The Art of Quality Chip Seals

Presented in Cooperation with LA DOTD and LTRC
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- 2003 -2005 TxAPA Seal Coat Committee Chairman
- Appointed TxDOT/TxAPA Advisory Sub Committee Liaison
- 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’ Experience By the Numbers

► 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.
The most staggering statistic...

The Texas A&M Aggies are **GOOD** at Basketball!

Gig Em’ Aggies!
Chip Seals

...are applied to existing pavements to extend the life of the pavements and improve traction or “skid resistance”.
Chip Seals

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

...service life varies depending on the condition of the existing surface, traffic volumes, weather, choice of materials and...

how well it is placed!
Chip Seals 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
Chip Seals 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
Each $1.00 of renovation cost here
Will cost $4.00 to $5.00 if delayed here

- Lowest Annual Resurfacing Cost
- Acceptable Level
- Total Failure
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
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.
Bleeding Pavement

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.
Pavement Condition Prior to Chip Seal

Very often seal coat failures are misdiagnosed to be a material or rate problem where in fact, it was the pavement condition prior to chip seal that made the impact. These conditions are very difficult to avoid but trained engineersinspectors can located these areas and make adjustments.
Same Road, 180 degree view
What pavement conditions...?

- Rutting over ½” deep
- Hot or cold mix patches less than 90 days old
- Multiple seal coats applied in years past
- Poor drainage in adjacent ditches
- Weak sub grade
Potential solutions...

- Use the variable rate spray bar
- Strip seal wheel paths or do micro surfacing/slurry seal with a rut box
- Do your prep work 90-180 days ahead of seal coat application
- Consider milling old seal coat layers off as part of your prep work-make sure to fog seal these areas in the interim period, this will correct rutting also
- Address drainage issues as part of prep work, get the water away from the edge of pavement
Prep Work

- Structural repairs
- Fill Ruts
- Cleaning
- Blade pavement edges. Patch edges.
- Crack seal cracks wider than ¼”
- Unpaved surfaces primed unless inverted prime techniques are being used.
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)!
A Successful Program Requires Everybody

- Engineer / Designer
- Contractor
- **Inspectors / Superintendent**
- Operators
- Suppliers
- Taxpayers
Field Personnel

- 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
- Consider developing District Seal Coat Specialists
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 at the time of application...conditions can change between the time of design and construction
- We recommend using a tool like 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 based on roadway conditions. Traffic factor based on Vehicles Per Day.
Average asphalt rate ranges from .32 gallons per sq yd up to .43 gallons per sq yd. Same roadway, same materials.
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
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.

► Never determine shot length solely by asphalt distributor capacity.
Streaking...for several feet!!
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
Strapping the Distributor
Application Equipment
Aggregate Spreader

- Calibrated for proper rate distribution for a specific aggregate size and shape
- Gates operating properly
- Hitch operating properly
- Control ground speed to keep rock from tumbling or rolling
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
- Sweep right in front of asphalt application
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.
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 costs
Aggregate Properties

- Gradation
- Particle shape
- Skid characteristics or polish value (safety)
- Toughness or durability
- Adhesion characteristics
Aggregate Properties Must Balance

Gravel, for example is very tough and durable but is also very slick from the moment of application. Additionally, the slick, marble like texture of gravel does not adhere to the asphalt well.
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.
Over Application of Aggregate

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

Note that the liquid level went up when more dice were added.
EFFECT OF AGGREGATE RATE ON BINDER RATES
Where's the rock?
Aggregate Embedment

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

- Properly sized aggregate
- Small stone displaces binder
- Improper aggregate gradation (excess small stone)

Results of Improper Aggregate Gradation

- Aggregate loss due to poor embedment
- Irregular surface texture
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; poor skid resistance also

- 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
When to Drop the Rock...

As soon as you possibly can... period!
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!
Water Phase
Beginning to Break
95% Broke
Hot AC Application

- Hot AC is applied at 320-350 degrees F.
- Hot AC loses 150-200 degrees F in the first 30-45 seconds after application.
- Applying the aggregate on the AC while it is hot and liquid is imperative as the initial locking of the aggregate occurs when the AC begins to cool.
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!
Dump truck loading hopper
Transverse Paper Joint
Start and Stop on Paper
Sweeping Longitudinal Joint
Proper Overlap Must Be Achieved on the Centerline

Last 3 nozzles set at 45 degree angle
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!
This guys loves lightweight aggregate...
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
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.
Application Tips

► Have all dump trucks loaded and on site prior to asphalt application
► Sweep pavement in front of asphalt distributor
► 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
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
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 make sure they meet specifications.
► Timely application of asphalt and aggregate to optimize aggregate embedment
END ROAD WORK
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