SEAL COATS
for
PAVEMENT
PRESERVATION

Presented in Cooperation with the
Louisiana Department of Transportation
and the
Louisiana Transportation Research Center


Seal Coats
For
Pavement Preservation
Chip Seal Best
Practices
JUN 23 2003

Kevin King – TXI

- 2002 – Current, TXI Highway Sales/Marketing Manager; Lightweight Aggregate Division
- 2003 -2005 TxAPA Seal Coat Committee Chairman, TxDOT/TxAPA Advisory Sub Committee Co-Chair
- 1998 – 2001, Lion Oil Company, Ergon Asphalt and Emulsions. Area Sales Manager TX-LA
- 1993 – 1998, TxDOT District Maintenance Superintendent, Bryan District
- 1989 – 1993, TxDOT District Seal Coat Project Manager, Tyler District

“Good judgment comes from experience; experience comes from bad judgment”.

-Wise Old Indian Proverb

Texas Seal Coat Statistics

- In 2005 TxDOT Seal Coated 19,374 Lane Miles
- Assuming that each lane averages 12’ wide, that is 136,392,960 Square Yards
- At .45 gallons per square yard that is 61,376,832 gallons of asphalt or emulsion
- At 1 CY/100 SY that is 1,363,930 cubic yards of aggregate
- These numbers represent Pavement Preservation seal coats only. No under seals or inverted prime seals seals are being tabulated.

Seal Coat Economics

- Assumptions: 20 mile program @ 24’ wide is 281,600 square yards.
  - Aggregate Spread Rates: S1 - 0.02 (1/50), S2 - 0.0111 (1/90), S3 - 0.0075 (1/133)
  - Asphalt Rates: .46 for the S1, .40 for the S2, .29 for the S3

Economics (cont')

- Aggregate Volumes and Costs:
  - 5632 CY's S1
    $197,120
  - 3126 CY's S2
    $109,410
  - 2112 CY's S3
    $73,920

  Assume that aggregate costs $35 per CY.

Economics (cont')

- Asphalt Volumes and Costs:
  - .46 for S1, 129,536 gals. ($155,443)
  - .40 for S2, 112,640 gals. ($135,168)
  - .29 for S3, 81,664 gals. ($97,997)

Assume that asphalt costs $1.20 per gallon

Economics (cont')

- Cost Comparison

S1, $1.25 per sq. yd., $17,628 per mile
S2, $.87 per sq. yd., $12,229 per mile
S3, $.61 per sq. yd., $ 8,596 per mile

Total Material Costs per size
S1 - $352,563
S2 - $244,578
S3 - $171,917

Economics (cont')

- Seal Coat Material Budget - $200,000
  - 11.35 mile program with S1
  - 16.35 mile program with S2
  - 23.27 mile program with S3

Just for comparison sake...at today's prices, $200,000 will get you approx. 4.2 miles of 1.5 inch hot mix overlay if you lay it yourself!

Glossary of Terms

- **Surface Treatment** - an application of asphalt material covered with a single layer of aggregate when applied to a compacted base course.
- **Fog Seal** - a light spray application of dilute asphalt emulsion used primarily to seal existing asphalt surfaces to reduce raveling and enrich dry and weathered surfaces
- **Transverse Variable Spray Bar** – the use of smaller nozzles applying less binder in the wheel paths than outside and in between. Design rate to be used in the wheel paths.
- **Rock Land** – the area covered, at the desired aggregate application rate, by one predetermined size truckload of aggregate

Rock Land Calculation

- Assumptions
  - One 14 CY dump truck,
  - Aggregate spread rate of 1/125
  - 12 ft wide lane
- (Truck capacity) x (rock rate) x 9 / lane width

14 x 125 x 9 / 12=1,313 feet

Glossary of Terms (cont')

- **Asphalt Application Rate** – measured in gallons per square yard; it is the amount of asphalt that is required to evenly cover one square yard of surface area. (.45, .50, etc.)
- **Aggregate Spread Rate** – measured is cubic yards per square yards; it is the amount of aggregate that is required to cover one square yard of surface area, one layer of rock thick with proper voids. (1/110, 1/125, etc.)
- **Strapping the Distributor** – method of measuring the amount of asphalt that is in a distributor with a strapping stick that is supplied by the manufacturer and calibrated to a specific unit.

Setting the Asphalt Shots

- Shot length should be based on full rock lands, which are governed by the number and size of trucks available
- An asphalt shot should equal 1,2 or 3 rock lands, not 1.7 etc.
  (Example: 3 x 1,313 ft = 3,939 ft)
- Never determine shot length solely by asphalt distributor capacity


Streaking...for several feet!!

Seal Coat

A seal coat is generally a single, double, or triple application of asphaltic material covered with aggregate.

Surface Treatments

...are applied to prepared base courses or other surfaces.

(Prime seals, inverted prime seals, etc.)

Seal Coats

...are applied to existing pavements to extend the life of the pavements.

Seal Coats

...are not intended as permanent pavement surfaces and are expected to last approximately five years.

Seal Coats

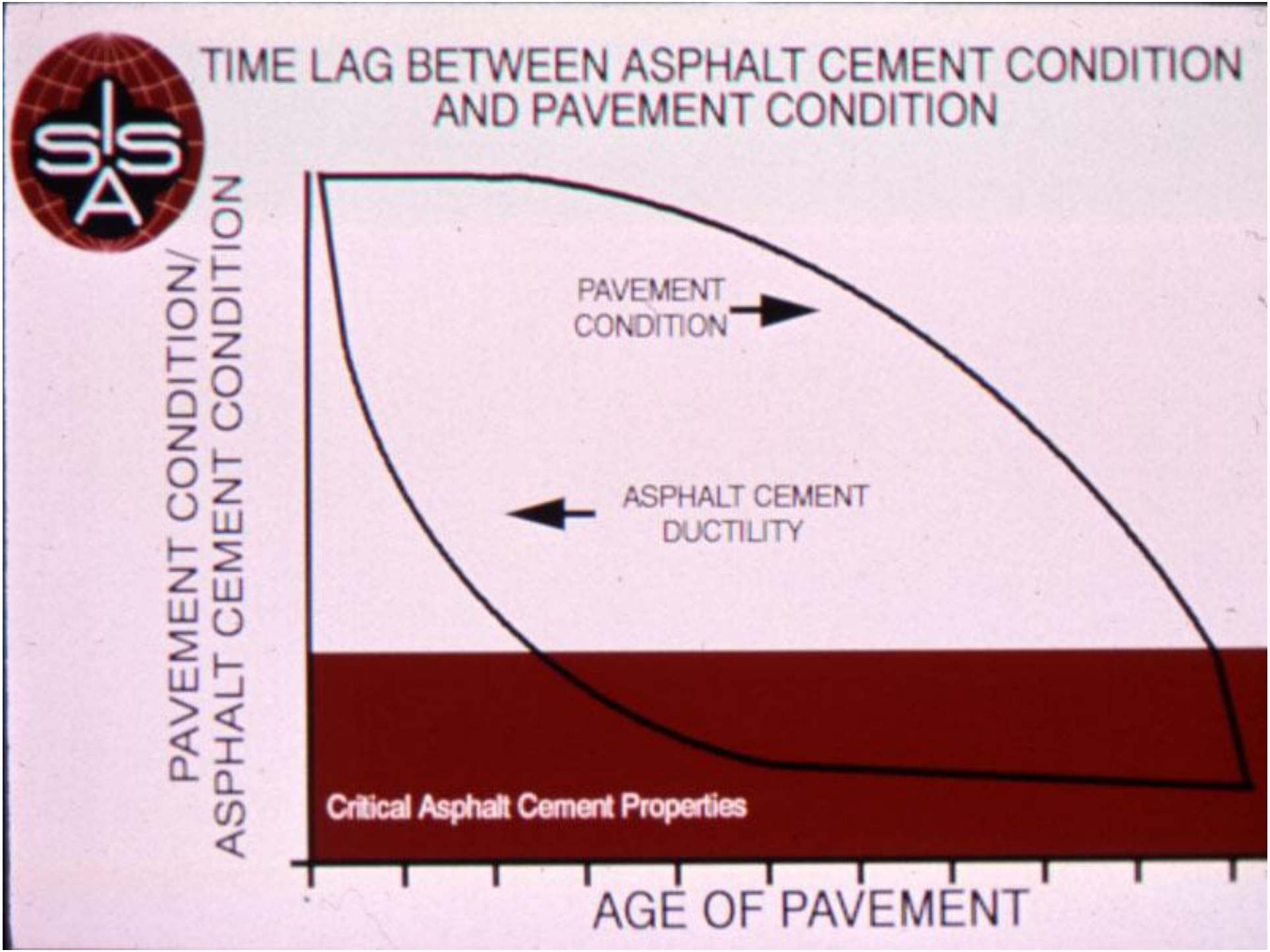
...service life varies depending on condition of existing surface, traffic volumes, weather, etc.

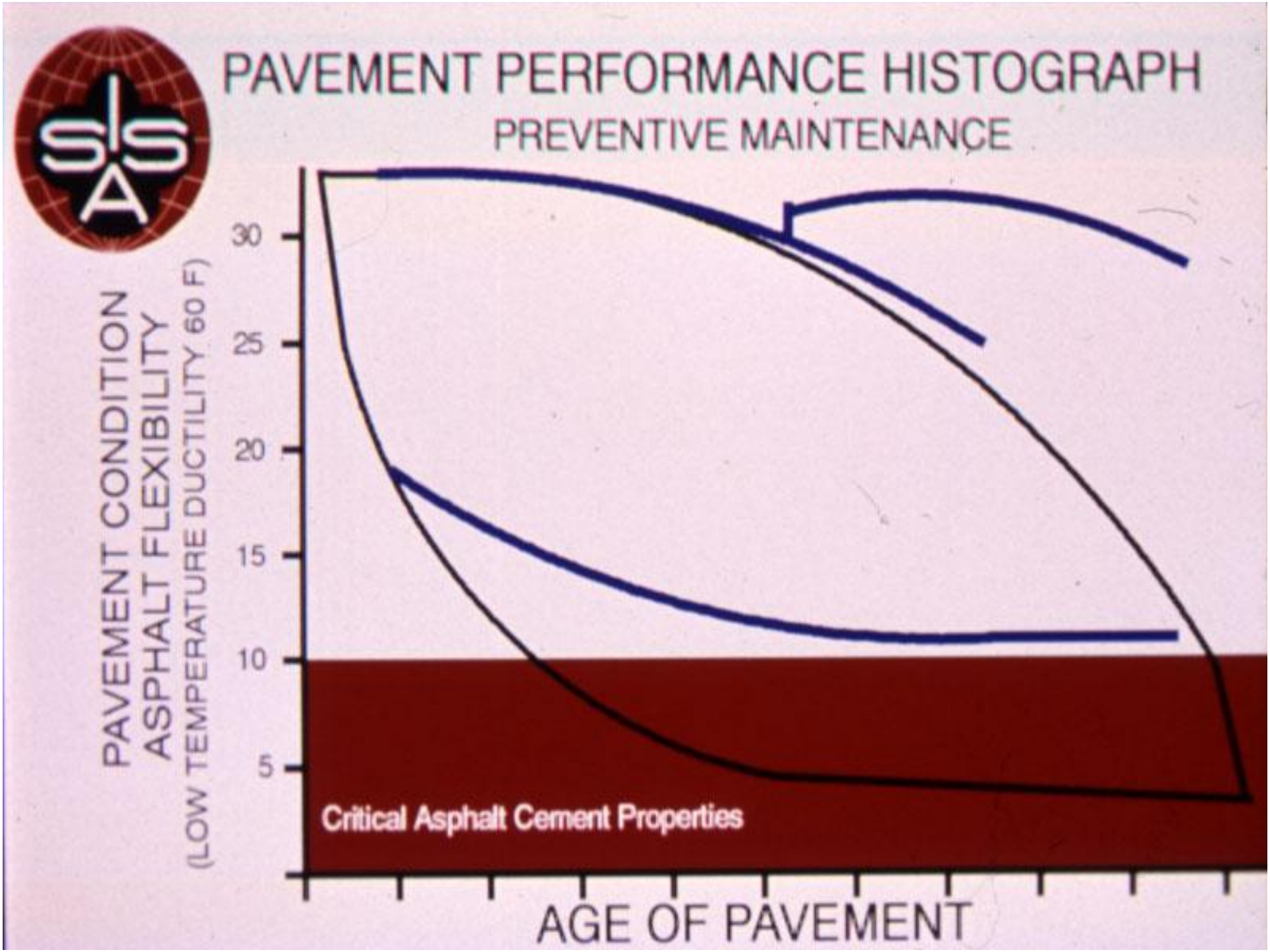
Seal Coats serve to correct deficiencies such as:

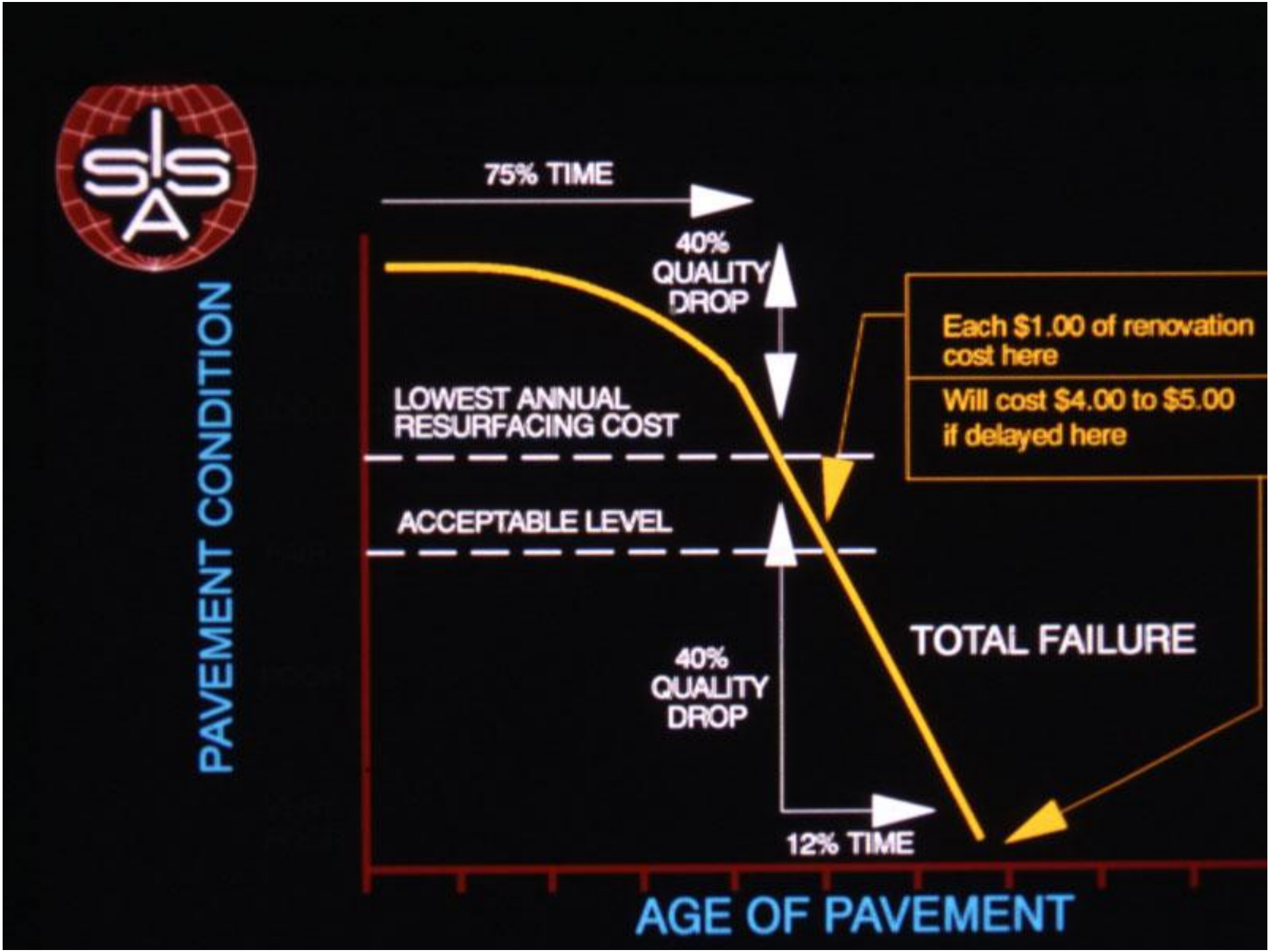
- Lack of skid resistance
- Cracks (less than 1/4”)
- Raveling (or shelling)
- Bleeding
- Aged or oxidized pavement
- Provides a uniform-appearing surface

Seal Coats do NOT:

- Strengthen the existing pavement
- Increase the load-bearing capacity
- Smooth out rough pavement
- Bridge major cracks (wider than 1/4 inch)
- Eliminate the need for maintenance or reconstruction


TIME LAG BETWEEN ASPHALT CEMENT CONDITION AND PAVEMENT CONDITION
PAVEMENT CONDITION/ ASPHALT CEMENT CONDITION
PAVEMENT CONDITION
ASPHALT CEMENT DUCTILITY
Critical Asphalt Cement Properties
AGE OF PAVEMENT


PAVEMENT PERFORMANCE HISTOGRAPH
PREVENTIVE MAINTENANCE
PAVEMENT CONDITION
ASPHALT FLEXIBILITY
(LOW TEMPERATURE DUCTILITY 60 F)
30
25
20
15
10
5
Critical Asphalt Cement Properties
AGE OF PAVEMENT


75% TIME
40% QUALITY DROP
LOWEST ANNUAL RESURFACING COST
ACCEPTABLE LEVEL
Each $1.00 of renovation cost here
Will cost $4.00 to $5.00 if delayed here
TOTAL FAILURE
40% QUALITY DROP
12% TIME
PAVEMENT CONDITION
AGE OF PAVEMENT

Factors Affecting Seal Coat Quality

- Condition of surface
- People (field decisions)
- Design
- Equipment
- Materials (Types and Grades, Rates)
- Application technique
- Traffic
- Weather


RAVELLING, LOSS OF FINES


Flushed, slick surface
OCT 3 2005


Bleeding

Flushed vs. Bleeding

- On a **FLUSHED** pavement, the aggregate embedment is such that the traffic is riding on the asphalt rather than rock. It is slick and subject to bleeding in Summer months.
- On a **BLEEDING** pavement, the asphalt is very liquid and rock will stick if applied. When it cools and becomes a solid once again it will have the appearance of a flushed pavement.

Existing Pavement Condition

Often times the pavement that is being sealed is simply too soft. The newly applied aggregate, regardless of size, will push into the pavement below. When this occurs, the new seal coat will flush and loose skid resistance rapidly.

On the other side of the coin...pavement that is very dry and brittle will soak up the asphalt prompting early rock loss or shelling.

Same Road, 180 degree view

The People

- Engineer / Designer
- Contractor
- Inspectors / Superintendent
- Operators
- Suppliers
- Taxpayers

Inspectors / Superintendents

- Adequately trained and experienced
- Freedom to make timely, informed field decisions
- Develop partnering relationships with contractor and suppliers
- Understand that plans are only a guide and that each road requires special considerations
- Suppliers are excellent resources for information on their respective products

Seal Coat Design

- Simply a starting point for estimating costs
- Be prepared to deviate from design or plans
- Asphalt and Aggregate rates *MUST* be determined in the field.
- We recommend using a form of the “penetration design report” in the field to confirm rates

Asphalt Rate Adjustments

- TxDOT Brownwood developed a seal Coat design method that combines lab testing and actual field conditions. They design for the aggregate size as though you are applying the seal coat on glass. Then they calculate adjustments based on several factors. Hunger factor (from -.03 to +.09) is determined base on roadway conditions. Traffic factor based on Vehicles Per Day.

Rev. 8.93

Ref. No. _____

PENETRATION DESIGN REPORT

		File	Actual
Aggregate Type	PB4 /PB4	Proj	CPM 7-4-102, etc. / CPM 7-4-102
Producer	Vulcan Industrie/Vulcan Industrie	CSJ	000704102 / 000704102
Asphalt Type	AC20-5TR /AC20-5TR	Hwy	SH 6 / SH 6
Producer	Marlin Asphalt, /Marlin Asphalt,	Co.	Eastland Co. / Eastland Co.

Ref No.	Crse	Width	LOCATION	Noz Set	% Var	Configuration	ADT Per Lane	Hunger Factor Code #
1	1	12	FR:US 183 in Cisco E. to FM 490 (OL)		30.0	6 9 9 9 4	1530	0.32
2	1	12	2FR:US 183 in Cisco E. to FM 490 (IL)		30.0	6 9 9 9 4	1020	0.37
3	1	12	FR:FM 490 to Ammerman St.in Eastland(OL)		30.0	6 9 9 9 4	960	0.39
4	1	12	FR:FM490 to Ammerman St.in Eastland(IL)		30.0	6 9 9 9 4	620	0.40
5	1	Var.	Shoulder		00.0	0000000000	00000	0.43
6								
7								
8								
9								

ASPHALT AND AGGREGATE RATE DISTRIBUTION

Description		Reference No. 1	2	3	4	5	6	7	8	9
Computed Asphalt Rate for % Emb		0.24	0.24	0.25	0.25	0.27				
Adjustment for Traffic		-0.02	-0.01	0.00	0.01	0.09				
Adjustment for Hunger Factor		0.03	0.06	0.06	0.06	0.04				
Above 60°F Volume Adjustment		0.03	0.03	0.03	0.03	0.03				
Subtotal		0.28	0.32	0.34	0.35	0.43				
Asphalt Volatile Adjustment		0.00	0.00	0.00	0.00	0.00				
ASPHALT APPLICATION RATE	Inside WP	0.28	0.32	0.34	0.35	0.43				
	Outside WP	0.36	0.42	0.44	0.46	0.43				
	Average Rate	0.32	0.37	0.39	0.40	0.43				
Spread Ratio (SR)			164	164	164	162				
Recommended Distribution Rate		125	125	125	125	125				
Desired Embedment		46.0	46.5	47.0	47.5	50.5				

Remarks: _____ Prepared By _____ Date _____

_____ Approved By _____ Date _____

Ref# 1

Inspectors/Superintendents Getting Ready

- Equipment calibration
- Know the design rates
- Understand factors affecting rate adjustments
- Inspect road for current conditions
- Determine rock lands, mark asphalt shots
- Strap distributor
- Insure that proper signing and traffic control are in place

Calibration
Asphalt Distributor

- Spray bar height
- Nozzle angle
- Spray bar pressure
- Thermometers
- Strapping stick

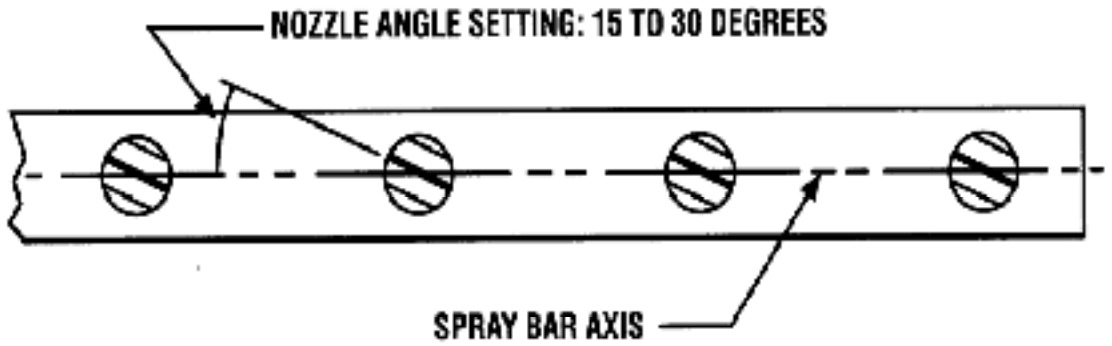


Figure 6.6 Proper Nozzle Angle Setting

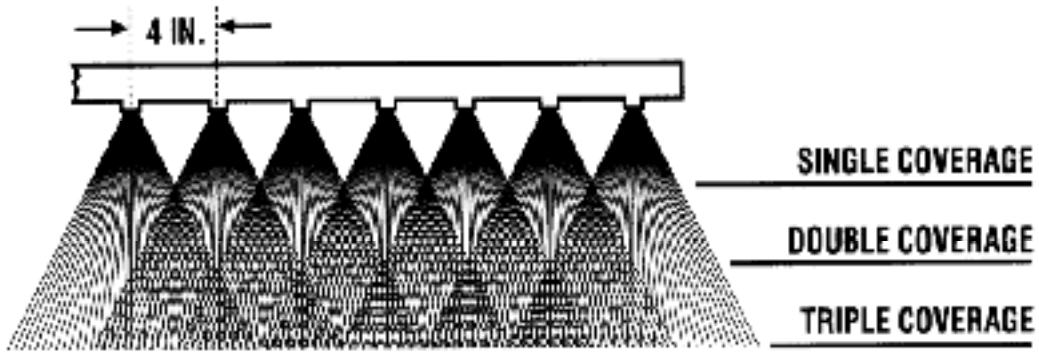


Figure 6.7 Spray Bar Height Must Be Set Exactly for Proper Coverage


ALWAYS STRAP
DISTRIBUTOR

Application Equipment
Aggregate Spreader

- Calibrated for proper rate distribution
- Gates operating properly
- Hitch operating properly
- Control ground speed to keep rock from tumbling or rolling

Aggregate Spreader

Application Equipment
Rollers

- **Pneumatic Tire Rollers Only!**
- Clean and properly inflated tires
- No Foam Filled Tires!
- Properly trained operators
- Control ground speed to reduce skids and turning over rock
- 3 Medium or 4 Light Pneumatic rollers are recommended for high production jobs

4 Light Pneumatic Rollers

Application Equipment
Power Broom

- Preferably self-propelled
- Good core
- Smooth operation
- Vacuum curb and gutter areas
- Properly trained operators


C432

Trucks

- Adequate size and quantity
- Measure and record each truck volume
- Control speed of trucks through project
- Stagger trucks in and out of wheel paths
- Pre-station loaded dump trucks down the road facing the right direction to hook up with the spreader box


Pre Stationed dump truck off of new seal coat.
MAY 7 2004

Aggregates:

- Natural
- Synthetic

Natural Aggregates:

- Crushed gravel
- Crushed stone
- Limestone Rock Asphalt (LRA)
- Basalt (Trap Rock)

Synthetic Aggregates:

- Lightweight Aggregate or Expanded Shale and Clay
- Crushed Slag

Aggregate Selection:

- Type of roadway
- Volume of traffic
- Type of traffic
- Noise factor
- Availability of aggregate
- Transportation

Aggregate Properties:

- Gradation
- Particle shape
- Skid characteristics or polish value (safety)
- Toughness or durability
- Adhesion characteristics

LA DOTD Item 1003.05 Gradations

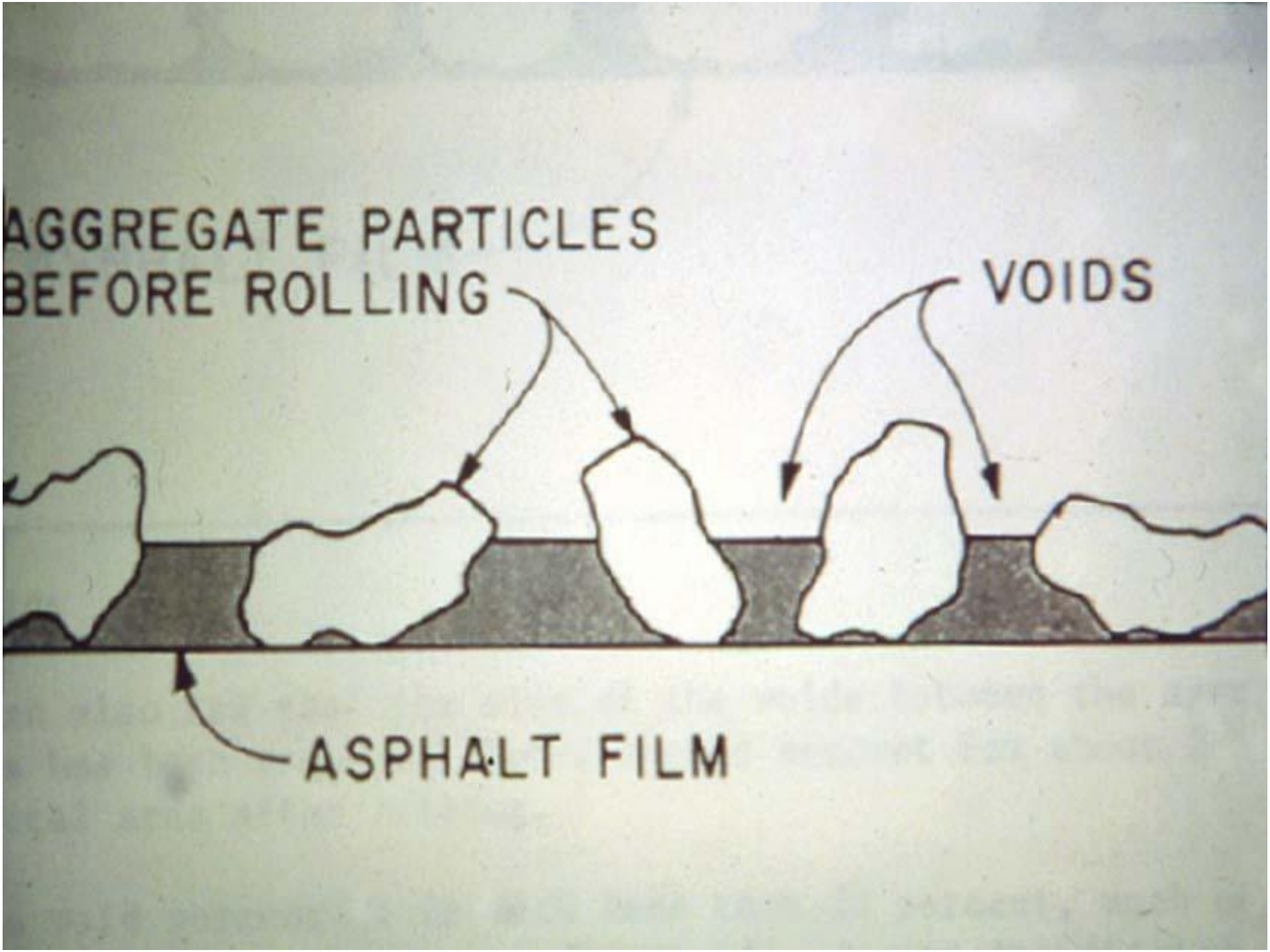
- Size 1, 1” top size, majority retained on the 3/4
  - Specified Spread Rate 0.0200 (1/50)
- Size 2, ½” top size, majority retained on the 3/8
  - Specified Spread Rate 0.0111 (1/90)
- Size 3, 3/8” top size, majority retained on the #4
  - Specified Spread Rate 0.0075 (1/133)

Voids

...are the spaces between the aggregate particles.

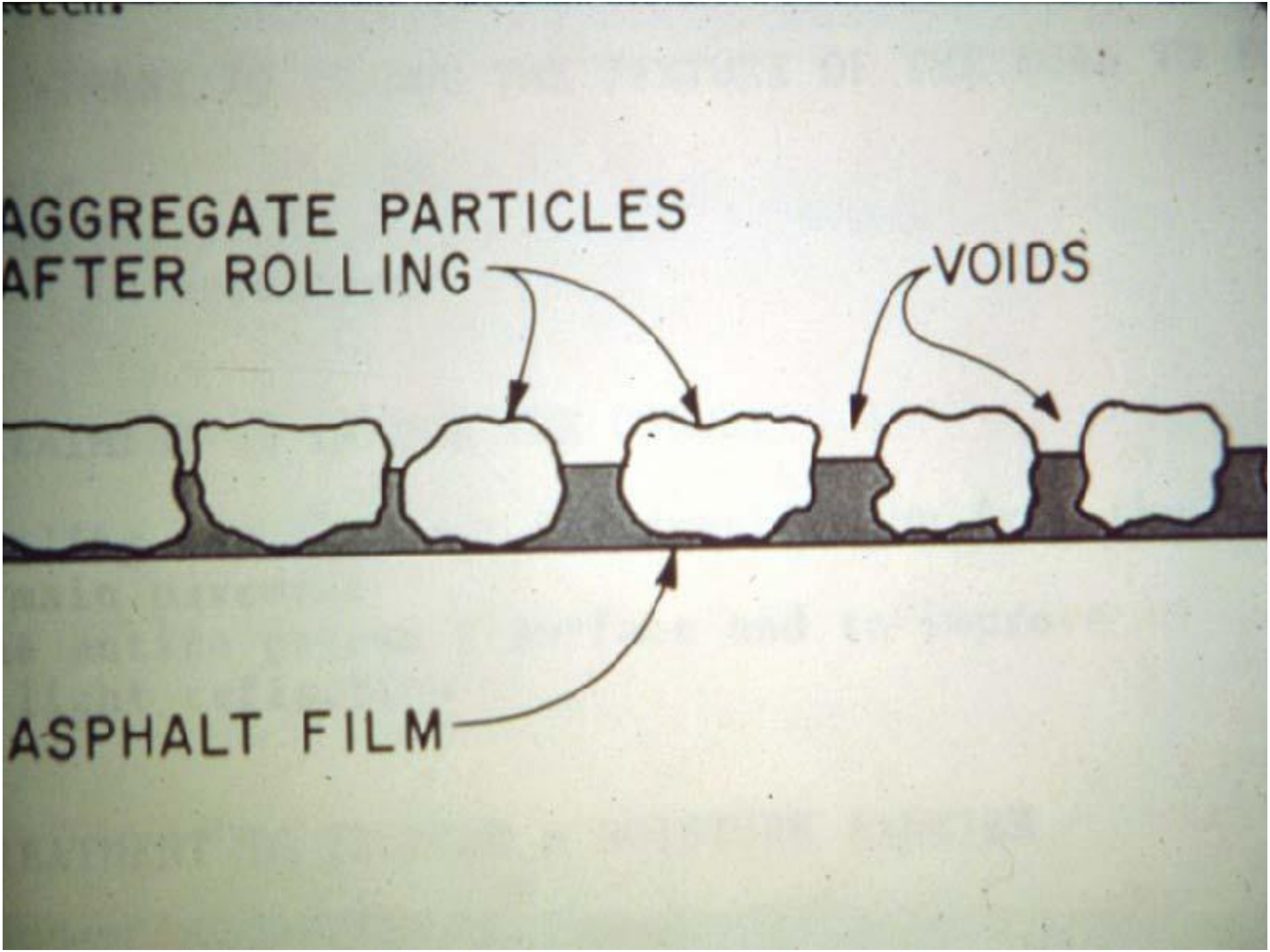
Voids

As the aggregate particles are dropped into the wet asphalt they will be in disoriented positions.


AGGREGATE PARTICLES
BEFORE ROLLING
VOIDS
ASPHALT FILM

Voids

After rolling and after traffic, the aggregate will be seated in the asphalt in their flattest position.


AGGREGATE PARTICLES
AFTER ROLLING
VOIDS
ASPHALT FILM

Voids

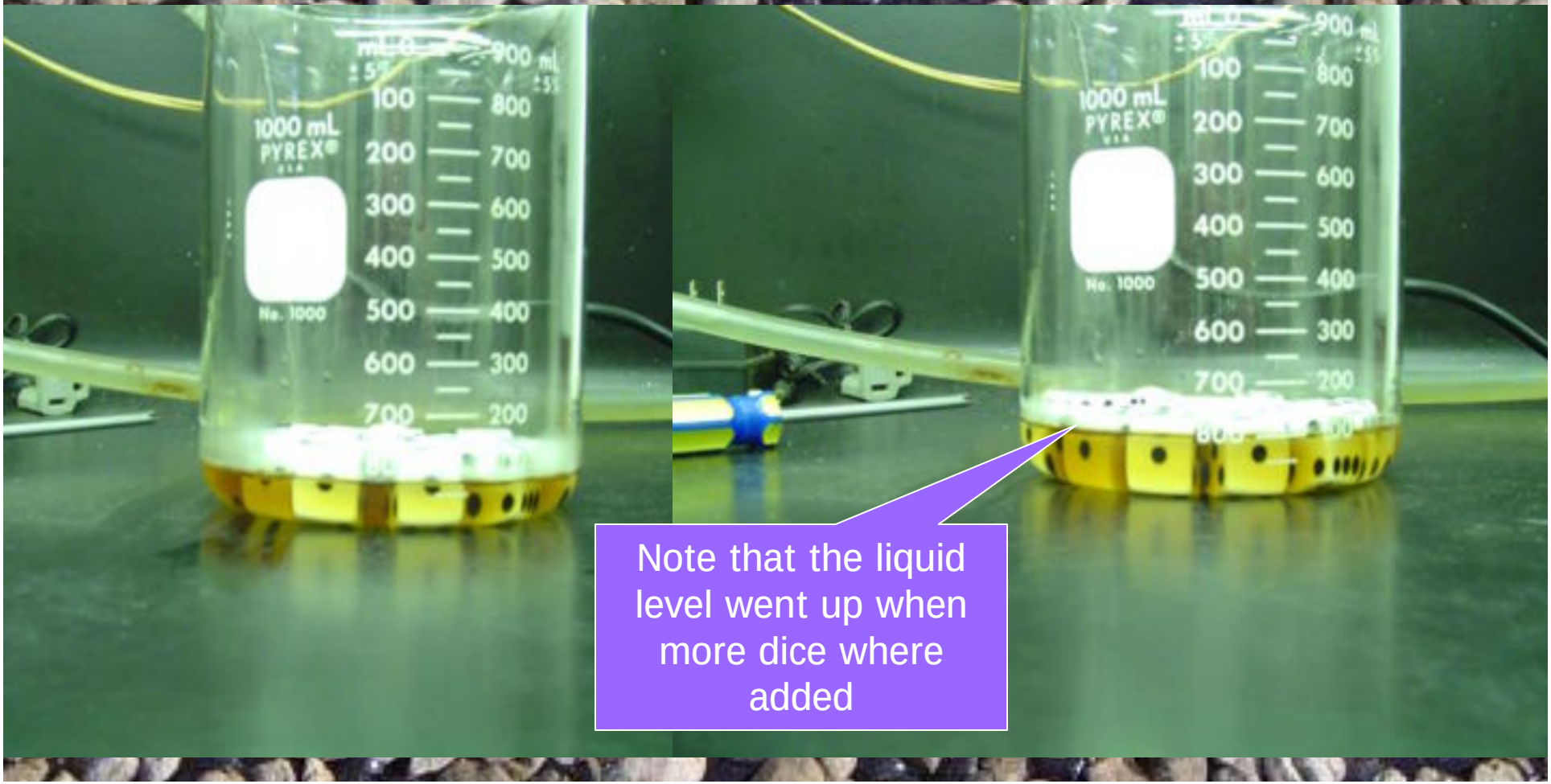
...should account for approximately 20 percent of the area after rolling.


You want to see some black…if you cannot, you more than likely have excess aggregate on the road.
JUN 24 2004

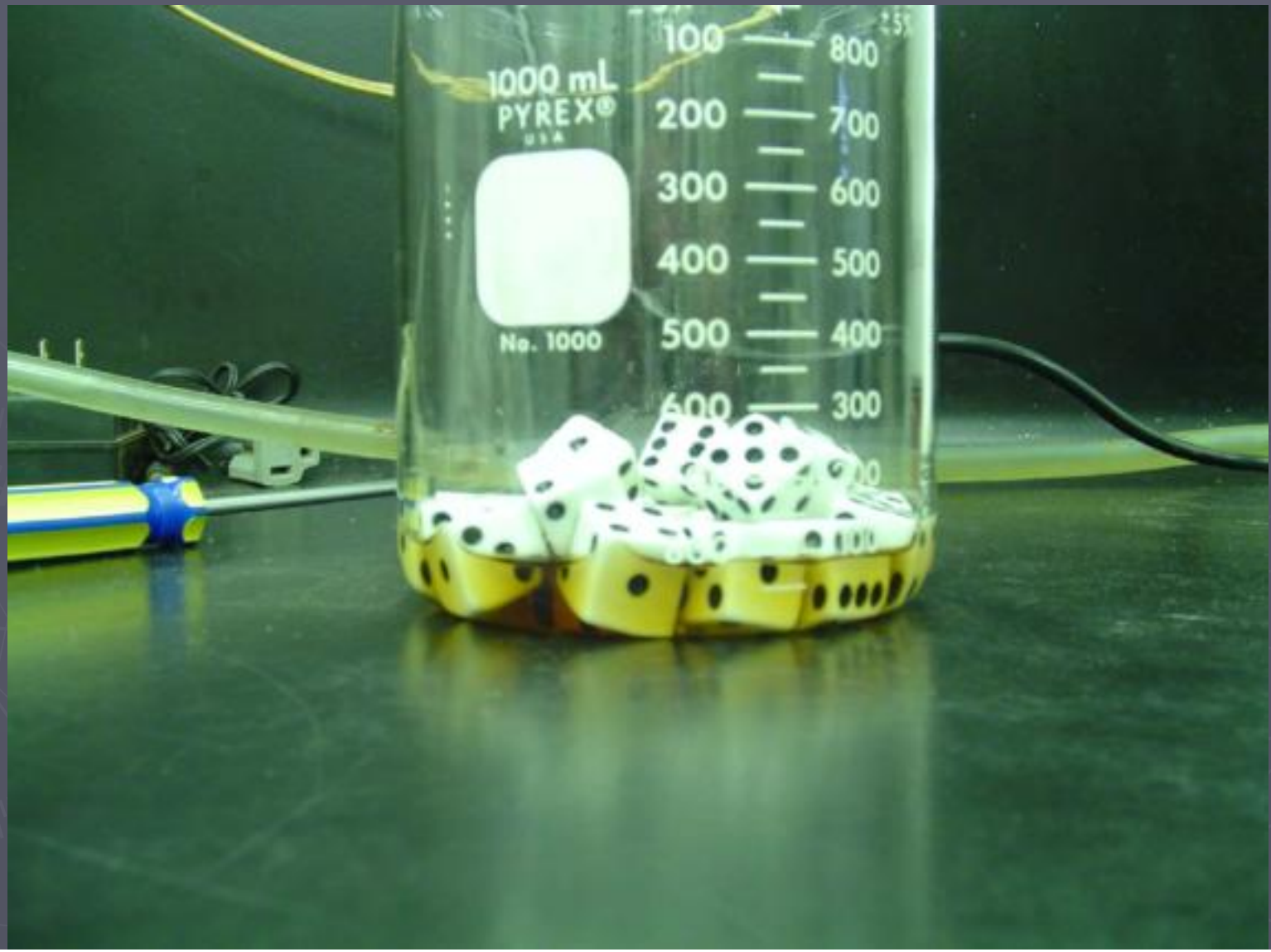
Voids

Rock on rock contact can and will eventually dislodge or damage other rock particles. This can contribute to eventual asphalt flushing and/or bleeding and ultimately loss of skid resistance

EFFECT OF AGGREGATE RATE ON BINDER RATES



EFFECT OF AGGREGATE RATE ON BINDER RATES




Where's the rock?
AUG 9 2004

Embedment

Generally, on low volume roads, the aggregate particles should be approximately 40 to 50% embedded.

Embedment

Generally, on high volume roads, the aggregate particles should be approximately 30 to 40% embedded.

Aggregate Shape

Pay particular attention to the average particle size and particle shape in order to consistently match asphalt rates with aggregate gradations. Proper embedment depends on good particle shape.

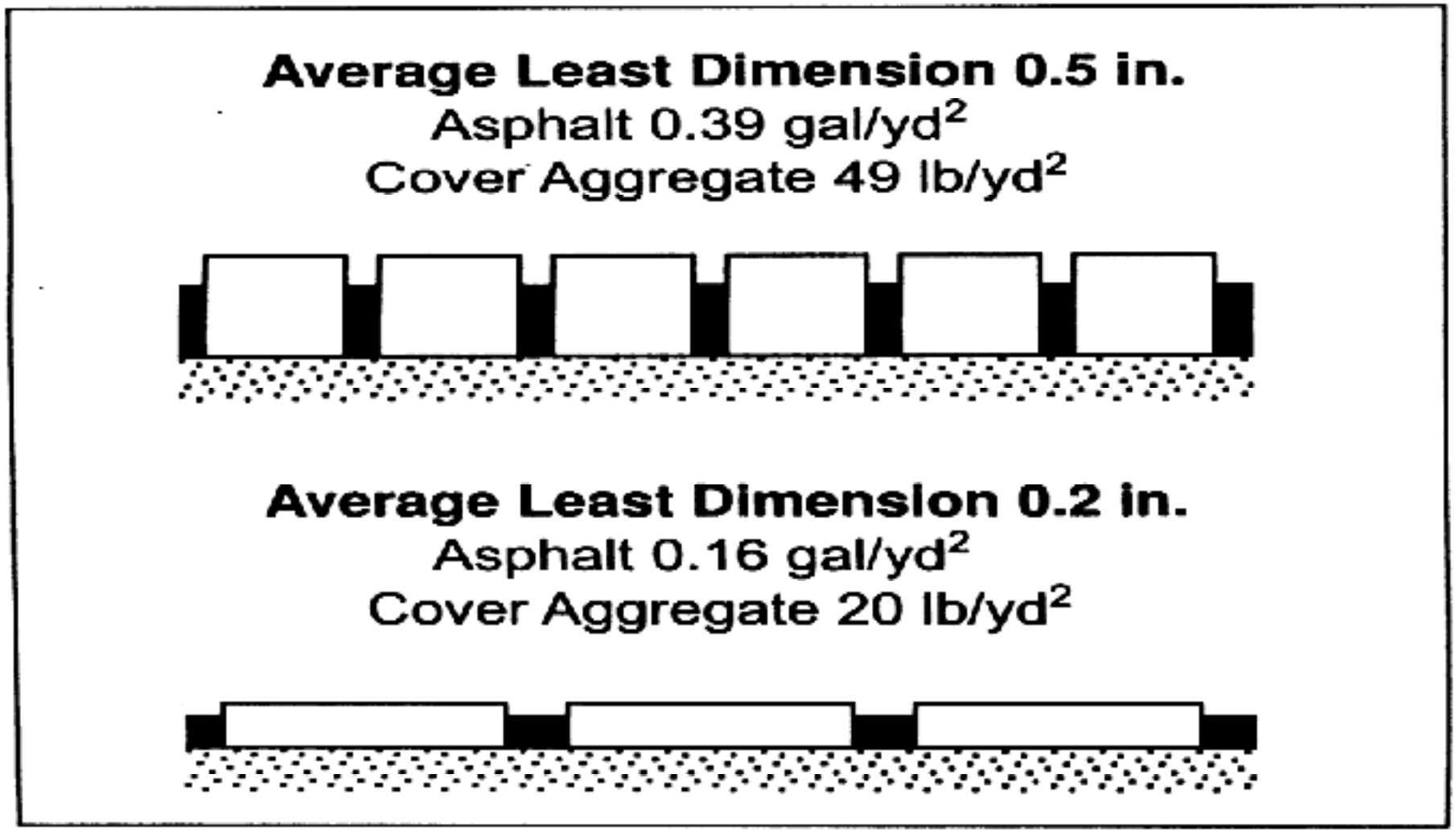
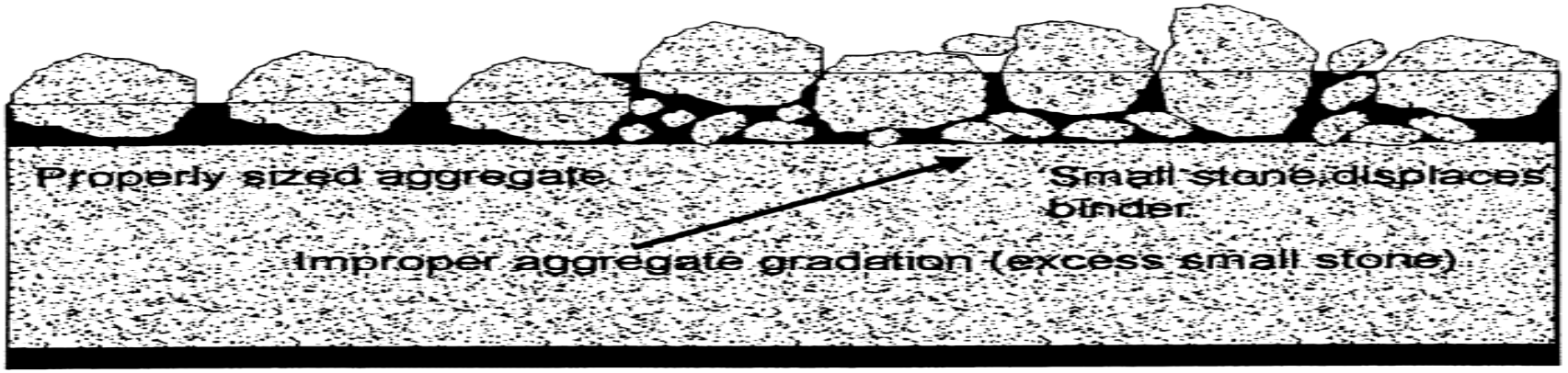


Fig.2 Illustrating the effect of aggregate particle shape on materials quantities. Both aggregates are 0.5 inch as measured by sieve analysis. One is cubicle, the other is flat and elongated. Voids filled is 70% for both aggregates.

Effects of Improper Aggregate Gradation



Results of Improper Aggregate Gradation

Aggregates

- Clean, cubical aggregates for optimum performance, avoid flat particle shapes
- For "*optimum performance"*, we recommend using **pre-coated** aggregate with **hot applied asphalt** binders and **non pre-coated** aggregate with **emulsion** binders
- Pre-Coating aggregates with CSS-1H emulsion that are to be used on hot applied asphalt binders is acceptable and will have NO adverse impact! The residual asphalt will be AC-20.

Aggregates (con’t)

- Avoid using uncrushed or pea gravel; slick, smooth surface tends to not adhere to the asphalt binder. Early life looks OK but deteriorates quickly
- When stockpile sites are available; strategically place stockpiles to avoid running dump trucks and/or traffic over the new surface for the duration of the job.


Contamination from poorly maintained stockpiles or poor loader operation

Aggregates (con't)

- Loader Operation Checklist
  - Insure that the loader is not segregating your stockpile; penetrate the stockpile from the bottom of the pile
  - Pay close attention to contamination from the stockpile site, i.e. grass, clay, soil, etc.
  - Keep the wheels off of the stockpile to minimize degradation
  - Fill each truck to its predetermined level
  - If the stockpile has excessive dust, sprinkle the stockpile with water. This is only recommended when emulsions are being used

LOADER DOING STOCKPILE MAINTENANCE

Asphalts and Emulsions

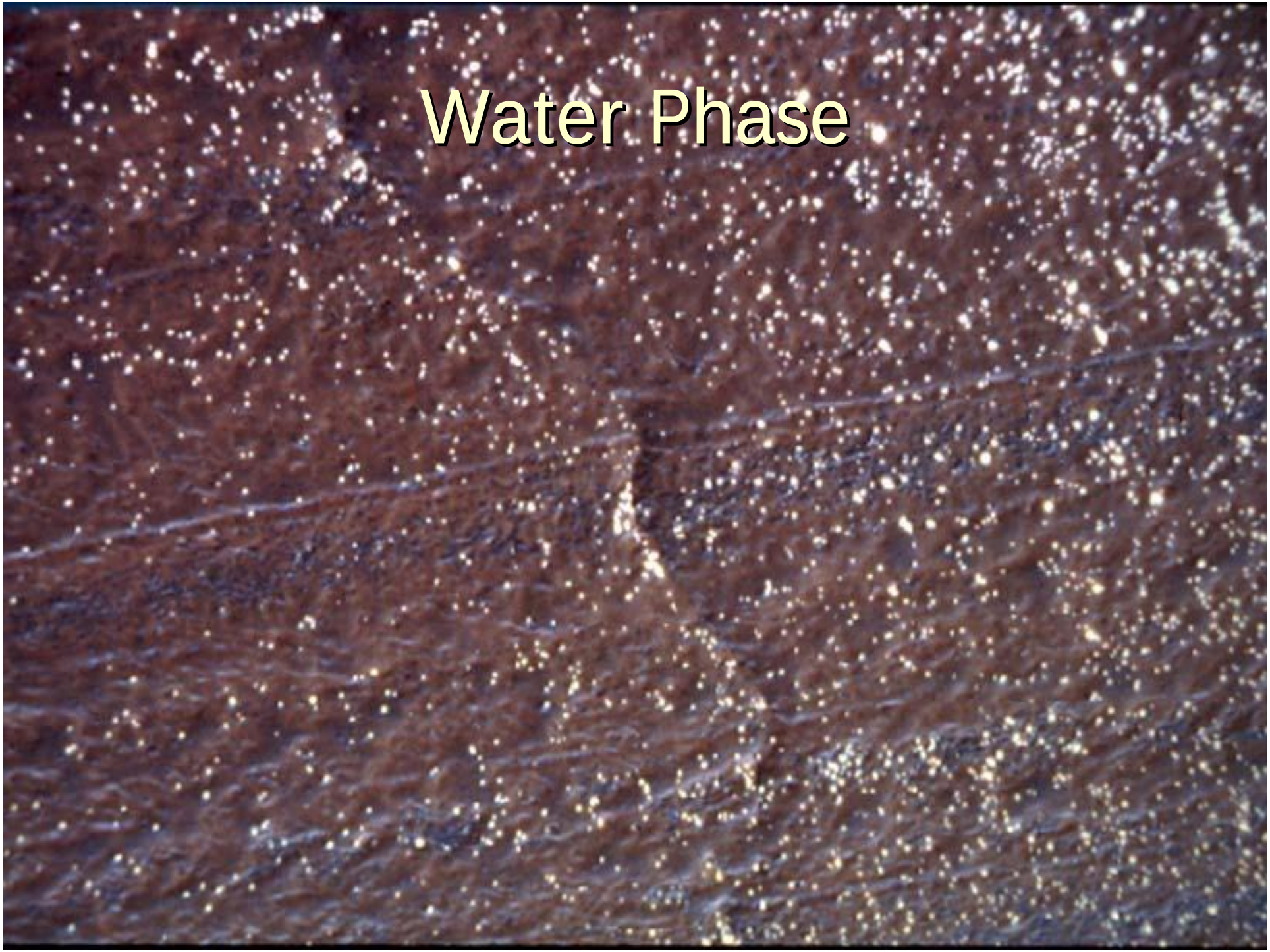
- AC 20-5TR, AC 15P, AC 20 XP, AC-10, AC-5 w/Latex
- CRS-2, CRS-2P, HFRS-2, HFRS-2P, CRS-1P (Cooler Weather)
- New Emulsions and/or Systems: CHFRS-2P, PASS, Road Armor, etc.

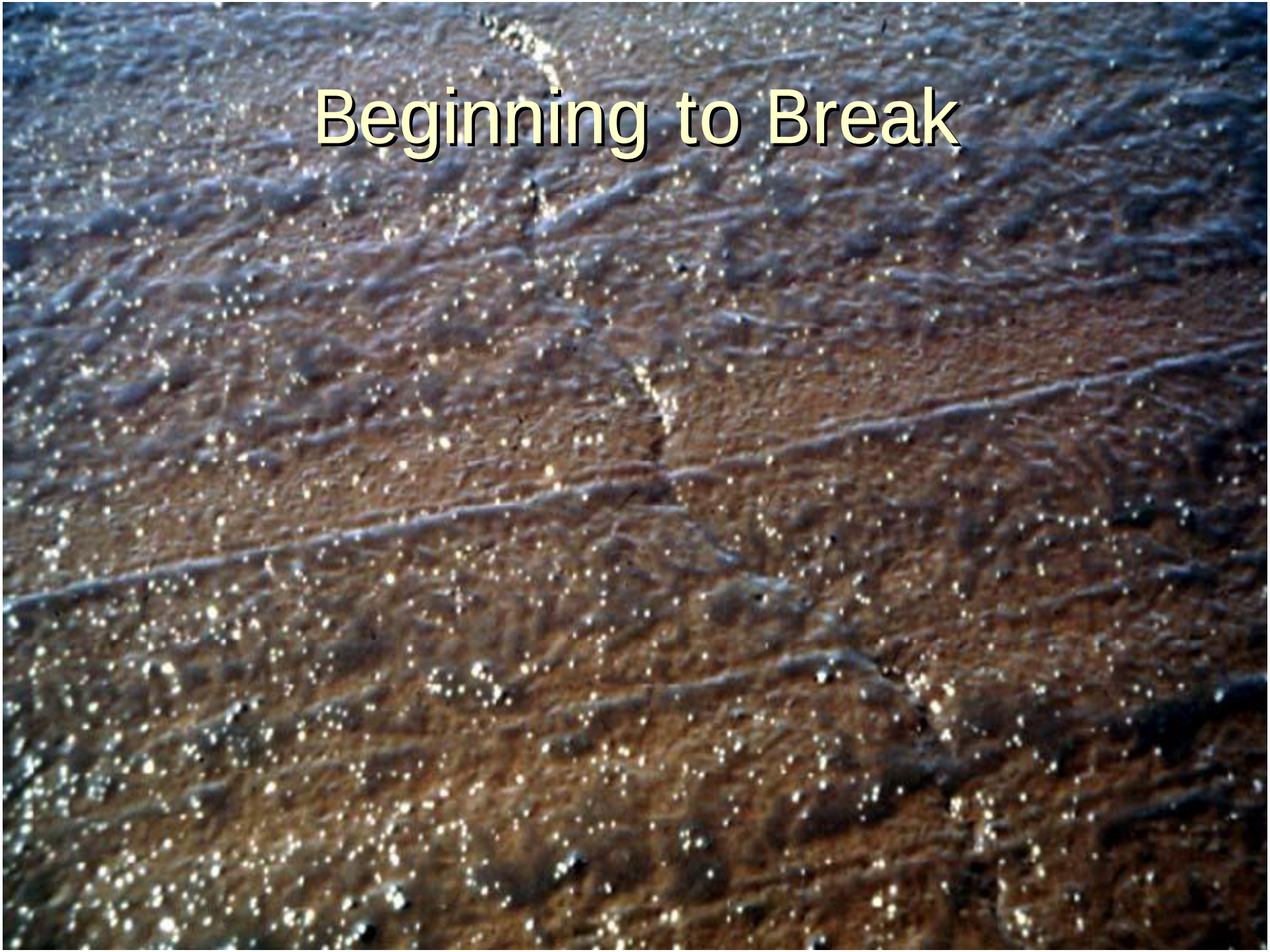
Prime Seals, Fog Seals and Tack

- SS-1, SS1h, CSS-1, CSS-1h, MS-2 and PASS for prime seals, fog seals, tack and dust control
- RC-250 for inverted prime seals and tack; limited usage due to environmental and safety concerns and below average performance.
- MC-30 and A-EP for penetrating prime

Emulsion Breakage

- Evaporation
- Chemical
- Surface contact
- Temperature
- Humidity


Water Phase


Beginning to Break


95% Broke

Timing of Aggregate Application

- Chapter 8, Section 14-TxDOT Seal Coat/Surface Treatment Manual
  - For best results, aggregate should be applied to emulsified asphalt or hot AC immediately. Applying the aggregate while the asphalt is very liquid maximizes embedment depth. As emulsion breaks and cures, the residue is deposited up on the sides of the aggregate particles and a meniscus is formed.

Emulsion Application

- Apply aggregate to emulsion binders while the emulsion is in “water phase” or still brown
- If it begins to track immediately, back off slightly or consider a slight ***AGGREGATE*** rate reduction
- It is NOT necessary to consider ionic (+/-) compatibility between emulsions and aggregates for seal coats!

Hot AC Application

- Hot AC is applied at 320-350 degrees F.
- Hot AC looses 150-200 degrees F in the first 30-45 seconds after application.
- Applying the aggregate on the AC while it is hot is imperative as the initial locking of the aggregate occurs when the AC begins to cool.

5 Keys to Success

- Repair old surface (90-180 days ahead)
- Calibrate equipment prior to use
- Inspect surface (day of application) to determine rates
- Choose the right materials and the make sure they meet specifications.
- Timely application of asphalt and aggregate to optimize aggregate embedment

Top 5 Reasons for Failures

- Over application of aggregate
- Under application of binder
- Road being sealed is not ready
- Too cool at night...
- Aggregate embedment not being achieved in a timely manner

Old Surface

- Structural repairs
- Cleaning
- Blade pavement edges. Patch edges.
- Crack seal cracks wider than ¼”
- Unpaved surfaces primed unless inverted prime techniques are being used.
- Sweep thoroughly.

BASE FAILURES

BLADE LEVELING

Blade leveled patch

Hints About Repairs

- Do repairs 90-180 days ahead of seal coat
- Hot or cold mix patches need adequate curing time.
- If that isn't possible, then consider fog sealing before chip seal.
- Smooth patches reduce impact loading.
- Crack seal properly(3” max, 2” preferred)!

Asphalt Application

- Shoot intersections first
- Shoot entire intersection or widening prior to aggregate application to avoid excess joints
- Paper joints at all starting and stopping points
- Shoot only on clean, dry surfaces!


AUG 2 2005


AUG 2 2005


Dump truck
loading hopper
BeanCat
AUG 2 2005


AUG 2 2005


MAY 7 2004


MAY 7 2004


MAY 7 2004


Fat Spot

Asphalt Application Continued

- Wind can and will affect binder consistency
- Always use rock lands to determine shot length
- Slightly turn the last 3 nozzles on longitudinal joints. DON'T SQUARE THE NOZZLES!

Application Tips

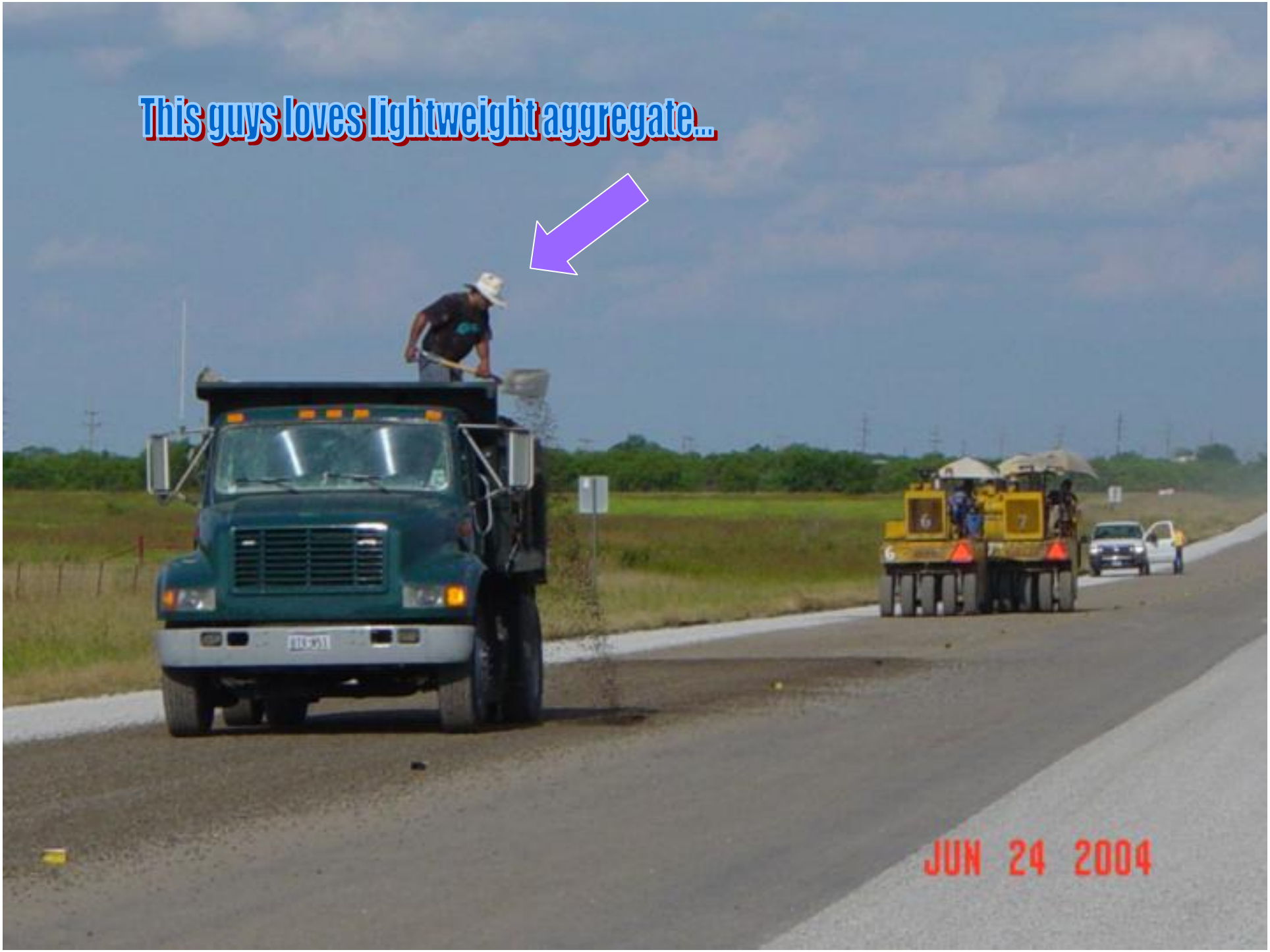
- Know your aggregate size and type
- Know your application rate
- Control your application rate
- One layer of rock thick
- Control spreader box speed!
- 20-30% voids before rolling

Application Tips

- Check your spreader box tire pressure...
- Spreader box right behind distributor !
- Control the spreader box speed!
- High heat afternoons, back off a little
- Marginal surface temperatures require excellent construction techniques
- Increase aggregate rates slightly in curves and intersections to keep rock from rolling or sliding

Sweeping Longitudinal Joint


STOP


This guys loves lightweight aggregate...
JUN 24 2004

Rolling

- Immediately after spreading of aggregate
- Pneumatic tires only
- The slower the better
- Always moving


New seal coat damaged because equipment was traveling too fast

Rolling cont’

- When a job is delayed for more than 10 minutes, get the rollers and the trucks off of the fresh seal.
- Stagger dump trucks in and out of wheel paths or station down the roadway.


Stagger Your Trucks
JUN 24 2004

Post Application Sweeping

- Always sweep excess aggregate as soon as possible.
- Sweep the following day when using emulsion binders to allow for curing.
- Hot AC seal coats can be swept the day of application.

Inverted Prime Seal

- Applied directly to treated base after finishing.
- Designed to preserve the finish while the balance of the roadway is being re-worked.
- If the base is finished properly, no type of seal coat asphalt will penetrate the base. Seal coat asphalts are designed to break and/or cure quickly therefore allowing traffic to drive on the seal coat sooner than a penetrating prime.

Inverted Prime Seal

Inverted Prime

Inverted Prime Seal (con't)

- RC 250 is commonly used because it is a cutback asphalt. Problems associated with this type of cutback is that the volatiles escape upward through the seal coat, thus softening the asphalt and creating a bleeding pavement.
- Basic seal coat emulsions such as CRS-2P and HFRS-2P work great in this application without the bleeding problem. Try .25-.27 with a grade 5 at a 1/120 spread rate.


END
ROAD WORK
4-WAY
49
TEXAS

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