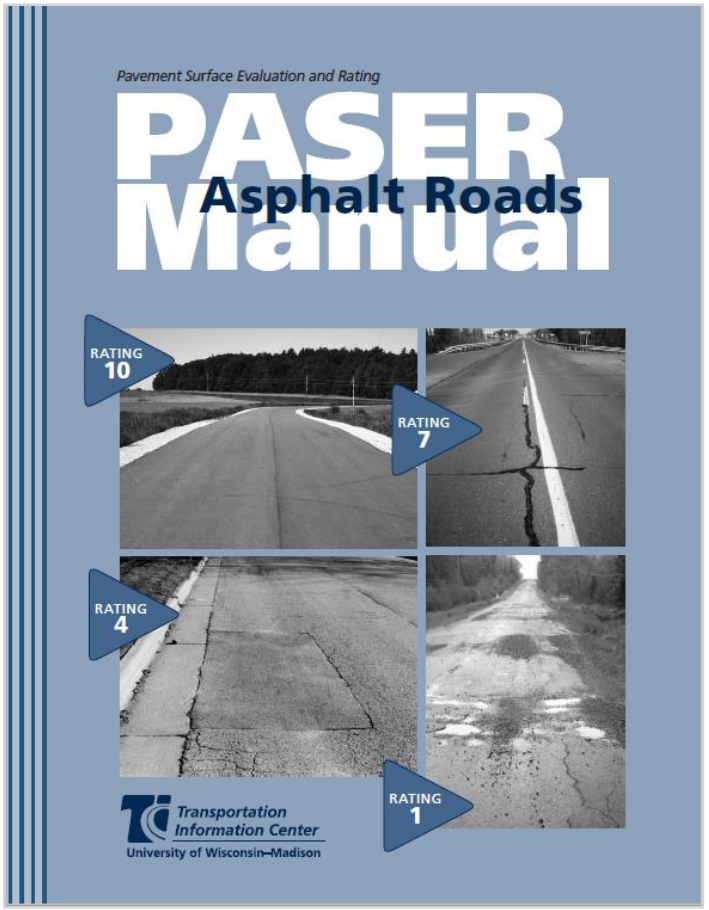
Asphalt Pavement Forensics: Understanding the Problem to Better Determine the Solution

63rd Annual Asphalt Paving Conference
FireKeepers Casino Hotel
Battle Creek, Michigan
March 6-7, 2019

Pavement Surface Evaluation and Rating (PASER) Manual

- Transportation Information Center at the University of Wisconsin - Madison
- Manuals for various pavement types
- Asphalt distress types and descriptions
- Provides a simple system to visually rate the pavement condition
- Photographs
- Tables and charts of recommended criteria



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Identification of Pavement Distresses

- Fundamental pavement performance indicator
- Characterized by:
  - Type – What is it?
  - Severity – How bad is it?
  - Cause – What is causing the distress?

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Identification of Pavement Distresses

- Surface Defects
  - Raveling, Flushing, Polishing
- Surface Deformation
  - Rutting/Distortion
- Cracking
  - Transverse, Reflective, Slippage, Longitudinal, Block, Alligator
- Patches and Potholes

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Surface Defects - Raveling

Description

- Wearing away of the pavement surface. Caused by the dislodging of aggregate and the loss of asphalt binder.
- Ranges from loss of fines to loss of coarse aggregate.
- Ultimately leads to a very rough and pitted surface.

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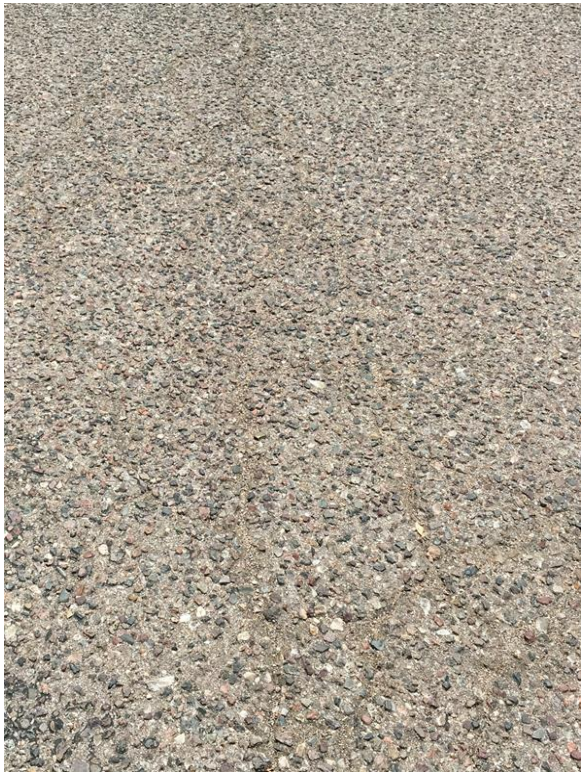
Surface Defects - Raveling

Slight



Moderate

Severe

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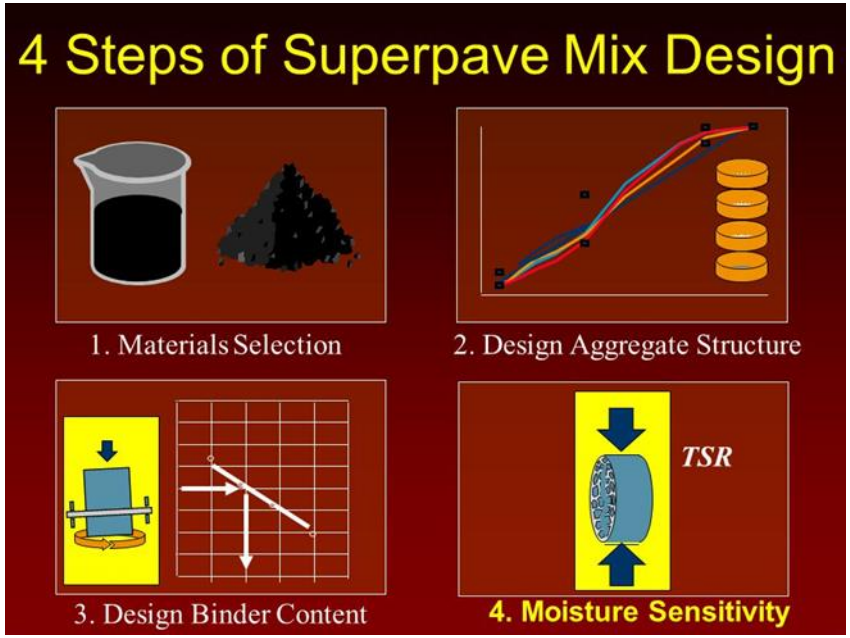
Surface Defects - Raveling

Possible Causes

- Insufficient asphalt content (film thickness)
- Stripping of asphalt film on aggregates
- Age-hardening of asphalt
- Poor compaction
- The presence of raveling indicates potential mixture-related performance problems.



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Surface Defects - Flushing

Description

- Excess bituminous material occurring on the pavement surface. Usually found in the wheel paths of traffic movements
- Ranges from surface discoloration relative to the remainder of the pavement.

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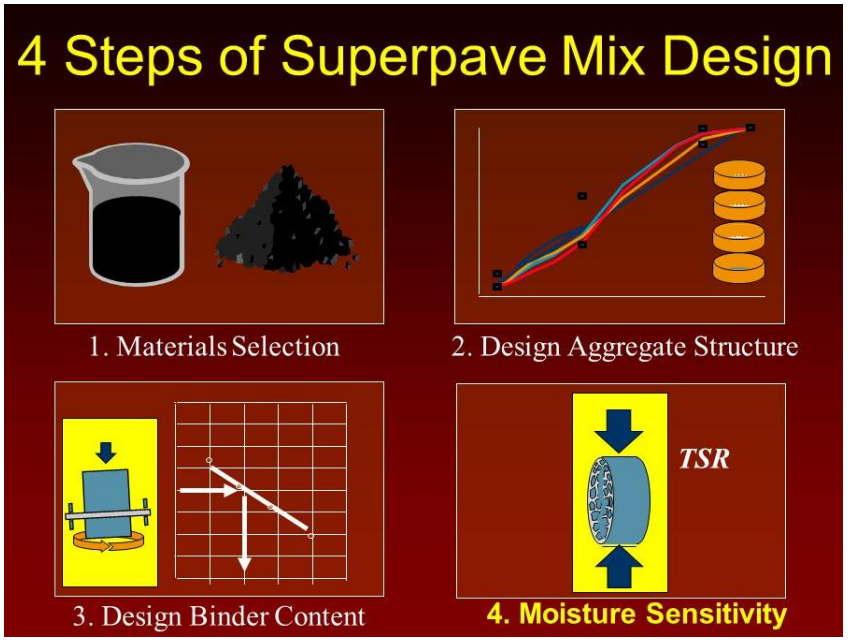
Surface Defects - Flushing

Possible Causes

- The presence of flushing indicates potential mixture-related performance problems
- Poor initial mix design properties
- Paving or Sealcoating over an already severely flushed surface



Surface Defects - Polishing

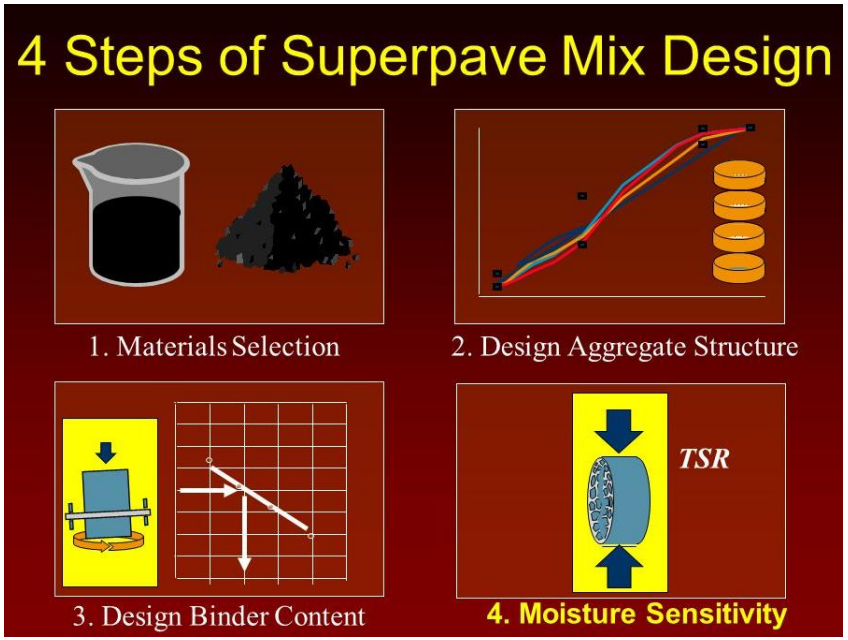
Description

- Surface binder worn away thus allowing sharp edges of aggregates to be smoothed or polished

Surface Defects - Polishing

Possible Causes

- Wearing away of asphalt film from aggregate
- Low asphalt content (film thickness)
- Mix design properties
- Soft or non-skid-resistant aggregates



Types of Asphalt Pavement Distress

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Surface Deformation - Rutting

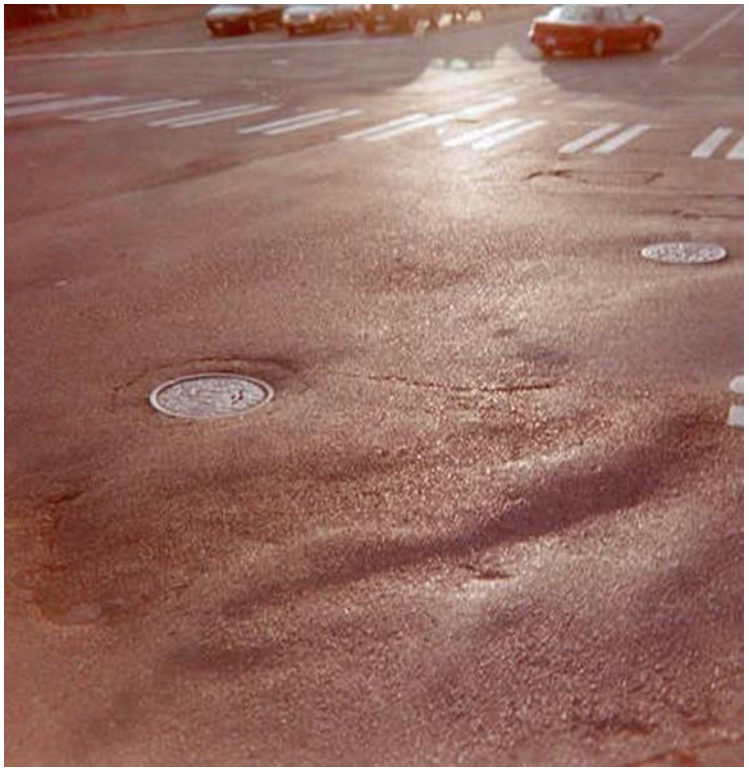
Description

- Longitudinal surface depression in the wheel path.
- It may have associated transverse displacement.

Surface Deformation - Distortion

Description

- Shoving or rippling is a longitudinal displacement of a localized area of the pavement surface.
- It is generally caused by braking or accelerating vehicles
- It also may have associated vertical displacement.



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Surface Deformation – Rutting/Distortion

Severity Levels

- Severity levels could be defined by categorizing the measurements taken
- Record average depths to the nearest inch
  - Slight: less than 1/2”
  - Moderate: 1/2” – 2”
  - Severe: greater than 2”

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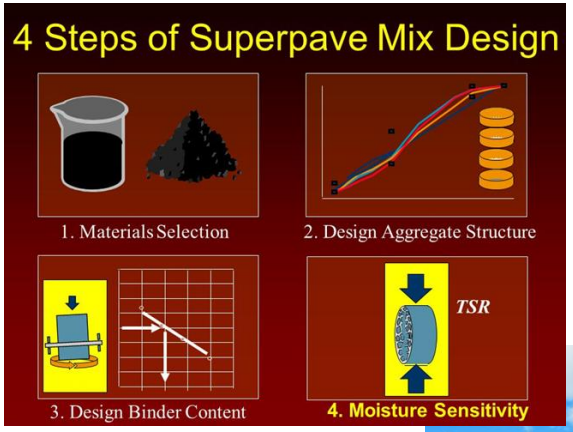
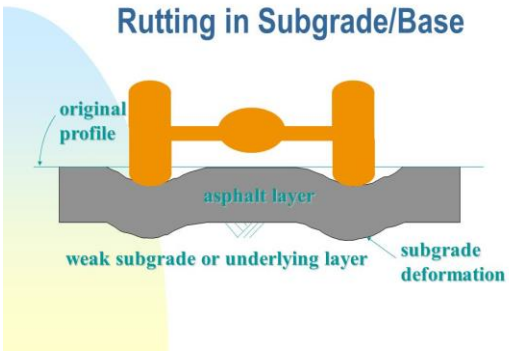
Surface Deformation – Rutting/Distortion

Possible Causes

- Mix design properties (unstable mixture)
- Lack of initial compaction
- Base and/or Subgrade consolidation
- Potential drainage problems in subsurface
- Can be combination of these!





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Cracking – Transverse

Description

- Cracks at approximate right angles to center line
- Often regularly spaced
- Typically a result of movement due to temperature changes and age-hardening of the asphalt

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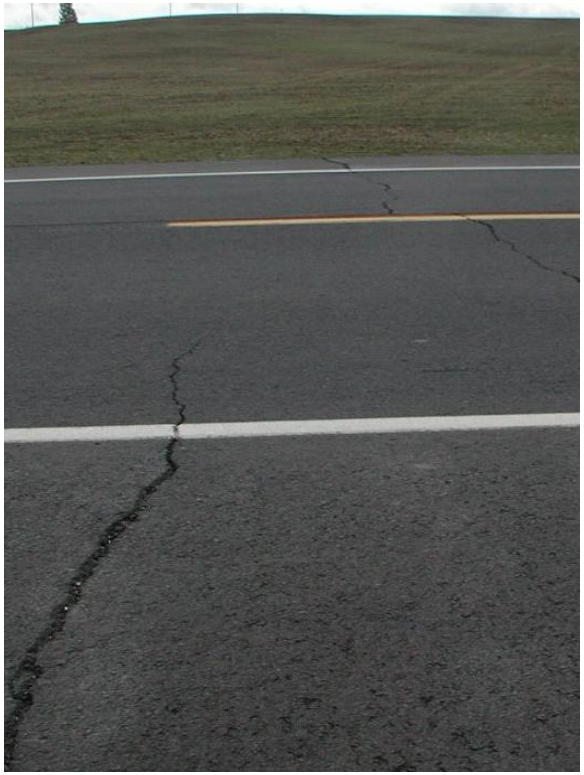
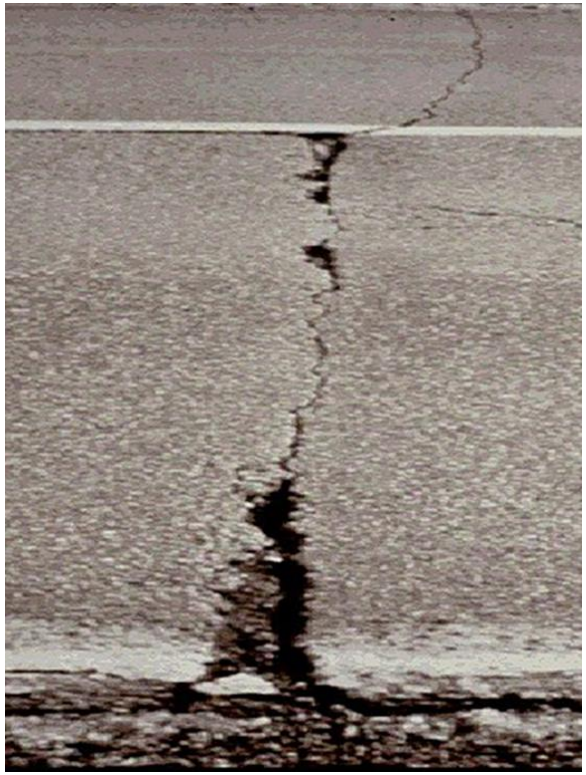
Cracking – Transverse

Slight



Moderate



Severe

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Cracking - Reflective

Description

- Cracks in asphalt overlay surfaces that “reflect” the crack pattern underneath
- Note: When over PCC joint spacing in the slabs beneath the asphalt overlay must be known in order to identify as reflection cracking at joints

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Cracking - Reflective

Possible Causes

- Typically a result of a thin overlay placed over “working” or active cracks in the existing surface
- Asphalt overlays over failed or cracked PCC pavements

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Cracking - Slippage

Description

- Crescent or rounded cracks in the direction of traffic
- Primarily occurs at areas of the pavement where traffic is stopping and starting

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Cracking - Slippage

Possible Causes

- Slippage between an overlay and an underlying pavement
- Lack of bond between layers (tack coat?)
- Dusty or dirty surface when placing tack

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Cracking - Longitudinal

Description

- Cracks predominantly parallel with the pavement centerline.
- Location is significant
  - Wheel Path
  - Non-Wheel Path

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Cracking - Longitudinal

Load Related

Poor Construction

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Cracking - Block

Description

- A cracking pattern that develops into approximately rectangular pieces or blocks.
- Blocks typically range in size from 1 ft. to 10 ft. across
- Typically caused by pavement shrinkage due to environmental factors

Cracking - Block

Possible Causes

- Shrinking and hardening of the asphalt over time
- As the asphalt ages and then tries to contract during low temperature cycles, it develops block cracking

Cracking – Alligator (Fatigue)

Description

- Normally occurs in areas of repeated traffic loadings (Wheel Paths) but can also be seen in non-wheel path areas.
- Develops into a chicken wire or alligator pattern in later stages.

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Cracking – Alligator (Fatigue)

Possible Causes

- Typically caused by inadequate pavement structure for actual traffic loadings
- Lack of base and/or subgrade support

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Patches and Potholes

- Patch/Patch Deterioration
- Potholes

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Patch/Patch Deterioration

Description

- Portion of original pavement surface that has been either removed and replaced or additional material has been applied to the pavement after initial construction.

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Potholes

Description

- Bowl-shaped holes of various sizes and shapes in the pavement surface.

Patches and Potholes

Possible Causes

- Utility cuts
- Underlying base and/or subgrade support
- Fatigue cracking and/or inadequate pavement strength
- Poor drainage

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Identification of Pavement Distresses

- Fundamental performance indicator
- Characterized by:
  - Type – What is it?
  - Severity – How bad is it?
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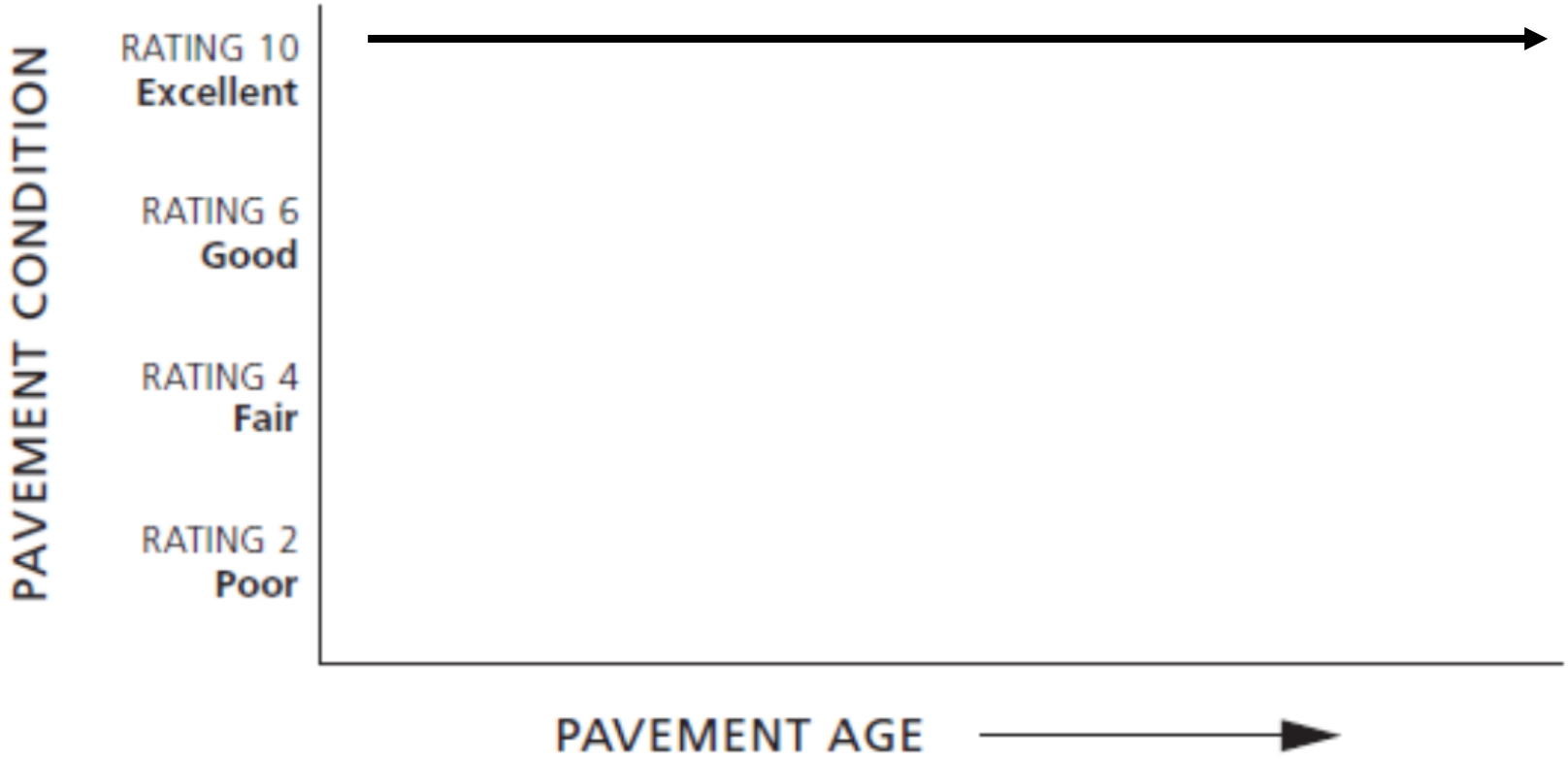
Pavement Condition Rating – PASER



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Pavement Condition Rating – PASER

Surface rating	*Visible distress**	*General condition/ treatment measures*
10 Excellent	None.	New construction.
9 Excellent	None.	Recent overlay. Like new.
8 Very Good	No longitudinal cracks except reflection of paving joints. Occasional transverse cracks, widely spaced (40' or greater). All cracks sealed or tight (open less than ¼").	Recent sealcoat or new cold mix. Little or no maintenance required.
7 Good	Very slight or no raveling, surface shows some traffic wear. Longitudinal cracks (open ¼") due to reflection or paving joints. Transverse cracks (open ¼") spaced 10' or more apart, little or slight crack raveling. No patching or very few patches in excellent condition.	First signs of aging. Maintain with routine crack filling.
6 Good	Slight raveling (loss of fines) and traffic wear. Longitudinal cracks (open ¼"–½"), some spaced less than 10'. First sign of block cracking. Sight to moderate flushing or polishing. Occasional patching in good condition.	Shows signs of aging. Sound structural condition. Could extend life with sealcoat.

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Pavement Condition Rating – PASER

5 Fair	Moderate to severe raveling (loss of fine and coarse aggregate). Longitudinal and transverse cracks (open 1/2") show first signs of slight raveling and secondary cracks. First signs of longitudinal cracks near pavement edge. Block cracking up to 50% of surface. Extensive to severe flushing or polishing. Some patching or edge wedging in good condition.	Surface aging. Sound structural condition. Needs sealcoat or thin non-structural overlay (less than 2")
4 Fair	Severe surface raveling. Multiple longitudinal and transverse cracking with slight raveling. Longitudinal cracking in wheel path. Block cracking (over 50% of surface). Patching in fair condition. Slight rutting or distortions (1/2" deep or less).	Significant aging and first signs of need for strengthening. Would benefit from a structural overlay (2" or more).
3 Poor	Closely spaced longitudinal and transverse cracks often showing raveling and crack erosion. Severe block cracking. Some alligator cracking (less than 25% of surface). Patches in fair to poor condition. Moderate rutting or distortion (1" or 2" deep). Occasional potholes.	Needs patching and repair prior to major overlay. Milling and removal of deterioration extends the life of overlay.
2 Very Poor	Alligator cracking (over 25% of surface). Severe distortions (over 2" deep) Extensive patching in poor condition. Potholes.	Severe deterioration. Needs reconstruction with extensive base repair. Pulverization of old pavement is effective.
1 Failed	Severe distress with extensive loss of surface integrity.	Failed. Needs total reconstruction.

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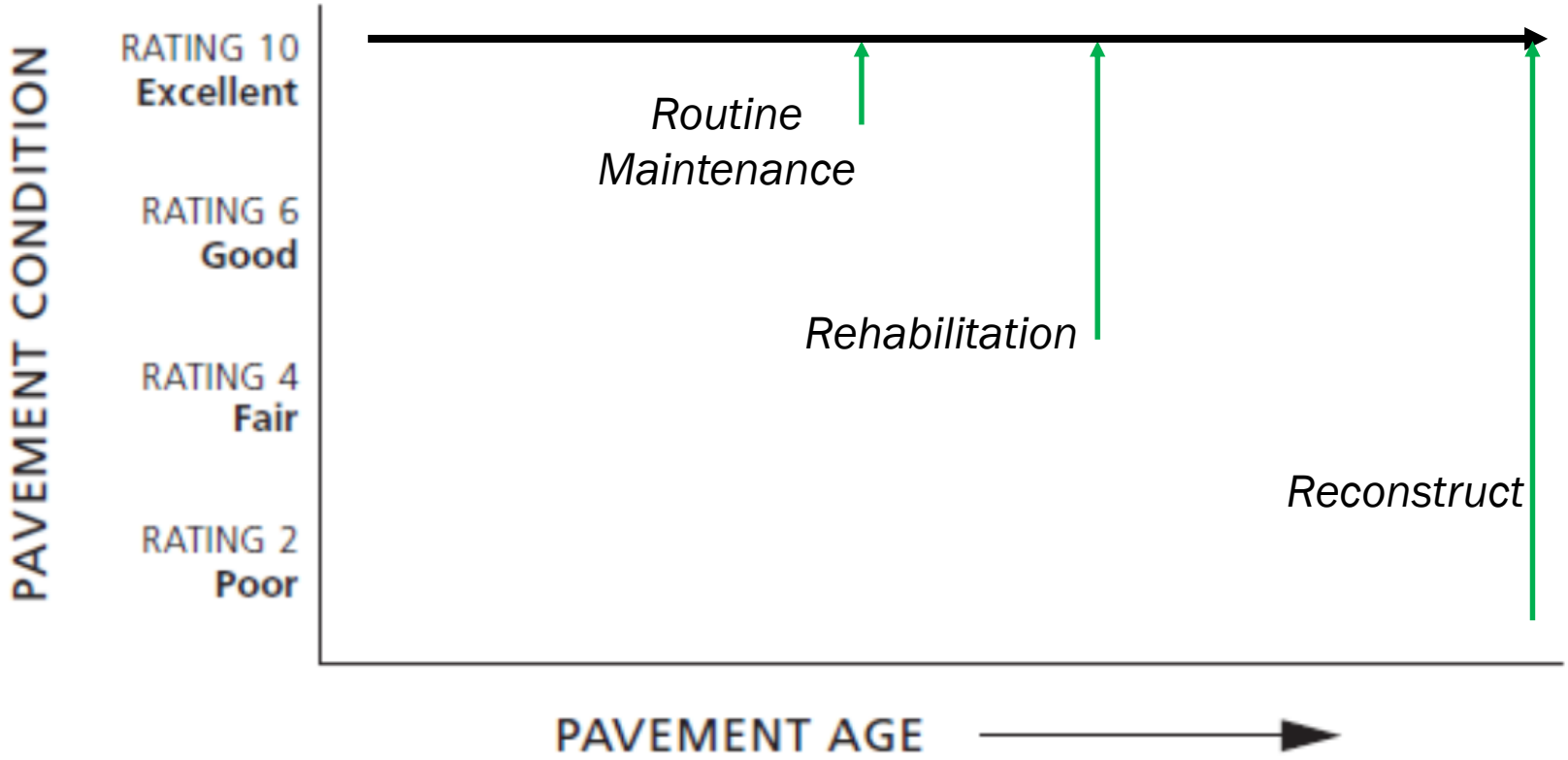
Pavement Condition Rating – PASER

RATINGS ARE RELATED TO NEEDED MAINTENANCE OR REPAIR	
Rating 9 & 10	No maintenance required
Rating 8	Little or no maintenance
Rating 7	Routine maintenance, cracksealing and minor patching
Rating 5 & 6	Preservative treatments (sealcoating)
Rating 3 & 4	Structural improvement and leveling (overlay or recycling)
Rating 1 & 2	Reconstruction

So, where are you on the curve?



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Forensic Investigations

- Identify and/or determine the cause for the distresses that are seen using forensic analyses

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Forensic Investigations

- Project Documentation
  - Layer Thicknesses?
  - Materials & Mixtures?
  - Traffic Levels?
  - Performance History?
  - Maintenance Actions?
  - Soil & Drainage?

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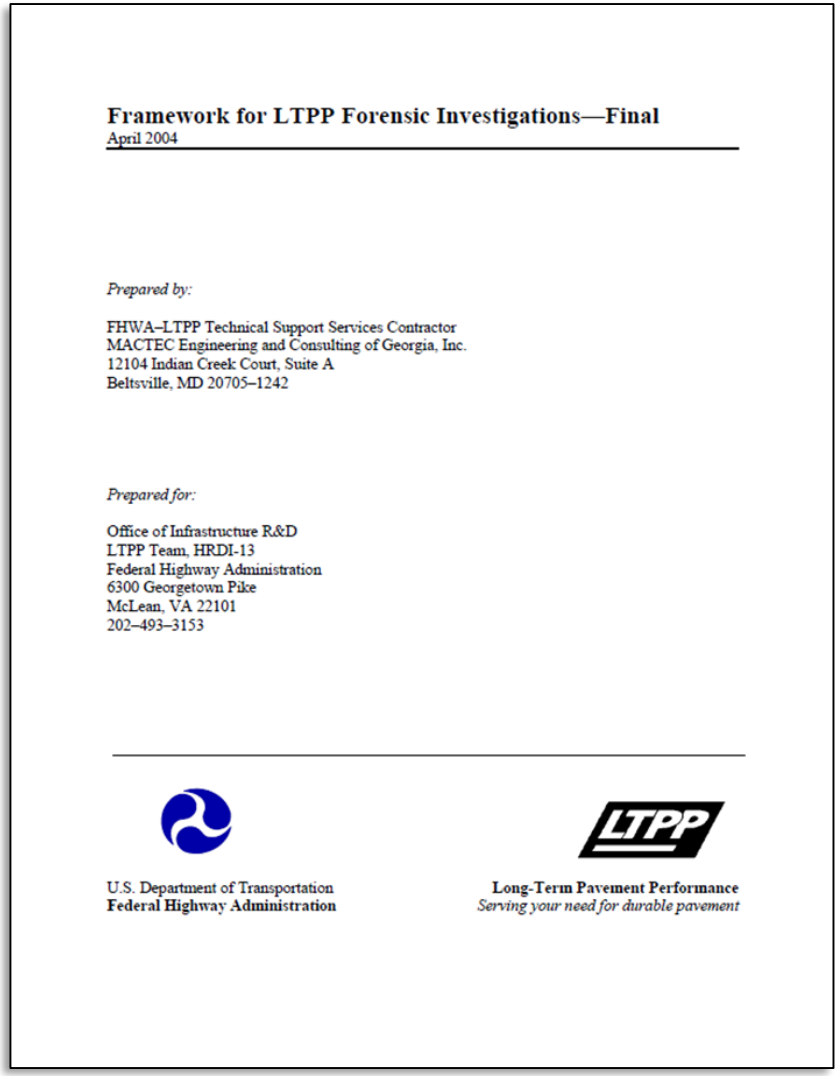
Framework for Forensic Investigations

- FHWA's *Framework for LTPP Forensic Investigations*
  - Recommendation for forensic investigation
  - Development of forensic investigation plan
  - Implementation of forensic investigation plan
- Details on the activities to be performed in each element



Framework for LTPP Forensic Investigations—Final
April 2004

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U.S. Department of Transportation
Federal Highway Administration

Long-Term Pavement Performance
Serving your need for durable pavement

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Forensic Investigations

- "Tools in the Toolbox"
  - Identified Distresses
  - Dry Drilling
  - Wet Coring
  - Trenching
  - Deflections
  - Ground Penetrating Radar

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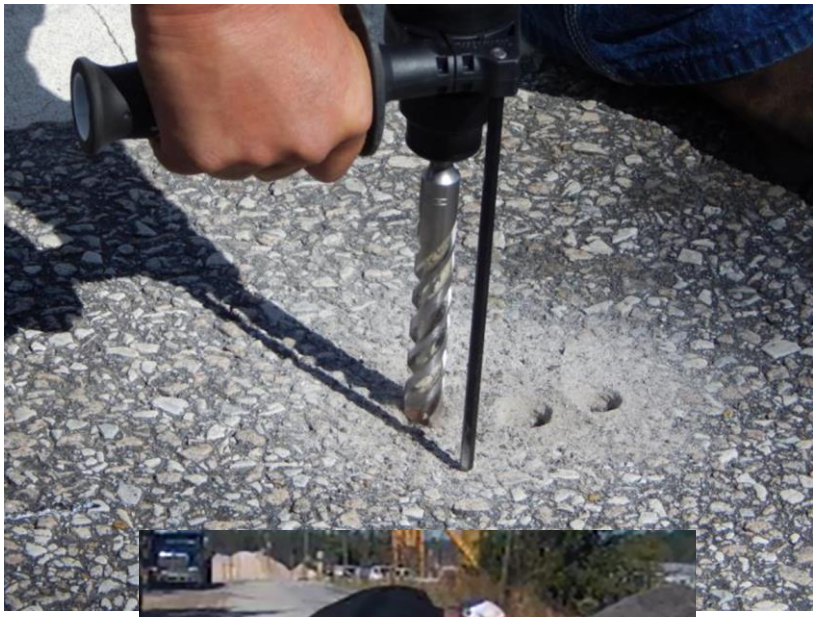
Forensic Investigations

- Dry Drilling
  - Asphalt Thickness
  - Base Material & Thickness
  - Subgrade Depth
  - Moisture/Drainage?



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Forensic Investigations

- Wet Coring
  - Layer Thicknesses
  - Crack Type/Depth
  - Stripping
  - De-Bonded Layers
  - Test Specimens
    - Mix Testing
    - Binder Grading
    - Aggregate Quality

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Forensic Investigations

- Trenching
  - Layer Thicknesses
  - Identify Problem Layers
  - Test Specimens

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Forensic Investigations

- Deflections
  - Pavement Strength Characteristics
  - De-Bonded layers, stripped layers, etc…

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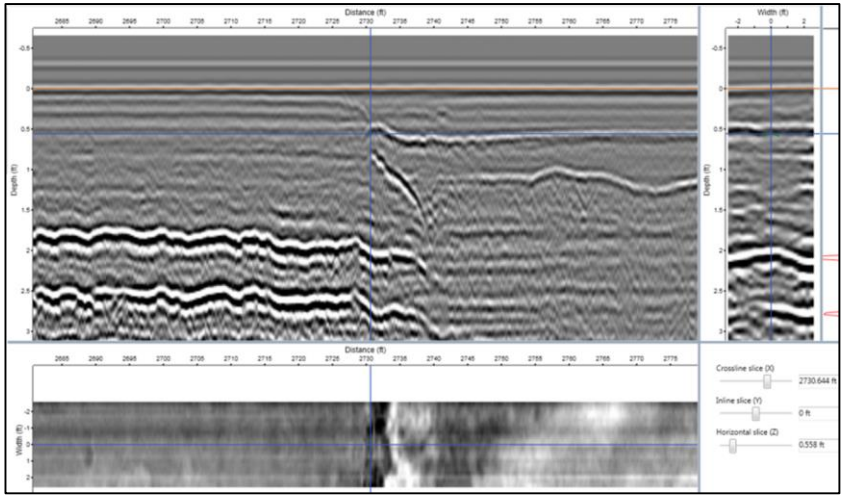
Forensic Investigations

- Ground Penetrating Radar
  - Layer Thicknesses
  - Stripping and/or Layer Seperation
  - Subsurface Moisture



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Corrective Actions

- Correct pavement deficiencies in preparation for successful overlays
  - Crack Sealing/Filling
  - Patching
  - Surface Treatments
  - Mill & Inlay
  - Structural Patching or Milling
  - Specialty Layers

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Corrective Actions

- Crack Sealing/Filling
  - Preserve the intended design life
  - Extend the service life of the existing asphalt concrete by reducing moisture infiltration
  - Prepare the existing pavement prior to construction of an asphalt concrete overlay

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Corrective Actions

- Patching
  - Repair localized distress
  - Improve motorist safety
  - Reduce pavement roughness
  - Reduce rate of deterioration
  - Repair pavement prior to overlay
  - Utility cuts

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Corrective Actions

- Surface Treatments
  - Fog Seals
  - Sand Seals
  - Scrub Seals

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Corrective Actions

- Surface Treatments
  - Chip Seals
  - Slurry Seals
  - Micro-Surfacing

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Corrective Actions

- Surface Treatments
  - Thinlay Asphalt
  - Sandwich Seals
  - Cape Seals

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Corrective Actions

- Mill & Inlay
  - Removal of rutting
  - Removal of distressed layer
  - Restore curb line
  - Restore cross slope
  - Restore surface friction

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Corrective Actions

- Structural Patching or Milling
  - Many distresses that we see on the surface are a result of a deeper structural problem
  - Steps should be taken to address the source of the problem
  - Removal of all distressed layers and materials

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Summary

- The success of any asphalt pavement overlay is directly related to the condition of the layers beneath it.
- Properly identifying and addressing existing pavement distresses is a must to ensure the long-life performance of the overall pavement structure

Covering up problems don't make them go away!

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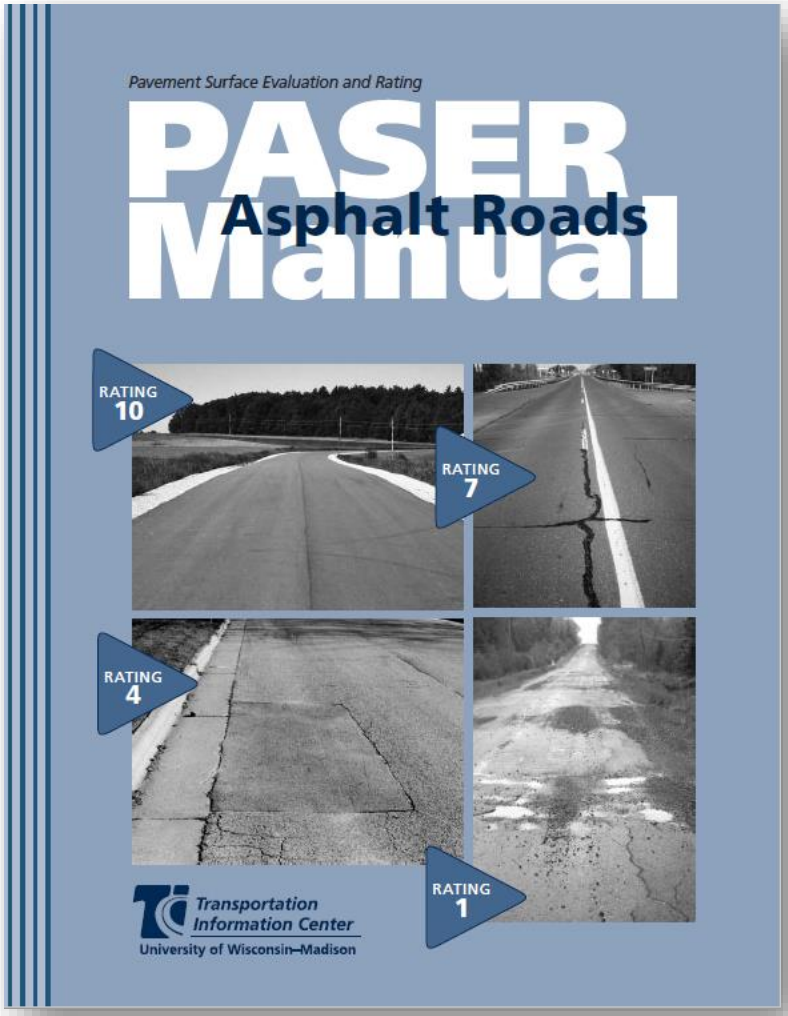
Key References

- Transportation Information Center at the University of Wisconsin – Madison. *Pavement Surface Evaluation and Rating (PASER) Manual*
- https://www.michigan.gov/documents/tamc/asphaltpaser_602531_7.pdf



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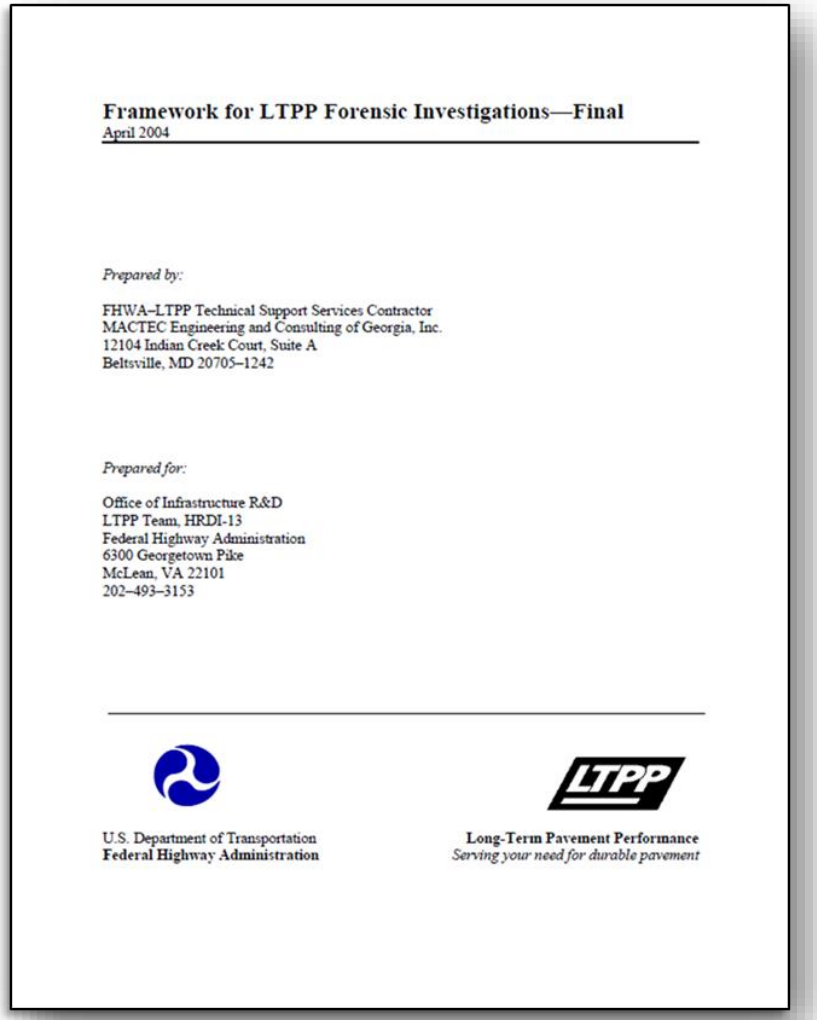
Key References

- FHWA Publication. *Framework for LTPP Forensic Investigations* - April 2004
- https://www.fhwa.dot.gov/publications/research/infrastructure/pavements/ltpp/framework/



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Questions?

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