Association of Modified Asphalt Producers (Feb. 1, 2005)

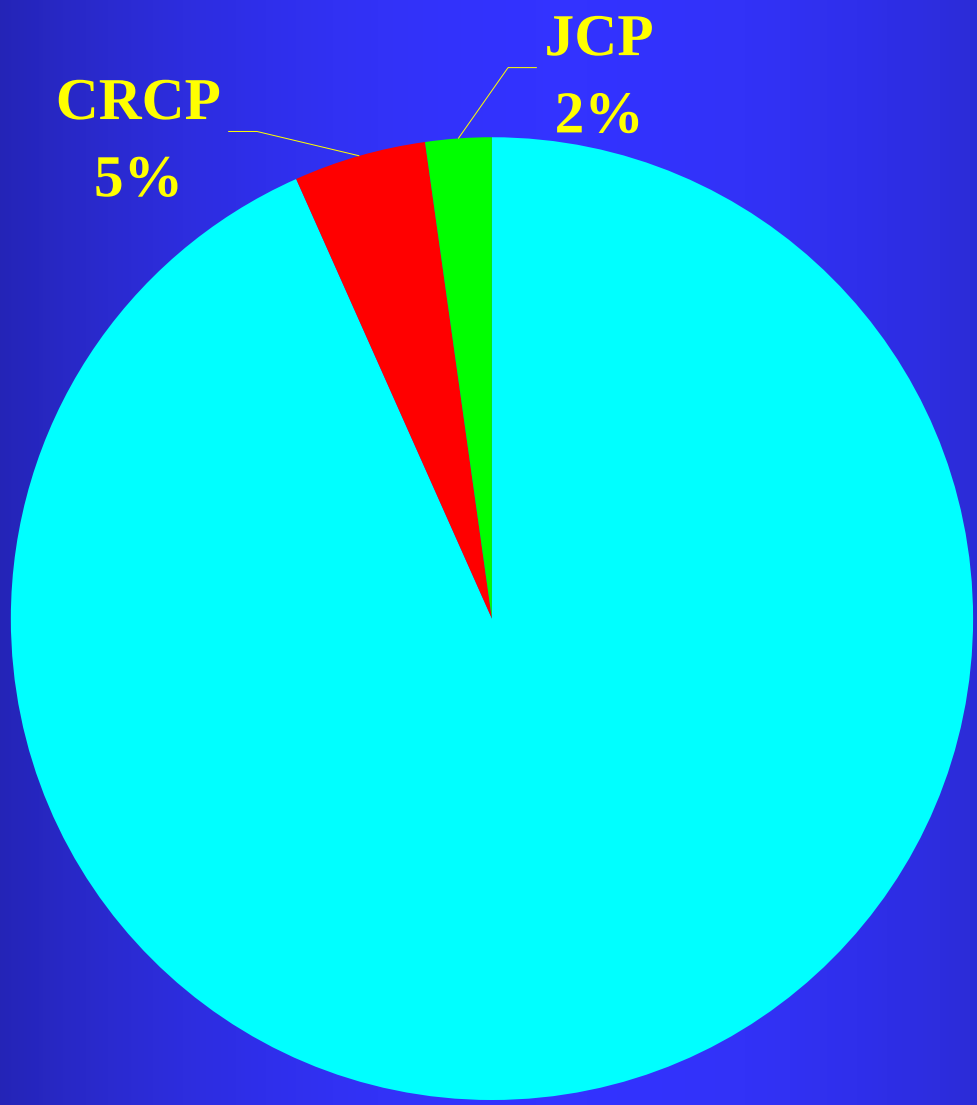
TxDOT's Specifications to Predict Performance

Texas Department of Transportation

Darren G. Hazlett, P.E.

TxDOT Construction Division

Texas Highways
Pavement Types, Lane Miles



Represents over 79,000 center lane miles

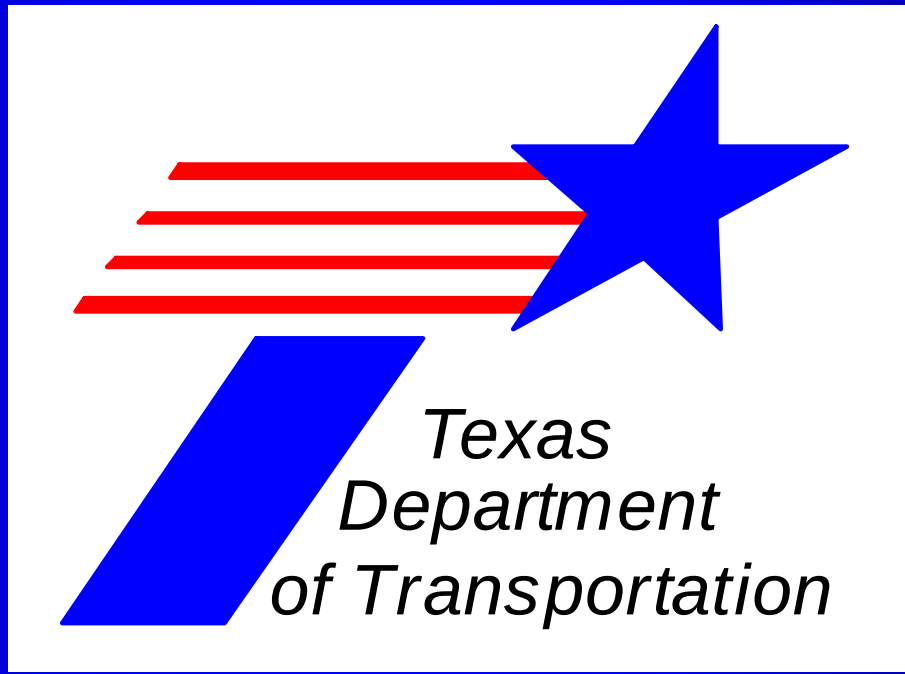
Source: 2003 PMIS Report

Texas Department of Transportation

Presentation Topics

- Hamburg Wheel Track Testing.
- Permeable Friction Course.
- Binders.

Hamburg Wheel Test
TxDOT Summary



DaleA. Rand, P.E.

as modified by Darren Hazlett, P.E.

TxDOT Construction Division

In the Past

- Up until the late 1990's TxDOT was experiencing approximately 3 premature failures per year related to stripping and/or rutting.
- Conventional tests such as Lottman, Hveem Stability, Boil Test, Static Creep etc did not show a very good correlation with performance. Mixes would pass all of these tests yet fail on the roadway.
- Two extensive field studies showed that AASHTO T-283 (Tex-531-C) did a poor job identifying mixtures susceptible to moisture damage.
  - CTR Study: 8 TxDOT Districts, 92 test sections
  - TTI Study: 3 Districts, over 35 pavements

The Present

- Hamburg Wheel Track testing has increased dramatically
- Stripping and rutting problems have decreased dramatically
- The Hamburg Wheel has proven to be the best identifier of mixtures susceptible to premature failure

The Future: Effective with the TxDOT 2004 Specification Book

- Hamburg Wheel Track testing will be used as a screening tool on all mixture designs and during production
- AASHTO T283 (Tex-531-C) will no longer be used on TxDOT projects
- Hveem Stability and Static Creep tests will no longer be used on TxDOT projects

TxDOT RESEARCH

A Follow-Up Evaluation of Hot Mix Pavement Performance in Northeast Texas

M. Tahmoressi and T. Scullion, Report 4104-1, Texas Transportation Institute, Texas A&M, College Station,, 2002

- Hamburg indicated effectiveness of anti-stripping agents (lime and liquids) whereas TSR didn't.
- Hamburg performance was related to visual assessments of pavement performance.

Hamburg vs. TSR

Aggregate Type	Additive Type	Tensile Strength Ratio	Hamburg Rut Depth (mm)	Visual Perf. Rating
Gravel	Lime	0.91	2.9	90
Gravel	Liquid	0.82	29.3	76
Gravel	None	0.99	18.2	58
Limestone	Liquid	0.86	7.9	90
Limestone	None	0.98	27.7	70

Hamburg vs. VPR

Avg. Hamburg rut @ 20,000 cycles, mm	Visual Performance Rating
2.2	87.3
8.6	80.0
32.0	65.8

Precision of the Moisture Susceptibility Test Method Tex 531-C: Research Report

M. Solaimanian and T. W. Kennedy, Report No. 7-4909-1, Center for Transportation Research, University of Texas at Austin, 2000.

- Tex 531-C is similar to AASHTO (T-283) Lottman.
- Poor reproducibility for mixes with lime additives.
- Better for mixes with liquid additives.
- Test is sensitive to specimen preparation.

Long-term Evaluation of Stripping and Moisture Damage in Asphalt Pavements Treated with Lime and Anti-Stripping Agents

M. Solaimanian, T. W. Kennedy and W. E. Elmore, Report No. 1286-1F, Center for Transportation Research, University of Texas at Austin, 2000.

- TSR is not related to field performance.
- TSR test results do not indicate any consistent pattern with regard to effectiveness of certain anti-stripping additives versus others.

In Texas We…..

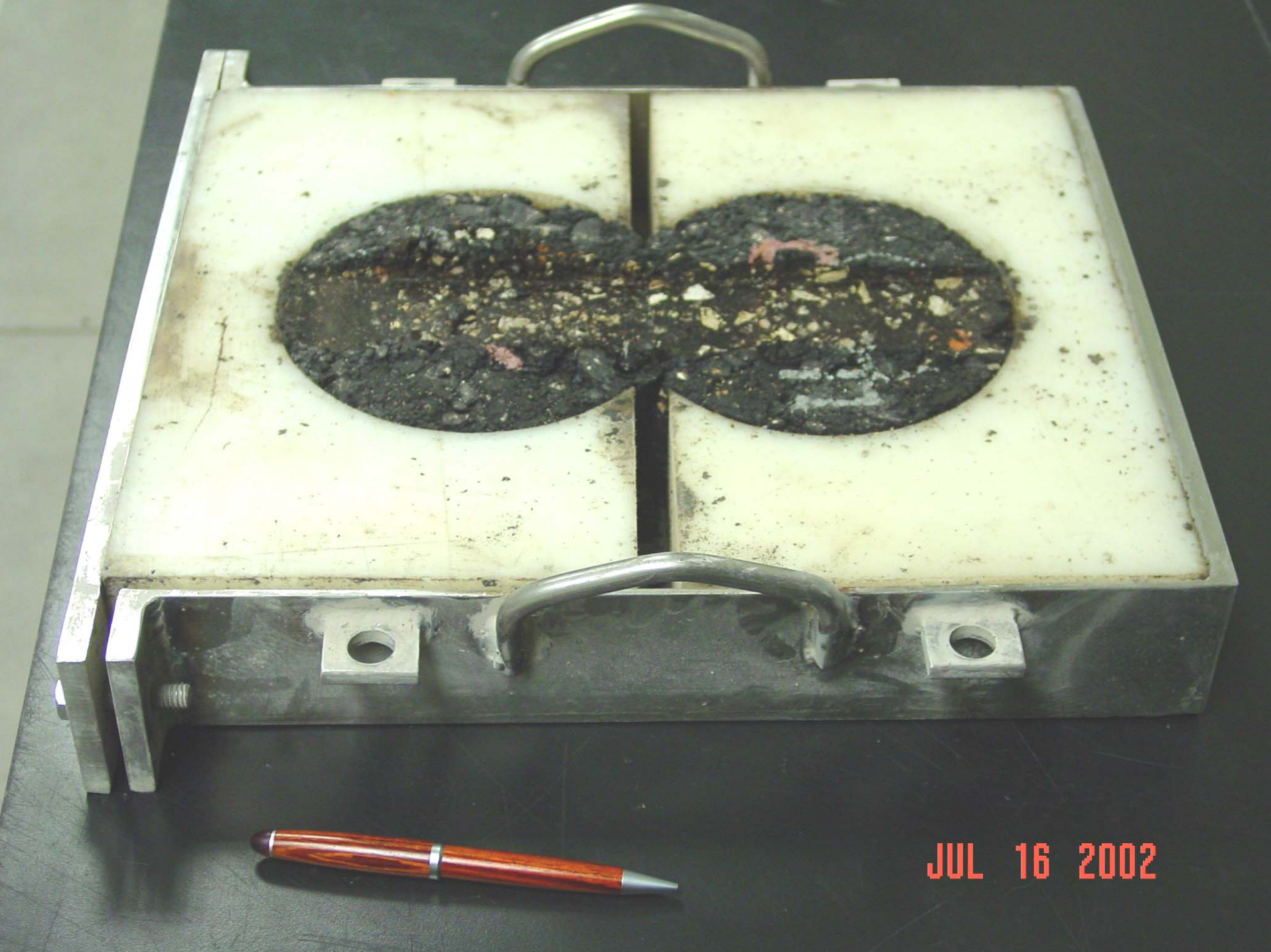
- Use about 12 million tons of hot mix per year
- Have over 100 aggregate sources for hot mix
- Have over 10 asphalt suppliers
  - Unmodified, Air Blown, SBS, SBR, Tire Rubber (TR) Elvaloy, Crumb Rubber (CRM) etc
- Use Lime and liquid as anti-strip agents
- Use numerous types of mixes
  - Dense graded, Superpave, SMA, Stone filled, CMHB, OGFC, PFC etc

“ Think of the number of possible combinations ……are all these materials compatible?”

Why We Like Hamburg Testing

- It shows us what we tend to see in the field
- The results are logical….. Better materials produce better results
- It gives you a very good visual image unlike most other tests

Hamburg (PMW) Wheel-Tracking Device


JUL 16 2002

Famous Quotes

- “One picture is worth a 1,000 words” - anonymous
- “One test is worth a 1,000 expert opinions” - slogan for TxDOT’s Materials Section

Randism

- “A picture of a test must be worth 1,000,000 something……it is at least worth a beer” - Dale A. Rand (circa 2000)

Rutting: 12.5 mm # of Passes: 15,000* Temp: 50C

District: Mix Type: “B” Binder: 64-22

Aggr.: Gravel+ Additive: Lime (1%) ID: 540031

Rutting: 0.7 mm # of Passes: 20,000 Temp: 50C

District: Mix Type: “B” w/14%RAP Binder: 76-22

Aggr.: Sandstone Additive: Lime (1%) ID: 540087

Rutting: 12.5+ mm # of Passes: 4,800* Temp: 50C

District: “Research” Mix Type: “C” Binder: 64-22

Aggr.: Limestone Additive: None ID: 540017

Rutting: 12.5+ mm # of Passes: 6,200* Temp: 50C

District: “Research” Mix Type: CMHB-C Binder: 64-22

Aggr.: Limestone Additive: None ID: 540051

Rutting: 12.5+ mm # of Passes: 13,300* Temp: 50C

District:“Research” Mix Type: CMHB-C Binder: 70-22

Aggr.: Limestone Additive: None ID: 540067

Rutting: 7.2 mm # of Passes: 20,000 Temp: 50C

District: “Research” Mix Type: CMHB-C Binder: 76-22

Aggr.: Limestone Additive: None ID: 540068

What Does the Hamburg Test Tell Us?

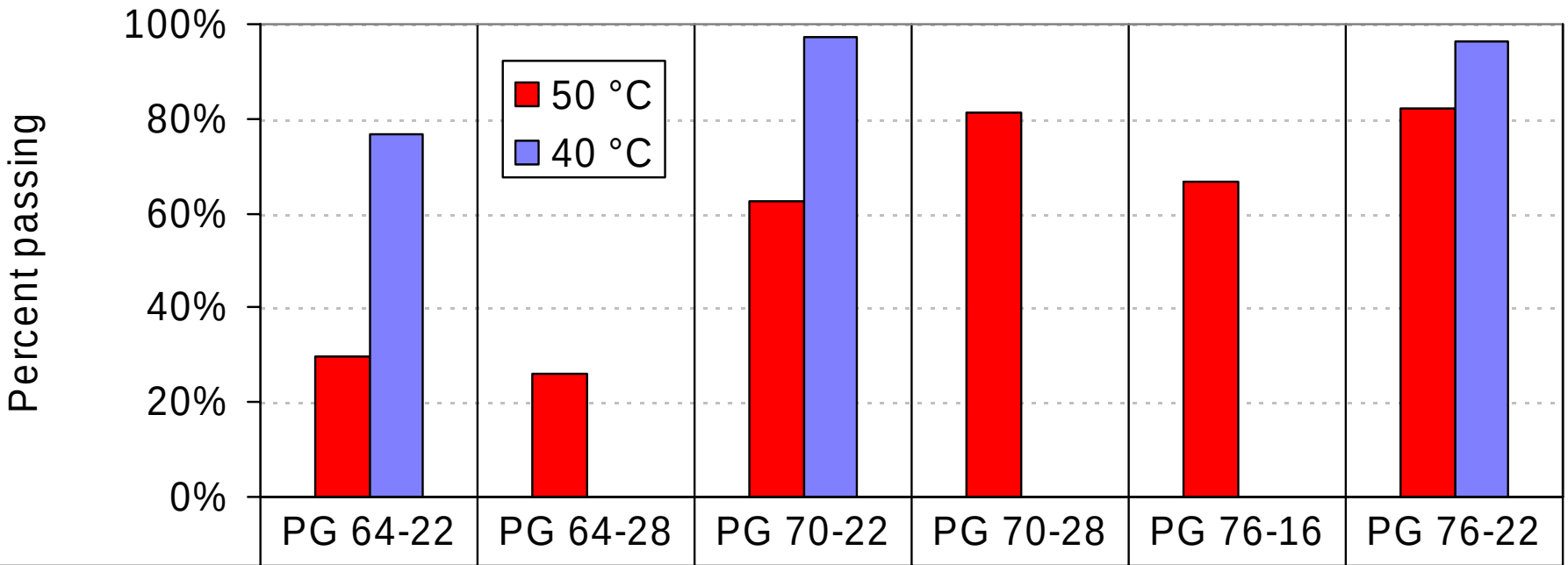
- Dale's Definition: Hamburg is a torture test that is an indicator of a hot mix paving mixture's susceptibility to premature failure that may be attributed to factors including:
  - A weak aggregate structure
  - Inadequate binder stiffness
  - Moisture Damage
  - Inadequate binder to aggregate adhesion
  - Murphy's Law, etc, etc, etc.

Hamburg Test Results

- Approximately 1,500 tests have been performed
- Summary only includes PG graded binders tested at 50 °C (about 850 records). These include mixes with modified binders i.e. SBS, SBR (Latex), Tire rubber
- The summary only includes data where there were more than 5 occurrences of a similar variable (binder grade, test temp, additive, aggregate type, mix type)
- The data includes some duplication - if the same mix failed 10 times, we entered it 10 times
- “The results are unclear but the conclusions are obvious” - Maghsoud Tahmoressi (1995)

Influence of temperature

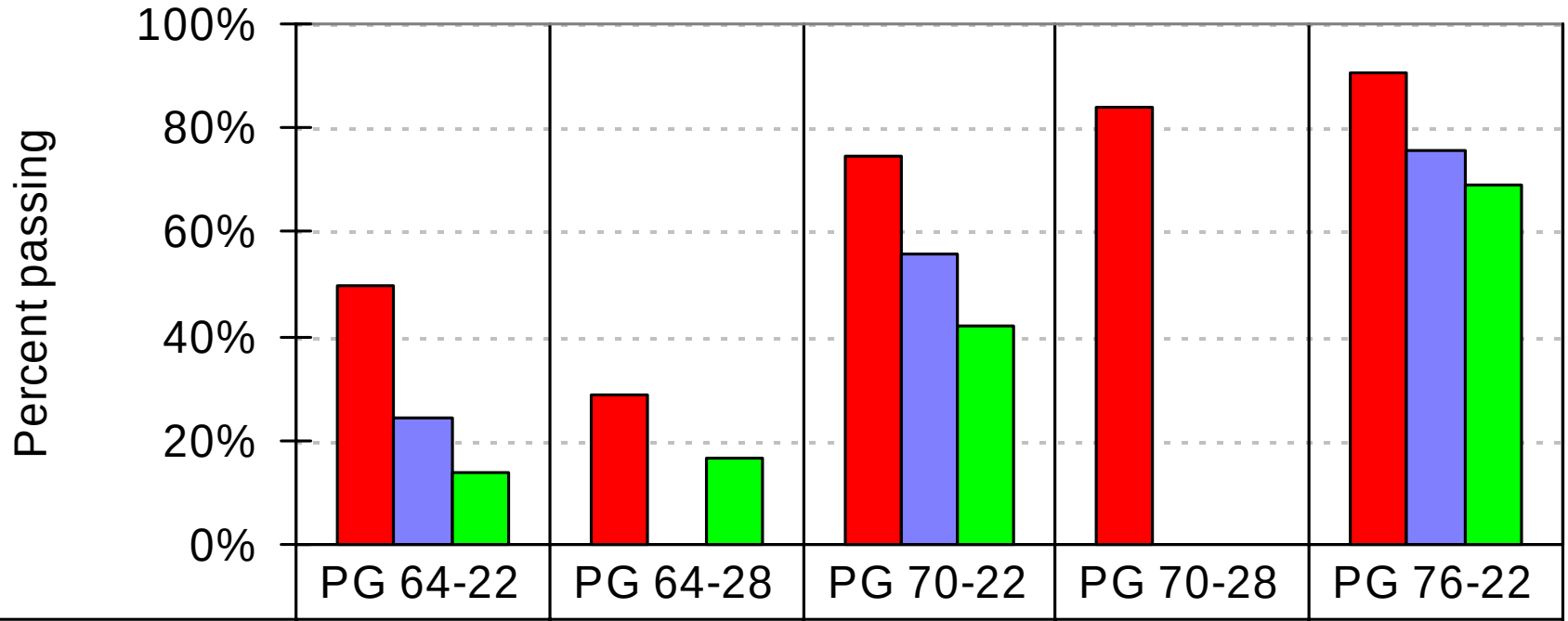
Includes all: additives, aggregate types, mix types



	PG 64-22	PG 64-28	PG 70-22	PG 70-28	PG 76-16	PG 76-22
50 °C	30%	26%	63%	81%	67%	82%
40 °C	77%		97%			96%
Count (50 °C)	169	31	230	27	9	384
Count (40 °C)	64		39			28

Influence of additives @ 50 °C

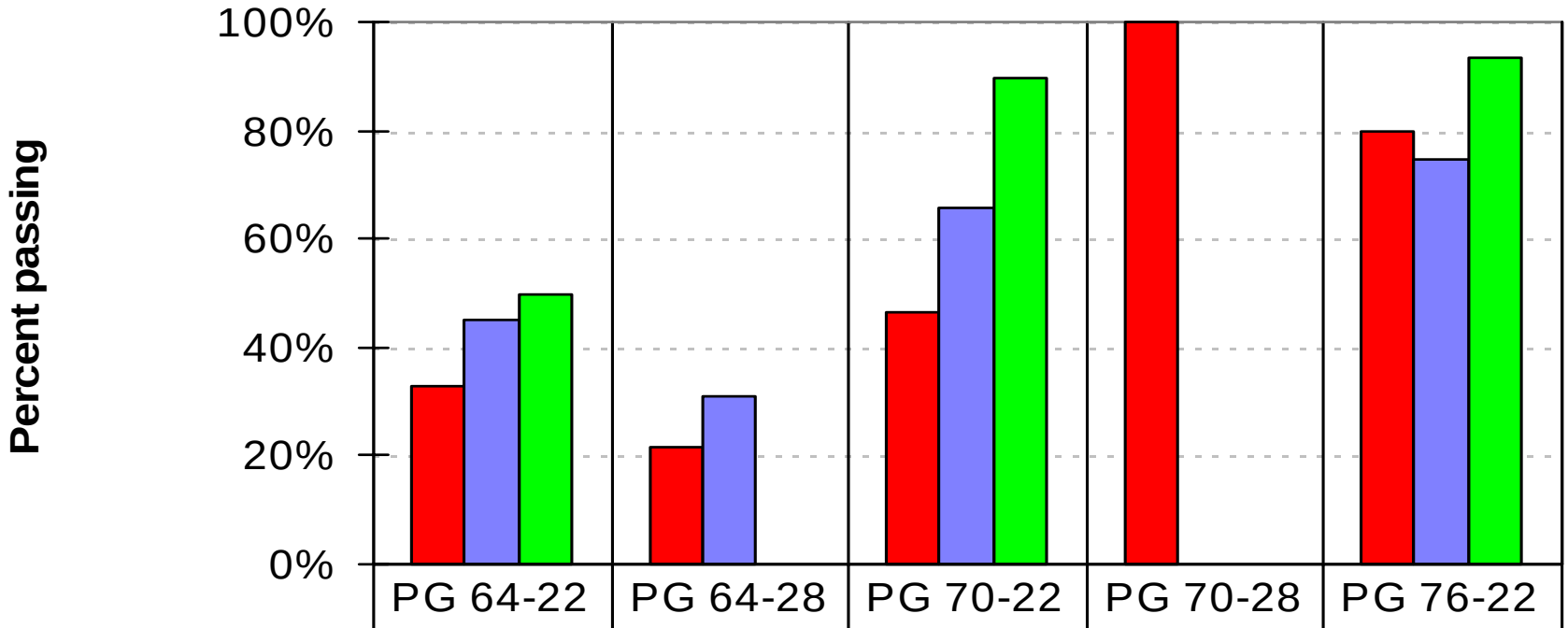
Includes all: aggregate types, mix types



	PG 64-22	PG 64-28	PG 70-22	PG 70-28	PG 76-22
Lime	50%	29%	74%	84%	91%
Liquid	24%		56%		76%
None	14%	17%	42%		69%
Count (Lime)	62	21	113	19	194
Count (Liquid)	41		50		86
Count (None)	50	6	45		78

Influence of aggregate type @ 50 °C

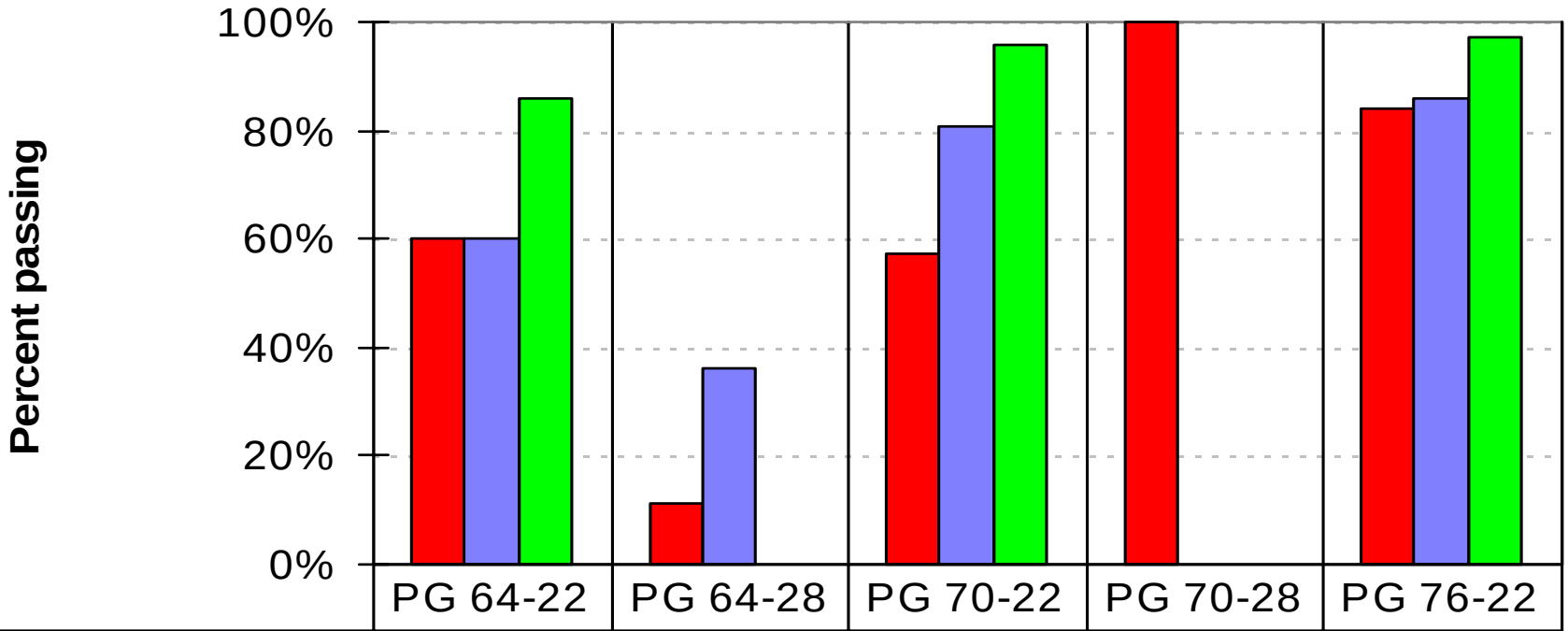
Includes all: additives, mix types



	PG 64-22	PG 64-28	PG 70-22	PG 70-28	PG 76-22
Limestone	33%	21%	46%	100%	80%
Gravel	45%	31%	66%		75%
Igneous	50%		90%		93%
Count (Limestone)	58	14	82	8	125
Count (Gravel)	20	13	35		63
Count (Igneous)	18		29		61

Influence of aggregate type @ 50 °C

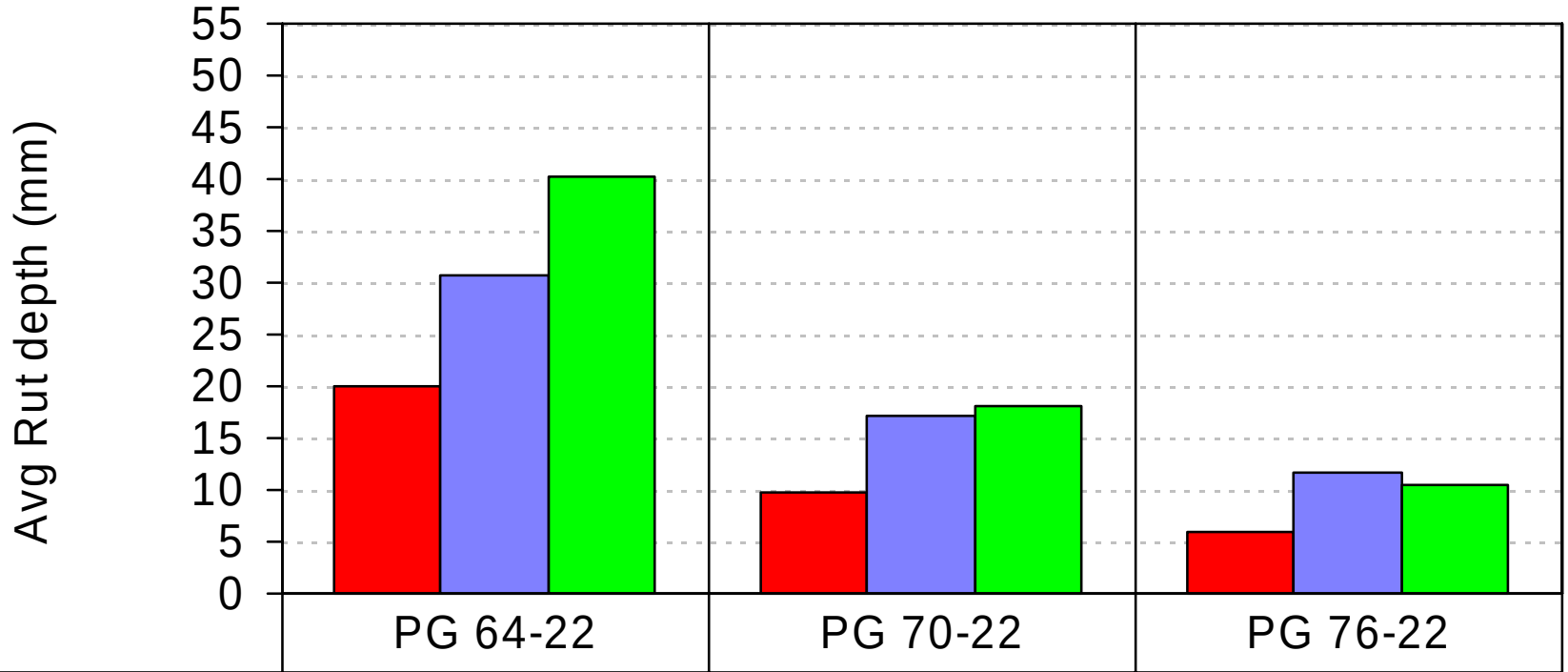
LIME ADDITIVE Includes all mix types



	PG 64-22	PG 64-28	PG 70-22	PG 70-28	PG 76-22
Limestone	60%	11%	57%	100%	84%
Gravel	60%	36%	81%		86%
Igneous	86%		96%		97%
Count (Limestone)	15	9	42	6	56
Count (Gravel)	15	11	21		42
Count (Igneous)	7		23		34

Effect of binder grade and additive type

Includes all: 50 °C, mix types & aggregate types



	PG 64-22	PG 70-22	PG 76-22
Lime	20	10	6
Liquid	31	17	12
None	40	18	10
Count (Lime)	62	113	194
Count (Liquid)	41	50	86
Count (None)	50	45	78

What have we learned about Hamburg testing

- Hamburg does a better job of identifying mixtures that are susceptible to premature failure (Lottman, Hveem, Creep, etc)
- Higher (stiffer) PG grade binders do better
- Adding liquid antistrips or lime usually improves the Hamburg results
- Harder aggregates do better (Igneous -Vs- limestone)
- Stone on stone mixes do better than dense mixes
- There are no absolutes……...
- Do not assume…….. Measure!

Different Aggregate, Same Binder

Rutting: 12.5+ mm # of Passes: 18,900* Temp: 50C

District: W.Falls Mix Type: Stone Filled(0.5) Binder: 76-22

Aggr.: Limestone Additive: Lime (2%) ID: 540010

Rutting: 2.9 mm # of Passes: 20,000 Temp: 50C

District: W.Falls Mix Type: Stone Filled(0.5) Binder: 76-22

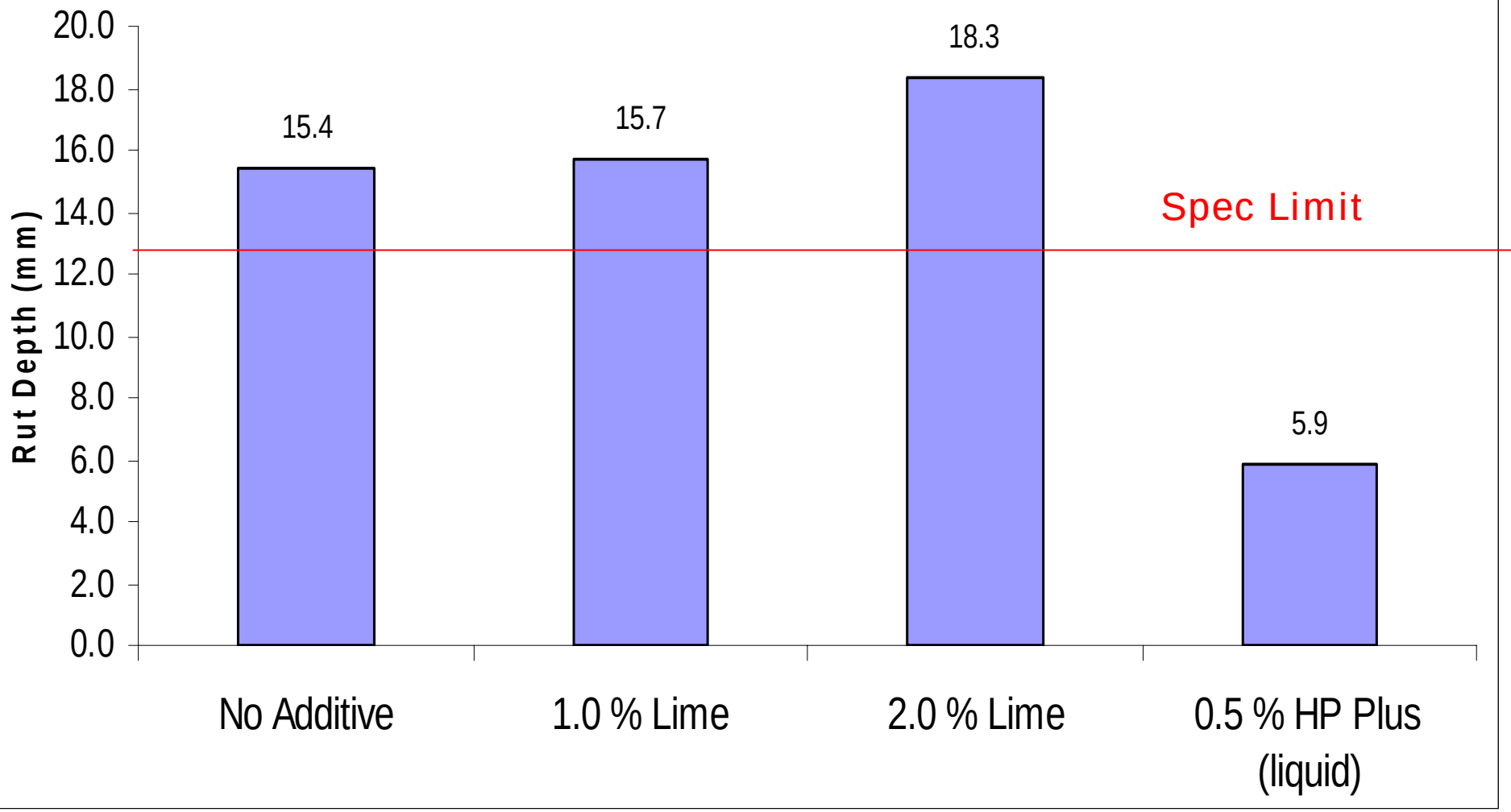
Aggr.: Granite+ Additive: Lime(1%) ID: 540027

Same Mix, Different Treatment

Hamburg Wheel Test Results (20,000 Passes)

Wichita Falls (12.5mm SFHMACP)

Limestone Aggregate with Koch PG 76-22

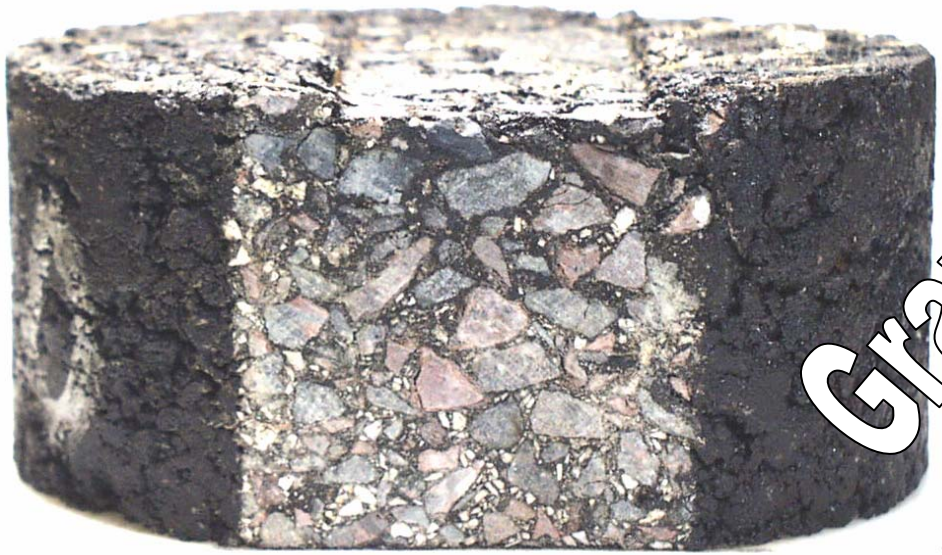


Rutting: 3.4 mm Additive: None

Rutting: 4.1 mm Additive: 1% Lime

Granite

Rutting: 3.2 mm Additive: 0.5% ML

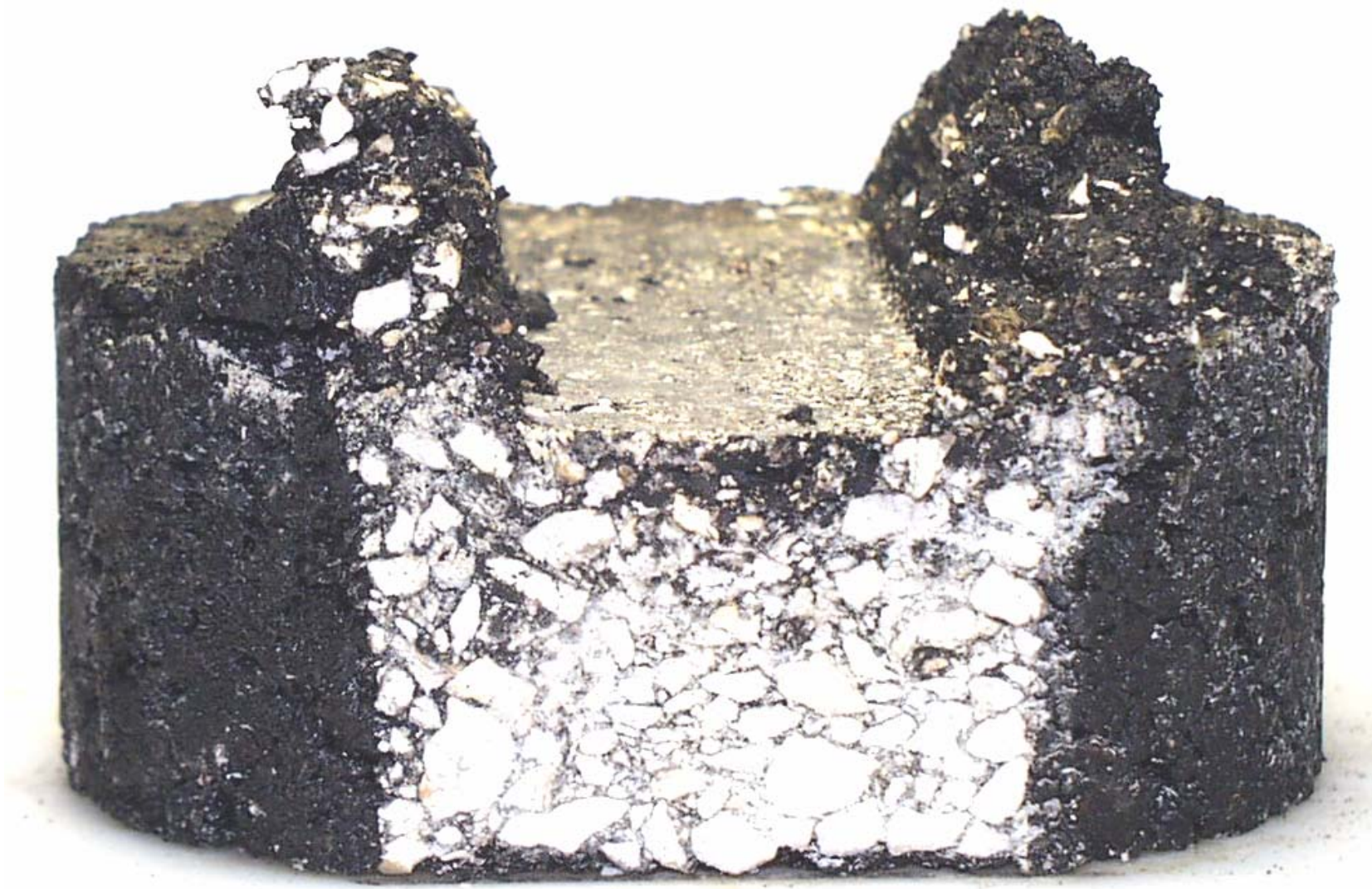


Rutting: 5.5 mm Additive: 0.5% KB

Granite

Same Aggregate, Different Binder Source

Rutting: 12.5 mm # of Passes: 10,200 Temp: 50C



District: Abilene Mix Type: Superpave Binder: **76-22 (Source 1)**

CSJ: 0068-07-046 Aggr.: Limestone Additive: None

ID: 01500318 Lab Mix Notes:

Rutting: 2.8 mm # of Passes: 20,000 Temp: 50C

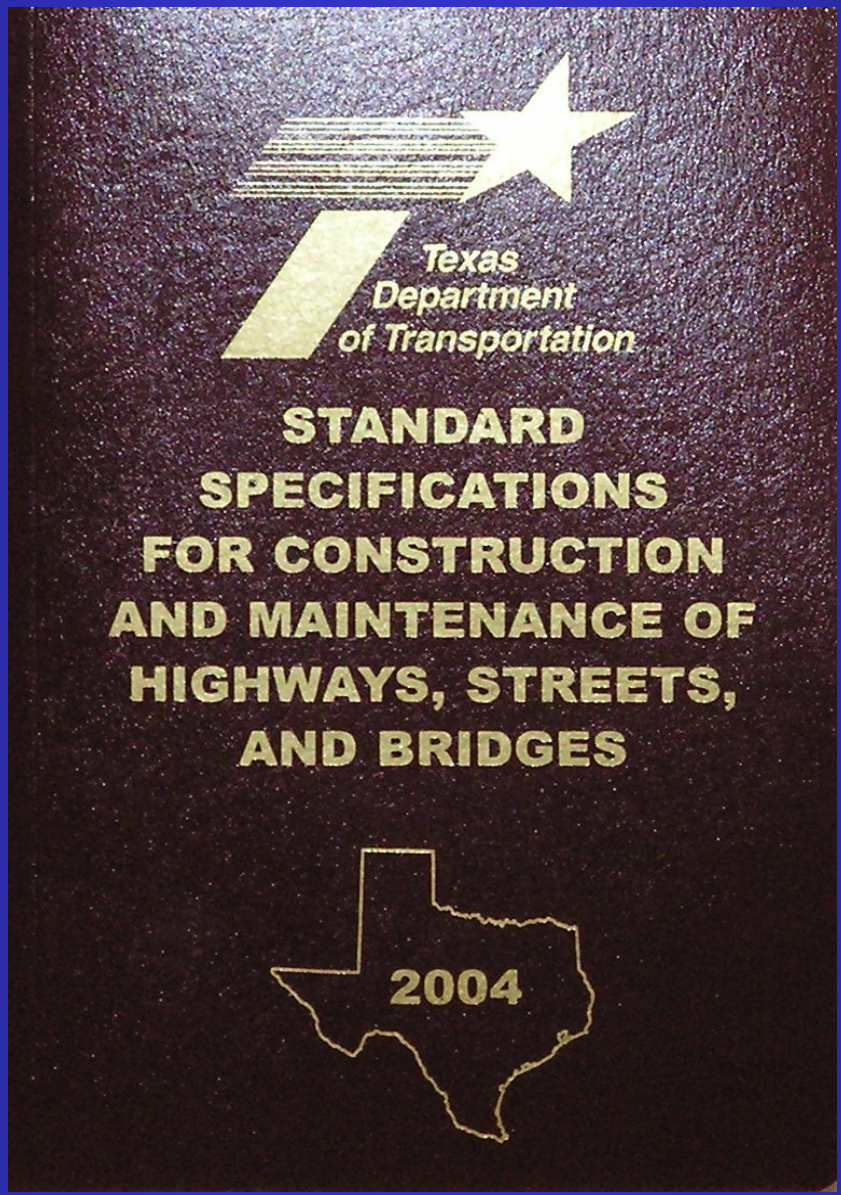
District: Abilene Mix Type: Superpave Binder: **76-22 (Source 2)**

CSJ: 0068-07-046 Aggr.: Limestone Additive: None

ID: 01500380 Lab Mix Notes:

When In Doubt……

Hamburg!


Texas
Department
of Transportation
STANDARD
SPECIFICATIONS
FOR CONSTRUCTION
AND MAINTENANCE OF
HIGHWAYS, STREETS,
AND BRIDGES
2004

New TxDOT Hamburg Specifications @ 50 °C

Grade	Passes @ 0.5 in rut
PG 64	10,000
PG 70	15,000
PG 76 +	20,000

Caution!!!

- Hamburg only tells one side of the story
- Rutting resistance - versus- Fatigue cracking
- Fatigue cracking is increasingly becoming our biggest problem!
  - Relatively thin (and overly stiff) layers of hot mix placed on flex base can be a recipe for disaster
  - Thick and stiff (OK)
  - Thin and flexible (OK)
  - Thin and stiff (no good)


5 4:16PM

Now, Switching Topics: Benefits of Using PFC

- **Comfort**
  - –Lower pavement noise levels
- **Safety**
  - –Improved visibility
  - –Minimized hydroplaning

Binder Requirements for PFC

- PG 76, Fibers, and Lime, or
- Type I or II Asphalt-Rubber.


New CRCP (black truck)
3. 17. 2002

New Superpave mix (black truck)

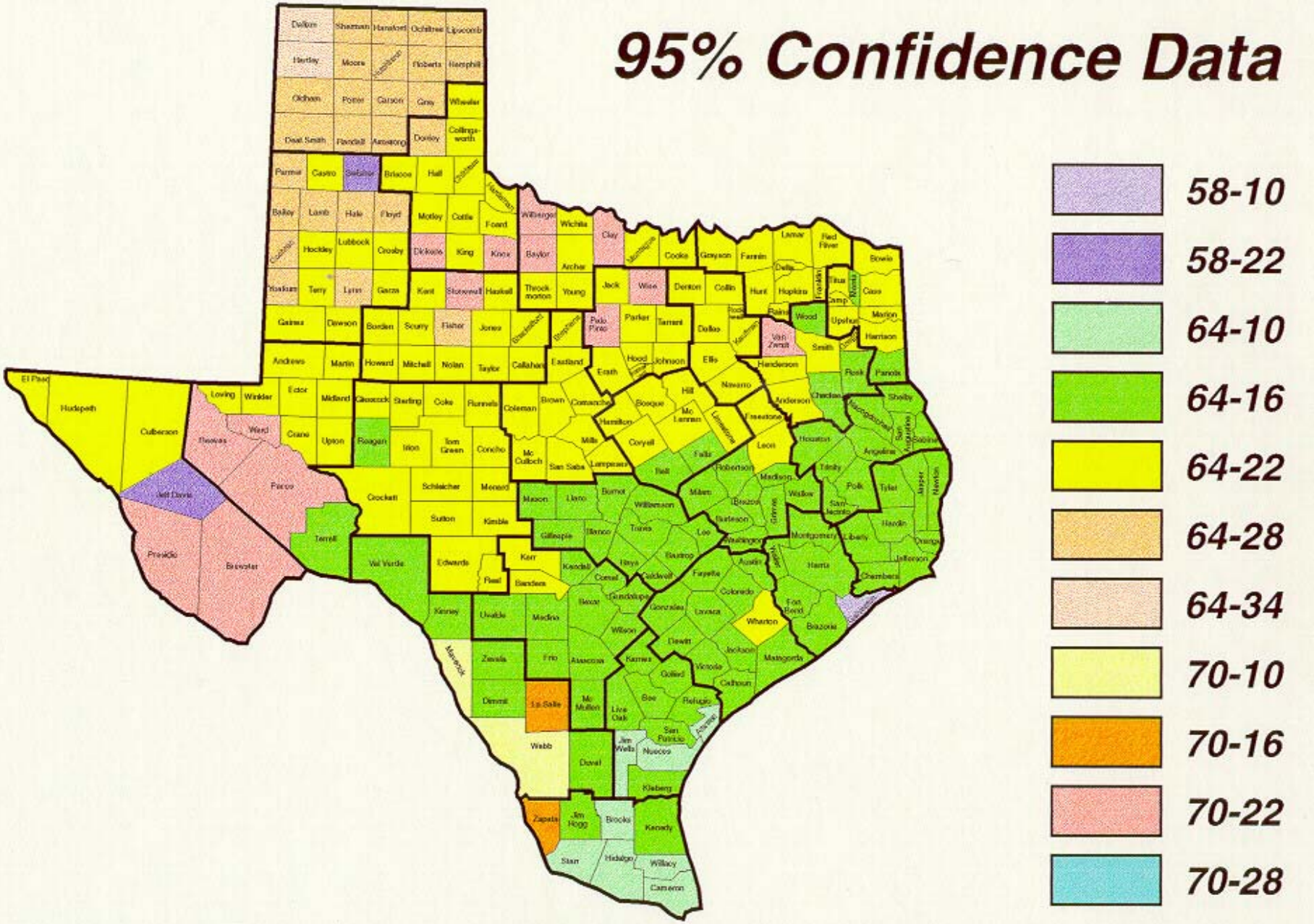

New PFC (black truck)
3.17.2002

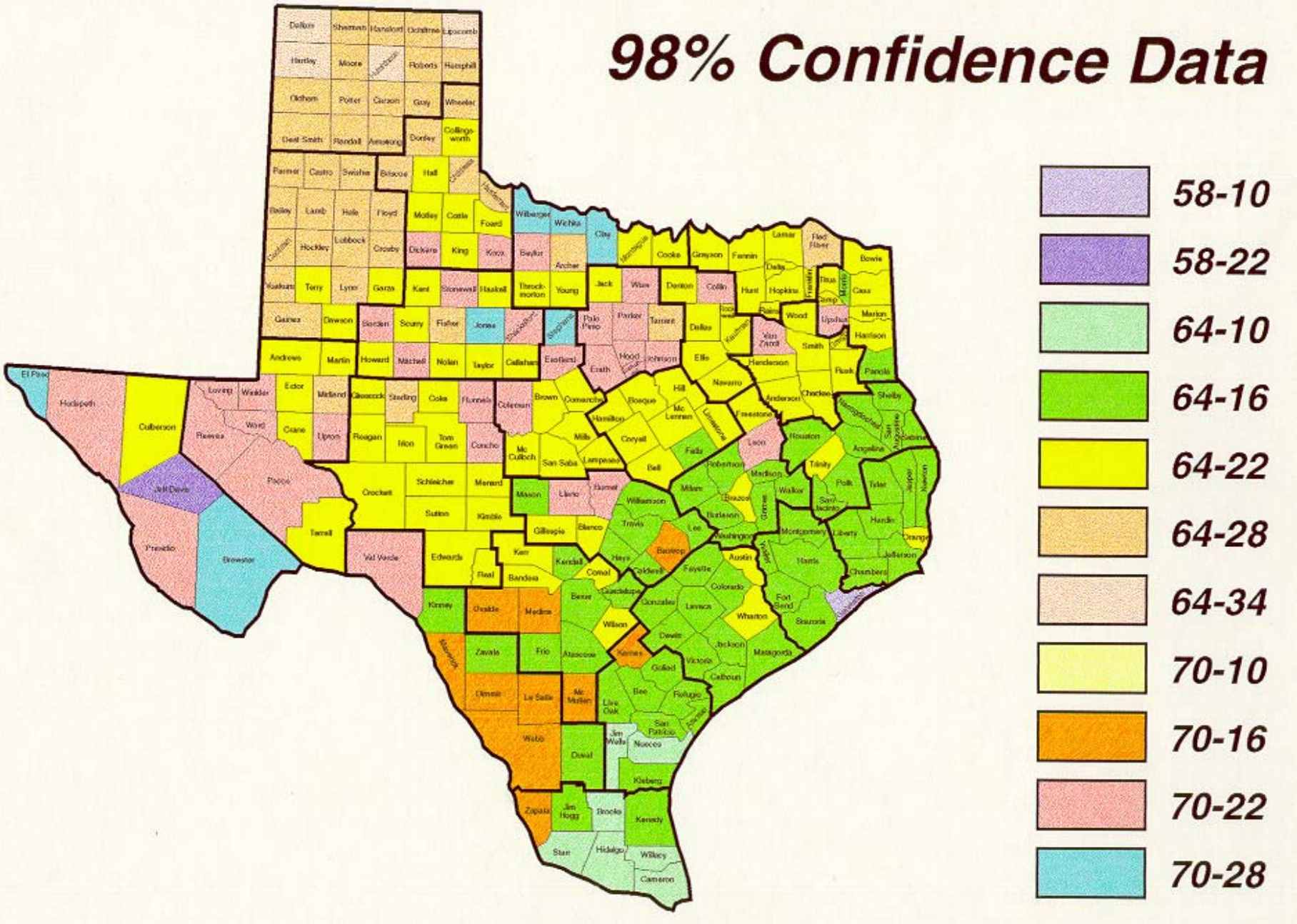
TxDOT's PG Binder Spec

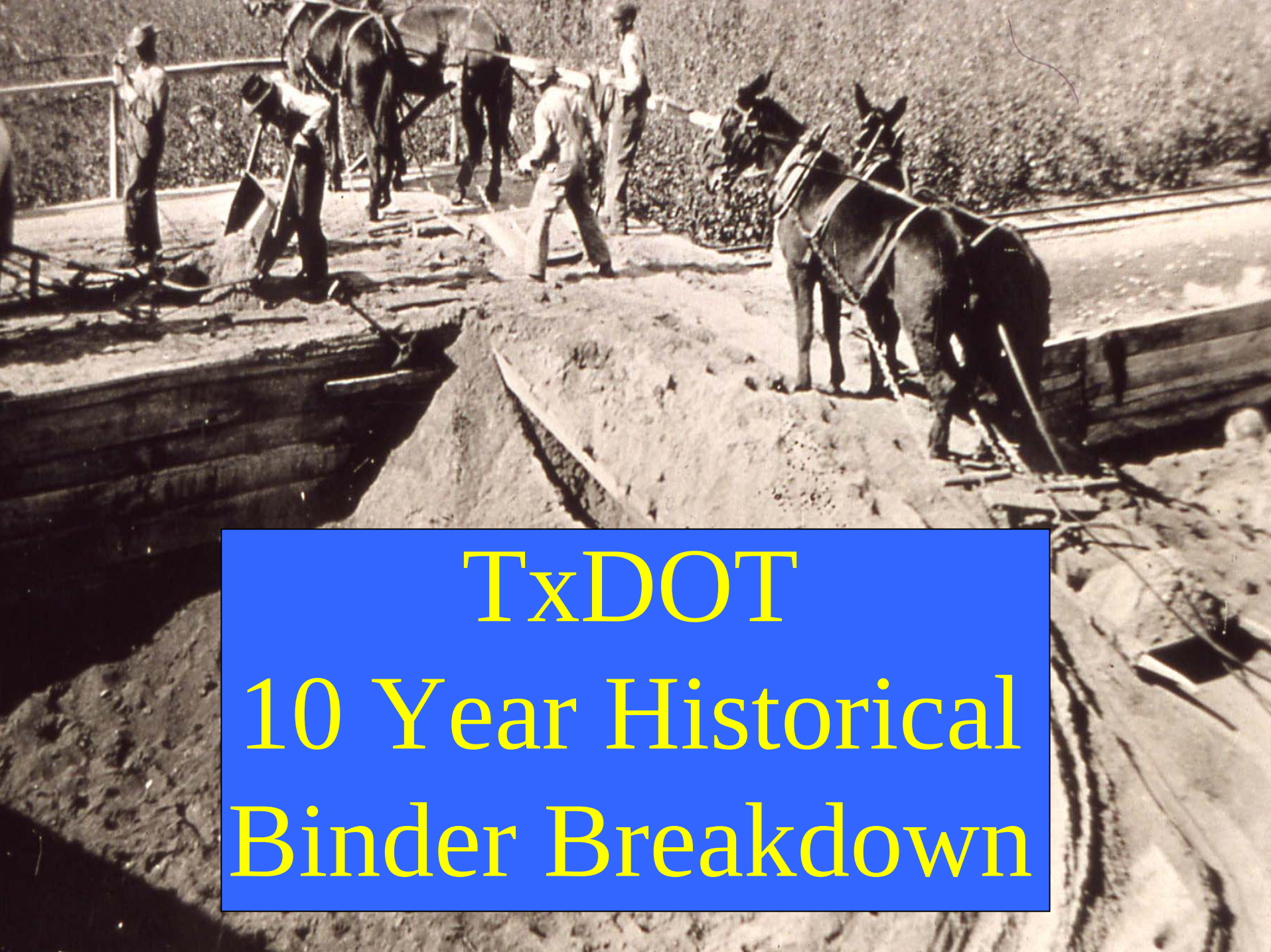
AASHTO M-320 except:

- PAV Temp of 100C
- PAV/DSR test temp tied to low temp, based on low temp using PG 64 as basis.
- Elastic Recovery (ASTM D 6084 @ 10C) for all binders with a temp spread >= 92C.

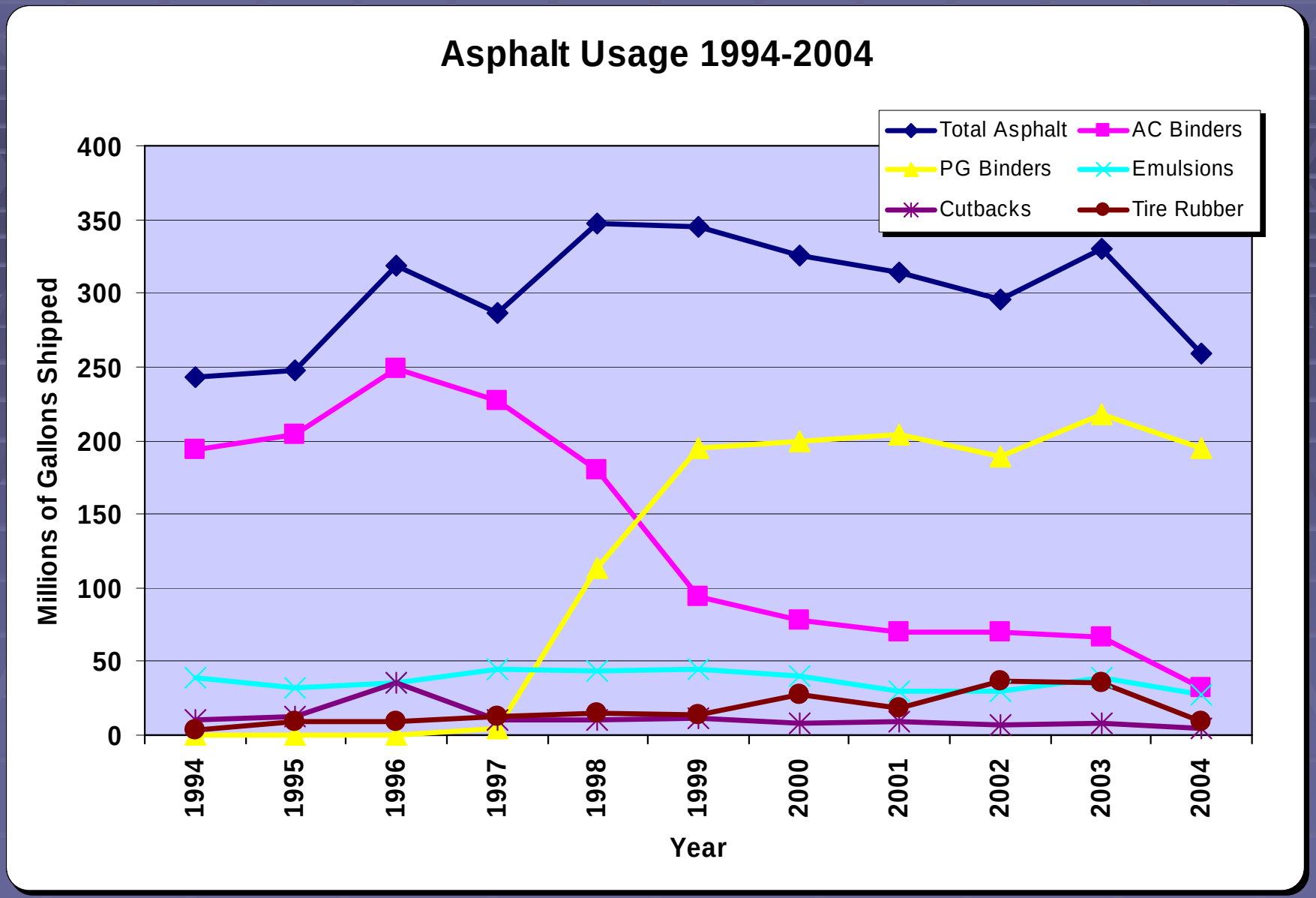
95% Confidence Data

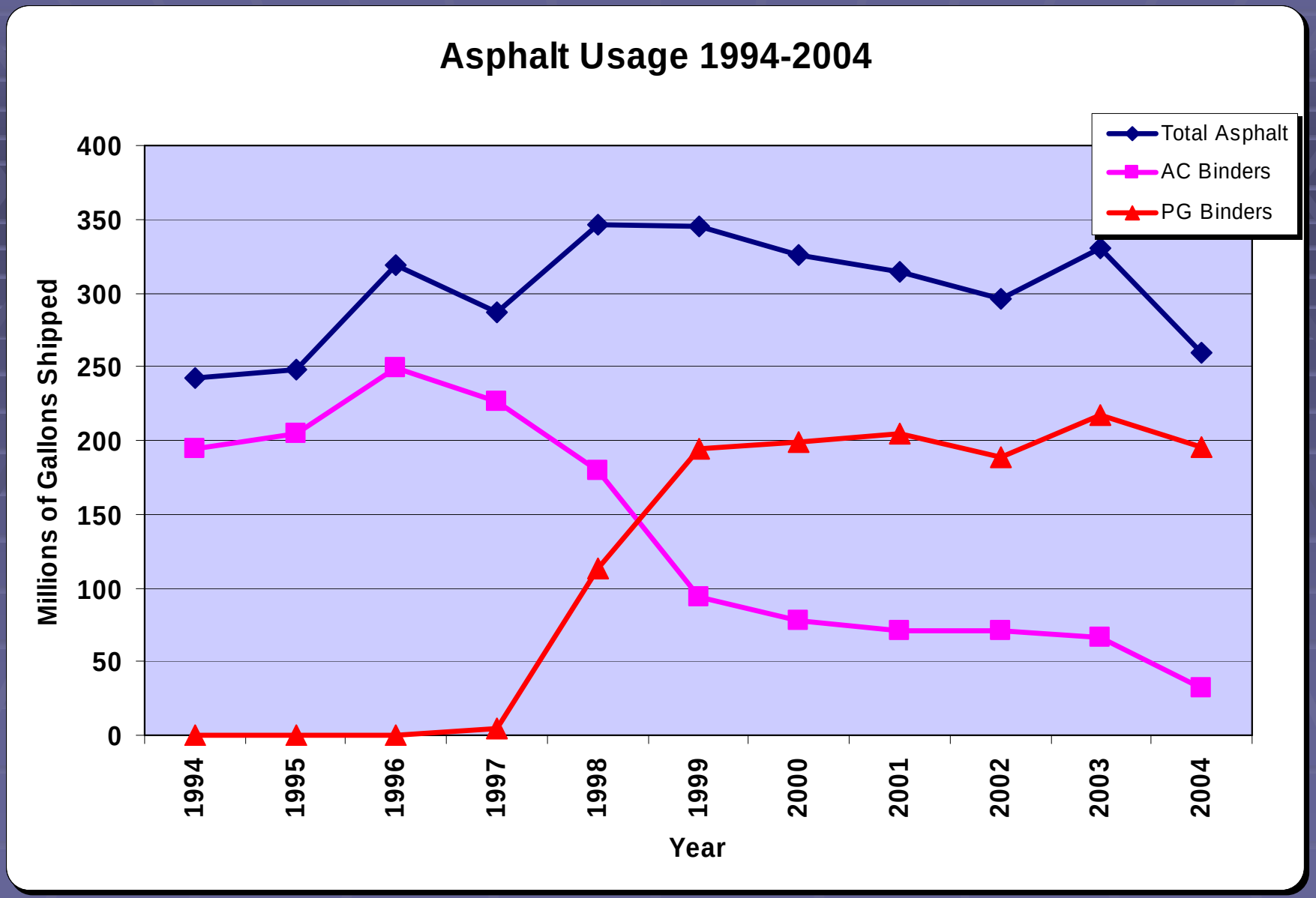


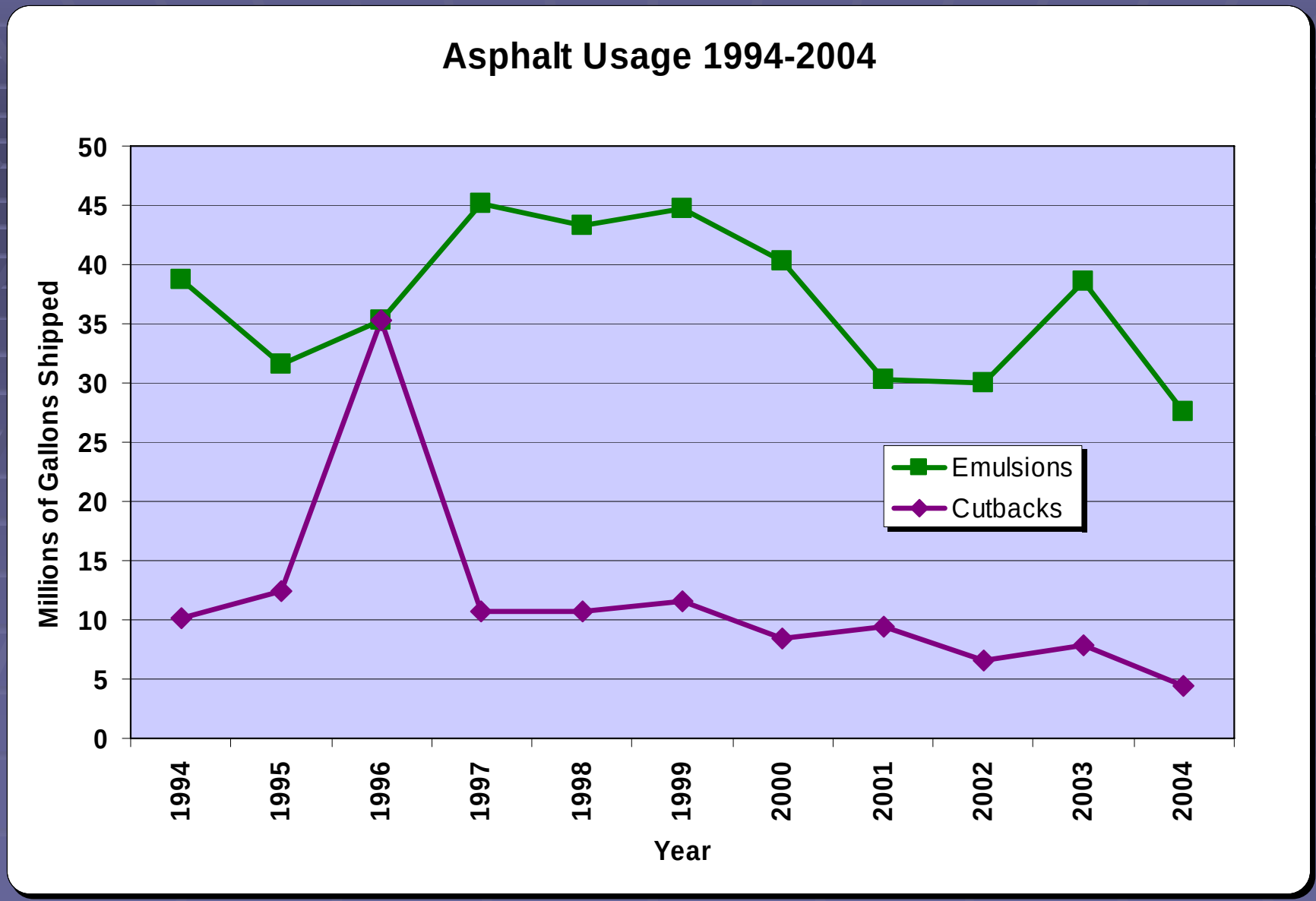

98% Confidence Data
58-10
58-22
64-10
64-16
64-22
64-28
64-34
70-10
70-16
70-22
70-28

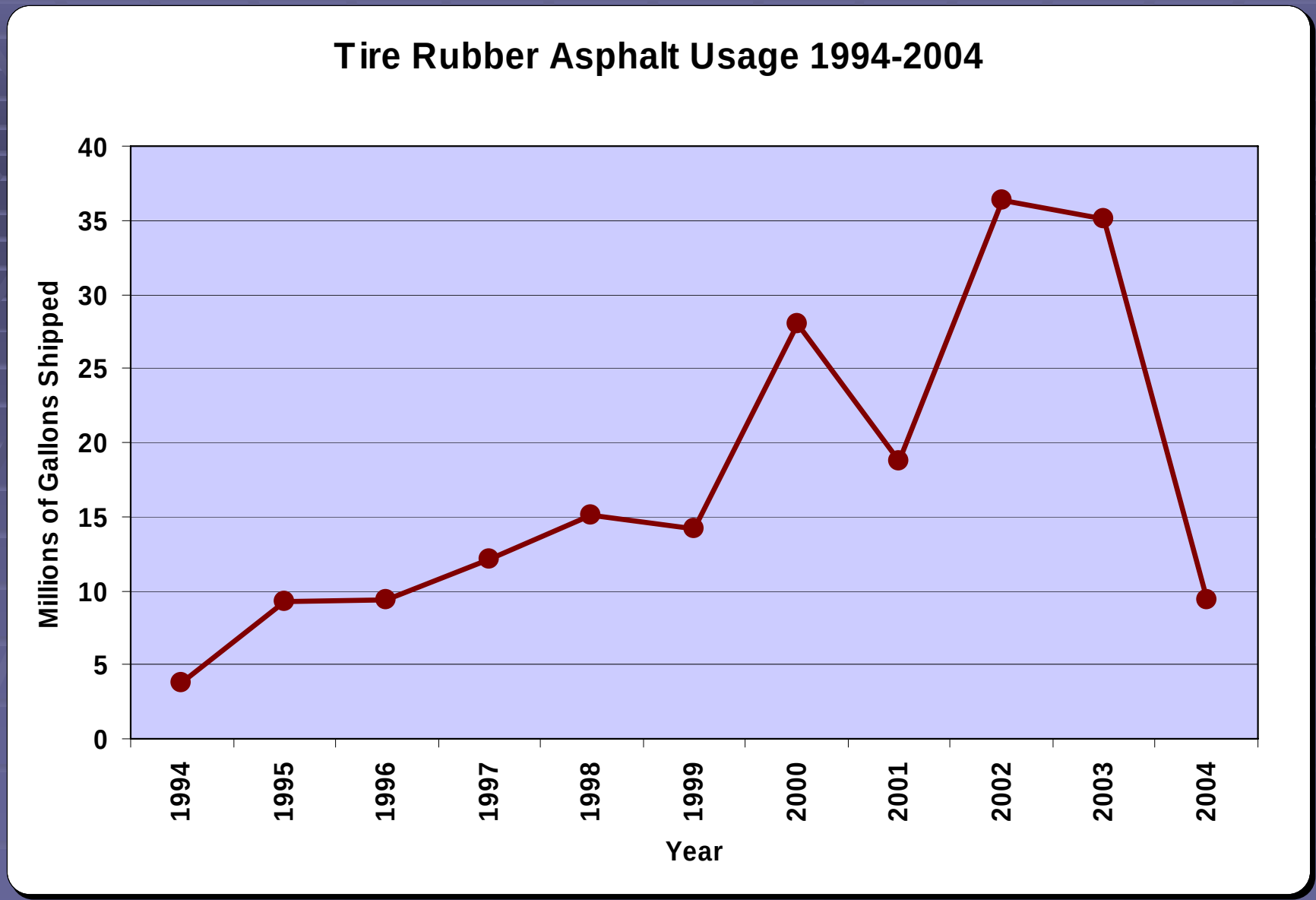


TxDOT
10 Year Historical Binder Breakdown

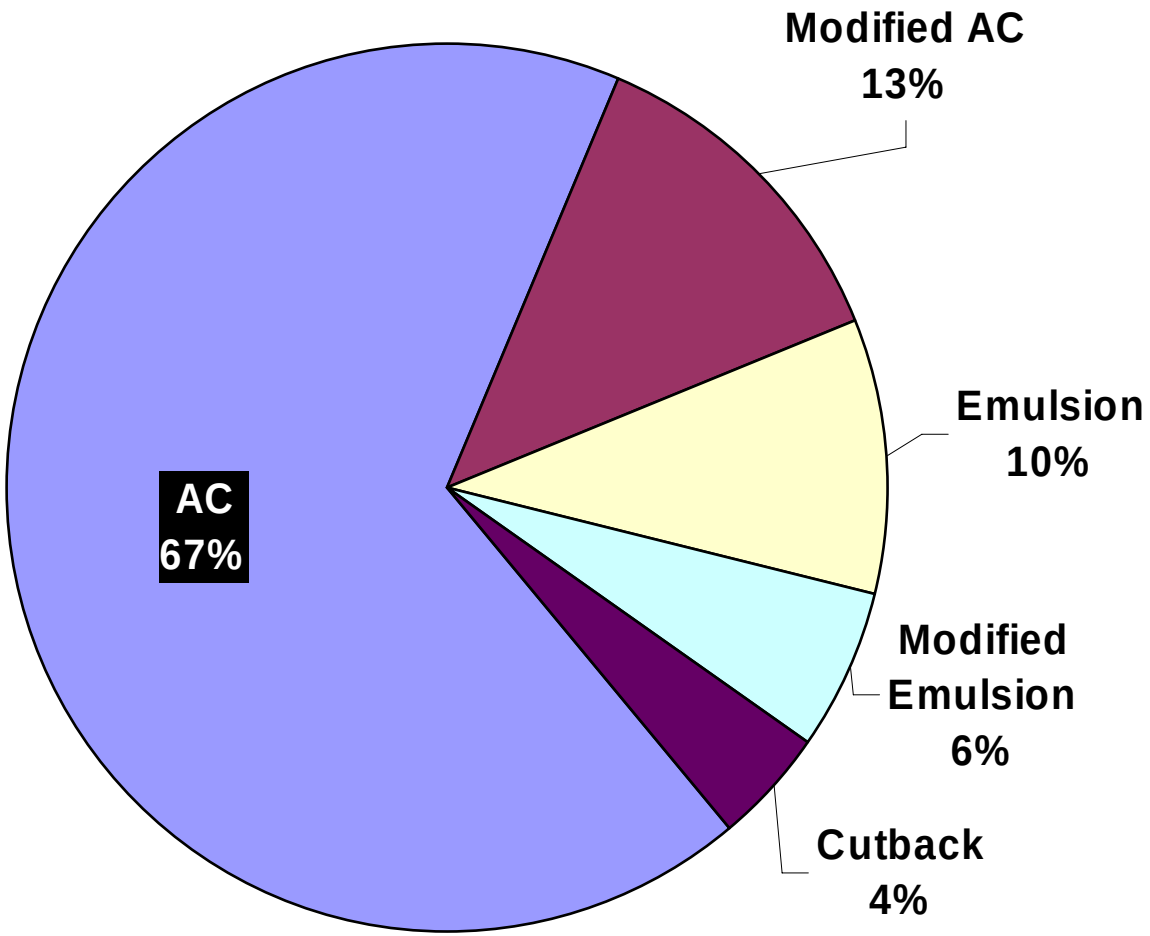

Asphalt Usage 1994-2004
Total Asphalt
AC Binders
PG Binders
Emulsions
Cutbacks
Tire Rubber
Millions of Gallons Shipped
400
350
300
250
200
150
100
50
0
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
Year


Asphalt Usage 1994-2004
Total Asphalt
AC Binders
PG Binders
Millions of Gallons Shipped
400
350
300
250
200
150
100
50
0
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
Year

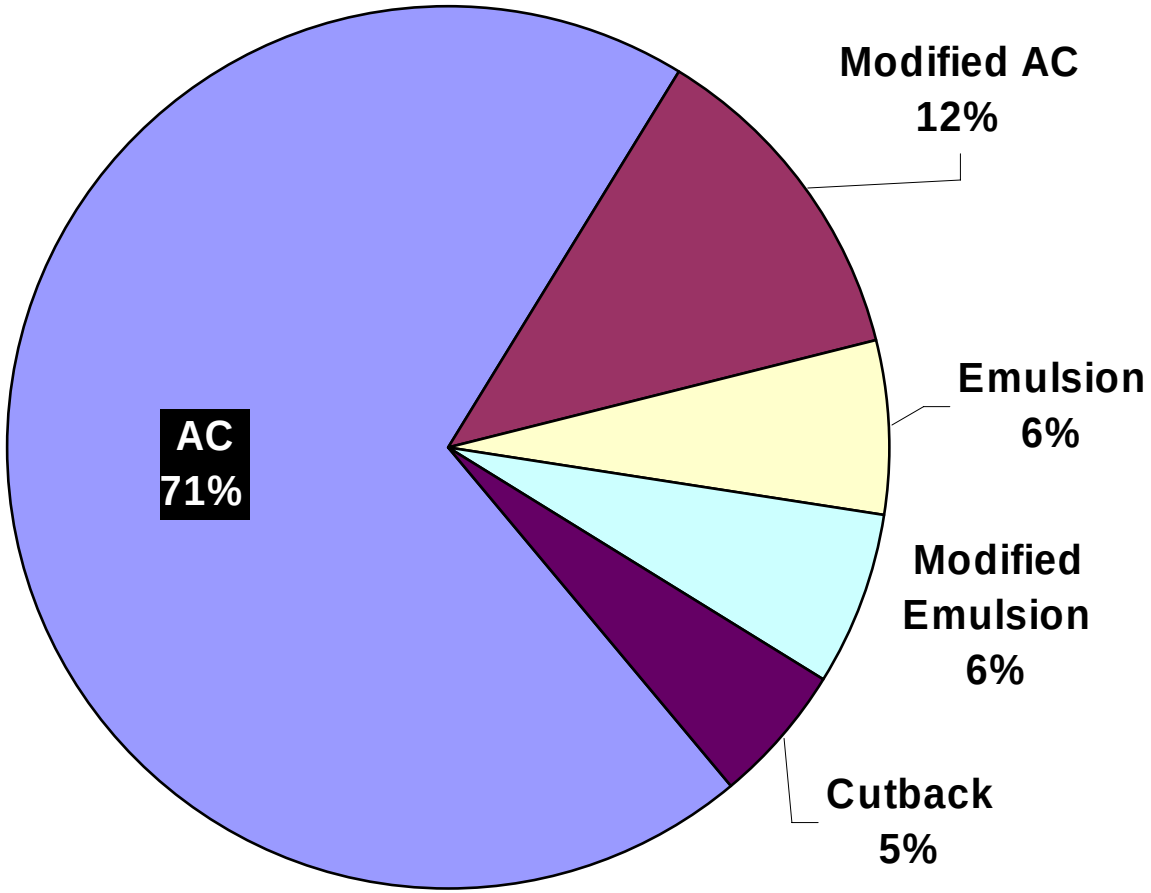

Asphalt Usage 1994-2004
Millions of Gallons Shipped
50
45
40
35
30
25
20
15
10
5
0
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
Year
Emulsions
Cutbacks


Tire Rubber Asphalt Usage 1994-2004
Millions of Gallons Shipped
40
35
30
25
20
15
10
5
0
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
Year

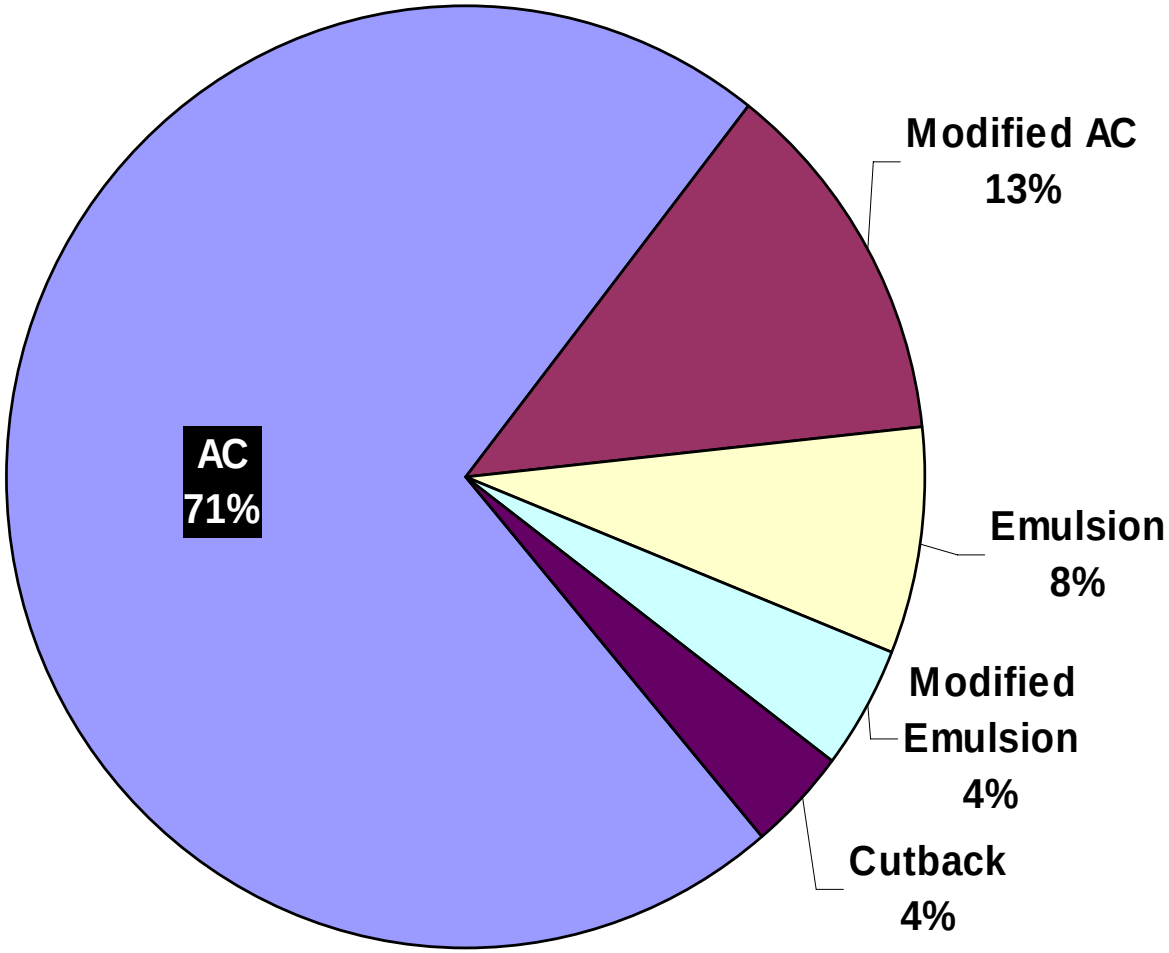
1994 Asphalt Usage by Volume



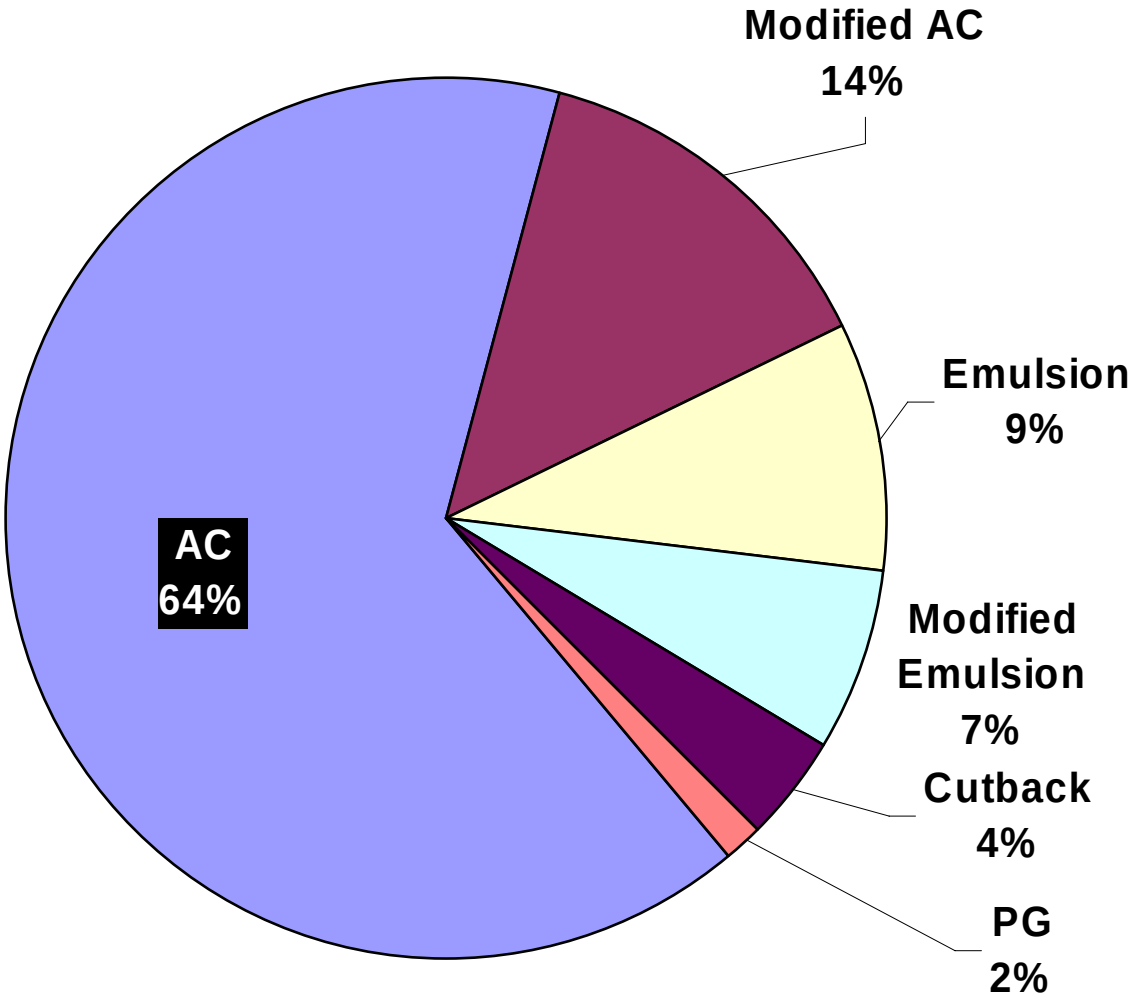
1995 Asphalt Usage by Volume



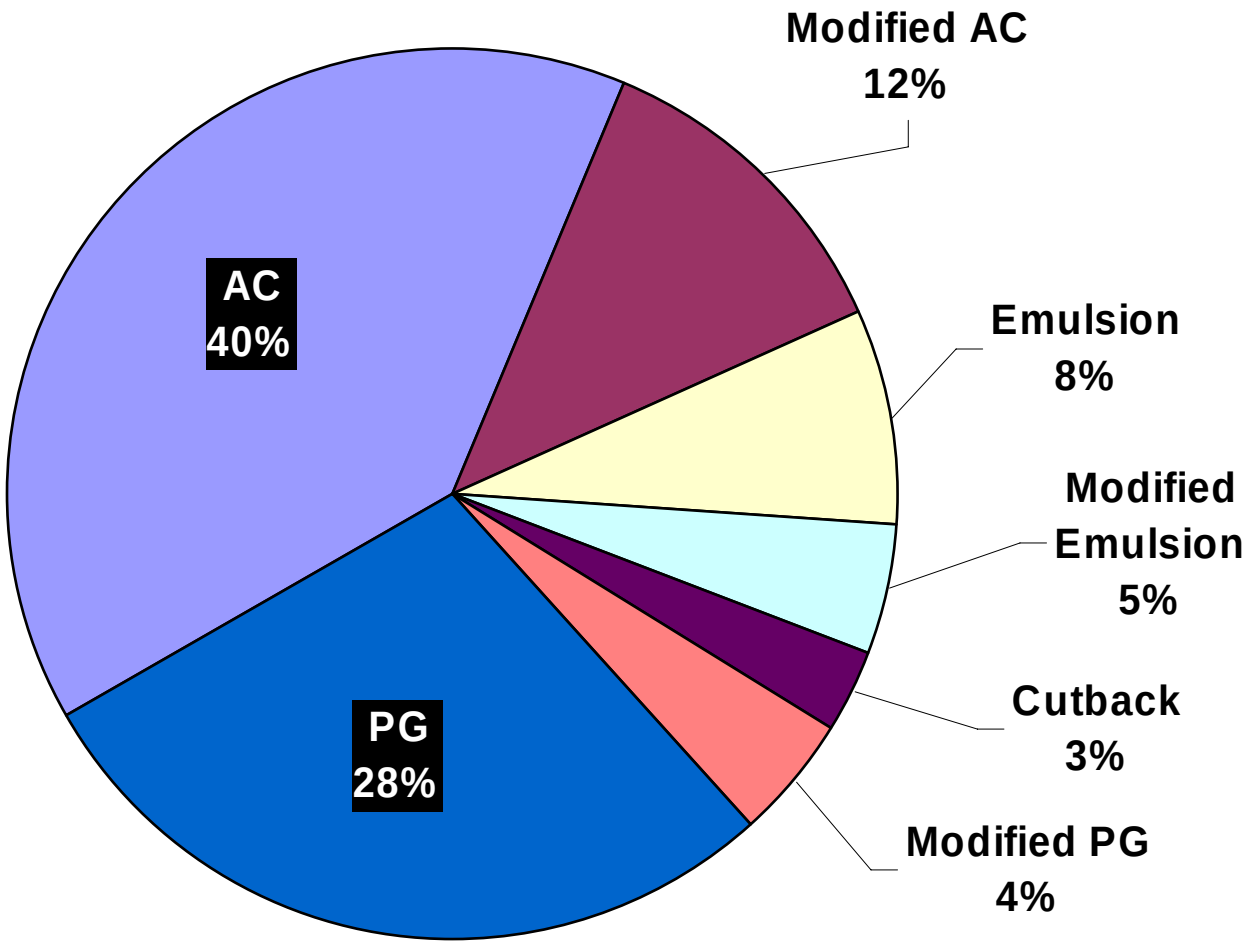
1996 Asphalt Usage by Volume



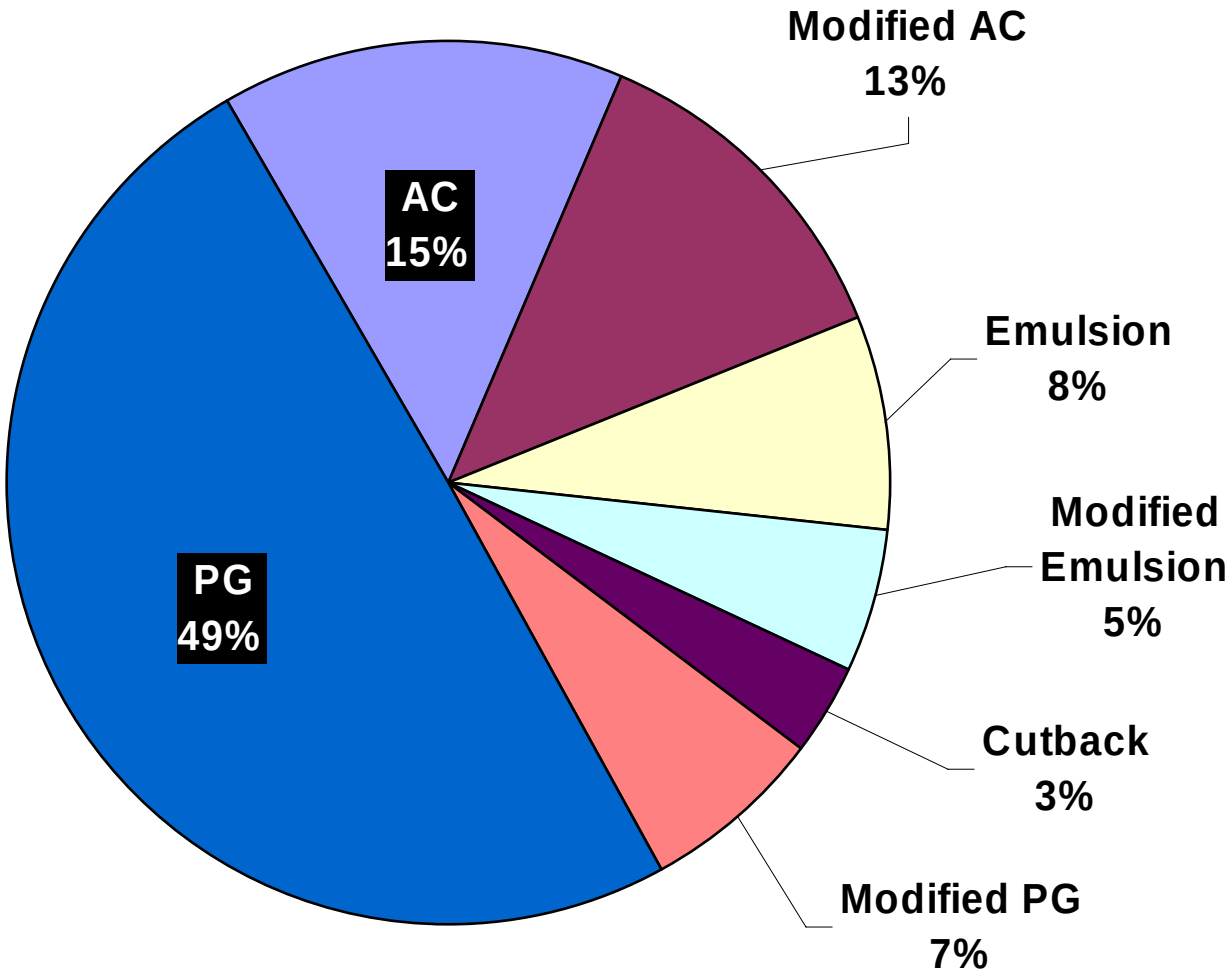
1997 Asphalt Usage by Volume



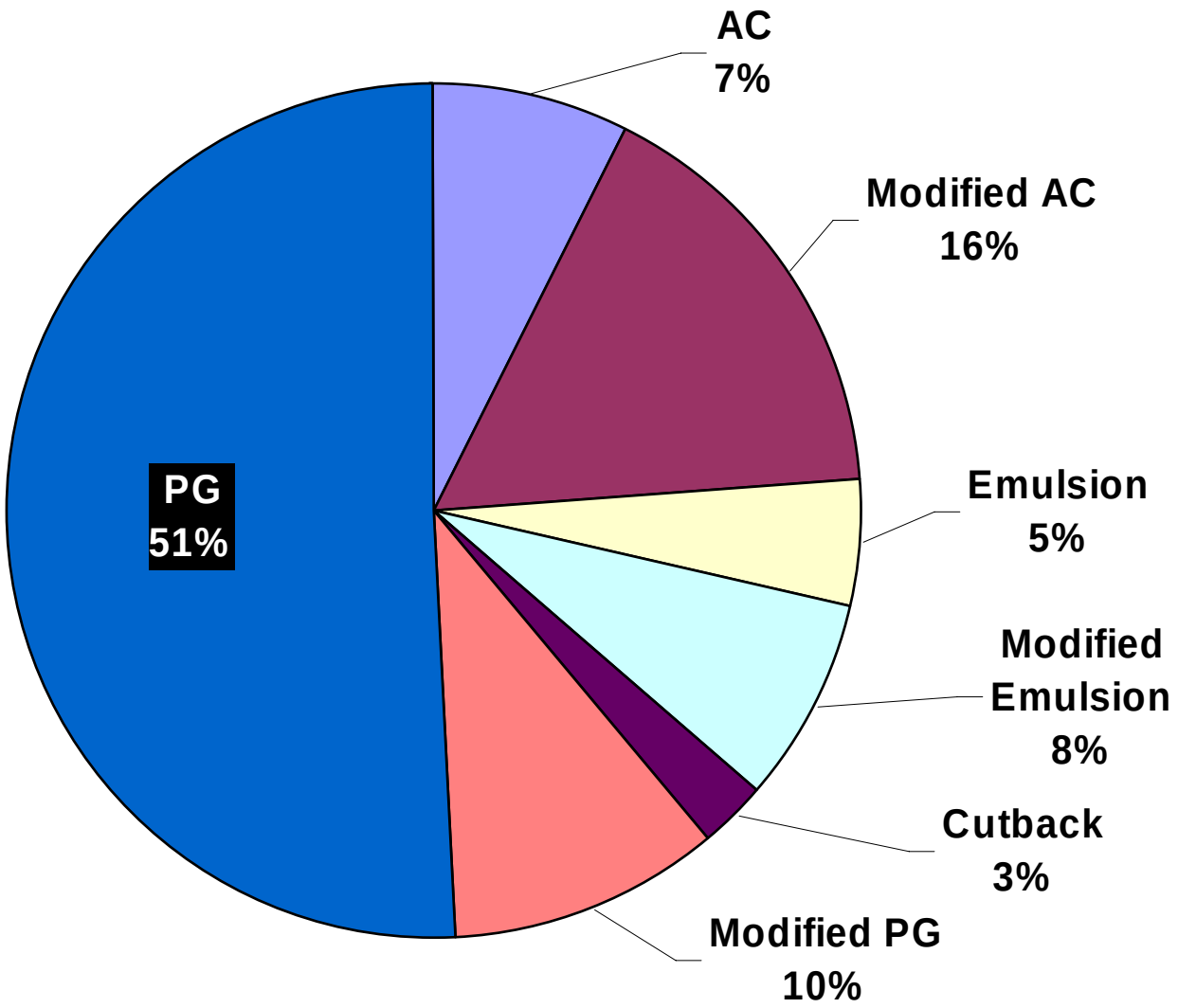
1998 Asphalt Usage by Volume



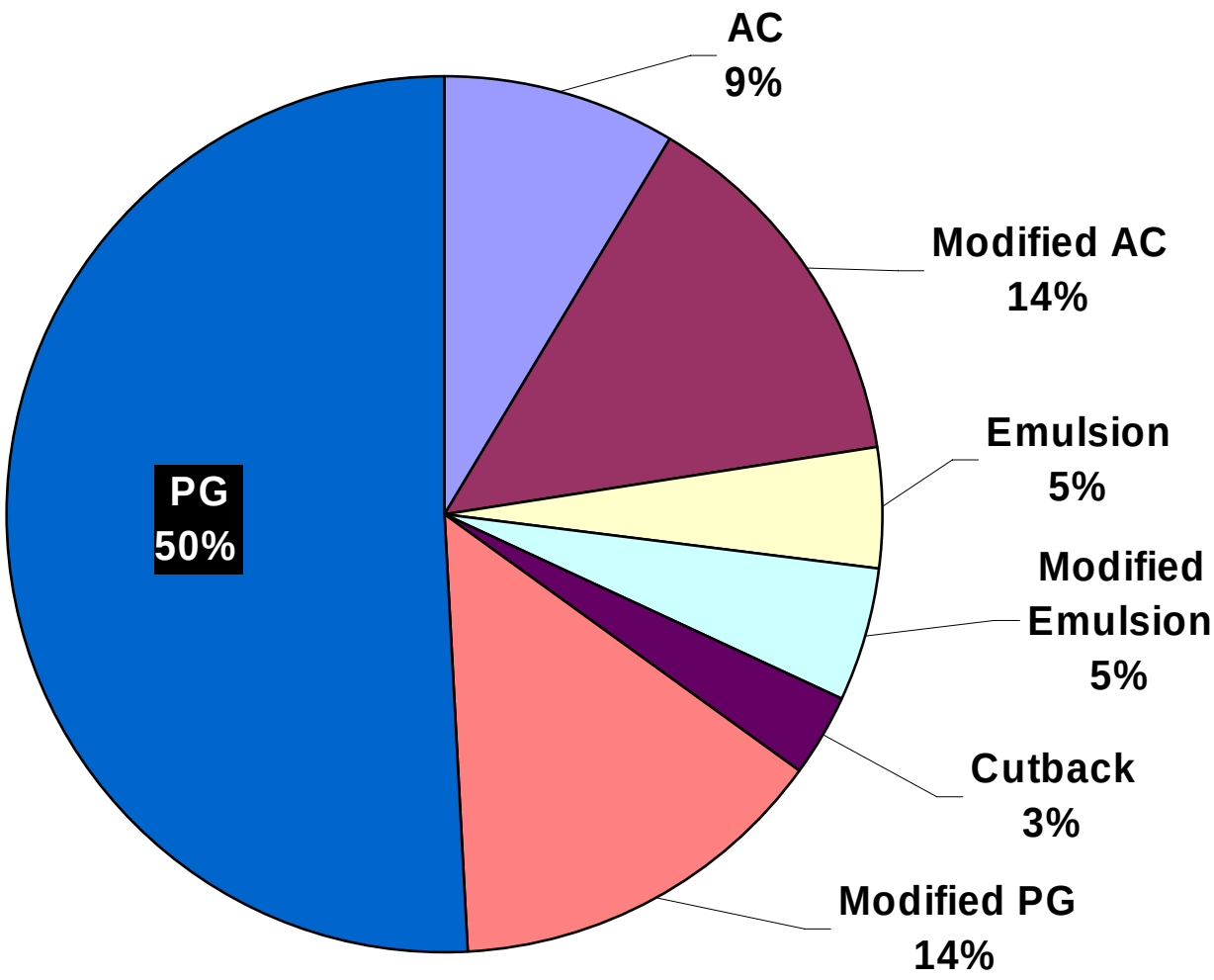
1999 Asphalt Usage by Volume



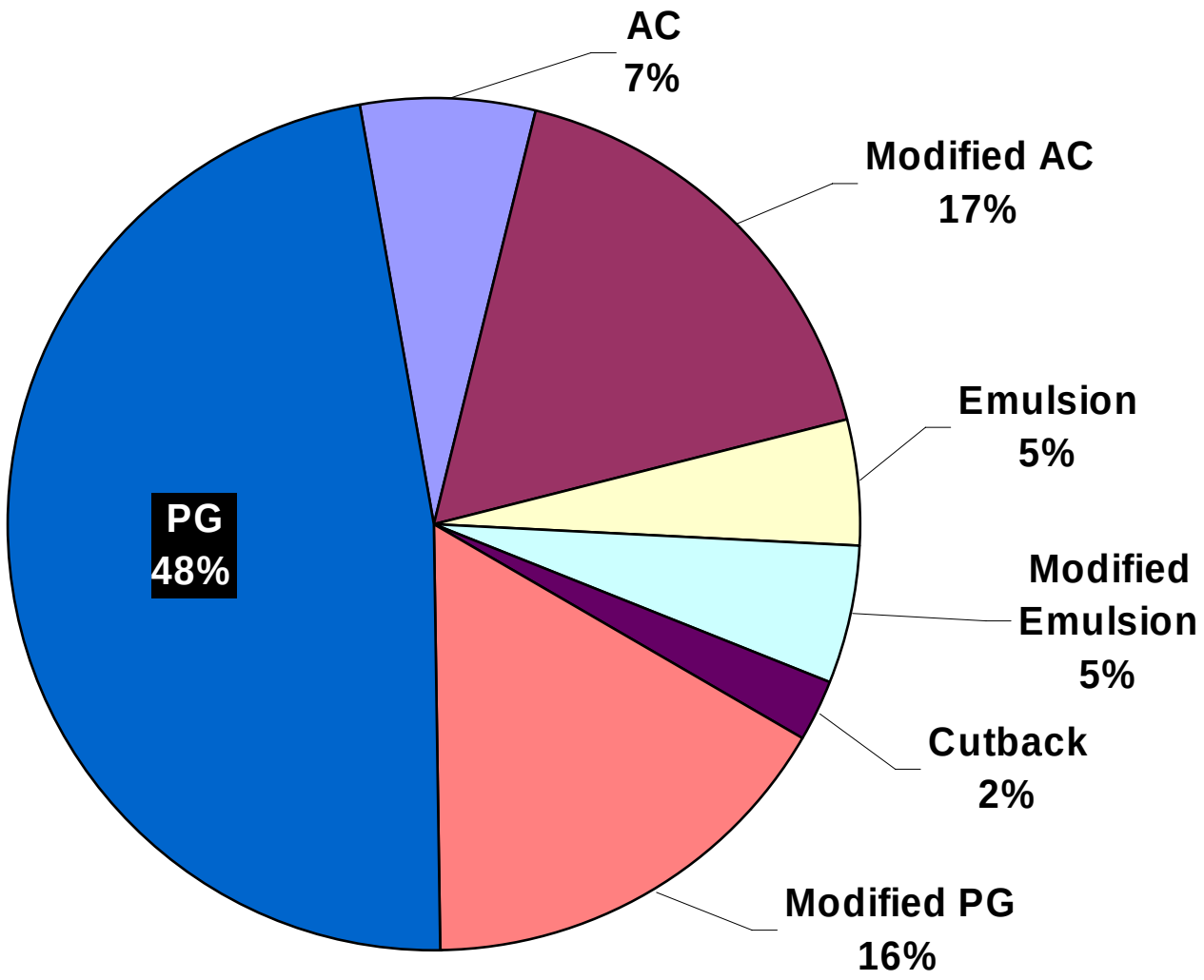
2000 Asphalt Usage by Volume

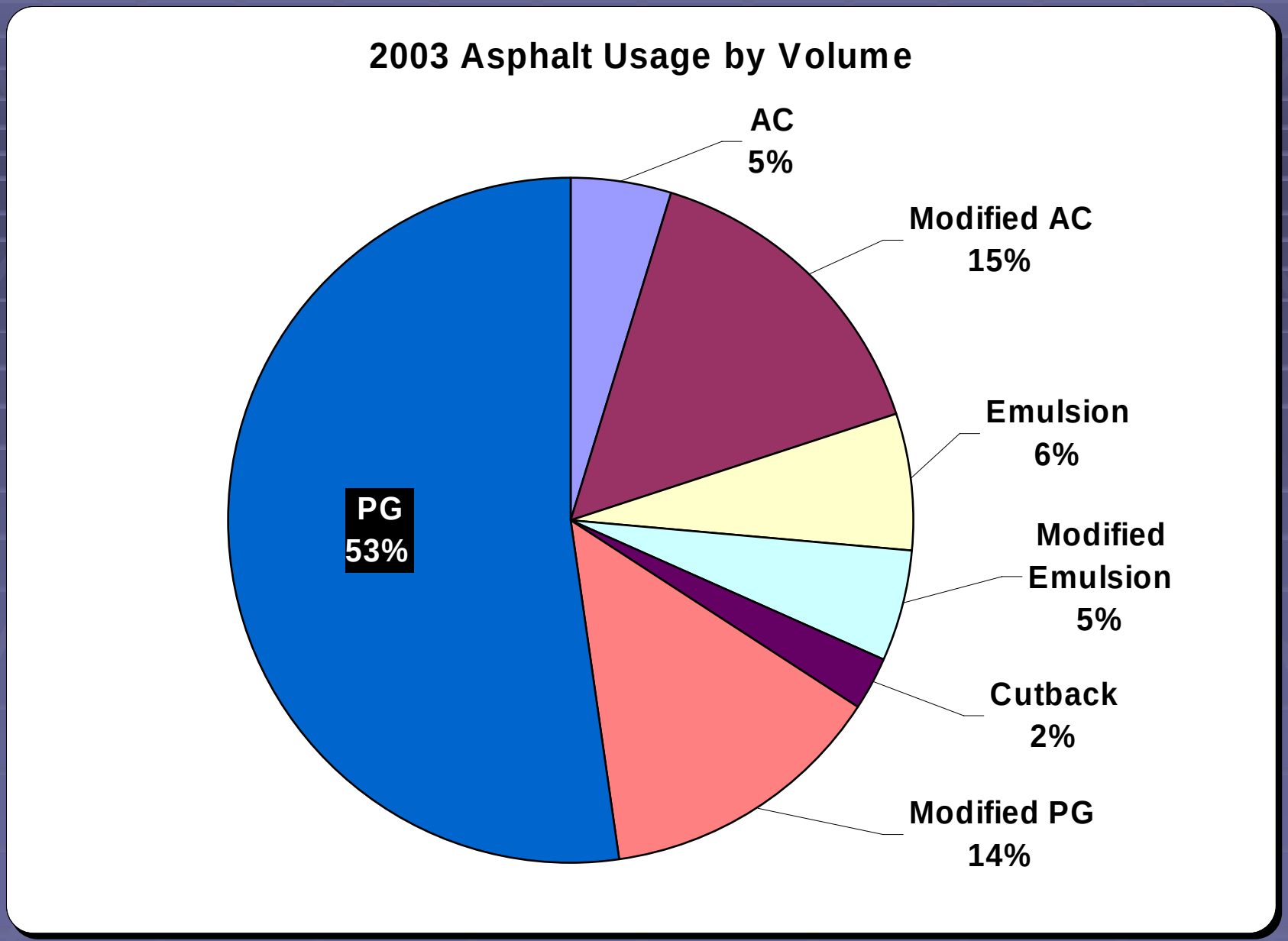


2001 Asphalt Usage by Volume

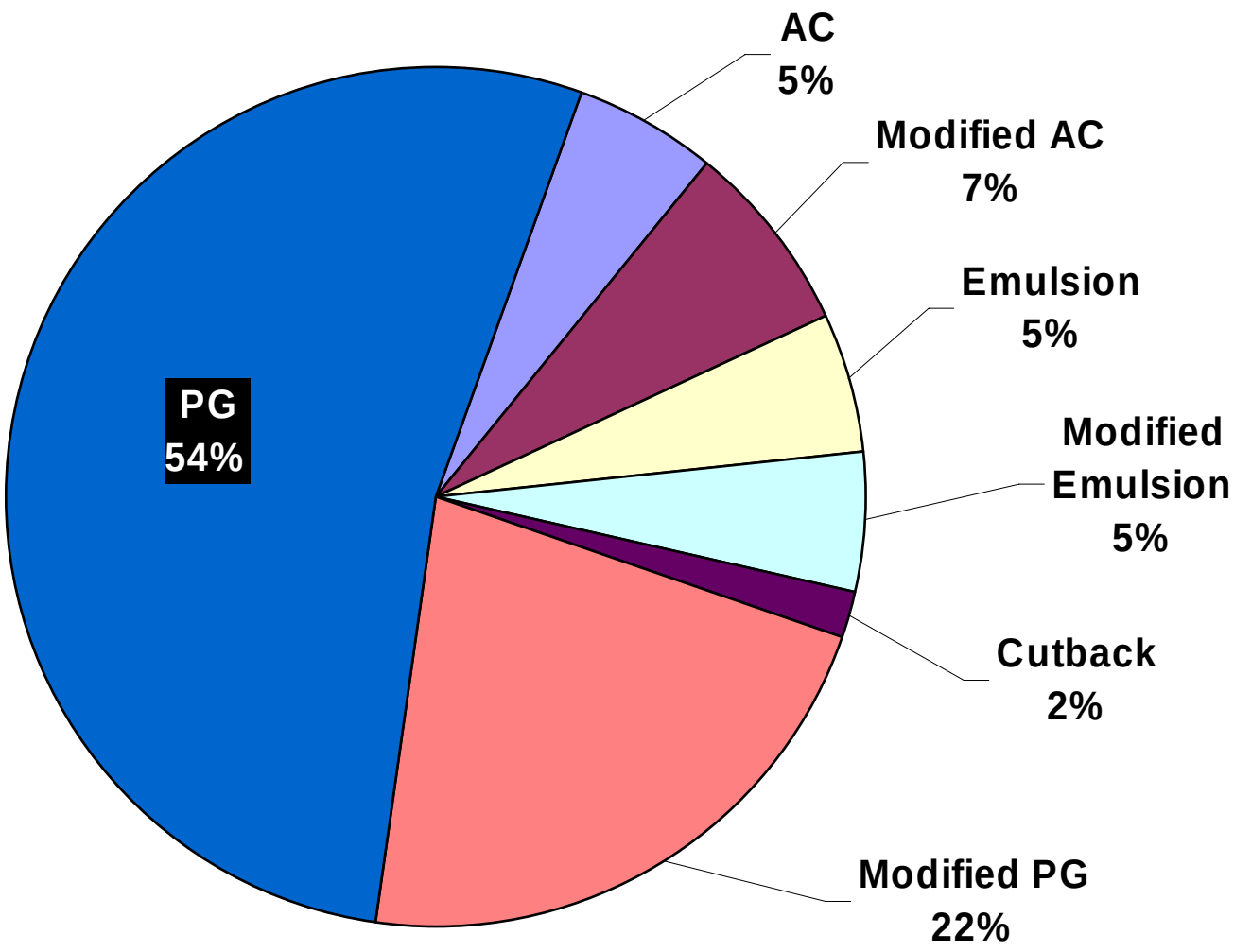


2002 Asphalt Usage by Volume




2003 Asphalt Usage by Volume
AC
5%
Modified AC
15%
Emulsion
6%
Modified
Emulsion
5%
Cutback
2%
Modified PG
14%
PG
53%

Partial Year 2004 Asphalt Usage by Volume



To Summarize

- Hamburg Wheel used for Design and Project Testing – Because It Works.
- PFC Standard Spec and will be utilized significantly.
- TxDOT uses lot of asphalt binders, and the amount of polymer-modified binders continues to rise.


"That's all Folks!"