Bonded HMA Overlays – a matter of tack materials & method of application

10/25/2012

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What is a tack coat?

- A light spray application of an asphalt emulsion used to create a bond between an existing pavement surface and the application of a bituminous mixture.

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Traditional Tack Coat Materials and Application Rates

- Slow setting emulsions
  - SS-1, SS-1h, CSS-1, CSS-1h
- Usually diluted up to 50% with water to allow more uniform distribution at low application rates
- Rate selected between 0.02 and 0.1 gal/square yard based on undiluted emulsion

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How bonded are pavement layers?

- Slippage cracks

How bonded are pavement layers?

- Slippage

Utah - 2009

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How bonded are pavement layers (cont.)?

- Slippage – Same core hole, a few days later

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How bonded are pavement layers (cont.)?

- This pavement had Premature pavement failure (within 1 year)
  - Longitudinal cracking near the wheel path and rutting

Utah - 2008

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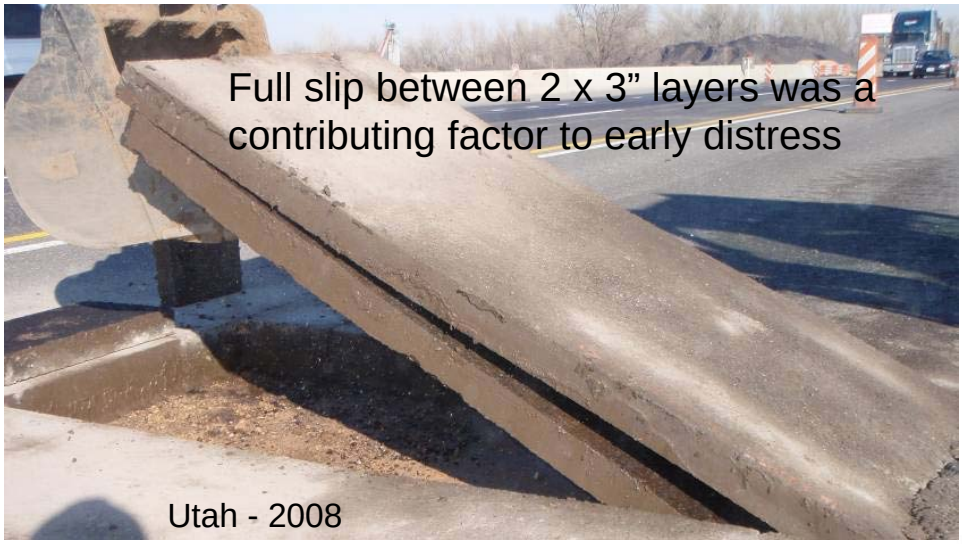
How bonded are pavement layers (cont.)?

- Premature pavement failure – within 1 year
  - Longitudinal cracking in the wheel path and rutting



Utah - 2008

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How bonded are pavement layers (cont.)?

- Coring of new asphalt lifts is a routine QC/QA activity to verify in-place density/calibrate nuclear density gage
- How often do cores break at the interface between layers?

De-bonding →

Utah - 2008

Tack Coat - Constructability vs Performance

- Construction favors:
  - Low application rates
    - Curing of the tack
    - Traction for paving equipment
  - Use of non-tacky hard binders
    - Reduces Tracking
- Performance favors:
  - Higher, more uniform application rates
  - Higher adhesion materials
    - Polymer modified asphalt emulsions

How Can Higher Tack Rates and Improved Tack Coat Materials be Applied?

- Modify the process to keep all construction equipment and trucks off from the tack during construction
- Replace the distributor with a paving machine equipped with an emulsion tank and spray bar all in one unit

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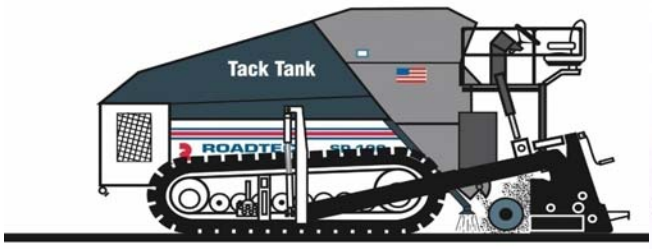
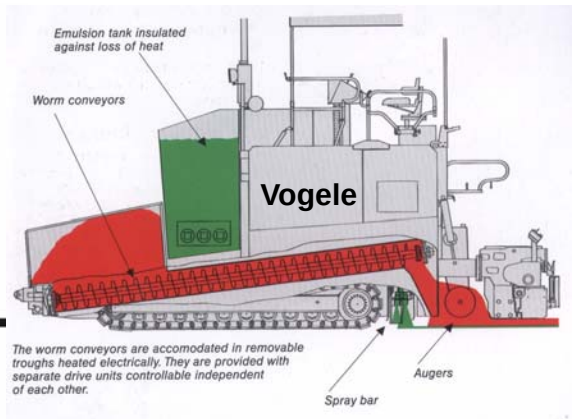
Bonded Overlay Delivery System

- Single pass paving/sealing system
  - **Hot mix** asphalt overlay
  - Polymer modified **emulsion** tack
  - Placed with **spray paver**
    - Paver + distributor



ROADTEC STEALTH PAVER WITH TACK TANK



Spray Paver

- 3 Processes
  - Spray emulsion
  - Lay hot mix
  - Smooth the mat

Application of emulsion

Application of HMA

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Spray Paver Features

- 60-100 ft/min travel speed
- No tracking of tack
- Uniform application of tack
- No construction traffic on tack

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How is a bonded overlay different?

- Improved delivery system and materials
- Composite system
  - HMA + PMEM (Polymer Modified Emulsion Membrane)
- Asphalt content of the system is a gradient
  - Higher binder at the bottom to lower on the top
- Tack coat material and rate can change the performance properties of the overlay system
  - Reduce Rutting
  - Reduce Cracking
  - Increase the Overlay life through improved bonding

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Bonded Overlay Features

- Non-tracking tack application reduces public complaints
- Better bond of overlays to existing pavement structure
- Reduced overlay thickness is possible without delamination
- Improved joint compaction resulting in better pavement performance
- Easier compaction results in less damage to the mix

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Field Performance Data

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Route T, Franklin County, MO

- Constructed: October 2008
- Contractor: N.B. West
- Project length: 3.5 miles (test sections)
- Surface: Composite, HMA over PCC
- Mix: 1 ¾" Bonded BP-1 HMA w/ PG64-22
- Tack:
  - Test sections at 0.1, 0.15, and 0.2 gal/yd2 PMAE at 65% AC
  - Test sections at 0.1 gal/yd^2 thru distributor and 0.1 and 0.15 gal/yd^2 CSS-1h thru SP-200
- Equipment: RoadTec SP-200 spray paver

June 2009

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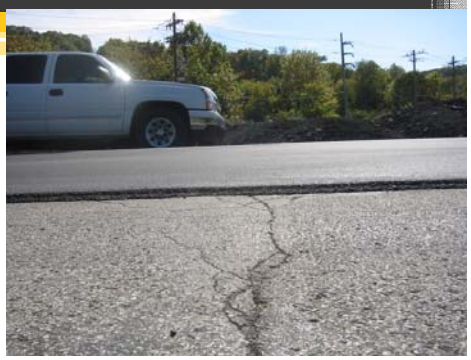
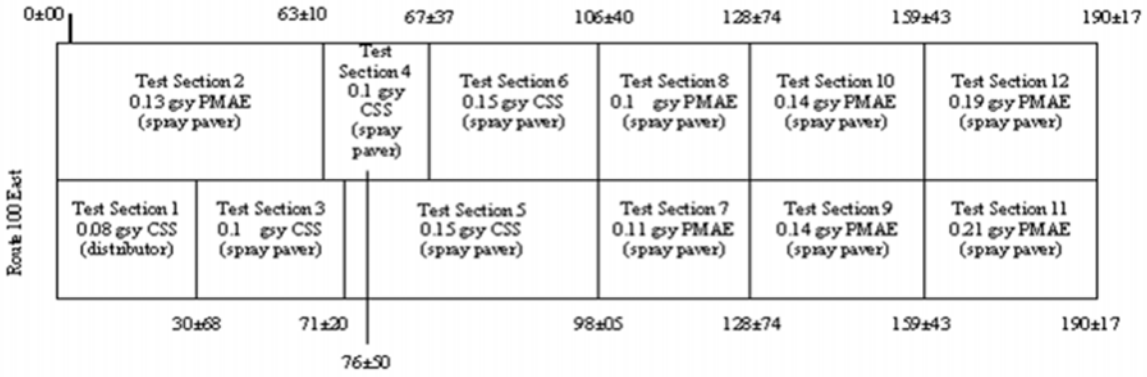
MoDOT Route T Project – Oct 2008

1 ¾” BP-1 overlay over composite pavement





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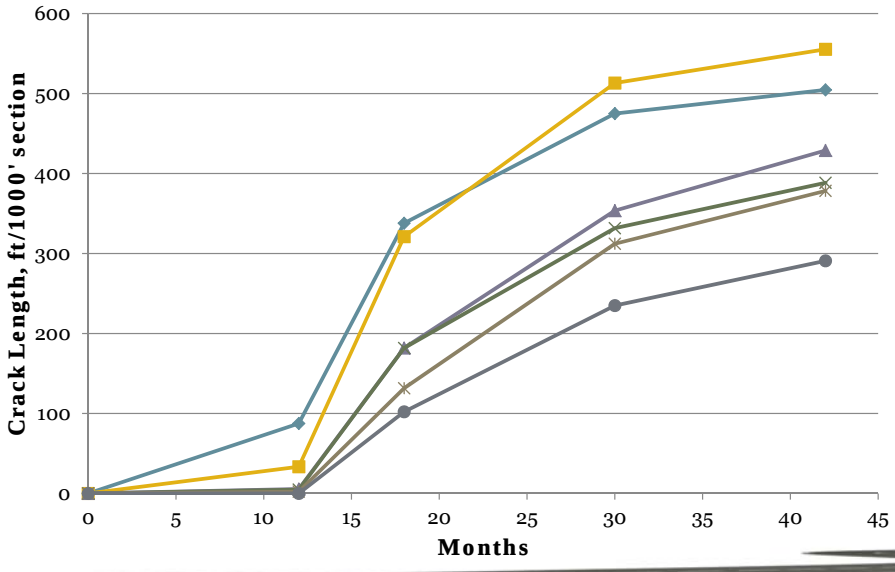
MoDOT Route T
Transverse Crack Length at 41 months
1 ¾ " BP-1 over HMA/PCC Composite



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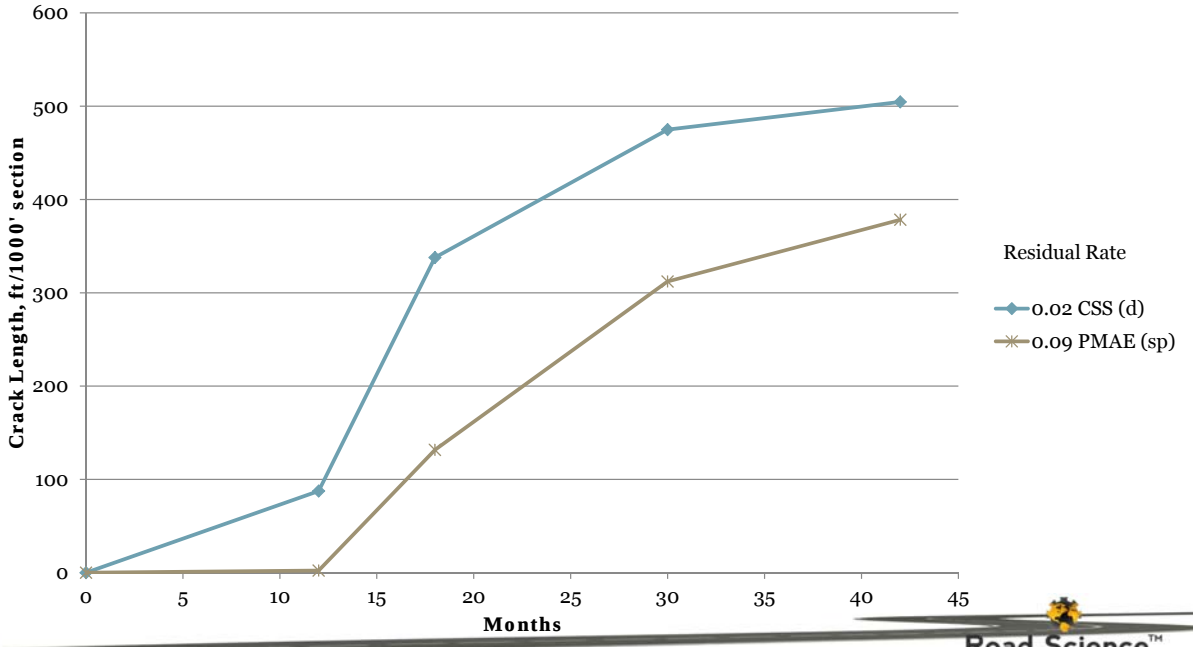
MoDOT Route T 2008
Transverse Cracking at 41 months
1 ¾" BP-1 over Old HMA/PCC Composite



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MoDOT Route T
Longitudinal Crack Length at 41 months
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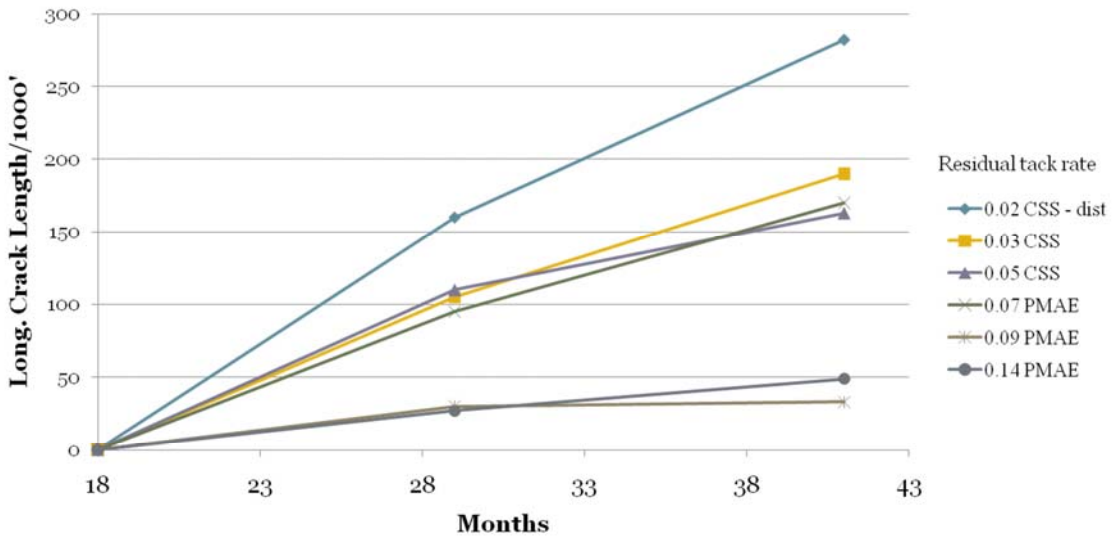

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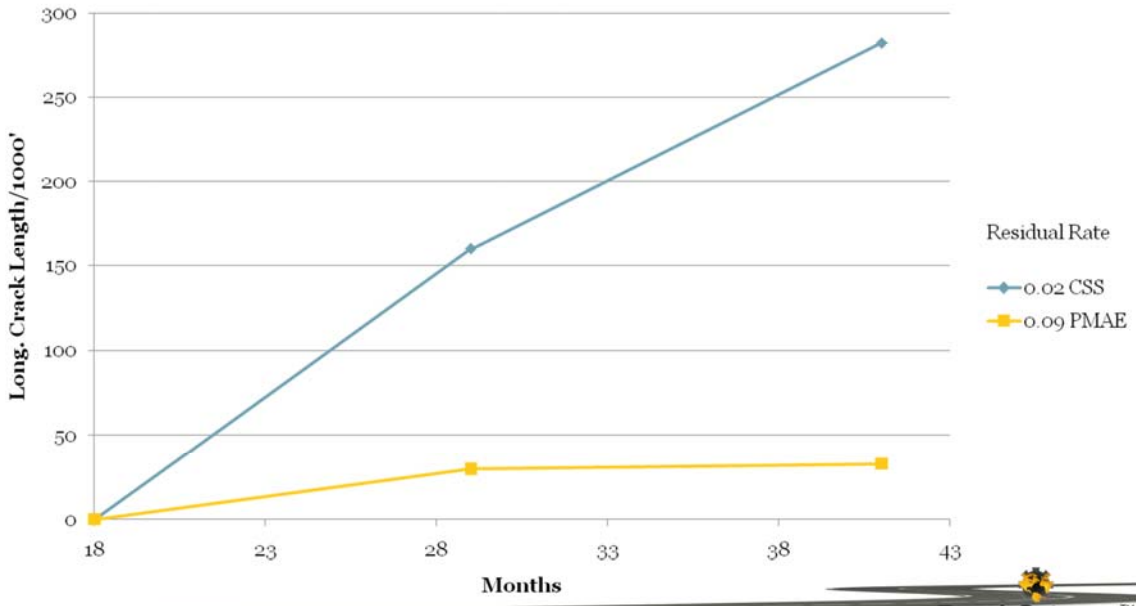

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Route T Franklin Co Test Sections
11/12
Before & Four Years After

2008 2012

0.14 gal/yd2 residual PMAE Tack

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KDOT US 36 Washington Co
Project – Sept 2009
1 ½" SR-12.5A over a Milled Surface

	Test Section 2 25% RAP 0.08 gal/yd2 CSS-1H	**Test Section 4** 25% RAP 0.16 gal/yd2 CSS-1H	**Test Section 6** 25% RAP 0.20 gal/yd2 CSS-1H	**Test Section 8** 25% RAP 0.12 gal/yd2 CSS-1H		
Test Section 1 25% RAP No Tack	**Test Section 3** 25% RAP 0.08 gal/yd2 EBL	**Test Section 5** 25% RAP 0.16 gal/yd2 EBL	**Test Section 7** 25% RAP 0.20 gal/yd2 EBL	**Test Section 9** 25% RAP 0.12 gal/yd2 EBL	**Test Section 10** 40% RAP 0.25 gal/yd2 EBL	**Test Section 11** 40% RAP 0.35 gal/yd2 EBL

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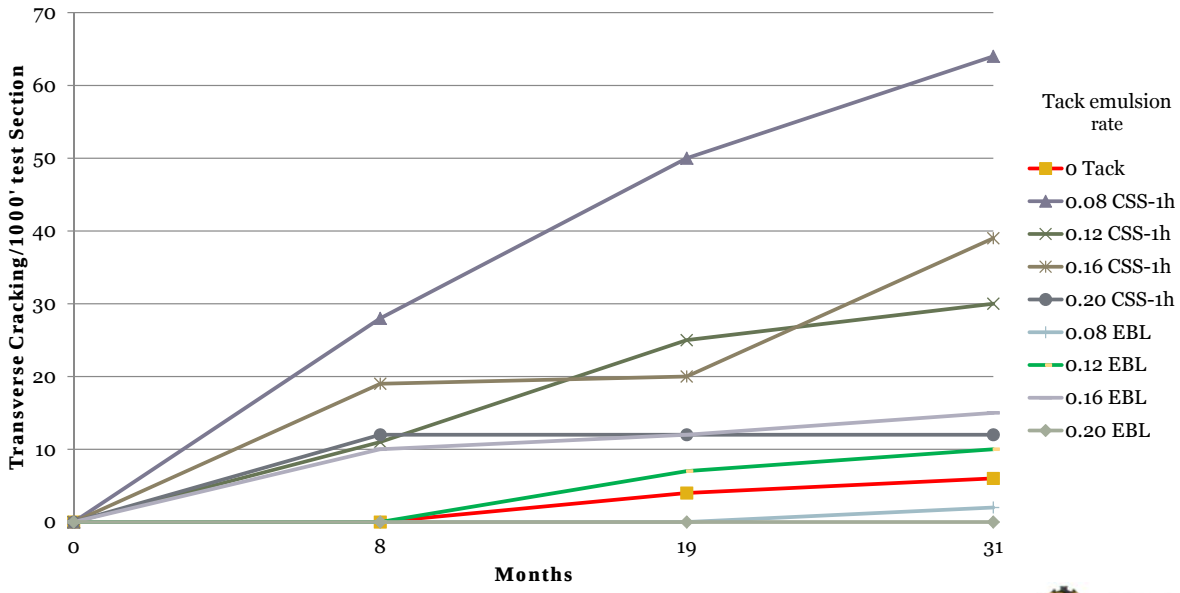
KDOT US 36 Washington Co. 2009
Transverse Cracking at 31 months
½" Mill, 1 ½" SR12.5A, PG58-28



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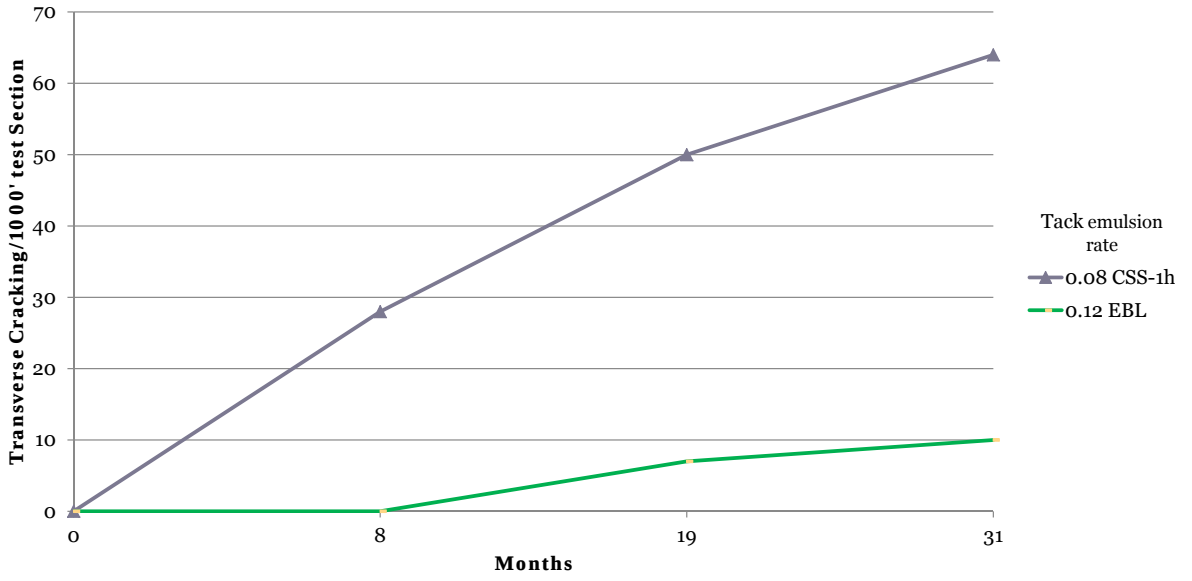

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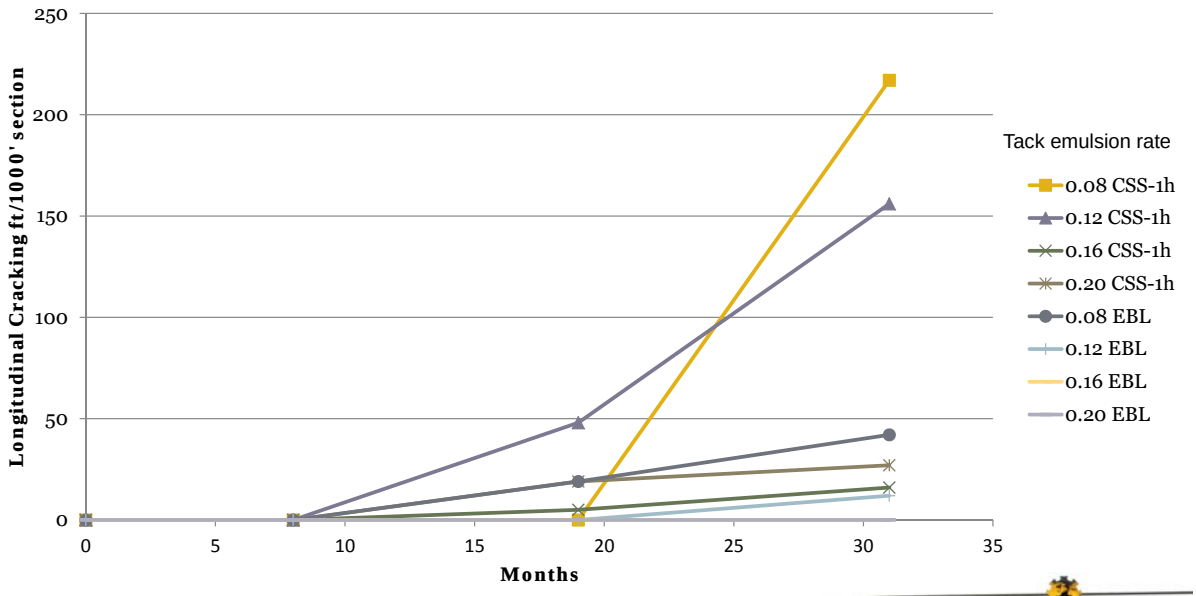

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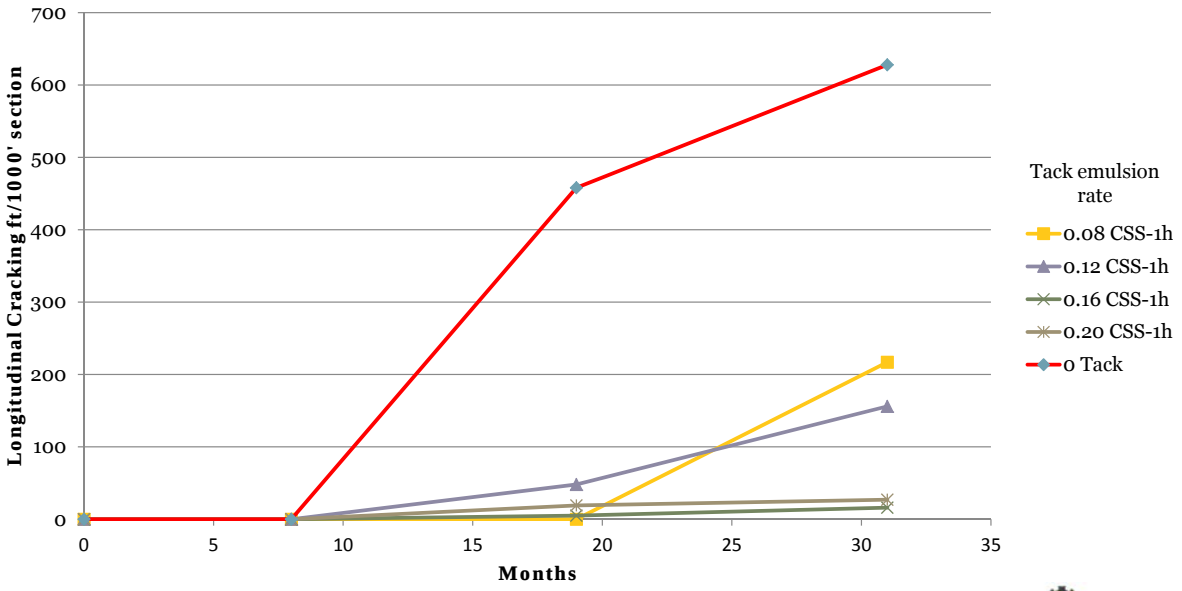

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No tack over a milled surface

- US 36 Washington County, KS - 2 years old
- Fatigue cracking in the inside wheel path
- Effect of unbonded overlay

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KDOT US 81 Cloud County 2011
WMA over PCC

- 2 – 1 ½" WMA lifts over PCC
- 3 Spray paver sections
  - Sec 1, 0.135 gal/yd^2 residual PMAE
  - Sec 2, 0.20 gal/yd^2 residual PMAE
  - Sec 3, 0.095 gal/yd^2 residual PMAE
- Distributor section
  - Sec 4, 0.026 gal/yd^2 residual SS-1hP (lower polymer content)

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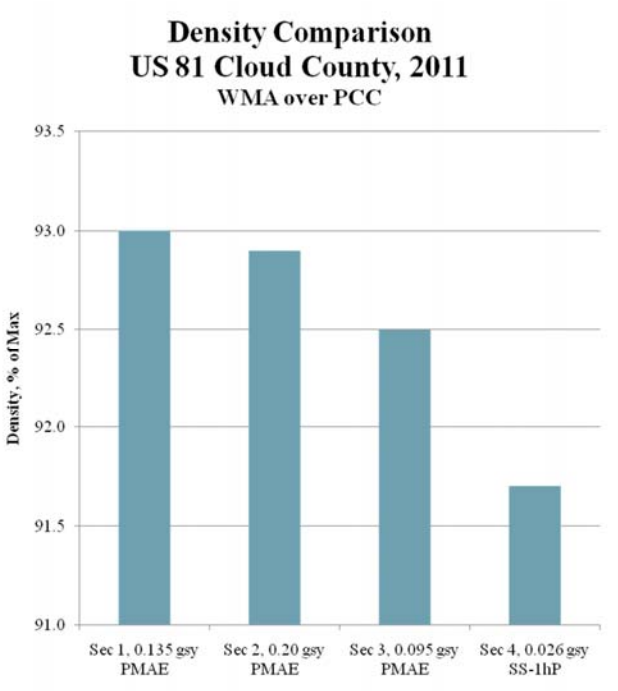
KDOT US 81 Cloud County 2011



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May 2003
During Installation

May 2006
3 Years Later

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Summary

- Lack of bond between pavement layers leads to pavement distress and reduced pavement life
- Traditional tack coat materials and rates may yield inconsistent bonding between pavement layers over time
- Tack coat materials and rates can have an effect on the overall overlay performance
  - Higher than traditional application rates improve performance
  - Higher elasticity and higher adhesive tack coat materials can improve performance

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Summary

- Spray Paver can deliver both the tack coat and HMA mix in one pass, allows
  - heavier tack coats than conventional application rate without tracking or traction issues
  - undiluted Polymer Modified Emulsion Membrane (PMEM), PMAE, EBL, etc.

- Need QC to quantify degree of bonding achieved in the field. (Another discussion)

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Thank you!

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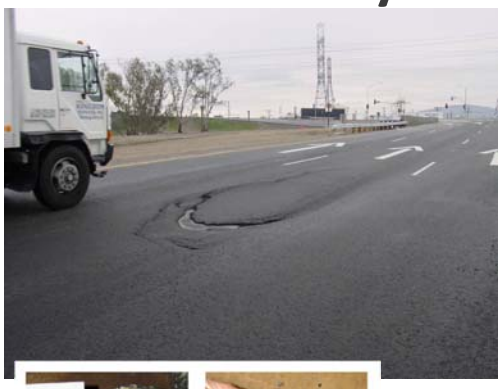
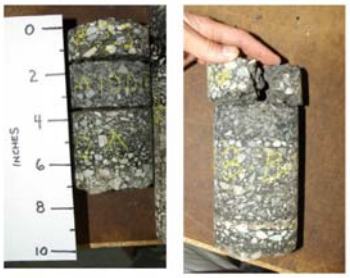
Effect of Poor Bond between Pavement Layers





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Is Applying a Tack Coat Important?

- Pavement design assumes 100% bond to existing surface
- Full bond versus partial bond can change the pavement service life by 2.6 times, for a 2” overlay*
- Loss of bond creates high tensile stress at the bottom of the overlay, creating:
  - Delamination
  - Slippage
  - Cracking

*ESAL’s to failure based on TAI rebound equation

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A Bonded Overlay Requires:

- An application of a hot mix asphalt concrete
  - Open-graded, gap-graded or dense-graded
- Well-bonded to an existing asphalt or PCC pavement surface
- Bonded by means of a uniform and uncontaminated application of an asphalt tack coat
  - Usually polymer modified

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How Does a Bonded Overlay Differ From the Traditional Paving Methods used Today?

- Conventional tack and overlay creates issues of constructability vs performance
- Improved delivery system and materials replace construction methods which have been troublesome
  - No tracking of tack coat or paver friction issues
- Better bond from better materials
  - Higher amounts of tack coat emulsion can be applied
  - Polymer modified tack coat materials
    - Higher polymer content
    - Undiluted emulsion

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Examples of Bonded Overlay Systems

- Ultrathin Bonded Asphalt Wearing Course
  - Example, Novachip® UTBWC
- Bonded Dense-Graded HMA
- All placed by means of a spray paver delivery system

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BondTekk® Bonded Dense-Graded HMA Overlay System

- Bonded DG-HMA is a hot mix asphalt overlay applied using a spray paver delivery system to provide a uniform application of a tack coat material. The tack may be conventional or polymer modified asphalt emulsion
- The asphalt mixture is a dense-graded type
  - Marshall design
  - Superpave design
  - SMA design

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Summary

- Other improved features:
  - Enhanced cracking resistance
  - Improved compaction
  - Increased overlay life/reduced distresses
  - Increased structure value over traditional tack (Another Discussion)

Road Science is a resource for you if you have further questions or interest in Bonding all of your Hot Mix Pavements

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