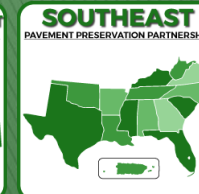


# Pavement Preservation College Curriculum

Andrew Braham, Professor  
University of Arkansas – Fayetteville  
September 19, 2023



# Why am I here? To talk about class projects...

- ▶ Pavement preservation often overlooked in undergrad college classroom
- ▶ Two classes explored RoadResource.org
  - Split each class into groups
- ▶ CVEG 4423: Transportation Infrastructure
  - Required senior-level class
  - Explored single treatment on ARDOT entire network (NOT recommended!!)
- ▶ CVEG 4863: Sustainability in Civil Engineering
  - Senior-level technical elective
  - Compared “conventional” to “optimized” treatments on ARDOT network

Thank you to Logan Kiihnl and Sadie Casillas

# Simplified 2018 ARDOT network

Highway type	Lane-mile
Freeways	3,702
Multilane highways	4,587
Two lane highways	28,943
Total	37,232

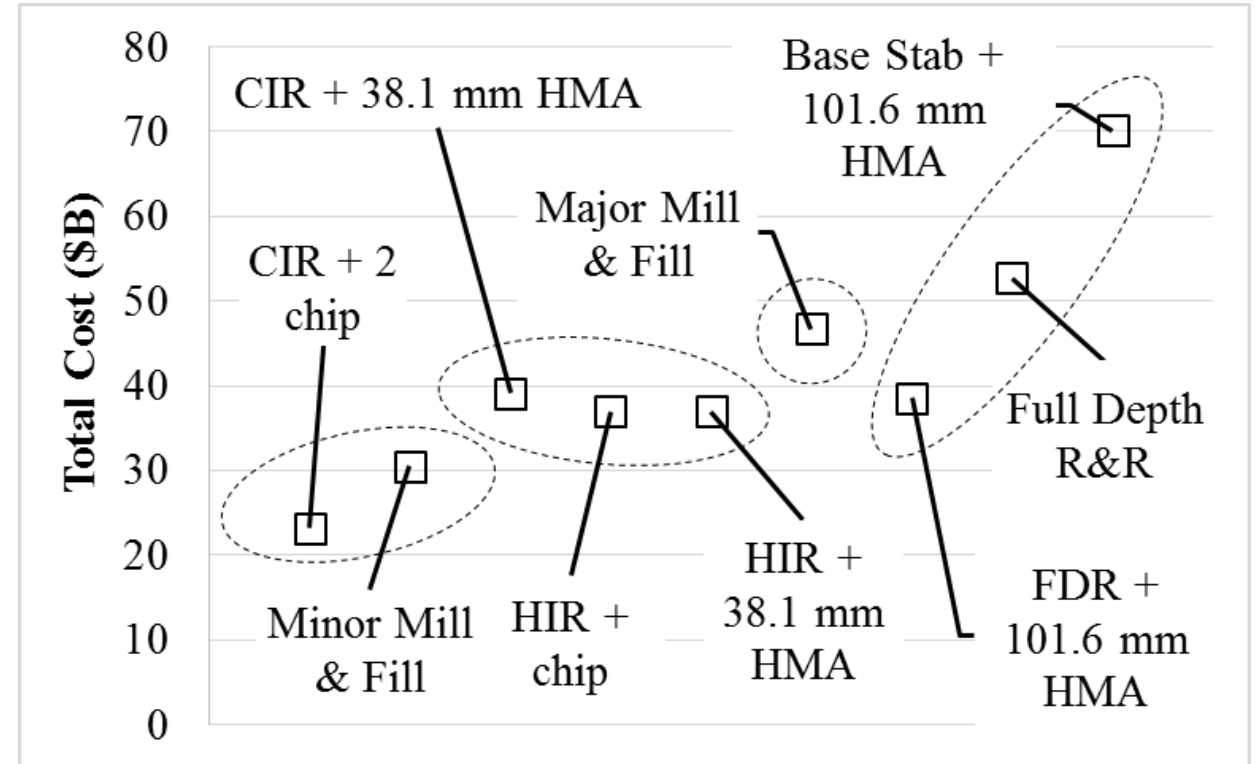
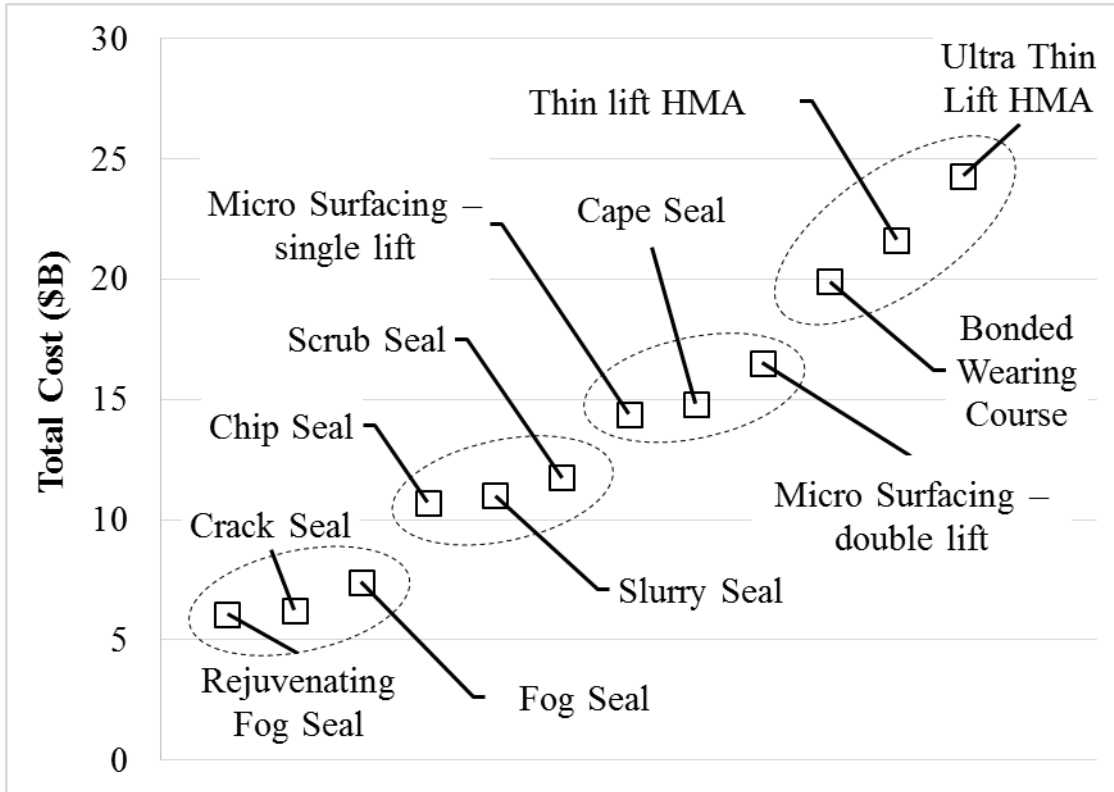
Multiple assumptions were made to simplify down to these three highway types

2018 budget: ~\$236 million

Four calculators on RoadResource.org – just look at LCC and RSL

# Life Cycle Cost (LCC) maintenance and rehabilitation (\$B)

NOT realistic...



Over 50 year design period:  
 ↑ “intensive” treatments ↑ cost, four groupings in each

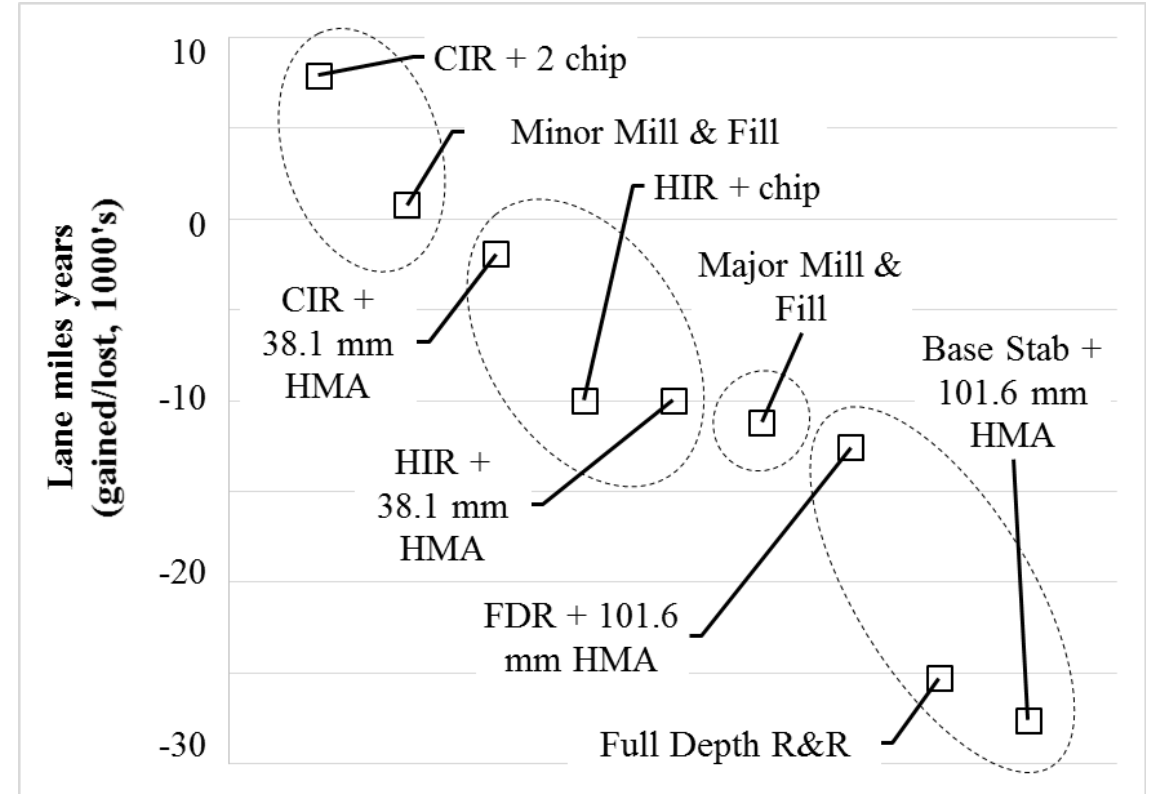
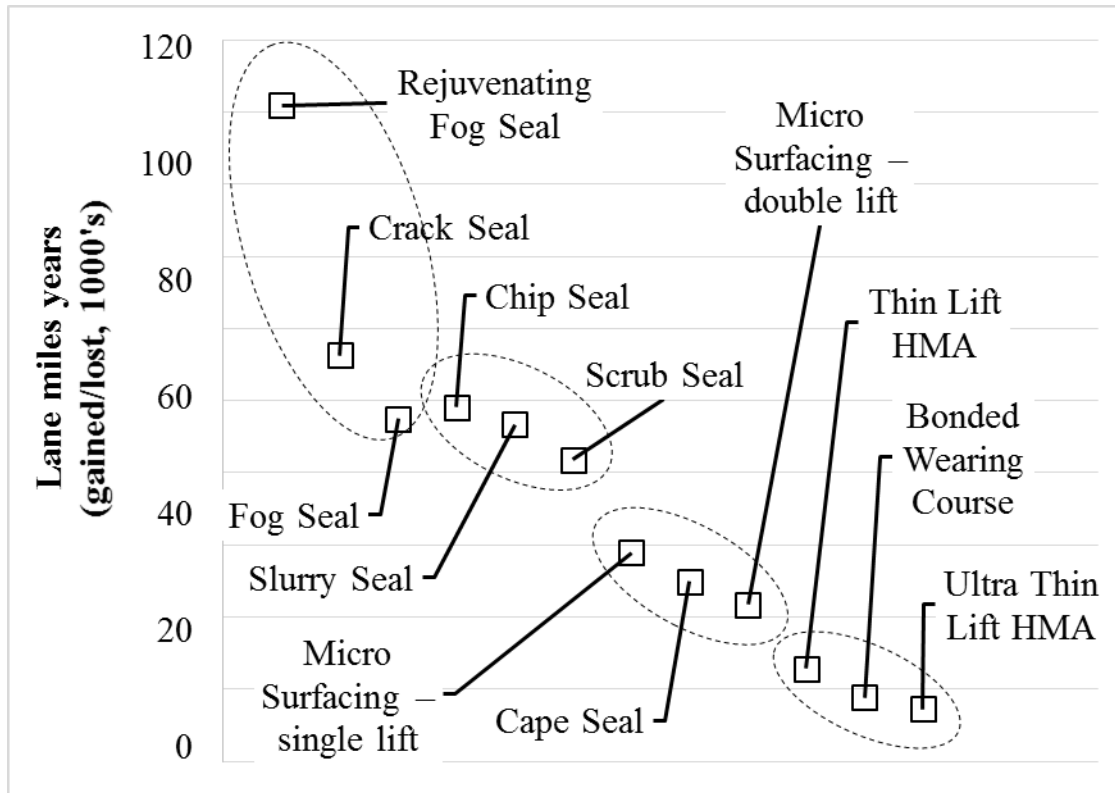
# Remaining Service Life (RSL)

Remaining Service Life  
→ lane mile years



# Remaining Service Life (RSL) maintenance and rehabilitation

NOT realistic...



Maintenance provides higher RSL than rehabilitation

All but two rehabilitation methods have negative lane-mile years

# CVEG 4863: Sustainability in Civil Engineering explored “optimized” treatments

- ▶ Existing Service Life (ESL) – age of pavement in terms of condition
- ▶  $t_{PRES}$  – time to achieve “true” pavement preservation
- ▶ True pavement preservation: all pavements in PCI A or B, zero lane-mile years gained/lost per year
- ▶ Conventional versus optimal treatments on ARDOT’s network

Class of 14 divided into groups to explore different groups of optimized treatments

# Existing Service Life (ESL)

- ▶ Represent amount of time pavements have been in service
- ▶ Multiply age of each PCI by length in network
  - PCI A → year range 0–12 → use average age of 6 years
  - Freeway: 1166 lanes miles → multiply by 6 → 6996 lane-mile years

PCI Grade	Year range	Average life (years)	Freeway Length (lane-miles)	Freeway ESL	Multilane ESL	Two lane ESL
PCI A	0-12	6	1166	6996	936	1216
PCI B	12-14	13	1407	18291	14788	27467
PCI C	14-15	14.5	692	10034	23346	102400
PCI D	15-16	15.5	326	5053	17561	166437
PCI F	16+	20	111	2220	11009	176552
Total (lane-mile-years)				42594	67640	474072



$t_{PRES}$

$$t_{PRES} = \frac{\text{Existing Service Life (lane – mile – years)}}{\text{Remaining Service Life (lane – mile – years)}}$$

Length of time to reach “true” pavement preservation:

Entire network PCI A and B  
Zero net lane-mile-years RSL

# Optimizing the network

## Select Pavement Treatments

- Chip Seal applied to PCI A and PCI B roads
- Minor Mill & Fill applied to PCI C and PCI D roads
- Full Depth Remove & Replace applied to PCI F roads

## Utilize RSL Calculator on RoadResource.org

- Treat same percentage of PCI D and PCI F roads
- Treat 100% of PCI A roads
- Maximize RSL within budget

## Determine $t_{PRES}$ and Preservation Budget

- Calculate  $t_{PRES}$  for each highway segment using RSL
- Ensure PCI D and F roads can be treated within  $t_{PRES}$
- Determine preservation budget to keep roads at PCI A
- Shift remaining budget to next highway segment

# ARDOT's current treatments: conventional

PCI Grade	Treatment	Freeway Lane-Miles Treated	
		Original Budget	Adjusted Budget
PCI A & B	Chip Seal	1929.7	-
PCI C & D	Minor Mill & Fill	682.1	-
PCI F	Full Depth R&R	55.5	-

This is a key part of pavement preservation

Taking care of roads that are in good condition

# ARDOT's current treatments: conventional

PCI Grade	Treatment	Freeway Lane-Miles Treated		Multilane Lane-Miles Treated		Two lane Lane-Miles Treated	
		Original Budget	Adjusted Budget	Original Budget	Adjusted Budget	Original Budget	Adjusted Budget
PCI A & B	Chip Seal	1929.7	-	724.7	1293.5	378.7	2315.4
PCI C & D	Minor Mill & Fill	682.1	-	362.7	740.4	517.9	1035.9
PCI F	Full Depth R&R	55.5	-	45.9	229.3	176.5	367.8

Budget proportionally allocated by "Vehicle Miles Traveled" (VMT, note, ARDOT does not do this)

# ARDOT's current treatments: conventional

PCI Grade	Treatment	Freeway Lane-Miles Treated		Multilane Lane-Miles Treated		Two lane Lane-Miles Treated	
		Original Budget	Adjusted Budget	Original Budget	Adjusted Budget	Original Budget	Adjusted Budget
PCI A & B	Chip Seal	1929.7	-	724.7	1293.5	378.7	2315.4
PCI C & D	Minor Mill & Fill	682.1	-	362.7	740.4	517.9	1035.9
PCI F	Full Depth R&R	55.5	-	45.9	229.3	176.5	367.8

Excess budget shifted “down” after true pavement preservation reached

# Pavement preservation: conventional

	<b>Freeway</b>
<b>tpRES - original</b>	2.21
<b>tpRES - adjusted</b>	2.21
<b>Budget - original</b>	\$94,247,372
<b>Budget - adjusted</b>	\$94,247,372
<b>Budget - preservation</b>	\$8,947,981

Once true pavement preservation reached, can reduce budget significantly

This savings is shifted “down” to multilane highways

# Pavement preservation: conventional

	<b>Freeway</b>	<b>Multilane</b>
<b>tpRES - original</b>	2.21	13.81
<b>tpRES - adjusted</b>	2.21	3.97
<b>Budget - original</b>	\$94,247,372	\$48,833,492
<b>Budget - adjusted</b>	\$94,247,372	\$134,132,883
<b>Budget - preservation</b>	\$8,947,981	\$11,087,085

**Adjusted budget:**

$$\$94.2 - \$8.9 + \$48.8 = \$134.1$$

# Pavement preservation: conventional

	Freeway	Multilane
<b>t<sub>PRES</sub> - original</b>	2.21	13.81
<b>t<sub>PRES</sub> - adjusted</b>	2.21	3.97
<b>Budget - original</b>	\$94,247,372	\$48,833,492
<b>Budget - adjusted</b>	\$94,247,372	\$134,132,883
<b>Budget - preservation</b>	\$8,947,981	\$11,087,085

Adding remaining freeway budget decreases  $t_{PRES}$

Pavement preservation savings is shifted “down” to two-lane highways

Adjusted budget:  
 $\$94.2 - \$8.9 + \$48.8 = \$134.1$



# Pavement preservation: conventional

	Freeway	Multilane	Two-Lane	Total
<b>t<sub>PRES</sub> - original</b>	2.21	13.81	n/a	n/a
<b>t<sub>PRES</sub> - adjusted</b>	2.21	3.97	85.57	92
<b>Budget - original</b>	\$94,247,372	\$48,833,492	\$93,504,271	\$236,585,135
<b>Budget - adjusted</b>	\$94,247,372	\$134,132,883	\$216,550,069	
<b>Budget - preservation</b>	\$8,947,981	\$11,087,085	\$69,959,578	\$89,994,644
<b>Preservation budget savings</b>				<b>\$146,590,491</b>

**t<sub>PRES</sub> is 92 years using conventional treatments**

# Pavement preservation: optimizing highways

	<b>PCI A</b>	<b>PCI B</b>	<b>PCI C</b>	<b>PCI D</b>	<b>PCI F</b>
<b>Freeways</b>	Rejuvenating Fog Seal	Micro Surfacing - Single Lift	Minor Mill & Fill	CIR + 1.5" HMA	Full Depth R&R
<b>Multilane</b>	Rejuvenating Fog Seal	Scrub Seal	CIR + 2 chip	CIR + 1.5" HMA	FDR + 4.0" HMA
<b>Two-lane</b>	Rejuvenating Fog Seal	Chip seal	CIR + 2 chip	CIR + 1.5" HMA	FDR + 4.0" HMA

Used “engineering judgement” and data harvest from class to determine treatments for each PCI condition

# Pavement preservation: optimized

	<b>Freeway</b>	<b>Multilane</b>	<b>Two-Lane</b>	<b>Total</b>
<b>t<sub>PRES</sub> - original</b>	2.53	10.38	n/a	n/a
<b>t<sub>PRES</sub> - adjusted</b>	2.53	3.39	40.44	46.36
<b>Budget - original</b>	\$94,247,372	\$48,833,492	\$93,504,271	\$236,585,135
<b>Budget - adjusted</b>	\$94,247,372	\$134,122,042	\$217,106,441	
<b>Budget - preservation</b>	\$8,958,822	\$10,519,872	\$61,808,947	\$81,287,641
<b>Preservation budget savings</b>				<b>\$155,297,494</b>

Went from 92 years to just over 46 to reach t<sub>PRES</sub> with existing budget and optimized treatments

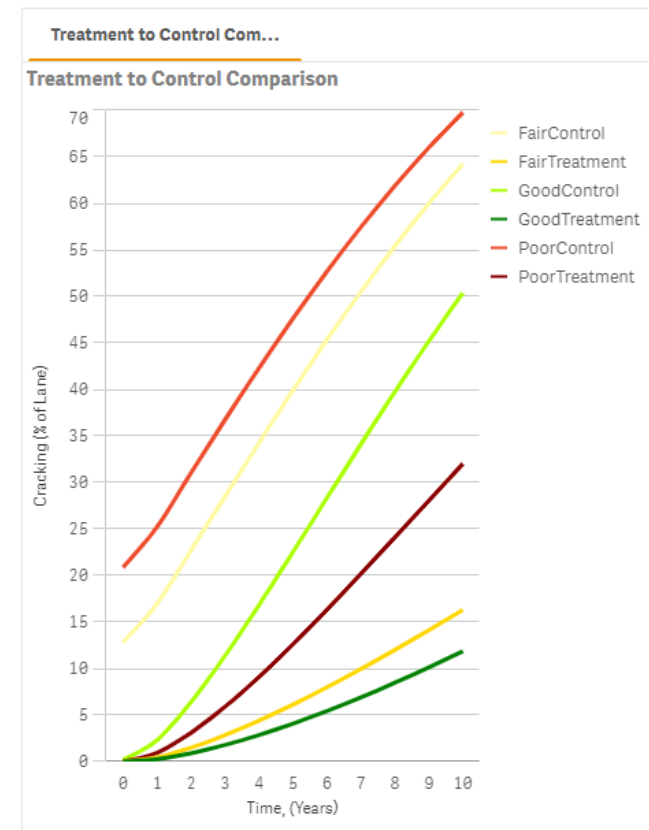
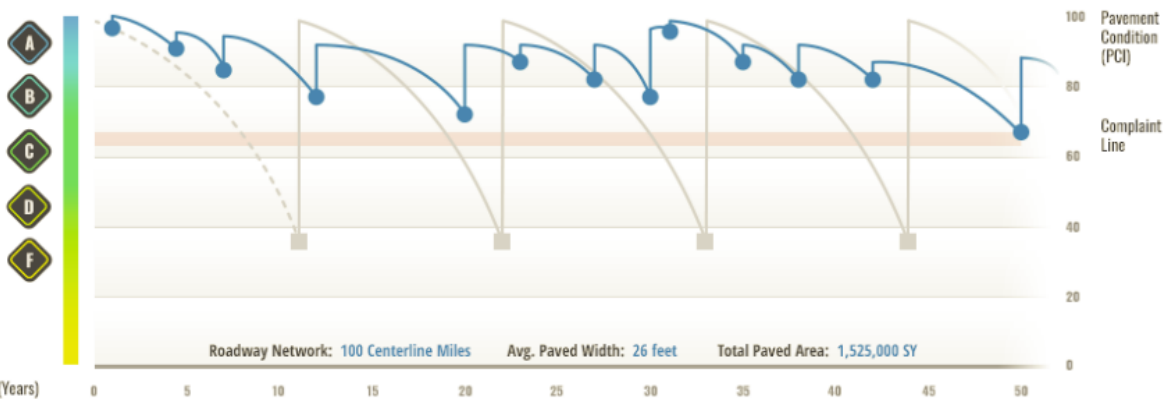
# Newly added component! Fall 2022

- ▶ First project did not consider existing pavement condition
- ▶ Leveraged NCAT's pavement preservation website
  - Lee Road 159
  - Tie together condition curves with real data
  - Real data doesn't always make sense!

Time to Poor (Control)      Crack Reduction (Average)      Time to Poor (Treatment)

1.8      28.6      6.7

A EXCELLENT B GOOD C FAIR D POOR F VERY POOR



# Conclusions

- ▶ Pavement maintenance provides higher RSL than rehabilitation and is cheaper
- ▶ Shifting to “optimized” treatments from “conventional” saves money and improves the network faster
- ▶ In general, applying treatments on roads in good condition provides greater life extension
  - Real data doesn’t always make sense!
- ▶ Using RoadResource.org and NCAT’s Pavement Preservation website introduces students to pavement preservation, maintenance, and rehabilitation of flexible pavements

Thank you, questions? [afbraham@uark.edu](mailto:afbraham@uark.edu)



# UNIVERSITY OF ARKANSAS®

**Andrew F. Braham, Ph.D., P.E.**

*Associate Professor  
Civil Engineering*

4190 Bell Engineering Center  
Fayetteville, AR 72701  
e-mail: [afbraham@uark.edu](mailto:afbraham@uark.edu)

Phone: 479-575-6028  
Fax: 479-575-7168  
[www.andrewbraham.com](http://www.andrewbraham.com)