Ground Tire Rubber in Asphalt Paving Applications

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Presentation Outline

- Processes
- Research
- Successful long-term performance
- New programs build on success
- Future Applications

The Processes

- The Wet Process – adds rubber to the binder, gets the rubber wet
- Field Blend – Coarse rubber added to binder at the hot plant, a binder and mix modifier
- Terminal Blend – Fine rubber added to the binder at the asphalt terminal, rubber is mostly dissolved, used to promote polymer linking
- Dry Process – Rubber replaces some of the fine aggregate

The Processes

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Advantages of Asphalt Rubber Binder

The increased viscosity allows for increased asphalt film thickness which enhances:

- Aggregate retention
- Eliminates drain-down problems
- Increases resistance to moisture damage
- Increases resistance to bleeding, flushing and deformation
- Reduces aging of the mix.

Asphalt Rubber Chip Seal

Whole Tire Shredded Down to 2 Inch Chips

Secondary Granulation ¾ Inch Being Reduced to 3/8 Inch While Separating Fabric and Steel

Finish Product and Bagging

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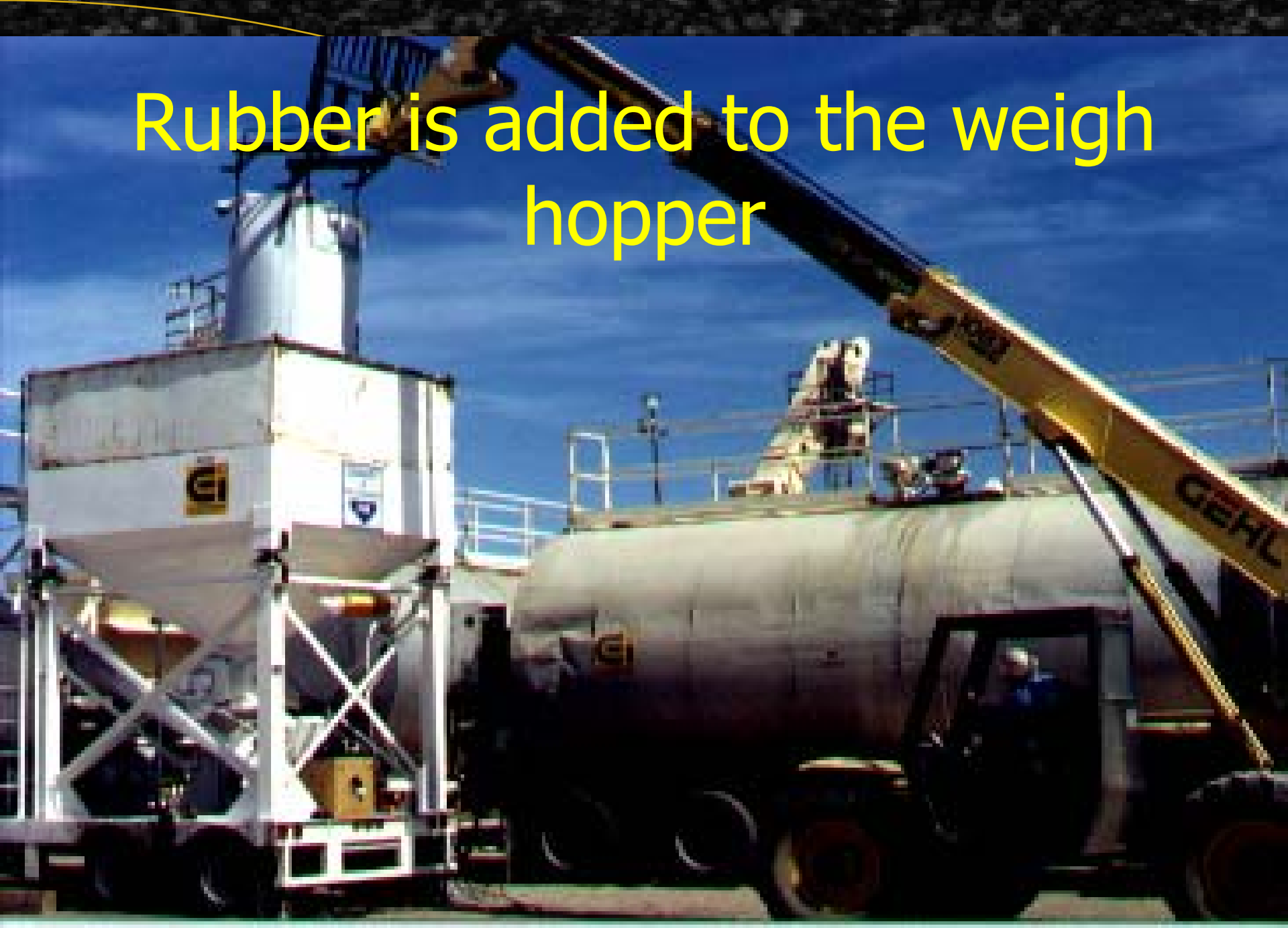
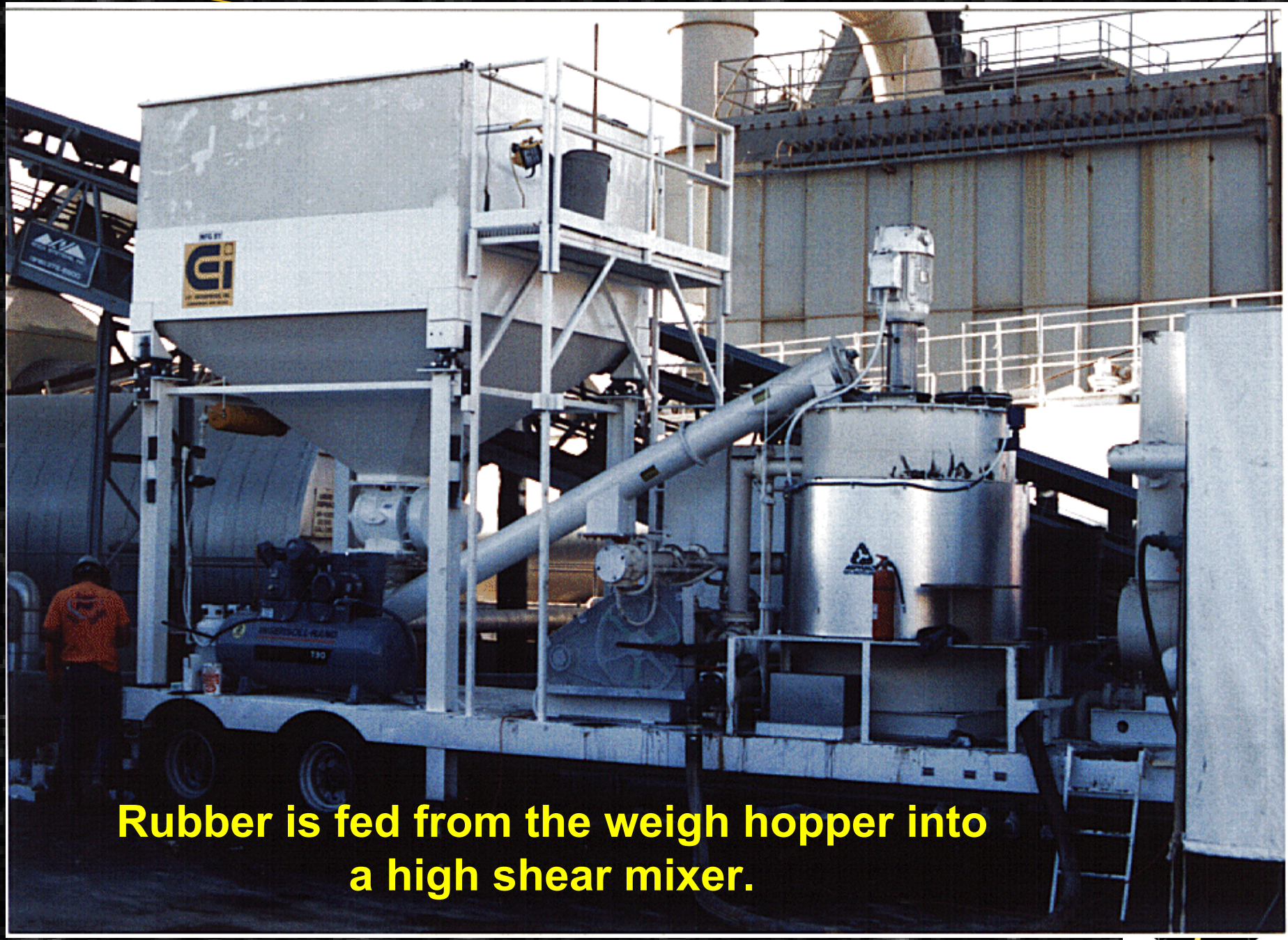
Rubber is delivered to the jobsite in Super Sacks

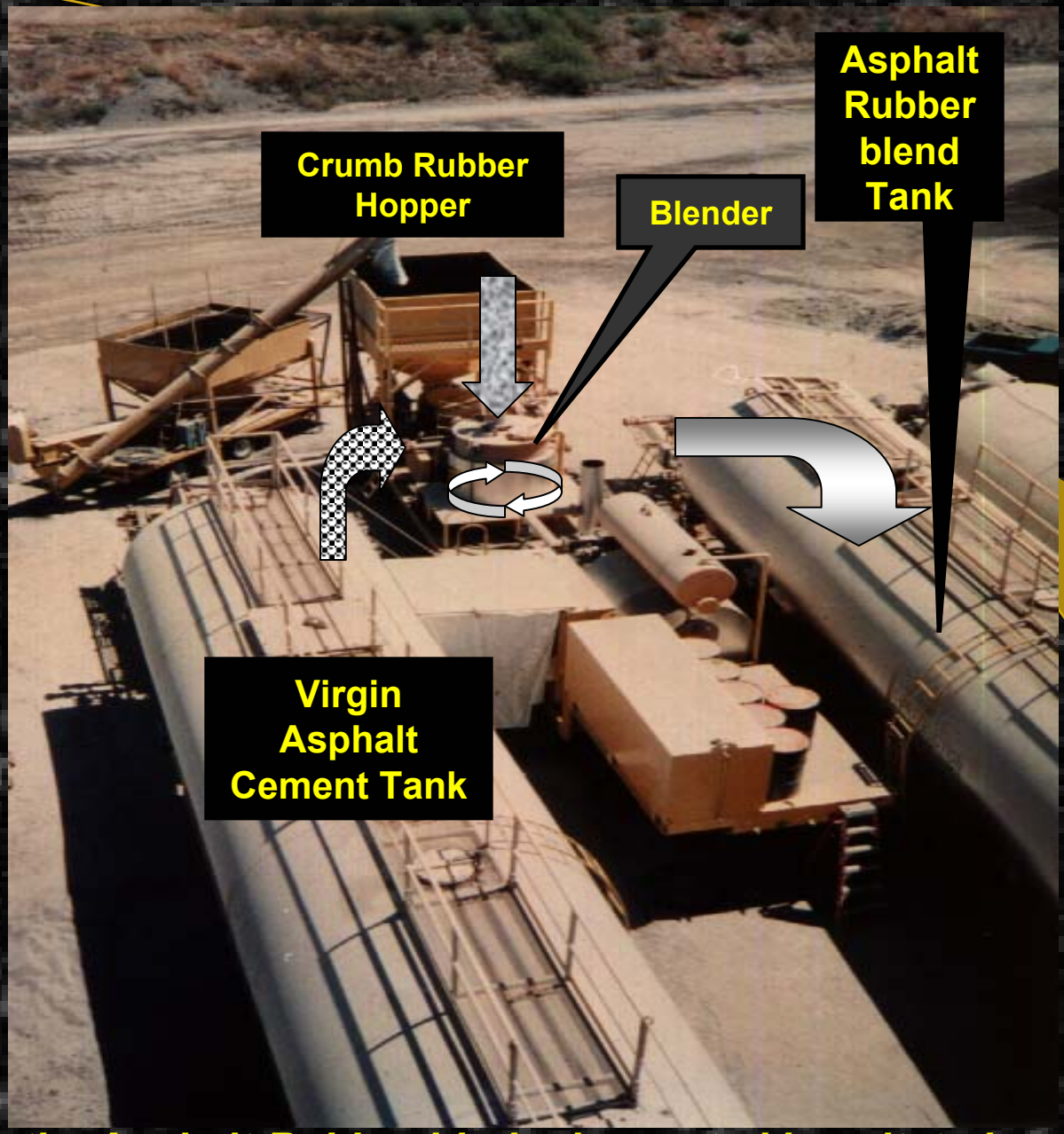
Rubber is added to the weigh hopper





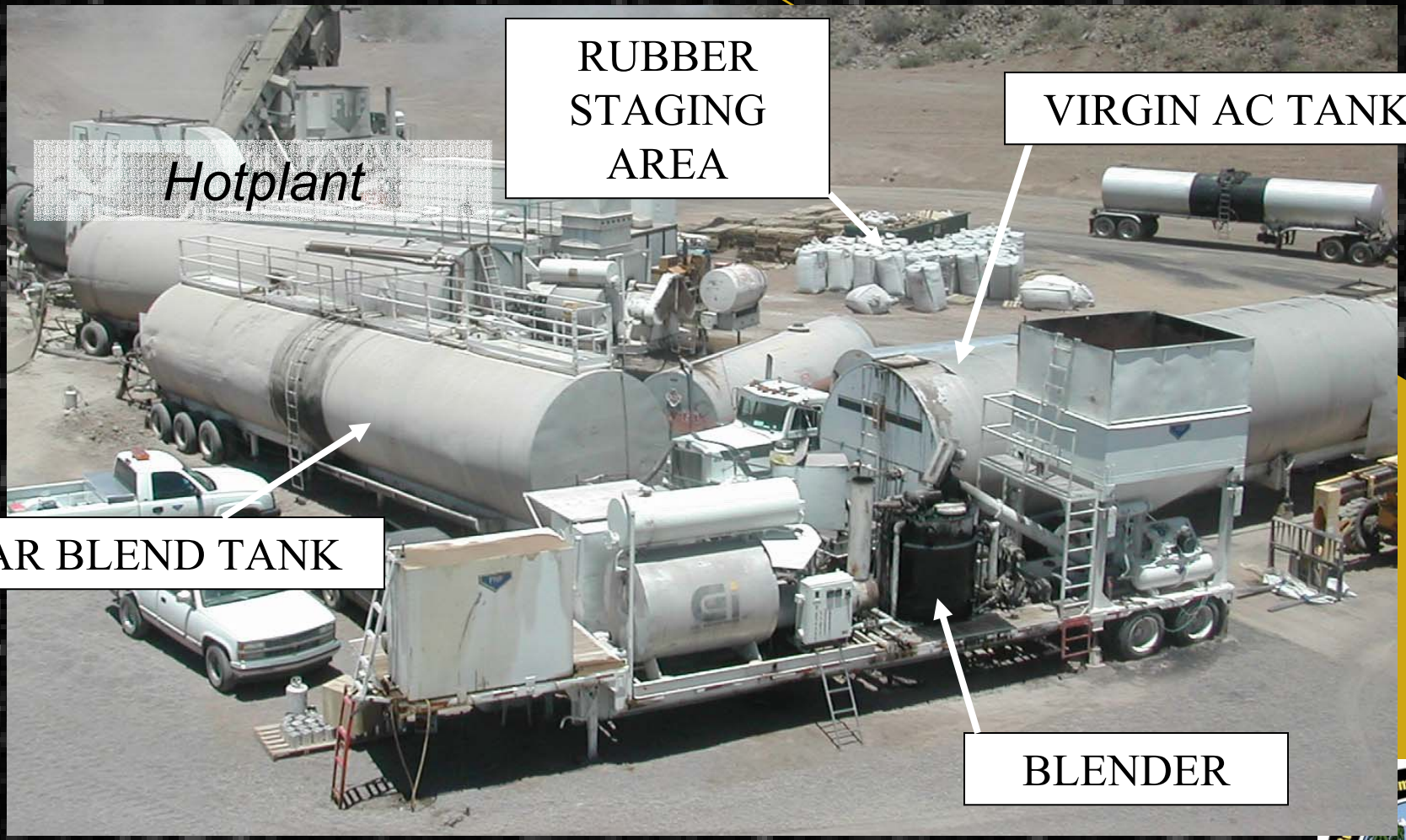
Rubber is fed from the weigh hopper into a high shear mixer.

Rubber is blended with liquid asphalt heated in excess of 350° F.

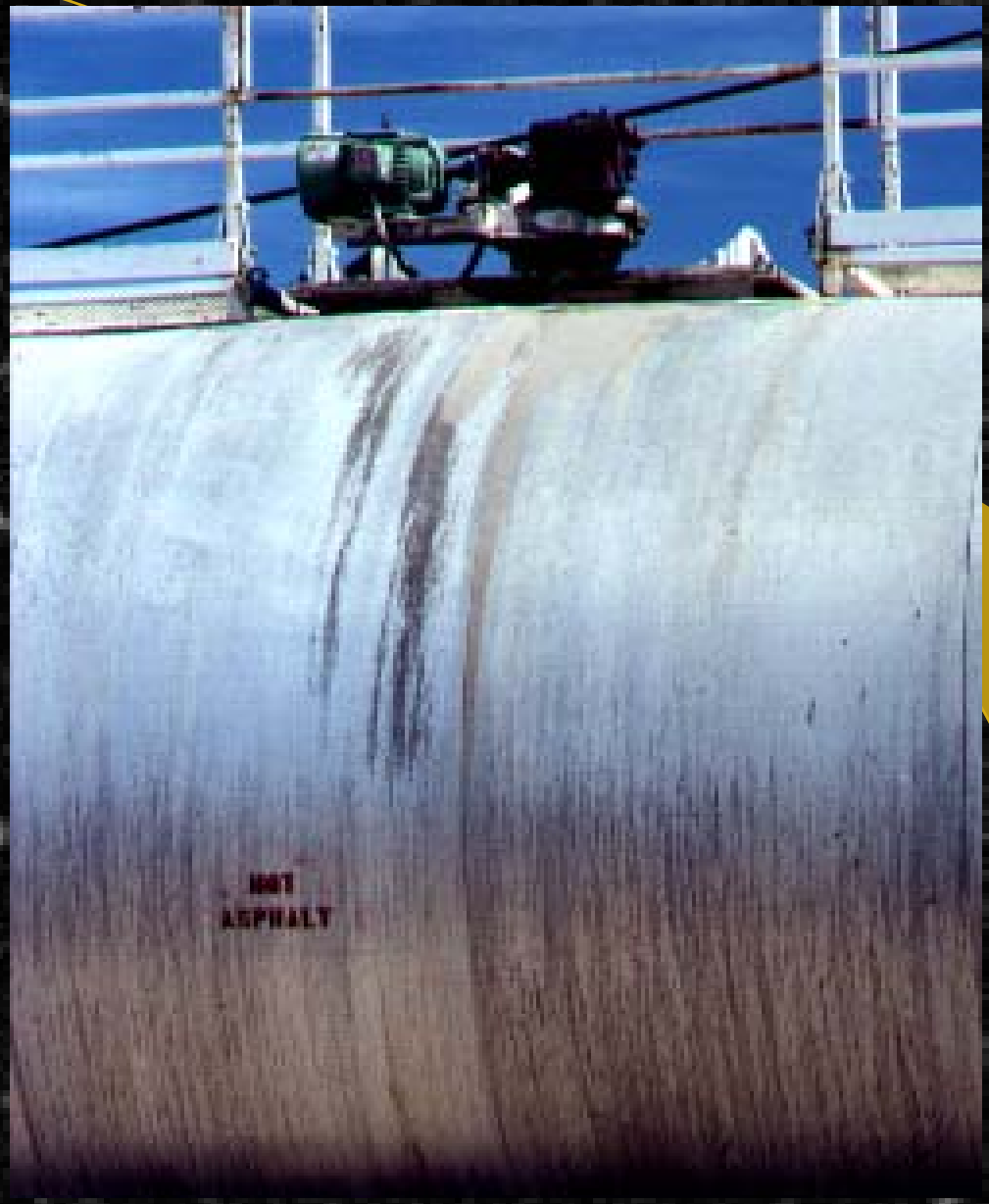


Once blended, the Asphalt-Rubber binder is reacted in agitated tanks for 45-60 minutes depending on specifications.

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



Augers keep the material blended and the rubber in suspension.



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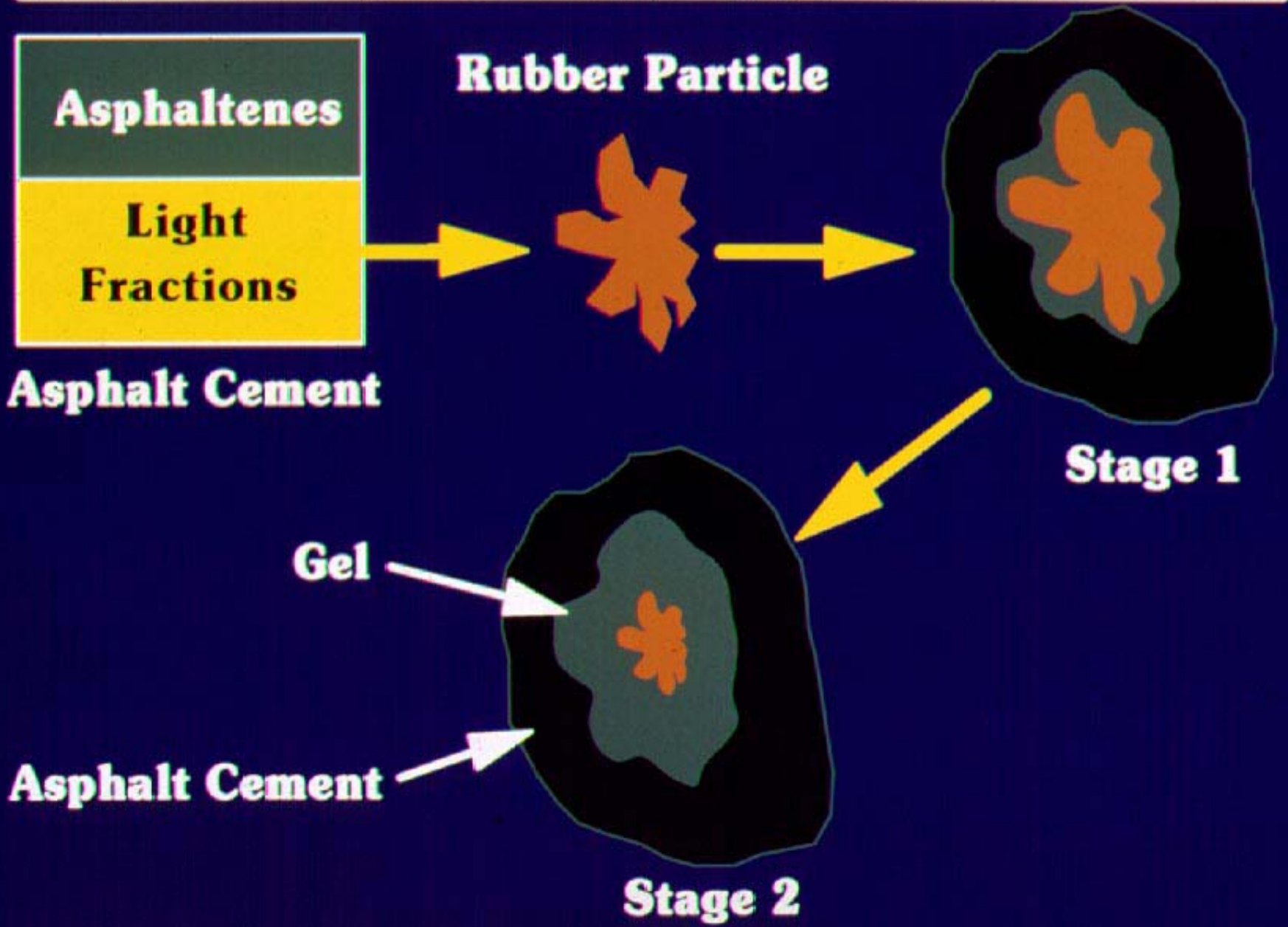
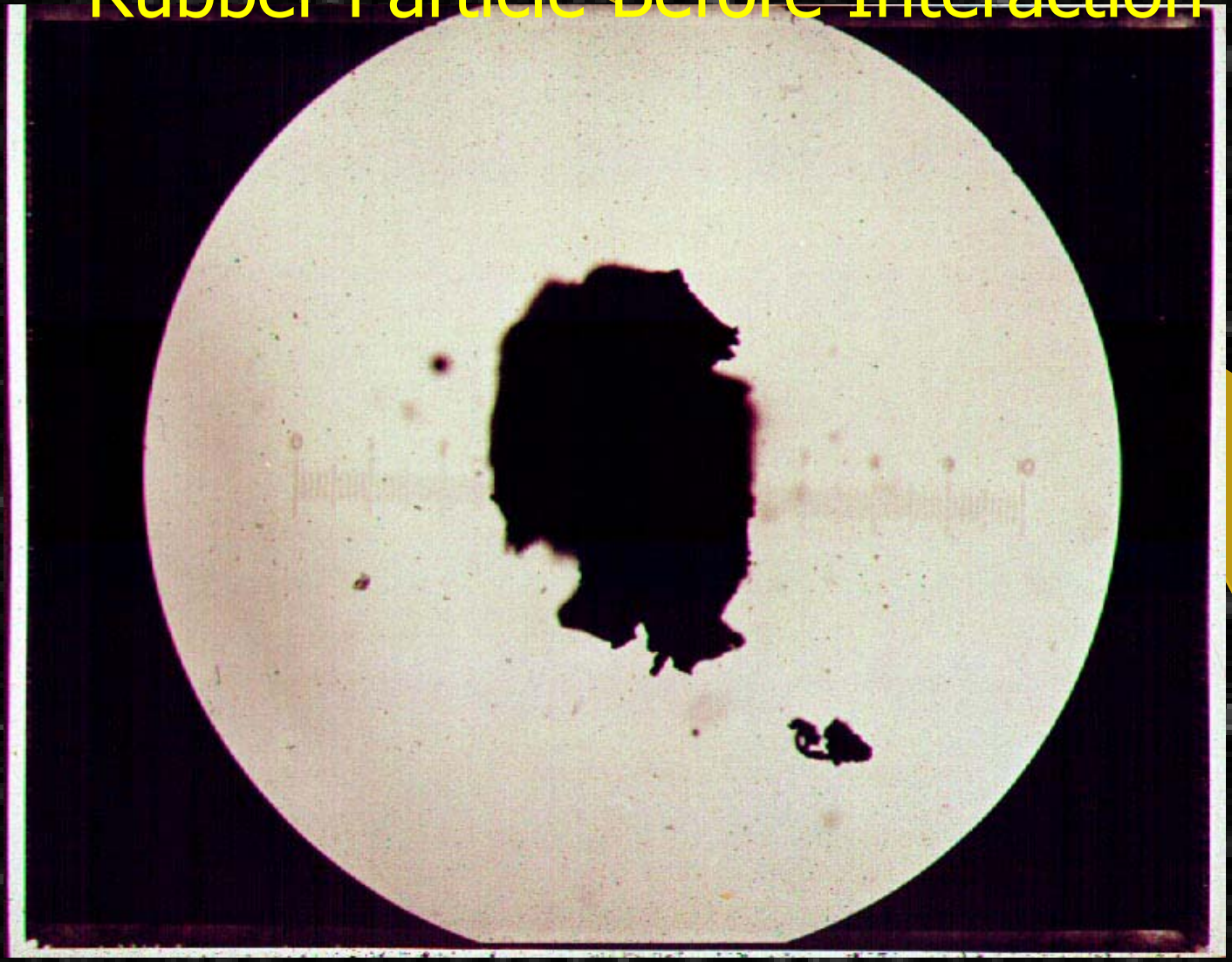
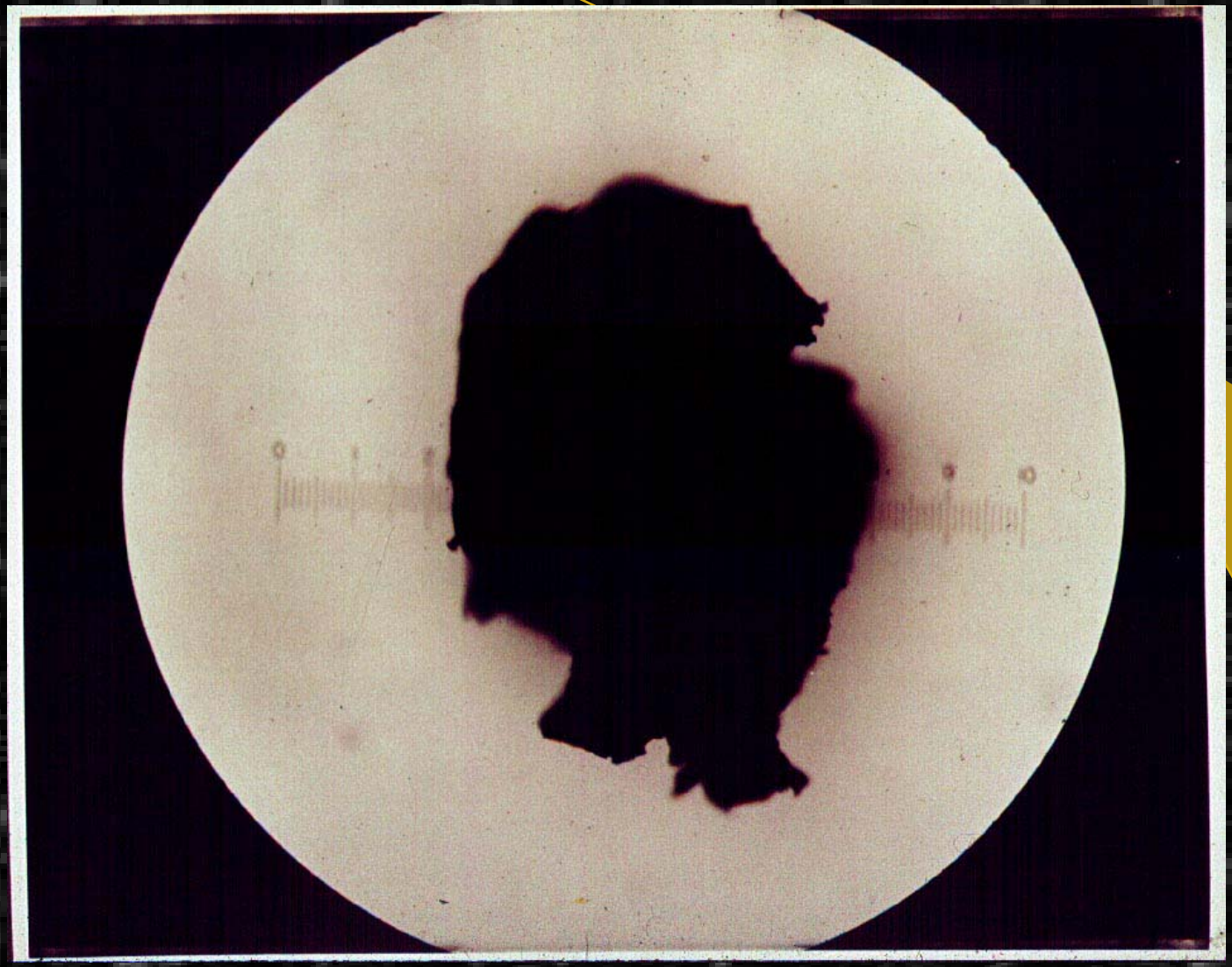
Reaction Stages of Asphalt & Rubber



Rubber Particle Before Interaction

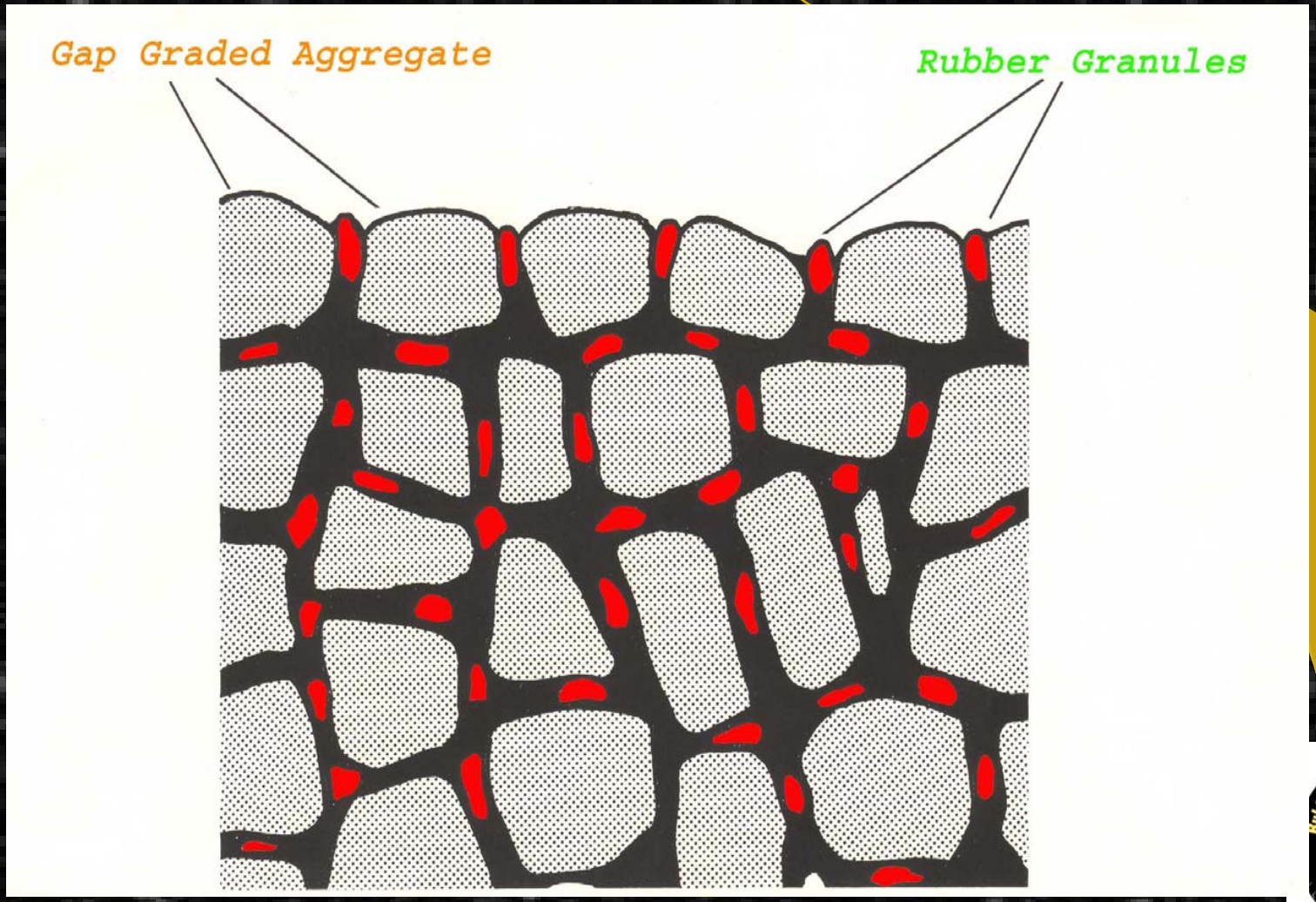


Rubber Particle After Interaction



Binder Quality Control Monitored by the Handheld Viscometer

Field Blend Rubber Hot Mix - Rubber Modifies Binder and Mixture



Metric Ton of Mix

Mix Type	Kgs of Asphalt	Kgs of Rubber	Kgs of Stone
HMA	42	0	958
Gap Graded	48	12	940
Open Graded	66	16	918

Asphalt Is Good!

Rubber Mixes Use More Of It!

30-60% More in Hot Mixes

I-17 2.5 cm ARFC over PCCP

Advantages of Asphalt Rubber OGFC

- Increased skid resistance
- Noise reduction
- Reduced vehicle spray on wet surfaces
- Increased draining characteristics
- Increased durability
- Resistance to cracking
- Improved smoothness

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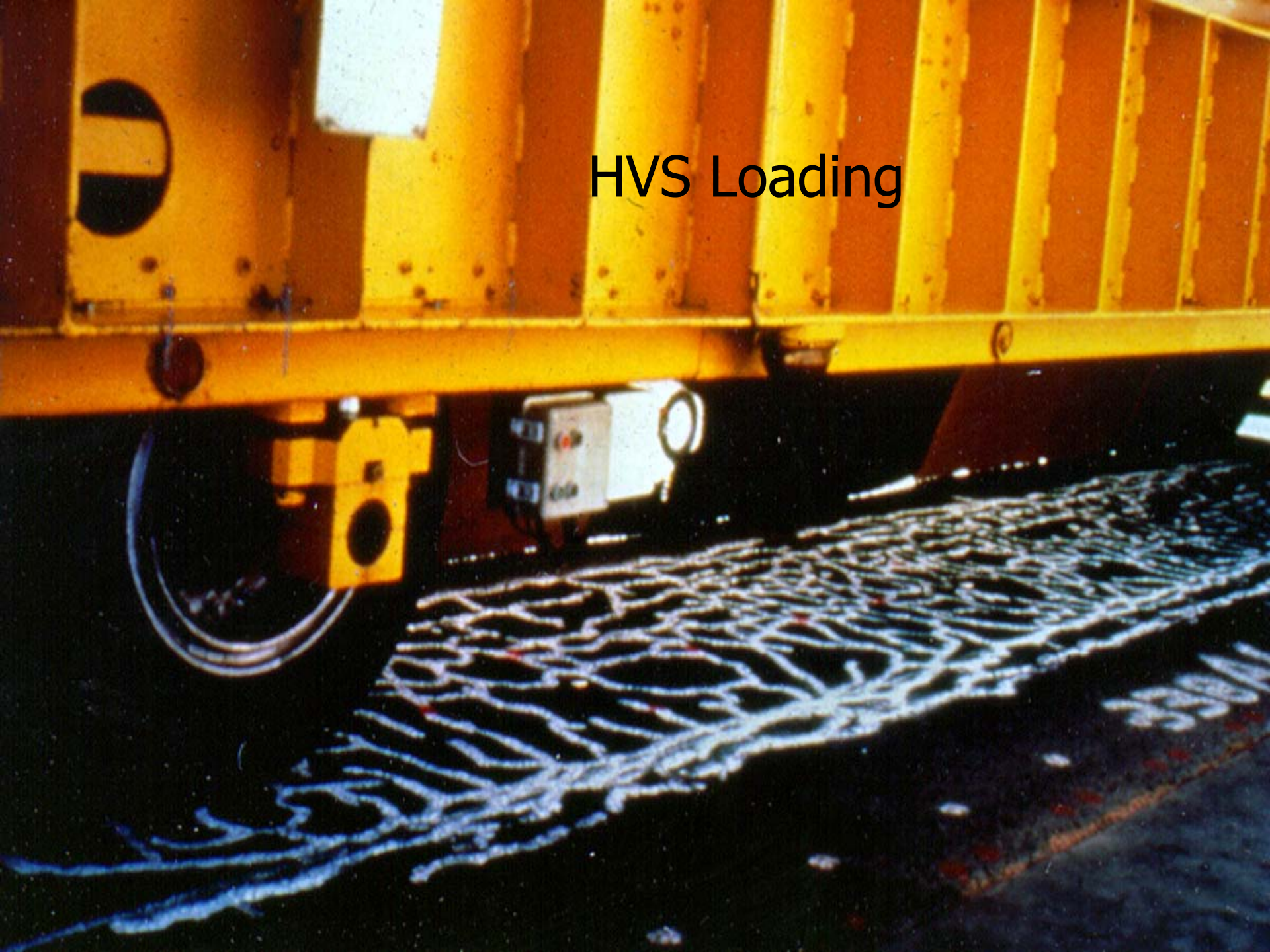
Heavy Vehicle Simulator Testing 1993

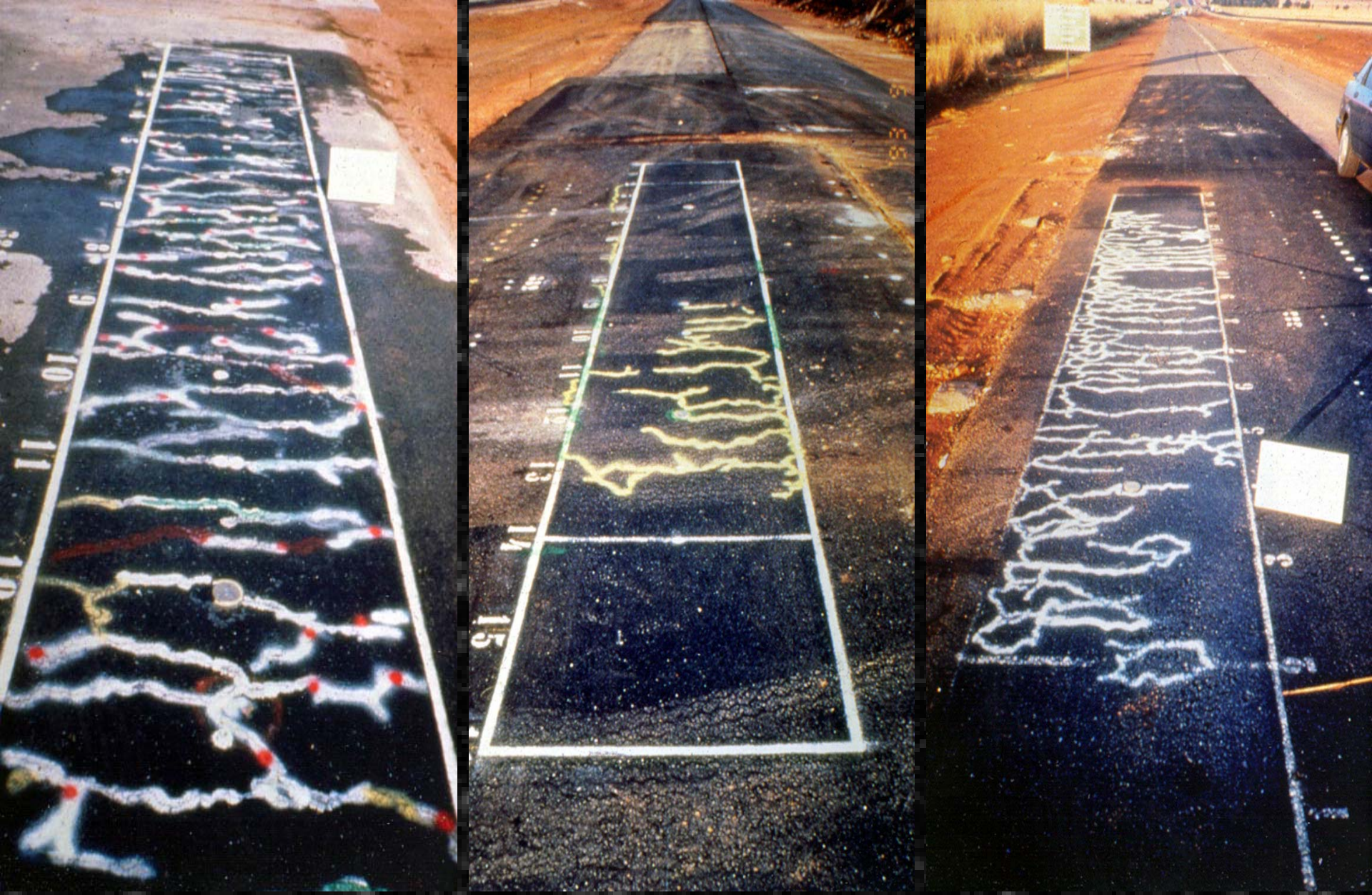
- UC Berkeley
- Dynatest
- Caltrans
- South Africa Council of Scientific and Industrial Research

Heavy Vehicle Simulator


HVS Loading

Performance

Repetitions	Wheel Load	AC Overlay Section (75mm)	ARHM-GG Section (38mm)	ARHM-GG Section (25mm)
0-100,000	40kN	Fine cracks at 100,000	—	—
100,000 to 175,000	40kN	Block cracks at 175,000	—	—
Wheel load Changed to 80 kN				
175,000 to 200,000	80kN	Completely cracked	—	Fine cracks
200,000 to 237,000	80kN	Test stopped	—	Completely cracked
Surface Temperature Reduced to –5 C				
237,000 to 250,000	80kN	Test stopped	1/2 of section cracked	Test stopped


75 mm DGAC
38 mm ARHM
25 mm ARHM

CALTRANS Structural Equivalency Tables (Thickness in feet)

DGAC	ARHM-GG1	ARHM-GG w/SAMI
0.15	0.10[a]	----
0.20	0.10	----
0.25	0.15	0.10
0.30	0.15	0.10
0.35	0.20	0.15
0.40	0.20	0.15
0.45	0.15[b]	0.20
0.50	0.15[c]	0.20
0.55	0.20[b]	0.15[b]
0.60	0.20[c]	0.15[c]

a - The minimum allowable ARHM-GG lift thickness is 0.10'.

b - Place 0.15' of new DGAC first.

c - Place 0.20' of new DGAC first.

Notes: The maximum allowable non-experimental equivalency for ARHM-GG is 2:, ARHM-GG may not prevent cold weather induced transverse cracks.

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CALTRANS Crack Reflection Retardation Equivalencies

DGAC	ARHM-GG	ARHM-GG w/SAMI
0.15	0.10[a]	---
0.20	0.10	---
0.25	0.15	---
0.30	0.15	---
0.35[b]	0.15 or 0.20[c]	0.10[d]

a - The minimum allowable thickness is 0.10’

b - A DGAC thickness of 0.35’ is the maximum recommended by Caltrans for reflection crack retardation

c - Use 0.15’ if the crack width is< 1/8” and 0.20’ if the crack is >= 1/8”

d - Use if the crack width is >= 1/8”. If < 1/8”, use another strategy

ARHM-GG may not prevent cold weather induced transverse cracks

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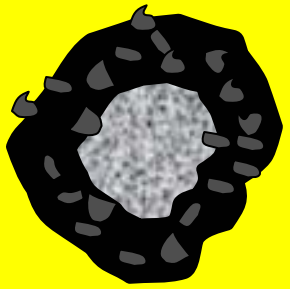
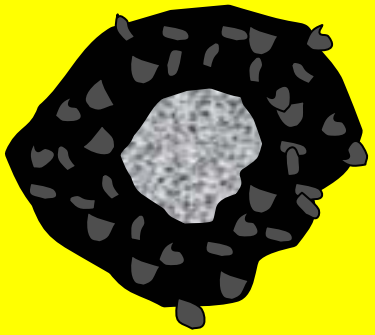
Recent Projects

- Mechanistic Overlay Design Method for Hot Mix - Sousa, Pias
- Influence of Aging on Fatigue Behavior - Raad
- A-R Design and Construction Guidelines – Hicks, Stonex
- LCCA of Asphalt Rubber Materials – Hicks, Epps
- Traffic Noise Analysis Before and After Paving with AR – Zhu, Carlson
- Stack Emissions with AR and Conventional AC – Stout, Carlson

Film Thickness on the Aggregate

Dense Graded 4.6% **HMA** **9 Micron**	
Gap Graded 7.4% **Asphalt Rubber** **18 Micron**	
Open Graded 9.2% **Asphalt Rubber** **36 Micron**	

Long Term Performance

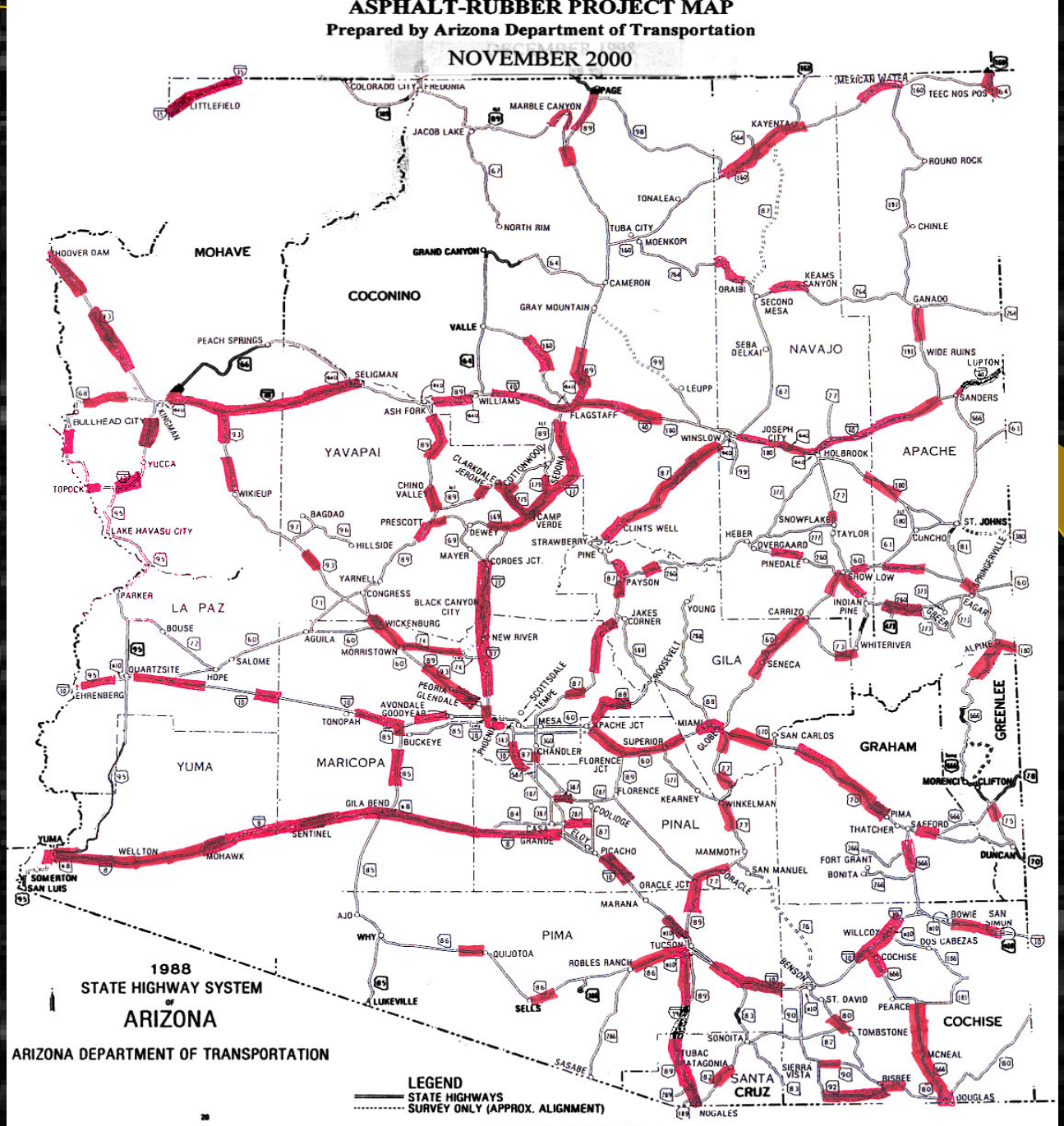
Aged Project Performance Evaluations

- Arizona
- California
- Texas

Arizona A-R Project Review 2000

- 20 projects 10 years or older
- OGFC and GG over PCCP and AC
- Almost all performing with very little maintenance
- I-19, I-40 and I-17 most notable

Asphalt-Rubber Projects 1988-2000



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California A-R Project Review

- 113 Projects built after 1995 examined in 1999.
- Only 11 with any distress, most non-binder related.
- Caltrans now routinely specifying 1.6 million tons each year.

Texas A-R Project Review

- Projects built after 1992 (patents expired) examined in 2001
- 18 Seal Coats
- 10 Hot Mix Projects
- 5 Porous Friction Courses
- Aggregate Gradation is key to Binder Success in the mixture.

New Program Developments

- Nebraska 2001
- Alberta, Canada 2002
- Colorado 2003

Nebraska Demonstration 2001

A Unique Nebraska Application


Highway 2

Highway 2 - Lincoln, Nebraska

Nebraska Demo 2002

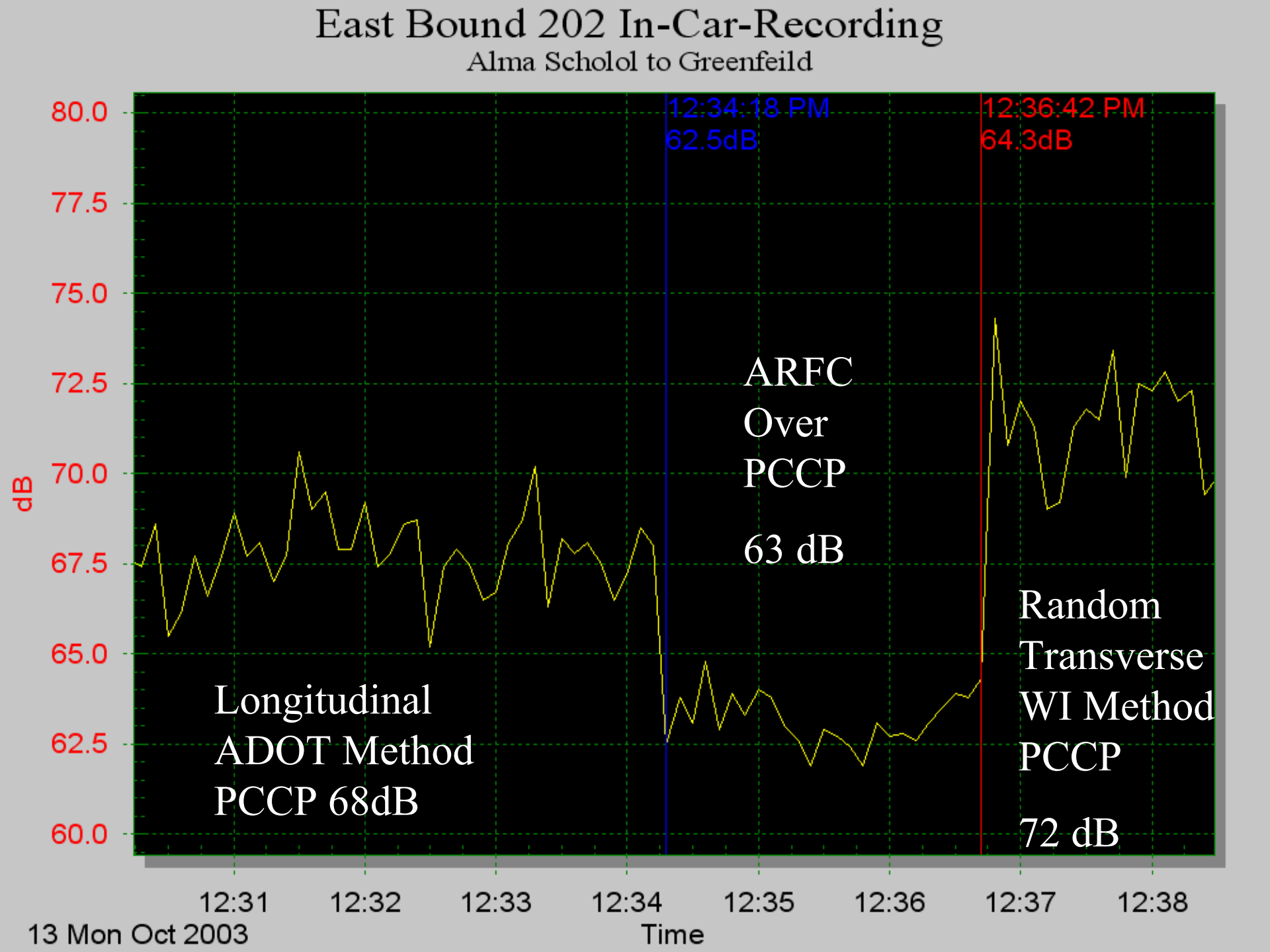
Alberta Demonstration Project 2002


MOORES
CLOTHING FOR MEN
Mark's Work Wearhouse
Petcetera
BINGO
Boston Pizza
CC42


PF-180 H
DYNAPAC

Future Applications

- Continued use in conventional paving applications
- Quiet Pavements Program very promising
- Dust Control on dirt roads in urban areas –Bituminous Surface Treatments


East Bound 202 In-Car-Recording
Alma Scholol to Greenfeild
12:34:18 PM
62.5dB
12:36:42 PM
64.3dB
80.0
77.5
75.0
72.5
70.0
67.5
65.0
62.5
60.0
dB
ARFC
Over
PCCP
63 dB
Longitudinal
ADOT Method
PCCP 68dB
Random
Transverse
WI Method
PCCP
72 dB
12:31
12:32
12:33
12:34
12:35
12:36
12:37
12:38
13 Mon Oct 2003
Time

ADOT Uses ARFC to Provide Quiet Pavements

- The ARFC is Minus 9.5mm & 9-9.5% Binder
- 12.5 mm Thick When Used on Flexible Pavement
- 25 mm Thick When Used on PCCP
- ADOT Uses Pavement Type (ARFC) as a Noise Mitigation Strategy (4 dBA)

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Noise Levels By Surface Type

104.9	Random Transverse (Wisconsin Method)
102.5	Uniform Transverse (ADOT Method-3/4”)
99.1	Longitudinal (ADOT Method-3/4”)
95.5	Whisper Grind (Industry Method)
91.8	ARFC (ADOT Method)

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BST Program Purpose To Reduce Dust

Asphalt-Rubber Application Over Dirt Surface

Phoenix BST Program

- Paved 65 miles of dirt roads and alleys within the City of Phoenix to reduce dust.
- 65,000 old tires were used
- The roads are expected to last 5-7 years
- Project cost $ 4 million.

Bituminous Surface Treatment

Thank You!

Resources online at:

www.rubberpavements.org

Cliffa@fnfinc.com