



# Pavement Evaluation Techniques

# Pavement Evaluation

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

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1. **Surface condition / distress**
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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.

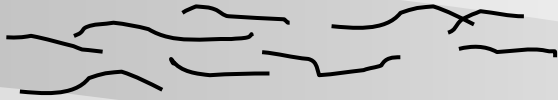
# Severity

- Low
- Moderate
- High

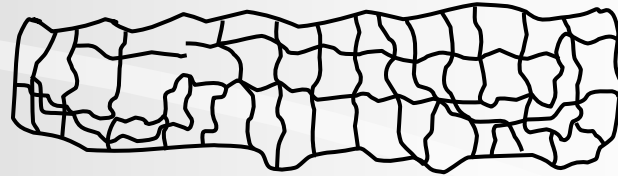


# Cracking Severity

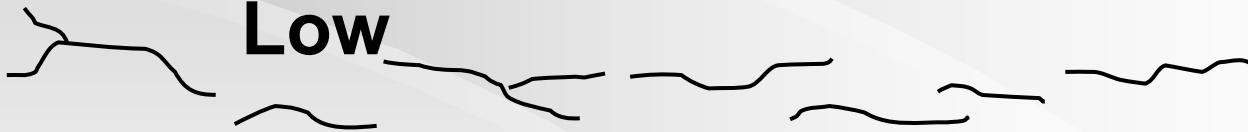
**Moderate**



**High**



**Low**





# Extra High Severity Cracking



# Extent

- Low
- Moderate
- High



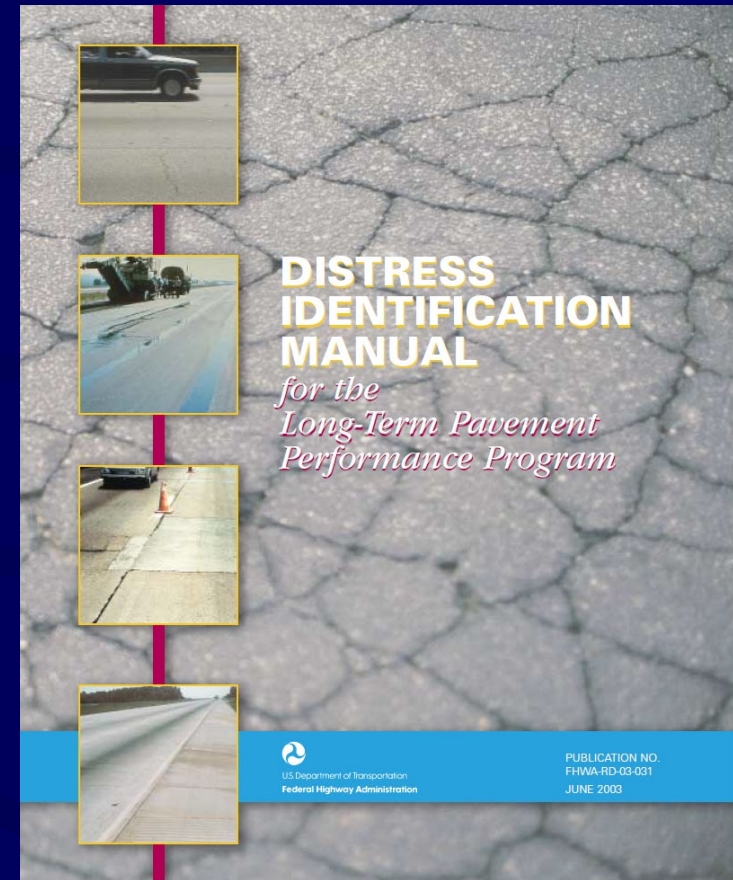
# Distress Identification Manual

## Benefits

- Consistent definitions
- Standardized
- Calibration

## Degree of sophistication

- LTPP (research oriented)
- Project Level (design oriented)





# Fatigue - Medium Severity





# Fatigue - High Severity & Extent



# Potholes - High Severity & Extent



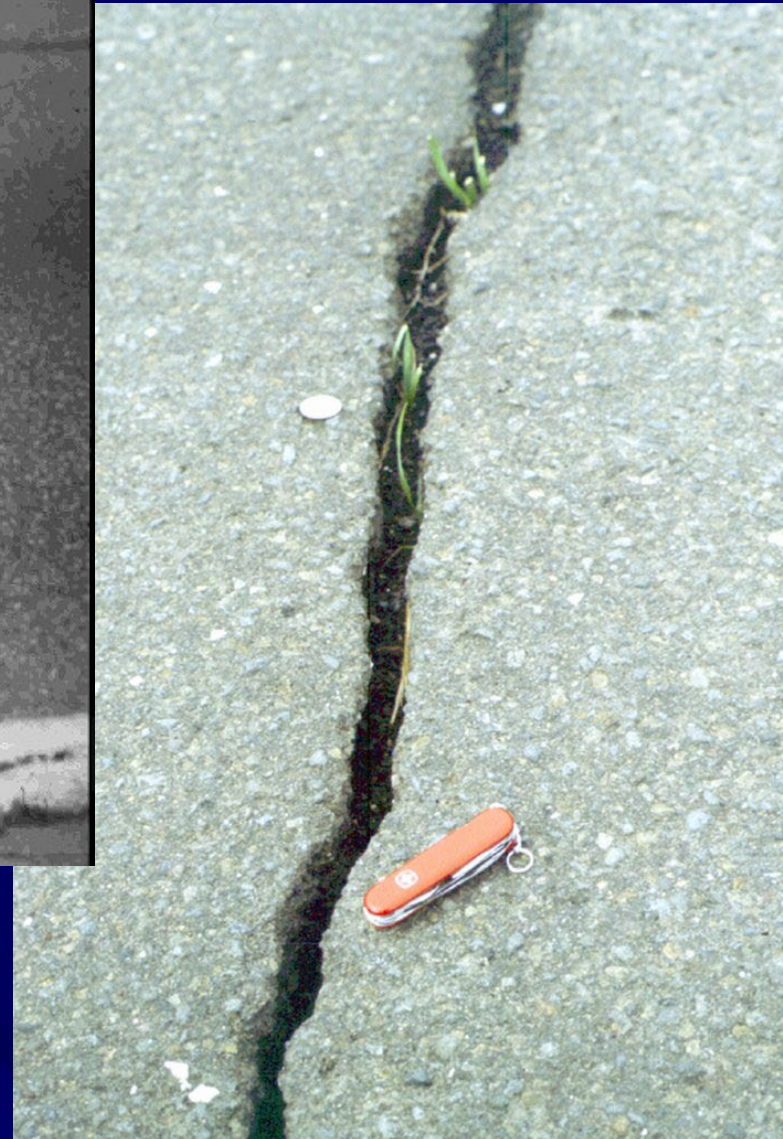


# Large Potholes-Signing ?



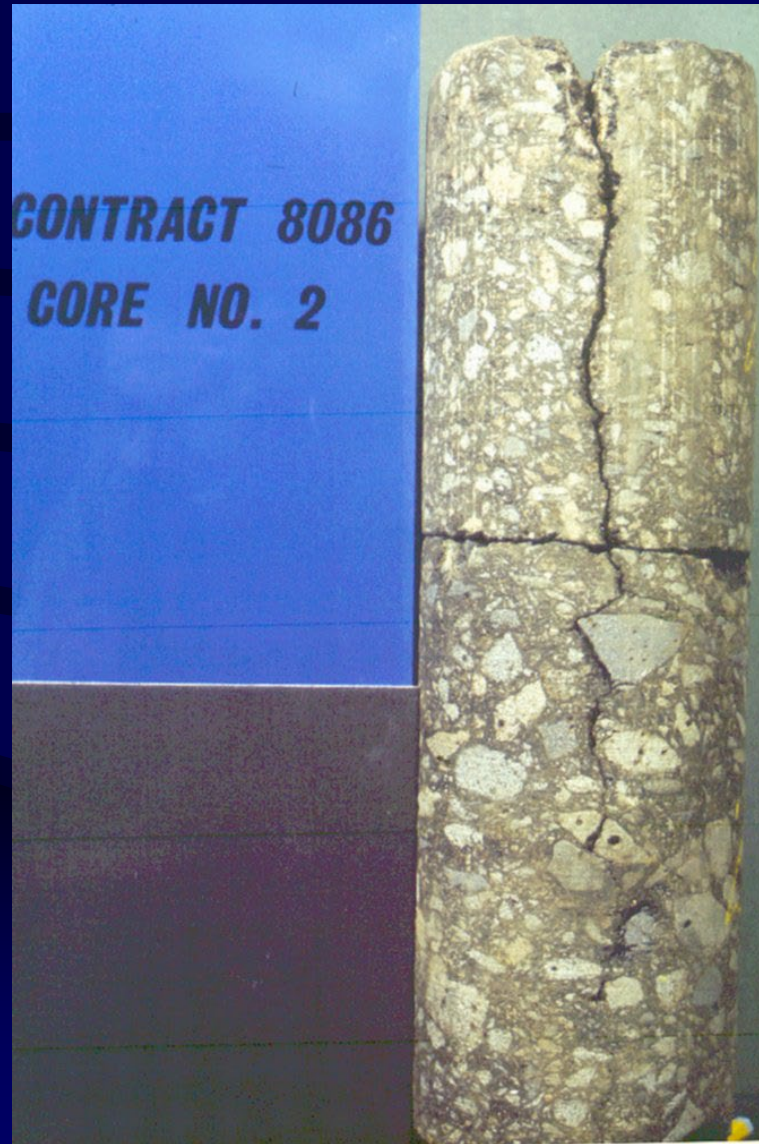


# Transverse Crack - Med. Severity





# Transverse Crack - Med. Severity



# Transverse Crack - High Severity





# Rutting - High Severity





# Flushing / Bleeding - High Severity





# Raveling - High Severity



# Condition (Distress) Survey

- Types of condition survey
  - ✓ Manual
  - ✓ Mechanical (automated)
- Network level versus project level
- Sampling versus complete coverage
- Frequency of surveys

# Manual Distress Survey

- More detailed than automated
- Slower than automated
- Types
  - ✓ Windshield survey
  - ✓ Walking
  - ✓ Combination
- Photos, Videos

# Windshield Survey





# Walking Survey



## Data Forms

Asphalt Pavement Distress Data Form

SECTION NO. 074 DATE 5/12

ROUTE NO. 15

NAME [unclear]

SUBMITTED BY [unclear]

PERCENTAGE OF AREA

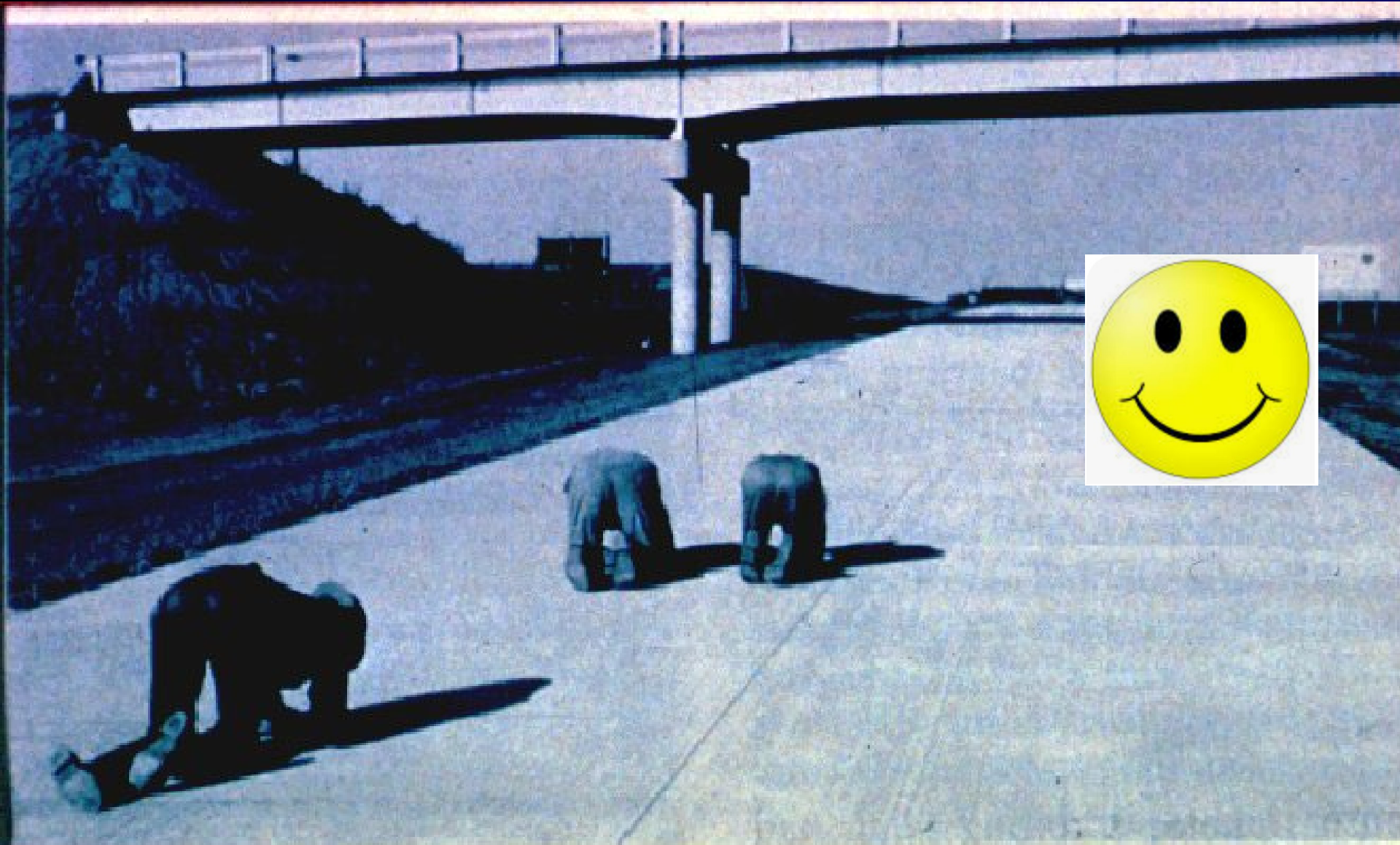
DISTRESS TYPE	SEVERITY	N	PERCENTAGE OF AREA			
			1-5%	6-15%	16-25%	26-100%
CRACKS	LOW	0	0	0	0	0
	MODERATE	0	0	0	0	0
	HIGH	0	0	0	0	0
SCALING	LOW	0	0	0	0	0
	MODERATE	0	0	0	0	0
	HIGH	0	0	0	0	0
WHALES/CHAINS OR SPALLS	LOW	0	0	0	0	0
	MODERATE	0	0	0	0	0
	HIGH	0	0	0	0	0
POTHOLES	LOW	0	0	0	0	0
	MODERATE	0	0	0	0	0
	HIGH	0	0	0	0	0
CORROSION	LOW	0	0	0	0	0
	MODERATE	0	0	0	0	0
	HIGH	0	0	0	0	0
REINFORCING (CRACKS)	LOW	0	0	0	0	0
	MODERATE	0	0	0	0	0
	HIGH	0	0	0	0	0
REINFORCING AND LONGITUDINAL CRACKS	LOW	0	0	0	0	0
	MODERATE	0	0	0	0	0
	HIGH	0	0	0	0	0
PITTSBURGH	LOW	0	0	0	0	0
	MODERATE	0	0	0	0	0
	HIGH	0	0	0	0	0

1 - PREVENTIVE MAINTENANCE RELATED  
2 - STRUCTURAL RELATED



## Hand-Held Computer

# Knees and Elbows Survey



# 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



<https://www.youtube.com/watch?v=rcDFVxcb> Q

# Automatic Road Analyzer(ARAN)

Condition &  
Roughness

A screenshot of the ARAN software interface. The top part shows a map view of a road with a green sign that reads "UC Davis Hutchison Dr". Below the map is a data table with columns for DISTANCE, COUNTY, ROUTE, PROFILE, LATITUDE, LONGITUDE, PROFILE, and ROAD TYPE. The table contains several rows of data.

DISTANCE	COUNTY	ROUTE	PROFILE	LATITUDE	LONGITUDE	PROFILE	ROAD TYPE									
11	YOL	113	0.075	NR	4300	38.5102743	-121.7681848	12.400	PLS	PLS	N	N	0.000	PLS	N	N
12	YOL	113	0.080	NR	4300	38.5102704	-121.7681878	12.300	PLS	PLS	N	N	0.000	PLS	N	N
13	YOL	113	0.085	NR	4300	38.5102665	-121.7681907	12.300	PLS	PLS	N	N	0.000	PLS	N	N
14	YOL	113	0.090	NR	4300	38.5102626	-121.7681936	12.400	PLS	PLS	N	N	0.000	PLS	N	N
15	YOL	113	0.095	NR	4300	38.5102587	-121.7681965	12.400	PLS	PLS	N	N	0.000	PLS	N	N
16	YOL	113	0.100	NR	4300	38.5102548	-121.7681994	12.400	PLS	PLS	N	N	0.000	PLS	N	N
17	YOL	113	0.105	NR	4300	38.5102509	-121.7682023	12.400	PLS	PLS	N	N	0.000	PLS	N	N

<https://www.youtube.com/watch?v=ws2hJSeSmBs>



# City of Phoenix ARAN



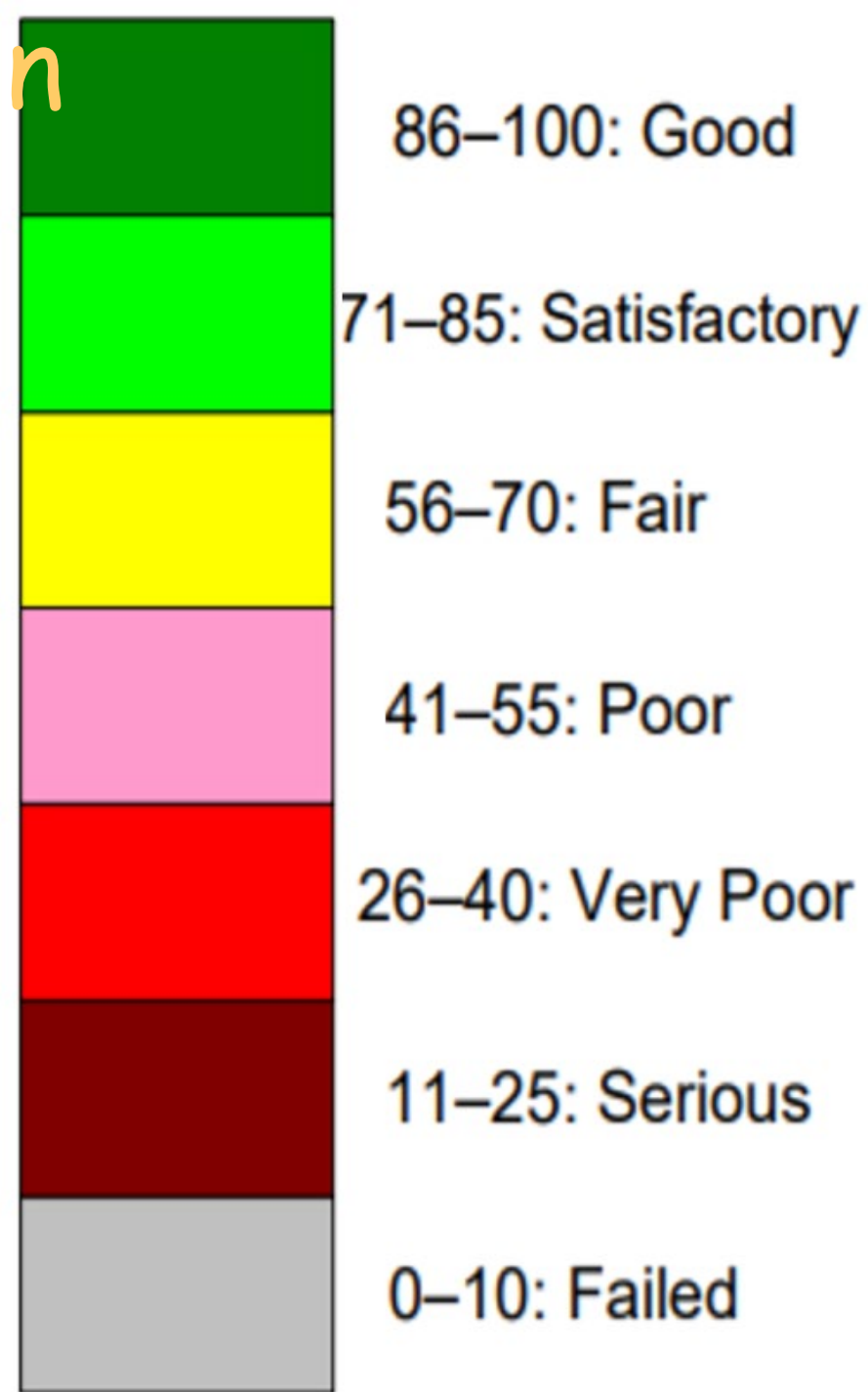
# Use of Drones in Pavement Condition Survey

- Still developing



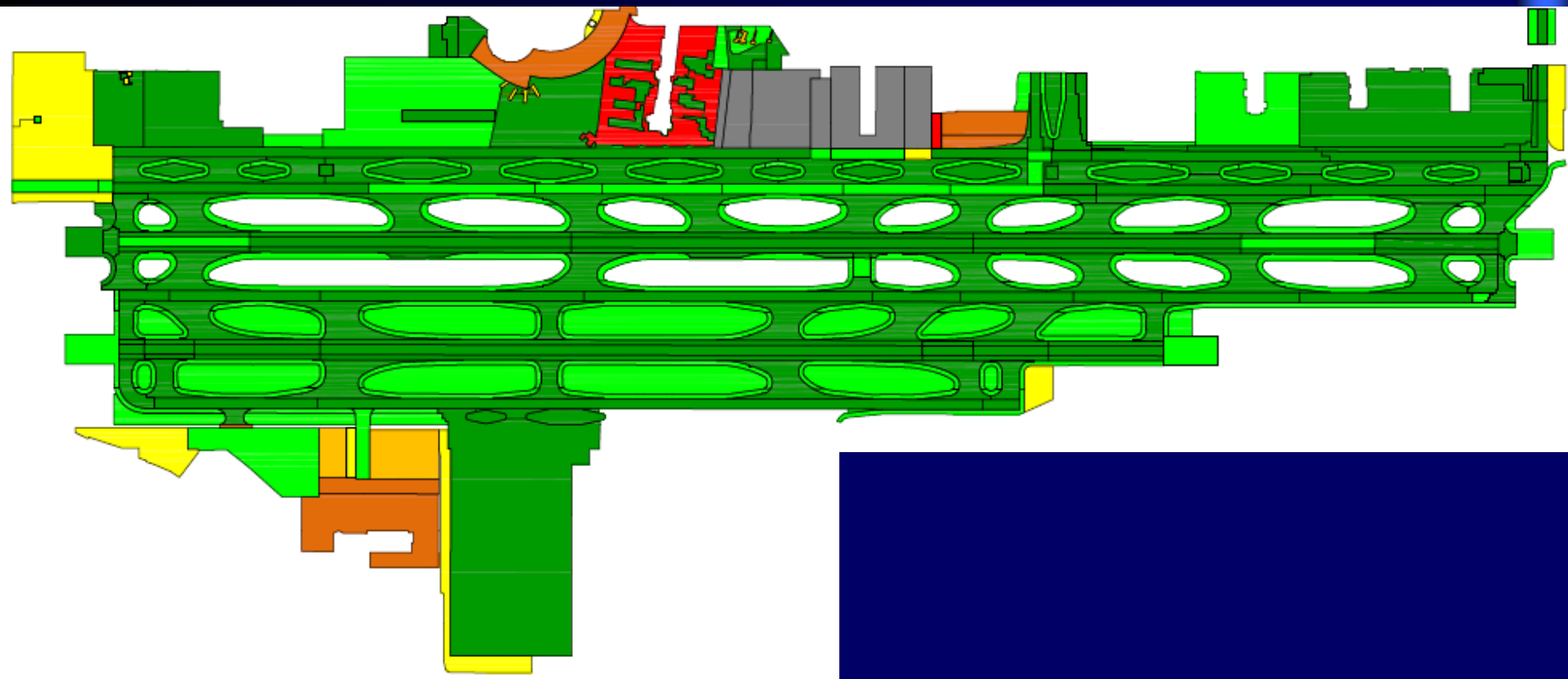
# Pavement Condition Index (PCI) (ASTM D6433)

- Numerical rating of pavement condition ranging from 0 to 100
- Deduct values for each distress type and severity

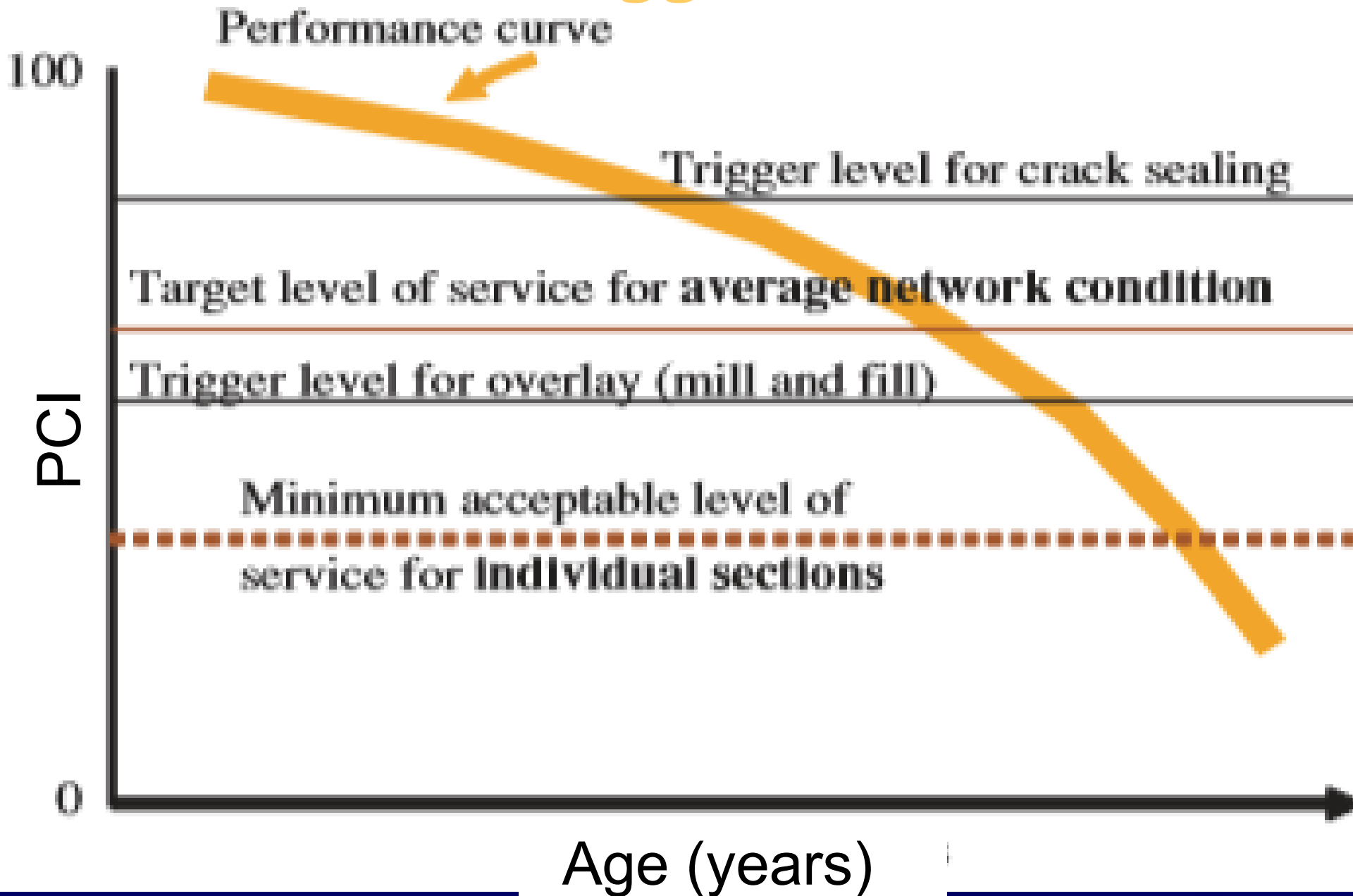




# Example of PCI of an Airport



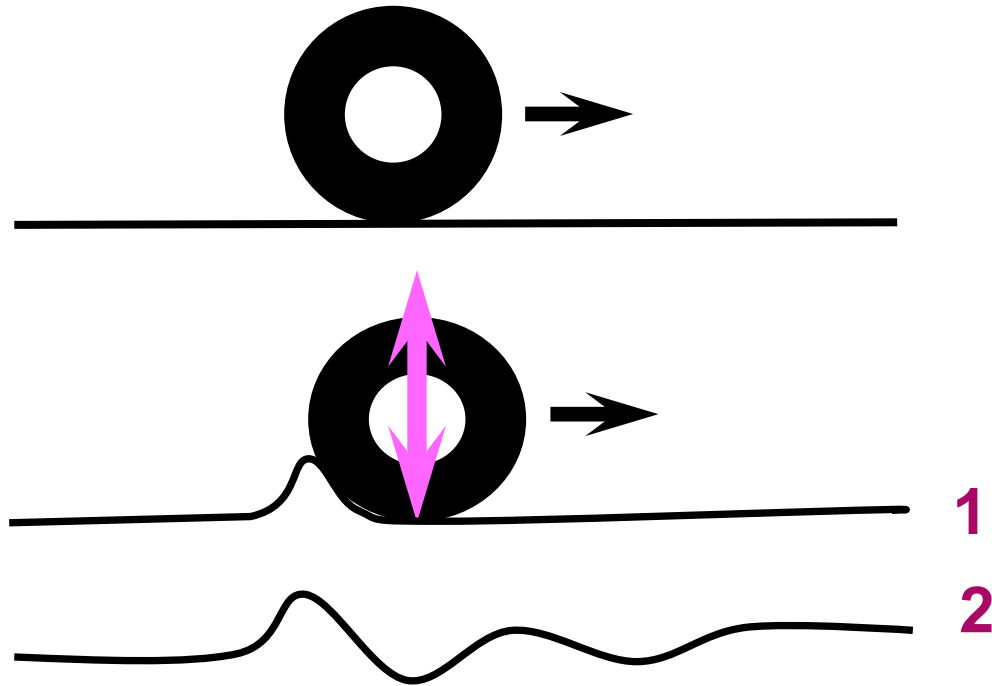
# M&R Trigger Levels



# Pavement Evaluation

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

# Vehicle-Pavement Interaction



## 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)

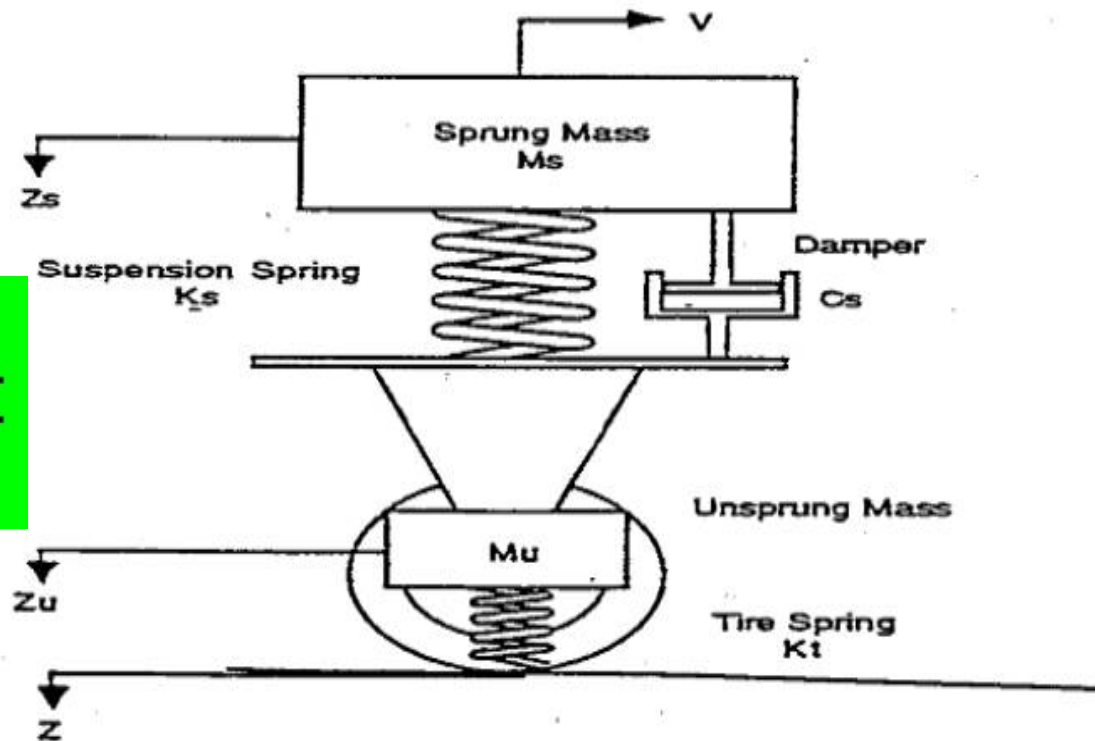
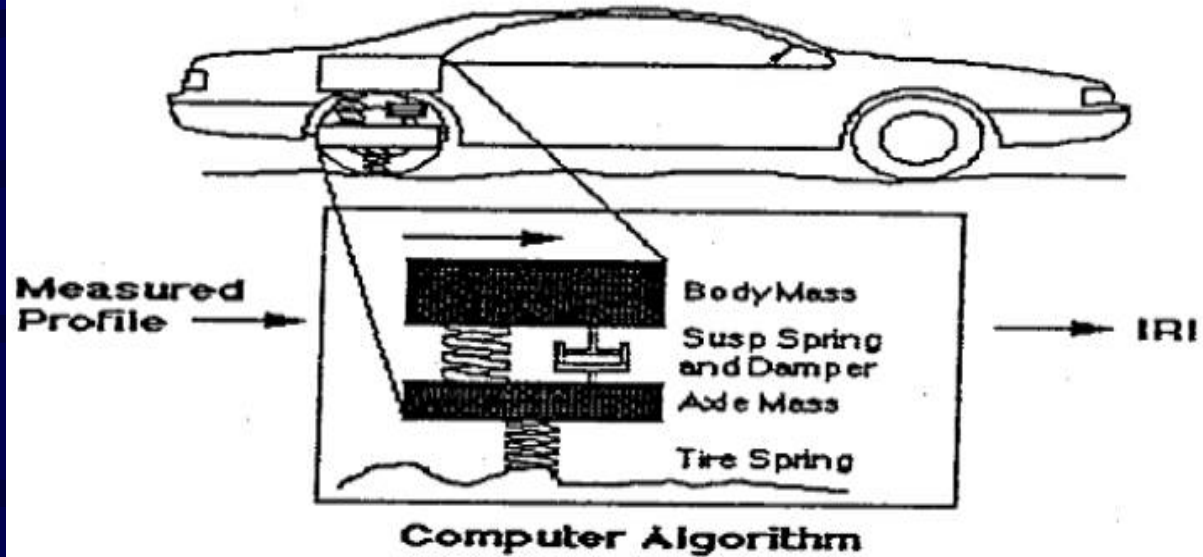
# Serviceability

- Developed during the AASHO Road Test
- Measure of user's perception of pavement rideability
- PSI Scale
  - Zero (impassable) to Five (very good)
  - Working range: 2.5 to 4.6
- PSI is highly correlated with roughness

# IRI

- A roughness scale based on the response of a generic motor vehicle (Quarter car model)
- IRI is the cumulative vertical deviations over a section of road per unit length (inches/mile)
- A wide range of roughness measuring devices can be used
- Typical values: 25 in./mile (smooth), 250 in./mile (rough)

# Quarter Car Model



$$IRI = \frac{1}{L} \int_0^{LV} |\dot{Z}_s - \dot{Z}_u| dt$$





ARAN



Profilometer



Maysmeter

# Pavement Evaluation

1. Surface condition / distress
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3. **Structural capacity**
4. Surface friction

# 3. Structural Capacity

- Directly related load carrying capacity and required overlay thickness
  - Nondestructive testing (NDT)
    - ❖ Deflection measurement
    - ❖ Faster
    - ❖ Provides weighted average of the whole pavement section
  - Lab testing

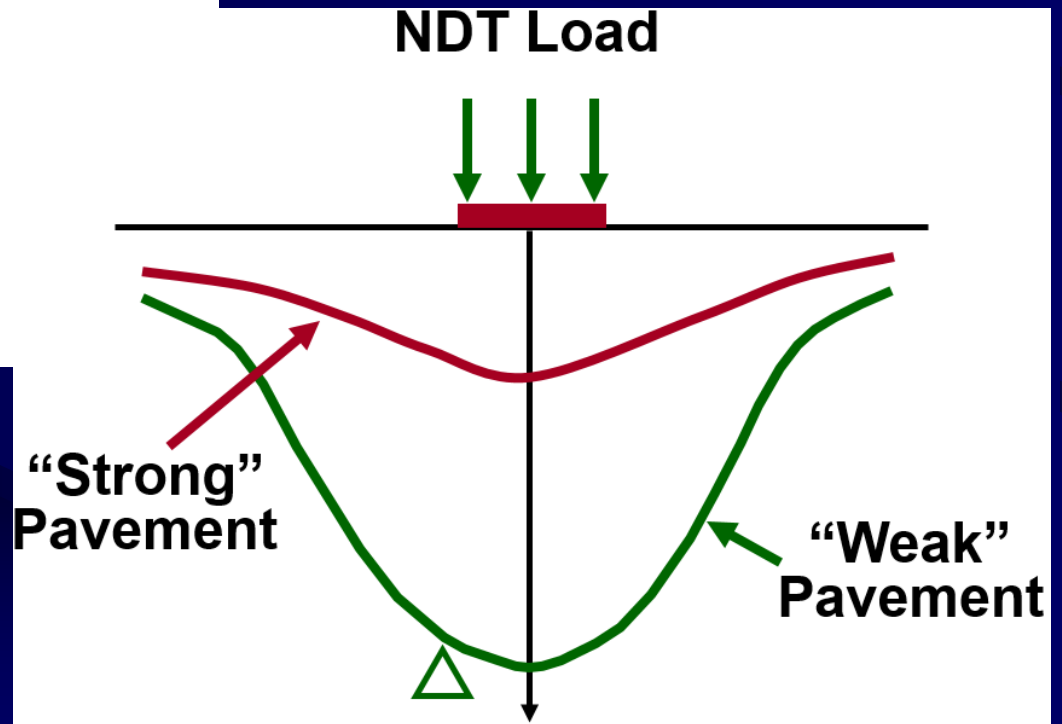
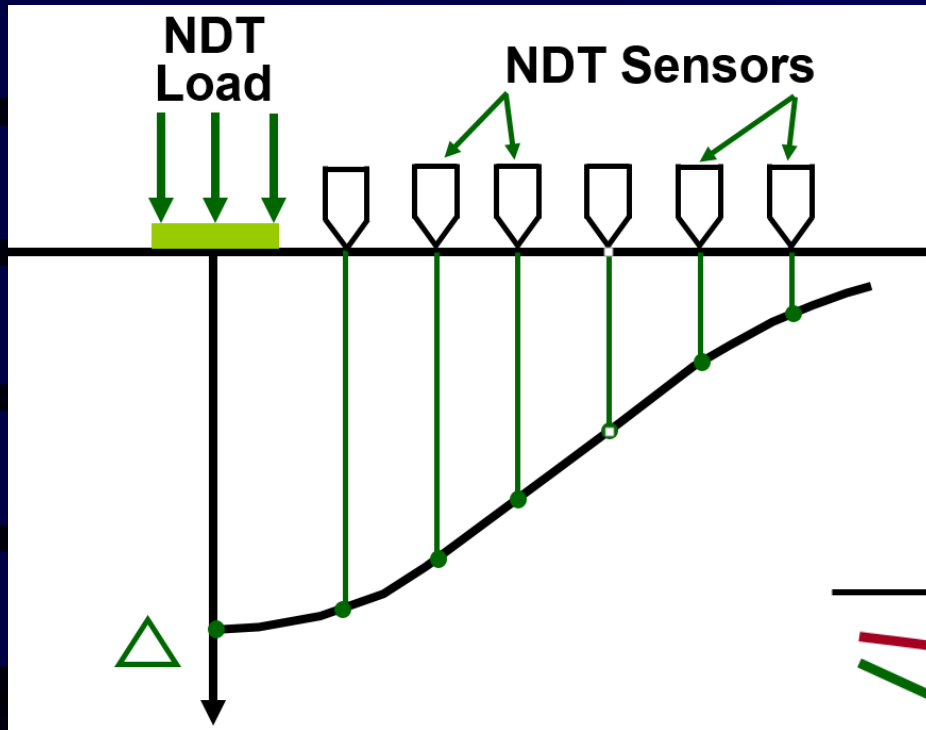
# Falling Weight Deflectometer (FWD)



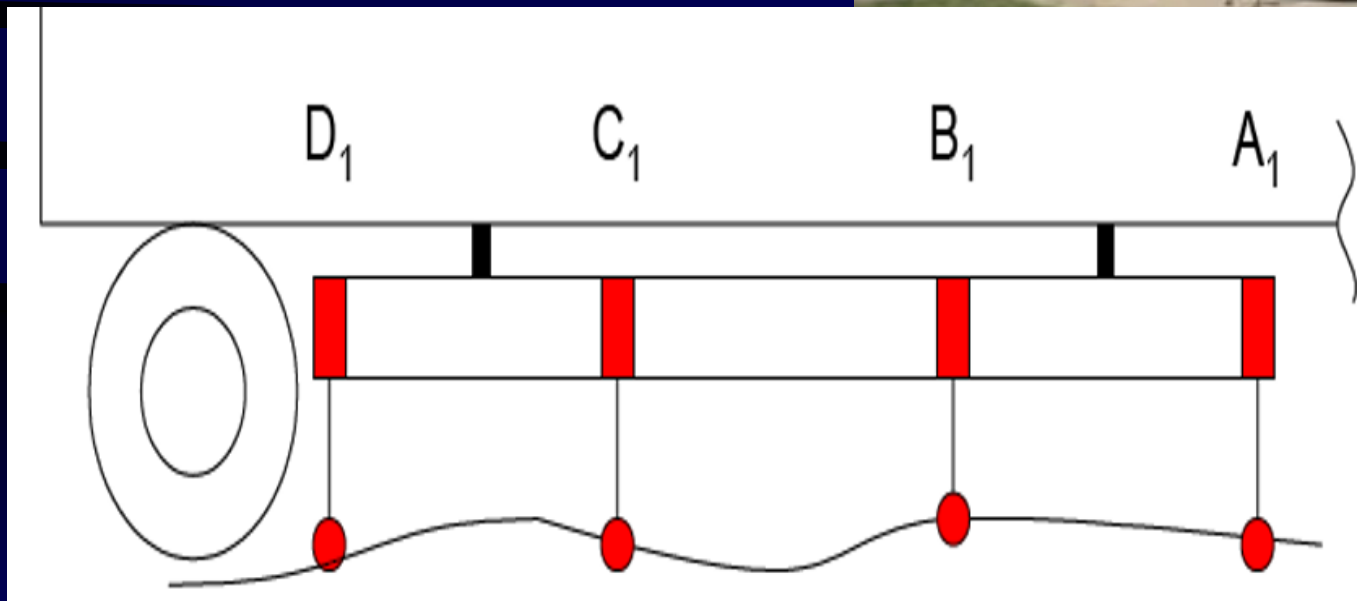
<https://www.youtube.com/watch?v=0KDp1KQwOAAQ>



# Deflection Measurement



# Traffic Speed Deflectometer (TSD)



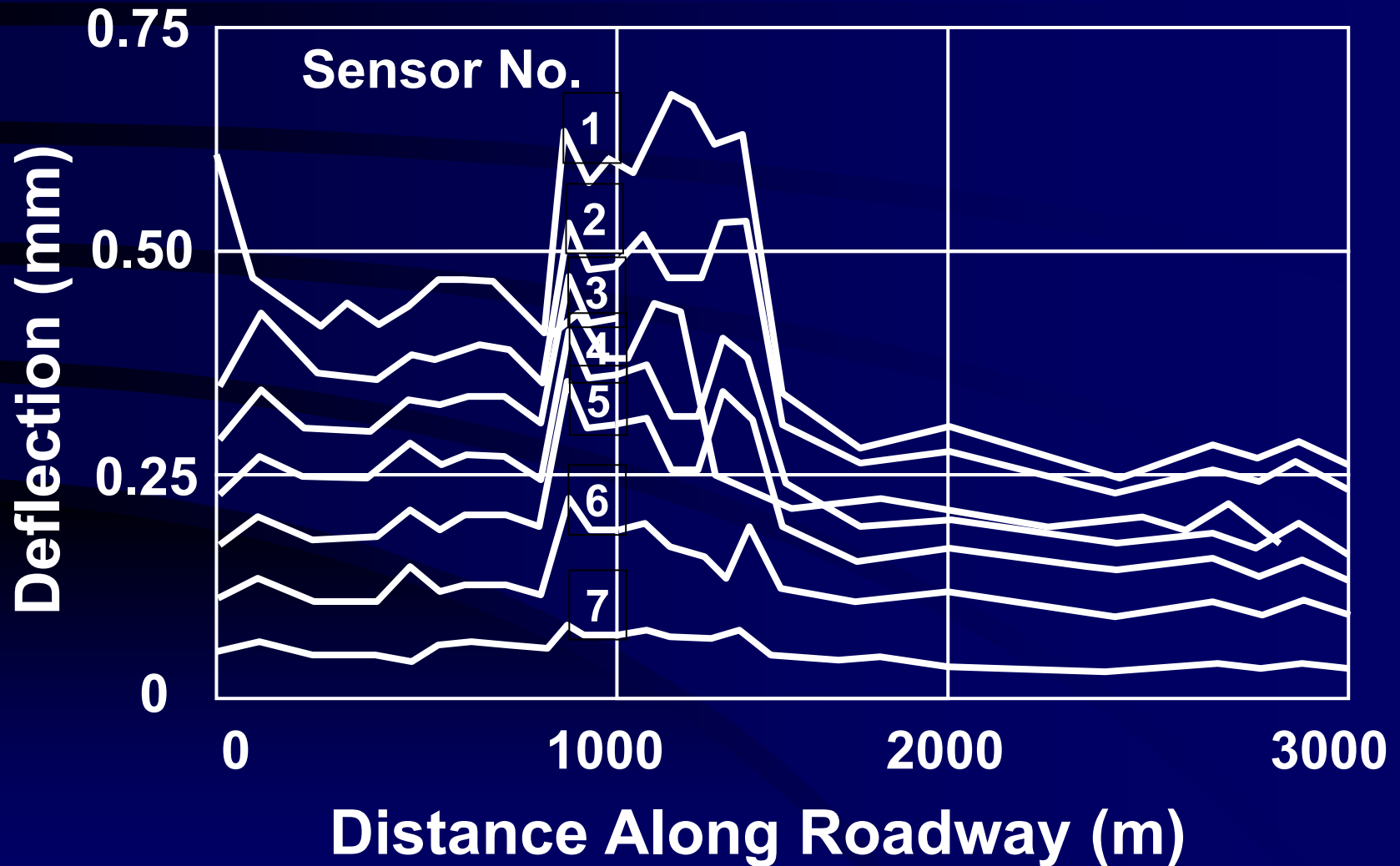
<https://vimeo.com/95111238>

# Potential Results From NDT

- Project variability
- Subgrade soil support
- Critical periods
- In-situ material properties
- Structural adequacy

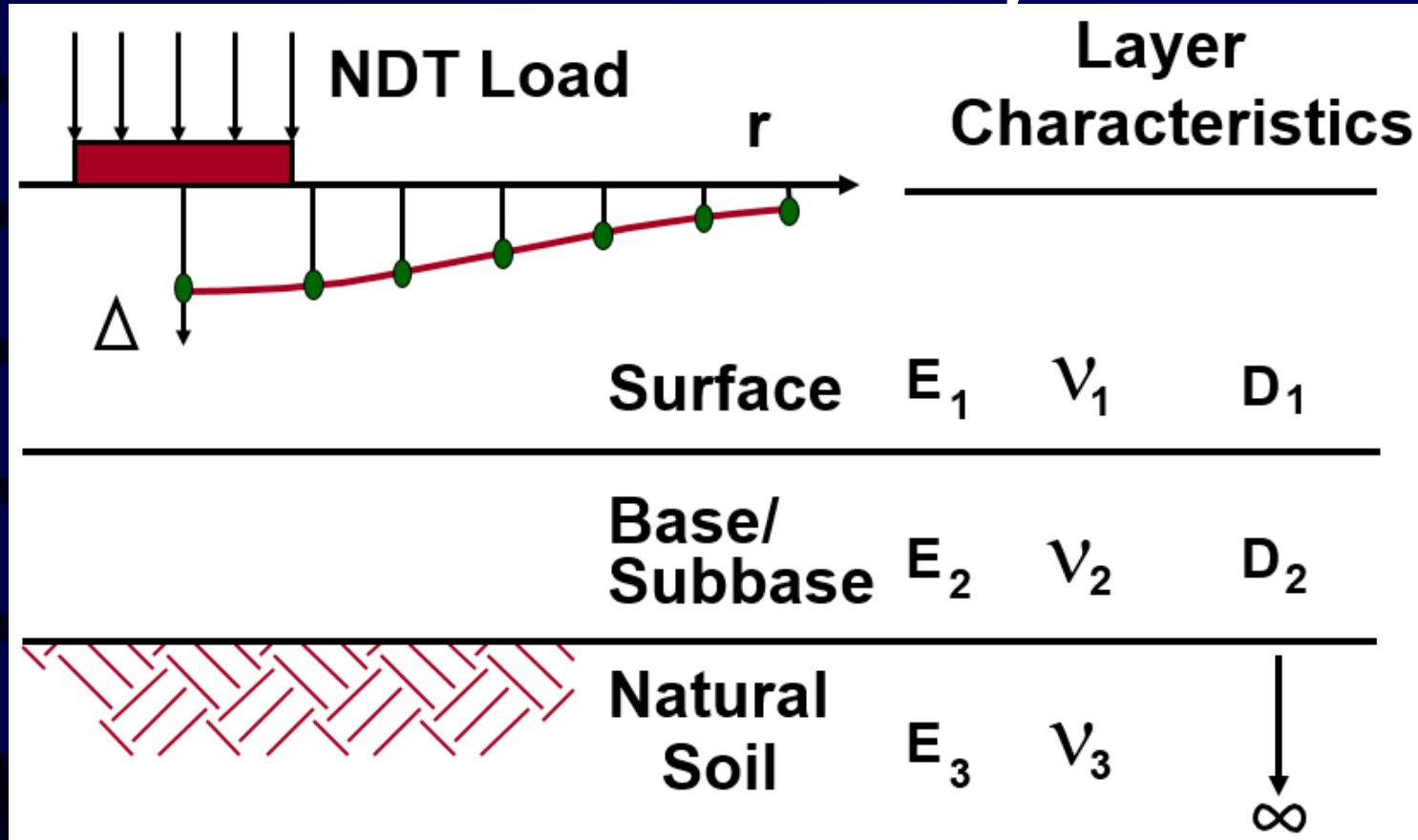


# Uniformity of Project



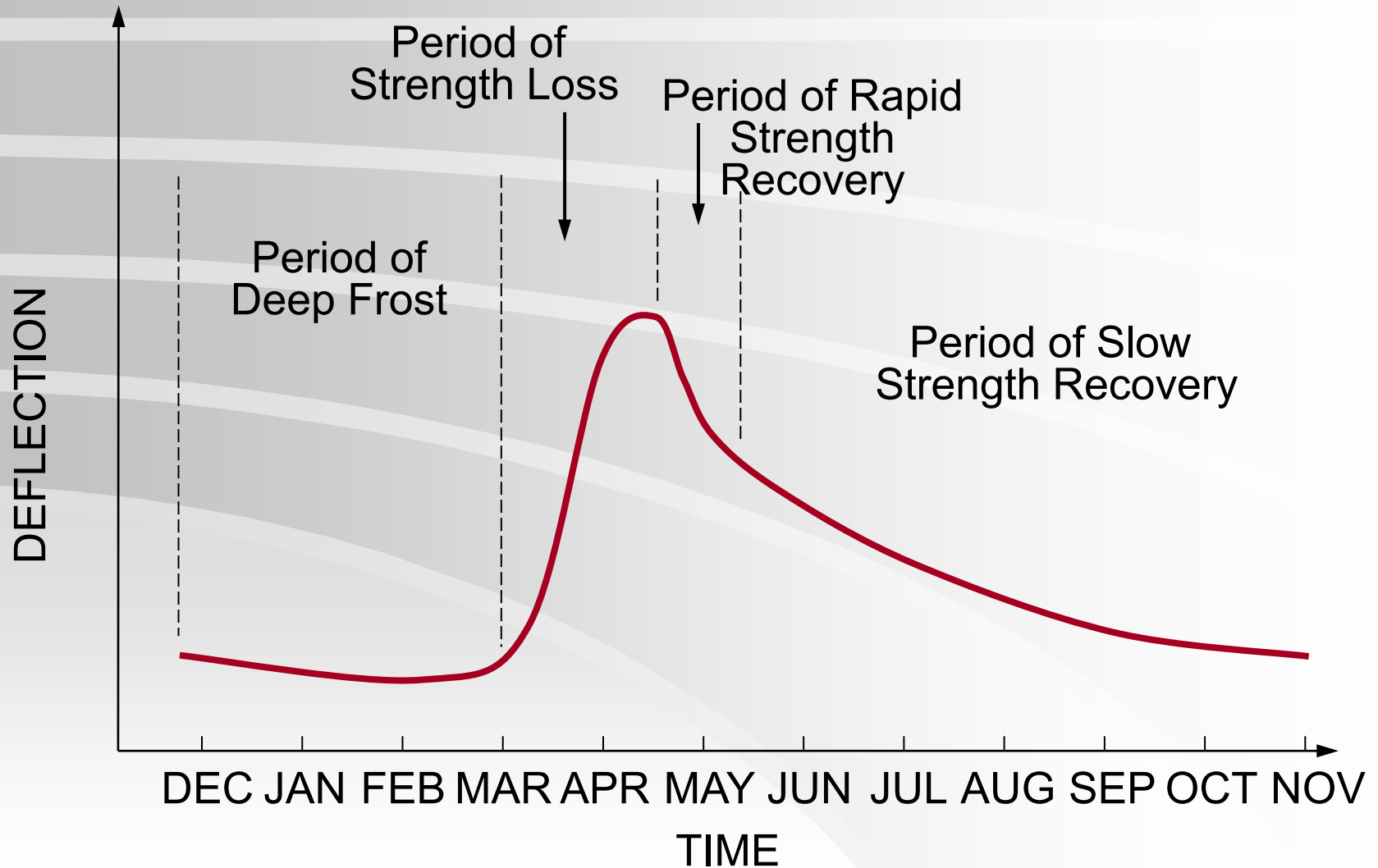


# Backcalculation of Layer Moduli



- From the FWD results, we can estimate the stiffness of each layer
  - Used in the mechanistic overlay design

# Typical Deflection / Time Plot



# Conducting NDT Surveys

## Temperature measurements

- Multiple locations
- Air and pavement
- Correction to standard (e.g., 70°F)

# Testing Locations

- 100 to 500 ft intervals
- Typically outer lane only
- Outer wheel path
- Both directions - staggered



# Condition Assessment / Pavement Evaluation

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

# 4. Surface Friction

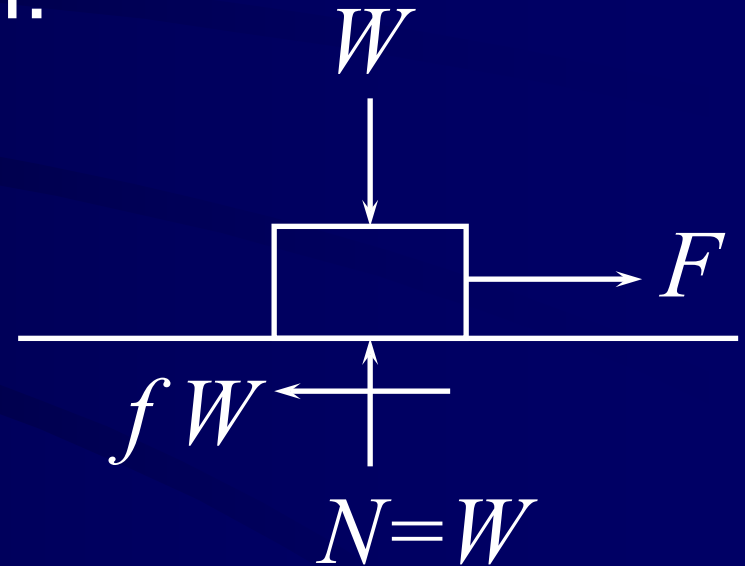
## Surface friction

- Skid resistance
- Safety concerns
  - ✓ Hydroplaning
  - ✓ Wet weather accidents

# Skid Resistance

- Interaction between tire and pavement
- Coefficient of friction:

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



- Wet condition is more critical

# Common Friction Measurement Equipment

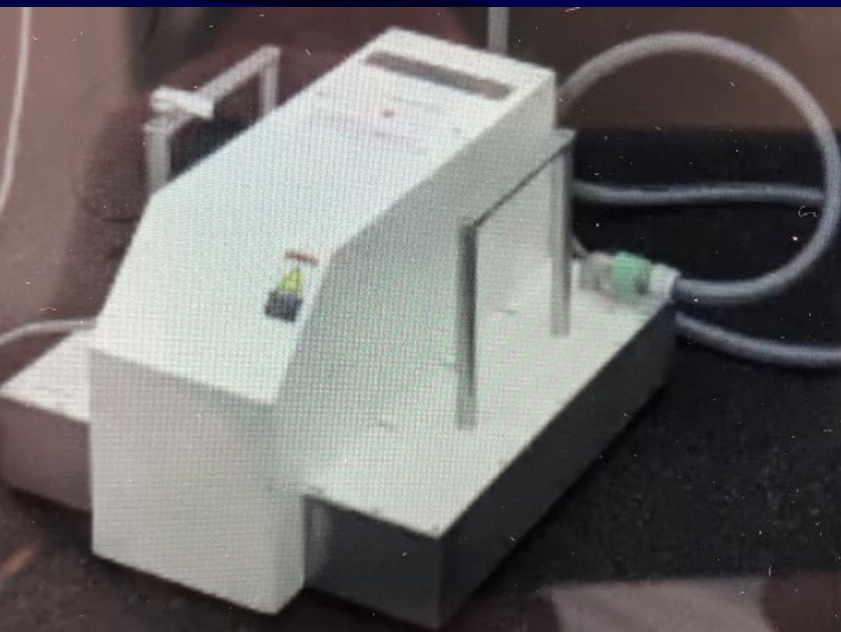


Locked wheel  
skid resistance

<https://www.youtube.com/watch?v=AnoWN4utBsY>



MU-Meter



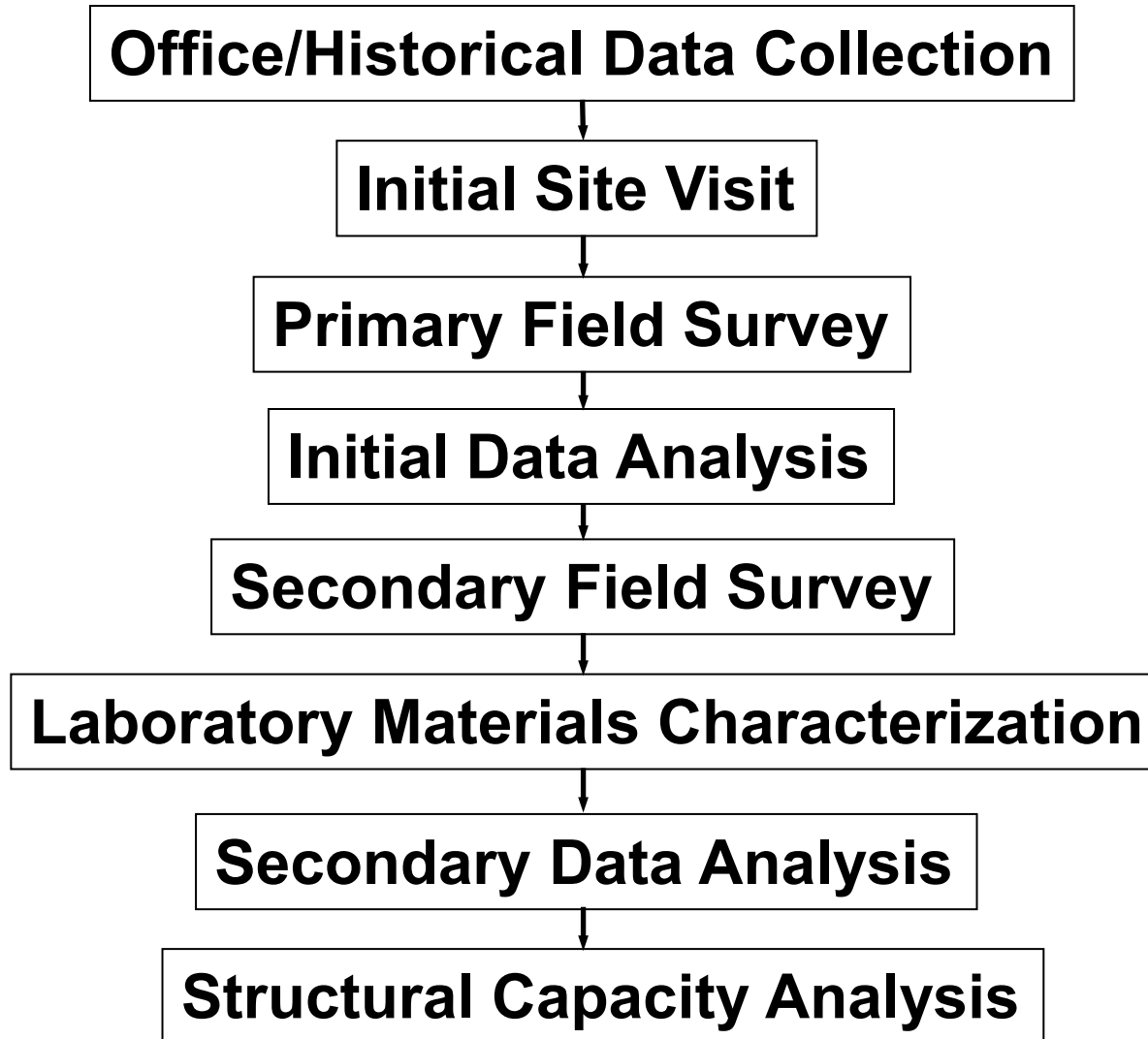
Dynamic  
Friction Tester



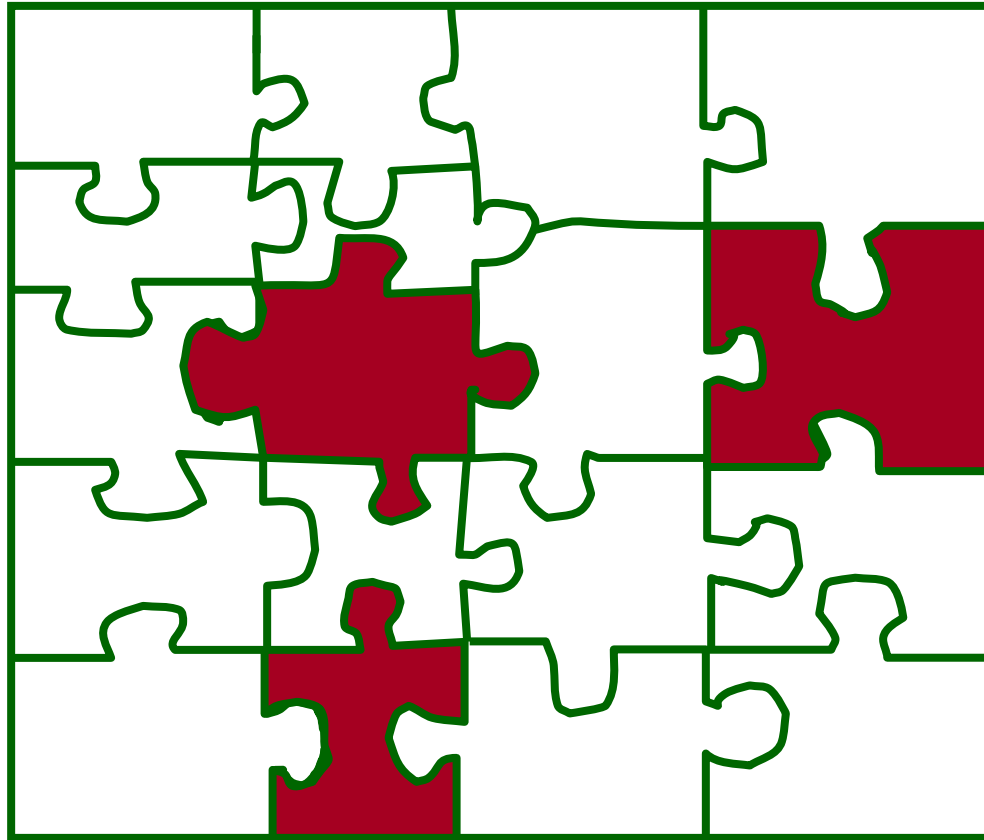
# Overall Project Evaluation

- Cost-effective solution
- Address deficiencies
- Satisfy constraints
- Project size versus thoroughness of evaluation

# Project Evaluation Flowchart



# Data Analysis



# Quit Complaining About Your Job

