Association of Modified Asphalt Producers

9th Annual Meeting

"Performance of Modified Asphalt Used on Kentucky Roadways"

Allen Myers
Kentucky Transportation Cabinet

February 12, 2008

KENTUCKY TRANSPORTATION CABINET

AMAP
The Association of Modified Asphalt Producers

In the tradition of Jim Bowie…

What's on the agenda for today?

Kentucky's usage of PG binders

"Different behavior" of PG 76-22

Increased durability research

Elastic recovery testing

Multiple stress creep recovery testing

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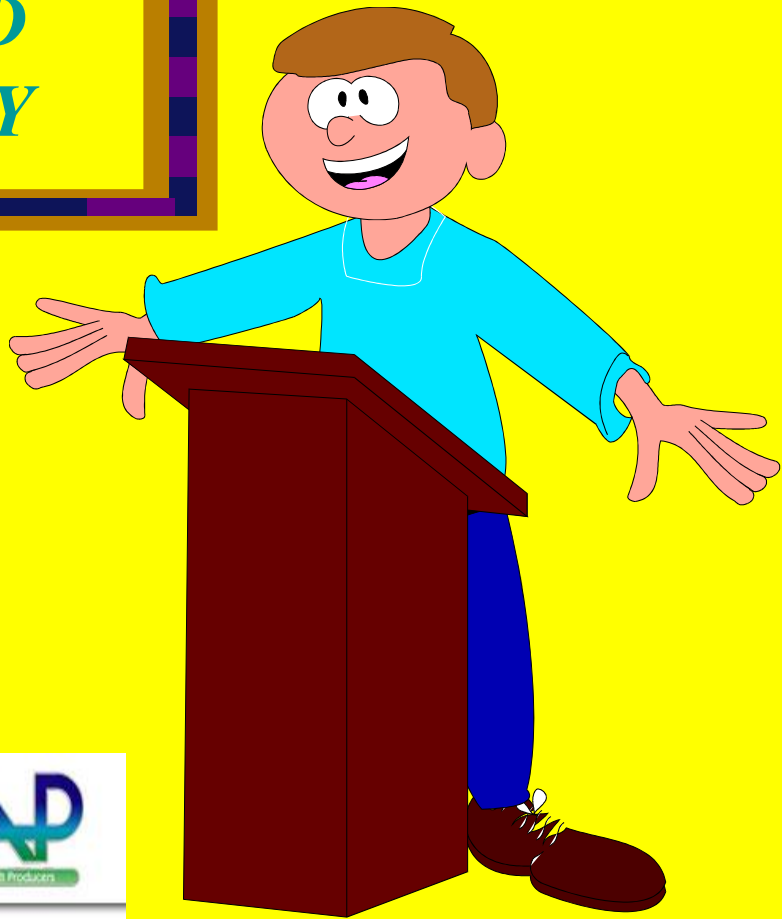
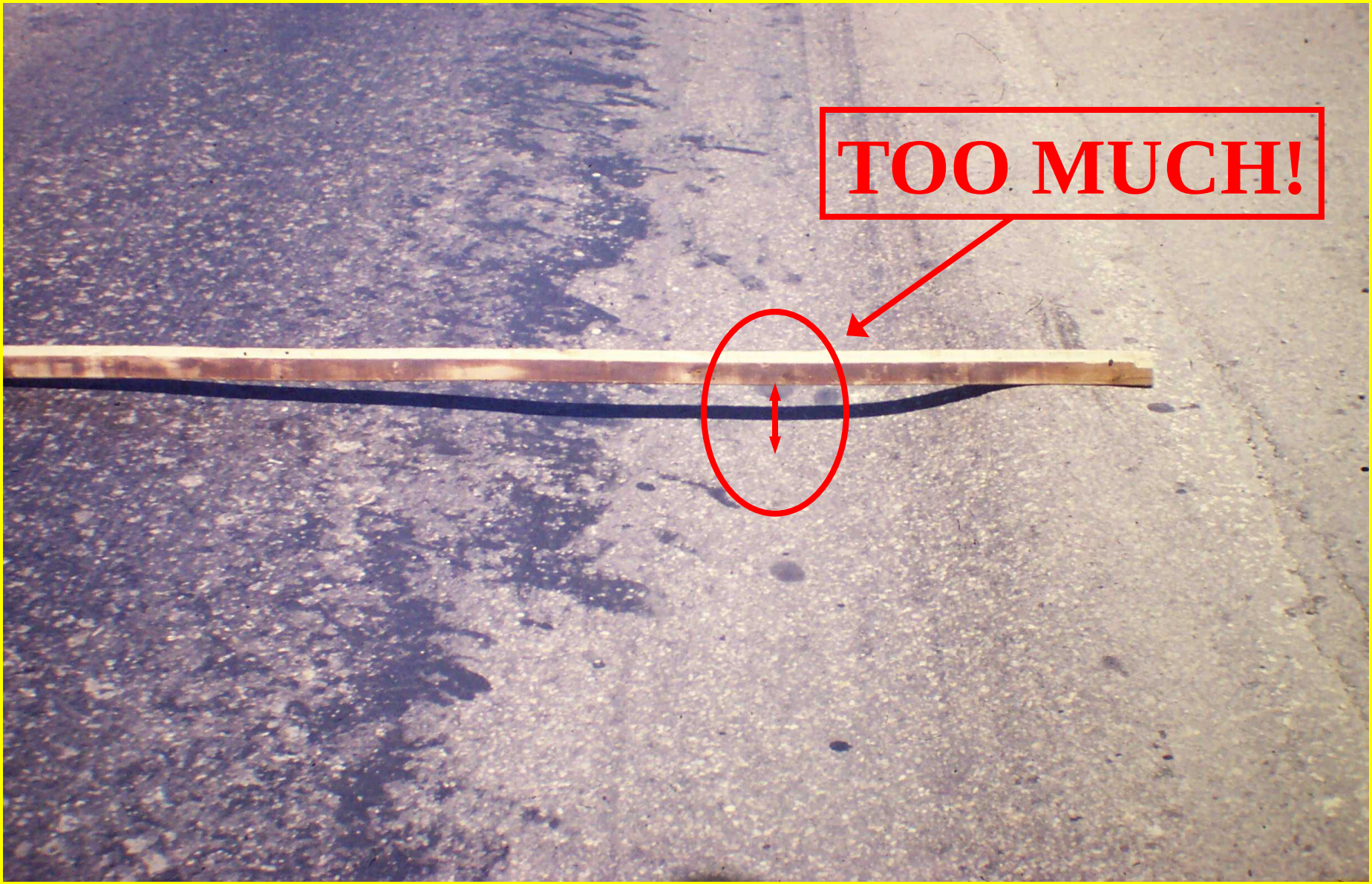
What else is on the agenda for today?

KY's maintenance rating program

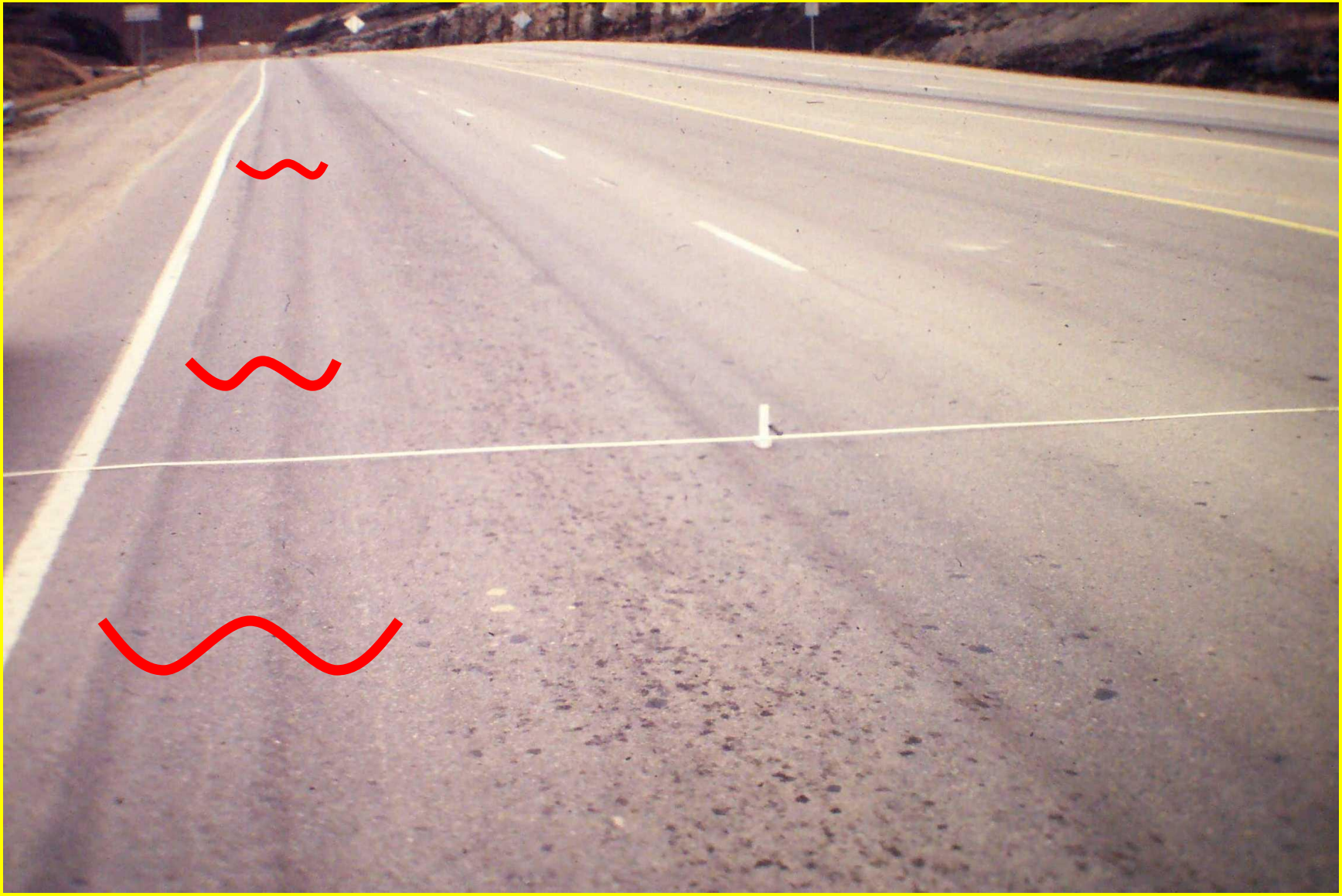
MY GOAL: GOOD UPDATE ON "ALL THINGS MODIFIED ASPHALT" IN KENTUCKY



Why did Kentucky turn to modified binders?



Why did Kentucky turn to modified binders?



Why did Kentucky turn to modified binders?

Obtain asphalt binder sample by scraping in this area

Warrants for use of PG binders

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Warrants for use of PG binders

5. Performance-graded (PG) binder designation

5.1 Determine the PG binder designation from the following table:

20-yr. ESALs	or	ADT	or	Truck percentage	PG binder designation
Mainline pavement with:					
>5.0 x 10^6	or	>30,000	or	>30 percent trucks	PG 76-22
2.5 10^6 to 5 10^6	or	15, to 3 0	or	20 30 perc rucks	PG 22
All other mainline pavement and all shoulder					PG 64-22

Warrants for use of PG binders

5. Performance-graded (PG) binder designation

5.1 Determine the PG binder designation from the following table:

20-yr. ESALs (millions)	or	ADT	or	Truck percentage	PG binder designation
Mainline pavement with:					
≥3.0	or	>20,000	or	>25 percent trucks	PG 76-22
All other mainline pavement and all shoulder					PG 64-22

Matches break in ESAL ranges from AASHTO R 35

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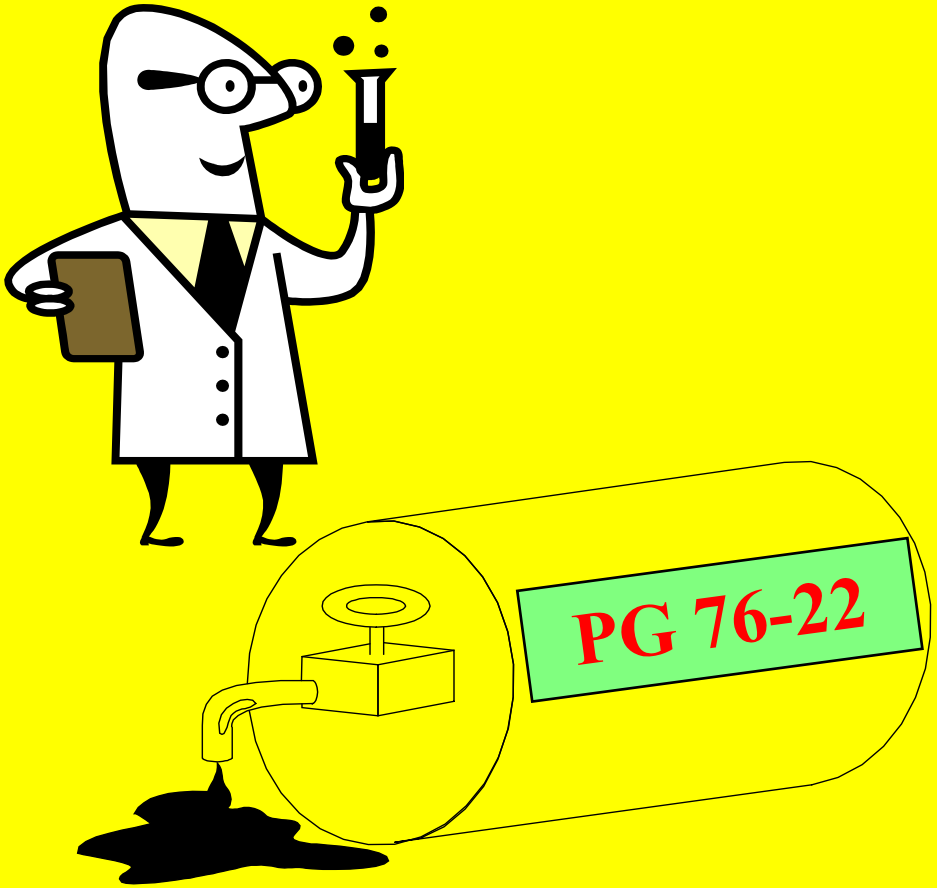
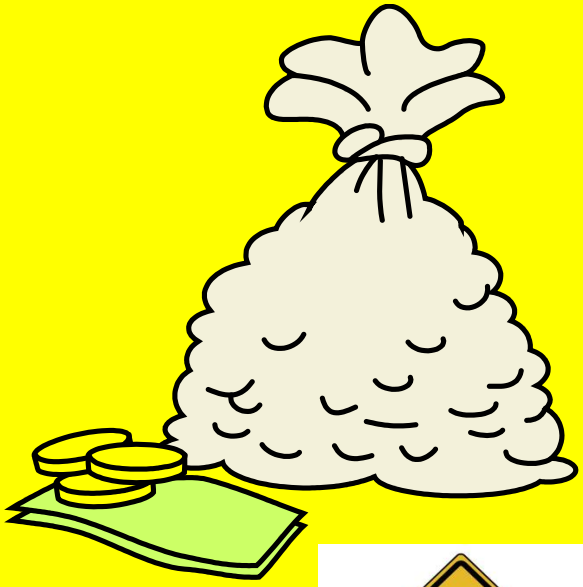
Revise PG binder warrants



- In 2006, Kentucky revised minimum threshold for specifying PG 76-22
  - Change from 3.0 to 7.0 million 20-year ESALs
- Primarily economic decision
  - PG 76-22 was nearly $500 per liquid ton

Revise PG binder warrants

- Information from Kentucky Transportation Center
  - About 20 percent of all routes have 20-year ESALs ≥ 3.0 million
  - About 10 percent of all routes have 20-year ESALs ≥ 7.0 million
- Implementing change should result in specifying approximately half as much PG 76-22 as before
- Using rough estimates, change results in savings of $5 million per year to Department



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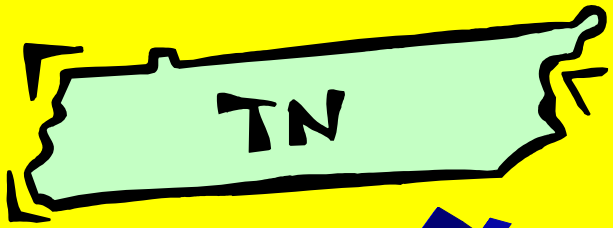
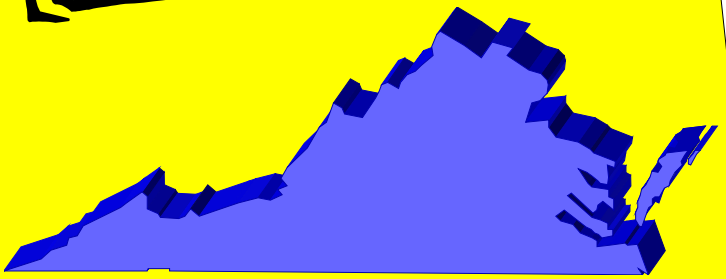
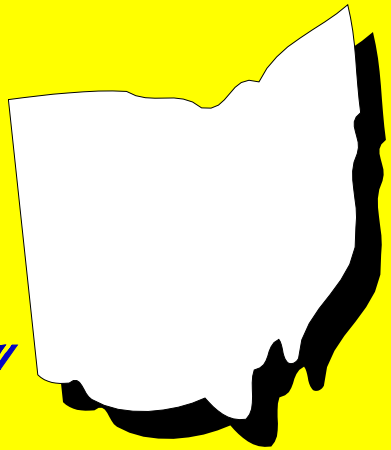
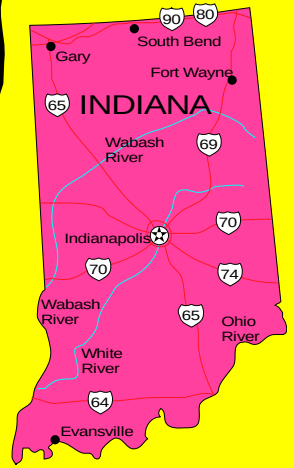
Revise PG binder warrants

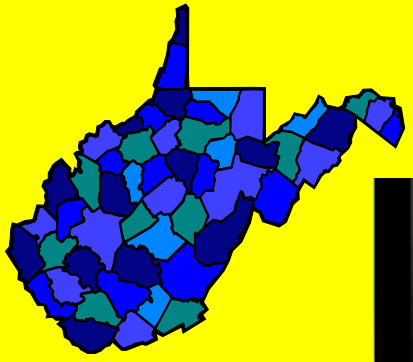
- Abbreviated survey of surrounding states revealed that, even at 7.0 million ESALs, we are likely specifying as much PG 76-22 or more than our neighbors











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Warrants for use of PG binders

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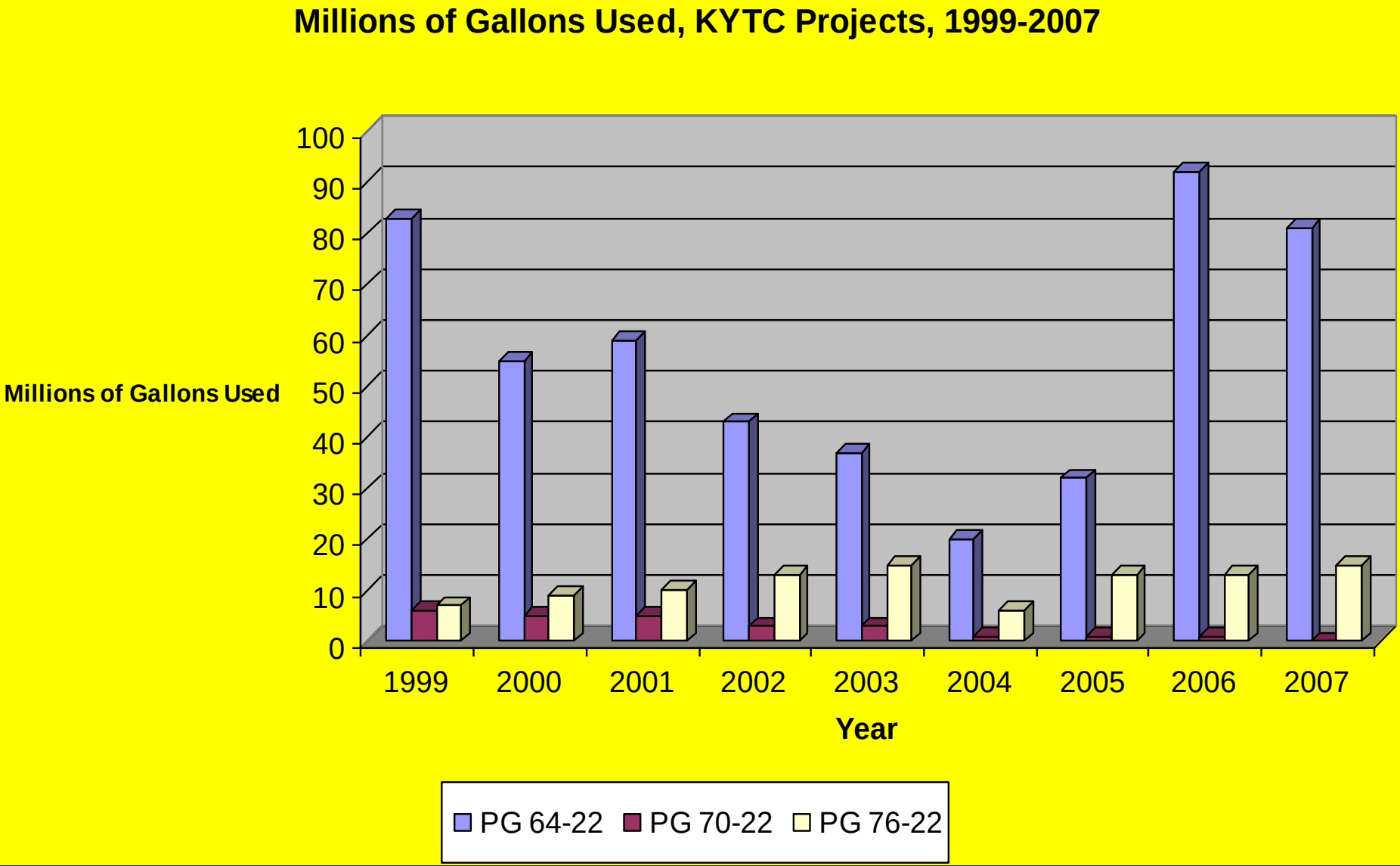
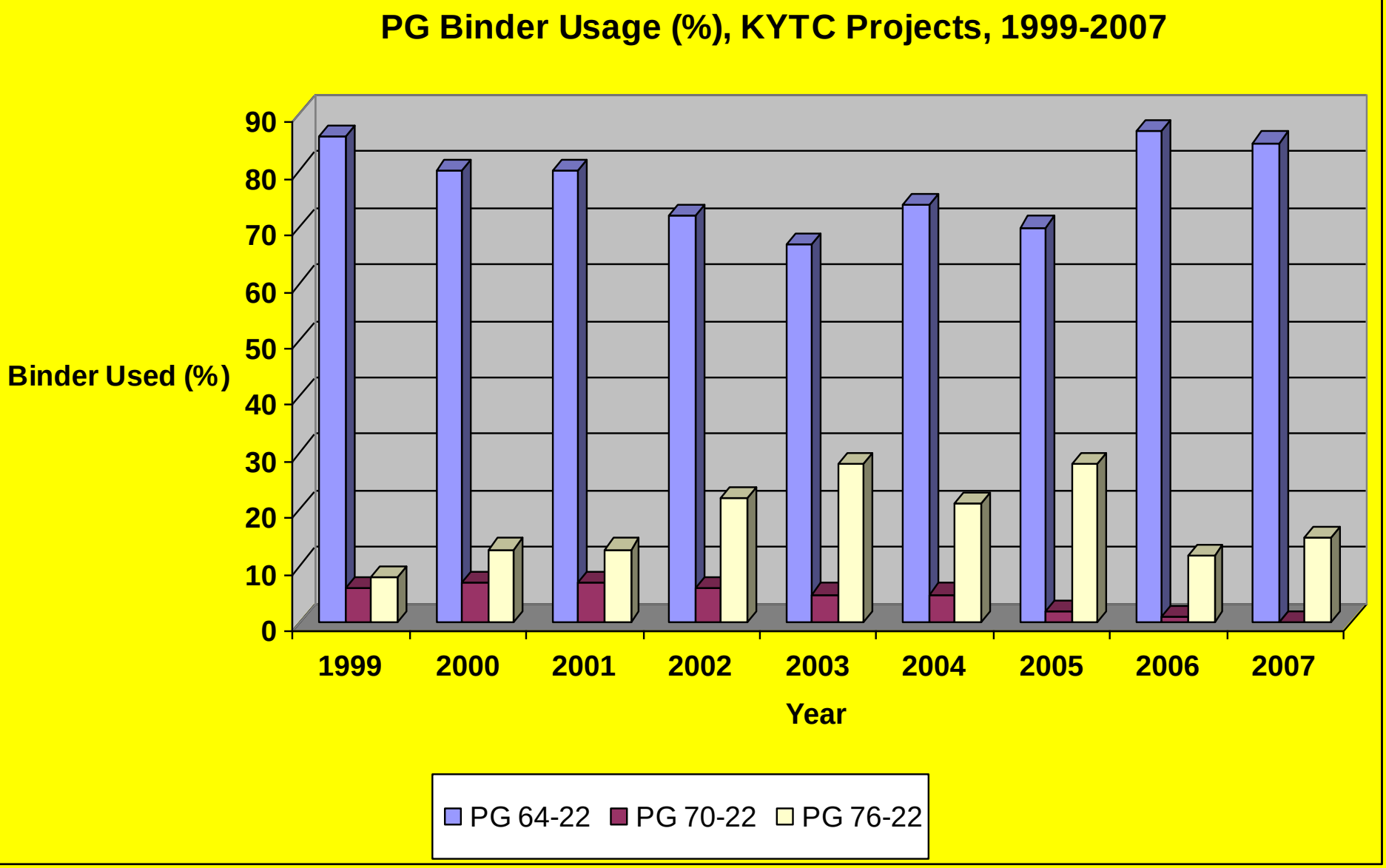
PG Binder Usage Chart (Million Gallons Used)



PG Binder Usage Chart (% Used)



"Different Behavior" of PG 76-22

"Something strange is going on here..."

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"Different Behavior" of PG 76-22

- Kentucky has been pleased with performance of polymer-modified asphalt for many years
  - Rutting and cracking resistance
  - Overcomes numerous other aggregate and mix concerns
- Naturally, when "status quo" is altered, concern arises

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"Different Behavior" of PG 76-22

- In 2005, several projects involving PG 76-22 experienced unusual binder and mix behavior
  - Binder was less viscous, less stringy, and less sticky
  - Theoretical maximum specific gravity samples separated easily

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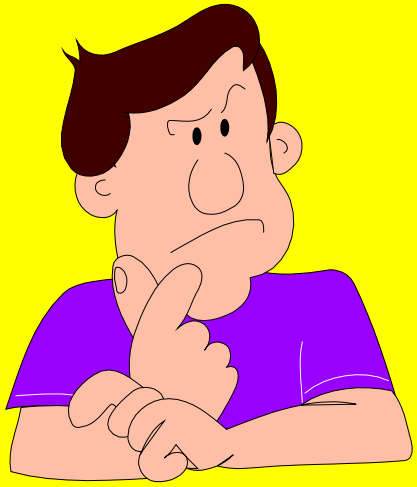
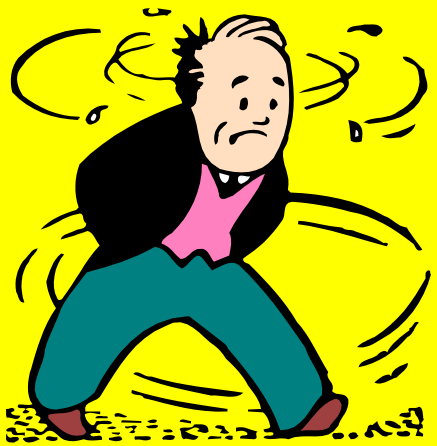
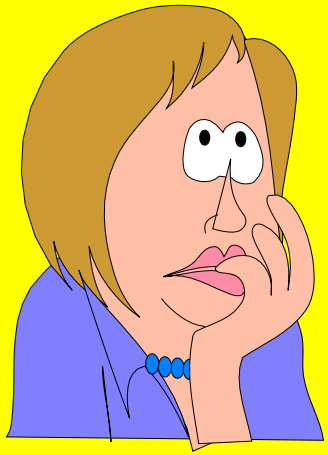
"Different Behavior" of PG 76-22







- In 2005, several projects involving PG 76-22 experienced unusual binder and mix behavior
  - Under compaction, mix exhibited tender characteristics with frequent cracking that would not heal
- Phenomena independently corroborated by multiple sources

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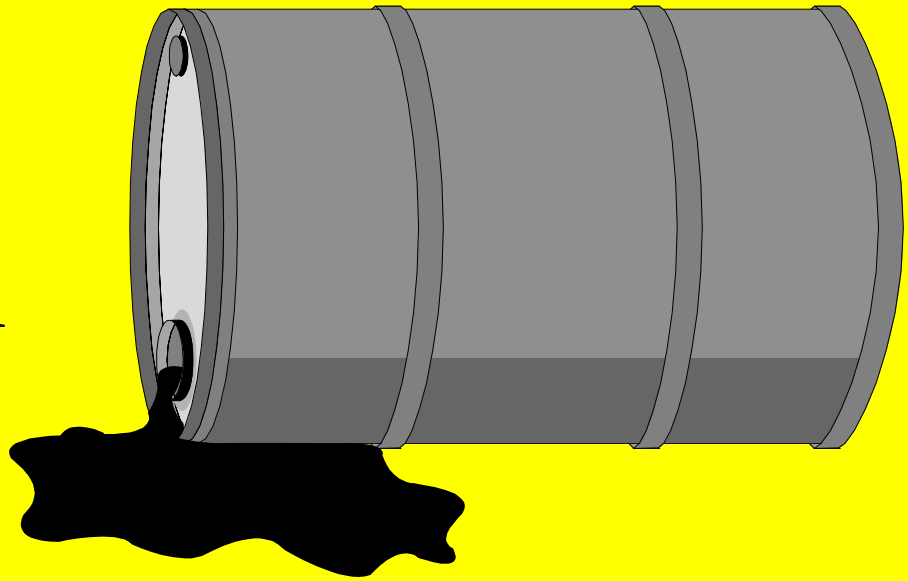
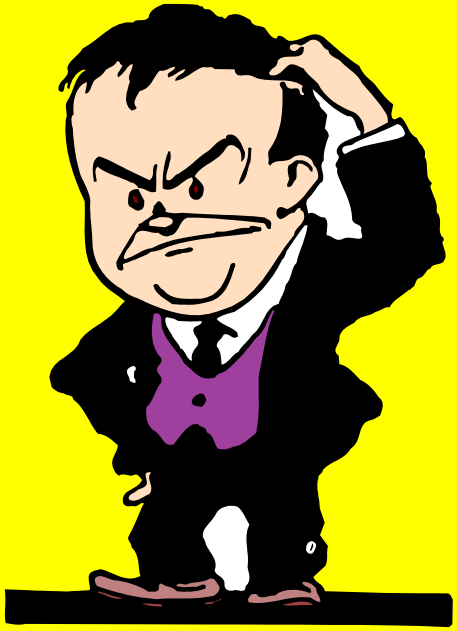
"Different Behavior" of PG 76-22

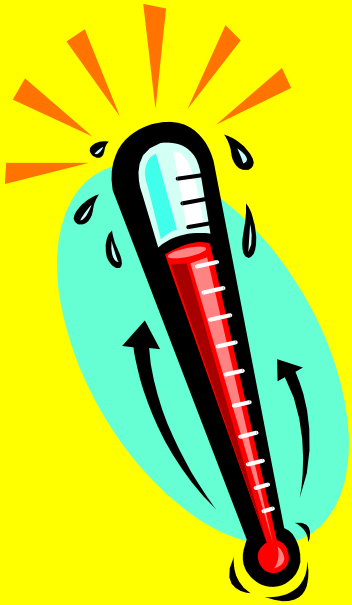
- Different binder suppliers involved
- Binder samples obtained from storage tank at HMA mixing plant for multiple projects in question
- All samples satisfied specifications for PG 76-22



"Different Behavior" of PG 76-22



- Few occurrences of "tender zone" in Kentucky even when topic was the "rage," but now. . .
- Change in formulation of some PG 76-22 binders?
  - Less polymer?
  - Polyphosphoric acid?
- Standard mixing and compaction temperatures for PG 76-22 too high?



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Increased Durability Research

"Let's keep those black pavements black!"

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Increased Durability Research

- In 2004, Kentucky Transportation Center launched research study
- Objective was to achieve greater durability in HMA pavements
- Based on idea from NCAT's test track
- HMA containing modified binder may not densify as readily under traffic

NCAT Pavement Test Track

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Increased Durability Research

- Increased asphalt binder content (AC) for projects with HMA containing modified PG 76-22
- Approximately 10 experimental projects constructed
- Control (optimum AC) and test (optimum AC + 0.3 %) sections included

Increased Durability Research

- No early distresses noted
- Long-term evaluation continues
- Goal is modified specification
  - HMA containing PG 76-22
  - Additional asphalt binder
  - Lower target air-void content?

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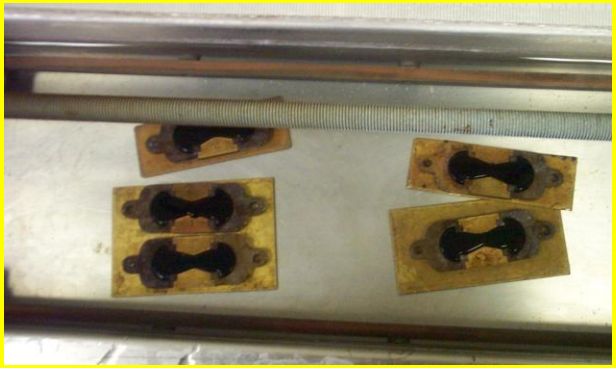
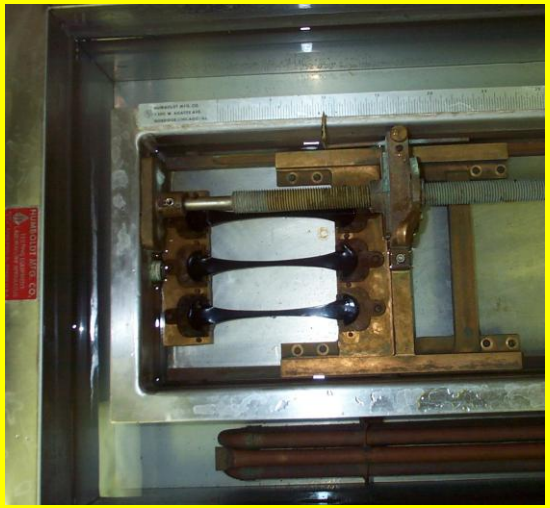
Elastic Recovery (ER) Unification

"Why can't we just keep it simple?"





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Elastic Recovery (ER) Unification

- Campaign within Southeastern Asphalt User/Producer Group (SEAUPG)
- Approximately nine SEAUPG member states specify ER test
- Various methods utilized
  - AASHTO T 301
  - ASTM D 6084
  - Numerous state variations

Elastic Recovery (ER) Test Parameters

CRITICAL TEST PARAMETERS		
	Test Options	KY Method
Tested binder	Original or RTFO	RTFO
Mold Geometry	Straight side or "V" side	"V" side
Test Temperature	10°C or 25°C	25°C
Elongation	10 cm or 20 cm	10 cm
Hold time	None or 5 min	5 min

KY requires minimum of 75 % ER for PG 76-22

Elastic Recovery (ER) Test Parameters

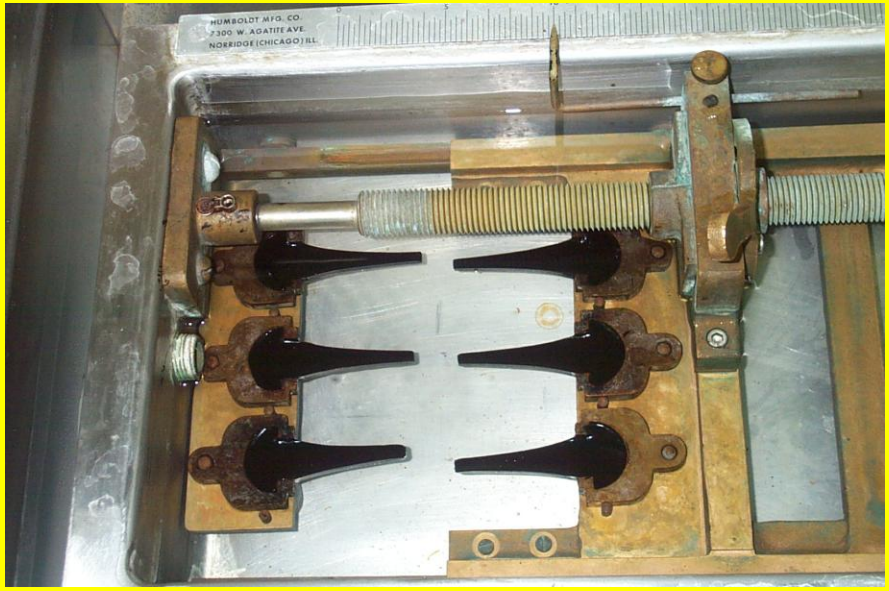
SEAUPG Recommendations

CRITICAL TEST PARAMETERS		
	Test Options	KY Method
Tested binder	Original or RTFO	RTFO
Mold Geometry	Straight side or "V" side	"V" side
Test Temperature	10°C or 25°C	25°C
Elongation	10 cm or 20 cm	1 cm
Hold time	None or 5 min	5 min

Elastic Recovery (ER) Test Results

- Approximately 30 samples of PG 76-22 from various suppliers tested for ER with both sets of parameters
  - Average ER by SEAUPG recommendations was 83 percent
  - Average ER by KY method was 78 percent
  - Current KY method is lower by average of 5 percent

Elastic Recovery (ER) Test Results



- Kentucky is agreeable to adopting SEAUPG recommendations
- If ER test procedure is modified, minimum ER specification will likewise need adjustment
  - Increase from 75 to 80 percent
  - Ensure same material as currently receiving

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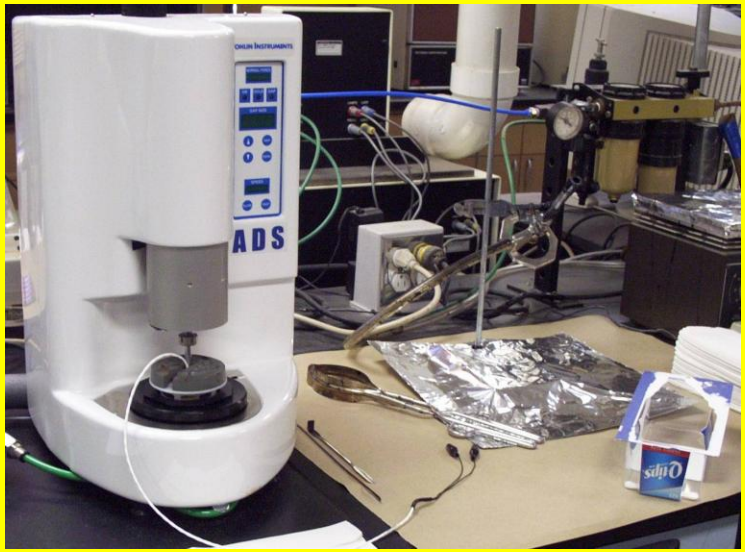
Multiple Stress Creep Recovery (MSCR) Testing

"I teach Daddy a lot about multiple stress levels."



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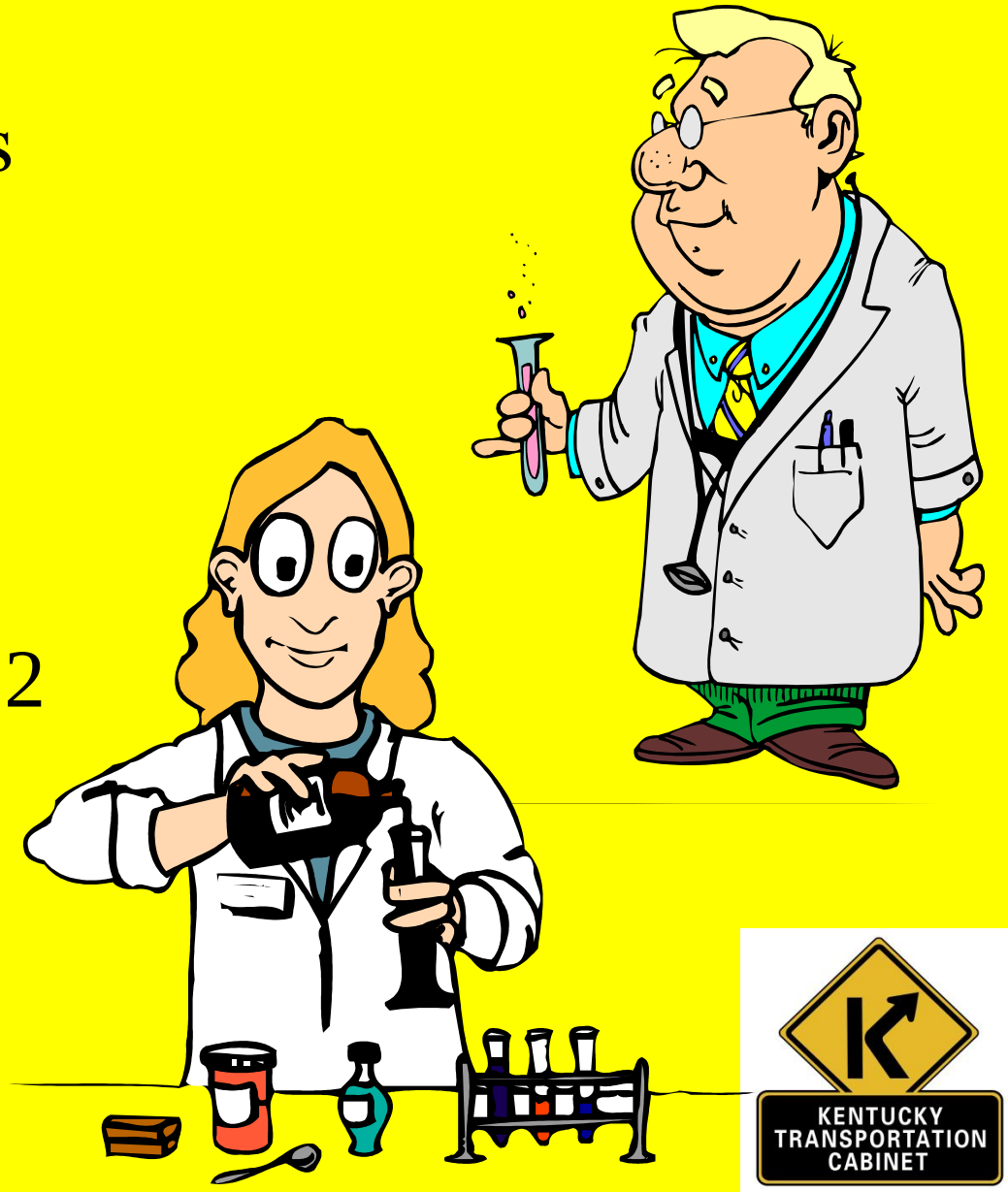
Multiple Stress Creep Recovery (MSCR) Testing

- Potential alternate to "PG plus" tests such as elastic recovery
- MSCR yields non-recoverable creep compliance (J_{nr}) value
- 36 samples of PG 76-22 from various suppliers tested for elastic recovery (using KY method) and MSCR



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Multiple Stress Creep Recovery (MSCR) Testing

Elastic Recovery (by KY method)

Average value = 78 %

Standard deviation = 4.5 %

29 of 36 samples ≥ 75 %

J_{nr} value from MSCR test at 76°C

Average value = 0.164

Standard deviation = 0.043

Multiple Stress Creep Recovery (MSCR) Testing

Proposed High-Temperature Spec

$J_{nr} \leq 0.4$ for standard traffic

$J_{nr} \leq 0.2$ for heavy traffic

$J_{nr} \leq 0.1$ for very heavy traffic

KY data

KY average J_{nr} at 76°C = 0.16

$J_{nr} \leq 0.4$ for all 36 samples

$J_{nr} \leq 0.2$ for 31 of 36 samples

$J_{nr} \leq 0.1$ for 3 of 36 samples

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Multiple Stress Creep Recovery (MSCR) Testing

- How do definitions of "standard," "heavy," and "very heavy" traffic correspond to KY's normal ESAL ranges?
- J_{nr} values should improve when tested at environmental grade temperature (64ºC)
- Will today's formulations for PG 76-22 satisfy MSCR requirement "as is?"

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KY's Maintenance Rating Program (MRP)

"Daddy says that rutting is 'ancient history' when we use modified binders."

"In fact, it's 'prehistoric.'"

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KY's Maintenance Rating Program (MRP)

- Kentucky's MRP
  - Performance measurements of highway infrastructure data
  - Support management decisions regarding maintenance resources
  - View business in terms of customer requirements and expectations
- MRP score based on 0 to 100 scale
  - 90 to 100 score corresponds to Level of Service "A - Excellent"
  - 23 total categories

KY's Maintenance Rating Program (MRP)

Statewide Total Scores FY '03

Feature Description	Score	99% Conf. Range	Level of Service	Weight Factor
Segments with No Reported Rutting of 0.375" or Greater	93.3	92.4 - 94.1	A	3%

Statewide - Interstate MRP Scores FY '08

Feature Description	Score	95% Conf. Range	Level of Service	Weight Factor
Segments with No Reported Rutting of 0.375" or Greater	94.2	91.5 - 96.9	A	5%

FY '03 Interstate score for rutting = 99.4

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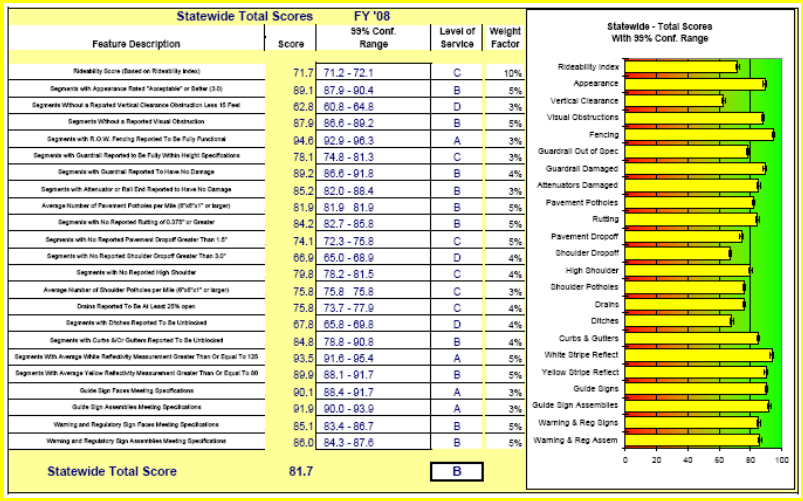
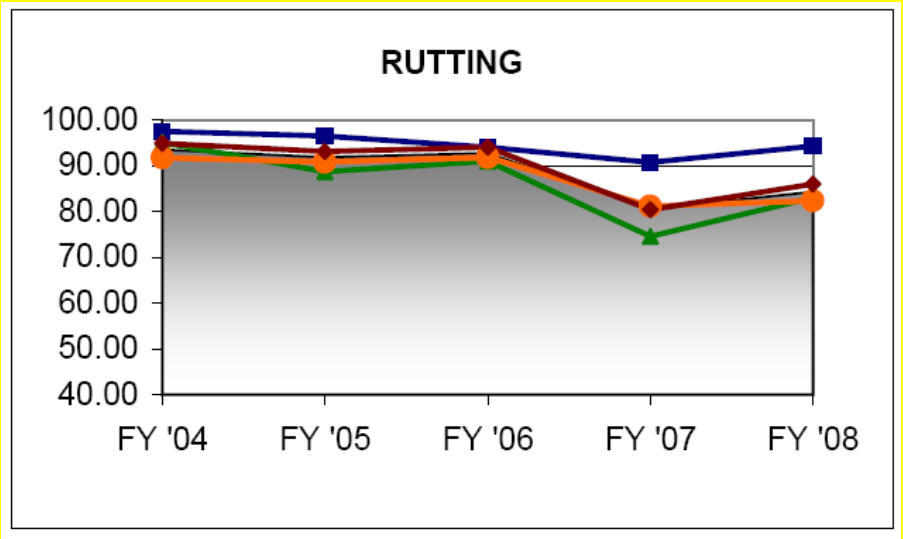
KY's Maintenance Rating Program (MRP)



Statewide Total Scores FY '08

Feature Description	Score	99% Conf. Range	Level of Service	Weight Factor
Rideability Score (Based on Rideability Index)	71.7	71.2 - 72.1	C	10%
Segments with Appearance Rated "Acceptable" or Better (3.0)	89.1	87.9 - 90.4	B	5%
Segments Without a Reported Vertical Clearance Obstruction Less 15 Feet	62.8	60.8 - 64.8	D	3%
Segments Without a Reported Visual Obstruction	87.9	86.6 - 89.2	B	5%
Segments with R.O.W. Fencing Reported To Be Fully Functional	94.6	92.9 - 96.3	A	3%
Segments with Guardrail Reported to Be Fully Within Height Specifications	78.1	74.8 - 81.3	C	3%
Segments with Guardrail Reported To Have No Damage	89.2	86.6 - 91.8	B	4%
Segments with Attenuator or Rail End Reported to Have No Damage	85.2	82.0 - 88.4	B	3%
Average Number of Pavement Potholes per Mile (6'x6'x1" or larger)	81.9	81.9 - 81.9	B	5%
Segments with No Reported Rutting of 0.375" or Greater	84.2	82.7 - 85.8	B	5%
Segments with No Reported Pavement Dropoff Greater Than 1.5"	74.1	72.3 - 75.8	C	5%
Segments with No Reported Shoulder Dropoff Greater Than 3.0"	66.9	65.0 - 68.9	D	4%
Segments with No Reported High Shoulder	79.8	78.2 - 81.5	C	4%
Average Number of Shoulder Potholes per Mile (6'x6'x1" or larger)	75.8	75.8 - 75.8	C	3%
Drains Reported To Be At Least 25% open	75.8	73.7 - 77.9	C	4%
Segments with Ditches Reported To Be Unblocked	67.8	65.8 - 69.8	D	4%
Segments with Curbs &/Or Gutters Reported To Be Unblocked	84.8	78.8 - 90.8	B	4%
Segments With Average White Reflectivity Measurement Greater Than Or Equal To 125	93.5	91.6 - 95.4	A	5%
Segments With Average Yellow Reflectivity Measurement Greater Than Or Equal To 80	89.9	88.1 - 91.7	B	5%
Guide Sign Faces Meeting Specifications	90.1	88.4 - 91.7	A	3%
Guide Sign Assemblies Meeting Specifications	91.9	90.0 - 93.9	A	3%
Warning and Regulatory Sign Faces Meeting Specifications	85.1	83.4 - 86.7	B	5%
Warning and Regulatory Sign Assemblies Meeting Specifications	86.0	84.3 - 87.6	B	5%
Statewide Total Score	81.7		B	



- Recent data from Kentucky's MRP indicate that rutting is somewhat increased
  - Specifying less PG 76-22 due to budgetary concerns
  - Change from 0.50-in. to 0.38-in. nominal surface due to permeability concerns
  - "Different behavior" and characteristics of PG 76-22 recently?

Why did Kentucky turn to modified binders?

- 20-year ESAL values for US 23 in eastern KY
  - Coal-haul route
  - Portions routinely over 120 million ESALs
  - Most heavily loaded section has 205 million ESALs
- Some coal trucks in Kentucky are reportedly loaded at or above 200,000 pounds

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Why did Kentucky turn to modified binders?

Association of Modified Asphalt Producers
9th Annual Meeting

Allen H. Myers

Division of Materials,
Asphalt Branch

Phone: 502-564-3160

Fax: 502-564-7034

E-Mail: Allen.Myers@ky.gov

"Thanks for listening to my Daddy drone on about asphalt."

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