North Carolina
DEPARTMENT OF TRANSPORTATION

Chip Seal Best Practices Training Session One

Presented by
David Spainhour, PE

SEPI ENGINEERING & CONSTRUCTION

June 2015

Introduction to Chip Seals

NCDOT 70 Years

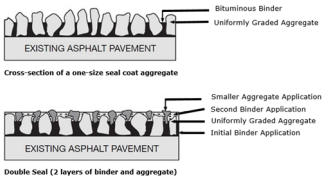
- Began in 1940's
- Dust suppression and roadway stability
- Backbone of NCDOT's Secondary Road System

Road Oil in North Carolina 1942; courtesy of E.D. Etnyre & Company

Introduction to Chip Seals

Known as:

- Road Oil
- Tar and Gravel
- Bituminous Surface Treatment (BST)
- Asphalt Surface Treatment (AST)
- Chip Seal
- Chip Seal – Layer of Emulsion, followed by a Layer of Aggregate



Cross-section of a one-size seal coat aggregate

Double Seal (2 layers of binder and aggregate)

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Introduction to Chip Seals

NCDOT Today

- Approximately 60,000 centerline miles on secondary road system
- 44% or 26,300 centerline miles are Chip Seals

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Introduction to Chip Seals

Benefits

- Water proof
- Increased skid numbers
- Extend pavement life 5 to 7 years
- Cost

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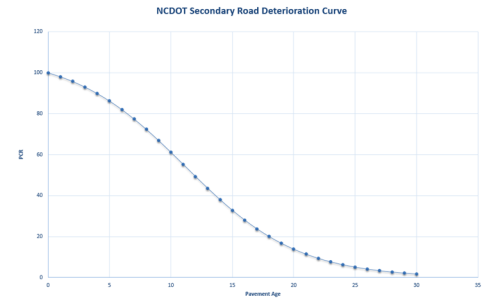
Introduction to Chip Seals



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Introduction to Chip Seals

Historical Concerns:

- No structural enhancement or coefficient
- Loose Rocks (Early in Life)
- Noise
- Rougher Ride
- Perceived Lesser Ride Quality

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Introduction to Chip Seals

- Applying Chip Seals is an "Art"
- Applying Chip Seal Treatment is not Plant Mix Paving or Microsurfacing Paving
- Chip Seal Treatment requires experience because of variability and ever changing conditions
- NCDOT is working towards a Contractor Certification program
- Today we want to share our experiences

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Next Section: Existing Roadway

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Existing Roadway

- Wearing course or protective skin to stop water intrusion
- Existing profile or shape will be same after Chip Seal Treatment
- Repairs must be complete before Chip Seal Treatment
- Roadway must be free of dust and debris
- Used on **Right Road** at the **Right Time** is the **Right Application**
- Used on **Wrong Road** at any time will lead to a **Disaster**
- Repairs potentially included in future NCDOT contracts

Profile

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Existing Roadway

Good Repair for Surface Type Distresses

- Oxidation
- Top down cracking
- Bleeding
- Raveling

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Existing Roadway

Wrong Treatment for Substructural or Structural Distresses

- Rutting
- Bottom up cracking
- Severe Alligator cracking

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Next Section: Equipment and Calibration

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Equipment and Calibration

Distributor

- Shoot between .20 and .50 gallons per square yard
- Uniform layer emulsion
- 8 to 14 foot spray bar
- Circulating tank for emulsion
- Elements to heat emulsion
- 15 to 30 degree nozzle angle
- Proper spray bar height

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Equipment and Calibration

Spreader

- Uniform layer of aggregate
- Self-propelled
- Front and rear hoppers for aggregate receivable and spreading
- Adjustable gates on front
- Spreader boxes available and fixed or adjustable widths

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Equipment and Calibration

Dump Trucks

- Deliver aggregate
- Hitch allows for connection to spreader for towing down the road
- Dump fins for aggregate control

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Equipment and Calibration

Pneumatic Roller

- Follow contour of road
- Follows spreader in sequence
- Reorientation of aggregate

Static Steel Wheel Roller

- Follows pneumatic roller
- Helps seat the aggregate into the emulsion
- Provides smoother finish

Pneumatic tire roller (in background) being followed by a static steel roller (in foreground)

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Equipment and Calibration

Combination Rollers

- Best of both worlds
- Can replace steel wheel

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Equipment and Calibration

Mechanical Broom

- First and last thing on your project
- Pre Pave - Remove dirt and debris to clean surface
- Post Pave - Remove the loose aggregate

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Equipment and Calibration

Vacuum Truck

- Less abrasive
- More expensive
- Only use after Chip Seal Treatment

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Next Section: Calibration

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Calibration

Nozzle 15 to 30 degrees

Reminder:

- Nozzle size effects application rate

Good Nozzle Angle

Bad Nozzle Angle

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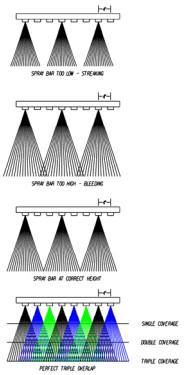
Calibration

- Height of spray bar for single, double, and triple coverage
- Cut out one or two nozzles so that the tips touch
- Uniform spray



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Calibration

Spreader

- Place yd^2 canvas on the ground
- Set aggregate application rate on the spreader
- Apply aggregate at operating speed
- Weigh the canvas with the aggregate inside
- Discard aggregate
- Weight the canvas empty
- Subtract the weights and this is your application rate
- Adjust if needed

Calibrating the stone spreader

Reminder:

- Each aggregate application rate must be calibrated by rate, by type, and by quarry

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Calibration

Distributor

- Determine 100 foot test section
- Record beginning volume
- Set application rate computer
- Apply emulsion
- Record ending volume
- Calculate yd^2 coverage by multiplying length x width shot
- Divide yd^2 into gallons used to verify rate
- Adjust application rate accordingly

Clogged Nozzle

100 foot test section

Reminder:

- Each application rate must be calibrated
- Emulsion application temperature range 160-170°F

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End of Session One

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Materials

Emulsion

- Emulsions are mixtures of liquid asphalt and water, with additives for stability
- Durable, long lasting, rapid setting, good aggregate retention
- Specifications require cationic rapid set emulsion
- CRS-2L or CRS-2P – proven reduction in loose aggregate
- Emulsion will have a slightly positive charge
- Do not mix emulsion grades
- Bill of Laden – Tanks
- Application Temperature 160-170°F

Materials

Aggregate

- Compatible – anionic
- Shape – cubical
  - * Flat tends to bleed
- Hardness – granite or slate
  - * Limestone tends to crush under roller or traffic
- Cleanliness – minimum fines
  - *** Dust tends to bleed and ravel
- Uniform size – single or gap graded
- Surface properties – crushed face
  - * Smooth or polished aggregate tends to ravel

Reminder:

- Keep stockpiles clean and dry
- Keep aggregate separated
- Keep base material out of aggregate pile

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Next Section: Specification

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Specification

Pre-application meeting

- Project Engineer
- Contractor
- Subcontractors
- Area Roadway Engineers
- State Pavement Construction Engineer (Optional)
- Materials and Test Representative (Optional)

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Specification

Certificate of compatibility

- Emulsion and aggregate
  - Per aggregate
  - Per grade
  - Per quarry

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Specification

- Season runs April 1st to Oct 15th
- 50°F and rising air and/or surface temperature
- No paving in rain, fog, or on wet roads
- Remove dust, dirt, and debris from roadway
- Self propelled aggregate spreader
- Emulsion Grades: CRS-2L and CRS-2P
- Emulsion application temperature 160-170°F
- 100 foot test section – required
- Brooming required 3 to 7 days after Chip Seal Treatment

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TABLE 660-1
MATERIAL APPLICATION RATES AND TEMPERATURES

Type of Coat	Layer	Aggregate Type	Aggregate Target Rate[A] (Lbs/Sy)	Emulsion Target Rate[B,C,D] (Gal/Sy)
Single Seal	Top	78M	18	0.35
		5/16" LW	10	0.32
		#9	10	0.32
		CA-9 LW	10	0.35
Double Seal	Top	78M	12	0.25
		5/16" LW	9	0.25
		#9	9	0.25
		CA-9 LW	9	0.25
		#14	7	0.20
	Bottom	78M	18	0.30
		5/16" LW	10	0.30
Triple Seal	Top	78M	12	0.22
		5/16" LW	9	0.25
		#9	9	0.25
		CA-9 LW	9	0.25
		#14	7	0.20
	Middle	78M	15	0.24
		5/16" LW	9	0.25
	Bottom	78M	18	0.30
		#67	30	0.32
		5/16" LW	10	0.30
Mat and Single Seal	Top	78M	14	0.22
		5/16" LW	9	0.25
	Mat	#67	38	0.32
		#57	40	0.35
Mat and Double Seal	Top	78M	12	0.25
		5/16" LW	9	0.25
	Middle	78M	16	0.25
	Mat	#67	38	0.40
Mat Coat		78M	18	0.35
		#67	38	0.40

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Specification

Tolerances:

- ± 0.03 gal/yd^2
- ± 1.0 1b/yd^2

- Divisions will include project special provisions:
  - Map numbers
  - Chip Seal type
  - Aggregate type per layer
  - Application rates

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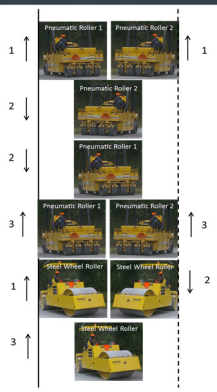
Specification

- Rolling 3 complete coverages on each layer (one pneumatic and one steel)
- Within 5 minutes of laydown when using CRS-2L or CRS-2P
- Rolling 3 complete coverages on each layer
- 1 complete coverage by Pneumatic Roller
- 1 complete coverage by Steel Wheel
- 1 complete coverage by either roller
- 1 complete coverage will require 2 or 3 passes depending on width



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Specification

Requires a 12 month warranty

Surface Defects	Severity	Extent (Per Lot)
Surface Patterns	Alternate lean and heavy lines streaking over the entire pavement surface.	Greater than 20% of a lot affected; distress spotted evenly over the lot or over localized areas within the lot.
Bleeding/ Flushing	Distinctive appearance (with excess asphalt binder already free).	Greater than 20% of the wheel tracks within a lot affected.
Loss of Cover Aggregate	Large patches of cover aggregate lost from the pavement surface.	Greater than 20% of a lot affected; distress spotted evenly over the lot or over localized areas within the lot.

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Specification

Pay Item	Pay Unit
Asphalt Surface Treatment, Single Seal	Square Yard
Asphalt Surface Treatment, Double Seal	Square Yard
Asphalt Surface Treatment, Triple Seal	Square Yard
Asphalt Surface Treatment, Mat and Single Seal	Square Yard
Asphalt Surface Treatment, Mat and Double Seal	Square Yard
Asphalt Surface Treatment, Fog Seal	Square Yard
Asphalt Surface Treatment, Sand Seal	Square Yard
Asphalt Surface Treatment, Mat Coat, No. __ Stone	Square Yard
Emulsion for Asphalt Surface Treatment	Gallon

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Next Section: Weather

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Weather

Moisture and Temperature

- Goldilocks and Three Bears

Moisture

- Too much water has the tendency to bleed
- Too little water has the tendency to ravel
- A little water on surface aggregate – just right

Temperature

- Extremely high temperatures have the tendency to bleed
- Extremely low temperatures have the tendency to ravel
- 70°F and 80°F degrees – just right

Wind

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End of Session Two

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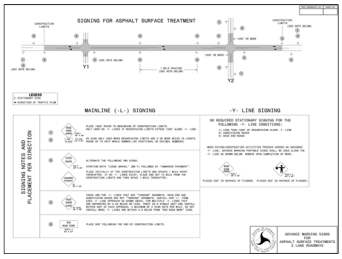
Traffic Control

- NCDOT contracts include standard
- Contract resurfacing modified for Chip Seals
- Pilot truck required
- Road construction ahead - prepare to stop, flagger ahead, and signs are required in addition to stationary signing during construction
- The AST Spec references the "Temporary Traffic Control (TTC) Special Provisions RWZ-1



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Sequence of Operations (Video)

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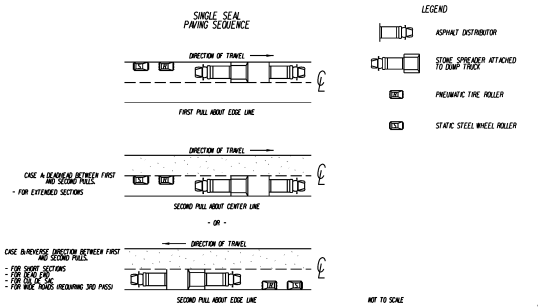
Single Seal



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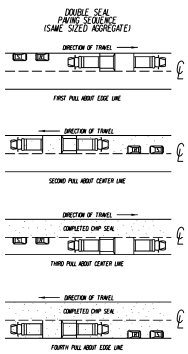
Double Seal – Same Sized Aggregate



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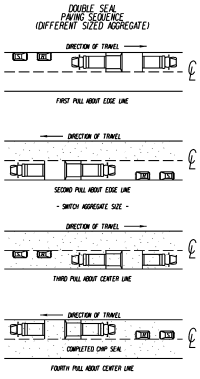
Double Seal – Different Sized Aggregates



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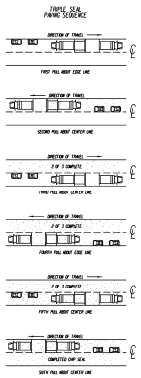
Triple Seal



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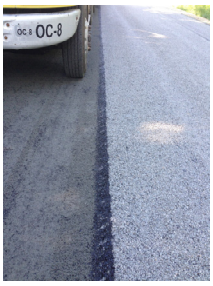
Centerline Tie Strip - Longitudinal Joints



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Traffic Control

Employee Safety

- Trucks going backwards
- Large and fast moving
- Blind spots
- Intersections
- Power lines

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Issues

- Chip Seals require an "Art," finesse, or experience in placement

Issues typically will revolve around:

- How materials are being used
- How materials are being placed

Remember Goldilocks

- Too much or too little emulsion or aggregate is bad
- Needs to be just right

Issues

Four Main Categories

- Excessive emulsion
- Excessive aggregate
- Insufficient emulsion
- Insufficient aggregate

These can be caused by:

- Human error
- Equipment malfunctions
- Materials out of specification

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Issues

Excessive emulsion – Bleeding

Causes:

- Emulsion rate too high
- Excessive overlap
- Existing road bleeding before application
- Dirty aggregate

- Over use of hand wand
- Leaks on the distributor – pump, bar, and nozzles
- Insufficient aggregate applied
- Improper spray bar height, or nozzle angles

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Issues

Insufficient emulsion – Streaking or Raveling

Causes:

- Cold emulsion
- Improper spray bar height
- Improper nozzle angle
- Emulsion rate too low

- Worn or clogged nozzles
- Improper pump speed
  - Distributor values not opening

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Issues

Excessive Aggregate, Raveling, and Shelling

Causes:

- Aggregate rate too high
- Insufficient or non uniform emulsion application
- Excessive overlap or spillage
  - Spreader operator
  - Belt operator
  - Truck drivers
- Applying aggregate where no emulsion is applied
- Improper rolling

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Issues

Excess Aggregate Piles

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Issues

Insufficient Aggregate – Bleeding
Causes:

- Aggregate rate too low
- Dirty aggregate
- Gates stopped up
- Gates not set properly
- Belt operator not supplying front hopper with aggregate
- Poor traffic control – traffic on seal too soon

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Issues

Poor Chip Seal
Treatment techniques:

- Construction vehicles whip off aggregate
- Broom too soon
- Failure to raise auxiliary axles on trucks
- Brooming before curing

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Issues

Other Issues:

- Timing or sequence of operations – poor workmanship
- Breaking vs curing
- Condition of existing road
  - Cleanliness
  - State or repair
- Wash boarding and crack sealing
- Distributor and spreader pulling straight lines – no voids
- Wrong road
- Worn and clogged nozzles

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Next Section: Common Practices

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Common Practices

- Varying application widths to avoid hand work
- Shooting blind or shooting on your off side
- Sweeping early in the morning 3 to 7 days after Chip Seal Treatment
- Blotting sand – bleeding or concrete drives
- Intersection paving – safety, excessive materials
- Stagger loaded dump trucks – behind spreader
- Lift drop axles upon arrival
- Turning around on job – Avoid intersections that were just paved
- Concrete driveway – DO NOT ENTER
- Watch for overhead power lines
  - Belt operator – responsible for keeping dump trucks out of power lines

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Next Section: Inspection

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Inspection

Areas of Concern Include:

- Condition of existing pavement
- Cleanliness of existing roadway
- Weather
- Proper traffic control
- Temperature of the emulsion
- Qualities of both emulsion and aggregate
- Gallons of emulsion used
- Square yards of aggregate placed
- Rate of materials laydown
- Timeliness of emulsion, aggregate, and rolling

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Questions and Checklist

NCDOT Chip Seal Best Practices Checklist

1. Has the Certificate of Compatibility been submitted for each Chip Seal type?
2. Has the existing roadway surface been cleaned and prepared for the Chip Seal?
3. Are weather conditions, air, and surface temperatures sufficient for Chip Seal application?
4. Are traffic control signs in place and is pilot car ready?
5. Have the Bills of Laden for the asphalt emulsion been received?
6. Has the Distributor truck been calibrated for this project?
7. Is the target rate of emulsion for each Chip Seal type known?
8. How will the gallons of emulsion be measured or determined?
9. Is the application temperature of emulsion between 160-170°F?
10. Does the Distributor spray a uniform lift of emulsion?
11. Is spray pattern free from streaks or heavy concentrations of emulsion?
12. Has the Aggregate Spreader been calibrated for this project?

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Questions and Checklist

13. Is the target rate of aggregate for each Chip Seal type known?
14. Has Aggregate Spreader been calibrated across the width of the Spreader box?
15. Does the Spreader apply a uniform lift of aggregate?
16. Is the aggregate clean and free from dirt, dust, or debris?
17. Are pulls covering the edge of road and centerline joints completely?
18. Is excess aggregate being removed before additional lifts are being placed?
19. Are the Pneumatic and Steel Wheel Rollers operational?
20. Are Roller coverages completed within 5 minutes of emulsion placement?
21. Is traffic being maintained through the work zone?
22. Are mechanical or other brooms in proper working condition?

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Next Section: QA/QC

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QA/QC

Certificate of Compatibility – required compliance before Chip Seal Treatment begins

During Construction:

- Asphalt Emulsion Sampling
- Aggregate Sampling
- Handled by materials and test unit in Raleigh 919.329.4000

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Questions?

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End of Session Four

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