AMAP Conference
Las Vegas, Nevada
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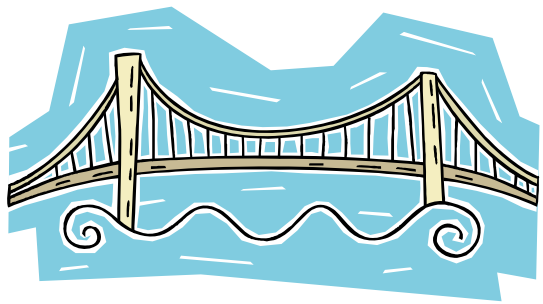
The Use of Modified Binders in Bridge Deck Overlays

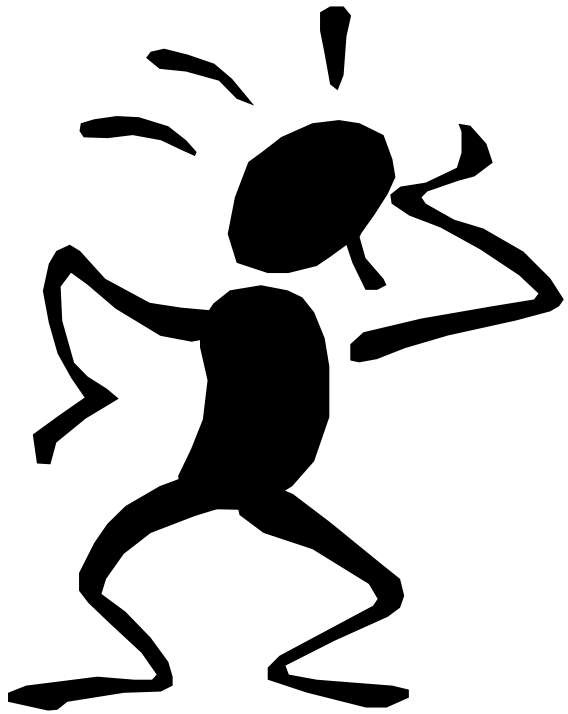
Speaker: Richard C. Mauch, P.E.

PROJECT

- Martin Luther King Bridge



"Learn from Your Mistakes"



Martin Luther King Bridge Project

MLK BRIDGE

- One of 4 bridges Connecting Illinois to downtown St. Louis
- Commuter Bridge
- ADT 35000

BRIDGE DECK

- Cast in Place Concrete Deck
- Steel Grid Deck w/ Light Weight Concrete and Bituminous Concrete Overlay

Steel Grid Deck Section

- 3 Sections
- Total Length = 725’
- Four 10’ Lanes
- Parabolic Curve

PROJECT SCOPE

- Structure Rehabilitation
- Bridge Deck Rehabilitation

Bridge Deck Overlay Rehab

- Remove Existing Bituminous Overlay
- Remove Existing Waterproof Membrane
- Apply New Waterproof Membrane
- Place New Bituminous Concrete Surface

Waterproof Membrane

- Proposed Cold Liquid Sprayed, Seamless Elastomeric Waterproofing System
- Experimental Feature
- Quick Application – minimize inconvenience

Contract Specification
Surface Mix Design

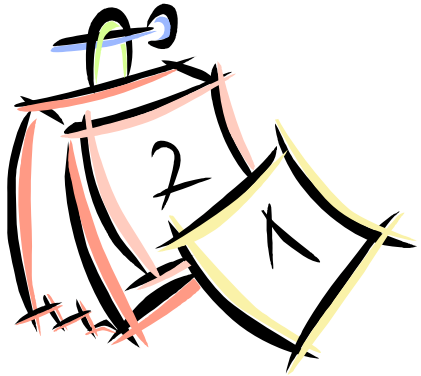
- Type I D Surface Mix
- 75 Blow Marshall Mix Design
- AC 20 Liquid Binder

- Design Air Voids = 4.0%
- 92.0% – 96.0% Field Density Requirement
- 32mm or 1 1/4” Thickness
- 400 Tons

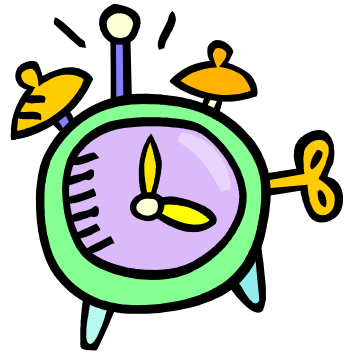
Contract Award

- Prime: Keeley & Sons, Inc.
  E. St. Louis, Illinois

- Asphalt Sub: Maclair Asphalt Company
  Collinsville, Illinois



Project Timeline



- Contract Let – January 1999
- Prime Contractor starts – April 1999
- Bituminous Concrete starts – September 1999
- Project Completed – October 1999

- There’s more to this story!

Contractor's Surface Mix Design

- 75 Blow Marshall Mix
  - 12.5mm Surface Mix
  - 65% Coarse Aggregate
    - 1:1 Blend (Crushed Gravel/Dolomite)
  - 35% Fine Aggregate
    - 3:1 Blend (Manuf. Stone/Natural River)
  - 5.1% Liquid Binder
    - PG64-22 (Non-Modified)

Plant Information

- GenTec Rotary Mix/Dual Dryer-Drum Plant

Paving Equipment

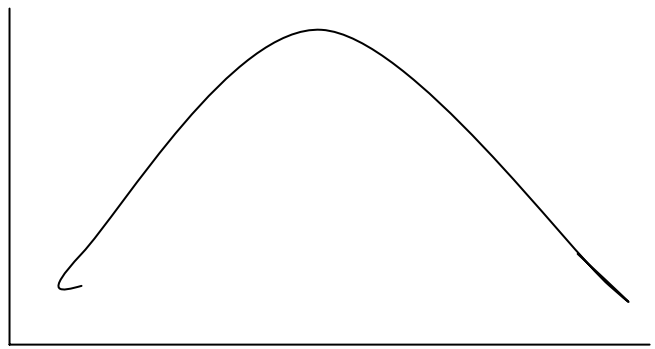
- Paving Machine – Rubber Tire
  – Barber-Greene (Model BG 240)

- Breakdown Roller – 3 Wheel Static Roller (12 Ton)
  – Huber (E1012)

TEST STRIP

- Evaluate Mix
  - Plant Tests

- Establish Rolling Pattern
  - Growth Curve (Peak Density)



Quality Control Tests

- 1st Production Day
  - Air Voids : 4.8% and 4.7%
  - Ignition Burns: AC Content 5.0% and 5.1%
    Gradation within allowable range
  - Field Density: 92.5% and 91.5%
- 2nd Production Day
  - Air Voids : 4.6% and 4.7%
  - Ignition Burns: AC Content 4.9% and 5.1%
    Gradation within allowable range
  - Field Density: 92.0% and 91.5%

First Sign of Trouble

- Mat movement – Push & Shove

- Coarse Texture

- Low densities

No Major Concerns

- Test Results – Within limits
- Visual Appearance of Mix - Predictable

More Signs of Problems

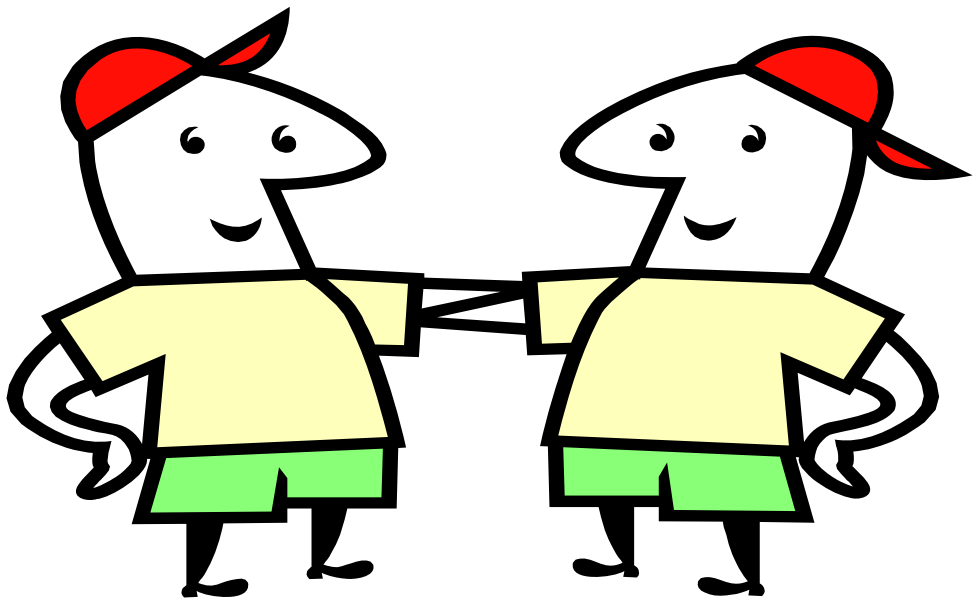
- Cracks Develop
- Mix Raveling

Forensic Testing

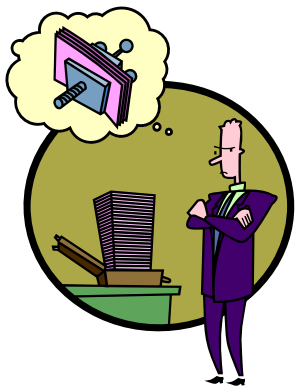
- CORES
  1. Nuc-Core Correlation
     1. Density
  2. Ignition Burns
     1. Gradation
     2. Binder Content

TEST RESULTS

- Forensic Test Data = Plant Test Data

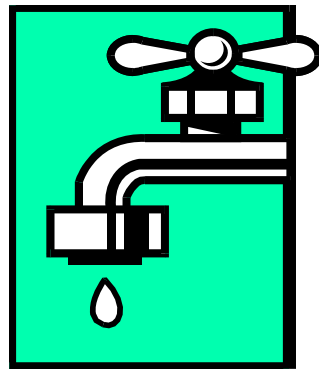


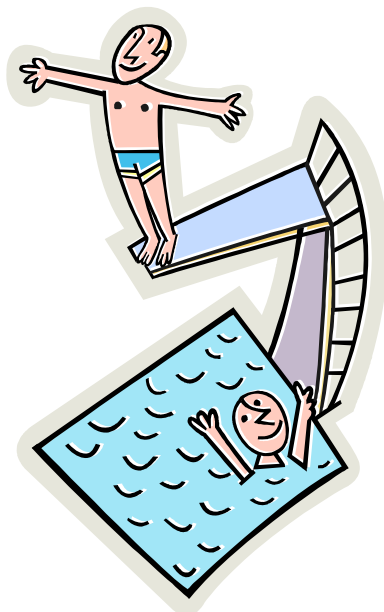
What caused the failures?



1. **<u>Water Infiltration</u>**
    - Raveling

2. **<u>Deck Deflection</u>**
    - Cracking





Raveling

Mix Characteristics – 75 Blow Marshall Mix

- Mat Thickness
  - Thin
- Aggregate Structure
  - Stiff/Brittle Mix
  - Coarse Graded
- Liquid Binder
  - Low content

SUSCEPTABLE

- Segregation
- Low Density
- Stripping
- Thermal Cracking

Cracking

Mat Movement

- Deck Deflection
  - Span Length
  - Steel Grid Deck w/ LW Concrete
- Low Shear Strength
  - Liquid Binder
  - Tack Coat

Waterproof Membrane

SUSCEPTABLE

- Low Density
- Shear Failure
- Fatigue Cracking

SOLUTION

Stop Water Infiltration

- Change the Mix Design
  - Aggregate Gradation
    - Tighter Mix
      - Increase Mat Density
  - Liquid Binder
    - Increase Content
      - Increase Mat Density
      - Increase Film Thickness

Eliminate Cracking

- Change Non-Mod. To Modified Binder
  - High Temp (Rut Resistance)
  - Low Temp (Reduce Thermal Cracking)
  - More Ductile/Flexible Mix

75 Blow Marshall to N70 Superpave

- Coarse Agg. Change
  - Gravel/Dolomite to Crushed Gravel Only
    - Nom. Max Size (Changed to 9.5mm)
- Fine Agg. Change
  - Replaced Man. Sand with River Sand
    - 3:1 to 2:1
- Liquid Binder Change
  - Non Modified to Modified
    - PG64-22 to SBS PG76-28
  - Increase Content
    - 5.1% to 5.5%

Repair Plan – Spring 2000

Remove Overlay down to WPS

Place Modified Superpave Surface Mix

PROBLEM

Experimental WPS

- Areas of Overlay not adhering to WPM
- Areas of Waterproof system not adhering to Deck

DECISIONS

1. Place N70 Mix over Experimental WPS

2. Remove the Experimental WPS

   Place Standard WPS

   Place N70 Surface

3. **Remove Experimental WPS**

   Place N70 Surface

Protection without WPS?

- 4 Elements Provide Protection
  - Modified Tack Coat (HFP/CRSP)
  - Dense Graded Mix
  - Modified Liquid Binder
  - Joint Construction

Modified Tack Coat

- Cationic Rapid Setting Polymer
  - Prevent Shear Slippage
  - Bearer/Sealant Against Water Infiltration on Deck

Dense Graded Mix

- N70 Superpave Surface Mix with good density characteristics
    - Tight MIX – Impervious to Water
    - High Liquid Binder content

Modified Liquid Binder

- SBS PG76-28
  - Rut Resistance
  - Prevent Thermal Cracking
  - Decrease Stripping of Aggregate
  - Increase Adhesion to Deck

Joint Construction

- Density
- Limit Longitudinal Joints
  - Reduce 3 to 2
- Apply Joint Sealant

Plant Test Results

- Average Air Voids = 3.8% and 3.7%
- Average Mat Density = 93.5% and 94.5%
- Liquid Binder Content = 5.4% and 5.5%

Question:

Is this Overlay going to last?

Answer:

Only time will tell!


US

If at first you don’t succeed,

If at first you don’t succeed,

skydiving is not for you!

THANK YOU

- QUESTIONS OR COMMENTS