

Mayors Climate Protection Agreement

1054 cities as of 10/28/11

Alaska Cities
Anchorage
Juneau
North Pole
Shishmaref
Sitka

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www.usmayors.org

Warm Mix Asphalt Definition:

a work in progress (Feb. 23, 2011).

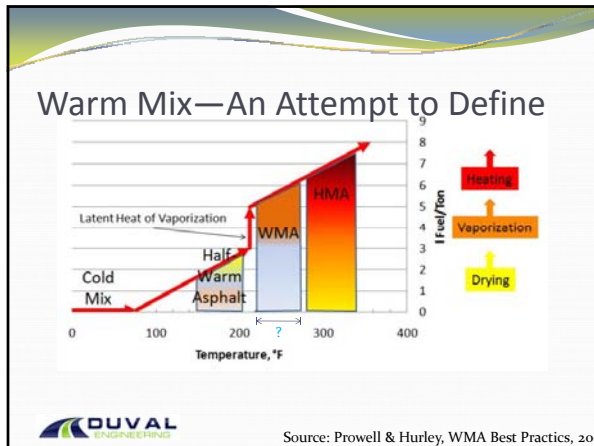
- Warm Mix Asphalt (WMA) technologies generally allow a reduction in the temperature at which asphalt mixes are produced and placed thus helping the environment and workers health and safety. WMA technologies can also be used as a compaction aid extending the paving season in colder climates when produced at normal temperatures at which the hot mix asphalt mixes are produced.
 - ❖ WMA – When ambient temperatures are consistently above 50 Degrees F, the asphalt mix temperatures are typically reduced by 25 Degrees F to 80 Degrees F (depending on technology used, mix plant configuration, %RAP used, and construction conditions).
 - ❖ Cold Weather WMA Application – When ambient temperatures are consistently below 50 Degrees F, the asphalt mixes are typically produced at near normal or slightly reduced temperatures of hot mix asphalt (depending on technology used, %RAP used and construction conditions) and is intended to facilitate field placement and compaction at colder temperatures.
- Authored by many Members of the WMA Task Force

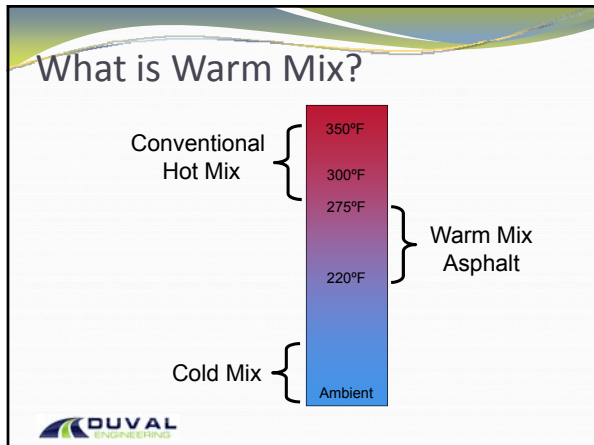
NEAUPG Northeast Asphalt User/ Producer Group PAPA

Warm Mix Asphalt “Re”-Definition

- Warm Mix Asphalt (WMA) technologies generally allow a reduction in the temperature at which asphalt mixes are produced and placed thus helping the environment and workers health and safety. WMA technologies can also be used as a compaction aid and also allow extending the paving season in colder climates when produced at normal temperatures at which the hot mix asphalt mixes are produced. WMA technologies can also be used as a compaction aid and are typically used for the following applications:
 - WMA – When ambient temperatures are consistently above 50 Degrees F, the asphalt mix temperatures are typically reduced by 25 Degrees F to 80 Degrees F (depending on technology used, mix plant configuration, %RAP used, and construction conditions).
 - Cold Weather WMA Application – When ambient temperatures are consistently below 50 Degrees F, the asphalt mix is typically produced at near normal or slightly reduced temperature temperatures of hot mix asphalt (depending on technology used, %RAP used and construction conditions) and is intended to facilitate field placement and compaction at colder temperatures.

PAPA NEAUPG





What is Warm Mix?

2005: There were three WMA technologies:

- Aspha-min – foam zeolite
- Sasobit – wax
- Evotherm – surfactant

2009: ~ 10 WMA technologies

2011: ~ 22 WMA technologies with many differences including:

- WMA mechanism—additive or process
- Effective temperature range for **production and compaction**

2015: ???

WMA Additives / Foaming Systems

- Advera
- Aspha-Min
- Evotherm
- LEA-CO
- Low Emission Asphalt
- Rediset WMX
- Sasobit
- WAM Foam
- Cecabase RT
- Qualitherm
- ECOBIT
- Thiopave
- Astec Double Barrel Green
- Gencor Green Machine
- Maxam Aquablack
- Stansteel Accu-Shear
- Tri-Mix WMA Injection
- Terex WMA System
- Eco-Foam II
- Meeker Warm Mix
- HGrant Warm Mix
- SonneWarmix

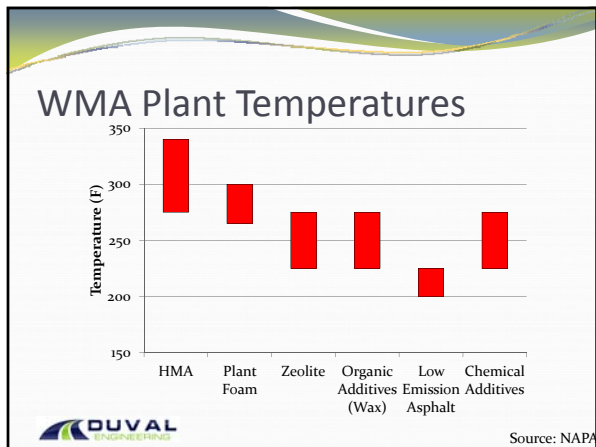
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Source: www.warmmixasphalt.com

There are three categories (types) of WMA Technologies:


Chemical Organic Foaming

PAPA **NAPA** NATIONAL ASPHALT PAVEMENT ASSOCIATION





Why Warm Mix?

- Reduced Emissions (IARC/Worker Safety)
- Reduced Energy Consumption (Save \$)
- Increased Durability (?)
- Increased Crack Resistance
- Cold Weather Paving (Extended Season)
- Longer hauls
- Compaction Aid
- Increased usage of RAP

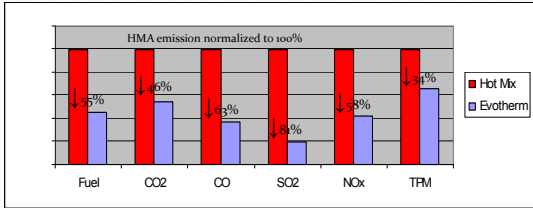


Reduced Emissions / Paver

- Limestone
- PG76-22
- T mix: 240°F
- ΔT: 95°F




Reduced Emissions / Plant



Category	Hot Mx (%)	Evotherm (%)
Fuel	55%	45%
CO2	46%	54%
CO	63%	37%
SO2	84%	16%
NOx	58%	42%
TPM	34%	66%

200 °F Evotherm, 310°F HMA control



Source: Pinchin Environmental 2005


Reduced Emissions / Plant




Hot Mix Warm Mix



Reduced Emissions / Plant



222 F **276 F**



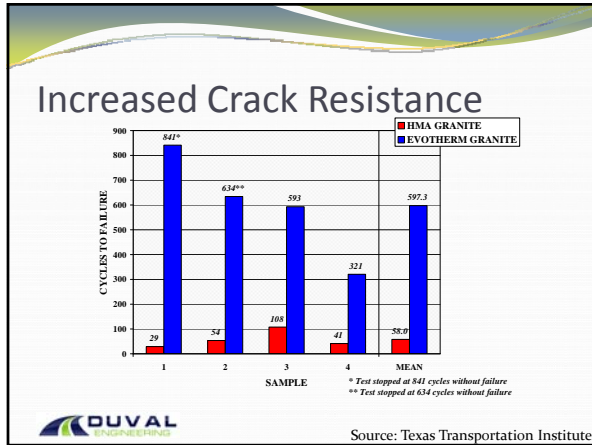
Increased Durability

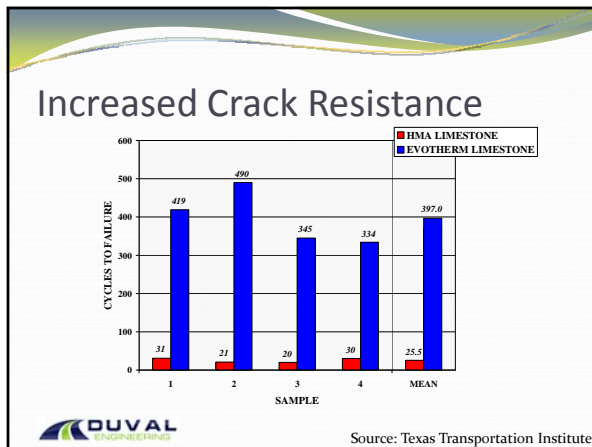
Warm Mix Asphalt **Hot Mix Control**



 (TxDOT Cores After 1 Year)







Extended Season Paving

Mix contained 40% RAP PG 64-22
WMA mix temperature
behind the screed



Ground temperature
at 7 a.m. was < 15°F



Extended Season Paving

Mix contained 40% RAP PG 64-22



Paving

Compaction



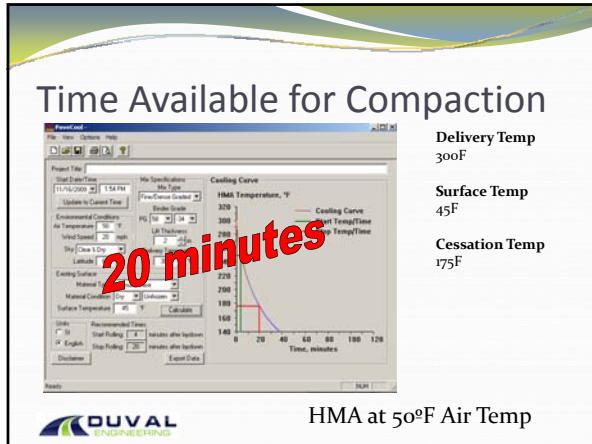
Extended Season Paving

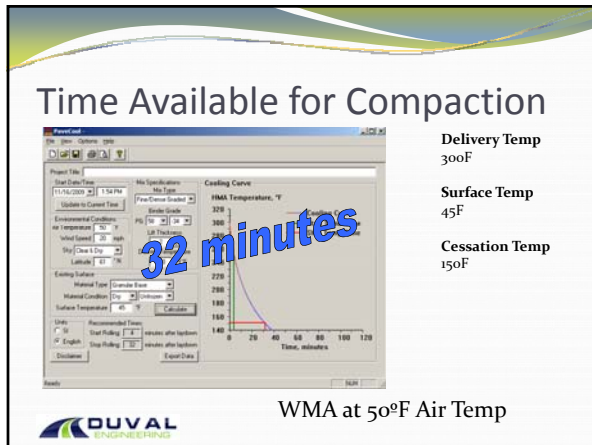
Mix contained 40% RAP PG 64-22
Excellent joint compaction

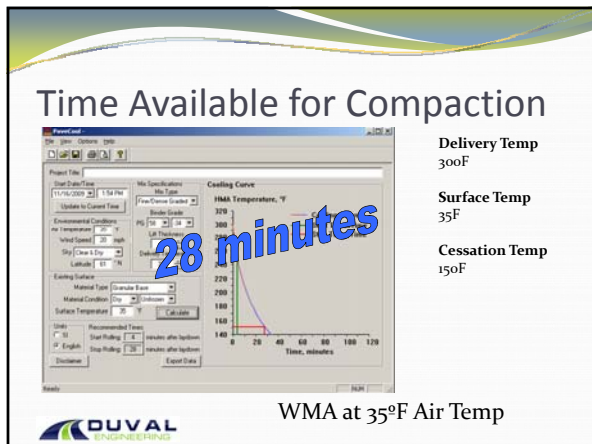


Air voids of cores
all > 92% of Gmm









Increased Usage of RAP

High RAP Warm Mix Asphalt

	Control	20% RAP	28% RAP	35% RAP
Pen	29	39	32	28
Viscosity	25,920	16,087	16,738	23,470
Ductility	38	79	54	42
DSR 64	7.35	4.39	5.74	7.56
MSCR	26	42	37	32
DSR 70	3.48	2.11	2.91	3.59
BBR -12	0.394	0.437	0.406	0.393

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Source: D. Williams - MoDOT

Increased Usage of RAP

Property	40% RAP HMA Control	40% RAP Evotherm WMA	Superpave Specification
Mix Production Temperature, °F	330	248	not applicable
Viscosity (Pa-s)	1.357	1.017	3 Pa-s max
G'/sinδ at 64°C, kPa	9.60	5.31	not applicable to field binder samples
G'/sinδ at 70°C, kPa	4.54	2.59	
G'/sinδ at 76°C, kPa	2.18	1.27	
G'/sinδ at 82°C, kPa	1.08	0.642	
G'/sinδ at 88°C, kPa	0.56	-	
Penetration (dmm)	15	23	not applicable
BBR Stiffness (MPa)	222	158	300 MPa max
m-value	0.296	0.328	0.300 min
Pressure Aging Vessel G* x sinδ, kPa	5663	3218	5000 kPa max

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Success Stories—Asphalt Rubber



- I-5 Near Orland, CA
- Heavy Traffic
 - 26,000 AADT
 - 28% Trucks
- 1/2" RHMA-O WMA
 - Open Graded Friction Course
- Asphalt Rubber
 - PG64-16 Base
- 16,000 Tons WMA

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Success Stories—Asphalt Rubber

Load Out Temp 290°F Windrow Temp 280°F



Success Stories—Asphalt Rubber

Breakdown Rollers 250-260°F at Breakdown



Success Stories—Increased RAP

City of Portland



Mix
½" NMAS 100 Gyration
30 % RAP
PG 70-22ER

HMA Production Temp
335 F



Success Stories—Increased RAP

City of Portland



WMA Production
255F

WMA Density
>= 94% Gmm

Crew Reports
Very workable and less exhausting to work with WMA compared to HMA



Success Stories—Airport Pavement

Anchorage Intl Airport—RON Aprons



Base Layer—PG 58-34, 3/4" NMAS Superpave



Source: AKDOT&PF

Success Stories—Airport Pavement

Anchorage Intl Airport—RON Aprons



Pavement Stiffness for WMA Equal to HMA



Source: AKDOT&PF