

Structural Health Monitoring Of Pavements

**Ben Franklin Center
for SHM**

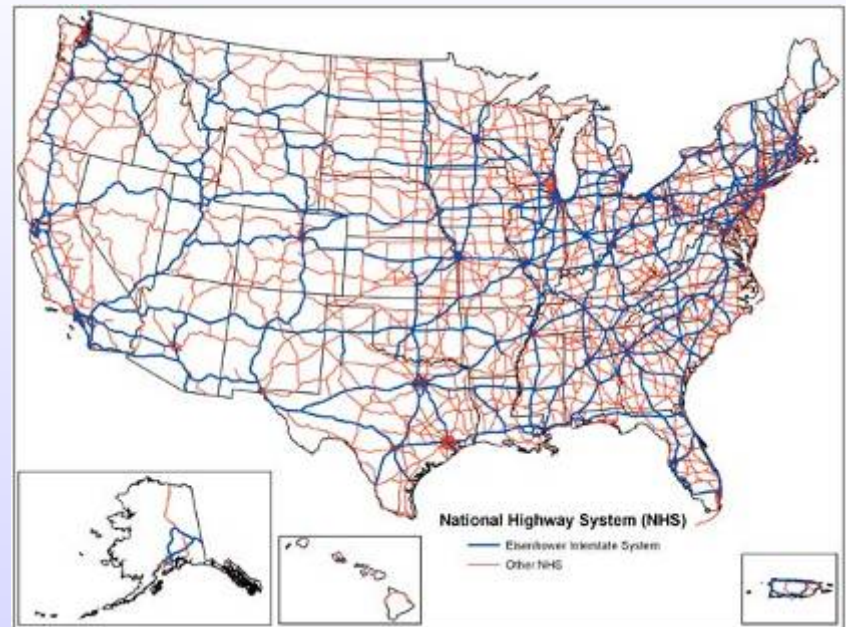
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USA Roadways

(ASCE, FHWA)

- Nation's Roads: **D+**
- **58%** poor, mediocre, or fair condition
- Corresponding motorist annual vehicle repair cost: **\$222**
- **\$94** billion/year for **20** years needed for transportation infrastructure

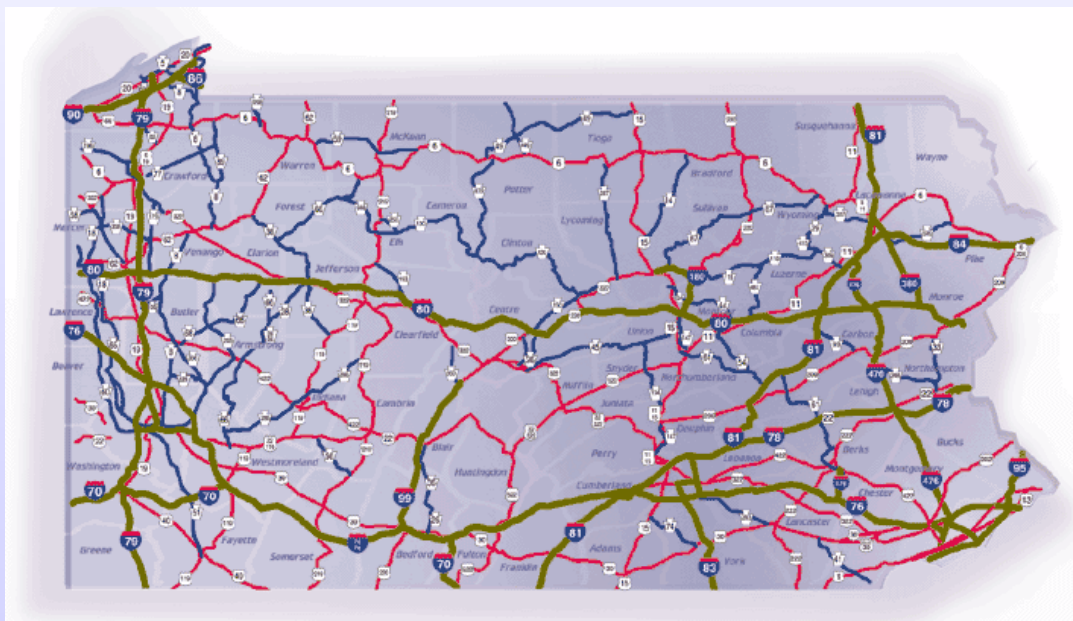




Pennsylvania Roadways

(ASCE/PENNDOT)

- **300** million vehicle miles **DAILY**
- **18%** traffic growth (1991-01)
- **21%** of freeways congested
- **46%** of pavements poor or mediocre condition
- **\$1.9** billion annual vehicle repair costs: **\$219** /vehicle



Roadway conditions cause **30%** of traffic fatalities



PTI at a Glance

- ✦ **Transportation Infrastructure Program**
 - ✓ Pavement Engineering
 - ✓ Geotechnical
 - ✓ Structures
 - ✓ Materials
- ✦ Transportation Operations Program
- ✦ Vehicle Safety and Systems



Transportation Infrastructure Program

➤ People

- ✓ CE Faculty
- ✓ Research Associates
- ✓ Graduate Students
- ✓ Technicians
- ✓ Staff

➤ Research and Partnerships:

- ✓ Industry and DOT's

➤ Outreach:

- ✓ **Northeast Center for Excellence in Pavement Technology**



Areas of Expertise

✦ Pavement Engineering

- ✓ Design and Management
- ✓ Performance Evaluation
- ✓ Product Evaluation
- ✓ Skid and noise measurement
- ✓ Testing and Characterization

✦ Materials

- ✓ Soils
- ✓ Asphalt Binders and Mixtures
- ✓ Cement Chemistry
- ✓ Plain and Reinforced Concrete
- ✓ Steel Reinforcement
- ✓ Composites and Repair materials
- ✓ Geosynthetics



Areas of Expertise

✦ **Structural Systems**

- ✓ Housing (PHRC)
- ✓ Infrastructure
- ✓ Transportation Structures
- ✓ Buildings

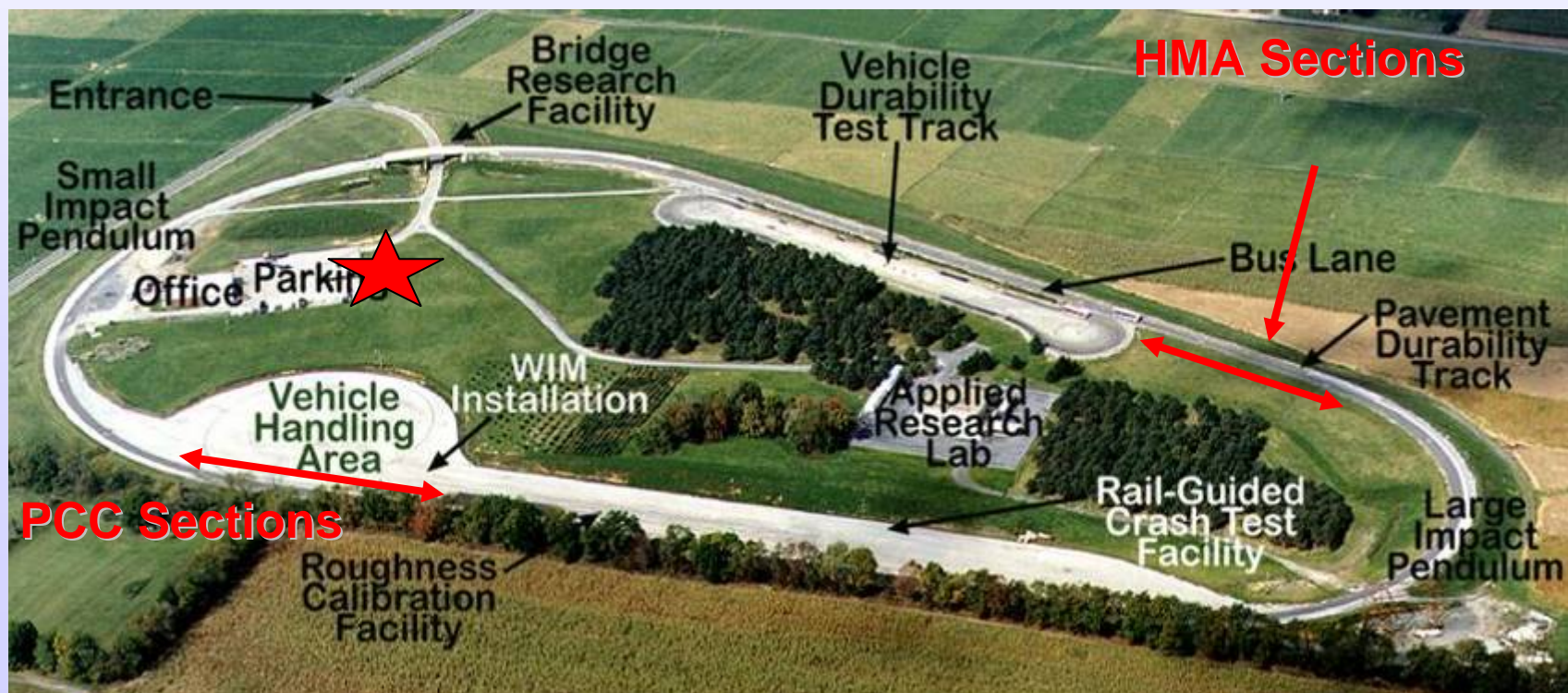
✦ **Non-destructive Evaluation**

- ✓ Microscopy
- ✓ X-Ray Imaging
- ✓ Lab and field testing
- ✓ Accelerated Testing
- ✓ Full-scale Testing



Facilities

- Asphalt Materials Lab
- Civil Engineering Labs
- **C**ivil **I**nfrastructure **T**esting and **E**valuation **L**ab
- PTI Test Track





Pavements!!

AC Pavement Distresses

Cracking

Permanent Deformation

Fatigue Cracking

Thermal Cracking

Reflective Cracking

AC layer deformation at high temperatures

Cracks in AC layer at low/medium temperatures due to repetitive loading

Cracks at low temperatures due to thermal stresses

Cracks in AC initiating from underlying cracked PCC layers



Rutting



Rutting





Thermal Cracking





Transverse Cracking





Pumping



photo courtesy of FHWA



Spalling



Fatigue Cracking





Fatigue Cracking



Surface Deterioration



Corner Breaks



Settlement



Underlying Voids

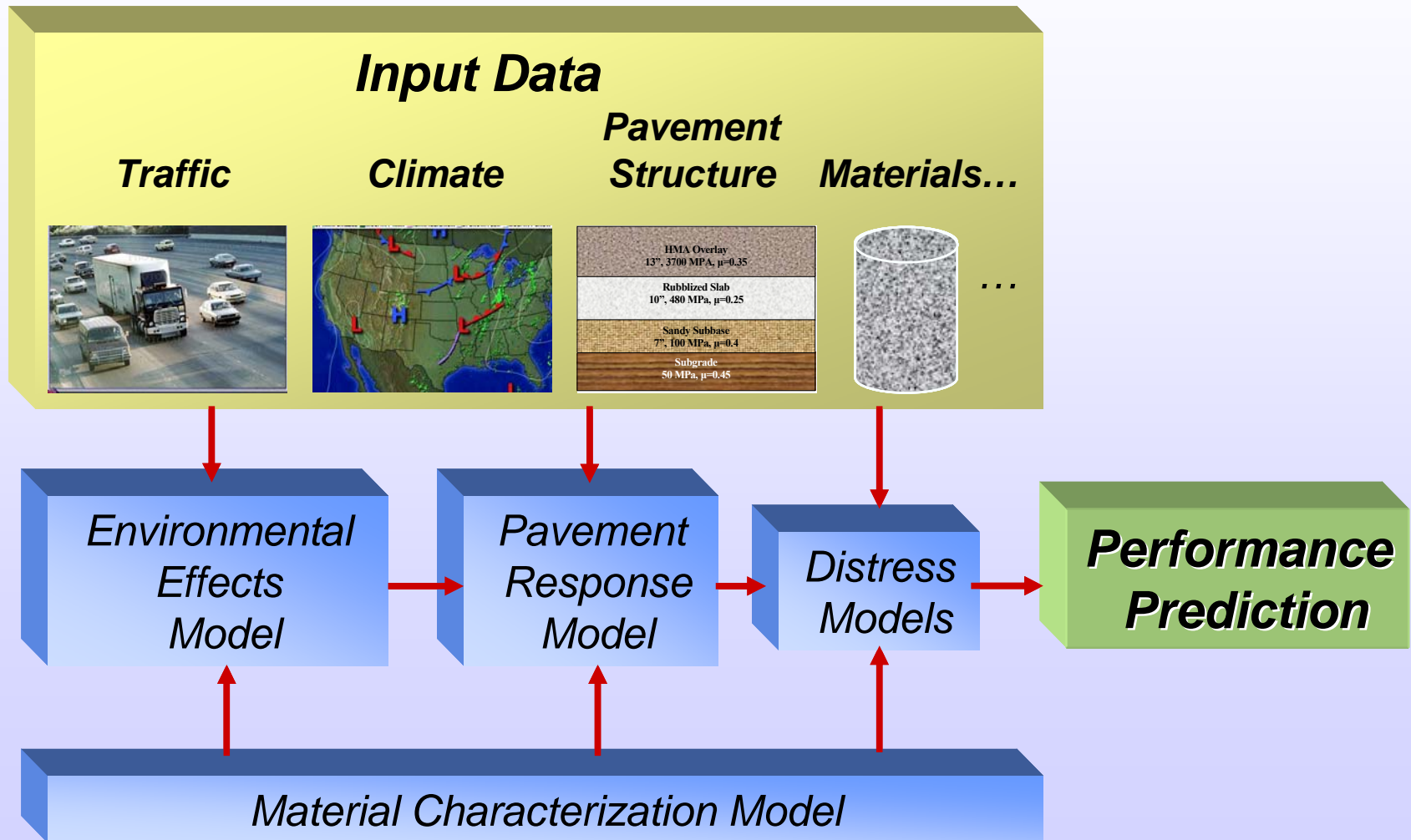


Potholes





Performance Prediction





Data Collection

Weigh in Motion



Stress and strain sensors



Weather station



Performance Monitoring & Documentation

pa.us - PENNDOT VideoLog - Microsoft Internet Explorer provided by Verizon Online

iVidLog Options: Select Other Road Segment View Local Map Help

Bring left frame to front or back Bring right frame to front or back

☒ Image on/off ☒ Image on/off ☒ Image on/off

County: Centre Rte: 6026 Offset: 0 ft. Interval: 0 ft. Dir: N Display Rate: 10

Date: 05/2004 Seg: 0212 ☐ Autorun

Place cursor on map and use right mouse button commands to zoom.

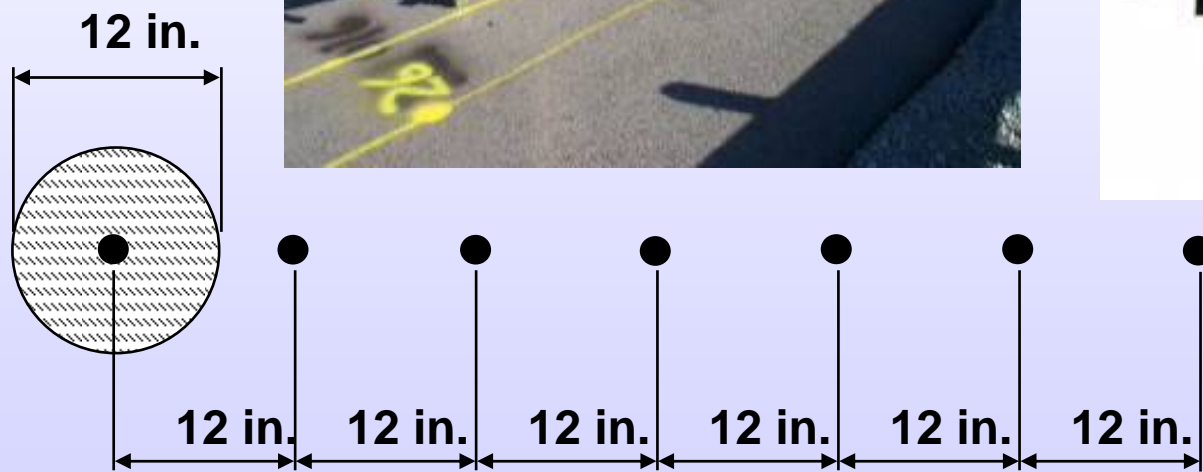
Click on the green areas to view video at desired location.

Click on the icon below to view an Overview Map



Structural Monitoring

Falling Wheel Deflectometer



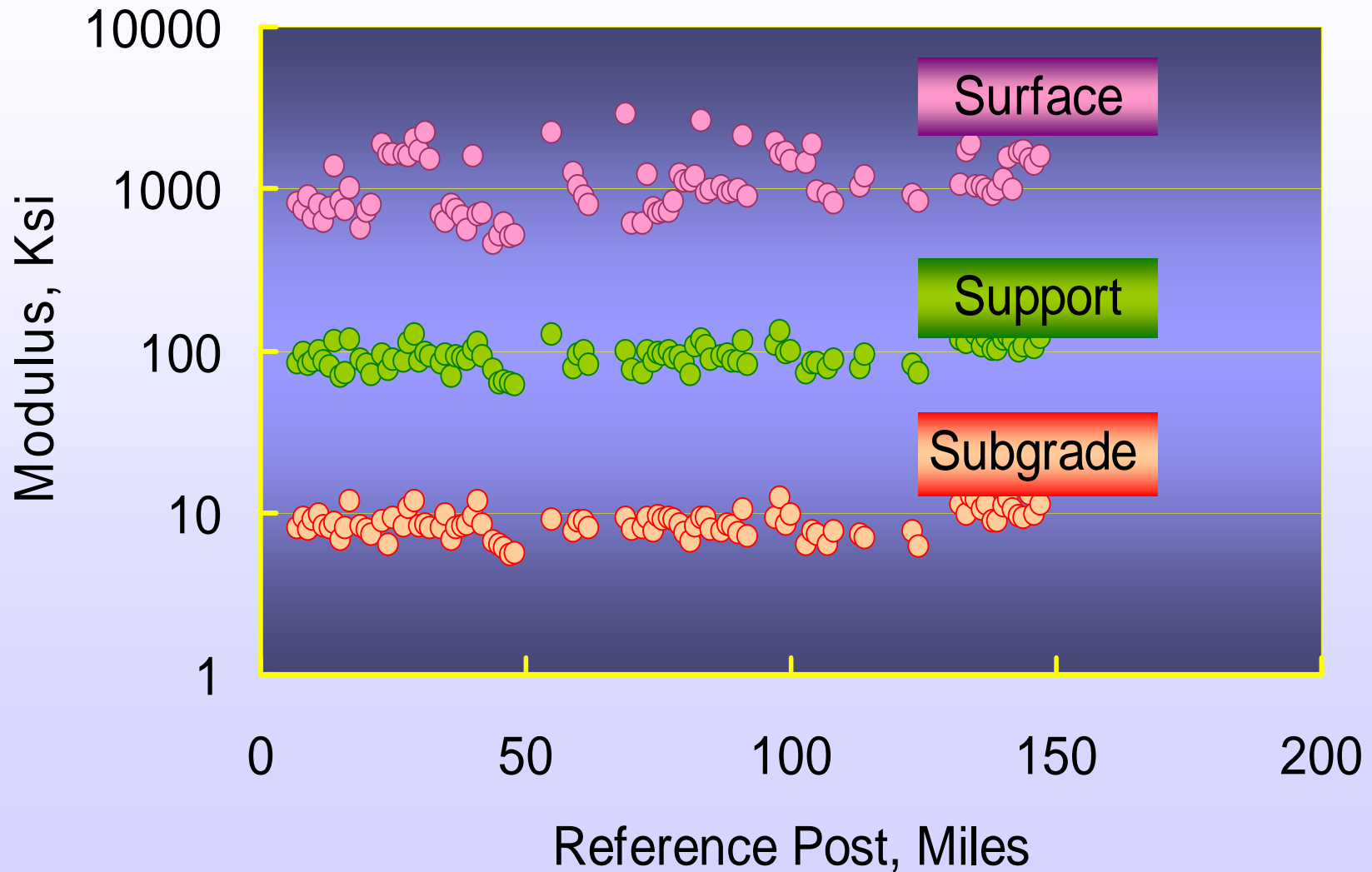
Loading Wheel Contact Area



Sensor

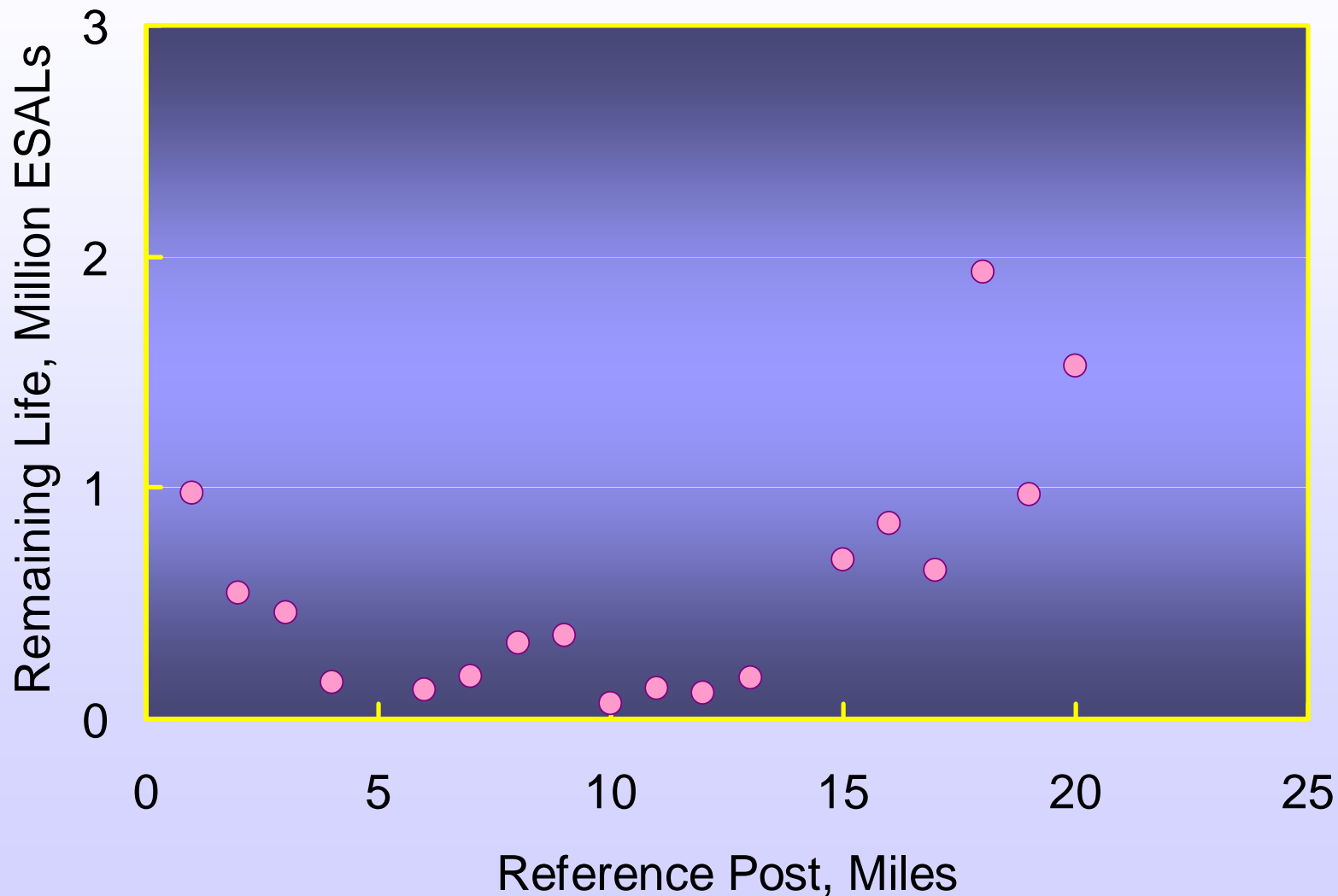


FWD for Structural Evaluation



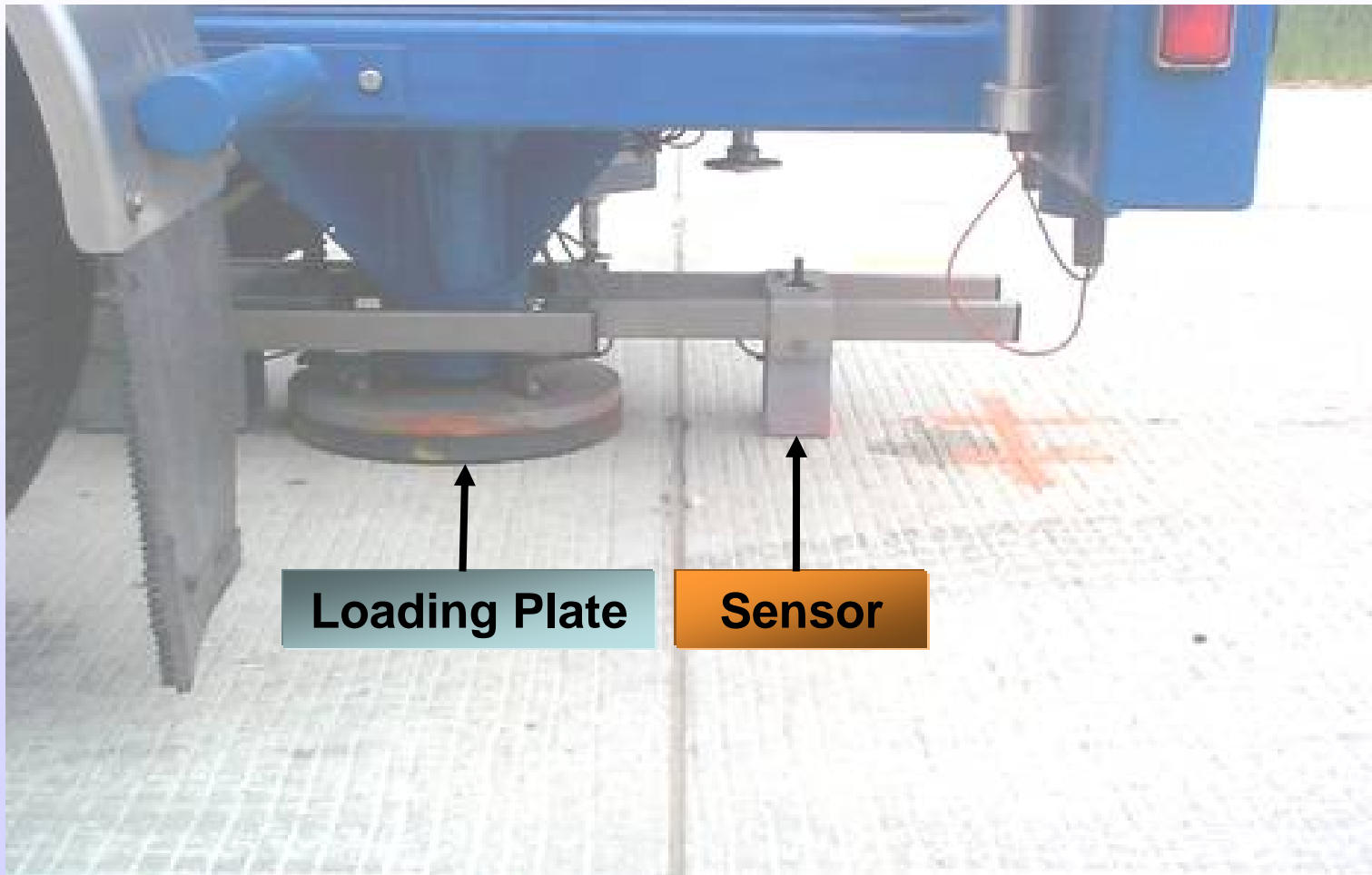


FWD for Estimating **Remaining Life**





FWD for Structural Evaluation



Loading Plate

Sensor



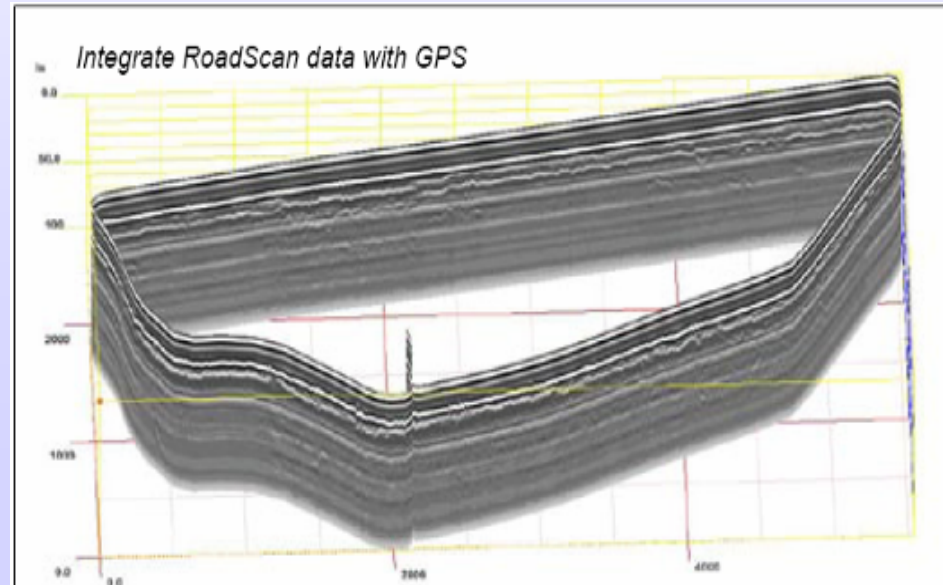
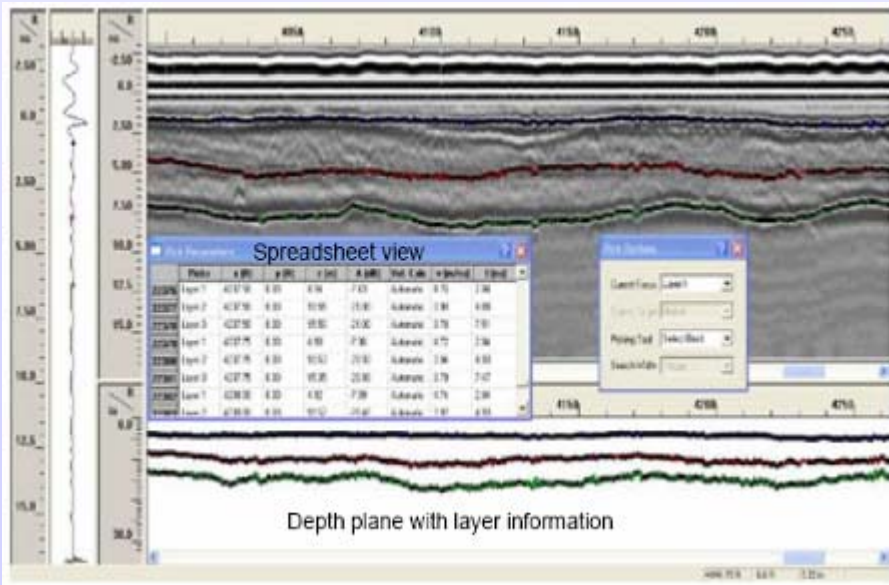
Structural Evaluation

Rolling Wheel Deflectometer



Structural Evaluation

Ground Penetrating Radar-GPR



Functional Evaluation

Surface Profilometers



Vehicle-mounted Profilometer



Pavement-mounted Profilometer

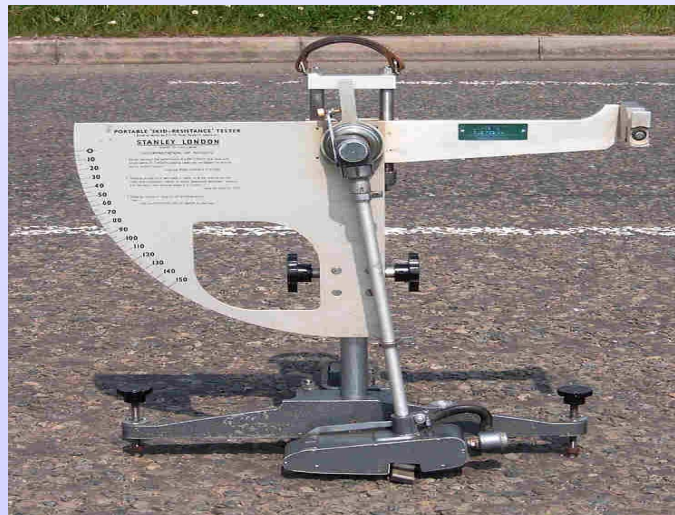


ROSANE Laser Profilometer



Functional Evaluation

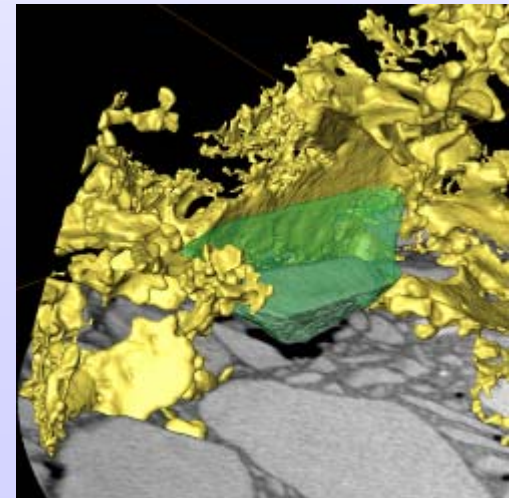
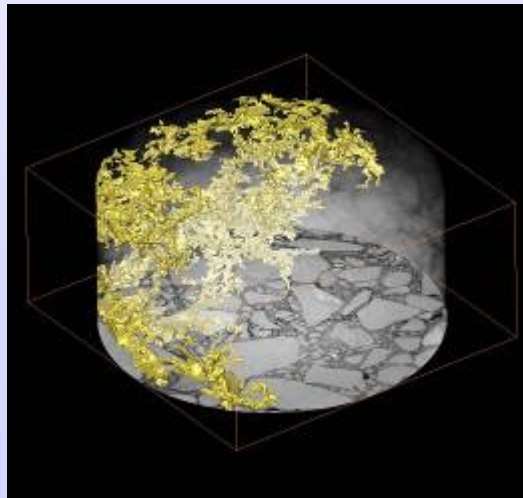
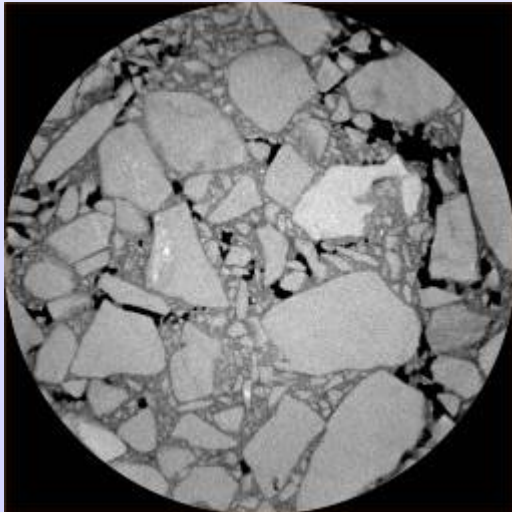
Surface Texture



Other Evaluation techniques



Accelerated Testing



X-Ray Imaging



Sample Projects with Industry in **PENNSYLVANIA**

- ◆ FiberMat A pavement surface treatment
- ◆ FiberMat B stress absorbing membrane interlayers
- ◆ Thermoplastic decorative markings
- ◆ FastTack rapid setting emulsion
- ◆ Manhole protection rings
- ◆ ALGRIP roadway steel plates



Sample Projects with Industry

Ongoing, Pending, & in the Works

- TruPave and Petromat paving fabrics
- Nyloplast Inlet drains and basins
- Performance of Geogrids in Pavements
- Durability of Pavement Surface Markings



I Thought We Put Subgrade?!

