Bullet-proof Chip Seals: Now, There’s No Reason Not to

A Summary of the NCHRP Report 680: Manual for Emulsion-Based Chip Seals for Pavement Preservation

by
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Knowledge to Go Places
Acknowledgements

National Cooperative Highway Research Program

Project 14-17 “Manual for Emulsion-Based Chip Seals for Pavement Preservation”

FHWA Federal Lands
City of Frederick, Colorado
Washington DOT
Research Product

by

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Keys to Successful Chip Seals

- Project Selection
- Overall Design
- Chip Seal Type
- Materials
- Specific Design
- Construction
- QA/QC
- Performance Expectation
Keys to Successful Chip Seals

- Project Selection
  - Pavement Condition
  - Traffic
  - Geometry
  - Materials
  - Pavement Prep
  - Maintenance
Keys to Successful Chip Seals

• Overall Design
  – Appropriate Pavements
  – Seal Type
  – Chip Seal Selection
  – Aggregate Size
  – Pavement Condition
  – Materials
Keys to Successful Chip Seals

• Appropriate Chip Seal
  – Single
  – Single with ‘Choke’
  – Multiple
Keys to Successful Chip Seals

• Materials Selection
  – Chip Gradation
  – Modified or Unmodified Emulsion
  – To Fog or Not to Fog
  – Emulsion-Aggregate Compatibility
Keys to Successful Chip Seals

• Specific Design
  – Binder Application Rate
  – Chip Application Rate
  – Excess Chips for Constructibility?
  – Time Until Sweeping
Keys to Successful Chip Seals

• Construction
  – Equipment Calibration
  – Operations
    • Pavement Preparation
    • Weather
    • Paper Joints
    • Chip Application Time
    • Roller Speed and Number
    • Initial Sweep
    • Traffic Control
    • Removing Traffic Control
Keys to Successful Chip Seals

• QA/QC
  – Sieve Analysis
  – Moisture in ‘System’
  – Embedment Depth During Construction
  – Field Viscosity
Who Thinks ‘Art’ is Part of Chip Seal Construction?

- Turning Traffic Loose/Sweeping
- Surface Texture
- Surface ‘Softness’
- Is That Emulsion the One You Expected?
Question

• Can a Lab Test be Used to Predict When to Broom/Turn Traffic Loose on a Chip Seal?

• If Used:
  – Judgment Could be Improved,
  – Windshields Saved,
  – Reputations Maintained,
  – More Chip Seals Would be Built
  – The deficit would be eliminated
  – World Peace would follow
Chips at One-Stone Thickness

“Pin-Art” Holds Chips
The ‘Grabber’

Template = 40% Embedment

A Pneumatic Roller Would be an Improvement
NCHRP 14-17
“Broom Simulator”
The Experiment

- **AGGREGATES:**
  - Basalt, Alluvial, Granite, Limestone

- **EMULSIONS:**

- **EMULSION CURE:**
  - 40%, 80%

- **AGGREGATE MOISTURE:**
  - Dry, SSD
Step 2 - Determine the Moisture Content Where <10% Chip Loss Occurs with Field Materials

Dry Aggregate
Chip Loss, % = -1.2179(Moisture Loss, %) + 98.203
R² = 0.8254

SSD Aggregate
Chip Loss, % = -1.3453(Moisture Loss, %) + 105.33
R² = 0.9283

Field Site Aggregates - Lab Sweep Test Results

At About 70 to 75% Moisture Loss
So the Lab Test Seems to Work,
Does This Relate to the Field?
Step 3 - Build Three Full-Scale Chip Seals and Compare Moisture Content to Chip Adhesion

Arches Natl Park, UT
Frederick, CO
US101, WA

Resists Broom and Traffic

75% Moisture Loss
Is the Emulsion What You Bought?
20 to 70 seconds at 85 to 150F for a 6 mm orifice or
10 to 60 seconds at 85 to 140F for a 7.5 mm orifice
Will Chips Disappear Into Substrate?
Surface Too Soft for Chip Seal Above this Line

Above Line C
Correction = -0.06 gal/yd² (-0.30 L/m²)

From Line B to C
Correction = -0.04 gal/yd² (-0.20 L/m²)

From Line A to B
Correction = -0.02 gal/yd² (-0.1 L/m²)

No Correction Needed
this side of Line A

Below Line B
Surface Too Soft for Chip Seal Above this Line

No Correction Needed
this side of Line A

Traffic, Veh/day/lane
Will Pavement Texture Swallow Emulsion?
Surface Texture Correction
U. S. Customary Units

Sand Patch Diameter*, in.
(*based on 1.5 in³ sand volume)
How Much are the Chips Embedded?
Conclusions

• The amount of water remaining in the chip seal (emulsion, chips, substrate) seems to have an effect on chip retention.
Conclusions

• The Modified Sweep Test may provide a means to Determine What Moisture Content is Appropriate Before Opening To Traffic/Sweeping.
Conclusions

• Significantly higher chip loss was measured for test specimens fabricated with dry aggregates compared with saturated surface dry aggregates.
Conclusions

• Simple, Practical, Quantitative Methods are Recommended for:
  
  * Estimating When ‘Traffic/Broom Ready’
  * Embedment Depth
  * Surface ‘Softness’
  * Emulsion Viscosity
  * Surface Texture
Thank You!