New Asphalt Technologies

26th Annual Region Local Road Conference
Thursday, October 27, 2011
Rapid City, SD

Ken Swedeen, Dakota Asphalt Pavement Assoc.
Dakota Asphalt Pavement Association Inc.

- Represent over 80 Contractor, Producer, Refiner, Engineering Firms and other Companies involved in the HMA Industry in North and South Dakota
- Dedicated to Quality Asphalt Construction through Education, Research & Training
- Bituminous Certification Courses – NDDOT/SDDOT
- Working with Agencies, LTAP’s
- Short Courses – Hot Mix Asphalt Technology
- Research – SDSU, UND, NDSU, SDSM&T
Let’s change the title to how we can use existing and new technology to make our pavements BETTER!
Recent HMA Developments

Performance Graded Binder
(Modified Binder)

Warm Mix Asphalt
Recent HMA Developments (Con’t)

M-E Design Principles

Asphalt Concrete

Base

Subgrade

Shear Stress \( \tau, \gamma \)

Tensile Strain \( \varepsilon_t \)

Vertical Compressive Strain \( \varepsilon_v \)

Perpetual Pavement

Porous Asphalt Pavement

Porous Asphalt

standard asphalt
Recent HMA Developments (Con’t)

Thermal & Compaction Control

SMA (Stone Matrix Asphalt) & Wearing Course Alternatives
Superpave performance grading (PG) is based on the idea that an HMA asphalt binder’s properties should be related to the conditions under which it is used. For asphalt binders, this involves expected climatic conditions as well as aging considerations.

This may require modifiers be added to the asphalt cement or binder.
- Developed out of SHRP in 1990’s
- Addressed the weakness of prior Specifications (e.g. Penetration, Viscosity, etc.)
- Modeled on the Engineering Properties of the Binder (and Mixture) at binder storage conditions, plant conditions, aged pavement conditions and pavement service conditions (high pavement temperature~summer, cold pavement temperature~winter)
- Viscosity
  - viscous effects only
- Penetration
  - empirical measure of viscous and elastic effects
- No Low Temperature Properties Measured
- Problems with Modified Asphalt Characterization
- Specification Proliferation
- Long Term Aging not Considered
Superpave Asphalt Binder Specification

- Grading System Based on Climate

PG 58-28

- Performance Grade
- Average 7-day max pavement design temp
- Min pavement design temp
Is a PG a Modified Binder?

“Rule of 90”

\[ \text{PG 64} - 34 > 64 - 34 = 98 \]

Probably modified!!

(Depends on Asphalt Source!)
### PG Binder/Crude Impact

<table>
<thead>
<tr>
<th>Low Temperature, °C</th>
<th>52</th>
<th>58</th>
<th>64</th>
<th>70</th>
<th>76</th>
</tr>
</thead>
<tbody>
<tr>
<td>-16</td>
<td>52-16</td>
<td>58-16</td>
<td>64-16</td>
<td>70-16</td>
<td>76-16</td>
</tr>
<tr>
<td>-22</td>
<td>52-22</td>
<td>58-22</td>
<td>64-22</td>
<td>70-22</td>
<td>76-22</td>
</tr>
<tr>
<td>-28</td>
<td>52-28</td>
<td>58-28</td>
<td>64-28</td>
<td>70-28</td>
<td>76-28</td>
</tr>
<tr>
<td>-34</td>
<td>52-34</td>
<td>58-34</td>
<td>64-34</td>
<td>70-34</td>
<td>76-34</td>
</tr>
<tr>
<td>-40</td>
<td>52-40</td>
<td>58-40</td>
<td>64-40</td>
<td>70-40</td>
<td>76-40</td>
</tr>
</tbody>
</table>

- **Green** = Crude Oil
- **Yellow** = High Quality Crude Oil
- **Red** = Modifier Required
• Select Binder (PG) Based on Climate (Location)
• Select Binder (PG) Based on Mix Type, Utilization of RAP and Pavement Design
• Account for Risk Tolerance (e.g. Functional Classification)
• Account for Economics (LCCA)
• Account for Loading/Rate of Loading
### Three Closest Weather Stations For Latitude/Longitude = 44.16183/96.75146

<table>
<thead>
<tr>
<th></th>
<th>A=18 km</th>
<th>B=19 km</th>
<th>C=25 km</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>State</strong></td>
<td>SD</td>
<td>SD</td>
<td>SD</td>
</tr>
<tr>
<td><strong>Station ID</strong></td>
<td>0392984</td>
<td>0391076</td>
<td>0399042</td>
</tr>
<tr>
<td><strong>County/District</strong></td>
<td>moody</td>
<td>brookings</td>
<td>lake</td>
</tr>
<tr>
<td><strong>Weather Station</strong></td>
<td>flandreau 4 sw</td>
<td>brookings 2 ne</td>
<td>wentworth 2 wnw</td>
</tr>
<tr>
<td><strong>Elevation, m</strong></td>
<td>476</td>
<td>500</td>
<td>515</td>
</tr>
<tr>
<td><strong>Latitude, Longitude</strong></td>
<td>44.05 , 96.60</td>
<td>44.32 , 96.77</td>
<td>44.02 , 97.00</td>
</tr>
<tr>
<td><strong>Last Year Data Available</strong></td>
<td>1996</td>
<td>1996</td>
<td>1996</td>
</tr>
</tbody>
</table>

### Air Temperature
- **Mean (Std. N)**: 32.9 (2.1, 39) / 32.9 (2.5, 62) / 33.4 (2.1, 35)
- **Low Temperature**: -33.4 (2.7, 37) / -33.0 (3.4, 63) / -32.0 (2.6, 38)
- **Low Temperature Drop**: 19.6 (5.1, 36) / 17.6 (5.8, 61) / 16.7 (5.4, 38)
- **Degree Days Above 30 C**: 84 (49, 39) / 86 (69, 62) / 97 (56, 35)

### Pavement Temp. and PG
- **High Low Rel. (50% Rel. Pavement Temp.)**: 50.1 -24.6 (50,50) / 50.0 -24.4 (50,50) / 50.5 -23.6 (50,50)
- **High Low Rel. (PG, High, Low Rel.)**: 52 -28 (71,88) / 52 -28 (70,86) / 52 -28 (66,94)
- **High Low Rel. (PG, High, Low Rel.)**: 58 -28 (98,88) / 58 -28 (98,86) / 58 -28 (98,94)
- **High Low Rel. (PG, High, Low Rel.)**: 58 -34 (98,98) / 58 -34 (98,98) / 58 -34 (98,98)
SD PG Binder Selection
(Low Temp-50% Reliability)

O = -34
O = -28
O = -22
SD PG Binder Selection
(Low Temp-98% Reliability)
• For new, resurfaced or reconstructed surfaces design the pavement and the asphalt binder
• If a polymer modified binder is called for…”don’t step over dollar bills to pick up pennies”. About $50/ton of liquid asphalt ($3/ton of mix) for upgrade 58-28 to 64-28
• A properly designed pavement and binder WILL:
  • Reduce thermal cracking and fatigue cracking saving future maintenance costs for crack sealing, pot hole patching, and associated problems
  • Provide and sustain better ride quality
  • Reduce aging and oxidation
  • Reduce rutting, particularly “green season” rutting (1st or 2nd year summer peak temperatures)
What is Warm Mix Asphalt (WMA)?
Asphalt is a *thermoplastic* material that softens as it is heated and hardens when cooled.
WMA Definition

![Graph showing temperature vs. fuel consumption for different asphalt types, including Cold Mix, Half-Warm Asphalt, WMA, and HMA. The graph indicates a two-stage process: heating and vaporization.](image-url)
WMA Types

- Asphalt Viscosity-reducing Organic Additives
- Water-bearing Additives
- Water-based Technologies
- Chemical Additives
Review

- WMA is a process of producing bituminous mixture for pavements at a significantly lower temperature than conventional HMA.
- There are more than 20 WMA technologies currently available, at least 15 in the US.
  - Fiber/Organic
  - Chemical
  - Physical
  - Foamed/Foaming Agents
- Goal: Reduce temperature requirements in production from 275-325 deg. F. (HMA) to 200-275 deg. F. (WMA)
Warm Mix Asphalt (WMA)

- Possible Benefits
  - Allowance for Construction Season & Environment
    - More Effective Late Season Paving
    - Portable Plant Setups...Long Hauls
  - Improve Pavement Quality by Increasing Density Compliance
  - Possible Winter Season Wearing Course?
  - Environmental & Personal Protection
  - Urban Pavement Alternative
Project SD2008-03
Evaluation of Warm Mix Asphalt Concrete Pavement in South Dakota Conditions
Goals

- Evaluate the suitability of using Warm Mix Asphalt (WMA) in SD
- Assess WMA suitability in all paving applications (e.g. overlays, leveling interim, etc.)
- Evaluate WMA properties (binder, aggregate & mixture)
- Evaluate WMA pavement integrity & durability characteristics w/ HMA
- Emissions evaluation (benefits) of WMA during paving & production
**Project Status (Con’t)**

- Tentative Testing Plan

<table>
<thead>
<tr>
<th>Mix Type</th>
<th>None</th>
<th>Advera</th>
<th>Evotherm</th>
<th>Foamed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Limestone/PG64-28</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Quartzite/PG64-28</td>
<td>X</td>
<td></td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Nat. Gravel/PG64-28</td>
<td>X</td>
<td></td>
<td>X</td>
<td>X</td>
</tr>
</tbody>
</table>
Without WMA - HMA
With WMA
Warm Mix Asphalt (WMA)

Case Study: WMA – Nov. 2009; Mission, SD
Rosebud Sioux Tribe
Turtle Creek Shopping Center
Mission, SD

Morris Inc.
Pierre, SD

Chris Boom
Asphalt Supt
Morris, Inc.
Pierre, SD

Dan Johnston
Research Asst.
SDDOT
Pierre, SD

Acknowledgement:
SDDOT Materials
Jim Costello &
Rick Rowen
Project Specifics

Transportation of Asphalt: 5 Belly Dump, 40 ton trucks and 2 Side Dump, 40 ton trucks, 3 End Dump 15 ton Trucks. All trucks were tarped.

Transportation Method: Asphalt was hauled 101 miles to Mission, SD, dumped from the 40 ton trucks on an existing pad and reloaded into the end dump trucks via front end loader and skidsteer.

Laydown Equipment: Caterpillar AP1055 Track Paver, CB534 Asphalt Roller

Paving Layout: Varying widths, multiple passes with radius’s, under traffic, utilizing flaggers.

Weather: November 18 – Mostly sunny, Low 30, High 57

November 19 – Mostly sunny/windy, Low 21, High52

November 20 – Partly Cloudy, Low 23, High 56
Project: Turtle Creek Crossing Shopping Center Access Road

Owner: Rosebud Sioux Tribe

Project Location: Mission, SD

Plant Location: Pierre, SD (101 miles from Project)

Asphalt Plant: ADM RoadBuilder 220 TPH

Project Dates: November 18th – 20th, 2009

Project Data: 2-2” Lifts or 900 tons of Class E, Type I Asphalt with PG64-28 Binder with Evotherm added at 0.6% placed on three roads. See Plan.
Paving Layout
Field Mix Analysis (SDDOT)

APA – Rutted Wheel Test

Average Rut Depth (8000 cycles) = 2.33 mm
Field Core Density Tests

Location 1**:
- Bottom Lift = 90.5%*
- Top Lift = 92.1%

Location 2***:
- Bottom Lift = 91.8%
- Top Lift = 90.0%

*All density based on comparison to Maximum Theoretical Density (Rice-Gmm)

**Core Locations not randomly selected. Location 1 typical for temperature and laydown conditions

***Core Location #2 selected as most suspect area (open texture apparent, transport truck 4+ hour wait, temperature to paver < 170 deg. F.)
Cross Road – 1st Day
130 deg. Mat Temp >
140 deg. Mat
Temp >
Warm Mix Application 11/18/09

- Mix production temperature-November 18-312°F
- Last covered 40 ton transport first round departed Pierre 9:55 AM
- Unloaded at DOT yard to remix and load into trucks at 1:10 PM
- AC dump pile core at 250-260°F-remix gave 235-240°F
- Temperature at job delivery- 165-185°F
Warm Mix Application
11/18/09 (con’t)

- Paving temperature- 145-165°F
- Mat exhibited no more than a 15-20°F temperature difference.
- Air temperature-high 59°F low 20°F
- Wind-south 6-16 mph-warm
- Marks rolled out down to 130°F
- Paving operations normal
Warm Mix Application 11/19/09

- Mix production temperature- 290°F
- Second run-275°F- “officially” warm mix
- Air temperature-high 48.9°F low 19.9°F
- Wind 13.8-20 mph-cold-gusts to 27 mph
- Paving operations mostly normal-surface more open after paving
- Sections will need flush seal next spring
Laydown on West Road
Transport/Laydown Delivery Transfer

![Image with temperature scale: 57.2°F to 237.6°F]
• Thermal Imaging Data Collected
• Full Field Testing Protocol
  • Pavement Cores – Per QC/QA (2 per 1000t sublot)
  • Nuclear Density Testing – Density “Tree” (1 per 500t)
• Full Volumetric Testing
• Moisture in Mixture
• Burner Fuel Comparison
SD2008-03
Anderson Western, Inc. (Bismarck, ND)
May 2010 - South Dakota Highway 20
Perpetual Pavements

www.AsphaltAlliance.com
Introduction

- Not a new concept
  - Full-Depth
  - Deep Strength
  - Mill & Fill
Why consider Perpetual Pavements????
Because of this.....
And this....
And this.....
And this....
And this....
And this.....
And this.....probably not so much!!!
1.5 - 3” SMA, OGFC or Superpave

4” Zone
of High
Compression

High Modulus
Rut Resistant Material
(Varies As Needed)

Max Tensile Strain

Flexible Fatigue Resistant Material 3 - 4”

Pavement Foundation
Bottom-up Design and Construction

Foundation

- Stable Paving Platform
- Minimize Seasonal Variability and Volume Change in Service

- Fatigue Resistant Lower Asphalt Layer
- Rut Resistant Upper Asphalt Layers
Mechanistic-Based Design

Material Properties (modulus values) → Pavement Model

Pavement Responses (strains, stresses, etc.)

Minimize likelihood of tensile strains > 65 με, comp. strains > 200 με

Transfer Function

Pavement Life OK?

Final Design
Mechanistic Performance Criteria

Limit Bending to < 65 με (Monismith, Von Quintus, Nunn, Thompson)

Limit Vertical Compression to < 200 με (Monismith, Nunn)
HMA Considerations

- HMA Base Layer
- Intermediate Layer
- Wearing Surface
Fatigue Resistant Asphalt Base

- Minimize Tensile Strain with Pavement Thickness
- Thicker Asphalt Pavement = \textbf{Lower Strain}
- Strain Below Fatigue Limit = \textbf{Indefinite Life}
Rut Resistant Upper Layers

- **Aggregate Interlock**
  - Crushed Particles
  - Stone-on-Stone Contact

- **Binder**
  - High Temperature PG
  - Polymers
  - Fibers

- **Air Voids**
  - Avg. 4% to 6% In-Place

- **Surface**
  - Renewable
  - Tailored for Specific Use
Impact of Temperature Gradient on Asphalt Grade.

Temperature

- High Perf. PG Binder
- SMA, OGFC or SP 1.5 - 3”
- Use proper PG Binder as dictated by climate and depth.
- Rut Resistant Material (Varies)
- Use proper PG Binder as dictated by climate and depth.
- Fatigue Resistant Material 3” to 4”
- Pavement Foundation
## Performance of Washington Interstate Flexible Pavements (based on 180 miles)

<table>
<thead>
<tr>
<th>Statistic</th>
<th>Time Since Original Construction (years)</th>
<th>Thickness of Original AC (mm (in.))</th>
<th>Time from Original Construction to First Resurfacing (years)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average</td>
<td>31.6</td>
<td>230 (9.2)</td>
<td>12.4</td>
</tr>
<tr>
<td>Range</td>
<td>23 to 39</td>
<td>100 to 345</td>
<td>2 to 25</td>
</tr>
</tbody>
</table>
Ohio Study of Flexible Pavements

- Examined Performance on 4 Interstate Routes
  - HMA Pavements - Up to 34 Years without Rehabilitation or Reconstruction
  - “No significant quantity of work . . . for structural repair or to maintain drainage of the flexible pavements.”
  - Only small incremental increases in Present Cost for HMA pavements.
FHWA - Data from Long-Term Pavement Performance Study

- Data from GPS-6 (FHWA-RD-00-165)
- Conclusions
  - *Most AC Overlays > 15 years before Rehab*
  - *Many AC Overlays > 20 years before Significant Distress*
  - Thicker overlays mean less:
    - Fatigue Cracking
    - Transverse Cracking
    - Longitudinal Cracking
TRL Report 250
Nunn, Brown, Weston & Nicholls

Design of Long-Life Flexible Pavements for Heavy Traffic

http:\\www.trl.co.uk
Overall Summary

- No structural deformation or roadbase fatigue cracking.
- Distresses confined to surface
  - Rutting
  - Cracking
- Roadbase stiffens with age and reduces deflection.
Perpetual Pavement

› Structure Lasts 50+ years.
  » Bottom-Up Design and Construction
  » Indefinite Fatigue Life
› Renewable Pavement Surface.
  » High Rutting Resistance
  » Tailored for Specific Application
› Consistent, Smooth and Safe Driving Surface.
› Environmentally Friendly
› Avoids Costly Reconstruction.

www.AsphaltAlliance.com
References

TRB Circular No. 503
On-line at www4.nas.edu
Porous Asphalt Pavement

"Is it possible to have a stormwater best management practice (BMP) that reduces impervious areas, recharges groundwater, improves water quality, eliminates the need for detention basins, and provides a useful purpose besides stormwater management? This seems like a lot to expect from any stormwater measure, but porous asphalt pavement on top of recharge beds has a proven track record."
Porous Asphalt Pavement
Gap Graded, Fines Starved, High A/C Content HMA
On Infiltration Bed/Drain Rock
<table>
<thead>
<tr>
<th>Sieve Size</th>
<th>% Passing</th>
</tr>
</thead>
<tbody>
<tr>
<td>1/2 in.</td>
<td>100</td>
</tr>
<tr>
<td>3/8 in.</td>
<td>95</td>
</tr>
<tr>
<td>#4</td>
<td>35</td>
</tr>
<tr>
<td>#8</td>
<td>15</td>
</tr>
<tr>
<td>#16</td>
<td>10</td>
</tr>
<tr>
<td>#30</td>
<td>2</td>
</tr>
</tbody>
</table>

Percent bituminous 5.75-6.0% by weight
Infiltration Bed
Recharge Trench
porous asphalt

standard asphalt
Deicing and Freezing Issues

“One of the most common questions relates to concerns about freezing conditions. Freezing has not been an issue, even in very cold climates. We were quite surprised when the owners of early installations first told us that there was less need to snowplow on the porous pavement surfaces. The underlying stone bed tends to absorb and retain heat so that freezing rain and snow melt faster on the porous pavement. The water drains through the pavement and into the bed below with sufficient void space to prevent any heaving or damage, and the formation of "black ice" is rarely observed. The porous surfaces tend to provide better traction for both pedestrians and vehicles than does conventional pavement. Not a single system has suffered freezing problems.”
Thermal & Compaction Technology

Temperature Control
Intelligent Compaction

www.AsphaltAlliance.com
Mix Temperature

- Major Factor in Compaction/Density
- Compaction/Density Major Factor in Pavement Durability
- Uniformity & Consistency, as in all paving operations, are equally important in the final operation: Rolling
- Segregation (mechanical) and Longitudinal Joint Failures are two major contributing factors on premature failure or reduction of pavement life
Least expensive part of the paving process

Aggregates and oil are expensive in comparison

Compaction adds little to the cost of a ton of asphalt
Effect of Compaction

- Compaction is equally important in extending pavement life
- Saves money in maintenance costs
- Understanding compaction is very important
Importance of Compaction

- Improve Mechanical Stability
- Improve Resistance to Permanent Deformation
- Reduce Moisture Penetration
- Improve Fatigue Resistance
- Reduce Low-Temperature Cracking Potential
Factors Affecting Compaction

- Properties of the Materials
- Environmental Variables
- Laydown Site Conditions
Mix Temperature

- Major effect on compaction
- Must compact while oil is still fluid enough to allow aggregate movement
- When oil is stiff, aggregates lock
Time Available for Compaction

- Temperature of mat passing under screed affects mat workability
- Work close to paver when mat is cool
- Add rollers when mat is cool
- Use more force if possible
Intelligent Compaction

- Proper in-place density is vital for good performance
- Conventional compaction equipment and procedures have limitations...

- **Intelligent compaction technology goal is to find “a better way”**
Conventional Limitations

- The Compaction Process...

Limited “On The Fly” Feedback

Over or Under-Compaction Can Occur
Conventional Limitations

- Provides little or no “on the fly” feedback for roller operator
  - Better if constant feedback is provided during the compaction process
- Over or under-compaction often occurs
  - Better if operator can tell when and if density has been obtained
Intelligent Compaction

Can we make the process... smarter?

Improved Roller Technology

Sophisticated / Clear Documentation Systems

ACE
Ammann Compaction Expert

Advanced Hardware & Software
IC – Goals / Benefits

- **Short Term**
  - Improve density... better performance
  - Improve efficiency... cost saving$
  - Increase information... better QC/QA

- **Long Term**
  - Comprehensive Compaction Control (CCC)
  - Estimate pavement moduli?
  - Tie to M-E Design Guide (verify design)?
  - Performance specifications?
IC TPF / FHWA Definition

GPS-based documentation systems

- Continuous recordation of materials stiffness
- Continuous recordation of corresponding roller location
- Color-coded mapping of stiffness, temperature and number of passes
Ex. Sakai...

Controller Units

Thermo Gauge

Accelerometer

PC Display
Advantages to GPS system

- Continuous recordation
  - density related outputs
  - corresponding roller location
- Color-coded mapping
- Project mapping
- Easy identification of poor density
Caterpillar

Intelligent Compaction

Courtesy of Caterpillar
Sakai IC Roller Project

- Temperature

Shoulder side (Supported)

Paving Direction

Longitudinal Joint
Accelerated Implementation of IC

Map showing states in different colors, with some states highlighted in orange.
Common Methods of Measuring Thermal Segregation

- Infrared Thermometers – less than $200
- Infrared Cameras – less than $5K
- Pave-IR System – less than $30K
# Comparison of Thermal Profiling Techniques

<table>
<thead>
<tr>
<th>Test Device</th>
<th>Strengths</th>
<th>Weaknesses</th>
</tr>
</thead>
</table>
| Handheld IR Thermometer | Inexpensive.  
Simple to use.  
Tests independent of paving train. | Requires constant operator attendance.  
May miss localized defects. No permanent record. |
| IR Camera         | Inexpensive.  
Simple to use.  
Tests independent of paving train.  
More coverage than thermometer. | Requires constant operator attendance.  
May miss localized defects. No permanent record (usually). |
| Pave-IR           | Does not require constant operator attendance.  
Provides real-time feedback.  
Tests virtually full-coverage.  
Automated data reduction.  
Permanent record. | Most costly device.  
Testing coverage could impact risk of finding defects.  
May include artificial cold spots in data set. |
Example report from project with minimal thermal segregation
Example report from project with severe thermal segregation
Conclusions

- Physical & thermal segregation are the “Cancer of HMA Paving Industry”
- You cannot always see it. It grows with time. It often results in the early death of the pavement - often the only reason some HMA pavement are in need of rehabilitation
- There are many known & suspected causes & cures – No consensus
- Identifying & Eliminating Thermal Segregation is a Major Goal for Quality Paving
Wearing Course Alternatives

• Chip Seal
• Slurry Seal
• Microsurfacing
• Dense Graded Hot Mix Asphalt
• “Engineered” Wearing Course
SMA (Stone Matrix Asphalt) & Smaller Aggregate Size (NMAS) Durable Wearing Courses
Rut Resistant Wearing Course?

I-29 Sioux Falls South SMA
Review of HMA Research Projects at UND
Funded by NDDOT

Presented to the DAPA Annual Meeting,
Deadwood, SD
January 8-9, 2009

Presented by
Nabil Suleiman, Ph.D.
Civil Engineering Department
University of North Dakota
Evaluation of North Dakota’s 4.75 mm Local Gyratory Mixtures for Thin Overlay Applications
4.75 mm Mix Project

Objectives

- To evaluate the rutting resistance performance of the 4.75 mm mixes
- To evaluate benefits/impacts of the 4.75 mm mixes as thin overlays or as maintenance appl. for med. to low vol. highways
- To show that the 4.75 mm NMAS mixtures are useful in providing utility for fine aggregate stockpile screenings
Original Scope

- Prepare local Superpave samples (4.75 mm NMAS)
  - **Binder:** ........................................PG 64-28, PG 58-28
  - **Aggregate blend (%NF/%CF):** ..100/0;80/20;60/40
  - **Aggregate gradation:** ..................4.75 (#4) NMAS
  - **Mix Design Air Voids:** .................4%
  - **APA Air Voids:** .........................7%

- Perform volumetric analysis

- Conduct rut tests using the APA .. Dry and wet
## Gradations

<table>
<thead>
<tr>
<th>Aggregate</th>
<th>Nat. Fines</th>
<th>Crushed Fines</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Sieve Size</strong></td>
<td><strong>% Passing</strong></td>
<td><strong>% Passing</strong></td>
</tr>
<tr>
<td>5/8&quot; (16mm)</td>
<td>100.0</td>
<td>100.0</td>
</tr>
<tr>
<td>1/2&quot; (12.5mm)</td>
<td>100.0</td>
<td>100.0</td>
</tr>
<tr>
<td>3/8&quot; (9.5mm)</td>
<td>100.0</td>
<td>99.0</td>
</tr>
<tr>
<td>#4 (4.75mm)</td>
<td>96.2</td>
<td>94.9</td>
</tr>
<tr>
<td>#8 (2.36mm)</td>
<td>86.1</td>
<td>71.8</td>
</tr>
<tr>
<td>#16 (1.18mm)</td>
<td>71.3</td>
<td>47.1</td>
</tr>
<tr>
<td>#30 (0.6mm)</td>
<td>50.7</td>
<td>31.0</td>
</tr>
<tr>
<td>#50 (0.3mm)</td>
<td>25.4</td>
<td>18.8</td>
</tr>
<tr>
<td>#100 (0.15mm)</td>
<td>8.5</td>
<td>11.9</td>
</tr>
<tr>
<td>#200 (0.075mm)</td>
<td>5.5</td>
<td>8.9</td>
</tr>
</tbody>
</table>
4.75 mm Mix Project

• Issues

- Realizing the utility of the 4.75 mm mixes as low-cost rut-resistant thin overlays for med. or LVR
- A cost-effective maintenance treatment alternative
- Providing use for CFs and NFs
- Benefit to roadway agencies, local HMA producers, and local aggregate producers on issues regarding aggregate availability and specification compliance
4.75 mm Mix Project

- **Implementation**
  - If research study is successful, thin-lift applications of the 4.75 mm mixes can be implemented as cost-effective overlays for medium and LVR roads.
  - The 4.75 mm mixtures can also be implemented as a low-cost maintenance treatment alternative for almost all pavement types.
Thanks!

- www.dakota-asphalt.org
- kswedeen@dakota-asphalt.org
- 605-224-8500 Office; 605-360-0045 Mobile
- DAPA Office
  Dakota Asphalt Pavement Association
  3030 Airport Road, Suite B
  Pierre, SD  57501