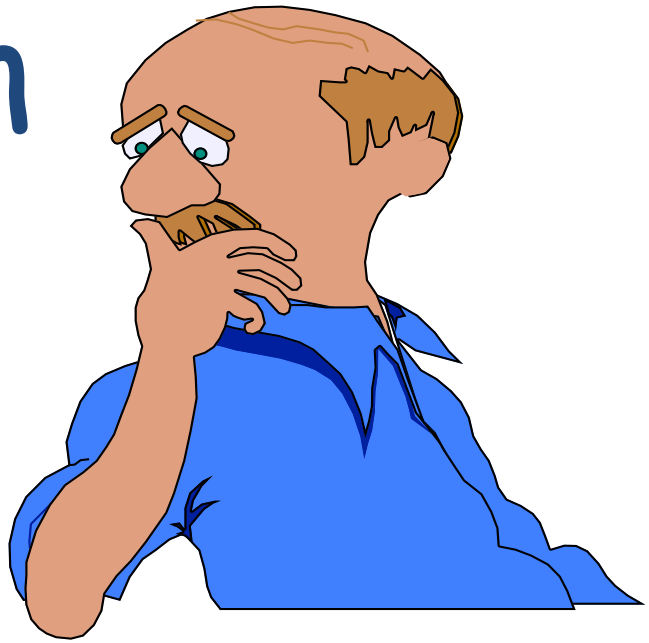
Pavement Distress and Evaluation



Mike Mamlouk

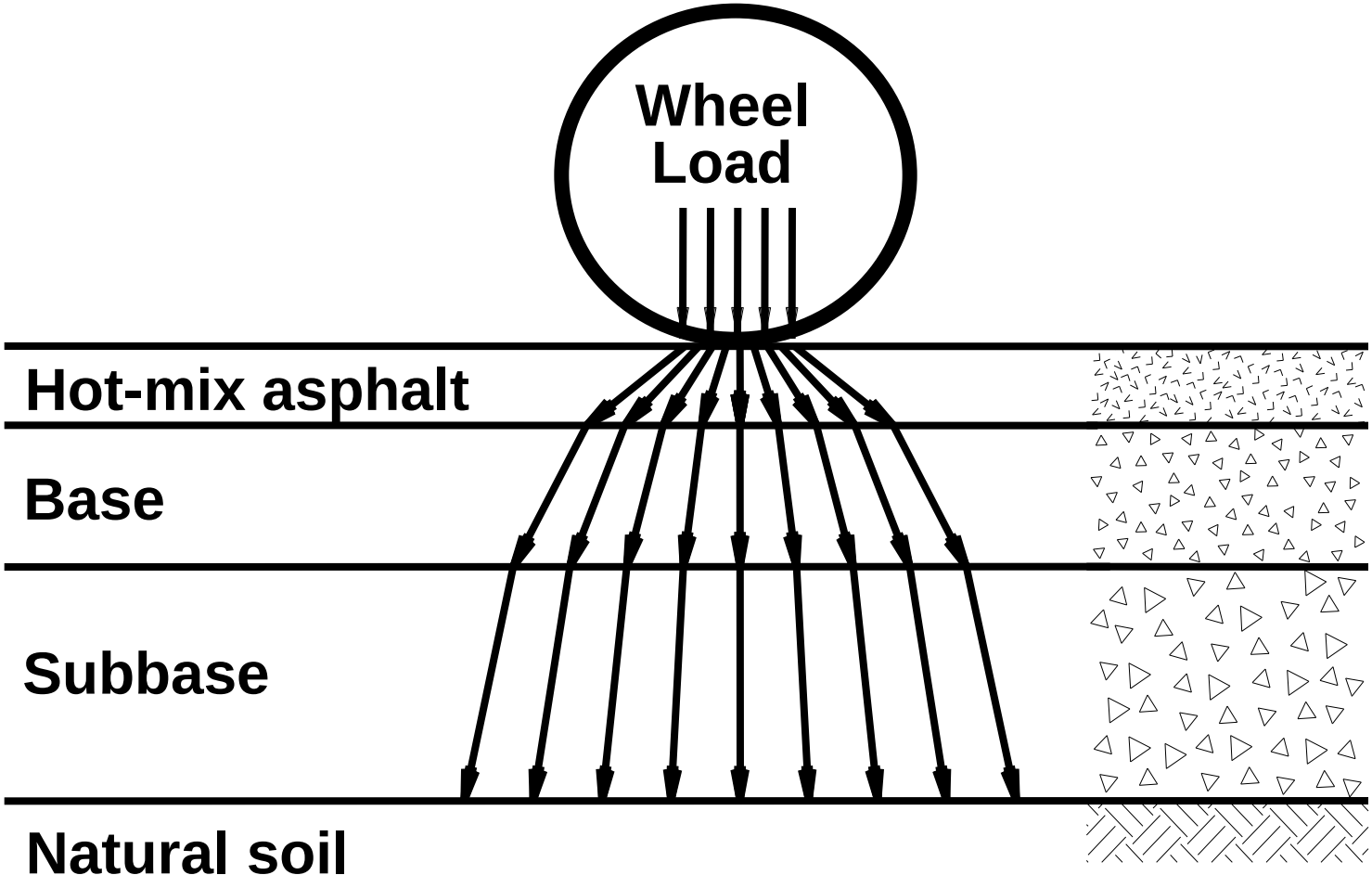
Arizona State University

Distresses in Asphalt Pavement

Basic Distress Mechanisms

- Load-related
- Temperature-related
- Moisture-related
- Age-related
- Material-related
- Construction-related
- Combinations

Distribution of Wheel Load

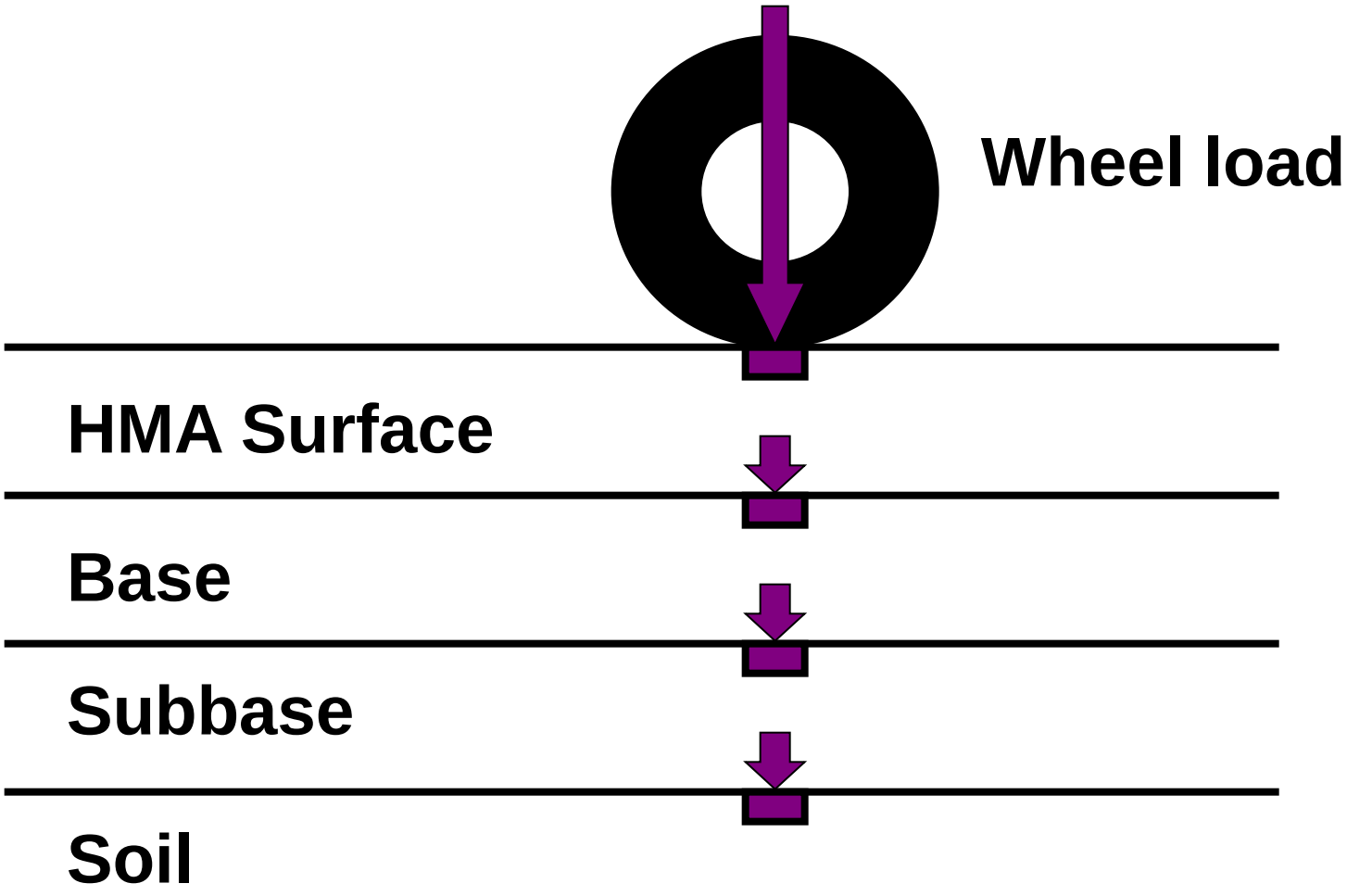



FATIGUE

Fatigue Cracking

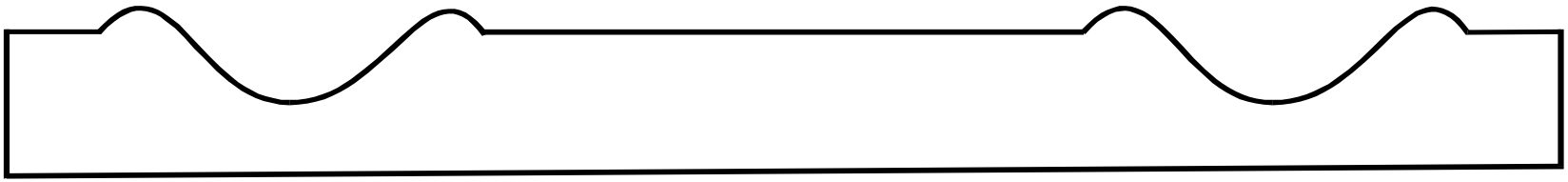
Advanced Stage of Fatigue Cracking

Permanent Deformation (Rutting)



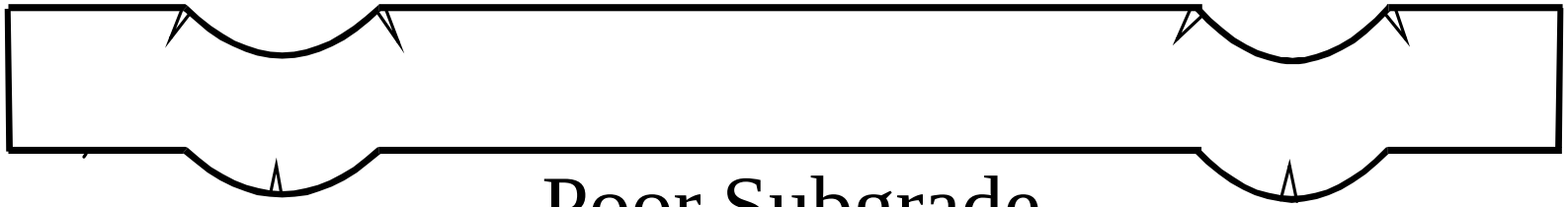
Rutting

Rutting Confined to HMA Layer



Unstable HMA

Poor Compaction During Construction



Poor Subgrade

Thermal Cracking

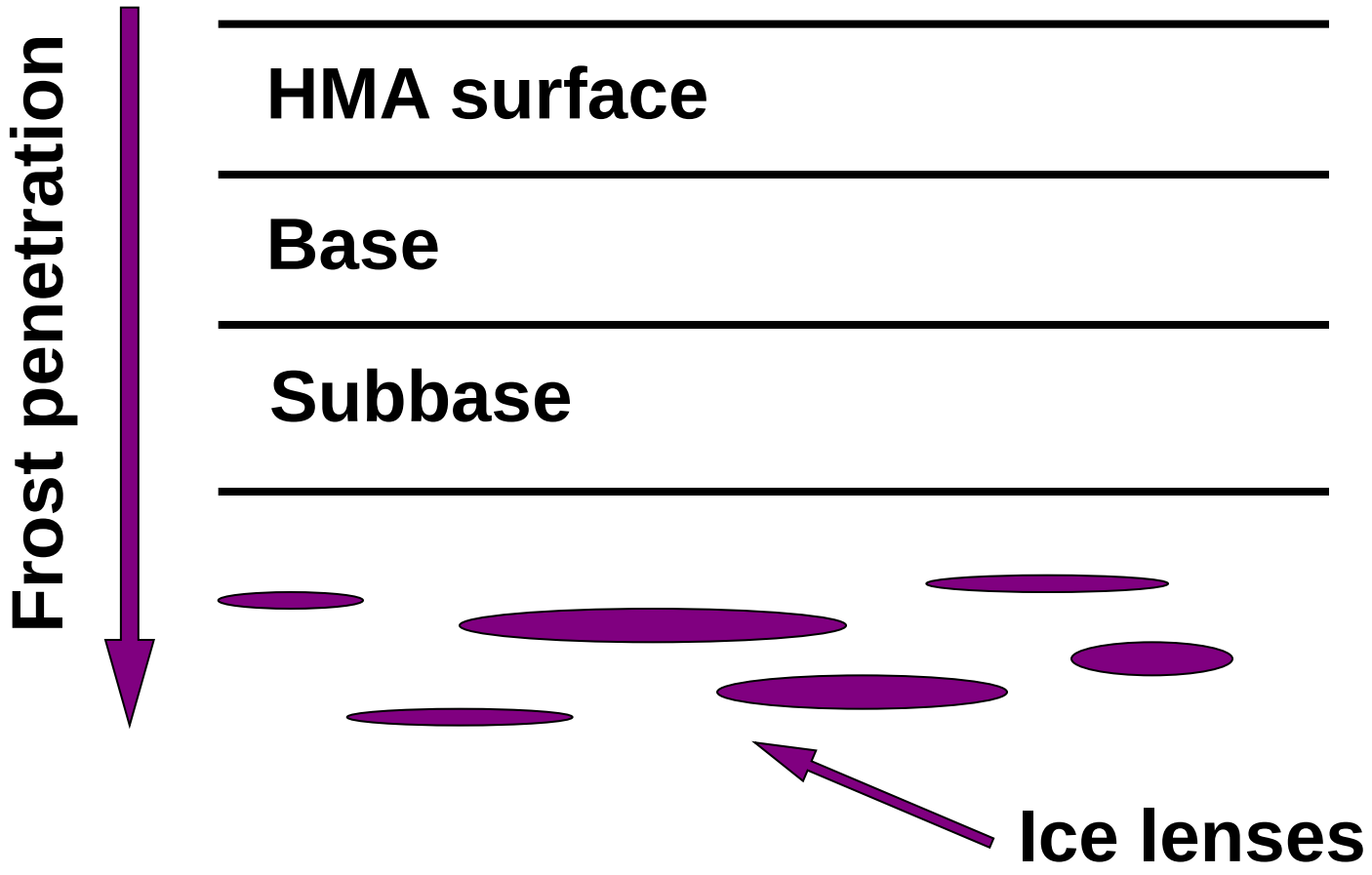
Thermal Cracks

Wide Thermal Crack

Block Cracking


CAUTION
FAULT ZONE
WATCH FOR
CRACKS IN ROAD

Frost Heave

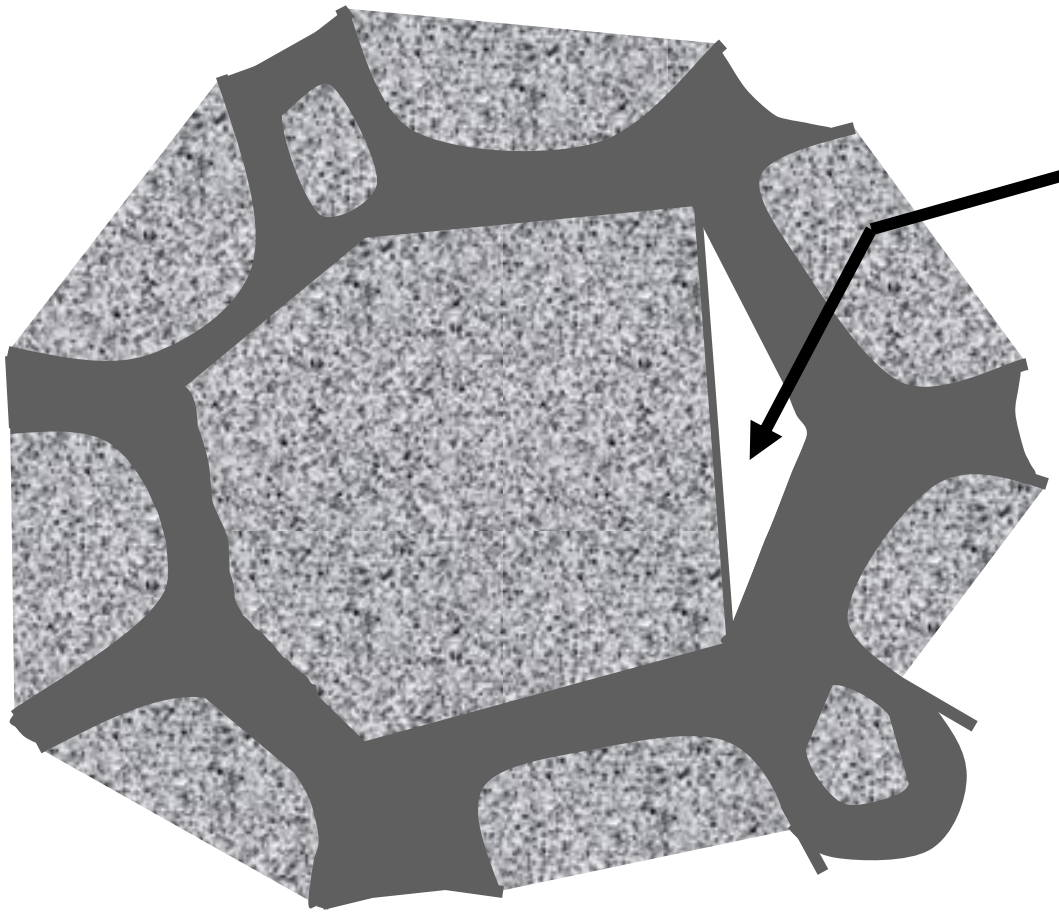



sappi usutu

Water Bleeding & Pumping

Depression due to Pumping

Stripping



Separation of asphalt from aggregate

Stripping

Stripping

Raveling

Flushing / Bleeding

Polished Aggregate

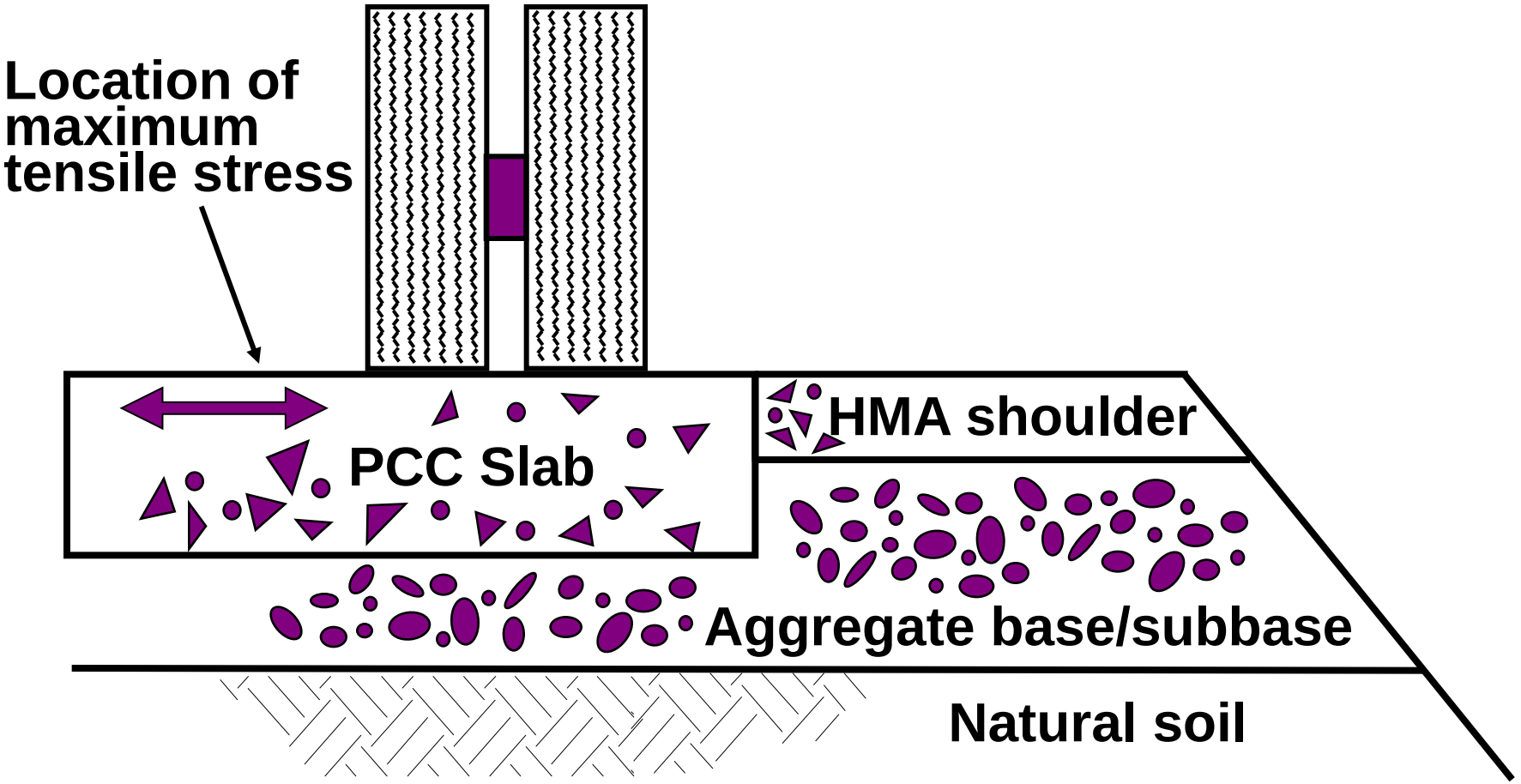
Shoving

Distresses in Concrete Pavement

Basic Distress Mechanisms

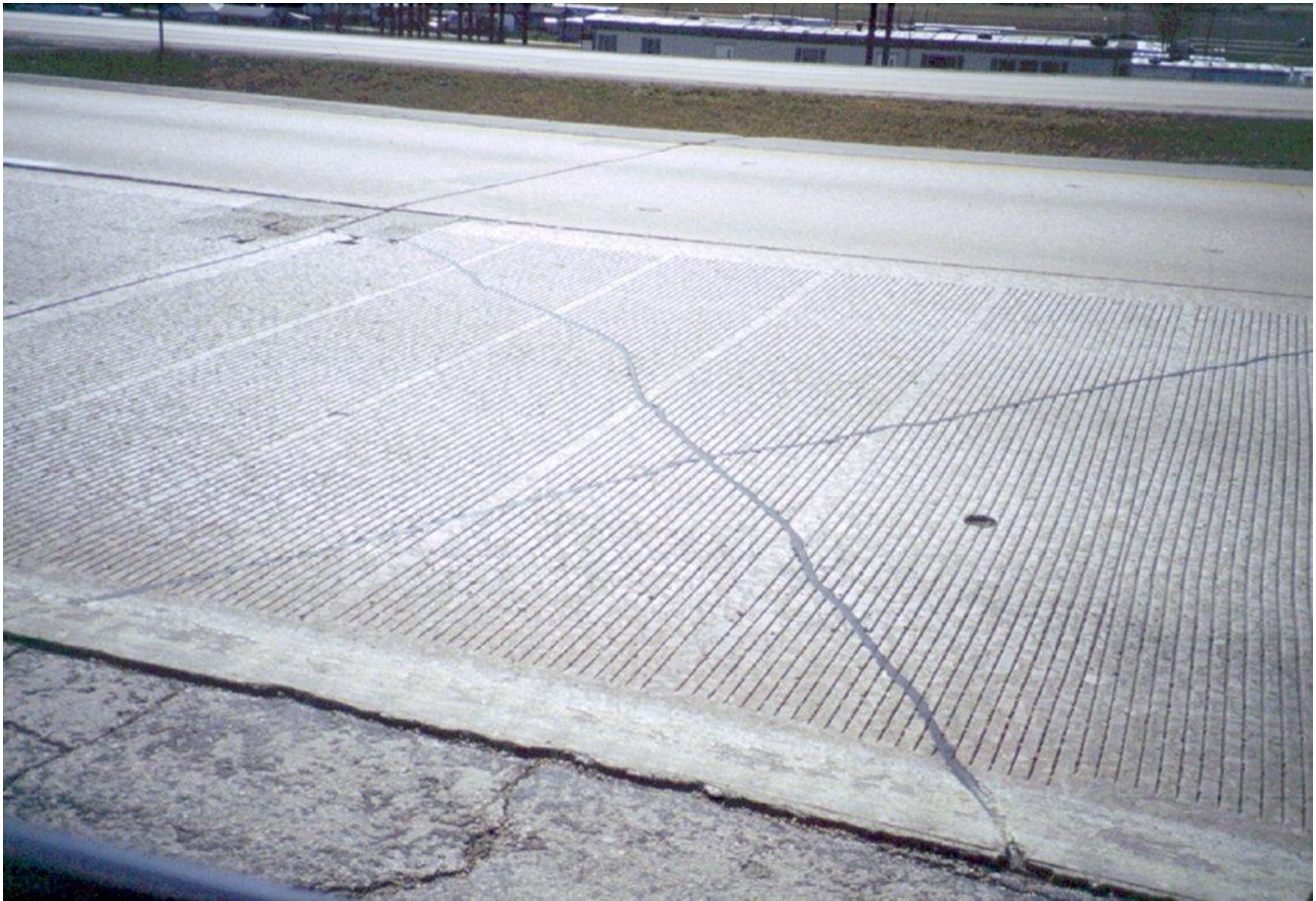
- Load-related
  - Fatigue
  - Faulting
- Temperature-related
  - Low-temp. mid-slab cracking
  - High-temp. joint / crack distress
- Moisture-related
  - Pumping
  - D - Cracking

Fatigue


Location of maximum tensile stress
PCC Slab
HMA shoulder
Aggregate base/subbase
Natural soil

Longitudinal Cracking

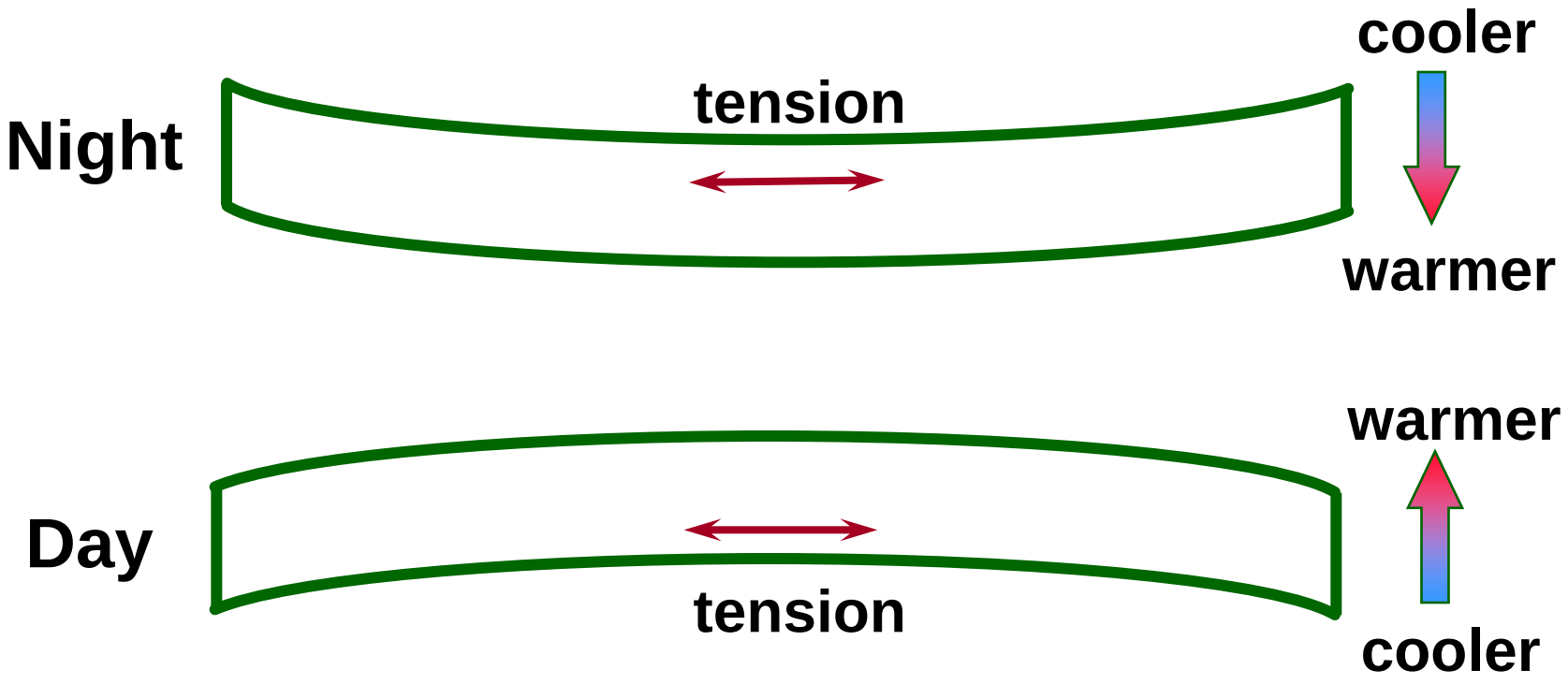
Diagonal Cracking



Faulting

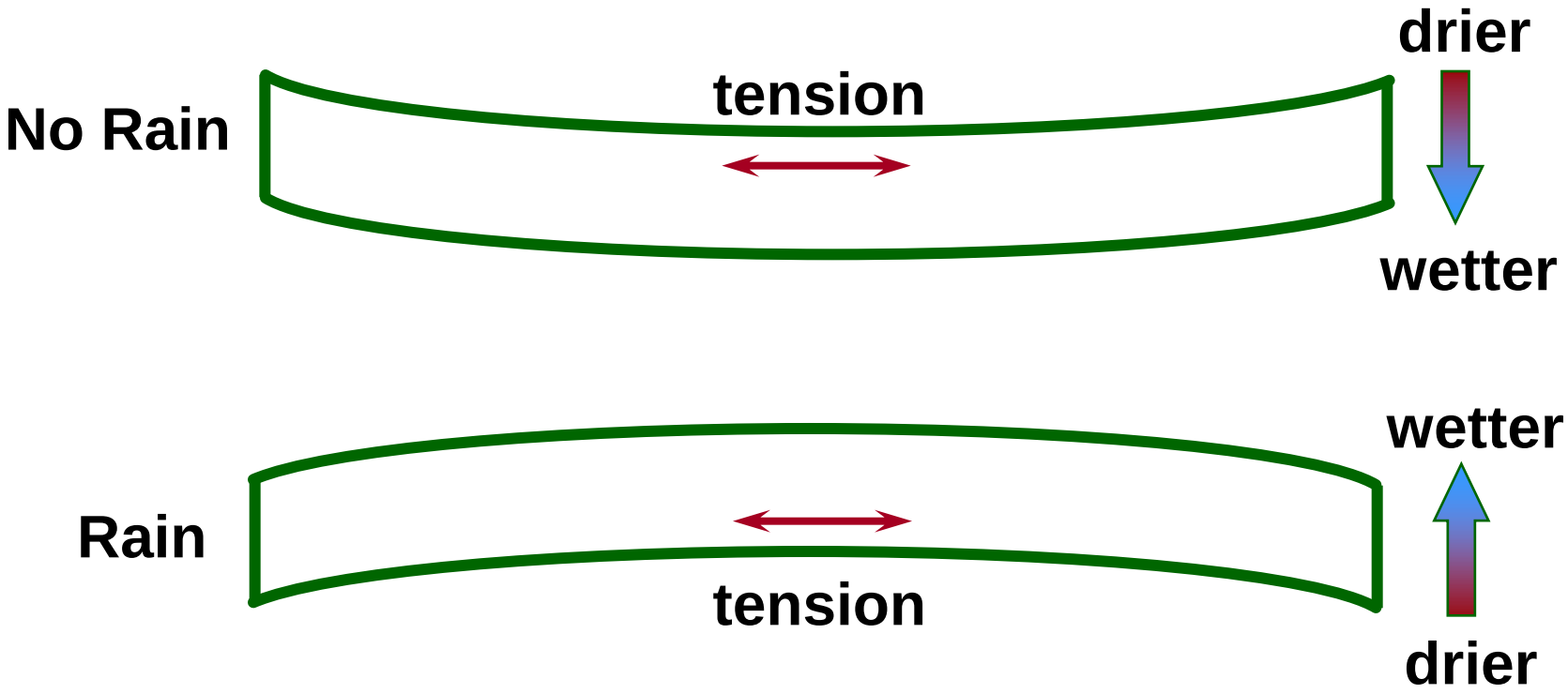
Thermal-Gradient Related Stresses

Temperature differential between the top and bottom of the slab



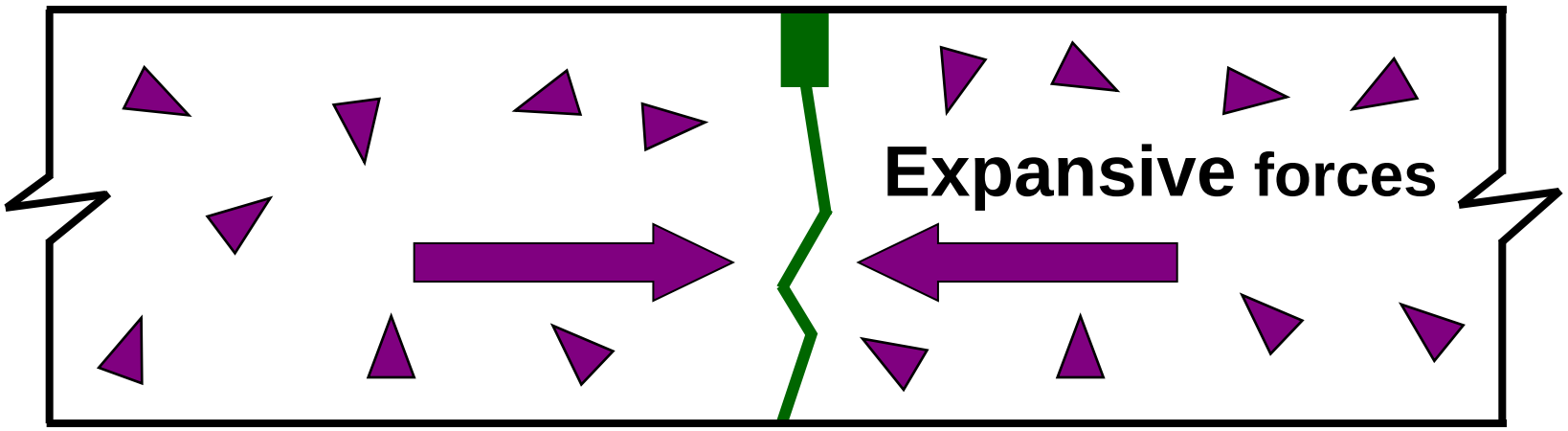
Moisture-Gradient Related Stresses

Variations in moisture content between top and bottom of slab



Curling / Warping Crack

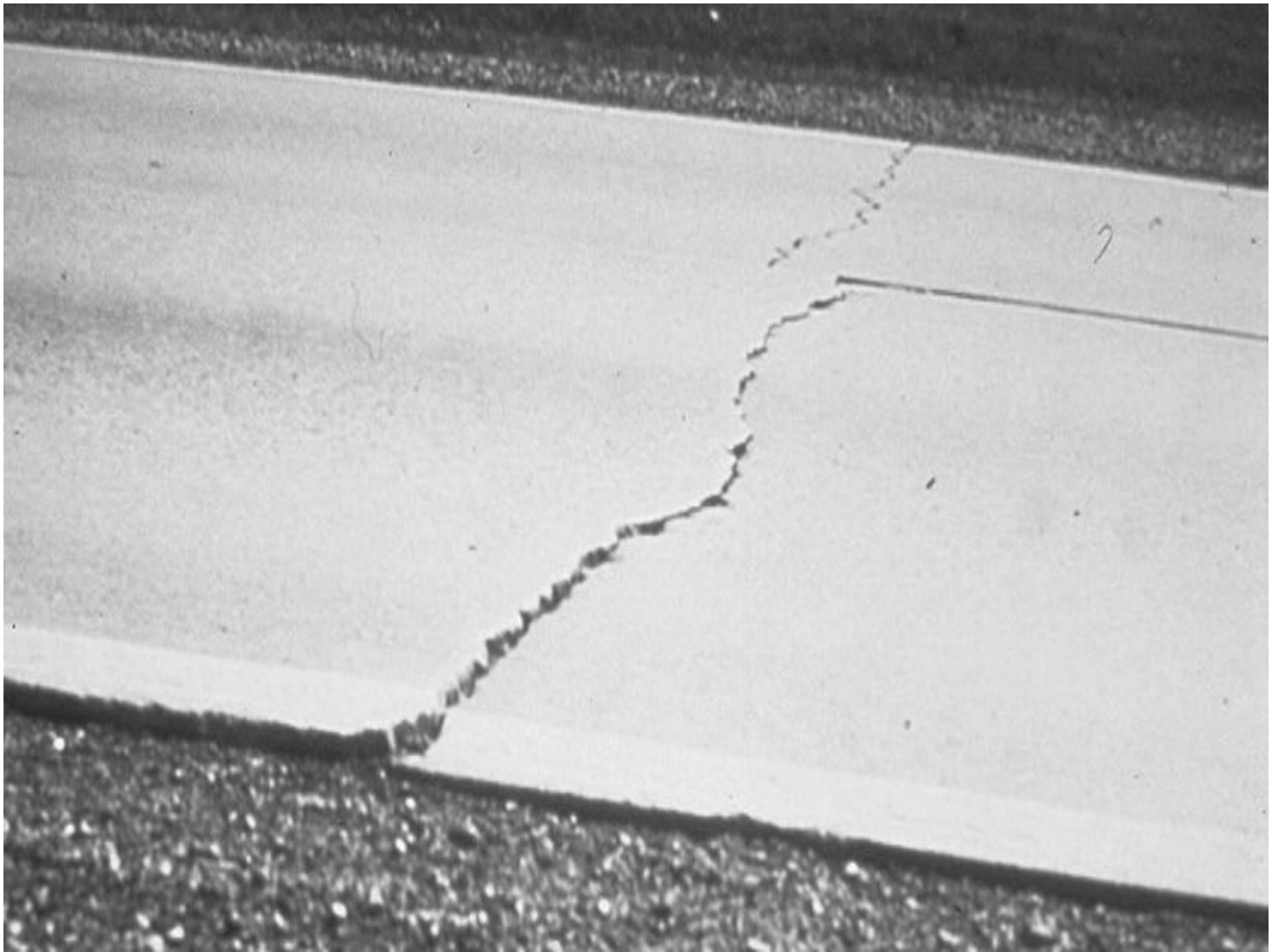
High-Temperature Joint / Crack Distress



Joint Spalling

Spalling

Mid-Slab Cracking



Pumping

Pumping

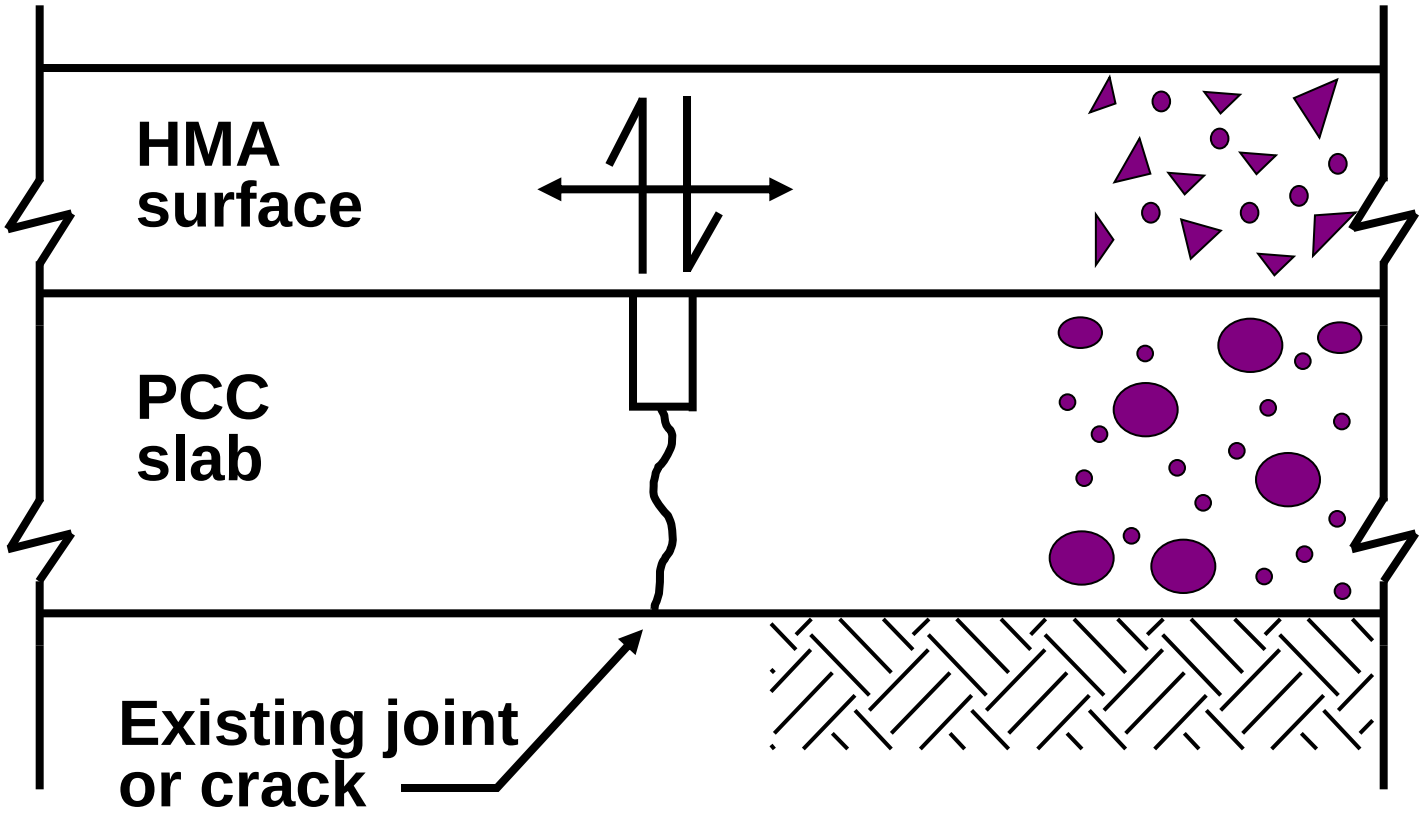
Pumping

Alkali-Silica Reactivity (ASR) Damage

D-Cracking

Scaling

Asphalt / Concrete Composite Pavements



Reflection Cracking

Lane-to-Shoulder Dropoff

Pavement Evaluation Techniques

Pavement Evaluation

1. Surface condition / distress
2. Serviceability / roughness
3. Structural capacity
4. Surface friction

1. Condition (Distress) Survey

- Document existing condition
- Determine causes of deterioration
- Identify repair locations and quantities
- Identify feasible maintenance alternatives

Distress Characterization

- Type
- Severity
- Extent

Distress Types for Asphalt Pavements

- Fatigue cracking
- Potholes
- Thermal cracking
- Rutting
- Bleeding
- Raveling
- Shoving
- Etc.

Distress Types for Concrete Pavements

- Cracking
- Spalling
- Faulting
- Pumping
- Etc.

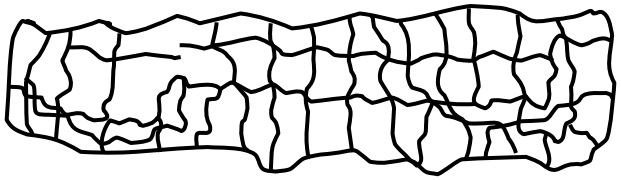
Severity

- Low
- Moderate
- High

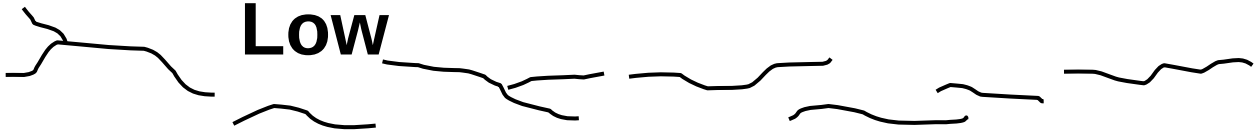
Cracking Severity

Moderate

High



Low

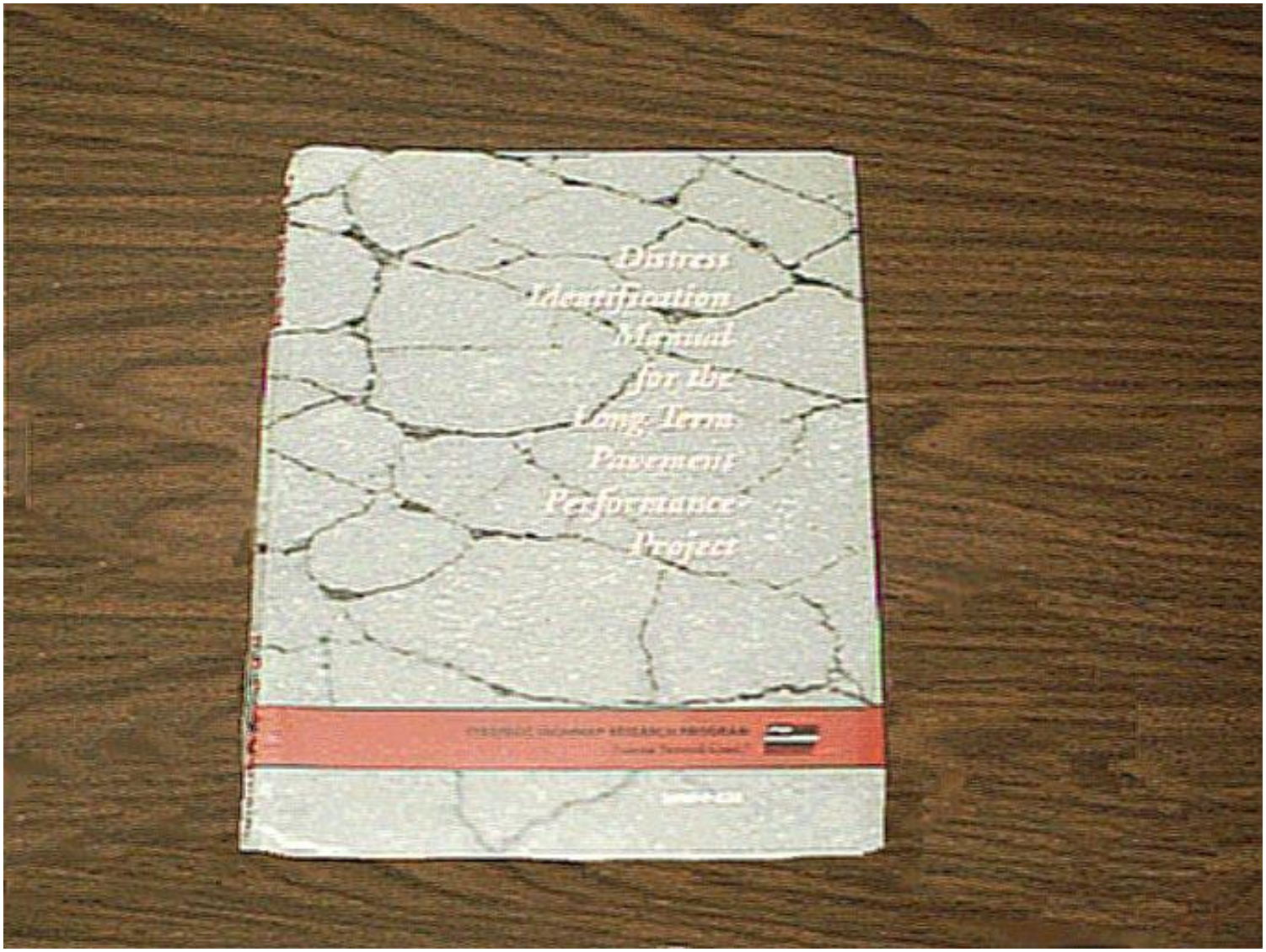


Extra High Severity Cracking

Extent

- Low
- Moderate
- High

Distress Identification Manual



Fatigue - Low Severity

Potholes - High Severity & Extent

Large Potholes-Signing ?

Transverse Crack - Medium Severity

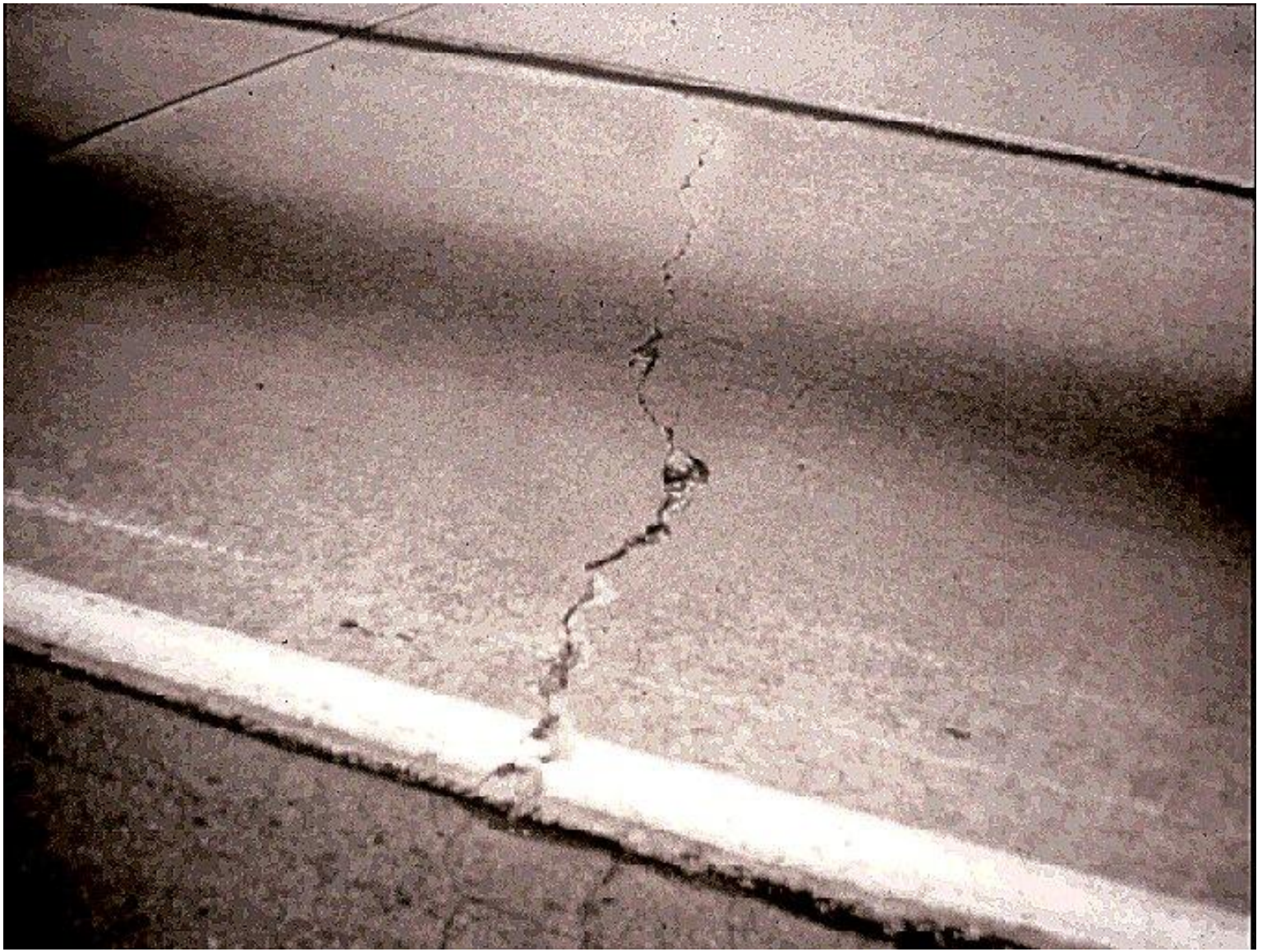
Transverse Crack - High Severity

Rutting - High Severity

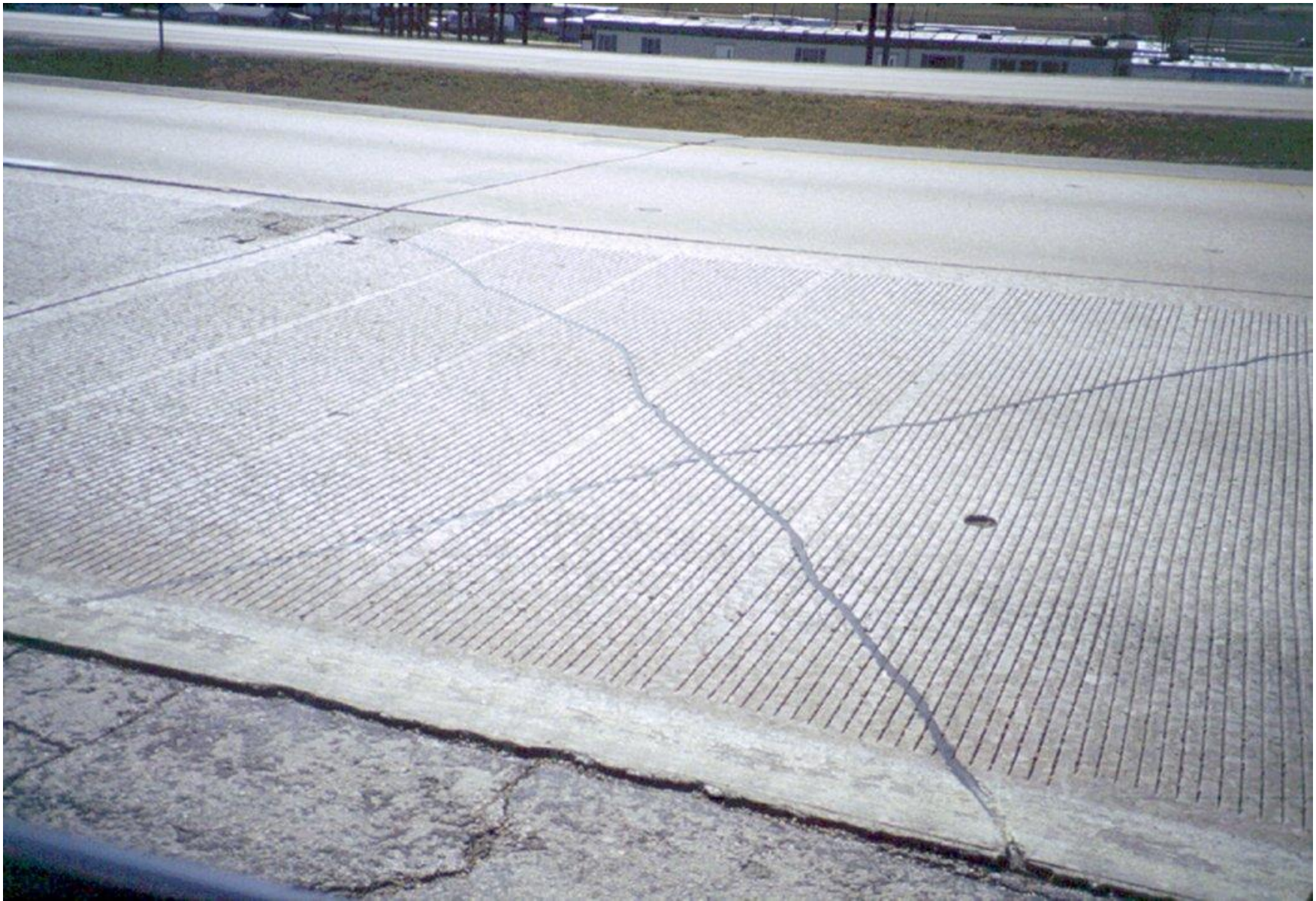
Flushing / Bleeding – High Severity

Raveling – High Severity

Transverse Crack - Spalling



Diagonal Cracking



Pumping - High Severity

Alkali-Silica Reactivity (ASR) Damage

Condition (Distress) Survey

- Types of condition survey
  - ✓Manual
  - ✓Mechanical (automated)

- Sampling versus complete coverage
- Network level versus project level
- Frequency of surveys

Manual Distress Survey

- More detailed than automated
- Slower than automated

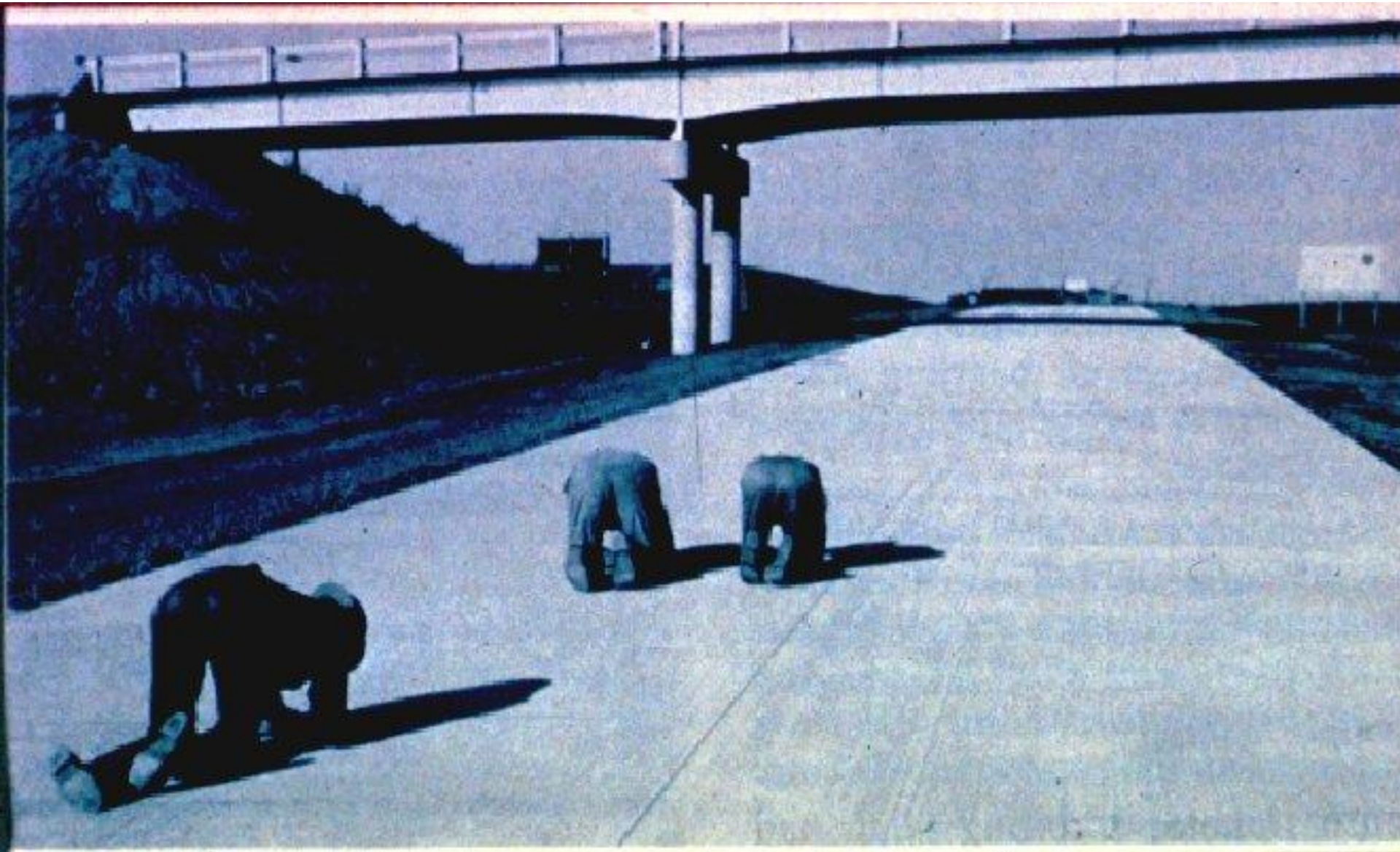
- Types
  - ✓Windshield survey
  - ✓Walking
  - ✓Combination

- Photos

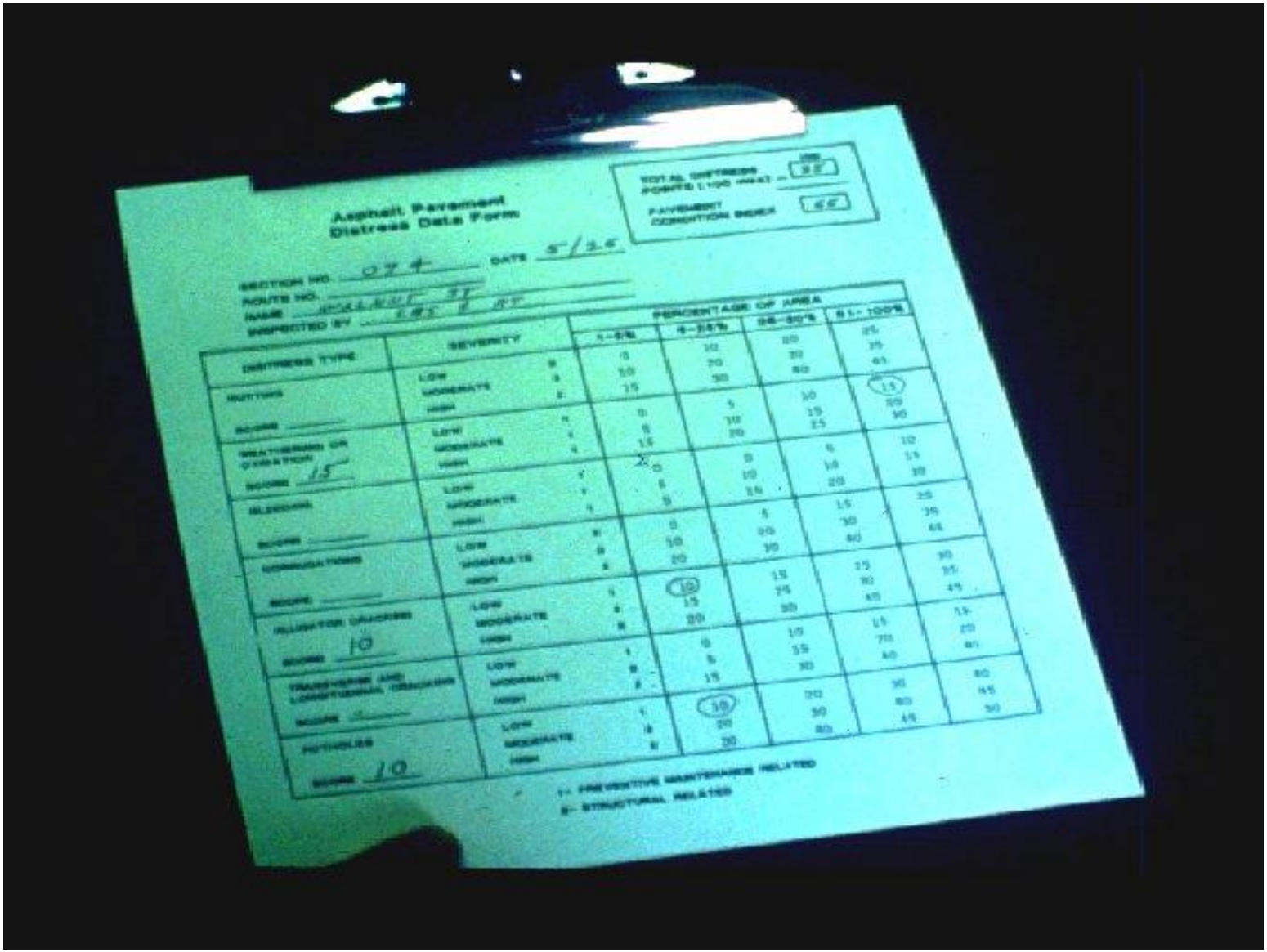
Windshield Survey

Walking Survey

Knees and Elbows Survey



Data Forms


Asphalt Pavement
Distress Data Form
SECTION NO. 024
DATE 5/3.6
PAVEMENT CONDITION INDEX 66
DISTRESS TYPE
SEVERITY
PERCENTAGE OF AREA
RUTTING
SCORE
WEATHERING OR OXIDATION
SCORE 15
BLEEDING
SCORE
CORRUGATIONS
SCORE
ALLIGATOR CRACKING
SCORE 10
TRANSVERSE AND LONGITUDINAL CRACKING
SCORE 0
POTHOLES
SCORE 10
LOW
MODERATE
HIGH
1= PREVENTIVE MAINTENANCE RELATED
2= STRUCTURAL RELATED

Hand-Held Computer

Automated Distress Surveys

- More consistent
- Increased safety
- No traffic disturbance
- Predictable productivity
- Objective output
- Increased sample size
- Cost saving (Long term)

Profilometer for Measuring Rutting and Roughness

Pasco Equipment

Pave Tech Equipment

Pavement Evaluation

1. Surface condition / distress
2. Serviceability / roughness
3. Structural capacity
4. Surface friction

2. Serviceability / Roughness

Roughness

- Deviations in pavement surface that affect ride quality
- Caused by:
  - ✓ Built-in surface irregularities
  - ✓ Irregularities caused by traffic and environment
- Present Serviceability Index (PSI)
- International Roughness Index (IRI)

K.J. Law Profilometer

Profilometer for Measuring Rutting and Roughness

Maysmeter

Pavement Evaluation

1. Surface condition / distress
2. Serviceability / roughness
3. Structural capacity
4. Surface friction

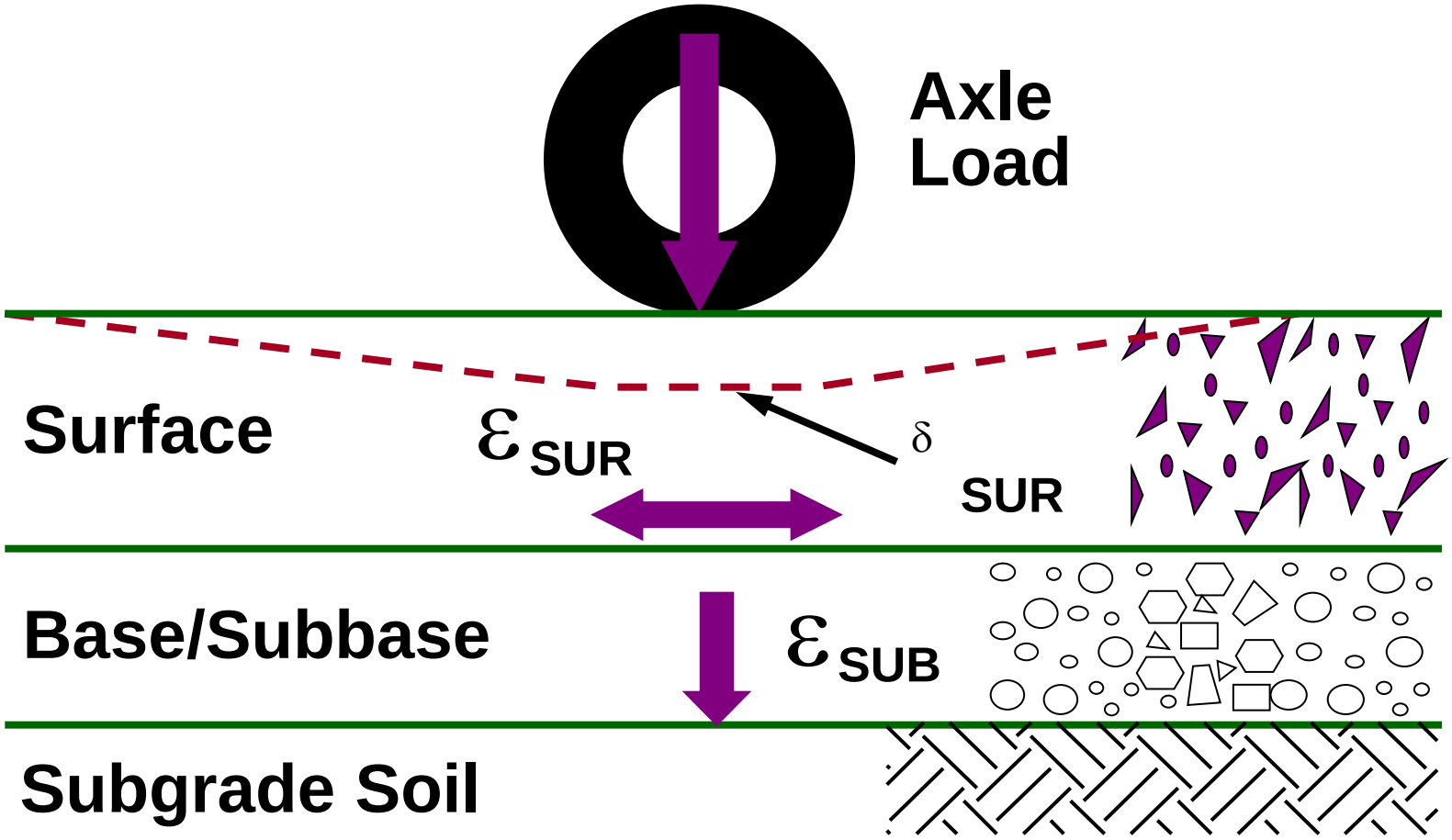
3. Structural Capacity

- Nondestructive testing (NDT)
  - Deflection measurement
  - Seismic technique
- Lab testing

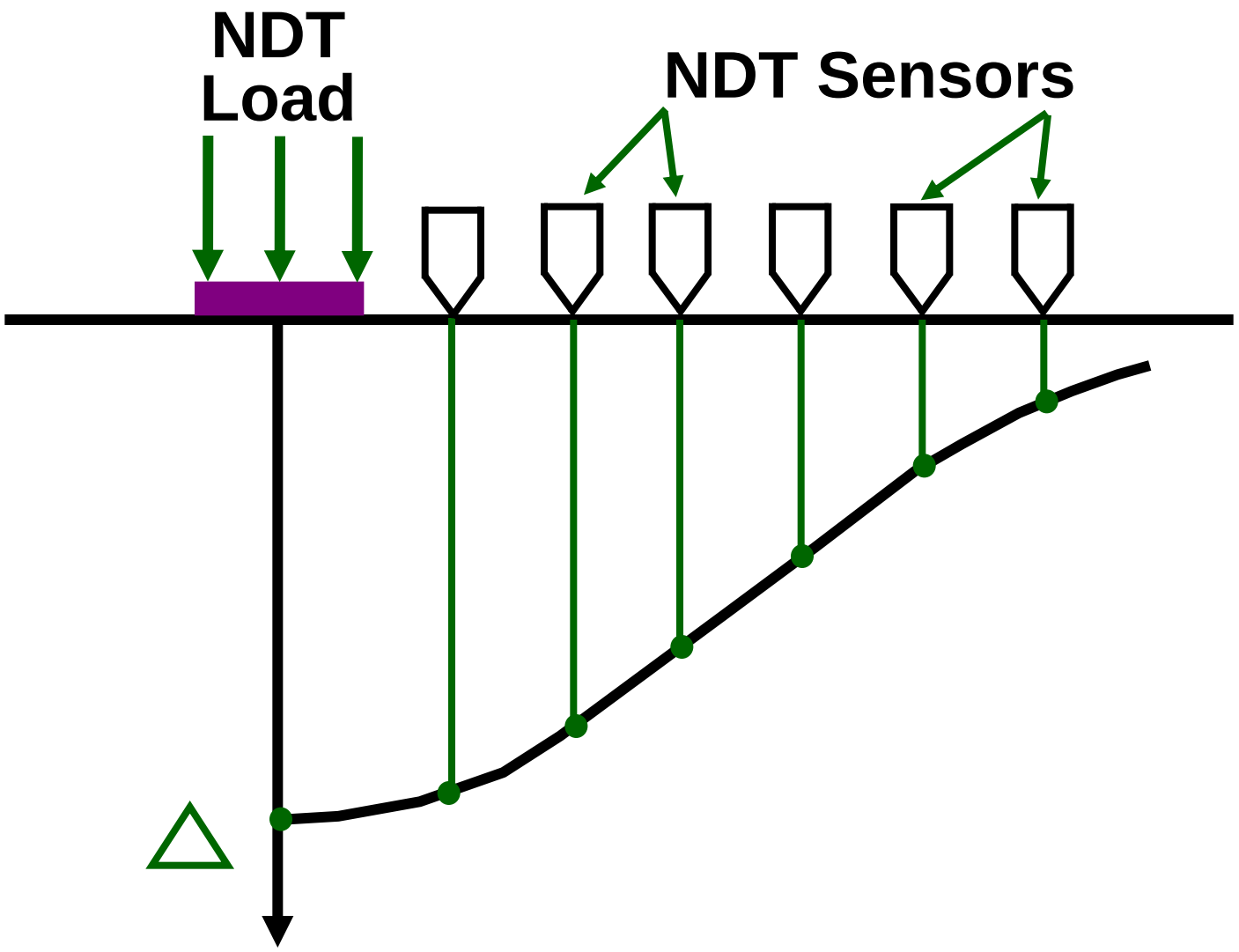
NDT

- Productive - 200 to 400 measurements per day
- Repeatable
- Deflection measurements are used by most states for project and some network evaluations

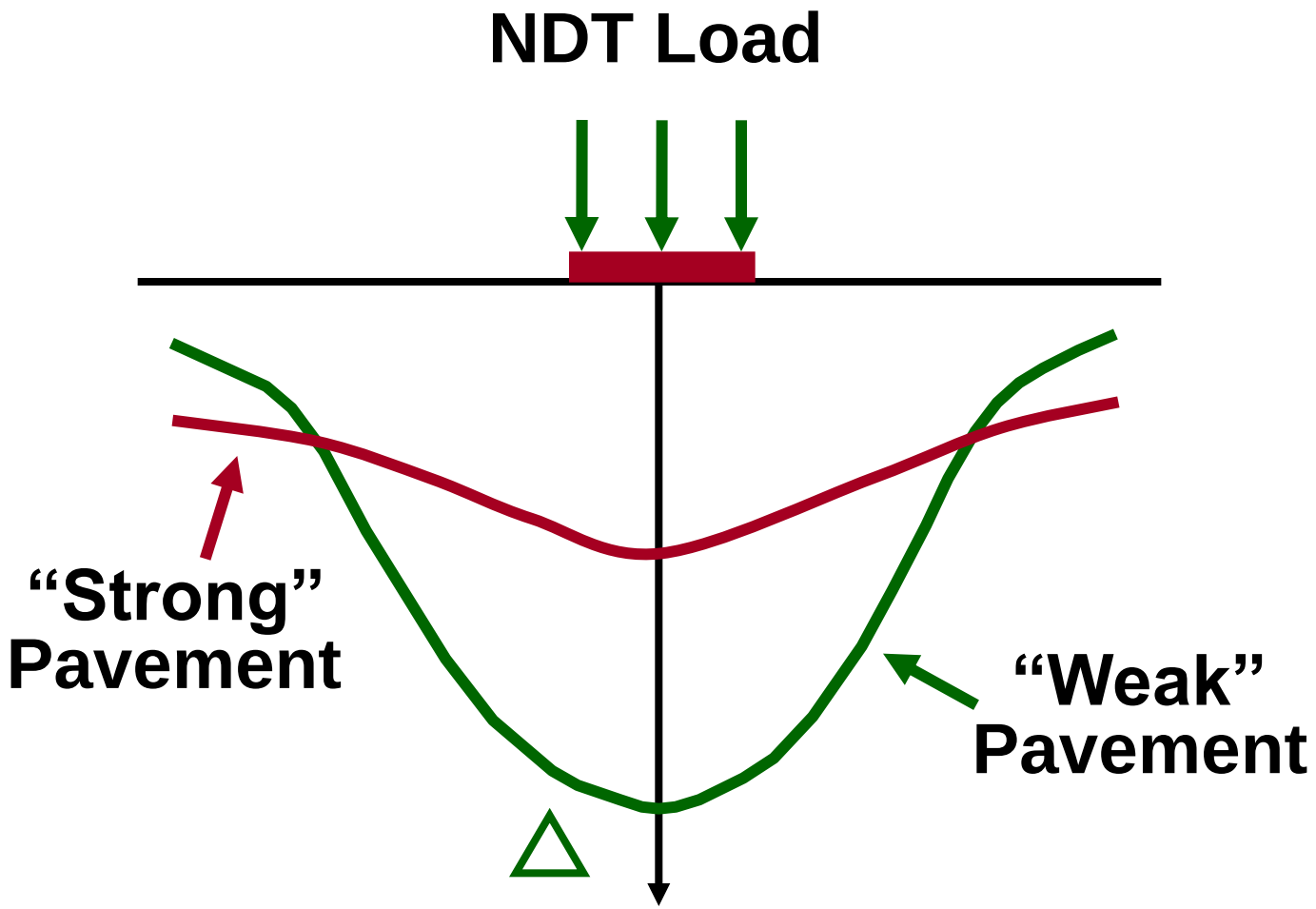
Pavement Responses Under Load



Measurement of Surface Deflection



Strong vs. Weak Pavements



Potential Results From NDT

- Project variability
- Subgrade soil support
- Void location
- Joint load transfer
- Critical periods
- In-situ material properties
- Structural adequacy

Dynaflect

Falling Weight Deflectormeter

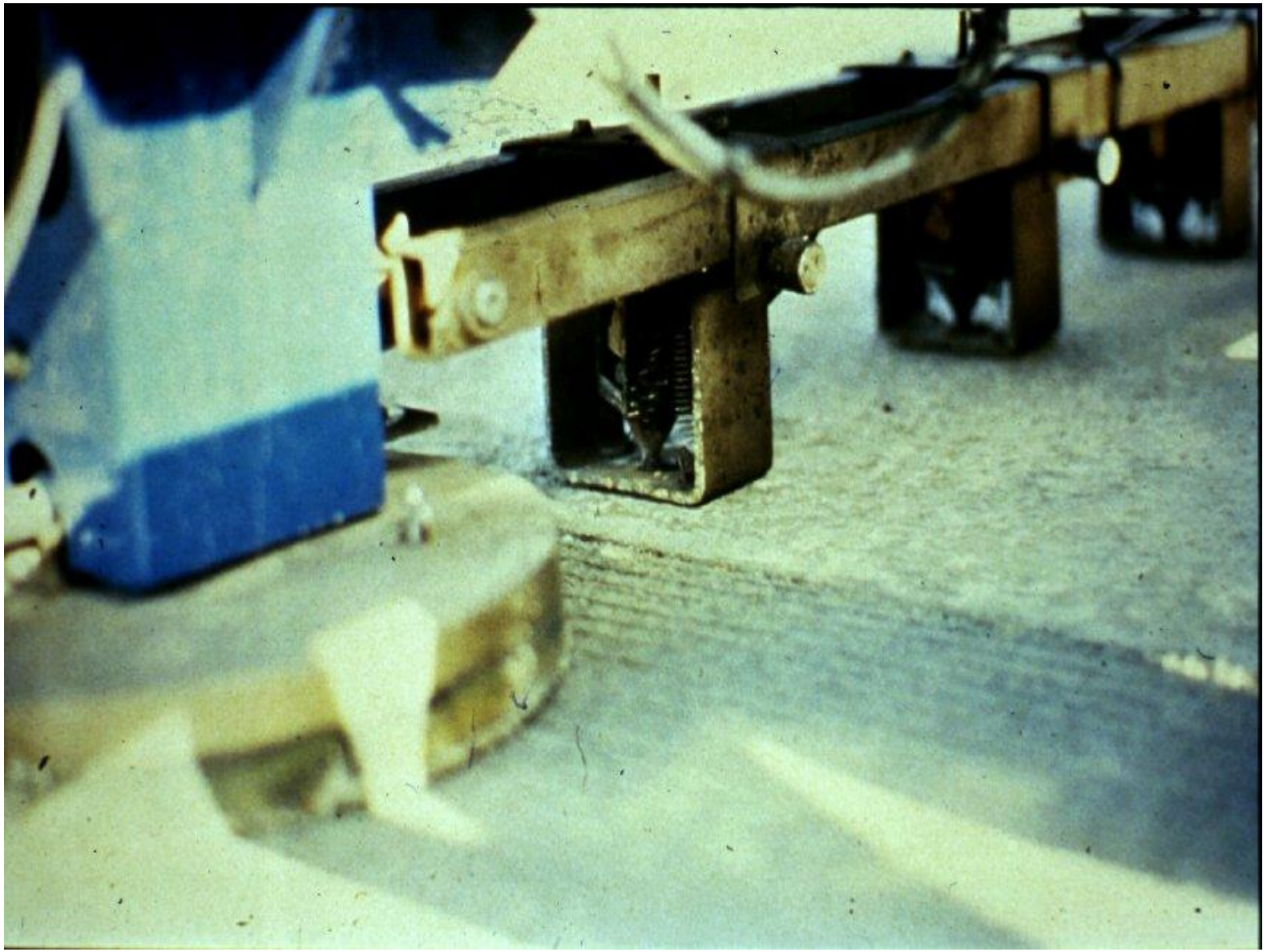
Factors that Influence Measured Deflections

- Load magnitude
- Pavement factors (distresses, transverse location, etc.)
- Climatic factors (moisture, Temperature, frost)

Testing Locations / Frequency

- 100 to 500 ft intervals
- Typically outer lane only
- Both directions - staggered
- Flexible - outer wheel path
- Concrete - midslab, joint, corner

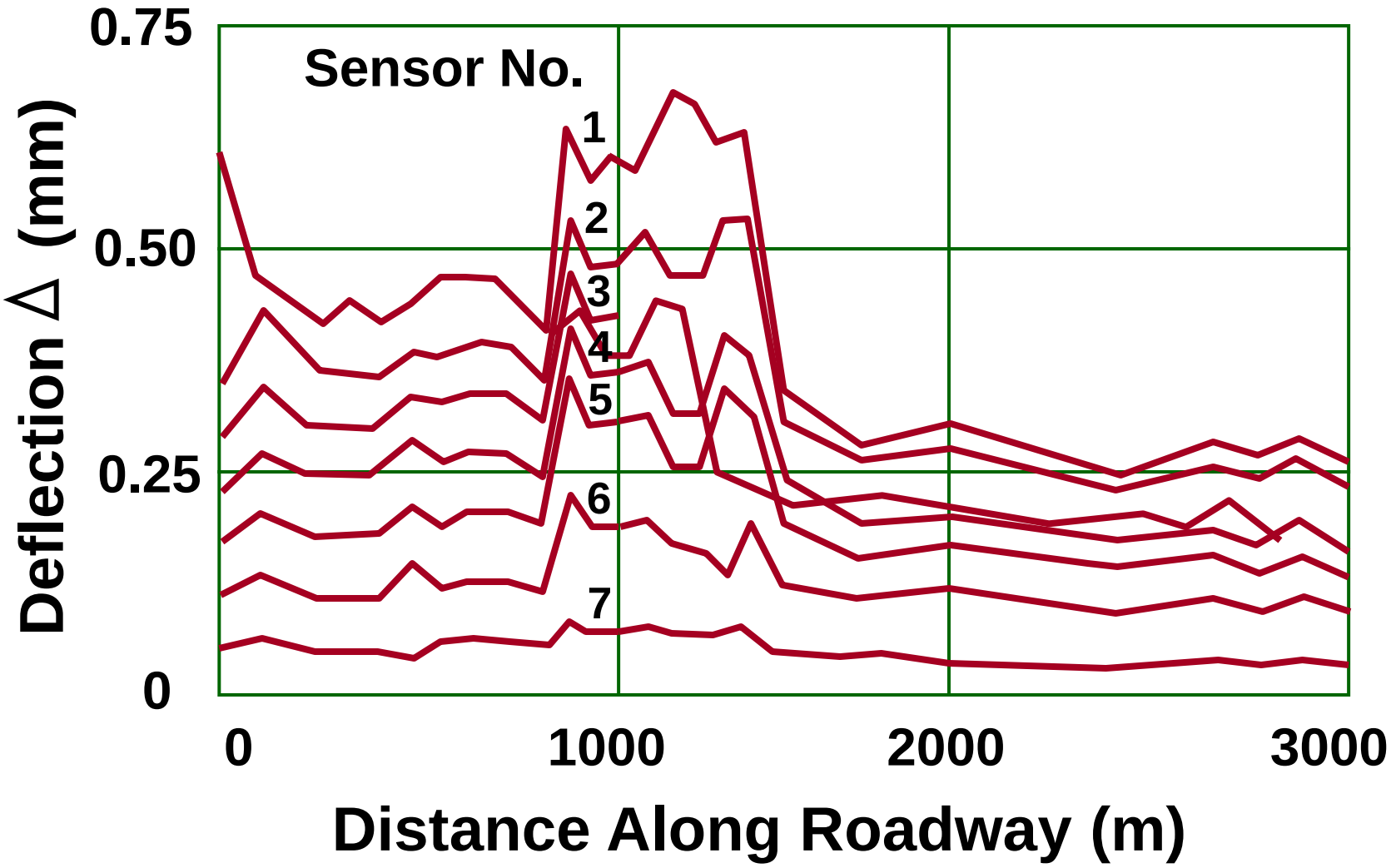
Testing at Joints



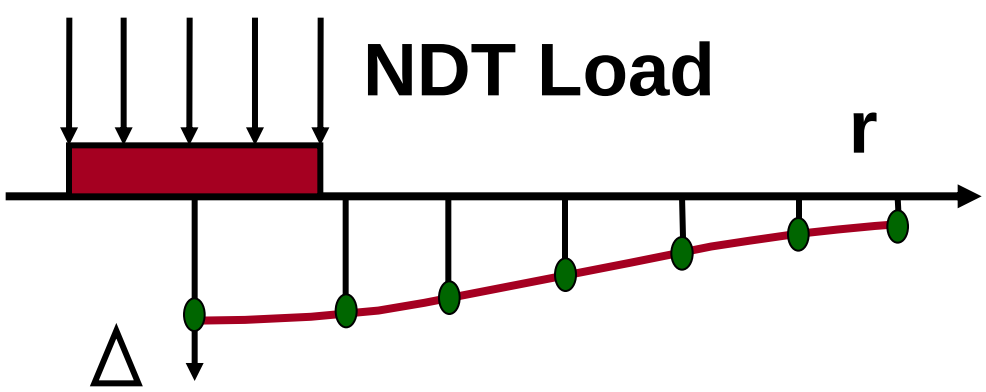
Interpretation of NDT Data

- Uniformity of project
  - ✓Design sections for rehabilitation
  - ✓Locations for sampling / testing
- Determining pavement layer moduli
  - ✓Insitu characterization
  - ✓“Backcalculation” process

Uniformity (Non-uniformity) of Project



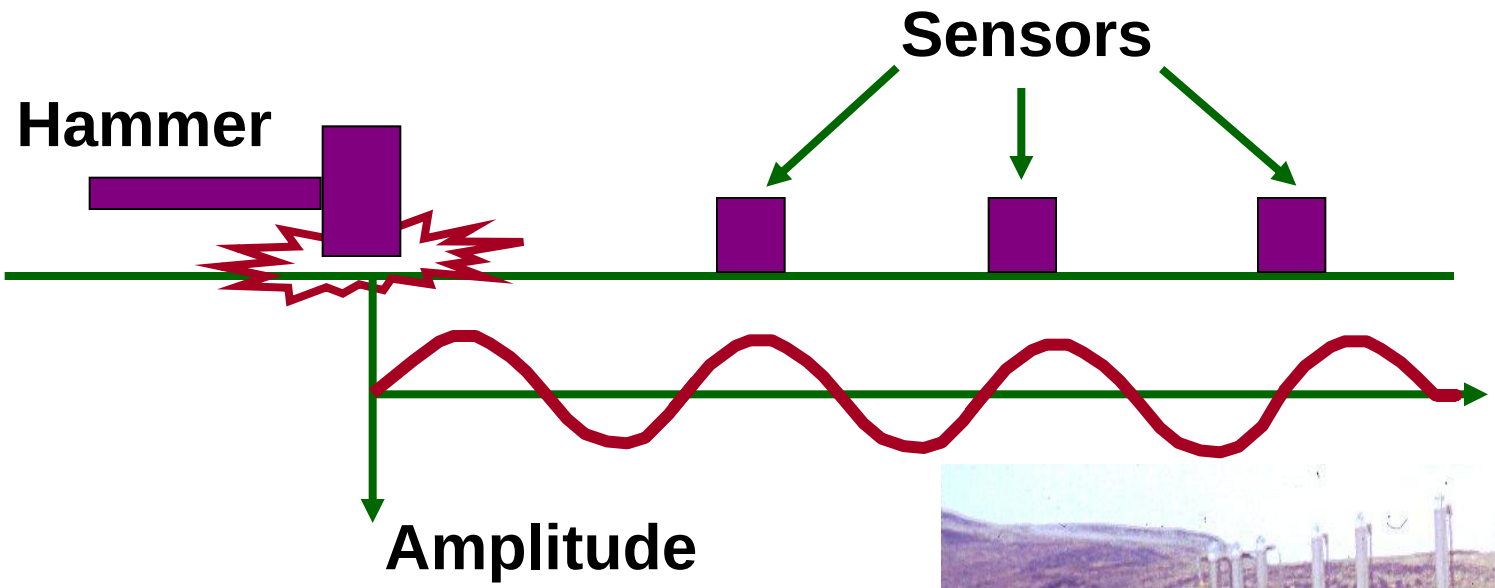
Typical Pavement Case

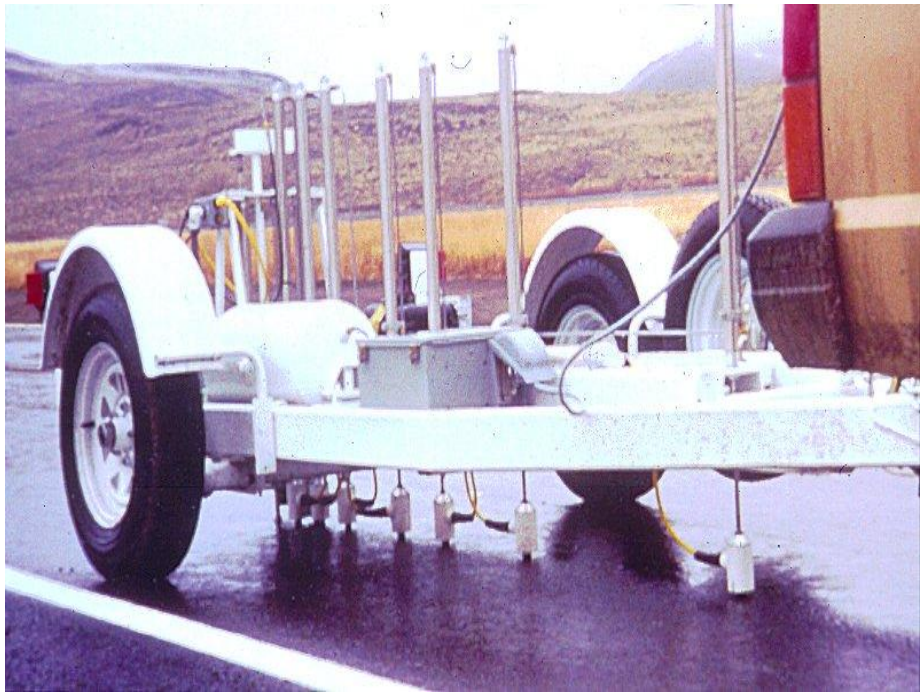


Layer Characteristics

Surface	E_1	ν_1	D_1
Base/ Subbase	E_2	ν_2	D_2
Natural Soil	E_3	ν_3	∞

Seismic Pavement Analyzer





Pavement Evaluation

1. Surface condition / distress
2. Serviceability / roughness
3. Structural capacity
4. Surface friction

4. Surface Friction Surveys

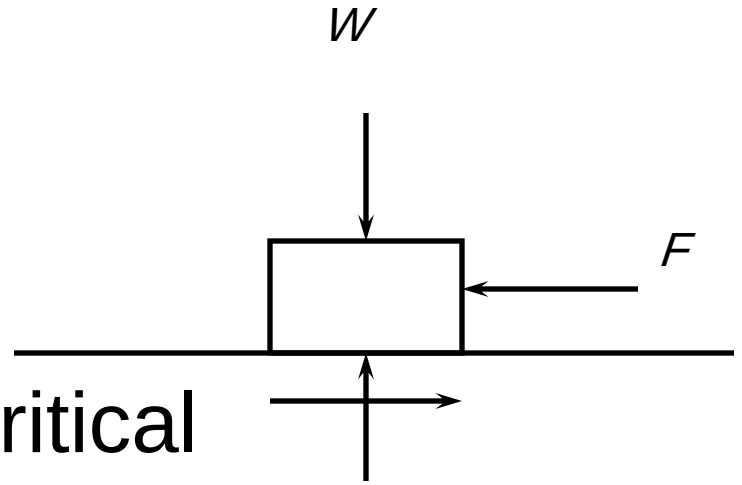
Surface friction

- Skid resistance
- Safety concerns
  - ✓Hydroplaning
  - ✓Wet weather accidents
- Influenced by
  - ✓Microtexture
  - ✓Macrotexture
  - ✓Cross-slope

Skid Resistance

- Interaction between tire and pavement
- Coefficient of friction:

$$f = \frac{F}{W}$$



- Wet condition is more critical

Measurement Equipment

- Locked wheel skid
- Mu meter
- British Pendulum Tester
- Others

Mu Meter


AND THIS WHAT THEY WANT !
BLACK PAINT