Asphalt Rubber
The Arizona Experience

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Terminology

- CRA – Crumb rubber asphalt (aka asphalt rubber)
- ARAC – Asphalt Rubber Asphaltic Concrete
- AR-ACFC – Asphalt Rubber Asphaltic Concrete Friction Coarse

History: Charles MacDonald

- City of Phoenix Materials Engineer
- Experimented with mixing crumb rubber from ground tires with asphalt in early 1960's
- Patented the MacDonald Process or Wet Process for making Asphalt Rubber

History: Early ADOT

- Began experimenting with the use of asphalt rubber in the early 1960's
  - 1964 band aid type maintenance application
  - 1968 spray applications
  - 1968-1972 six projects with seal coat type applications
  - 1972 Stress Absorbing Membrane (SAM) and interlayer (SAMI) experiment

History: More Early ADOT

- 1974-1989 more than 600 miles of SAM or SAMI asphalt rubber applications
- 1988 one-inch open-graded asphalt rubber asphalt concrete friction course (AR-ACFC) placed on I-19

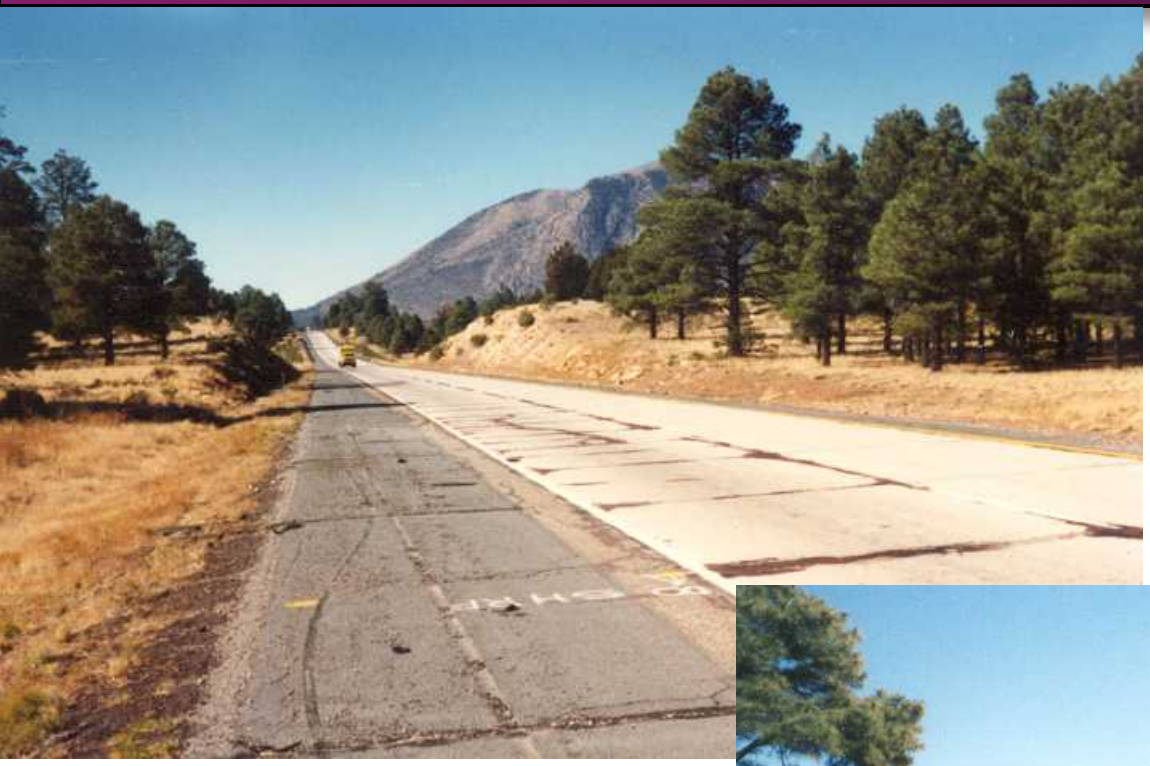
History: I-19 Project (1988)

- 10.0 % asphalt rubber by weight of mix
- Placed on plain jointed concrete pavement
- First reflection cracks noted in 1996
- Sections no longer in service because of I-10/I-19 interchange project not because of poor performance
- Experimented with recycling in this section


10/20/2004

History: ARAC

- 1990 placed on I-40 near Flagstaff
- 2” thick Structural Overlay
- Gap graded mix
- Placed on severely cracked and failed concrete pavement
- Least reflection cracking of any application



What is Asphalt Rubber?

- A mixture of
  - Aggregate
  - Crumb Rubber Asphalt (Wet Process) (crumb rubber + asphalt cement) OR
  - Terminal Blend AR Binder (asphalt cement + SBS + crumb rubber

Ground Tire Rubber

Specifing CRA

- Base Asphalt Cement
- Minimum 20% crumb rubber by weight of binder [100% pass #10 sieve]
- Rotational Viscosity
- Penetration
- Softening Point
- Resilience

CRA Blending

- Minimum 20% crumb rubber by weight of asphalt cement
- Crumb rubber added to 350 – 400°F asphalt cement
- Crumb rubber and asphalt cement mixed
- Asphalt rubber reacted for at least one hour at 325 – 375° with agitation

Asphalt Cements in CRA

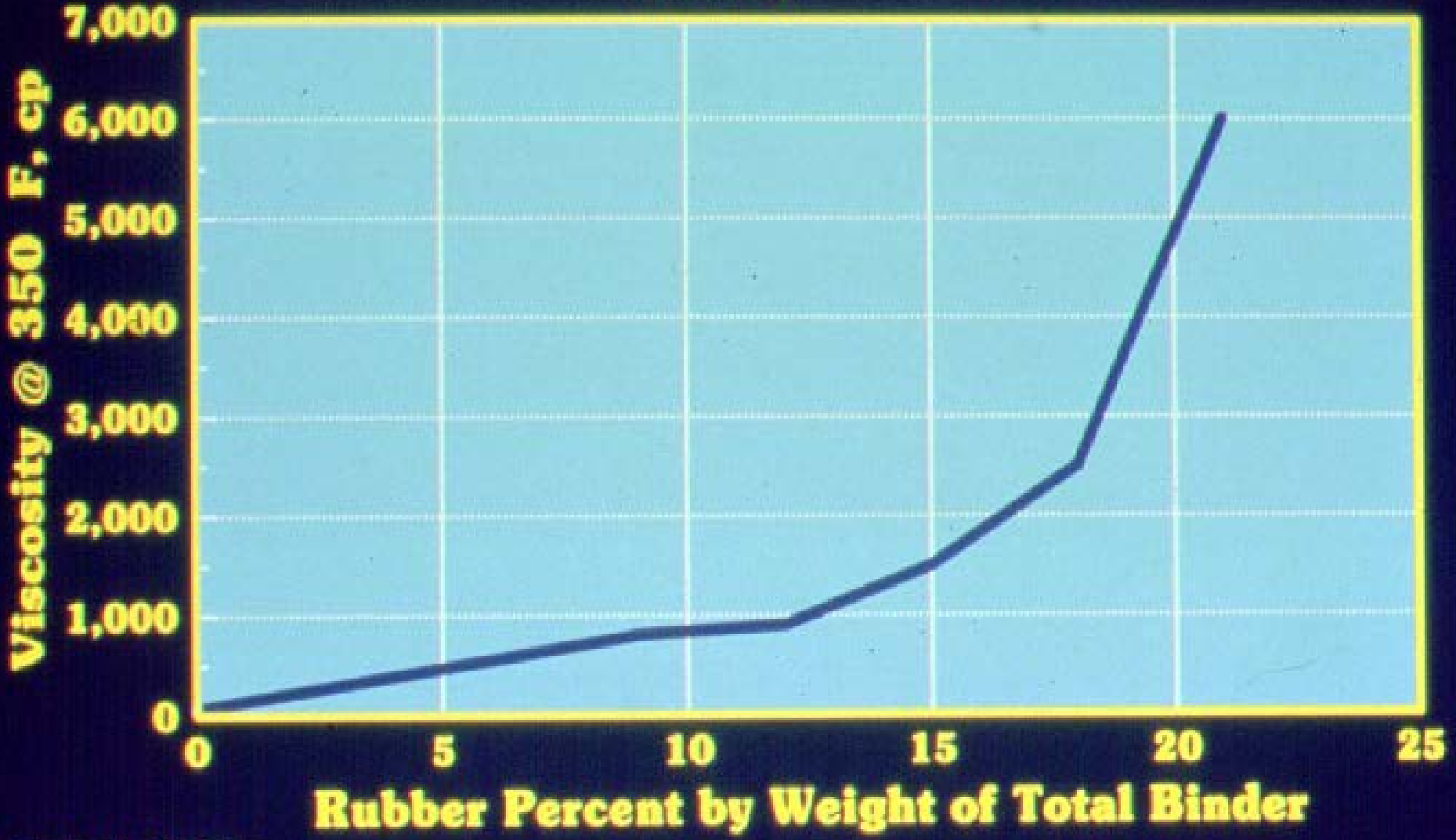
- Type 1 Hot Climate PG 64-16 (Phoenix)
- Type 2 Moderate Climate PG 58-22 (Prescott, Flagstaff)
- Type 3 Cold Climate PG 52-28 (Alpine, highest elevations)

CRA Properties Influenced by

- Asphalt Cement
- Amount of crumb rubber
- Crumb rubber gradation
- Reaction temperature and time

Effect of Rubber Quantity

Viscosity



Asphalt - AC-20

Rubber - No. 16 sieve maximum nominal size

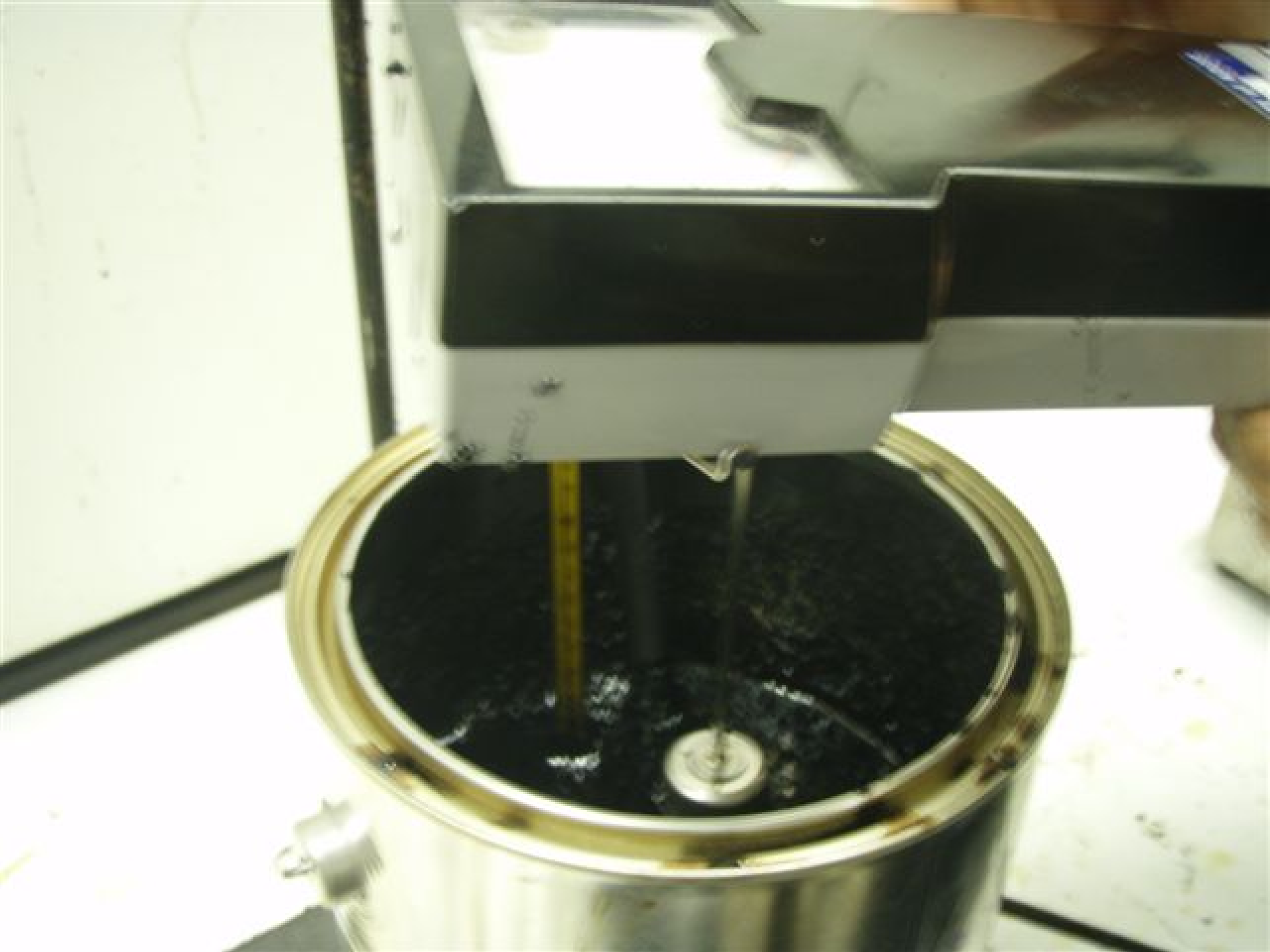
Ref: "Design Methods for Hot-mixed Asphalt Rubber Concrete Paving Materials," James G. Chehovits, Proceeding of the National Seminar on Asphalt-Rubber, October 1989

Viscosity

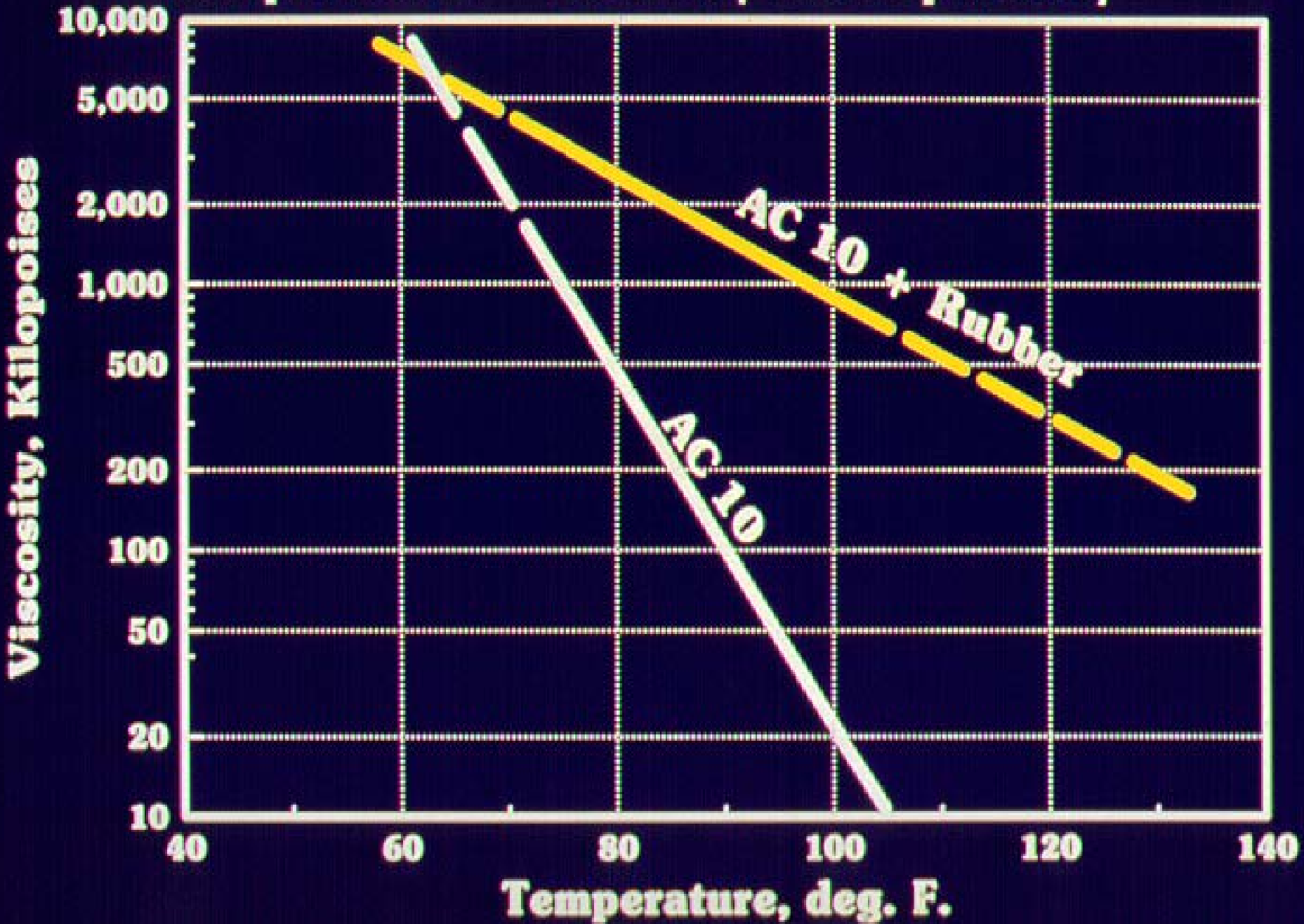
Monitors fluid consistency of binder to:

- Ensure pumpability
- Identify binder changes which might affect mix placement and compaction
- Can be done in field


dPa·s
PROPERTY of ADOT
RION VISCOTESTER VT-04



Temperature - Viscosity Susceptibility



Resilience

- Appears to be a reliable measure of the elastic properties of the asphalt rubber binder.
- Expressed as a percentage of rebound for the binder.
- Resilience is one of the most important properties of AR binders and is considered a primary indicator of performance.

ADOT Rubber Mixes

- AR-ACFC
  - Final wearing surface (friction course)
- ACFC with terminal blend
  - Final wearing surface
- ARAC
  - Structural Lift

AR-ACFC

- Open graded – Typically 95% 3/8” Chips and 5% Fines
- Typically around 9.5% asphalt rubber (by wt of total mix) (range 8.9% to 10.0%)
- Used as final wearing surface, not structural
- On asphalt pavements, typically ½ inch thick
- On concrete pavements, typically 1 inch thick

- Get as much asphalt binder in the mix as possible without draindown

How much rubber in AR-ACFC

- 20% rubber by weight of asphalt cement
- Approximately 9.5% asphalt rubber binder in mix
- Works out to about 1.75% rubber in the mix

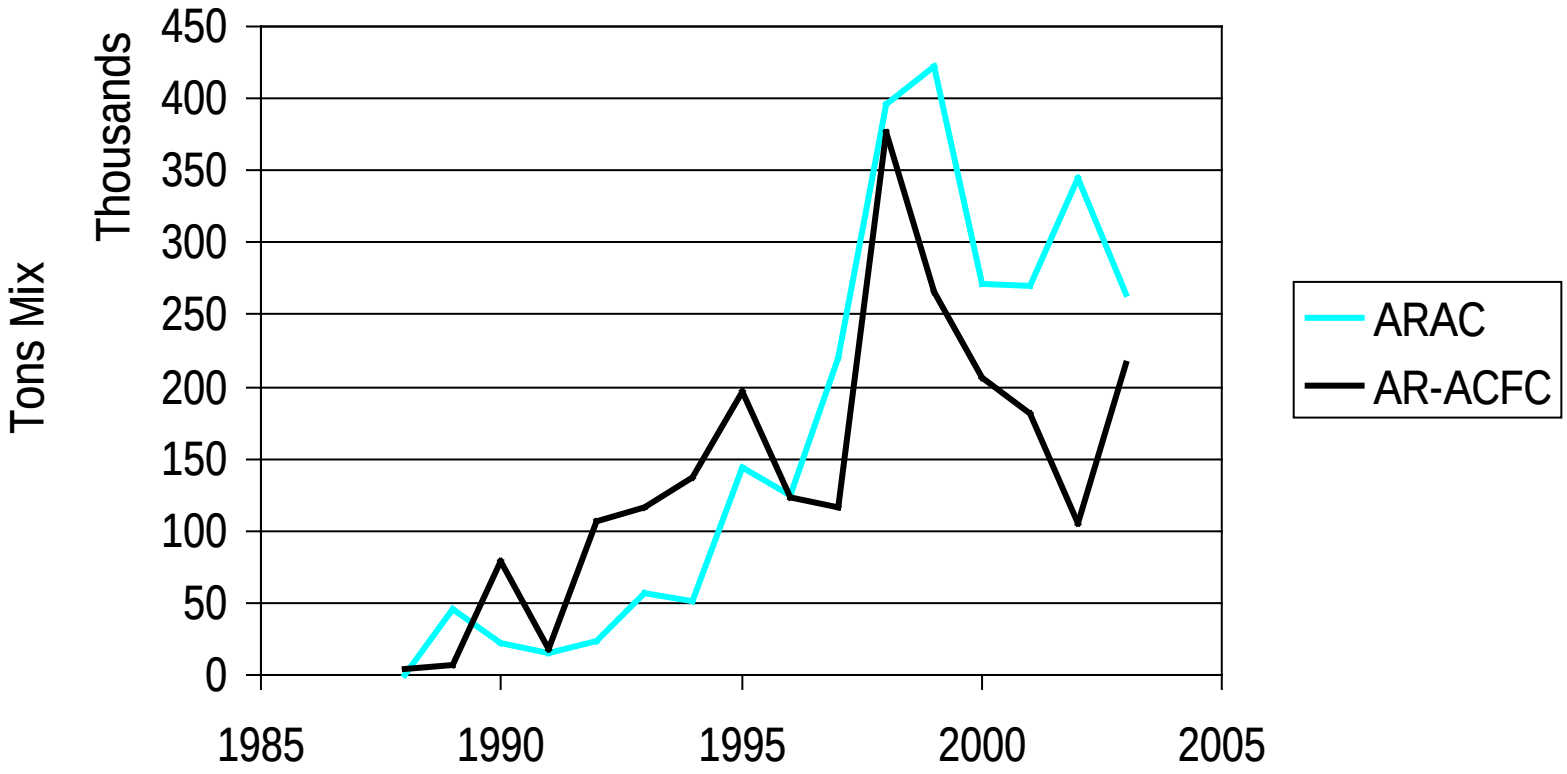
ARAC

- Gap graded (to allow space for rubber particles)
- Typical binder contents 6.5% to 8.0%
- Very limited use recently

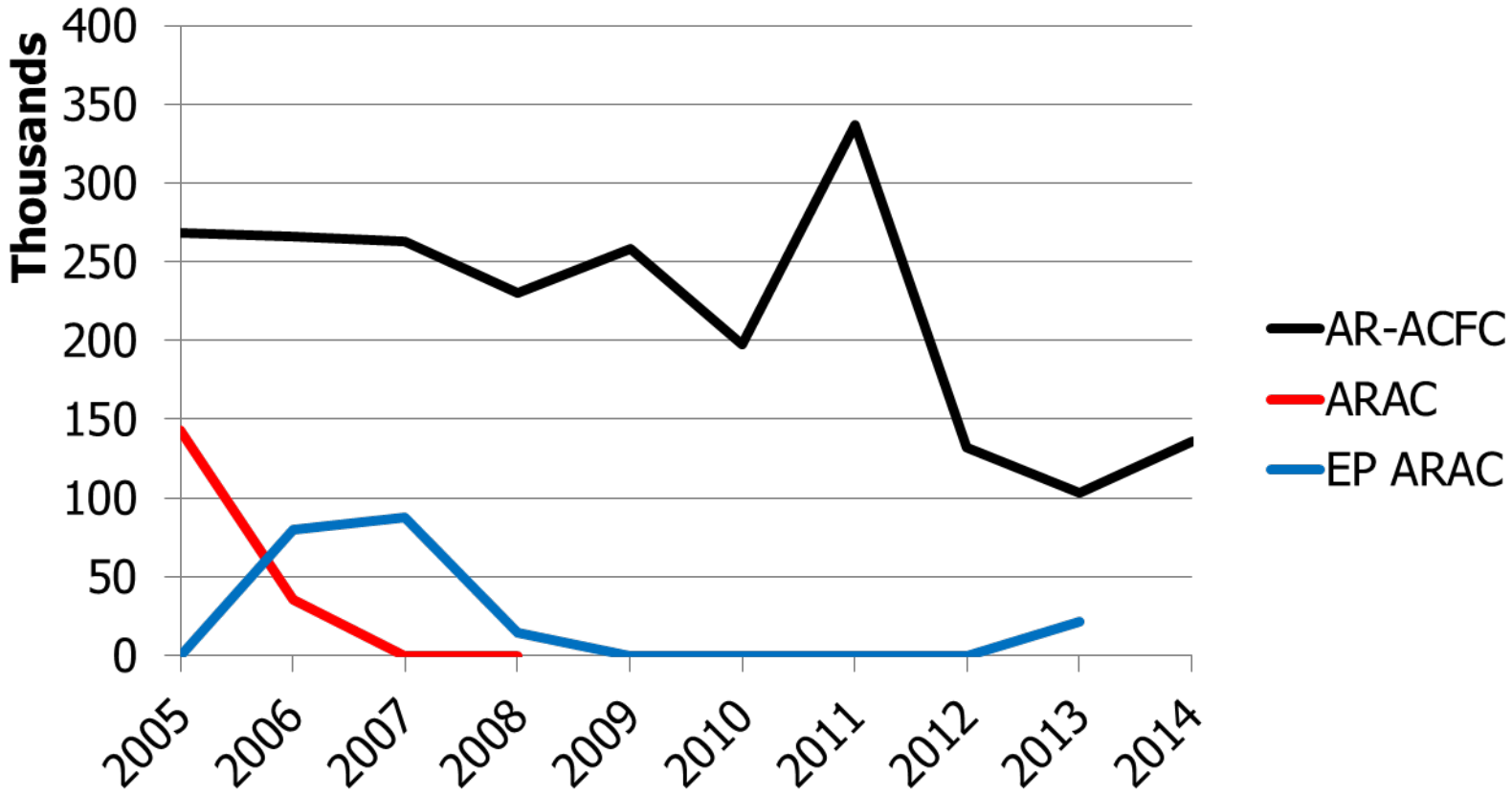
ARAC Design

- Design for 4.5 to 5.5% air voids
- Minimum VMA specified
- Have to watch for building of VMA by binder

Early Mix Usage



Recent Mix Usage



What does Asphalt Rubber do for us?

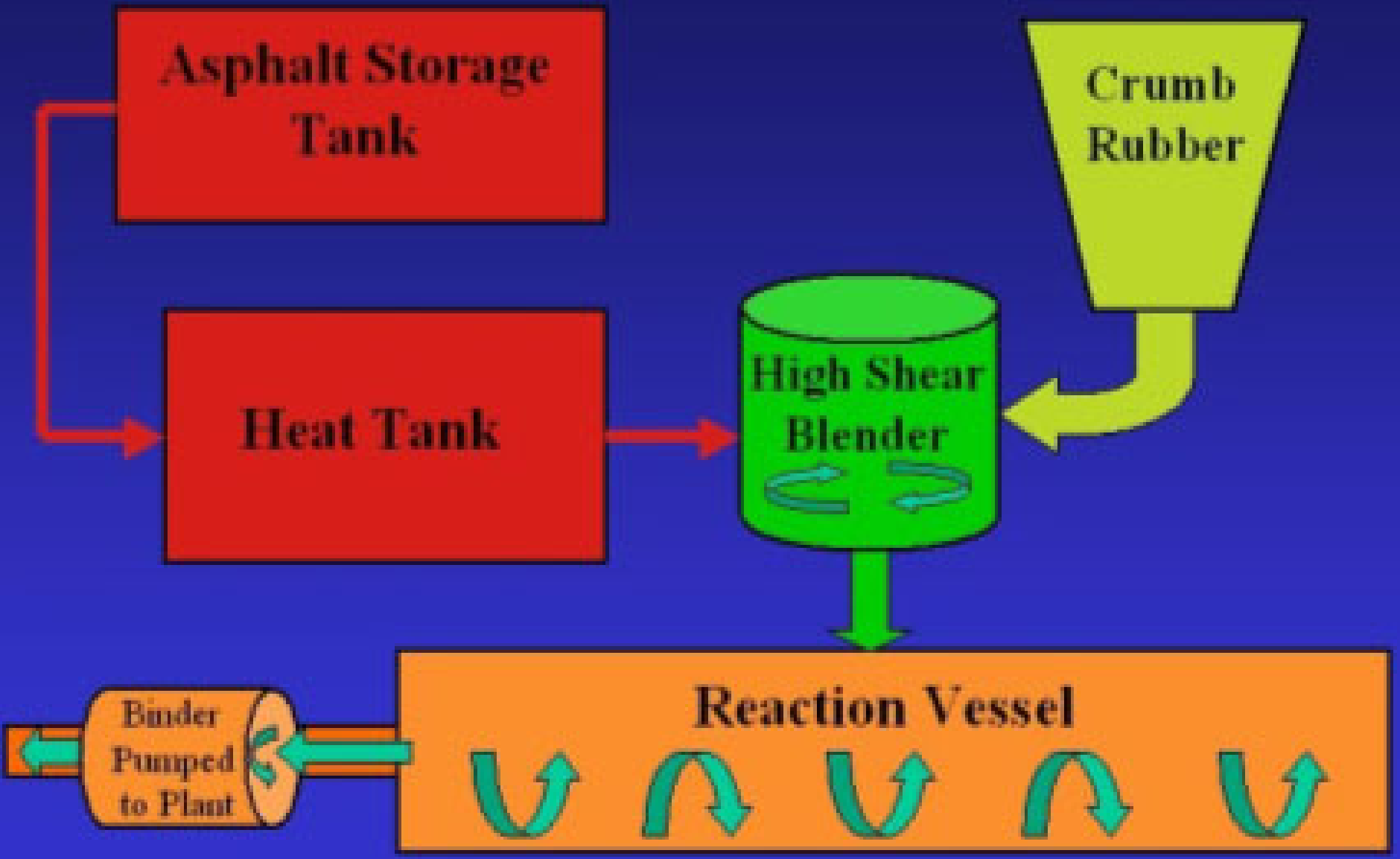
- Nature of wet process asphalt rubber binder allows the use of approximately 2% more binder than with asphalt cement
- Elastic properties slow reflective cracking
- Asphalt rubber binder does not seem to age as rapidly as asphalt cement
- It lasts!
- Reduces noise – Quiet Pavement Program
- It is not without its cost$$

About 1000 Tires Per Lane Mile

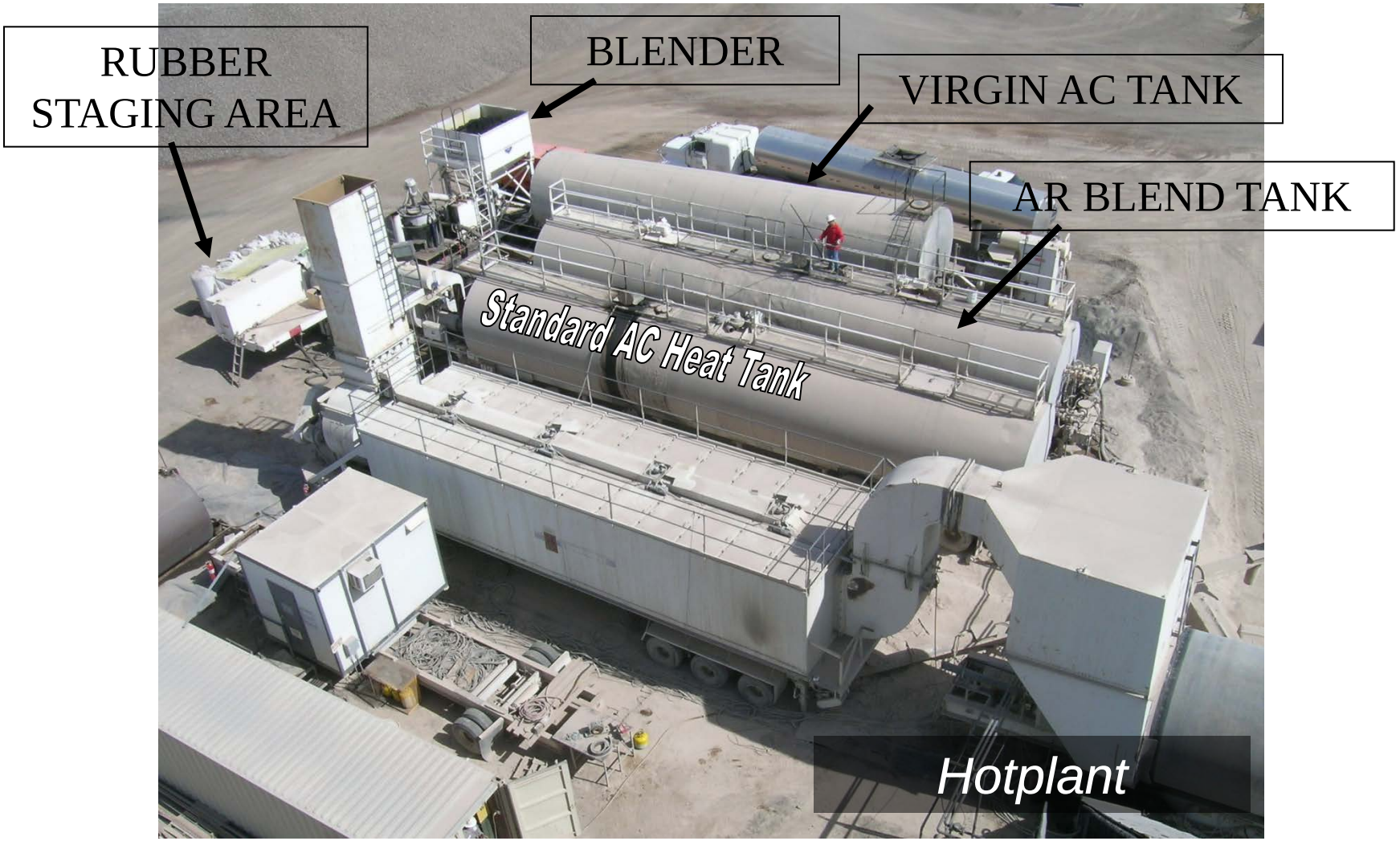
Crumb Rubber Asphalt

How is it made?

Asphalt Rubber Blending Schematic



An aerial view of a portable Asphalt-Rubber Plant setup at a Hotplant.



Mix Placement

Placement

- Seasonal placement (not too cold, not too hot)
- Not as workable as traditional mixes (minimize raking)
- Application of lime water can be used after paving to help “cure” the surface


SPEED
LIMIT
55


HERITAGE


CAT

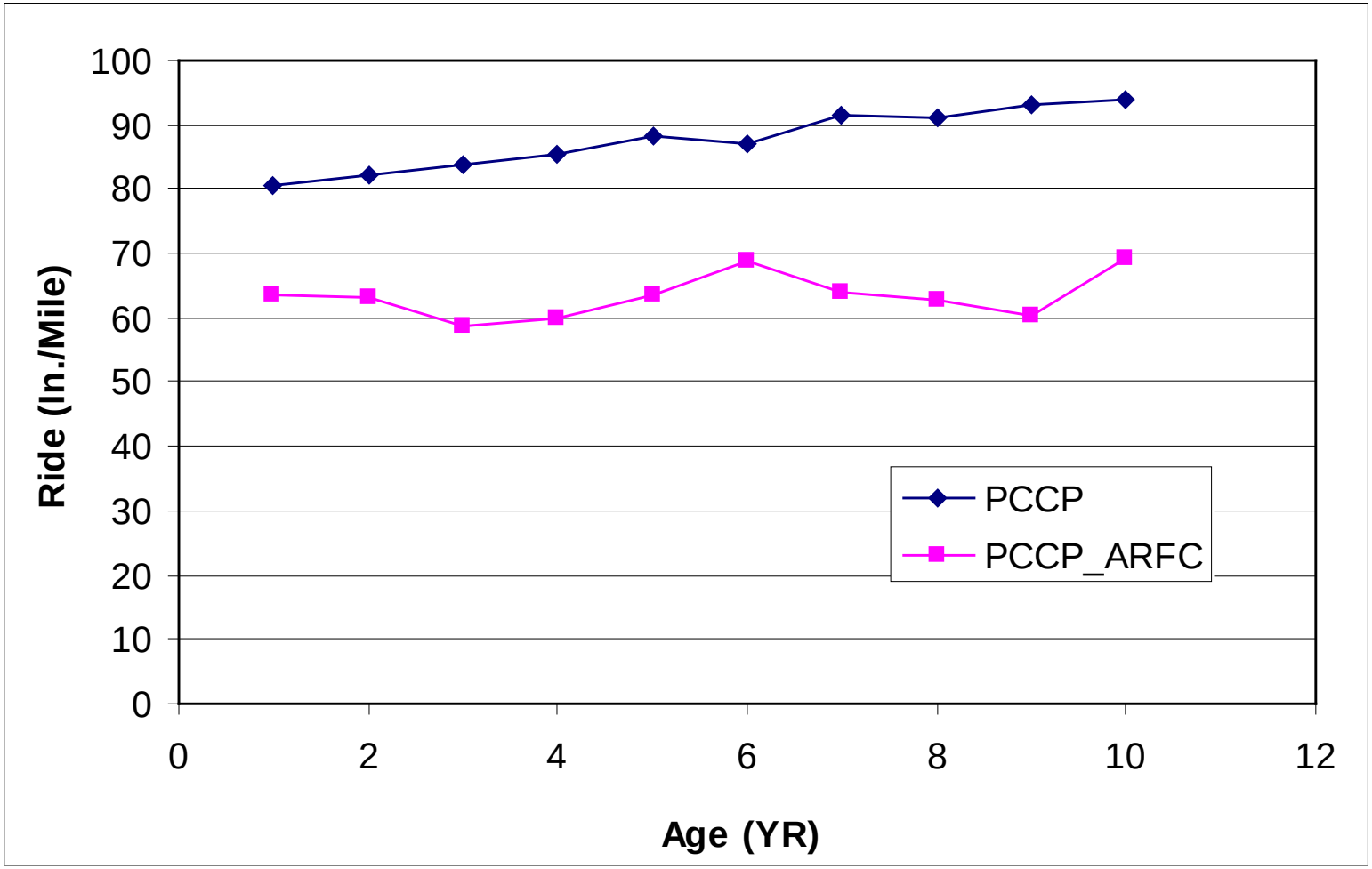

CAT


SPEED LIMIT 45

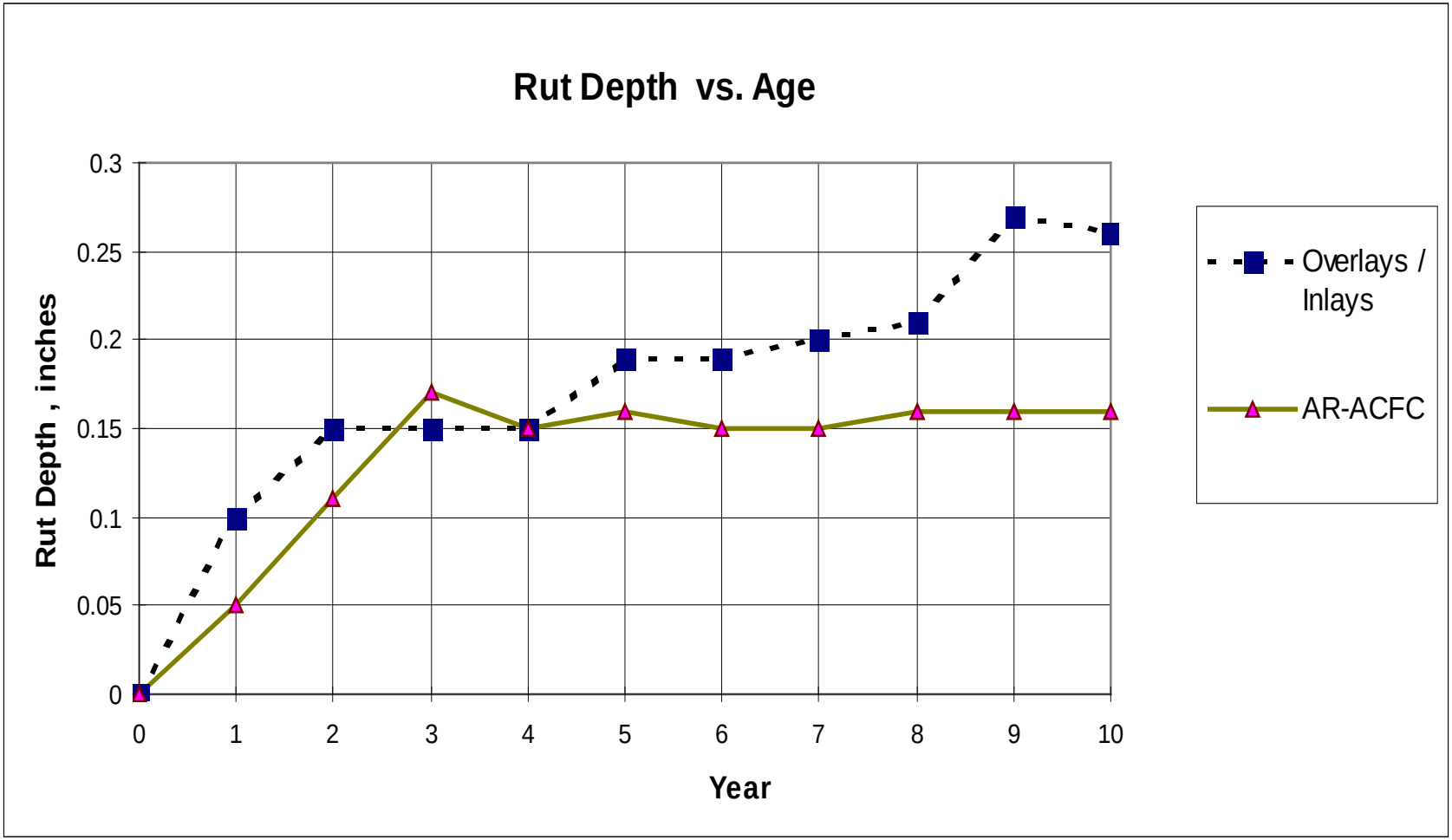

CAT
HOV 2+

Asphalt Rubber Performance

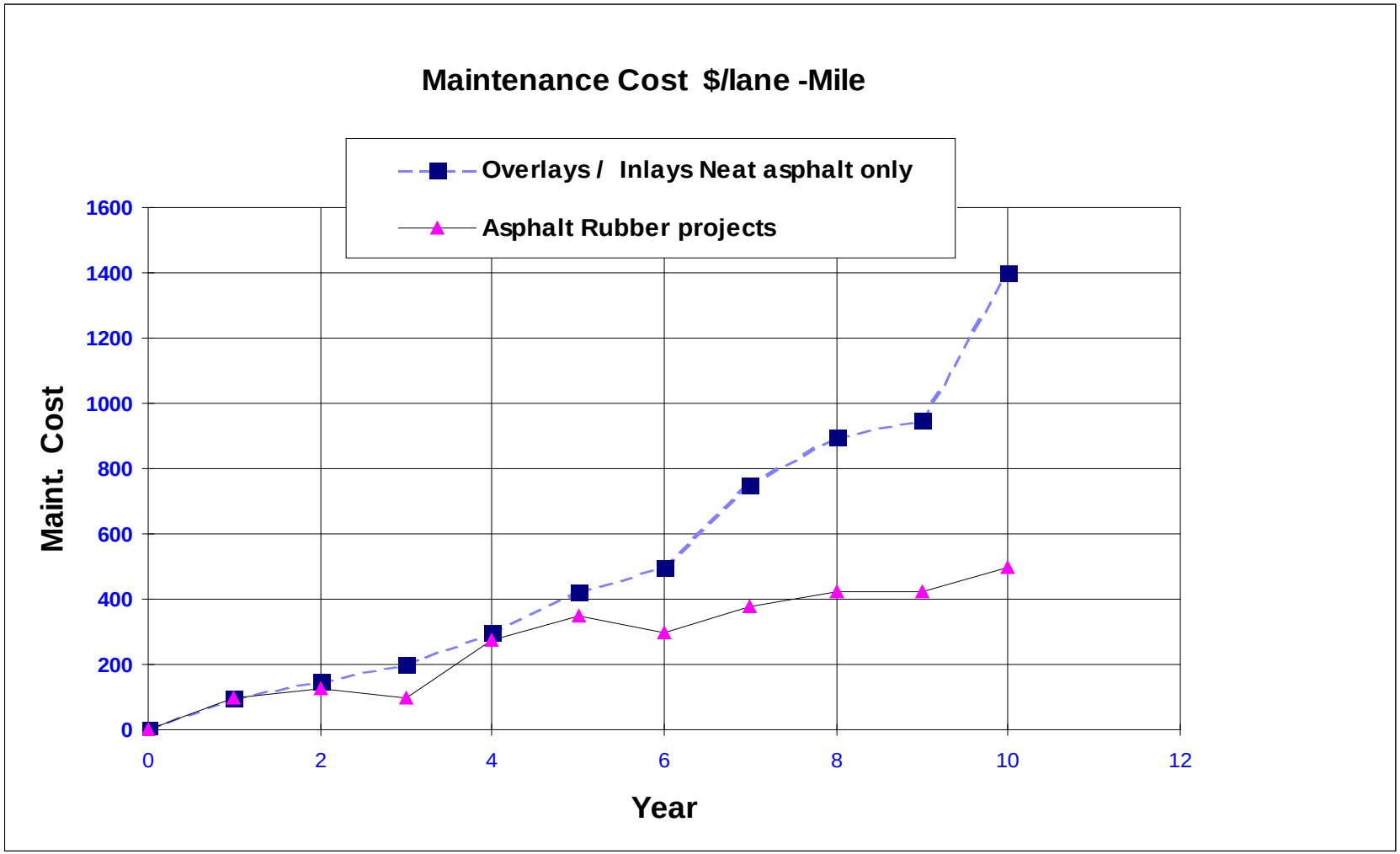
Smoothness


100
90
80
70
60
50
40
30
20
10
0
Ride (In./Mile)
0
2
4
6
8
10
12
Age (YR)
PCCP
PCCP_ARFC

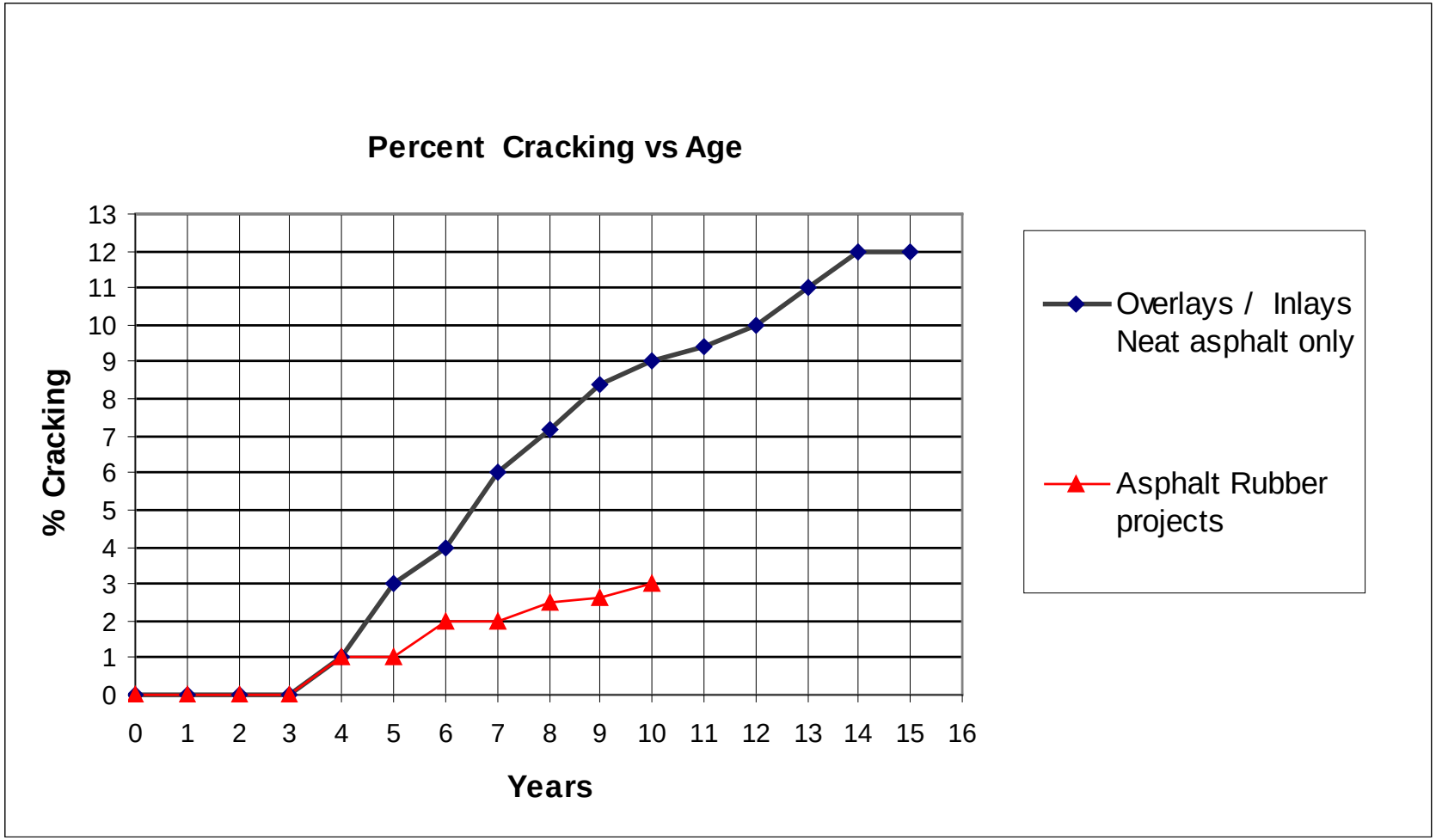
Rutting


Rut Depth vs. Age
Rut Depth , inches
0.3
0.25
0.2
0.15
0.1
0.05
0
0
1
2
3
4
5
6
7
8
9
10
Year
Overlays / Inlays
AR-ACFC

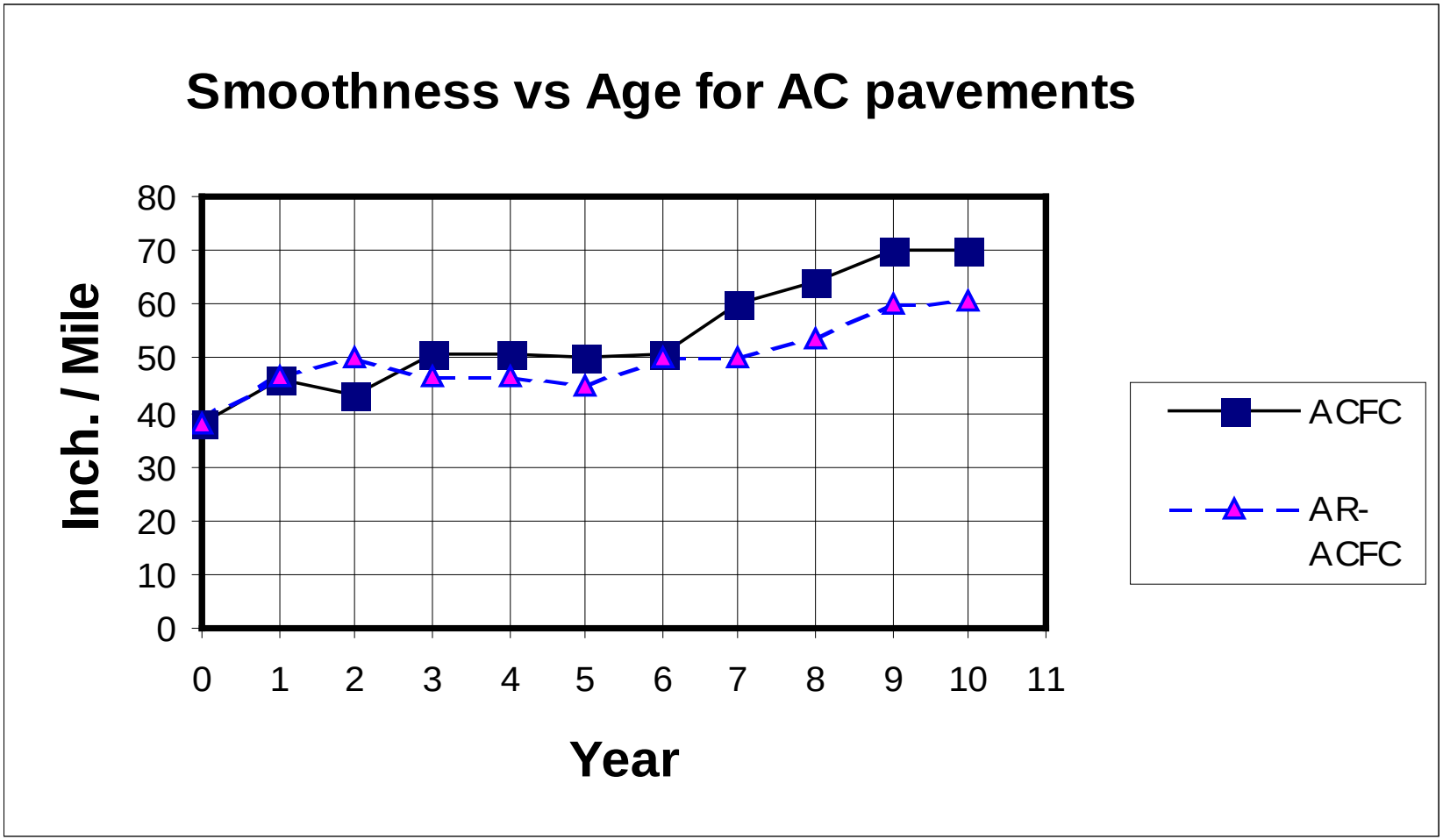
Maintenance Costs



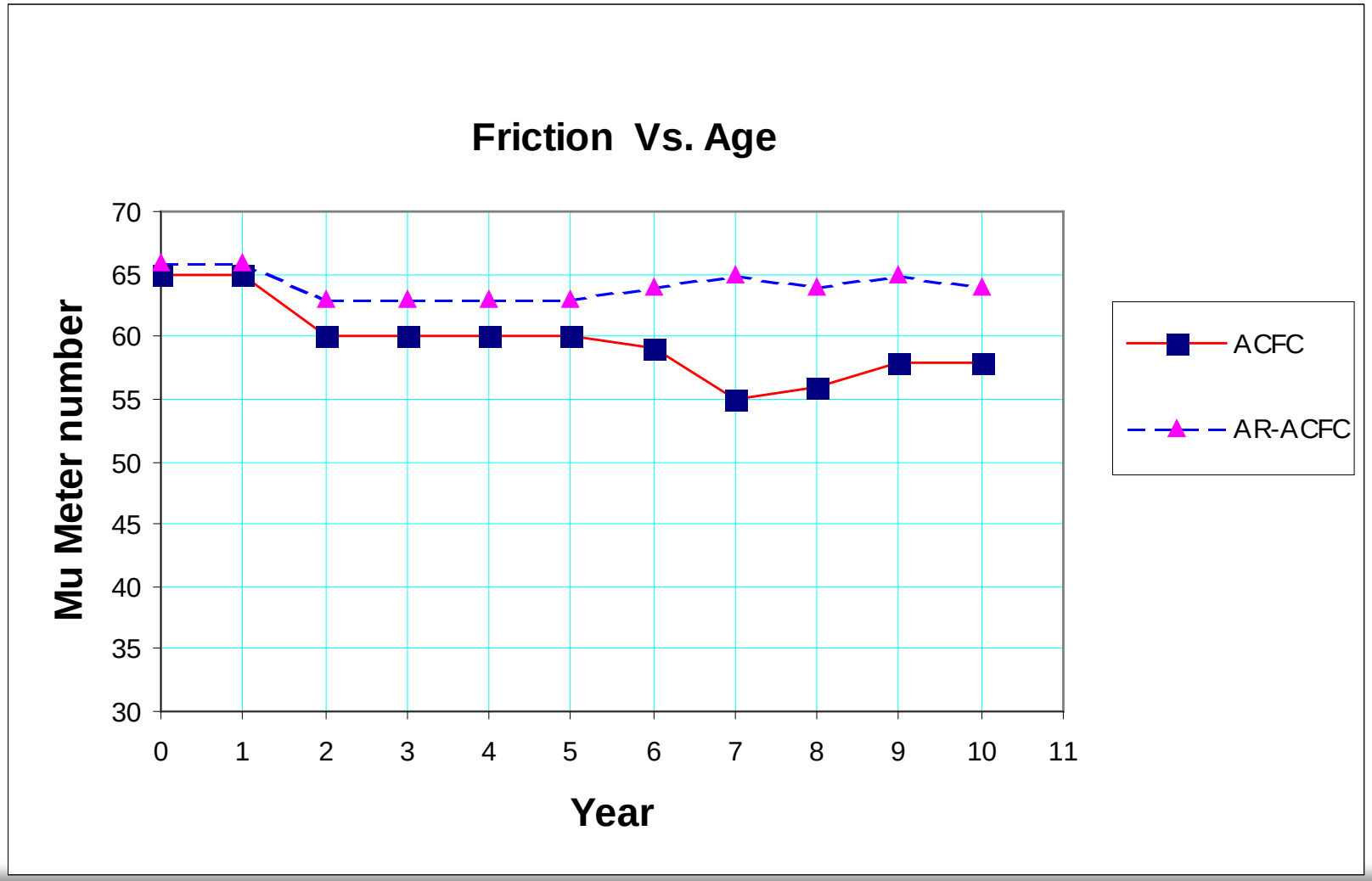
Cracking


Percent Cracking vs Age
% Cracking
0
1
2
3
4
5
6
7
8
9
10
11
12
13
Years
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16
Overlays / Inlays
Neat asphalt only
Asphalt Rubber
projects

Smoothness (AR-ACFC v. ACFC)

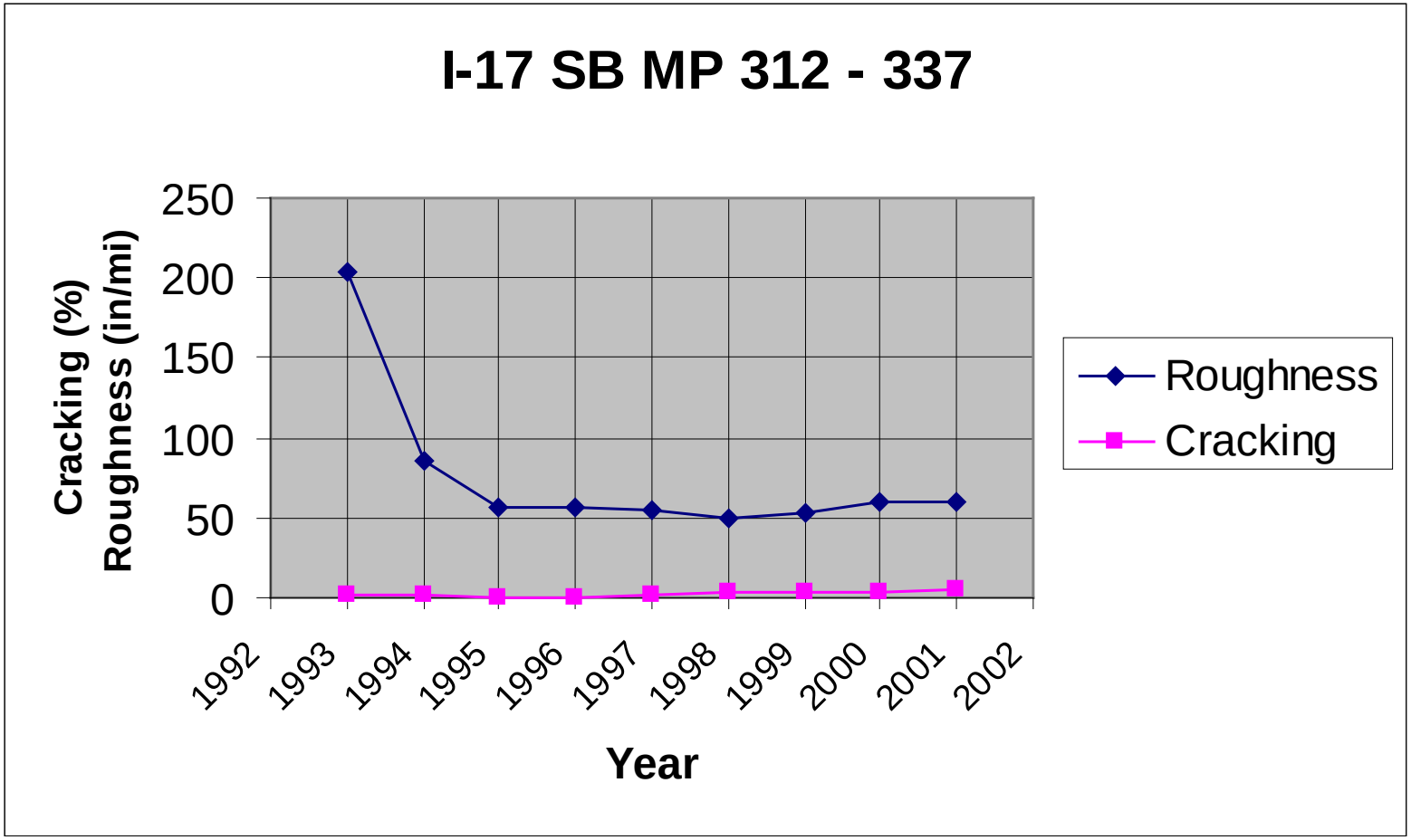


Friction Levels
AR-ACFC v. ACFC



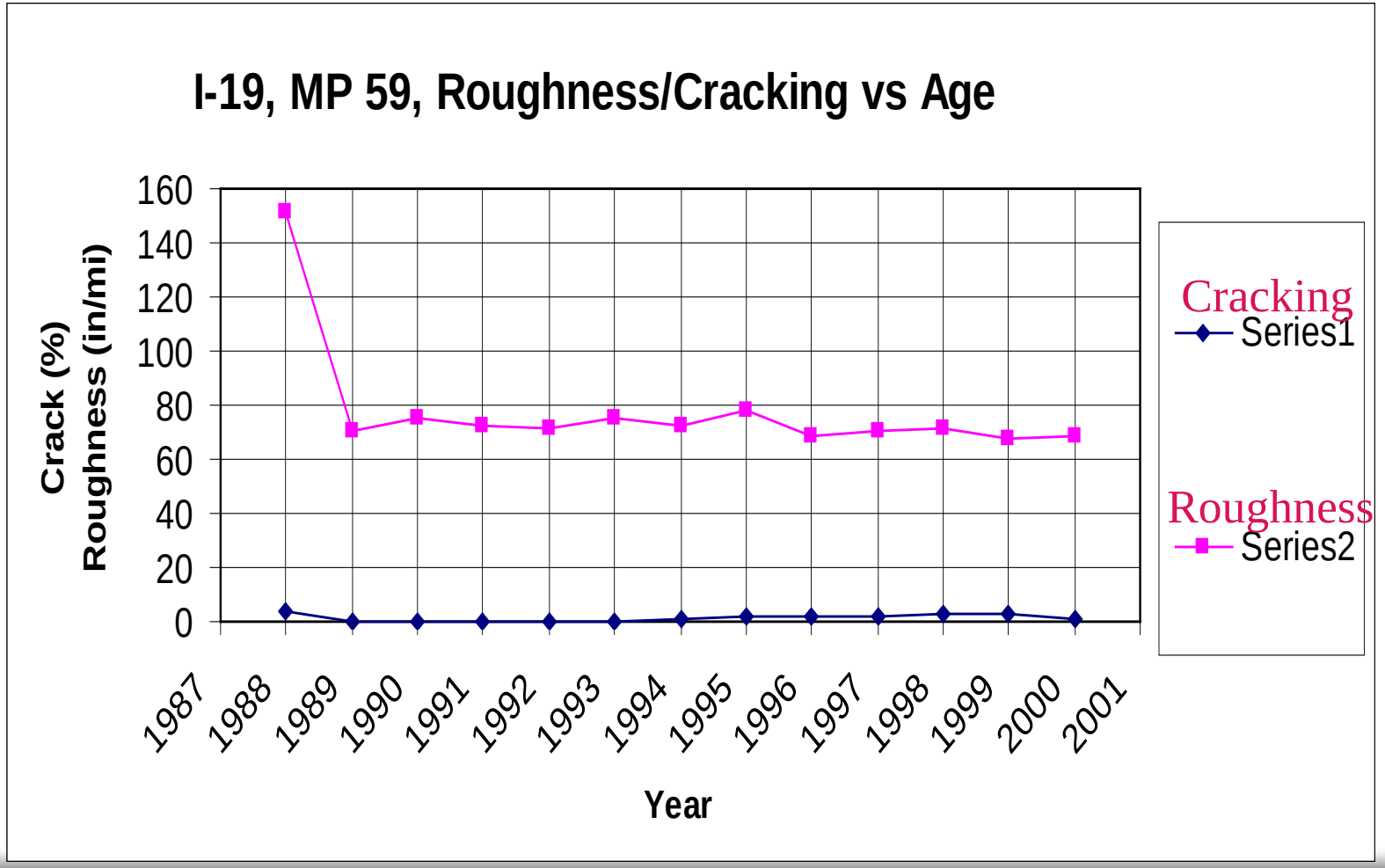
I-17 SB ARFC placed in 1994, elev. 6800‘

I-17 SB MP 312 – 337



I-19 AR-ACFC
placed in 1988, elev. 2700’

I-19
Project built in 1988



Its Perfect, isn't it?

When things go wrong….

I-17

Problem 1

I-17

The new Problem

I-40 - Jack Rabbit

SR 260

The Summer Problem


ACE

Questions?