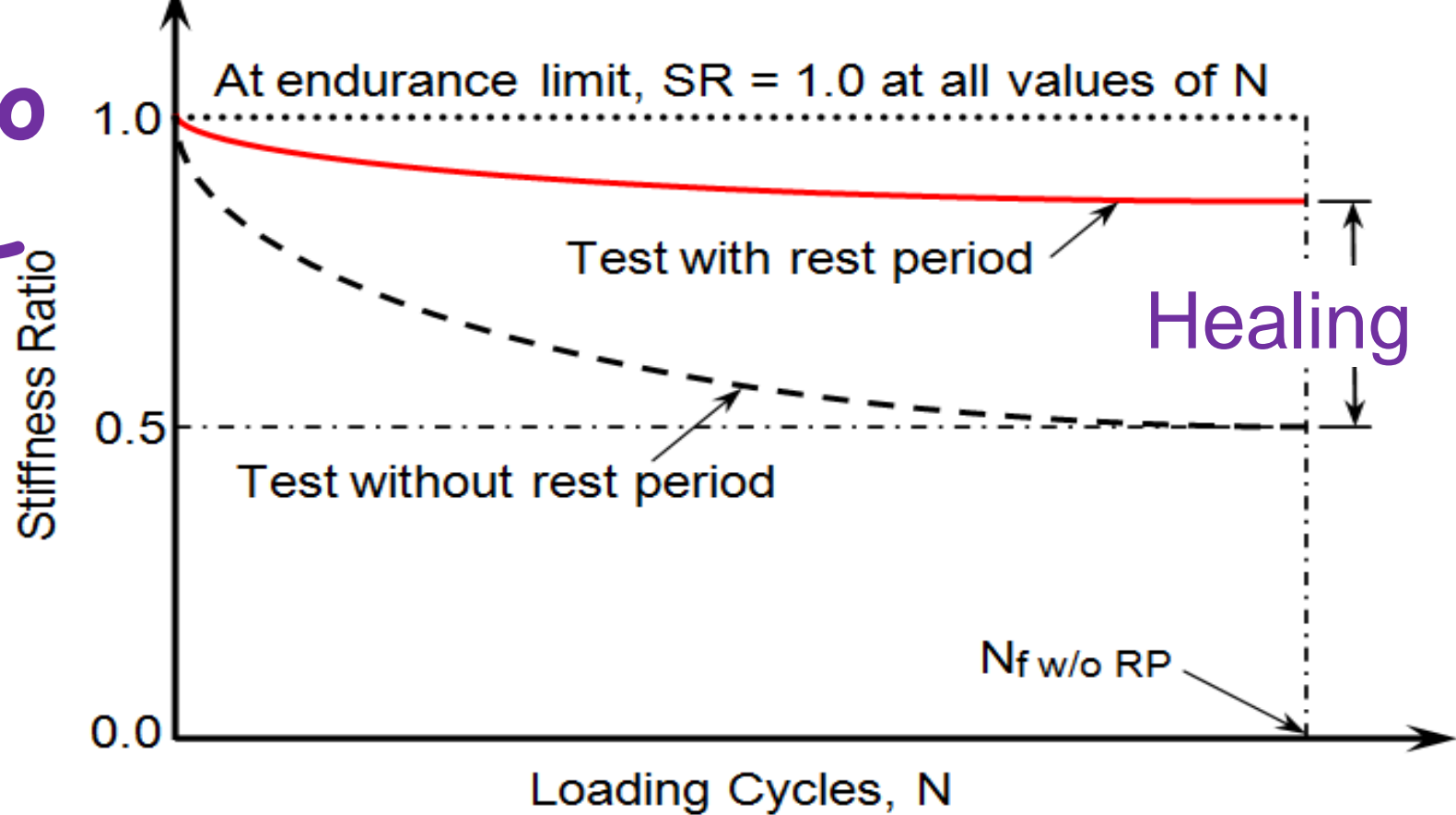
Model Development

$$SR = \frac{\text{Current Stiffness}}{\text{Initial Stiffness}}$$

$SR = f(\text{stiffness, strain, rest period, number of load applications})$

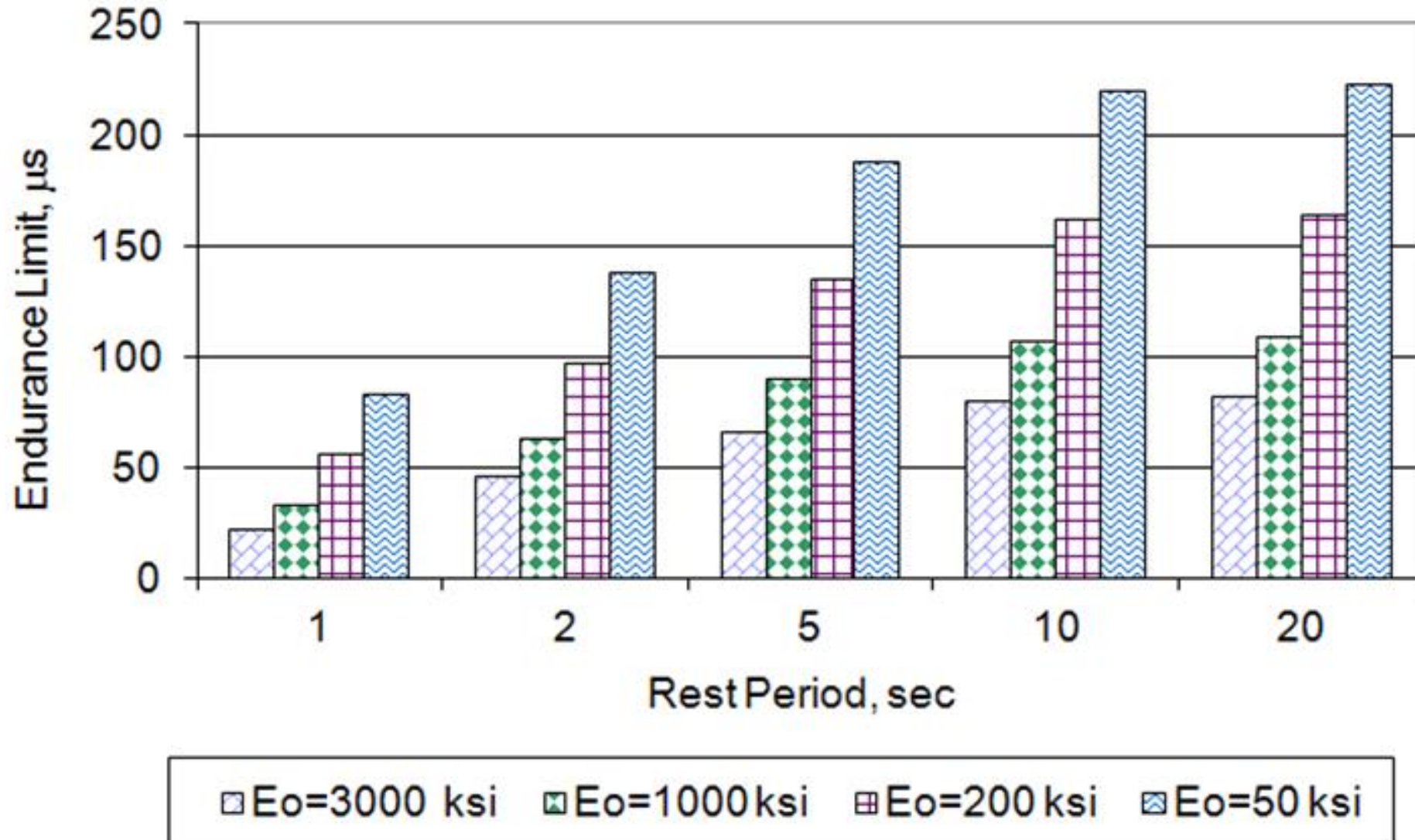


How to get EL

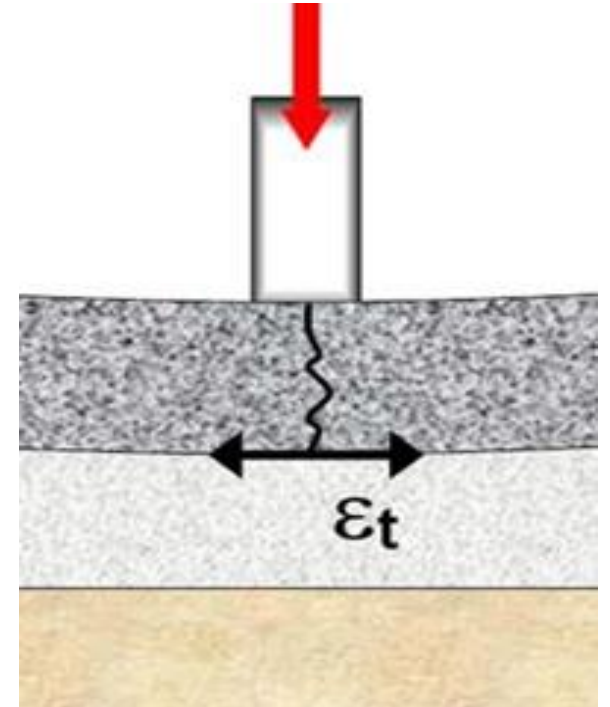
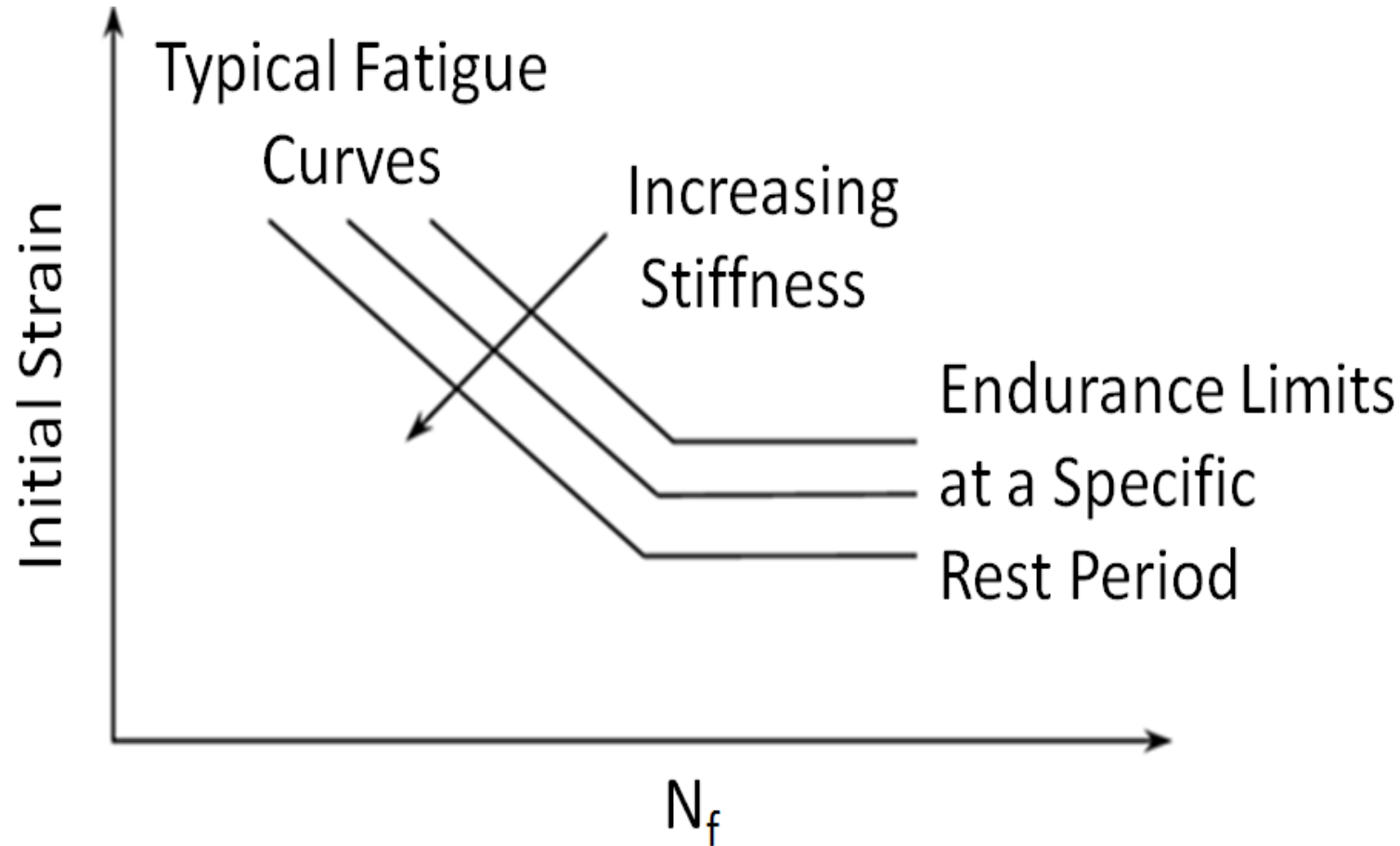


- When $SR = 1$ → Full healing
- Strain becomes EL
- EL is not a single value
- N is not a significant factor
- EL is based on healing

EL Values



Incorporation in Pavement Design



- Layer thicknesses and material properties can be controlled so that strain does not exceed the EL
- Field validation is still needed

Thanks for your attention!



Any Questions?