

Materials 106 – Introduction to



- Warm Mix Asphalt
- Yesterday
- Today 
- Tomorrow

Rocky Mountain Asphalt Conference & Equipment Show
February 19-21, 2014






Warm Mix Asphalt

- What is Warm Mix Asphalt?
 - Warm Mix Asphalt is the same as Hot Mix Asphalt only cooler!
 - Same Mix design
 - Same project requirements
 - All physical properties need to be met
 - Same end result requirements
 - Compaction
 - Volumetrics
 - Binder content

Background

- WMA is a technology that allows asphalt mixes to be produced 35-100 degrees lower in temperatures than traditionally required for HMA.
- The production of an asphalt mix at temperatures less than 275°F (135°C) can result in lower emissions, decreased fuel usage, and reduced oxidation of the asphalt compared to mixes produced at 300°F (149°C) and above.
- The reduced emissions and fuel usage can be environmentally beneficial, and reduced fuel usage can be economically beneficial.

Warm Mix Asphalt Background

- The question that arises is:
 - Is the performance of the asphalt mix affected by using a WMA technology?
 - If it is adversely affected, then the environmental, production, and economic benefits could be negated.
 - If the performance of WMA pavement is as good as or better than HMA pavement, then the change in production practices would likely be very worthwhile.





Why are we shifting to WMA?



Production of HMA

•Drying/Heating of aggregate requires approximately 300,000 btu for production of 1 ton of HMA

•Additional auxiliary heating requirements at HMA facility

- Silos
- Asphalt lines



Employee Exposure at Paver

- Employees are exposed to asphalt fume 8-10 hours/day
- Exponential relationship- every 10° degrees increase of temperature doubles exposure to asphalt fume

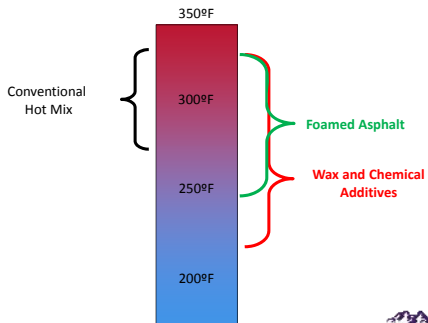




Advantages of Warm Mix




Warm Mix Production Temperatures




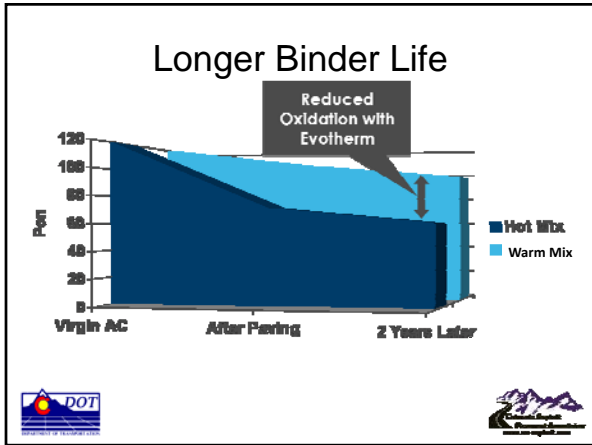
Advantages of Lowering Temperatures

85° - 100°F less than Hot Mix




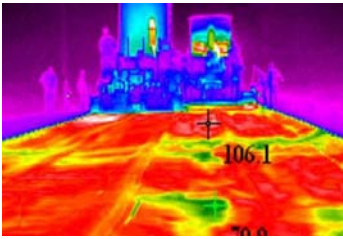
EVO THERM **Hot Mix**

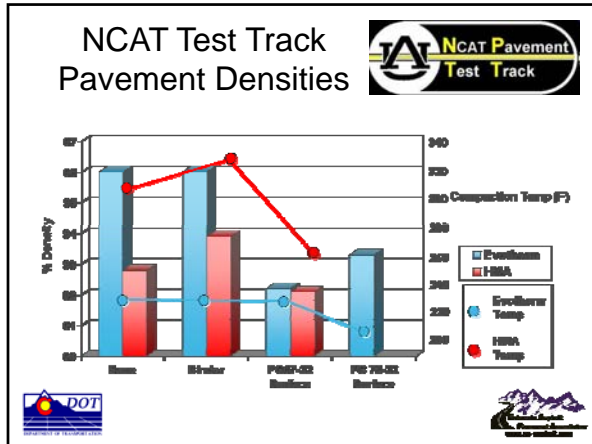




Advantages of Lowering Temperatures

- Improved Compaction





Advantages of Lowering Temperatures

- Increased Use of RAP and RAS

What is WARM?

Even at 276 °F, fumes are still visible.

Hot Mix

Reduced Emissions

45% reduction in fuel consumption & CO₂ emissions



Mexico City, Mexico owned & operated mix plants

100% of HMA production converted to Evotherm

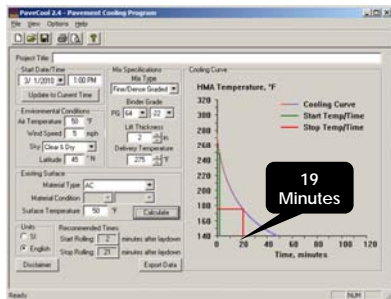


Advantages of Lowering Temperatures

- Extended Hauls and Paving Season



HMA at 50°F Ambient Temperature



HMA has only **19 minutes** of paving time until the minimum compaction temperature is reached.



WMA at 50°F Ambient Temperature

WMA has **35 minutes** until the minimum compaction temperature is reached.

> 80% Increase in compaction time

WMA at 1°F Ambient Temperature

It would have to be **1°F** outside for WMA to behave like HMA at **50°F!**

Foamed Asphalt

How much water is injected ?

2% by weight of virgin binder



Assuming 5% Binder per ton of mix, water injected per ton would be:

2 lb

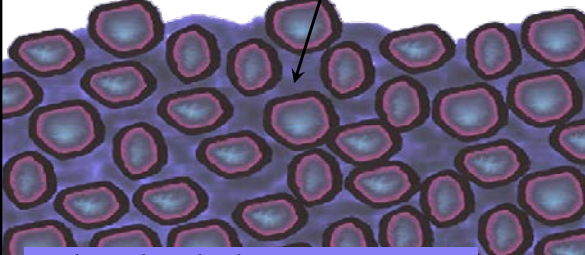
30.7 fluid oz

How much water remains in the mix?



How does foaming work

Uncompacted Mix:
Voids at about 25%

Voids are filled with steam at mix temperature

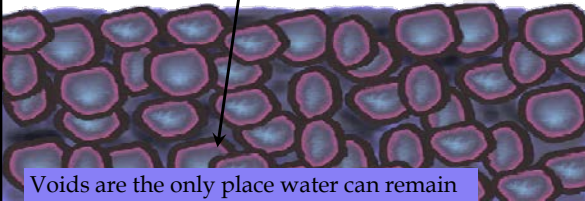


Voids are the only place water can remain





Compacted Mix:
Voids at about 5%



Voids are still filled with steam at mix temperature, but the void volume has been reduced.



Voids are the only place water can remain



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Warm Mix Asphalt - Yesterday

- What is the history of Warm Mix Asphalt?
 - First introduced to the USA in 2002
 - Scan tour of projects in Europe
 - World of Asphalt Demo in 2003
 - Introduced in Colorado in 2007
 - I-70 in Summit County



Warm Mix Asphalt

- Many trial projects in the USA after the demo at World of Asphalt
 - Plant producers begin to design and manufacture plants with WMA capability
 - Bolt on WMA foaming equipment is designed and produced
 - Many additives discovered and tried
 - Some states begin to allow the use of WMA on a trial basis
 - Foaming of Binder used for many trial projects and in regular production



Warm Mix Asphalt

- 2008-2009 - Many trial projects in Colorado
 - City of Aurora
 - Aurora Knolls Subdivision
 - Evotherm used as the additive
 - Church in Fort Collins
 - Evotherm Used as additive
 - 2009-2010 - Foaming apparatus begin to be installed on plants in Colorado
 - Foaming of Binder used for many trial projects and in regular production
 - City of Lakewood allow for WMA to be used on City overlay projects, 5,500 tons placed in 2009



Warm Mix Asphalt

- 2010 WMA specification being developed by CDOT
 - Sample specification available from CAPA
 - Added to PPRTA specification
 - Added to MGPEC Specification
 - Many more trial projects for Contractors and owners
 - Foaming of Binder used for many trial projects and in regular production
 - City of Lakewood allowed for WMA to be used on City overlay projects, 28,350 tons placed in 2010



Warm Mix Asphalt

- 2011 WMA production continues to grow
 - Used in commercial work parking lots and for trench repairs and patching
 - Suncor adds a blending tank to allow for the introduction of MVW – Evotherm 3G product to any delivery of PG binder
 - Foaming of Binder used for many trial projects and in regular production
 - City of Lakewood allowed for WMA to be used on City overlay projects, 50,755 tons placed in 2011
 - Featured in a scan tour as part of the APWA International Congress held in Denver 2011



Warm Mix Asphalt

- Trial and Demonstration projects
 - CDOT US Highway 50 Las Animas-East
 - CDOT Region 2, Maintenance Project, Wilkerson Pass
 - Larimer County
 - City of Centennial
 - Arapahoe County
 - And more



Warm Mix Asphalt

- 2012 CDOT specifics WMA on a project
 - Highway 9 south of Hartsell
 - Foaming and MVW- Evotherm 3G used on the 30,000 + of mix placed
 - Required due to the excessive amount of crack sealant and previous chip seals placed on the roadway since it was constructed in 1968






Warm Mix Asphalt

- 2013 More plants equipped to produce WMA
 - More Localities allow WMA on a trial basis
 - Town of Parker
 - Town of Castle Rock
 - City of Arvada
 - City of Lakewood allow for WMA to be used on City overlay projects, 73,000 tons placed in 2012






● Warm Mix Asphalt

● Yesterday

● **Today**

● Tomorrow




Warm Mix Asphalt - Today

- Contractors are approaching City and County decision makers to allow for the use of WMA on a permanent or trial basis
- More Cities and Counties have permissive specifications allowing for the use of WMA



CDOT approval Process

- **Warm Mix Implementation (WMA)** – CDOT continues to receive submittals for approval of WMA.
- (Additives) Evotherm & Advera has been approved without restrictions.
- Foaming is approved for limited use on projects depending on the manufacturer (either up to 5,000 tons or 10,000 tons). Maxam Foaming system is unrestricted.
- Many technology suppliers and producers have made a submittal. For approval as a supplier or producer of the WMA products
- CDOT has established an approval process for WMA technologies as outlined in [\(CP-59\)](#) [\(403-NSM\)](#) [\(CP-59 checklist\)](#) [\(CP-11\)](#).



How To Implement?

- Specify Warm Mix
 - Produce Mix -- 275° to 215°
 - Allow Liquid Anti-strip or Lime

The use of WMA is required. Produce an asphalt mixture within the temperature range of 215°F and 275°F. Delivery and placement temperature of WMA shall be a maximum of 235 °F.





Warm Mix Asphalt Use for Local Agency Projects

"The use of warm mix asphalt (WMA) is allowed as an alternative to hot mix asphalt provided the following conditions are met."





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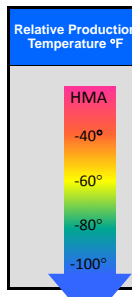





Warm Mix Asphalt - Tomorrow

- The use of WMA will continue to increase as Owners, Cities, Counties, CDOT and Developers realize the value and benefits gained from using WMA
- The use of HMA will become obsolete in the near future, as the market demands more and more WMA. Production of HMA will be a cost prohibitive proposition

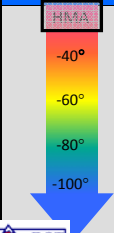



The Value of WMA

Relative Production Temperature °F	Zone	Driver	Warm Mix Technology Category...	
	Total Project	Extended Paving Season		
		Improved Mix Performance		
	Production	Improved Aggregate Coa	A Lot	Yes
		Reduced Fuel Usage		
		Reduced Emissi		Maybe
	Transport	Enhance Worker	A Little	
		Extend Effective Haul Distance		
	Lay Down	Improved Compactio		No
		Reduce Emissions	Unlikely	
		Enhance Worker Comfort		

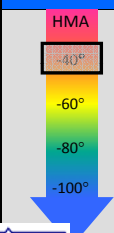



Can I use WMA at Conventional HMA temperatures?



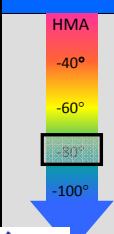
Relative Production Temperature °F	Zone	Driver	Warm Mix Technology Category...
HMA -40° -60° -80° -100°	Total Project	Extended Paving Season	Yes
		Improved Mix Performance	No
	Production	Improved Aggregate Coating	Yes
		Reduced Fuel Usage	No
		Reduced Emissions	No
		Enhance Worker Comfort	No
	Transport	Extend Effective Haul Distance	Yes
	Lay Down	Improved Compaction	Yes
		Reduce Emissions	No
		Enhance Worker Comfort	No

What benefit is there at a 40F drop?



Relative Production Temperature °F	Zone	Driver	Warm Mix Technology Category...
HMA -40° -60° -80° -100°	Total Project	Extended Paving Season	Yes
		Improved Mix Performance	Maybe
	Production	Improved Aggregate Coating	Yes
		Reduced Fuel Usage	A Little
		Reduced Emissions	A Little
		Enhance Worker Comfort	A Little
	Transport	Extend Effective Haul Distance	Maybe
	Lay Down	Improved Compaction	Yes
		Reduce Emissions	A Little
		Enhance Worker Comfort	A Little

What benefit is there at a 80F drop?



Relative Production Temperature °F	Zone	Driver	Warm Mix Technology Category...
HMA -40° -60° -80° -100°	Total Project	Extended Paving Season	Maybe
		Improved Mix Performance	Yes
	Production	Improved Aggregate Coating	Yes
		Reduced Fuel Usage	Yes
		Reduced Emissions	Yes
		Enhance Worker Comfort	Yes
	Transport	Extend Effective Haul Distance	No
	Lay Down	Improved Compaction	Yes
		Reduce Emissions	Yes
		Enhance Worker Comfort	Yes



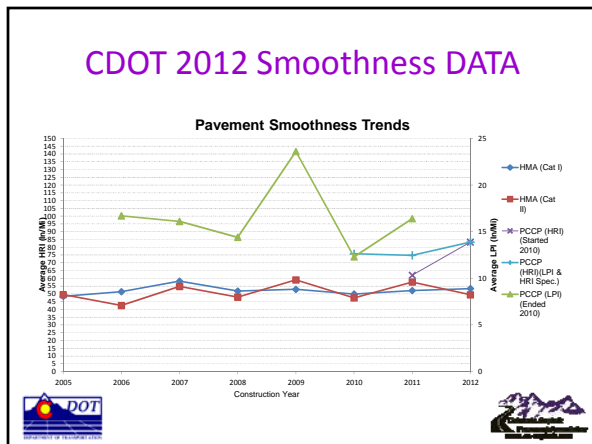
Is there any issues achieving smoothness when using WMA?

NO

- Recent data released by CDOT shows the smoothness in Asphalt pavements is continuing to show smoother rides while the data in the concrete roads continues to get rougher.

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Pavement Smoothness Data

	HMA (Cat II)			HMA (Cat III)			PCCP (LPI) (Ended 2010)			PCCP (HRI) (Started 2010)			PCCP (HRI)(LPI & HRI Spec.)		
	Best	Average	Worst	Best	Average	Worst	Best	Average	Worst	Best	Average	Worst	Best	Average	Worst
2005	44.1	48.4	57.7	46.5	49.5	54.6									
2006	39.7	51.4	61	34.7	42.5	60	7.3	16.7	29						
2007	42.5	58.2	94.3	44.5	54.8	73.8	12.2	16.1	36.6						
2008	38.2	51.8	74.8	31.6	47.9	115.3	8.4	14.4	34.2						
2009	28.2	52.9	104.6	38.7	59	118.9	12.4	23.6	27.9						
2010	33	49.9	83.7	36.6	47.4	99.3	7.2	12.3	32.4				63	75.8	122.7
2011	37.7	52.1	134.3	33.9	57.6	149	10.8	16.4	25.5	57.8	62	76.4	57.8	74.8	112.8
2012	38.8	53.4	131.8	38.8	49.4	118.3				56.2	83.3	142.2	56.2	83.3	142.2



Is there any issues in timing when using WMA

- NO
 - Placement of Asphalt, especially WMA, will cause less user delays and less lane restrictions during construction. The motoring public will be less impacted as the construction process can be completed in day not weeks or months like other pavement types will take.



If some of the water remains in the mix, won't I show a high AC content?

NO

- A small amount of water remains in the mix after compaction
- Theoretically, this could show up as AC content.
- Maximum of 0.00117% of the water remains (virgin mix)
- Beyond the measurement accuracy of AC content (typically reported to the nearest 0.1%).



Won't the baghouse temperature be too low when I lower mix temperature?

Varies

- Depends on a number of factors.
- Decreases BH temps about 35°F to 40°F (CF dryer) all other factors constant.
- Things go better with RAP



Can coating be affected?

YES

- Depends on a number of factors
- Coating is affected by many factors: aggregate, mix temperature, AC type, and/or fines content
- Generally, coating decreases with mix temperature
- Coating begins to deteriorate below 250°F
- Good coating has been observed below 200°F
- Has shown significantly improved coating if coating initially appeared less complete



Do I have to do anything special to my binder?

NO

- Generation 1 units had the requirement that binder be kept above 300°F due to small AC nozzle size.
- Generation 2 units have no binder temperature requirement.



Won't I experience a drop in mix temperature since I am adding water?

NO

- Significant temperatures drops during ordinary hauls in moderate weather is caused by internal moisture
- Internal moisture signs: steam and water at the silo tops, water running out of the truck beds, and a drop in mix temperature (27°F per ¼%).
- Water remaining in the mix post compaction is 0.00117% (0.07°F drop)



What mix temperatures should I run?

- 240F - 250F (virgin)
- 270F - 280F (RAP)

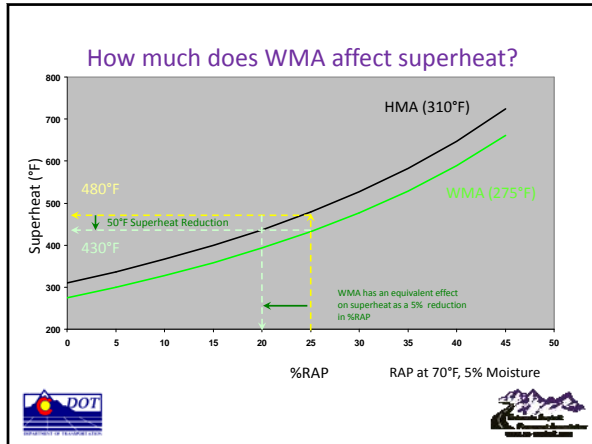


Can I run WMA produced at higher temperatures?

Depends

- For water based foaming technologies, there is no danger in running the mix at higher temperatures
- Mix simply remains workable for a longer period
- Some additives have maximum allowable temperatures that should not be exceeded





Can WMA be stored?

Depends

- For foamed WMA, as long as the corresponding HMA may be stored
 - First test was 24 hours then 48 hours
 - Have stored as long as 4 days
- For additives, consult specific manufacturers recommendations

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Will rolling patterns change?

YES

- Generally, crews have been able to begin rolling immediately.
- At some locations, less rolling was required
- Experiment. Each situation is unique.

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Is handwork different than that of HMA?

YES

- Can be different depending upon the situation
- Cold day tight quarter handwork on base mixes have become difficult on a couple of jobs
- Straight pulls never an issue

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Does WMA look different?

Varies

- Can look the same as ordinary HMA minus smoke as smell
- Can look rich (especially virgin mixes) due to film thickness increase

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Won't my water freeze when it gets cold?

YES

- "Cold weather package" available
- Not meant for "winterizing".
- Do not use anti-freeze, chlorine or other additives. Clean water only.
- Some customers have had bad experiences with anti-freeze, etc



Will running WMA with RAP affect the heating and mixing of the RAP?

NO

- RAP still obtains its heat from superheated virgin aggregate.
- There is just less superheat required.



More information

- Colorado Asphalt Pavement Association
 - <http://www.co-asphalt.com/documents/Warm%20Mix/WarmMixTech1.doc>
 - 303-741-6150 Ext 151
 - 303-902-2439 (Cell)
 - tomclayton@co-asphalt.com
- NAPA Publication QIS -125
 - Warm Mix Asphalt; Best Practices
 - Warm Mix Asphalt Website
 - www.warmmixasphalt.com



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