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## Warm Mix Asphalt; State of the Practice

**55<sup>th</sup> Annual Asphalt Paving Conference**  
March 15-16, 2011

Soaring Eagle Casino & Resort  
Mt Pleasant, MI

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### Asphalt Binder Properties

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Asphalt is a *thermoplastic*

- Softens as it is heated
- Hardens as it cools
- Rate of Loading

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### Warm Mix Asphalt

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**WMA Technologies**

- Several ways to classify WMA technologies
- One is by of temperature reduction
  - Hot Mix Asphalt > 275 °F (135 °C)
  - Warm Mix Asphalt > 212 °F (100 °C)
  - Half-Warm asphalt mixtures < 212°F (100 °C)

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### Warm Mix Asphalt

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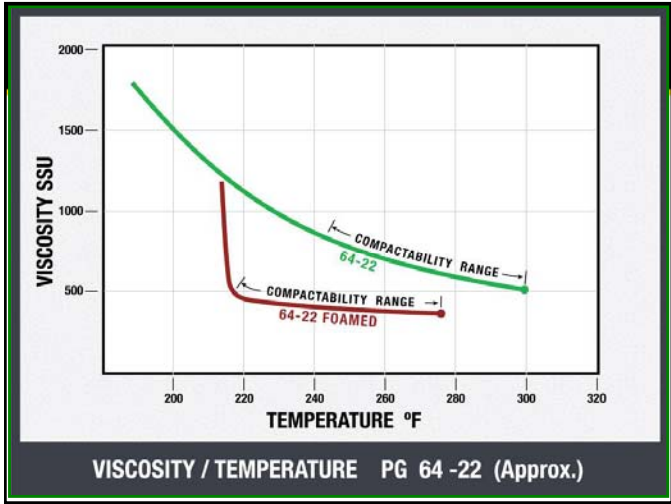
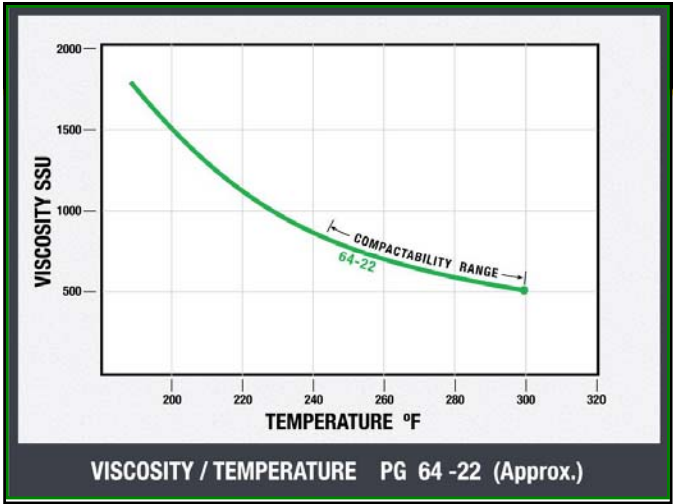
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Processes that allow:

- Normal plant mix asphalt
- Produced at lower temperatures
- Lowers viscosity
- Maintain workability


## Warm Mix Asphalt Scan Tour

**May-June 2007**  
**Norway-Germany-Belgium-France**

  
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## Warm Mix Asphalt

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**Driving Factors in Europe including:**

- Environmental concerns
- Sustainable development
- "Green Construction,"
- Reduction of energy consumption
- Reduction in CO<sub>2</sub> emissions
- Reduced worker exposure

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Federal Highway Administration  
**Every Day Counts**  
Innovation Initiative

**Chris Wagner, P.E.**  
FHWA – Resource Center – Atlanta, GA

**2010 Iowa Safety Edge Installation**

**Warm Mix Asphalt**

✓ WMA encompasses a wide range of enabling technologies that enhance asphalt production and/or lay-down properties...

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**Warm Mix Asphalt**

✓ WMA encompasses a wide range of enabling technologies that enhance asphalt production and/or lay-down properties...

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**Warm Mix Asphalt (WMA)**

**General Technology Categories:**

- Materials Processing
- Organic Additives
- Chemical Additives
- **Foaming Processes**
- Hybrid Systems (combination of technologies)

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**Currently Twenty Two (22) Technologies Marketed and Available in the US.**

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## What is WMA?

Relative Production Temperature (°F)	Zone	Driver	WMA Technology
HMA - 40° - 60° - 80° - 100°	Total Project	Extend Paving Season	Yes
		Improve Aggregate Compaction	A lot
	Production	Reduce Fuel Usage (F)	Maybe
		Reduce Emissions (E)	
Transport	Enhance Worker (W) Comfort	A little	
	Extend Effective Haul Distance		
Lay-Down	Improve Compaction (I.C.=)	Unlikely	
	Reduce Emissions (E)	n/a	
	Enhance Worker (W) Comfort		

## I.C. = I.P.

- The BAD mix with GOOD density out-performed the GOOD mix with POOR density

Nevada Automotive Test Center

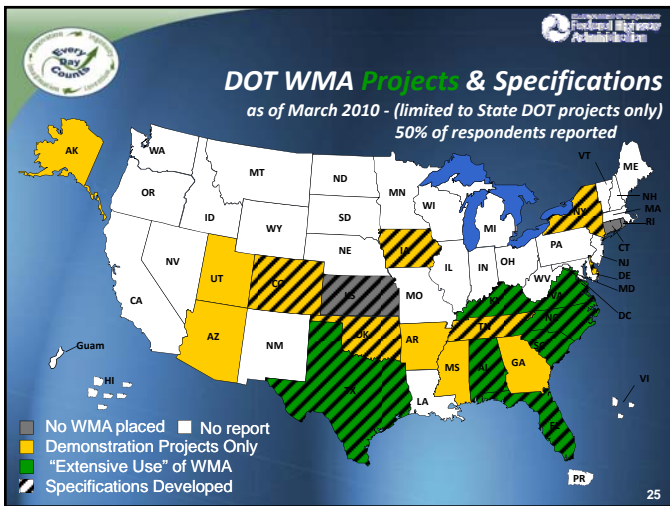
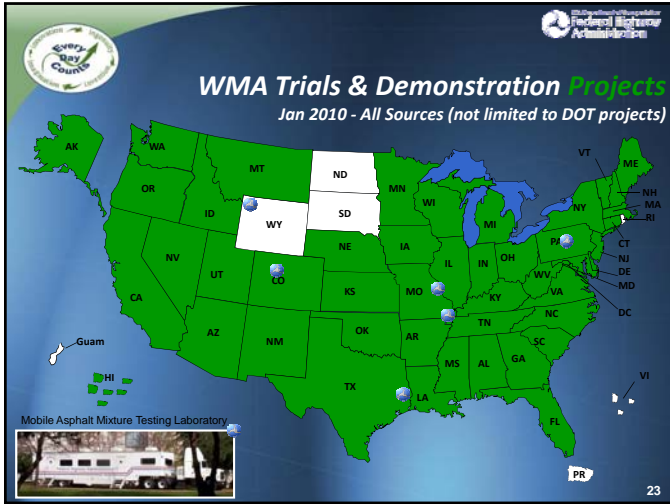
## Economics of WMA

- WMA Technology (Operating) Cost:
  - Foaming Systems... water is basically free. If a liquid antistriper is needed, this adds ~ \$1 to \$2 / ton
  - Additive Systems... \$1.75 to 2.50 / ton of mix
  - This does NOT include fuel savings  
Net cost ~ Zero to \$1.50 / ton

## WMA Trials & Demonstration Projects


Jan 2007 - All Sources (not limited to DOT projects)

Mobile Asphalt Mixture Testing Laboratory



## Allowing WMA


- There are several approaches being employed to allow WMA by State DOTs...
  - Florida/Texas/Washington – Approved/Qualified Products List
  - Texas/Illinois – Performance Approach
    - WMA with Hamburg LWT for rutting & moisture damage
  - Illinois/New York – Experimental Features Program
    - [www.fhwa.dot.gov/programadmin/contracts/expermnt.cfm](http://www.fhwa.dot.gov/programadmin/contracts/expermnt.cfm)
- NCAT WMA Evaluation Program



### Challenge: Reduced Production Temperatures

Federal Highway Administration

- Concerns:
  - Incomplete drying of aggregate
  - Reduced production aging of binder
- Performance issues
  - Moisture susceptibility
  - Early rutting



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### National Research Initiatives

- 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 - \$450,000
  - Phase II, Long-Term Performance - \$900,000



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### Purpose

Warm Mix Asphalt usage is accelerating at a rapid rate


No “accepted” method for WMA mix design procedure

NCHRP 9-43 proposes a draft appendix to AASHTO R 35 entitled “*Special Mixture Design Considerations and Methods for Warm Mix Asphalt (WMA)*”

### Differences: Materials Selection

Item	HMA AASHTO R 35	WMA Proposed Appendix
WMA Process	N/A	Producer Selected
Gradation	AASHTO M 323	AASHTO M 323
Aggregate	AASHTO M 323	AASHTO M 323
Binder Selection	PG Grade AASHTO M 323	PG Grade AASHTO M 323
RAP	Blending Chart AASHTO M 323	Low Temp Chart Proposed Appendix



### Key Differences: Volumetric Design



Item	HMA AASHTO R 35	WMA Proposed Appendix
Mixing and Compaction Temperatures	Viscosity	Coating and Compactability
Specimen Preparation	Standard	Process Specific
Optimum Binder Content	AASHTO M 323 Volumetrics	AASHTO M 323 Volumetrics

### Key Differences: Mixture Evaluation

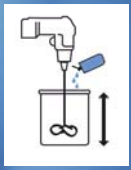
Item	HMA AASHTO R 35	WMA Proposed Appendix
Moisture Sensitivity	AASHTO T 283	AASHTO T 283
Rutting Resistance	None	Flow Number Test AASHTO TP 79

### Additional Laboratory Equipment


Mechanical Mixer (Planetary mixer specified in R-35 draft)

Low Shear Mixer (For mixes that require WMA additive to binder)



Laboratory Foamer (Simulates plant foaming for batches 10 – 20 kg)

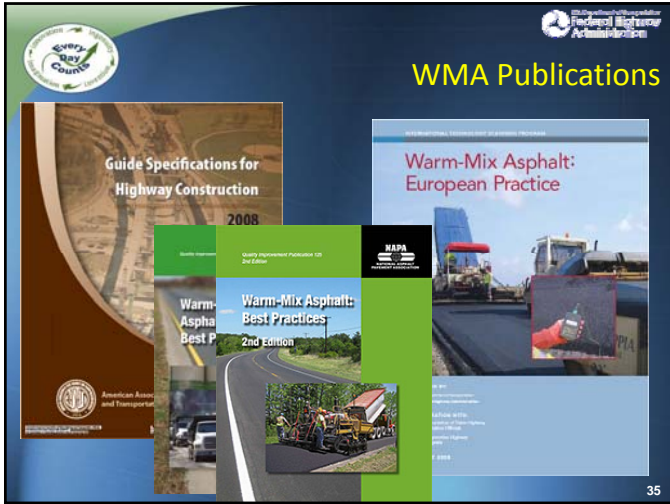


### RAP in Warm Mix Asphalt

The compaction temperature of the WMA shall be greater than the as-recovered high temperature grade of the RAP binder

*RAP binders typically range: PG 82 to PG 94*

*Corresponding minimum WMA compaction temperatures range: 180°F to 200°F*



**WMA Publications**

Guide Specifications for Highway Construction 2008

Warm-Mix Asphalt: European Practice

Warm-Mix Asphalt: Best Practices 2nd Edition

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**WMA Latest News**

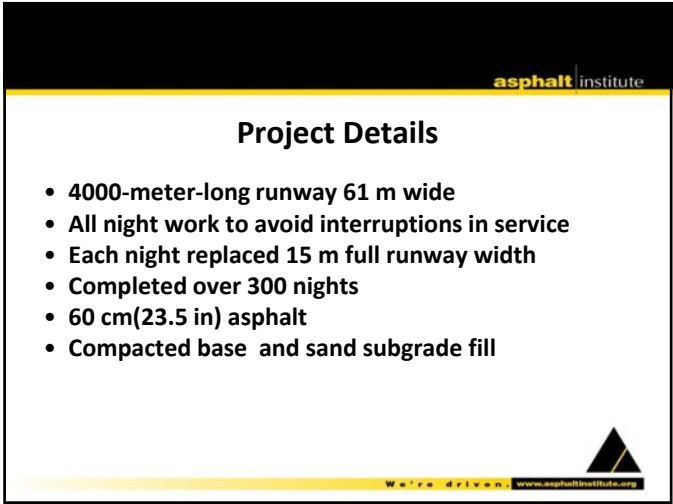
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- **Technical Working Group Meeting(s)**
- **2nd International Conference on WMA**  
October 2011 - St. Louis, MO



**Frankfurt Intl Airport**  
**July 2004**

Replacement of PCC Pavement on Main Runway with Warm Mix Asphalt While Maintaining Daily Flight Operations

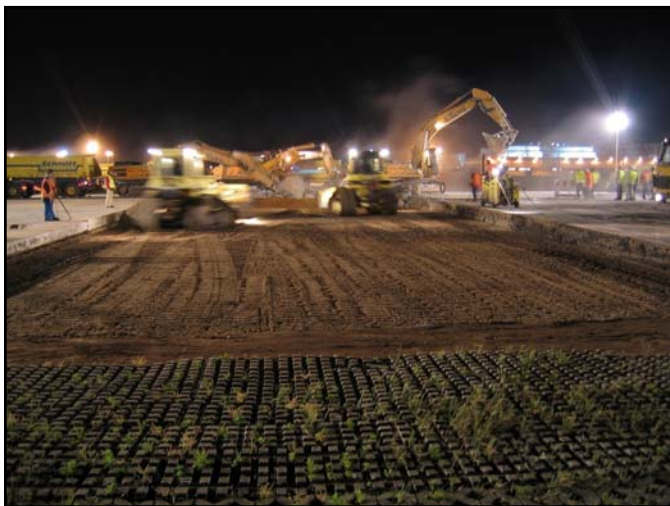


**Project Details**

- 4000-meter-long runway 61 m wide
- All night work to avoid interruptions in service
- Each night replaced 15 m full runway width
- Completed over 300 nights
- 60 cm(23.5 in) asphalt
- Compacted base and sand subgrade fill

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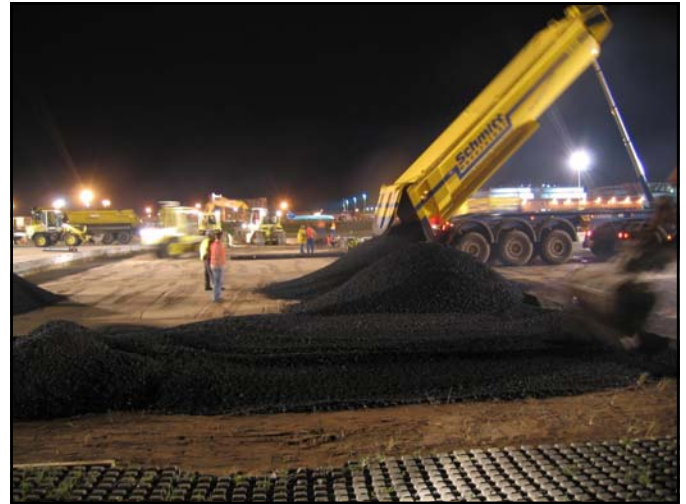


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### Project Details

- 300 people involved every night
- 425,000 tonnes of asphalt in the contract
- Because of new lighting conduits
  - No paver used for the first lift of 24 cm(10 inches)

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### Project Details

- Contract requirement
  - Surface temperature no higher than 85°C (185° F) at 06:30 – contractor chose warm mix
- After 200 m on centre-line completed
  - Or every 10 nights
  - Milled surface to a depth of 4 cm
  - Repaved full width with SMA surface for smoothness and friction

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**Boston 2010**

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Inset: Boston Municipal Airport circa 1930

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**Thanks !**

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