The Effects of Warm Mix Asphalt on Pavement Performance

Lisa Cui
Dr. Mena Souliman, Faculty Mentor
Department of Civil Engineering, University of Texas at Tyler

Introduction

- Asphalt offers environmental and energy advantages over other paving materials. However, in the midst of rising fuel costs and environmental awareness, this industry is always looking for ways to improve. WMA is fundamentally asphalt mixture with chemical additives to reduce viscosity, this translates to less heat usage when preparing the material while achieving the same product as Hot Mix Asphalt (HMA) would make.
- WMA Benefits:
  - ✓ Lower production and construction temperatures
  - ✓ Reduction in fuel and emissions
  - ✓ Longer paving seasons
  - ✓ Decrease in viscosity
- WMA Technologies:
  - ✓ Foam Technology: Advera, Double Barrel Green, Zeolites, Maxam Aqua Black
  - ✓ Wax: Sasobit
  - ✓ Chemical Modifiers: Evotherm

Objectives

- Evaluate field performance of WMA pavements compared to HMA pavements
- Evaluate properties in both field mixtures

Effects of WMA Additive on mixture design at three different mixing and compaction temperatures.
Effects of WMA on Performance tests
- Hamburg Wheel Tracking Test (HWTT) : decrease rutting resistance
- Overlay Test : increase cracking resistance
- Indirect Tensile Strength: decrease in tensile strength
- Dynamic Mechanical Analysis: Fatigue analysis

Methods

- Performance Tests
  - ✓ Hamburg Wheel Tracking Test (HWTT) : decrease rutting resistance
  - ✓ Overlay Test : increase cracking resistance
  - ✓ Indirect Tensile Strength: decrease in tensile strength
  - ✓ Dynamic Mechanical Analysis: Fatigue analysis

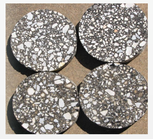
Project Information

District	Roadway	Lift Thickness (in)	Mix Type	Approx. Quantity of WMA (Tons)	WMA Additive/Process	Lab Density	In-Place Air Voids
Austin, TX	SH 71	2	Type C	8000	Evotherm	96.3	7.1
					Control	96.9	6.6
Lufkin, TX	FM 324	1	Type D	3800	Advera	97.5	11.7
					Akzo Nobel	97.4	NA
					Evotherm	97.3	10.6
					Sasobit	97.4	11.5
					Control	97.4	10.1
San Antonio	Loop 368	2	Type C	1200	Evotherm	96.4	6
					Control	96.6	6.9

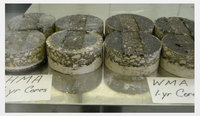
Field Performance Results: San Antonio – Loop 368

- Approximately 1200 tons of Evotherm
- AC Content
  - ✓ Control & Warm Mix: PG 76-22, 4.8% at 220°F WMA & 320°F for HMA
- Laydown & Compaction:
  - ✓ Used the same rolling technique on warm mix and control
  - ✓ Compaction and laydown with no issues
  - ✓ Traffic lanes opened up 2 hrs after placement

Absorption
(Test Cores after 2 Years
Top 2 Evotherm, Bottom 2 HMA)



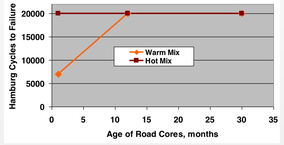
Hamburg Wheel Test- After 1 Year



Loop 368: Good Condition after 5 Yrs

Hamburg Wheel Testing Data

Figure A



Overlay Testing Data

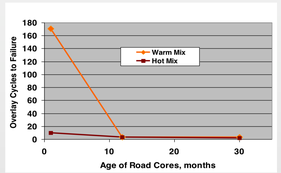


Figure B

Field Performance Results: Lufkin – FM 324

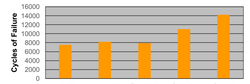
Figure C

- Mix:
  - ✓ 800 tons of Sasobit, Evotherm, Advera, Akzo Nobel
  - ✓ Produced at 260°F WMA, 270°F HMA
  - ✓ During field performance, performed equivalent to HMA
  - ✓ Uniformity of construction & density
  - ✓ Performed structurally equivalent to HMA

Production Data

Mixture Type	AC Content, %	Lab Molded Density, %	In-Place Air Voids, %
PG 64-22 HMA	4.1	95.7	10.1
WMA Rediset	4.2	97.4	NA
WMA Advera	4.5	97.5	11.7
WMA Evotherm	4.3	97.3	10.6
WMA Sasobit	4.3	97.4	11.5

Hamburg Wheel Testing- FM 324 (2 Hour Cure)



Average Overlay Test Results

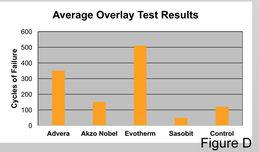


Figure D

Field Performance Results: Austin - US 71,

- Mix:
  - ✓ 8000 tons of Evotherm
  - ✓ PG 76-22
  - ✓ Type C Densely Graded (Item 341)
  - ✓ Produced at 240°F WMA, 330°F HMA
  - ✓ Rut Depth at 20,000 Cycles: 2.3mm HMA, 12.2mm WMA

WMA Project SH 71

Construction Field Trials

HWT of HMA and WMA

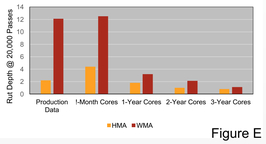


Figure E

Overlay Test Results of HMA and WMA

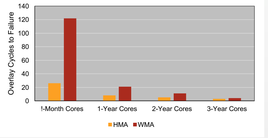


Figure F

Lab Performance Results

Texas Gyratory Mixture Design Volumetric

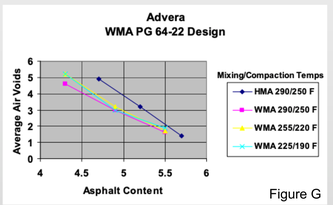


Figure G

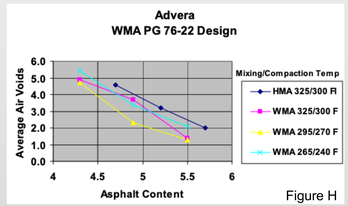


Figure H

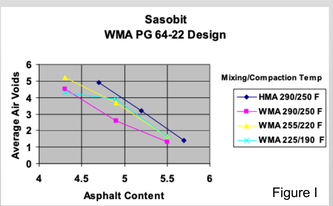


Figure I

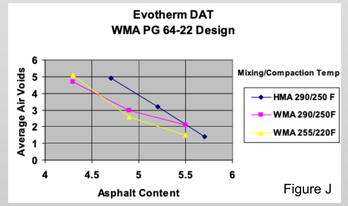


Figure J

- Designed according to Tex 206-F

Lab Performance Results

Effect of WMA Additive on Asphalt

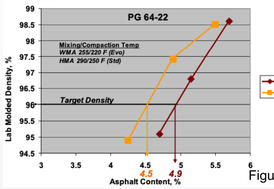


Figure K

HWT At Different Curing Conditions

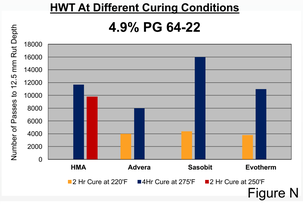


Figure N

Plant Mix Reheated and Compacted 2 months After Production

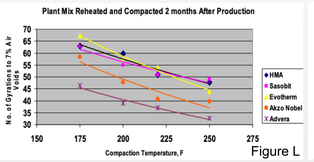


Figure L

WMA Mixtures 4.9% PG 64-22

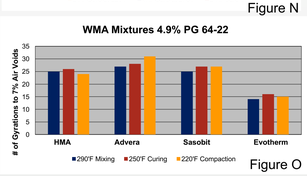


Figure O

Overlay Test Results: HMA 64-22

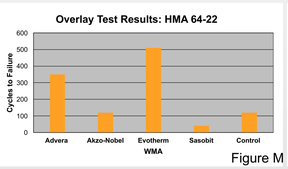


Figure M

Average Fatigue Life for Wet and Dry

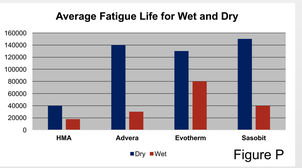


Figure P

Conclusions

- The performance of WMA additives has shown improvement

From Overlay testing, it is observed that there is a significant increase in cracking resistance. However, it can be a challenge to meet TxDOT's requirement for the Hamburg test. WMA additives produce more durable pavement since the oxidization and absorption has decreased, thus producing an improved fatigue life. WMA additives help compactability. This will lead to having a decrease in asphalt content. Even though WMA is less stiff than HMA, it does stiffen drastically during the first year of service.

- WMA can deliver a range of needs:
  - ✓ Improve compaction
  - ✓ Save Fuel
  - ✓ Reduce emission
  - ✓ Long Term Performance

Acknowledgements

- National Cooperative Highway Research Program
- Long Term Pavement Performance Program