2005 Pavement Performance Prediction Symposium

Adhesion and Cohesion of Asphalt in Pavement

Cheyenne, Wyoming
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Nebraska Department of Roads
STPD-43-2(106)
NE Highway #43
Adams to Bennett

• Let to Contract = January 13th, 2000
• Length of Project = Approximately 15.0 mi.
• SP-2 Superpave Mixture = 51,400. tons
• PG 58-28 Binder = 2,700. tons
• Mill ½” existing & replace with 3½” SP-2
• ADT = 2,045 with 9% Trucks
Our SP-2 Superpave Mixture?

- SGC # of Gyrations: (0.3 - 1 ESALs)
  - $N_{ini.} = 7$
  - $N_{des} = 76$
  - $N_{max} = 117$
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- **VMA** = Min. of 14.0%
- **VFA** = 65% to 78%
- **Dust / Binder Ratio** = 0.6 to 1.2
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- **Dust / Binder Ratio = 0.6 to 1.2**
- **PG Binder % = 5.0%**
SP-2 Mixture QC Results
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SP-2 Mixture QC Results

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FAA = 42.1%
VMA = 14.4%
VFA = 75.3%
SP-2 Mixture QC Results

PG Binder % = 5.1%
FAA = 42.1%
VMA = 14.4%
VFA = 75.3%
Air Voids = 3.6%
PG58-28 Test Results
Average of 24 Field Samples

• Original DSR = 1.050 KPa
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- RTFO Dynamic Shear = 2.521 KPa
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• PAV Dynamic Shear = 4100. KPa
PG58-28 Test Results
Average of 24 Field Samples

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- PAV Dynamic Shear = 4100. KPa
- PAV Creep Stiffness = 220. MPa
PG58-28 Test Results
Average of 24 Field Samples

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- PAV m – value = 0.305
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Note: 1 sample failed PAV Specifications
Dates of Construction

• May and June of 2000
July Arrives
with
HOT Temperatures!!
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Calls are coming in to our office asking us to come out and watch the project’s wheel paths turn dark, as the asphalt is flushing to the surface!!
Pictures of Hwy 43
What’s Next?
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This project was “tied” to 2 other State Highway Spur overlays.

A Change Order/ Supplemental Agreement was approved to require the use of PG 64-22 binder for the other 2 locations.

No flushing occurred on these 2 projects.
What’s Next?

We cold milled ½” of the surface off of Hwy 43 and to date the surface has not flushed again.

We applied a 1” OGFC on a 3 mile segment for test and evaluation in 2002. It is performing as expected.
The investigation begins....
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- Samples were provided to Western Research Institute.
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  - Cores from flushed areas
  - Cores from non-flushed areas
  - Original PG Binder samples
Review of Findings

- Western Research Institute
  - Methods Used to Investigate Samples.....
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• Western Research Institute
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    • Extracted binder from top & bottom ¾” of cores using toluene/95% ethanol (85/15)
Review of Findings

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  - Methods Used to Investigate Samples…..
    - Extracted binder from top & bottom ¾” of cores using toluene/95% ethanol (85/15)
    - Extracted binder with carbon disulfide (CS₂) for gas chromatographic simulated distillation
Review of Findings

• Western Research Institute
  – Methods Used to Investigate Samples…..
    • Extracted binder from top & bottom \(\frac{3}{4}\)" of cores using toluene/95% ethanol (85/15)
    • Extracted binder with carbon disulfide (CS\(_2\)) for gas chromatographic simulated distillation
    • Extracted binder subjected to dynamic shear Theological (DSR) analysis
Westerm Research Institute

- Methods Used to Investigate Samples
  - Extracted binder from top & bottom ¾” of cores using toluene/95% ethanol (85/15)  
  - Extracted binder with carbon disulfide (CS₂) for gas chromatographic simulated distillation  
  - Extracted binder subjected to dynamic shear Theological (DSR) analysis  
  - Binder analyzed using size-exclusion Chromatography (SEC)
Review of Findings

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    • Extracted binder from top & bottom ¾” of cores using toluene/95% ethanol (85/15)
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    • Binder analyzed using size-exclusion Chromatography (SEC)
    • Binder analyzed using Automated Heithaus Titration method
Review of Findings

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  – Methods Used to Investigate Samples.....
    • Extracted binder from top & bottom ¾” of cores using toluene/95% ethanol (85/15)
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    • Binder analyzed by Differential Scanning Calorimetry (DSC)
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  – Methods Used to Investigate Samples…..
    • Extracted binder from top & bottom ¾” of cores using toluene/95% ethanol (85/15)
    • Extracted binder with carbon disulfide (CS₂) for gas chromatographic simulated distillation
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    • Binder analyzed using size-exclusion Chromatography (SEC)
    • Binder analyzed using Automated Heithaus Titration method
    • Binder analyzed by Differential Scanning Calorimetry (DSC)
    • Binder viewed by Environmental Scanning Electron Microscope
Conclusions
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• There was “lower boiling” material in extracted core vs. original binder.
• Binder in top of flushed core is softer than the original binder below 86°F.
• More small molecular size material in top of flushed core than in original binder.
Conclusions (Cont.)

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• Lower molecular weight material is interfering in the crystallization of the wax material present in the original binder.
• There is an indication of the presence of Carbon Black, possibly crumb rubber?
In Summary

“The results do not find any conclusive evidence as to the cause of the asphalt problem on Highway 43 but the analyses show some very unusual chemical properties of the asphalt that most likely contribute to the problem. We (WRI) have become aware of some other states that have experienced similar problems at about the same time.”
Adhesion or Cohesion Problem?

Not your usual problem!
Special Thanks
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• Michael Harnsberger
  – Lead Scientist – Western Research Institute
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• John Dageforde – Nebraska Department of Roads, Bituminous Laboratory.
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- Bob Traudt – Project Manager, Nebraska Department of Roads