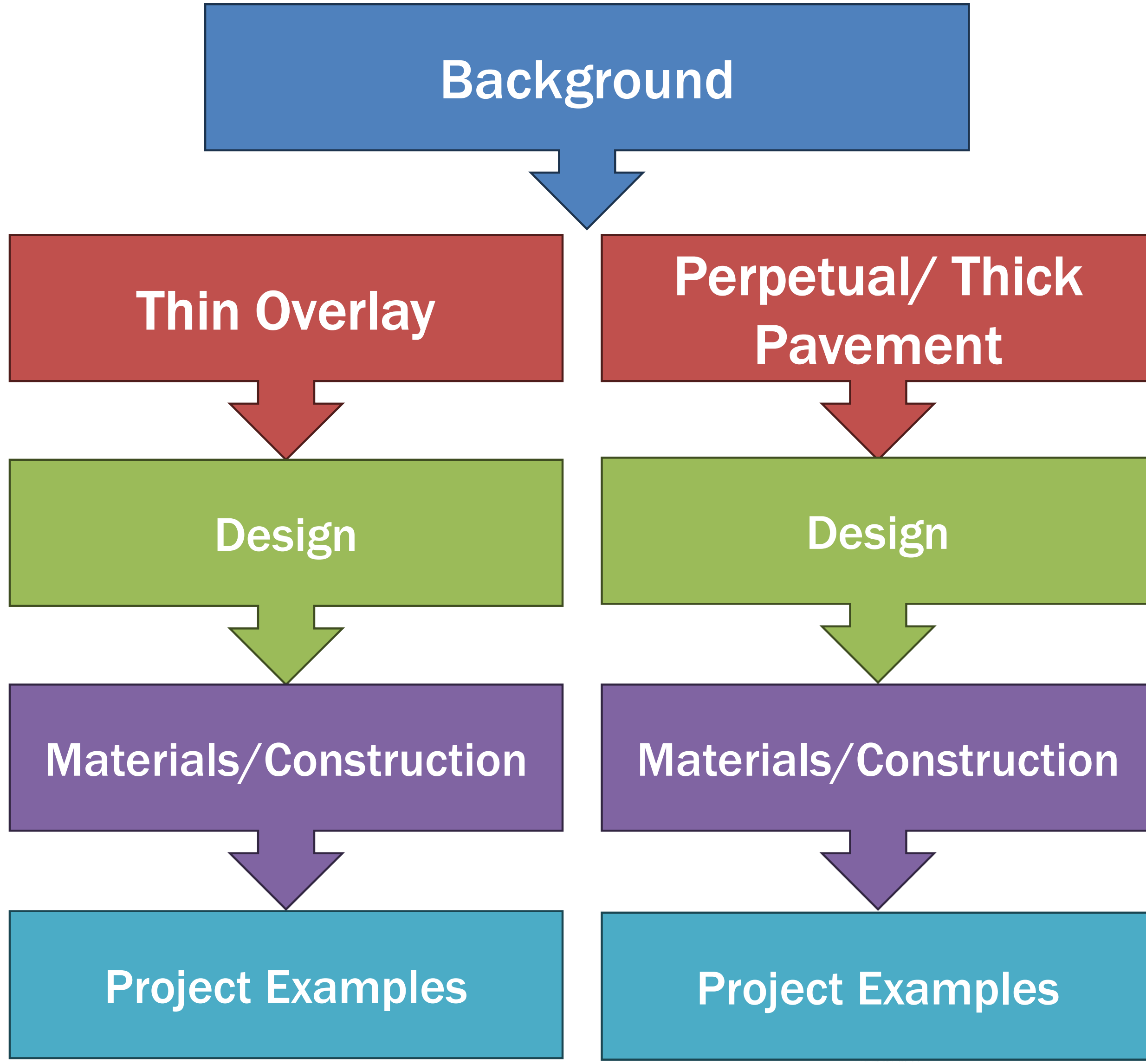
FROM VERY THIN TO VERY THICK… PAVEMENTS

LINDSI HAMMOND, PE

GRI

GEOTECHNICAL | GEOLOGICAL | PAVEMENT | ENVIRONMENTAL

AGENDA


Background
Thin Overlay
Perpetual/ Thick Pavement
Design
Design
Materials/Construction
Materials/Construction
Project Examples
Project Examples

ASPHALT vs. CONCRETE IN OREGON

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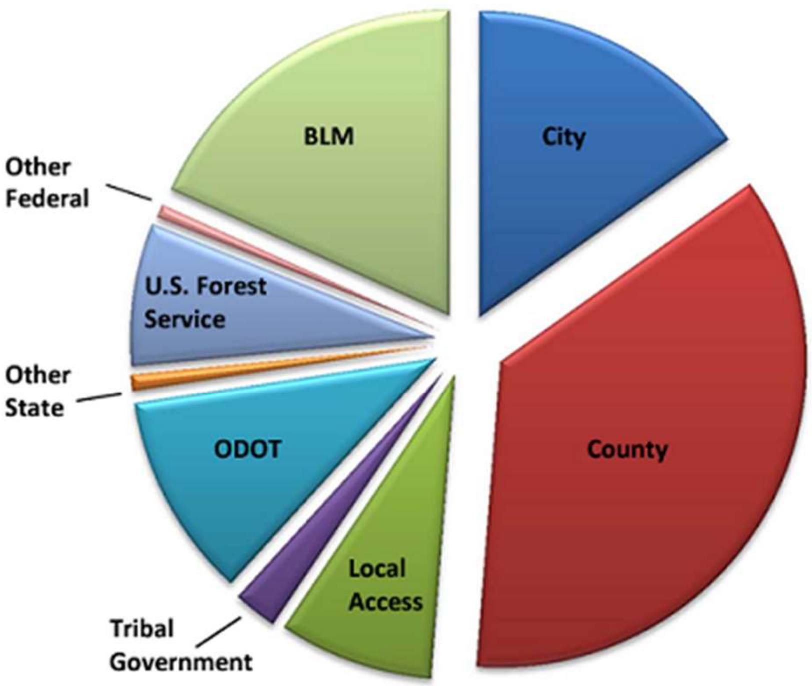
2020 OREGON MILEAGE REPORT
Percent of Road Miles by Jurisdiction



COUNTY			
Asphalt	Concrete	Other	Lane Miles
43%	0.1%	57%	26,663

CITY			
Asphalt	Concrete	Other	Lane Miles
84%	3%	13%	11,314

Other = Unimproved, Graded, Gravel, Oil Mat

https://www.oregon.gov/odot/Data/Documents/OMR_2020.pdf

ASPHALT vs. CONCRETE IN WASHINGTON

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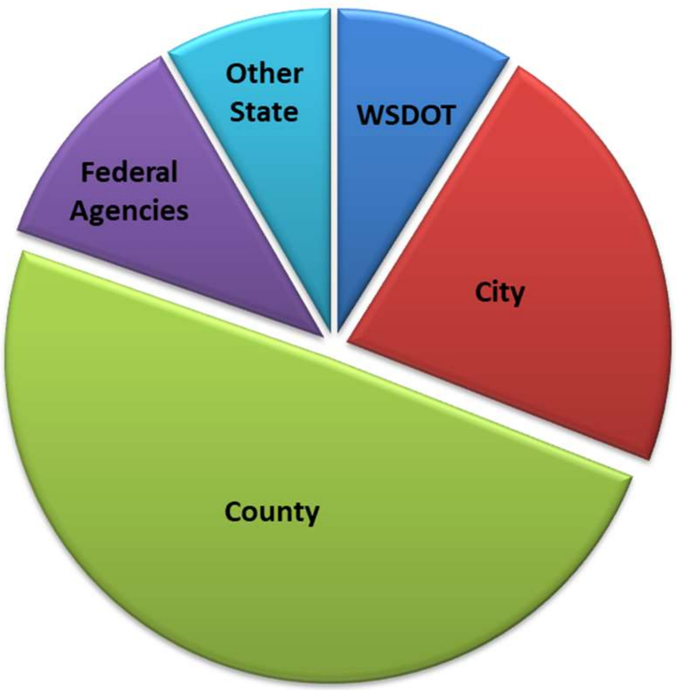
2021 WASHINGTON MILEAGE REPORT
Percent of Centerline Miles by Jurisdiction



https://wsdot.wa.gov/about/transportation-data/travel-data/annual-mileage-and-travel-information

WA State Highway Pavements		
Asphalt	Concrete	BST
60%	13%	27%

https://www.fhwa.dot.gov/asset/if08010/washcase_rev3.pdf

WHAT ARE THIN AND THICK PAVEMENTS?

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Thin (1 to 1½”) Asphalt Overlay

Get more out of your pavement structure

THIN OVERLAY

- Long life and low life-cycle cost!
- Safety / User
  - Minimize traffic delays
  - Smooth surface
  - Restore skid resistance
  - No loose stones & minimizes dust
  - Lower noise
- Structural
  - Maintain grade & slope
  - Withstands heavy traffic
- Sustainable
  - Recycled materials
  - Seals surface & no binder run-off

WHAT ARE THIN AND THICK PAVEMENTS?

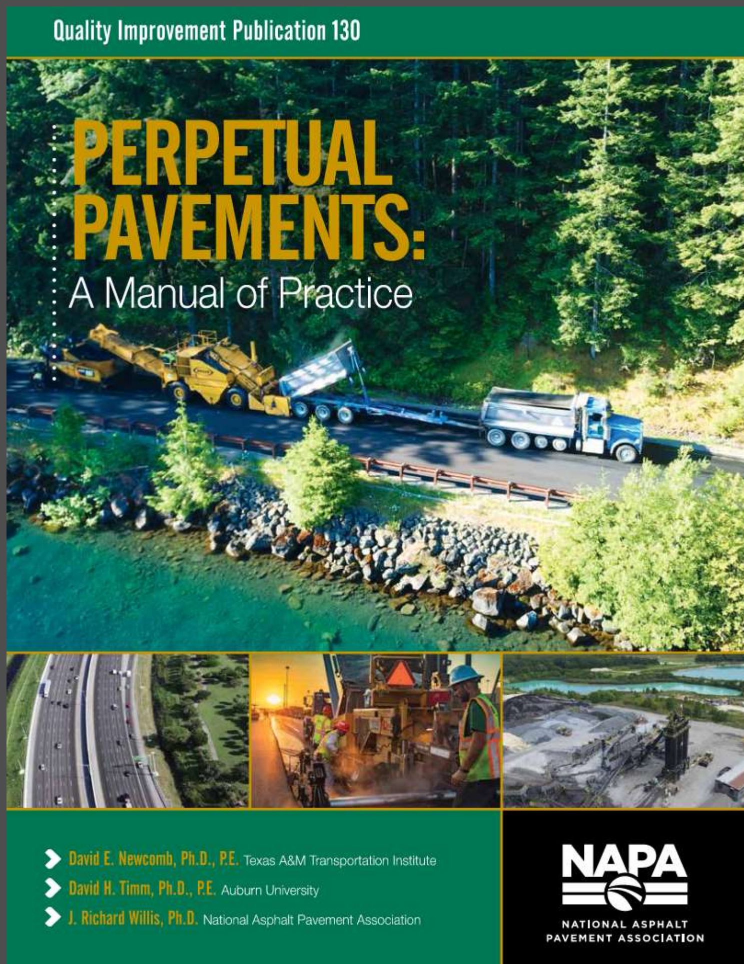
Perpetual Pavement

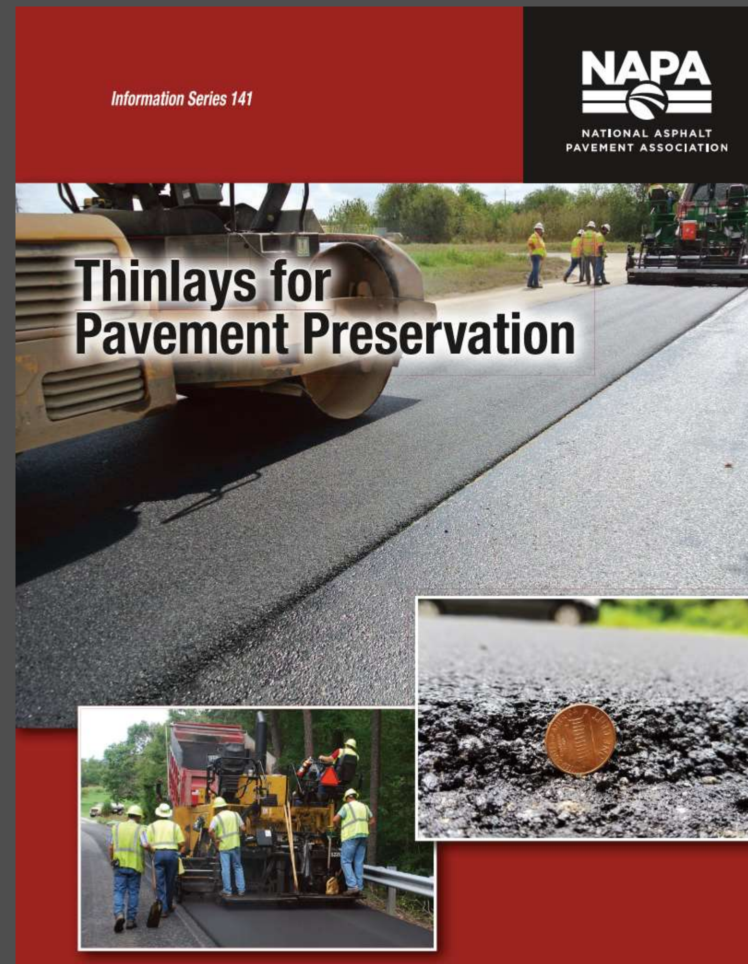
No deep structural distresses

35+ years of service

PERPETUAL PAVEMENT

- Long life!
- Structural
  - Top-down Cracking Only
  - Withstands heavy traffic
  - Easy to maintain
- Sustainable
  - Recycled materials
  - No Reconstruction





www.asphaltpavement.org

THIN OVERLAY

1) Project Selection
2) Design
3) Materials
4) Construction

THIN OVERLAY – Project Selection

BASIC EVALUATION

- Visual Survey
- Structural Assessment
  - No structural improvement required
- Drainage Evaluation
  - What changes are needed
- Functional Evaluation
  - Ride quality
  - Skid resistance
- Discussion with Maintenance Personnel

THIN OVERLAY – Project Selection

Weathering/Raveling

Longitudinal Cracking
(not in wheelpath)

Longitudinal Cracking
(wheelpath)

THIN OVERLAY – Project Selection

Transverse Cracking

Alligator/Fatigue Cracking

Rutting/Shoving (surficial/requires milling)

THIN OVERLAY – Project Selection

Drainage issues?

Rough Ride?

To Mill or

Not To Mill?

THIN OVERLAY - Design

If a Thin Overlay is the answer, you need to decide:

- **Surface Preparation**
  - Crack Sealing
  - Milling
  - TACK COAT!
- **Materials**
  - Binder Grade
  - Aggregate
    - 4.75 to 12.5 mm NMAS
- **Thickness**
  - $\leq$ 1.5 inches thick
  - Ratio of lift thickness to NMAS range 3:1 to 5:1

THIN OVERLAY - Construction

➢Production

- Aggregate Moisture
- Warm mix
- Storage/Haul

➢Surface Prep

- Milling
  - Standard, fine, micro
- Tack Coat
  - Rate: 0.10 to 0.15 gal/sy (undiluted emulsion)

THIN OVERLAY - Construction

- **Paving**
  - Best to move continuously
  - MTV or windrow can help
  - Cooling can be an issue
    - 1" cools 2× faster than 1.5"
  - Warm mix

- **Compaction**
  - Seal voids & increase stability
  - Low permeability
  - No vibratory on < 1"
  - Roller Pattern!

THIN OVERLAY – Real Projects

Polk County

- Paved 2010-2011
- Photos 2022

THIN OVERLAY – Real Projects

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City of Tigard

- Paved 2018
- Photos 2022

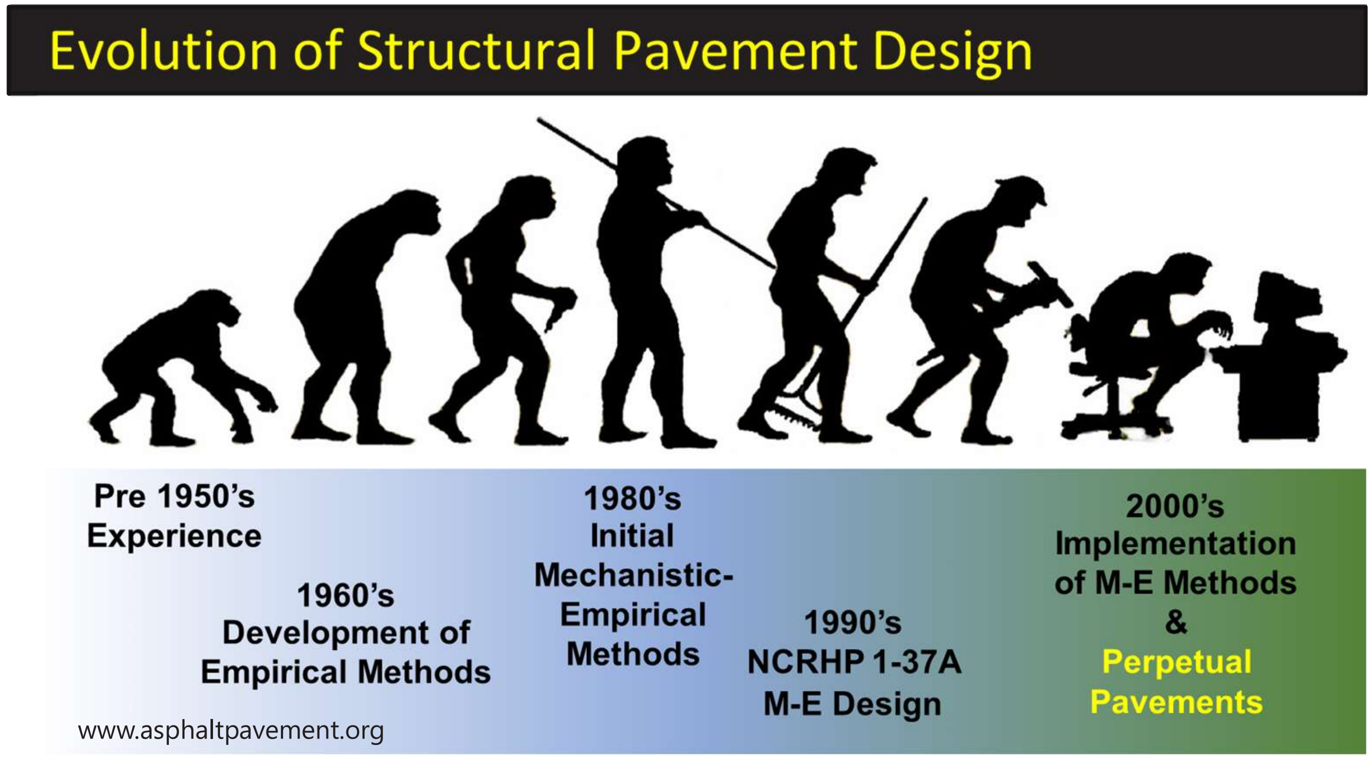
THIN OVERLAY – Real Projects

I-84

- Paved 2015/2016
- Photos 2022

PERPETUAL (THICK) PAVEMENT

1) Project Selection
2) Field Evaluation
3) Design
4) Materials
5) Construction



PERPETUAL PAVEMENT – Project Selection

- Reconstruction/New Construction/Overlay
- Design to Prevent Deep Structural Distresses
- All Functional Classifications

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PERPETUAL PAVEMENT – Project Selection

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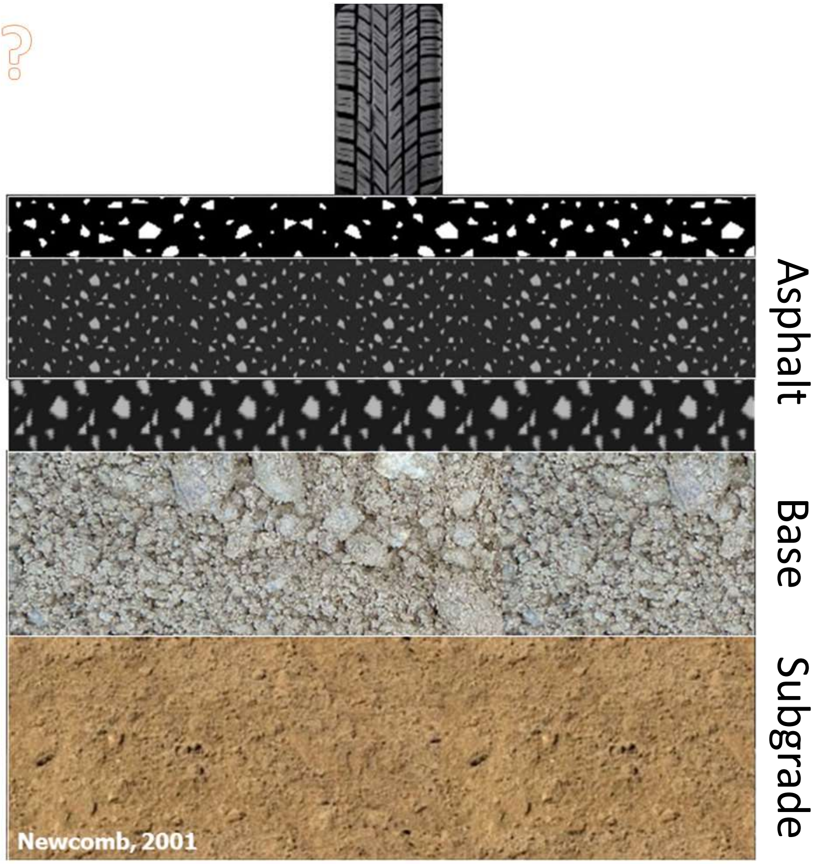
What Information Do You Need?

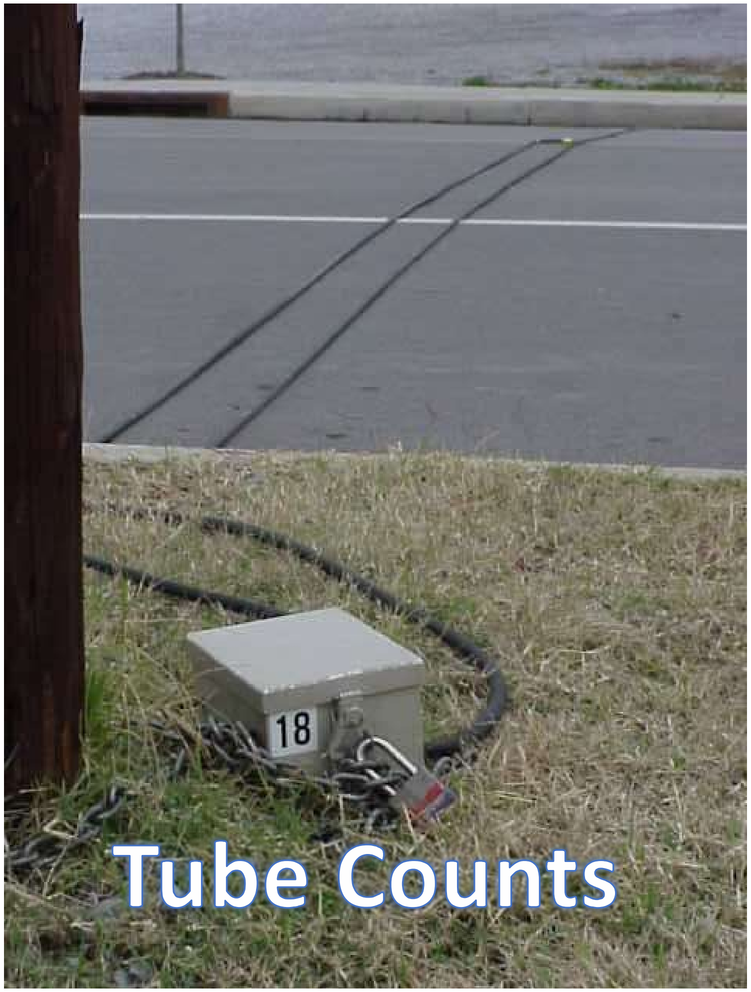
Project Road

- Traffic
- Thickness Info
- Material Properties

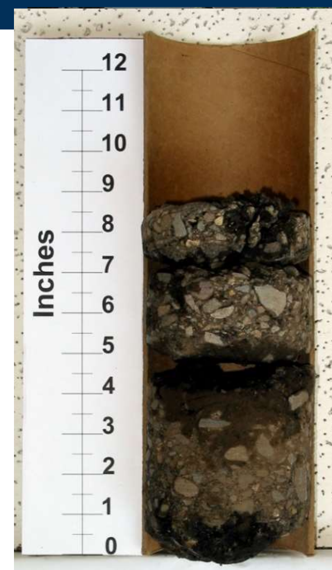
Subgrade Strength (M_R or CBR)



PERPETUAL PAVEMENT – Field Evaluation

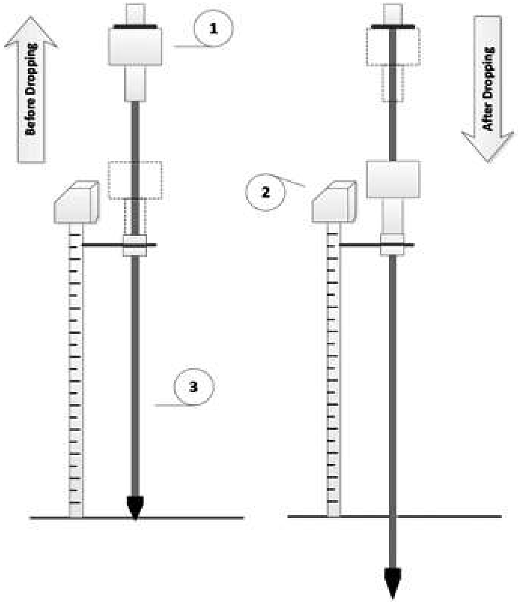


PERPETUAL PAVEMENT – Field Evaluation



PERPETUAL PAVEMENT – Field Evaluation

- What you Need to Know…Soil Resilient Modulus

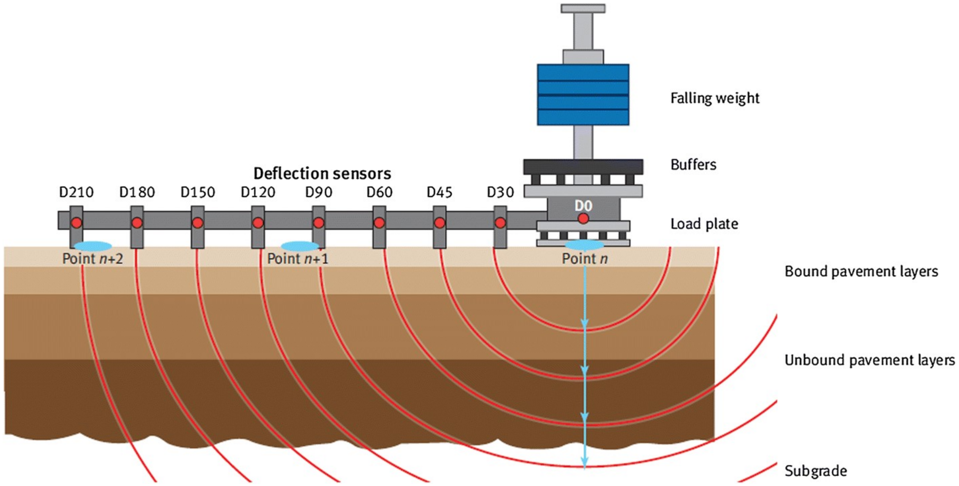


https://engineersforum.com.ng/2020/05/08/what-is-dynamic-cone-penetrometer-dcp/

Dynamic Cone Penetrometer (DCP)

PERPETUAL PAVEMENT – Field Evaluation

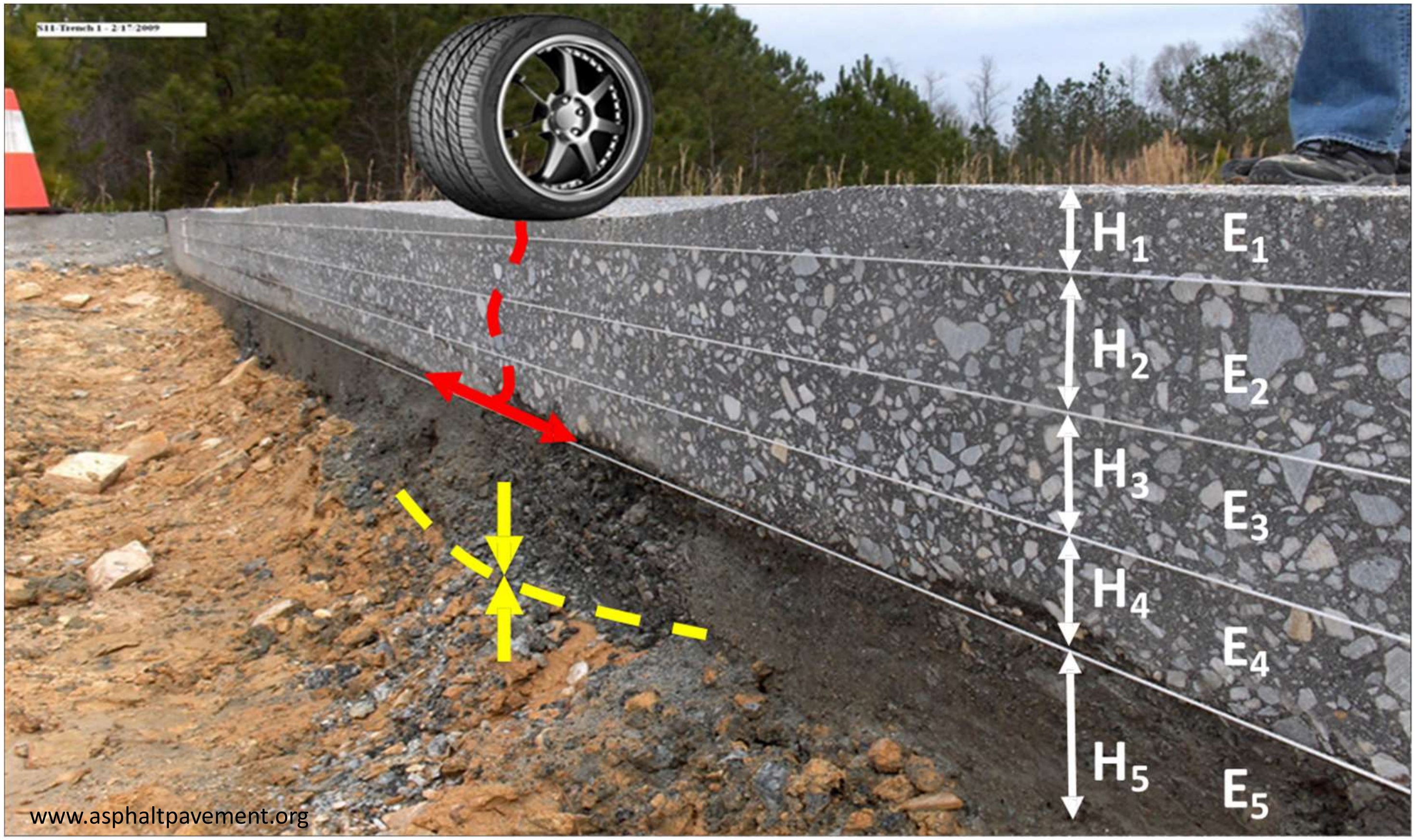
- What you Need to Know…Soil Resilient Modulus & Material Properties



Falling Weight Deflectometer (FWD)

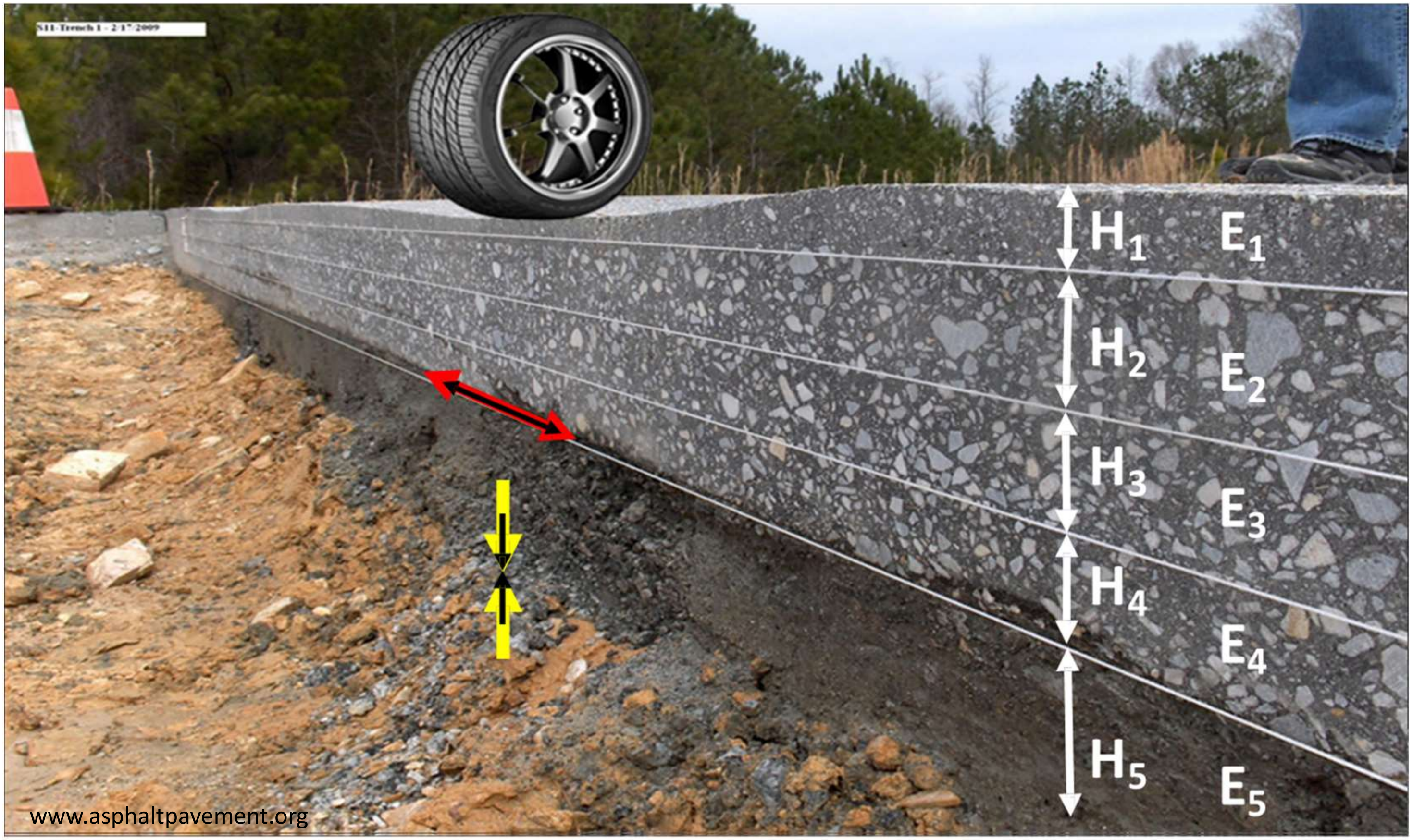
PERPETUAL PAVEMENT – Design

Mechanistic-Empirical Pavement Design



PERPETUAL PAVEMENT – Design

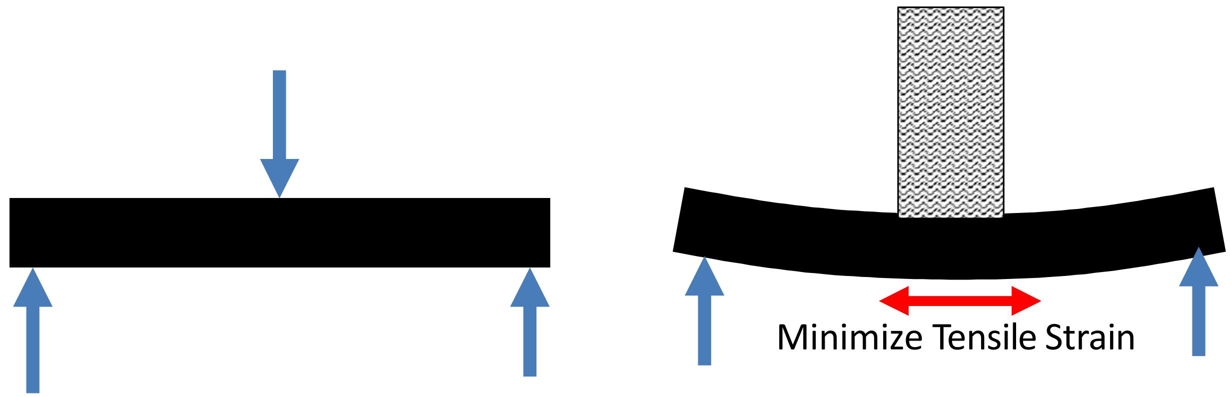
Mechanistic-Empirical **PERPETUAL** Pavement Design



PERPETUAL PAVEMENT – Design

Design Inputs

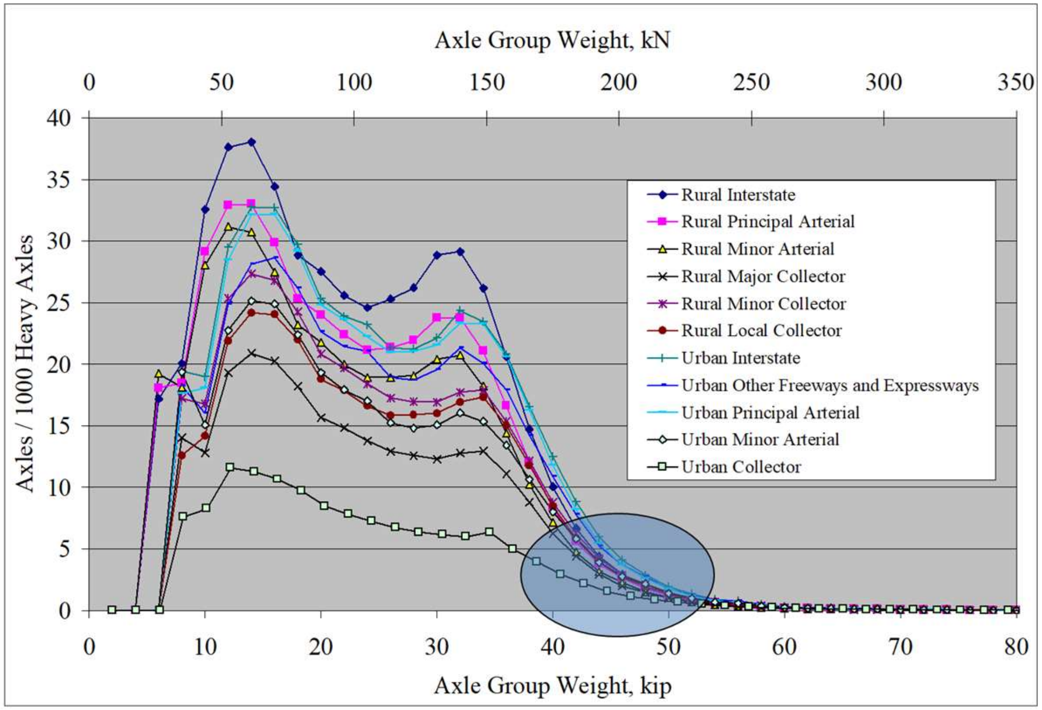
- Traffic Loading
- Endurance Limit
- Modulus
  - Asphalt
  - Base
  - Subgrade



PERPETUAL PAVEMENT – Design

Design Inputs

- **Traffic Loading**
- Endurance Limit
- Modulus
  - Asphalt
  - Base
  - Subgrade



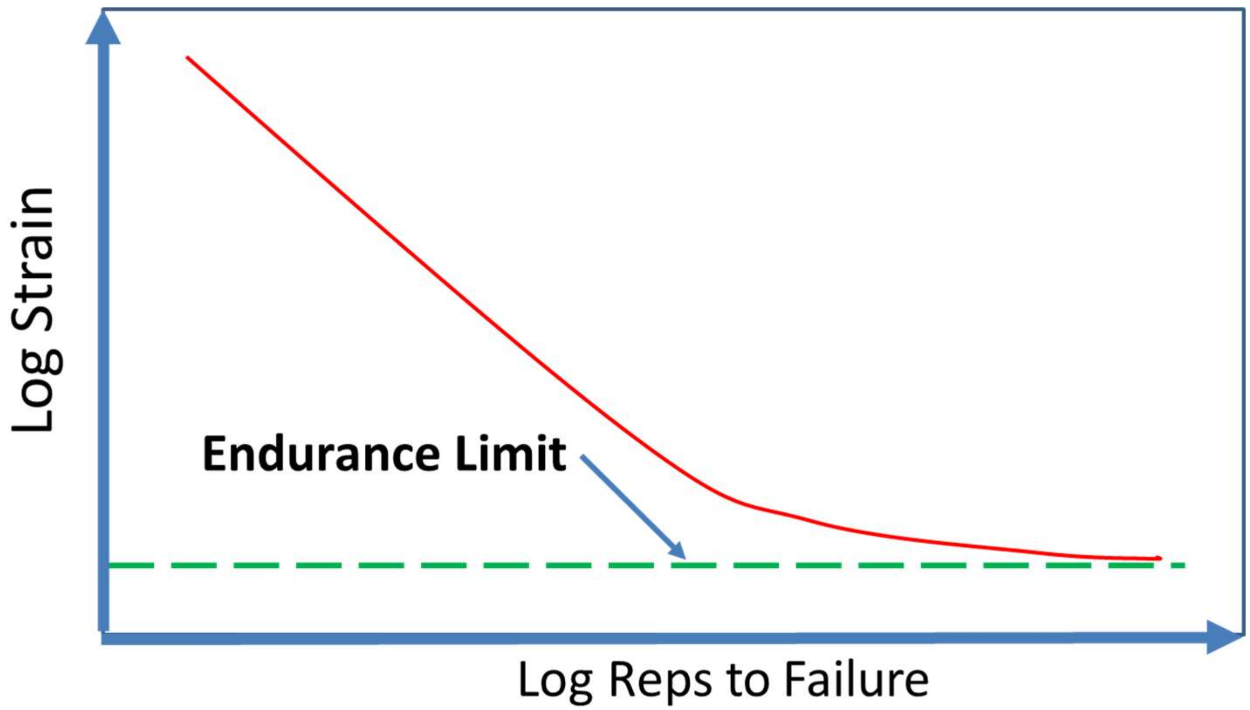
Efficient Design – Heaviest Wheel Loads

- **Does not depend on accurate traffic volume prediction**

PERPETUAL PAVEMENT – Design

Design Inputs

- Traffic Loading
- **Endurance Limit**
- Modulus
    - Asphalt
    - Base
    - Subgrade



An endurance limit is a threshold response below which damage does not occur.

PERPETUAL PAVEMENT – Design

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Design Inputs

- Traffic Loading
- Endurance Limit
- **Modulus**
  - **Asphalt**
  - **Base**
  - **Subgrade**

Asphalt, Base → Overlay

Subgrade → Overlay/Reconstruction/New Construction

PERPETUAL PAVEMENT – Design

Considerations if converting an exiting pavement to a Perpetual Pavement

Scenario 1) Healthy but structurally deficient

- Add thickness to meet design criteria

Scenario 2) Distressed or failing

- Perform rehabilitation to first deal with distress
  - Reflection cracking is a major problem…currently no perpetual design criteria
- Design for perpetual pavement performance criteria

avement.org

PERPETUAL PAVEMENT – Design

Design Output

Traffic Data	
Two-way Annual Average Daily Traffic (AADT)	21,800
Directional Distribution	59%
Percent of Trucks in Design Lane	100%
Annual Compound Growth Rate	1.73%

Truck Axle Spectra

Axle load spectra are based on the PerRoad default spectra for an urban principal arterial with truck distribution shown below

FHWA Class	4	5	6	7	8	9	10	11	12	13	Total
Percent in Category	19.31%	63.28%	6.23%	0.38%	0.38%	9.78%	0.38%	0.00%	0.00%	0.25%	100%

Season	Summer	Fall	Winter	Spring
Duration, weeks	17	9	13	13
Mean Air Temperature, degrees Fahrenheit	67.7	51.1	42	53.2

Analysis Case	Pavement Layers & Design Properties	Thickness, inches	Poisson Ratio	Average Modulus, psi				Thickness Variability		Modulus Variability	
				Summer	Fall	Winter	Spring	Distribution	COV,%	Distribution	COV,%
1	Level 4, ½-inch, Dense ACP Wearing Course, PG 70-22ER	3	0.35	531,365	1,046,001	1,516,272	960,112	Normal	5	Log-normal	30
	Level 3, ½-inch, Dense ACP Base Course, PG 64-22	8	0.35	391,324	784,928	1,149,595	718,767	Normal	5	Log-normal	30
	Aggregate Base	8	0.35	20,000	20,000	20,000	20,000	Normal	8	Log-normal	40
	Subgrade	Infinite	0.40	5,300	5,300	5,300	5,300	Normal	0	Log-normal	24
2	Level 4, ½-inch, Dense ACP Wearing Course, PG 70-22ER	3	0.35	531,365	1,046,001	1,516,272	960,112	Normal	5	Log-normal	30
	Level 3, ½-inch, Dense ACP Base Course, PG 64-22	9	0.35	393,056	786,689	1,150,800	720,578	Normal	5	Log-normal	30
	Aggregate Base	8	0.35	20,000	20,000	20,000	20,000	Normal	8	Log-normal	40
	Subgrade	Infinite	0.40	5,300	5,300	5,300	5,300	Normal	0	Log-normal	24
3	Level 4, ½-inch, Dense ACP Wearing Course, PG 70-22ER	3	0.35	531,365	1,046,001	1,516,272	960,112	Normal	5	Log-normal	30
	Level 3, ½-inch, Dense ACP Base Course, PG 64-22	10	0.35	394,683	788,340	1,151,929	722,275	Normal	5	Log-normal	30
	Aggregate Base	8	0.35	20,000	20,000	20,000	20,000	Normal	8	Log-normal	40
	Subgrade	Infinite	0.40	5,300	5,300	5,300	5,300	Normal	0	Log-normal	24
4	Level 4, ½-inch, Dense								5	Log-normal	30
	Level 3, ½-inch, Dense								5	Log-normal	30
	Aggregate Base								8	Log-normal	50
	Subgrade								0	Log-normal	24

Damage Analysis Transfer Functions

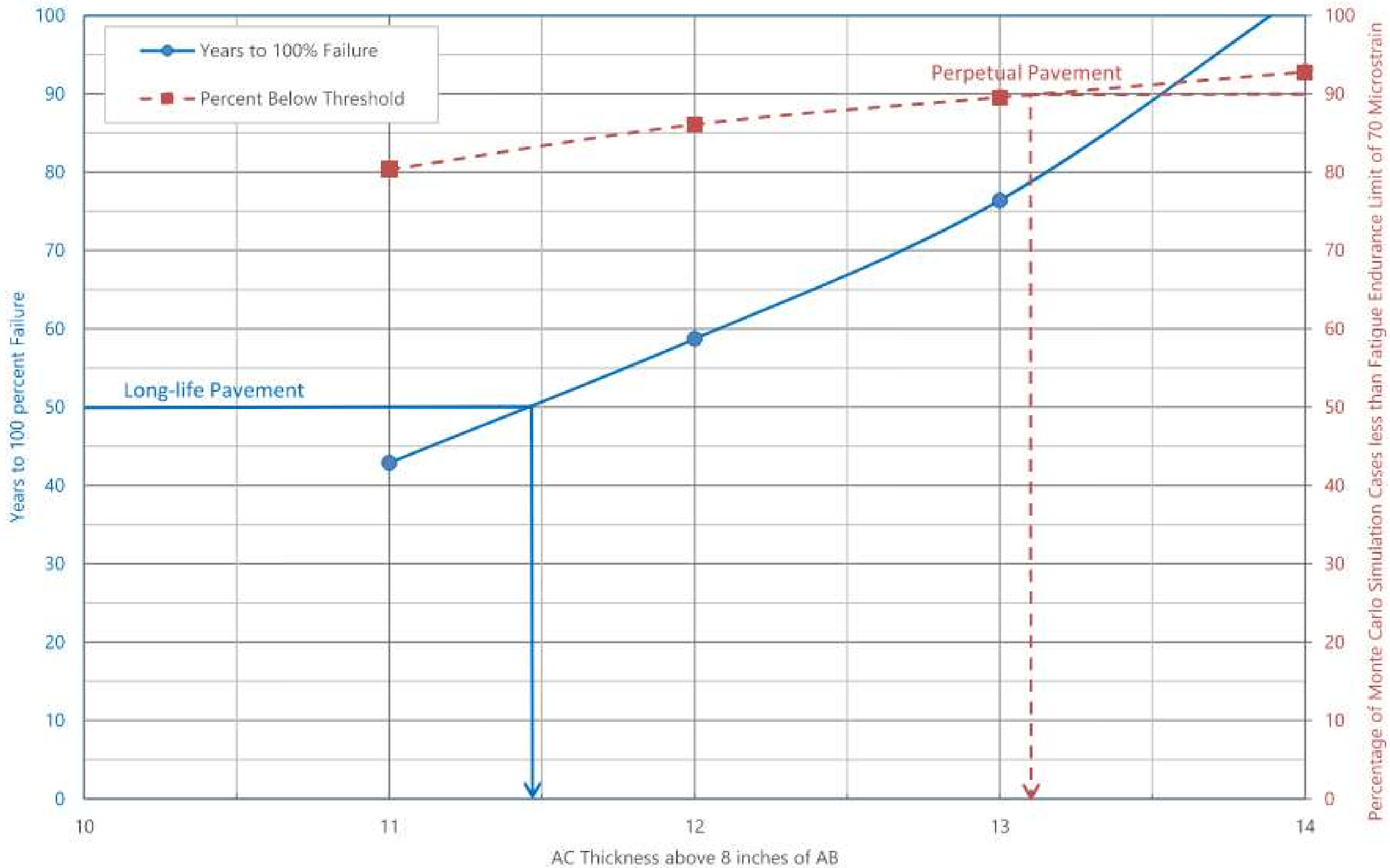
Layer	Critical Strain	Threshold value, microstrain	Function Parameters		Source
			k_1	k_2	
ACP	Horizontal Tensile	70	2.83E-06	3.15	PerRoad default transfer function
Subgrade	Vertical Compressive	200	---	---	50 percentile

Analysis Results (5,000 Simulations)

Analysis Case	Description	ACP Thickness, inches	AB or ICTB Thickness, inches	AC Tensile Strain			
				Percent below Threshold	Damage/ Million Axles	Time to 10% Damage, years	Time to 100% Damage, years
1	11 inches of ACP on 8 inches of AB	11.0	8.0	80	2.3%	6.0	42.9
2	12 inches of ACP on 8 inches of AB	12.0	8.0	86	1.4%	9.3	58.7
3	13 inches of ACP on 8 inches of AB	13.0	8.0	90	0.9%	14.0	76.4
4	14 inches of ACP on 8 inches of AB	14.0	8.0	93	0.5%	23.1	103.1

PERPETUAL PAVEMENT – Design

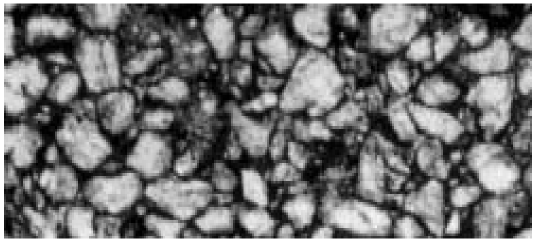
Design Output



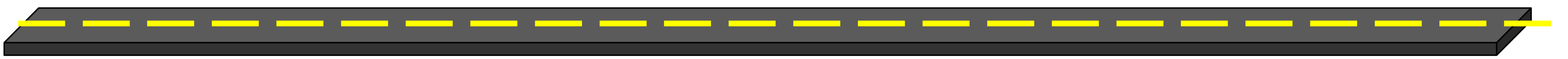
Abbreviations: AC = Asphalt Concrete; AB = Aggregate Base

PERPETUAL PAVEMENT – Materials

- Asphalt Materials and Mix Design
  - – Base Layer
  - – Intermediate Layer
  - – Wearing Course
- Functions of Asphalt Mixtures
  - Durable, economical base layers
  - Strong, rut resistant base and surface layers
  - Flexible, crack resistant surface and base layers
  - Smooth, safe, durable surfaces
  - Permeable, high-friction, low splash and spray surfaces



Compaction Support



Weak Support
Leads to Poor Compaction!

PERPETUAL PAVEMENT – Construction

Compaction Support

Strong Support
Helps Compaction!

PERPETUAL PAVEMENT – Construction

Paving Best Practices = Same as Conventional Asphalt Pavements

PERPETUAL PAVEMENT – Real Projects

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City of Eugene

- Design Standards
  - Minimum Asphalt Thickness (table)
  - New Construction Design = 30 Years
- www.eugene-or.gov/DocumentCenter/View/26574/2016-PIDS-Manual_FINAL

Street Classification	Minimum Thickness
Local or Neighborhood Collector	6 inches
Local or Neighborhood Collector w/bus route	8 inches
Major Collector	8 inches
Arterial	9 inches

City of Hillsboro

- Design Standards
  - New Construction Design = 40 Years
  - Minimum AC Thickness = 5 inches
- www.hillsboro-oregon.gov/home/showpublisheddocument/18134/637081131749530000

PERPETUAL PAVEMENT – Real Projects

City of Portland – 82nd Ave (Arterial)

Reconstruction

	AASHTO – 30 Year	Perpetual Pavement
AC Thickness, inch	13	13.5
Aggregate Thickness. inch	6 with geogrid	6 with geogrid

PERPETUAL PAVEMENT – Real Projects

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City of Eugene – Coburg Road (Arterial)

Rehabilitation

	Existing (Perpetual Pavement)	20-Year Rehabilitation/AASHTO
AC Thickness, inch	~11	4-inch mill/inlay
Aggregate Thickness, inch	~20	N/A

PERPETUAL PAVEMENT – Real Projects

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City of Eugene – Wilshire Lane (Local with buses)

Reconstruction

	AASHTO – 30 Year	Perpetual Pavement
AC Thickness, inch	10	15
Aggregate Thickness. inch	14 with geogrid	14 with geogrid

PERPETUAL PAVEMENT – Real Projects

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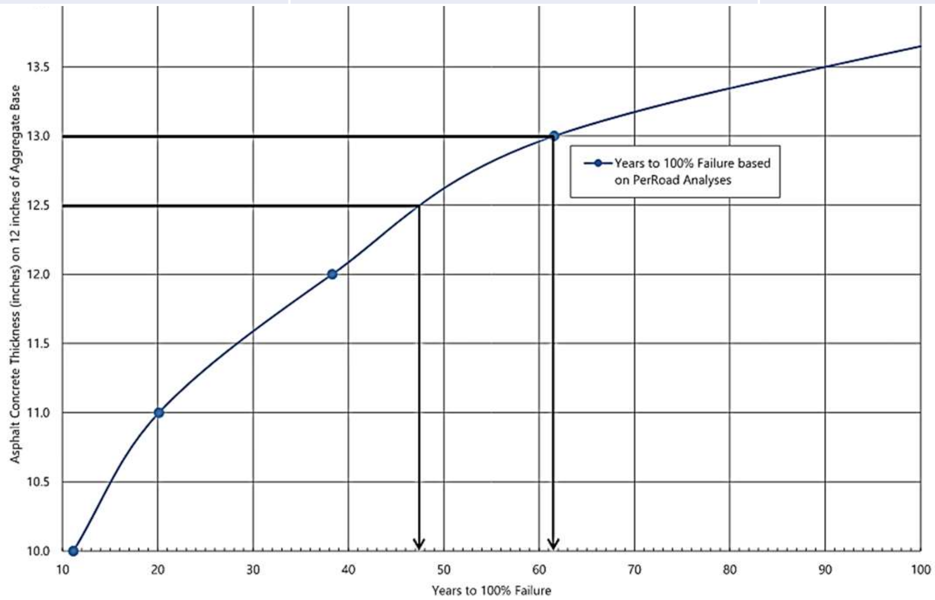
ODOT– I-5

New Construction

	AASHTO – 30 Year	Perpetual Pavement
AC Thickness, inch	13	13
Aggregate Thickness. inch	12	12



QUESTIONS?

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Our services include:

- Geotechnical Engineering
- Hazmat
- Geologic Hazards
- Laboratory Services
- Pavement Engineering
- Construction Services
- Seismic Engineering
- Alternative Delivery

Where we are located:

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