

Long-Life Asphalt Pavements for the 21st Century

What's New with WMA?

(at least since this meeting last year)

North Central Asphalt User/Producer Group

NCAUPG

Hot Mix Asphalt Technical Conference

February 4, 2010

Overland Park, KS

warmmixasphalt.com

WMA in
the USA!



BRUCE
SPRINGSTEEN



WMA Investigation and Implementation Premise

- ✚ Although there are many factors driving the development and implementation of WMA technologies globally, in order for WMA to succeed in the U.S., WMA pavements must have equal or better performance when compared to traditional HMA pavements



What is WMA?

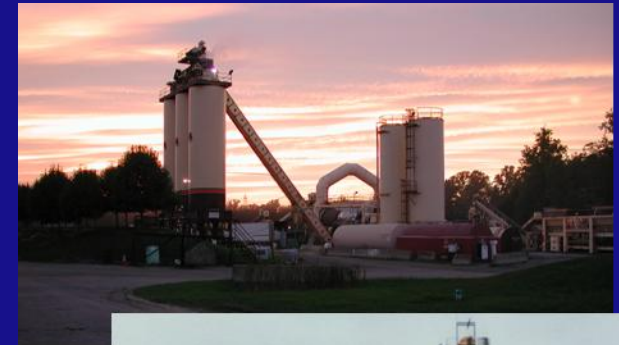
- ✦ Allows a reduction in the temperatures at which asphalt mixes are produced and placed
 - ~~■ Reduced viscosity at lower temps~~



Why WMA?

❖ Potential Advantages**

- ❖ Energy Savings
- ❖ Decreased Emissions
 - Visible and Non-Visible
- ❖ Decreased Fumes
- ❖ Decreased Binder Ageing
- ❖ Extended Paving Season
- ❖ Compaction Aid
- ❖ Increased RAP usage

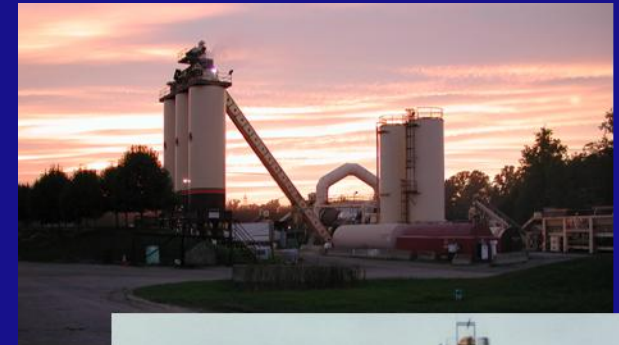




Why WMA?

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- ❖ Compaction Aid
- ❖ Increased RAP usage??





How Many WMA Technologies are Available in the U.S.?

Hint: This time last year there were fourteen (14) named technologies.



How Many WMA Technologies are Available in the U.S.?

Currently Twenty (20) Technologies Marketed and Available in the U.S.



Technology Overview**

WAM-Foam



Rediset WMX



Low Emission Asphalt



Aspha-Min



AquaFoam



Advera



Ultrafoam GX



Sasobit



Terex



REVIX



Accu•Shear



Evotherm



Aquablack



Cecabase RT



Double Barrel



Thiopave



Green





Technology Overview**

TLA-X



Lake Asphalt of
Trinidad and Tobago

Iterlow-T & HyperTherm



Static Inline Vortex Asphalt Blender



Ad-RAP (ECOBIT)



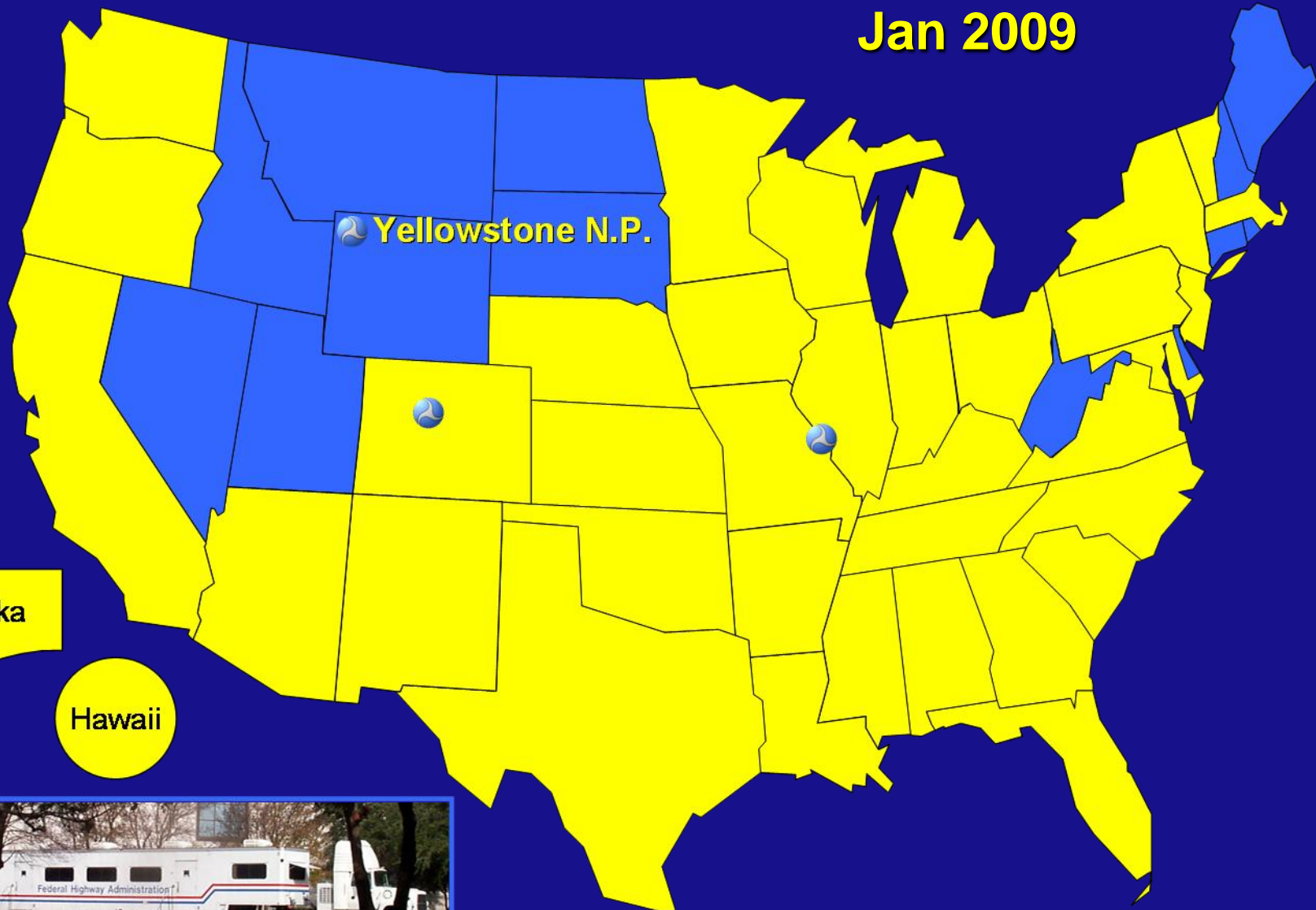
More to come ...

Many other technologies are also used
Internationally.



WMA Trials and Demonstrations

Jan 2009



Alaska

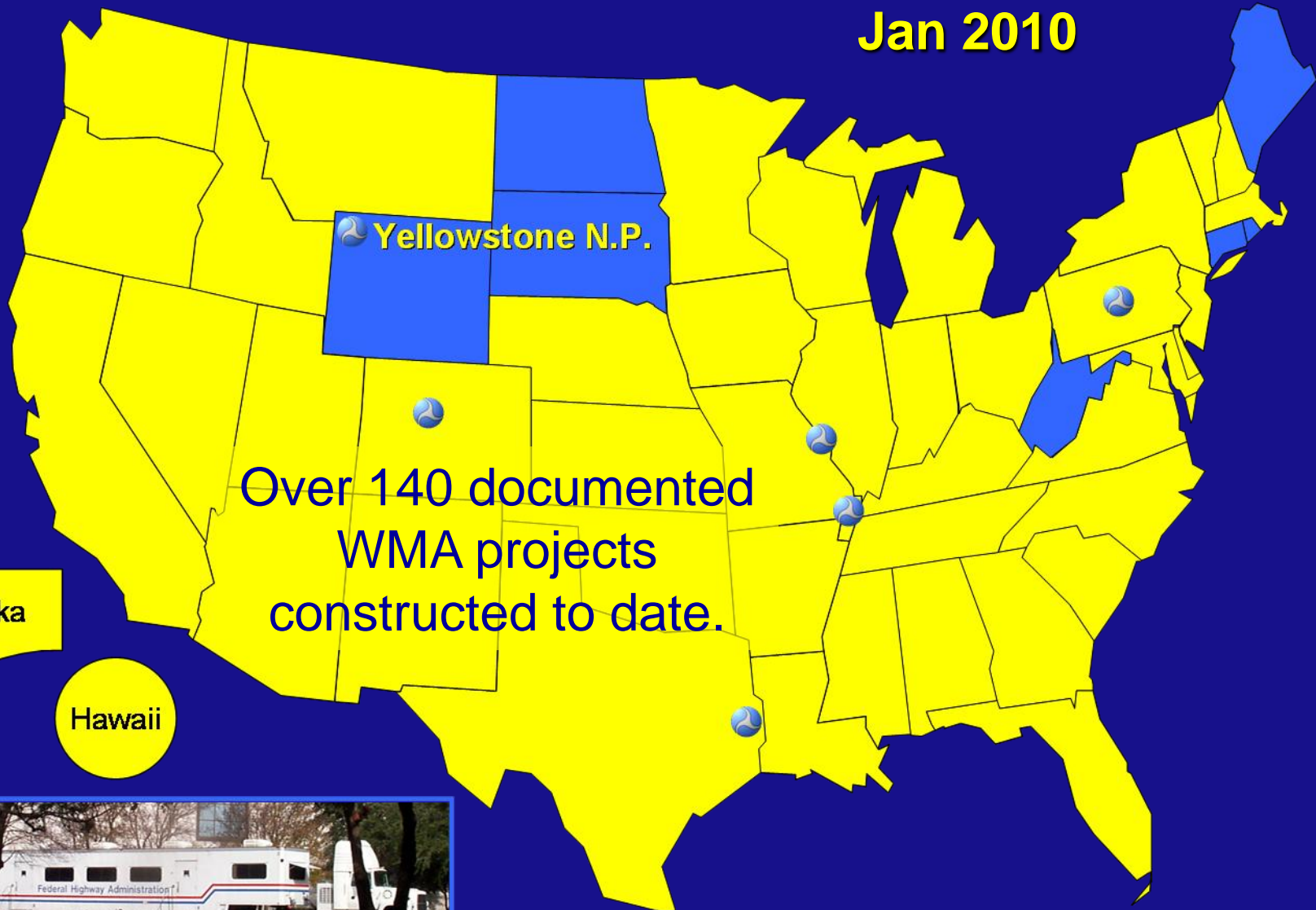
Hawaii





WMA Trials and Demonstrations

Jan 2010



Over 140 documented
WMA projects
constructed to date.





Well Documented WMA Projects

Climatic Region	State (Number of WMA Projects*)	Reported Performance Problems
Dry, No Freeze	CA(2), TX(4)	No performance problems reported
Dry, Freeze	CO(3), NV(2), WA(1), WY(2)	No performance problems reported
Wet, No Freeze	AL (3), AR(1), CA(8), FL(3), GA(1), MS(2), NC(2), SC(3), TN(1), TX(10), VA(2), WA(6)	Nashville, TN HMA and at least one WMA may be showing signs of moisture damage.
Wet, Freeze	AK (3), IL(1), IN(1), MD(3), MA(1), MI(1), MN(1), MO(5), NE(1), NY(46), OH(4), PA(3), TN(8), VT(1), VA(1), WI(6)	Kimbolton, OH sections are raveling, which may be a sign of moisture damage. No other problems reported



MAMTL Trailer WMA Projects

Warm Mix Asphalt Projects

Location	Mix Design	Lab Compaction Level, Gyrations	Base Binder Grade	Technologies
Hall St., St. Louis, MO	12.5 mm Superpave	100	PG 70-22	Aspha-min, Evotherm, Sasobit
I-70, Dillon, CO, West of Eisenhower Tunnel	9.5 mm Superpave	75	PG 58-28	Advera, Evotherm Sasobit
East Entrance Road, Yellowstone National Park, WY	19 mm Hveem	75	PG 58-34	Advera Sasobit
US 190, Jasper, TX	19 mm Superpave	55	PG 70-22	Rediset WMX
SR2006 Centre Hall & SR 2012 Spring Mills, PA	9.5 mm Superpave	75	PG 64-22	Aspha-min, Sasobit, LEA UltraFoam GX
I-55, Sikeston, MO	19 mm Superpave	125	PG 76-22	Aquablack



Mobile Asphalt Testing Laboratory (MATL)





Asphalt Mixture Performance Tester

Dynamic Modulus (E^*)

Test Temperatures

- ❑ 4.4° C (40° F)
- ❑ 21.1° C (70° F)
- ❑ 37.8° C (100° F)
- ❑ 54.4° C (130° F)

Frequencies

- ❑ 0.1, 0.5, 1, 5, 10, 25 Hz



IPC Global
AMPT Device





Asphalt Mixture Performance Tester

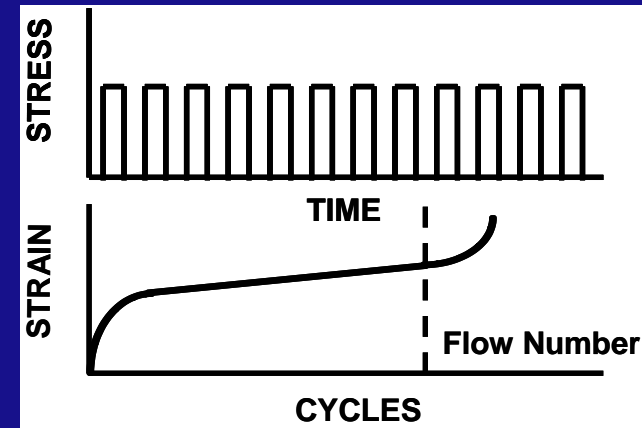
Flow Number, F_n

Loading

- ❑ Axial load applied for 0.1 second with 0.9 second rest period

Test Temperatures

- ❑ LTTPBind, Version 3.1 Software
- ❑ Site pavement temperature at 50% Reliability
 - Pavement Temperature
 - Pavement Temperature + 6° C
 - Pavement Temperature - 6° C



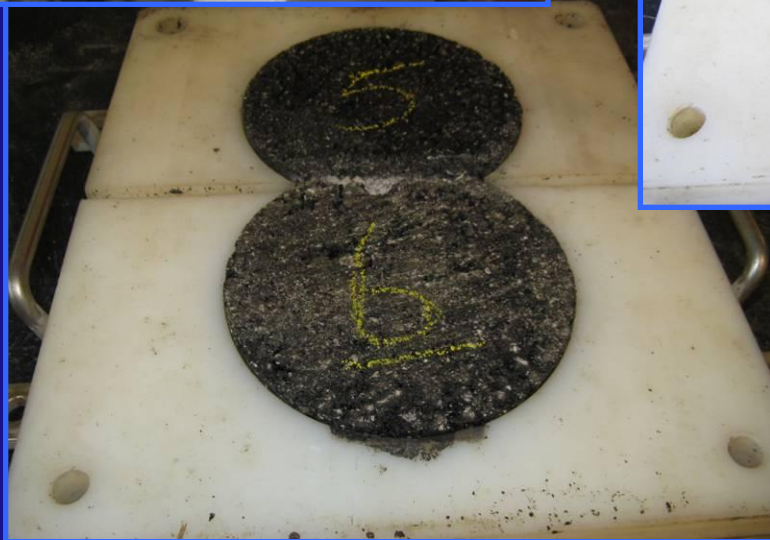
IPC Global AMPT Device



Hamburg Wheel Track Test



AASHTO T 324



7.0 ± 0.5% voids tested
wet @ 50°C to maximum
of 20,000 passes

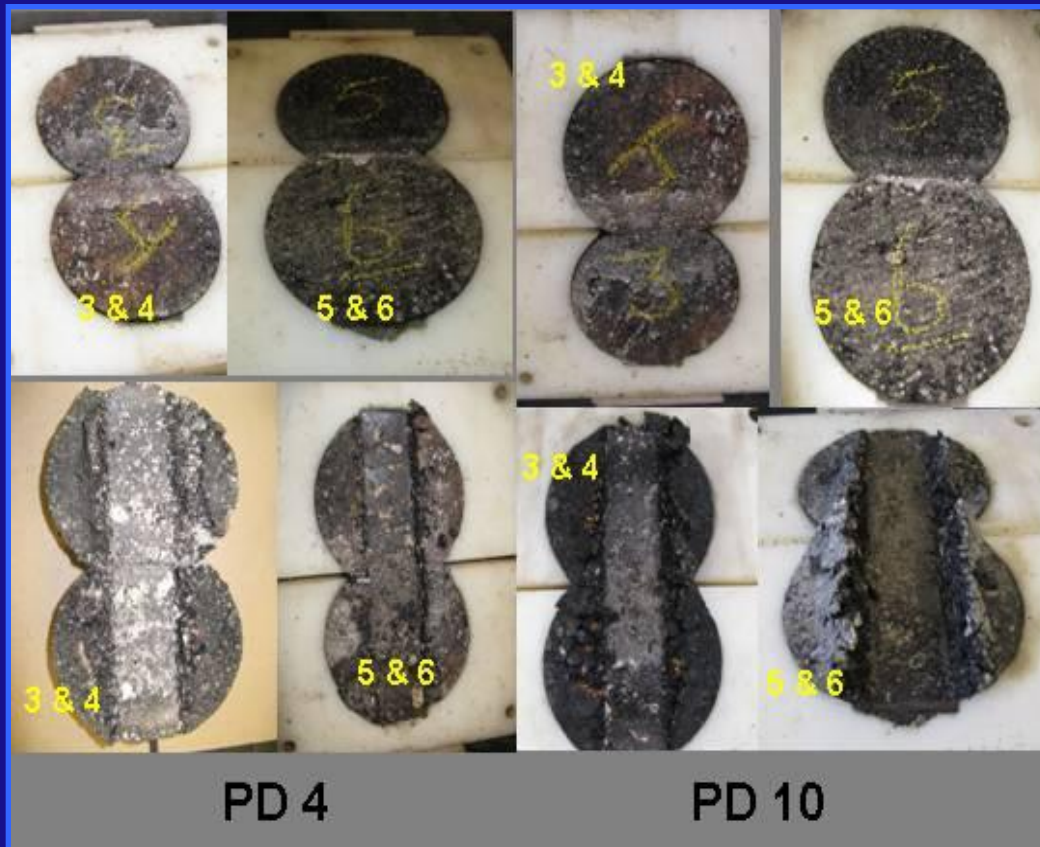


Jasper, TX Hamburg

Rediset WMX plant produced mixture

⊕ PD 4 - 13.18 mm

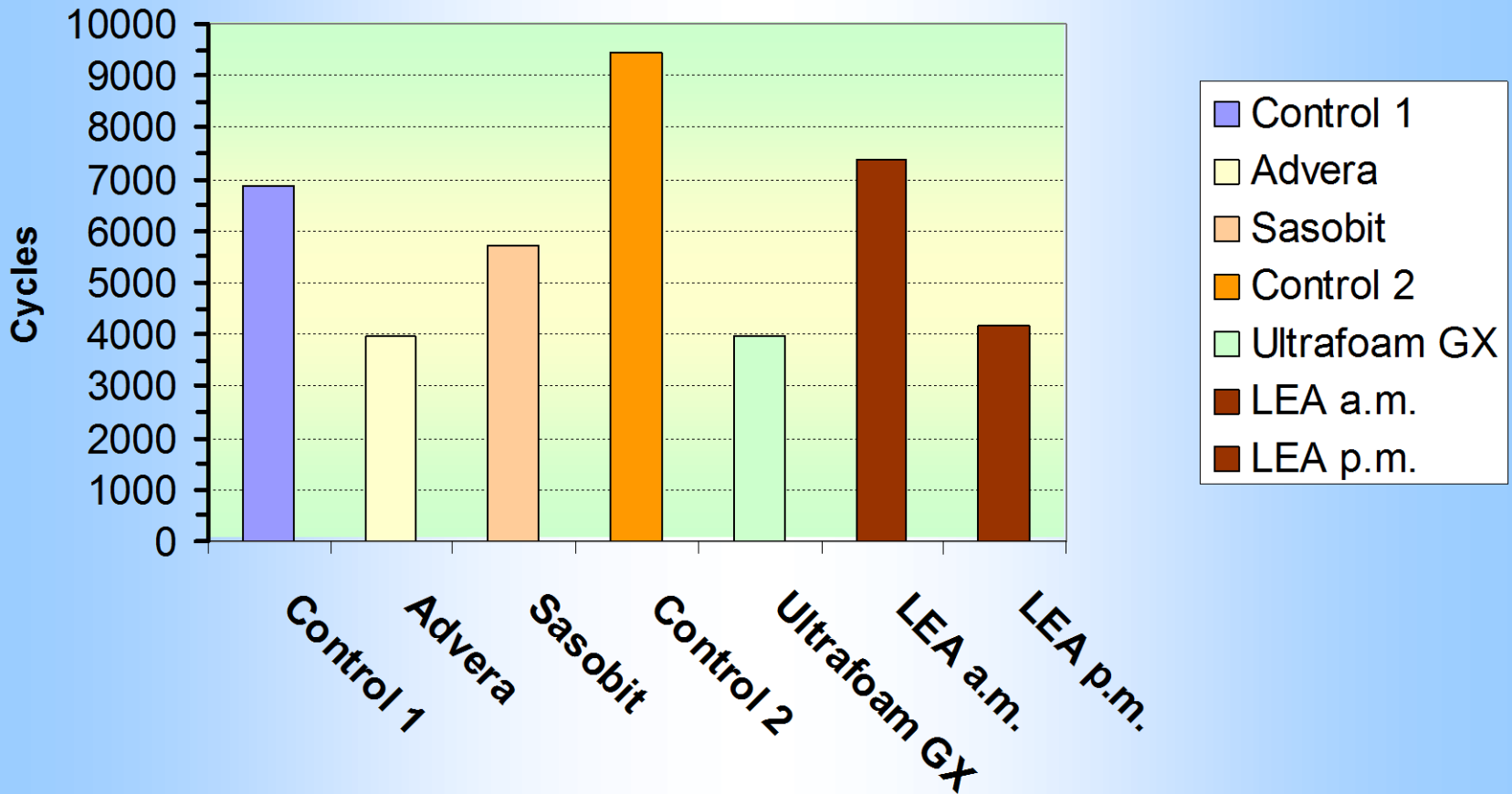
⊕ PD 10 - 18.80 mm





Centre Hall, PA Hamburg

AASHTO T 324 - Hamburg @ 50°C
Cycles to 20mm Rut Depth





I-55 Sikeston, MO Hamburg

Aquablack by Maxam

Testing currently being finalized

General Trend:

Cycles to
20 mm
rut depth



Total Rut
Depth





FHWA/NCAT Co-Op Agreement

● FHWA funded evaluations

- ▣ Nashville, TN
- ▣ Brownsburg, IN
- ▣ Graham, TX
- ▣ Kimbolton, OH
- ▣ Bridgeport, TX
- ▣ San Antonio, TX
- ▣ Royal, NE
- ▣ St. Louis, MO
- ▣ Iron Mountain, MI
- ▣ Milwaukee, WI





FHWA/NCAT Co-Op Agreement

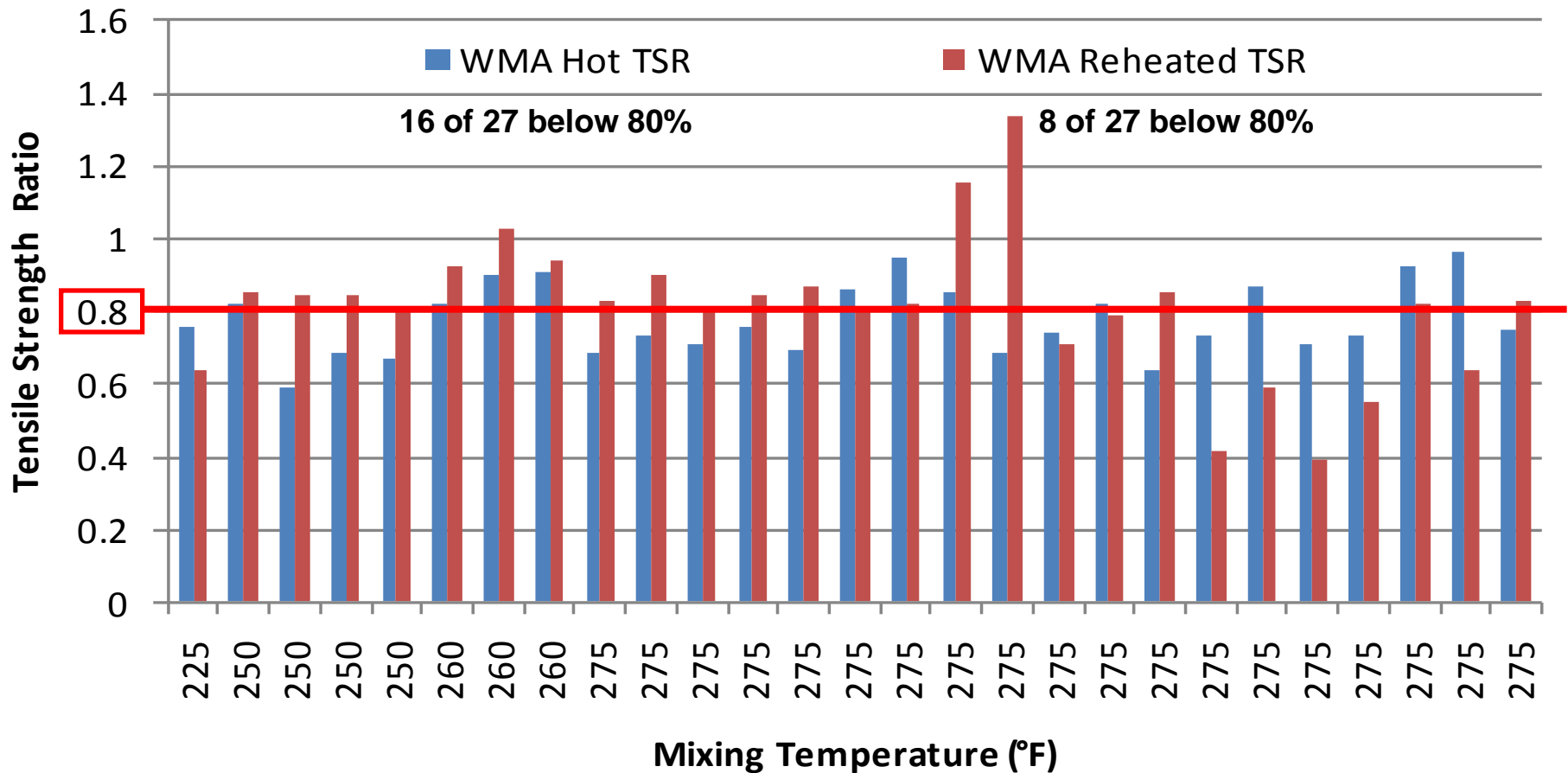
- ❖ Test Results from Field Produced WMA:
 - ❖ Tensile strengths and TSRs are typically lower for WMA compared to HMA. Sasobit mixes are the exception.
 - ❖ Hamburg results generally show the same trend
- ❖ Field cores of WMA after construction often have lower tensile strengths than HMA, but after two years WMA ITS increase to about the same as HMA





FHWA/NCAT Co-Op Agreement

Tensile Strength Ratios for Field Produced WMA





National Research Initiatives



TRANSPORTATION RESEARCH BOARD
OF THE NATIONAL ACADEMIES



- ❖ NCHRP 9-43 “Mix Design Practices for Warm Mix Asphalt” \$500,000
- ❖ NCHRP 9-47A “Engineering Properties, Emissions, and Field Performance” \$900,000
- ❖ NCHRP 9-49 “Long Term Field Performance of Warm Mix Asphalt Technologies”
 - ❑ Phase I, Moisture Susceptibility
 - ❑ Phase II, Long-Term Performance



NCHRP 9-43 *(preliminary findings)*

❖ Mixture Design

- ❖ Similar to AASHTO R35 “Standard Practice for Superpave Volumetric Design for (HMA)”
- ❖ Criteria for HMA from AASHTO M323
- ❖ Mandatory Test for Rutting Resistance utilizing the AMPT Flow Number (Fn) test

❖ Mixture Analysis

- ❖ Optional Performance Tests
 - Modulus
 - Thermal Cracking
 - Fatigue Cracking



NCHRP 9-43 *(preliminary findings)*

Summary of Differences from M323

- ❖ Process Specific Specimen Fabrication Procedures (Modified Wirtgen lab foaming device used)
- ❖ Recommended Binder Grade Changes Based on Production Temperature (Binder ageing index)
- ❖ Recommended Max. RAP Stiffness Based on Compaction Temp (RAP Binder $G^*/\sin \delta = 1.0$ kPa)
- ❖ Coating Evaluated at Production Temperature
- ❖ Rutting Resistance Evaluated for 3 Million ESAL or Greater mixtures



NCHRP 9-43 (preliminary findings)

$$\text{Binder Ageing Index} = \frac{G^* / \sin \delta_{RTFOT}}{G^* / \sin \delta_{Tank}}$$

PG High Temperature Grade	Aging Index (AI) ¹											
	1.4	1.6	1.8	2.0	2.2	2.4	2.6	2.8	3.0	3.2	3.4	3.6
	Minimum WMA Mixing Temperature Not Requiring PG Grade Increase, °F											
52	170	190	200	205	210	215	220	220	225	225	230	230
58	185	205	215	220	225	230	235	235	240	240	245	245
64	190	210	220	230	235	235	240	245	245	250	250	250
67	200	220	230	235	240	245	250	255	255	255	260	260
70	200	220	230	240	245	245	250	255	255	260	260	260
76	210	225	235	245	250	255	260	260	265	265	265	270
82	215	235	245	250	255	260	265	265	270	270	275	275



NCHRP 9-43 *(preliminary findings)*

Phase II work near completion

- ✚ Expanded RAP Mixing Experiment (ongoing)
- ✚ Low Temperature Binder Grade Experiment (ongoing)
- ✚ Mixture Design Experiment (completed)
- ✚ Fatigue Experiment (ongoing)
- ✚ Field Validation (completed)



NCHRP 9-43 *(preliminary findings)*

- ❖ Expanded RAP mixing study utilizing dynamic modulus E^* evaluation criteria developed by Advanced Asphalt Technologies: Bonaquist & Christensen
- ❖ E^* from specified mixing and compaction temperatures compared to fully blended condition E^* determined through the Hirsch model (assuming 100% blending of RAP and virgin binders)





NCHRP 9-43 (preliminary findings)

Expanded RAP mixing study

Process	Temperature	Conditioning Time, hrs		
		0.5	1.0	2.0
Control	280/255	X	X	X
	248/230	X	X	X
Organic	248/230	X	X	X
	230/212	X	X	X
Foaming	248/230	X	X	X
	230/212	X	X	X
Chemical	248/230	X	X	X
	230/212	X	X	X

Mixture E* results only approach Hirsch Fully Blended E*



NCHRP 9-43

- ⊕ Scheduled Completion March 2010
- ⊕ Final Report Will be Submitted in March
- ⊕ Three Month Time Extension Requested for Review/Revision of Deliverables



NCHRP 9-47A

- ❖ NCHRP 9-47A “Engineering Properties, Emissions, and Field Performance”
\$900,000
- ❖ National Center for Asphalt Technology at Auburn University, Alabama
- ❖ State of the Practice Report and Research Plan have been submitted to the NCHRP panel for review and approval
- ❖ Additional work will begin after panel approval of the Research Plan



NCHRP 9-49 Moisture ...

- ❖ Phase 1, Moisture Susceptibility
- ❖ Request for Proposal (RFP) submissions closing date was January 14, 2010
- ❖ Research Principle selection and contract award to occur Spring 2010
- ❖ 30 month duration
- ❖ \$450,000 funds available for Phase 1



Additional Research

Binder ETG Research Projects

- ❖ Laboratory Evaluation: Wax Additives in Warm-Mix Asphalt Binder
- ❖ Evaluated the effect of nine (9) non-paraffin wax additives
- ❖ **Testing Completed and Final Report is near completion**



WMA Technical Working Group (TWG)

● FHWA / NAPA sponsored

● Co-Chairs

■ Matthew Corrigan, FHWA

■ Ron White, Industry

● Represented

■ State DOT

■ AASHTO

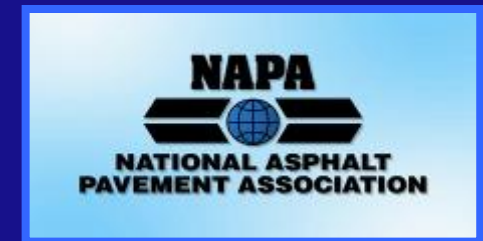
■ State APA

■ Labor

■ NCAT

■ NIOSH

■ Hot Mix Asphalt Industry





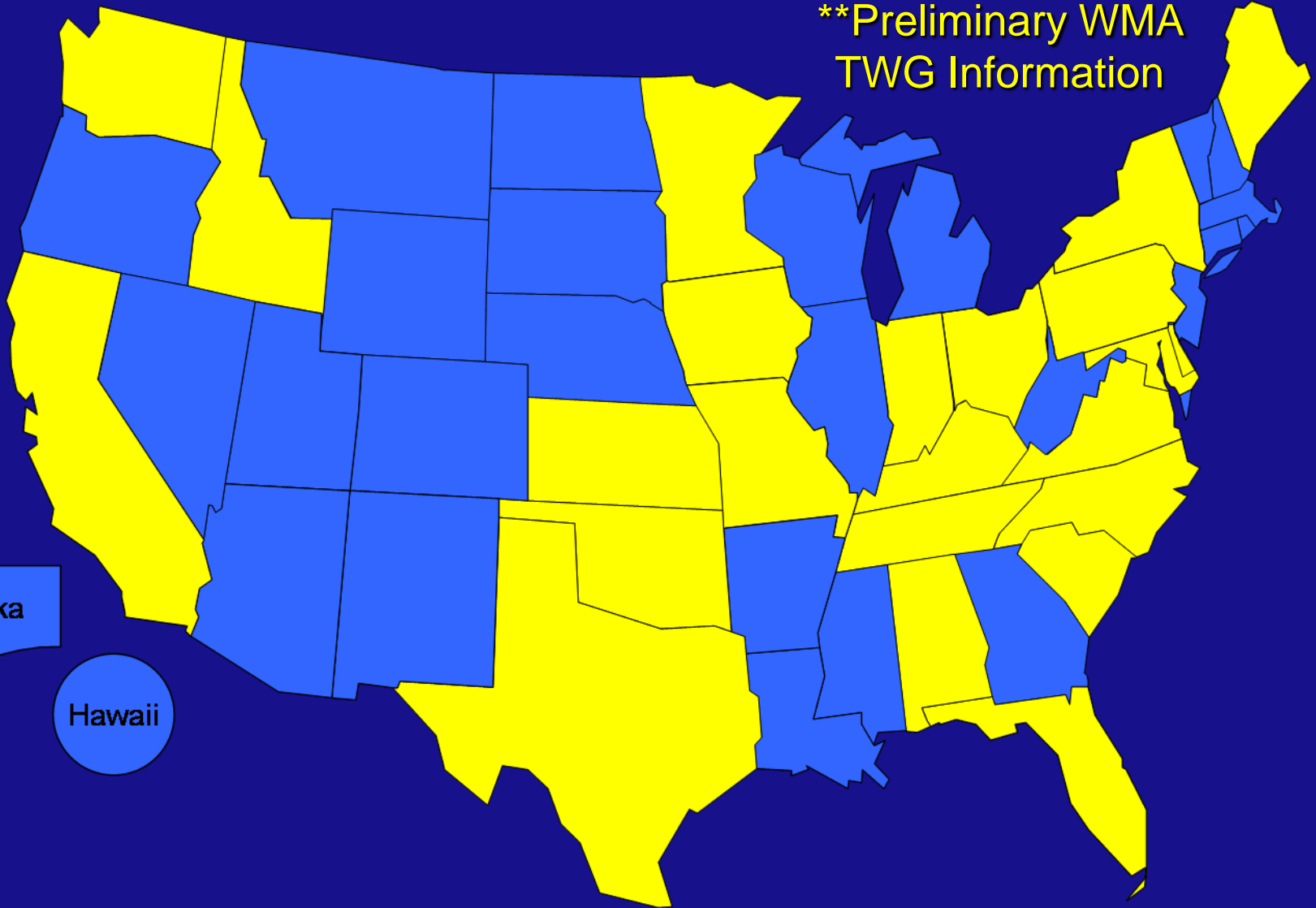
WMA TWG Task Forces

- ❖ Task Force 08-01 “Ageing/Conditioning Criteria for Mechanical Testing of WMA Technologies”
- ❖ Task Force 08-02 “National Approval/Certification Program for WMA Technologies”
 - ❖ To utilize AASHTO National Transportation Product Evaluation Program (NTPEP)
 - ❖ NCAT developed their own alternate evaluation program proposal
- ❖ Task Force 09-01 “State Agency WMA Specifications and Project Synthesis”



WMA Specification Language

**Preliminary WMA
TWG Information



Alaska

Hawaii



WMA TWG future initiatives?



TRANSPORTATION RESEARCH BOARD
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- ❖ WMA plus RAP/Shingles/Crumb Rubber
- ❖ Laboratory versus in service field ageing of WMA mixtures
- ❖ Conditioning criteria for mechanical testing of WMA
- ❖ Laboratory versus production ageing of WMA mixtures
- ❖ Synthesis/Collection of information on State DOT usage/implementation of WMA



WMA TWG future initiatives?

TRB TRANSPORTATION RESEARCH BOARD
OF THE NATIONAL ACADEMIES



- ❖ National Evaluation Program for WMA Technologies
- ❖ Understanding the role of additives in WMA production and construction
- ❖ Understanding the role of asphalt foam in aggregate coating, workability, compaction, and long term performance
- ❖ Quality control and acceptance testing for WMA mixtures
- ❖ Open Graded Friction Course (OGFC) plus WMA



Future WMA Specifications

Emphasis on “Performance”

Asphalt Mixture Performance Tester (AMPT)

- Flow Number (Fn), mixture rutting
- Dynamic Modulus (E^*), mixture stiffness
- Cyclic Tension – Compression, fatigue cracking

IDT Creep and Strength

- fatigue and thermal cracking

loaded wheel rut testing

- Hamburg or APA

Moisture Susceptibility Testing





Written Summary of WMA @

www.fhwa.dot.gov/pavement/asphalt/wma.cfm

The screenshot shows a Windows Internet Explorer browser window displaying the FHWA website. The address bar shows the URL: <http://www.fhwa.dot.gov/pavement/asphalt/wma.cfm>. The page title is "Warm Mix Asphalt Technologies and Research - Asphalt - Pavements - FHWA". The website header includes the U.S. Department of Transportation Federal Highway Administration logo and a search bar. The main navigation menu is titled "Pavements" and includes tabs for Research, Design, Construction, Preservation, Maintenance, Management, and Rehabilitation. The current page is "Warm Mix Asphalt Technologies and Research". The left sidebar contains a navigation menu with categories: Design and Analysis, Materials and Construction Technology, Management and Preservation, Surface Characteristics, Construction and Materials Quality Assurance, and Environmental Stewardship. The main content area is titled "Warm Mix Asphalt Technologies and Research" and contains the following text:

European countries are using technologies that appear to allow a reduction in the temperatures at which asphalt mixes are produced and placed. These technologies have been labeled Warm Mix Asphalt (WMA). The immediate benefit to producing WMA is the reduction in energy consumption required by burning fuels to heat traditional hot mix asphalt (HMA) to temperatures in excess of 300° F at the production plant. These high production temperatures are needed to allow the asphalt binder to become viscous enough to completely coat the aggregate in the HMA, have good workability during laying and compaction, and durability during traffic exposure. With the decreased production temperature comes the additional benefit of reduced emissions from burning fuels, fumes, and odors generated at the plant and the paving site.

There are three technologies that have been developed and used in European countries to produce WMA:

1. The addition of a synthetic zeolite called Aspha-Min® during mixing at the plant to create a foaming effect in the binder.
2. A two-component binder system called WAM-Foam® (Warm Asphalt Mix Foam), which introduces a soft binder and hard foamed binder at different stages during plant production.
3. The use of organic additives such as Sasobit®, a Fischer-Tropsch paraffin wax and Asphaltan B®, a low molecular weight esterified wax.

The Aspha-Min and Sasobit products have been used in the United States. Additional technologies have been developed and used in the United States to produce WMA:

4. Plant production with an asphalt emulsion product called Evotherm™, which uses a chemical additive technology and a "dispersed asphalt technology" delivery system.
5. The addition of a synthetic zeolite called Advera® WMA during mixing at the plant to create a foaming effect in the binder.

All five technologies appear to allow the production of WMA by reducing the viscosity of the asphalt binder at a given temperature. This reduced viscosity allows the aggregate to be fully coated at a lower temperature than what is traditionally required in HMA production. However, some of these technologies require significant equipment modifications.

This technology could have a significant impact on transportation construction projects in and around non-attainment areas such as large metropolitan areas that have air quality restrictions. The reduction in fuel usage to produce the mix would also have a significant impact on the cost of transportation construction projects.

The benefits of these technologies to the United States in terms of energy savings and air quality improvements are promising but these technologies need further investigation and research in order to validate their expected performance and added value. It is important to note that producing HMA at lower temperatures is the desired product to achieve these benefits, not the particular technology that is used to produce the WMA mix.

Product Descriptions

The right sidebar contains sections for "Events" (with a link to "View all Upcoming Pavements Events"), "More Information" (with links to "Foamed Asphalt", "Pavement Publications", and "Warm Mix Asphalt: European Practice"), and "Contact" (with contact information for Matthew Corrigan, Office of Pavement Technology, 202-366-1549, and E-mail Matthew).

The footer of the page includes the FHWA logo and the text "U.S. Department of Transportation Federal Highway Administration".

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Warm Mix Asphalt Program Manager

ASPHALT

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