

## INTRODUCTION TO WARM-MIX ASPHALT

by Michael H. Fleming, ISMF LLC

Production and placement of asphalt pavement has evolved over the last 100 years throughout the United States. Around 1939, Bruce Marshall of the Mississippi Highway Department developed the Marshall Mix Design, which was refined by the U.S. Army in 1943 for use in airfield pavement design to accommodate the ever-increasing wheel loads and tire pressures produced by larger military aircraft.

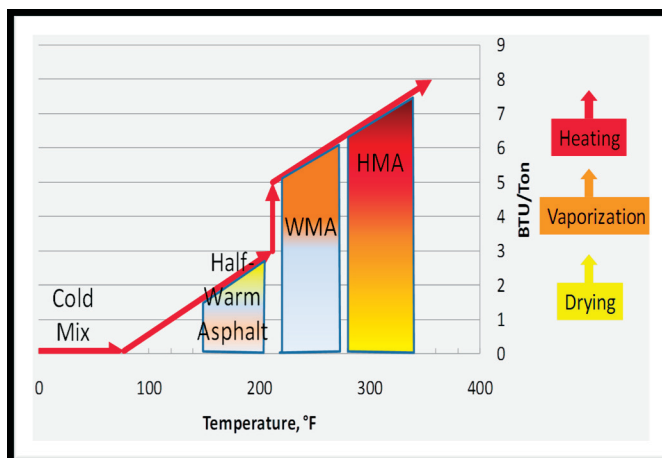
In 1995, the Federal Highway Administration introduced the SUPERior PERformance asphalt PAVement system, named SUPERPAVE, which allows us to design even more durable asphalt pavements. SUPERPAVE was coined “the mix design system for the next century.” It is composed of performance-grade asphalt based on a range of climates and pavement temperatures. Adoption of SUPERPAVE mix design procedure started in 2006 when PennDOT introduced local governments to it.

At the same time, the National Asphalt Paving Association was already exploring paving technologies in Europe to produce yet another mix: Warm-Mix Asphalt. Some consider Warm-Mix Asphalt the new “green” asphalt and the wave of the future in the paving industry.

### WHAT IS WARM-MIX ASPHALT?

What is the difference between Warm-Mix Asphalt and Hot-Mix Asphalt? Let’s first explain that whether it’s warm or hot, it is still SUPERPAVE. Everything that you learned in the past about performance-grade binders (PG 64-22), equivalent single-axle loads (ESAL), skid-resistance level determination (SRL), wearing, binder, and base courses remains the same. The biggest difference of Warm-Mix Asphalt is how the the asphalt mixture is produced and placed at lower temperatures than Hot Mix. Production and placement temperatures of Warm-Mix Asphalt can be reduced 50 to 100 degrees Fahrenheit (F) compared to Hot Mix. These lower temperatures not only benefit the producers, but they are also an advantage to municipalities in the field.

### HEAT – It is the cornerstone of the asphalt industry that has built roadways of the world.



This shows the classification of asphalt mixtures by temperature range. As the temperatures are increased to produce Hot-Mix Asphalt versus Warm-Mix Asphalt, a producer is required to spend additional money on fuel/ton of material produced. (Note: The technology of Half-Warm Asphalt was a process developed in the Netherlands to produce a mix with typically 50 percent Reclaimed Asphalt Pavement.)

## HOW DOES WARM-MIX ASPHALT WORK?

Warm-Mix Asphalt technologies reduce the viscosity (thickness) of the asphalt binder so that aggregate within the mix can be coated easier at lower temperatures than Hot Mix. The key that makes Warm-Mix Asphalt work are the additives (chemicals, organics, or water) in the asphalt mix:

- **Chemical** (surfactants) additives improve the capability of the asphalt binder to wet and lubricate the aggregate. This reduced resistance to coating and spreading over the aggregate surfaces at lower temperatures allows the chemical addition to improve the mix workability and compaction at lower temperatures compared to Hot Mix.
- **Organic** (wax) additives reduce the viscosity of the asphalt binder at higher temperatures but harden at service temperatures.
- The addition of **water** to the asphalt binder prior to mixing results in a foaming process where the steam causes the asphalt binder to expand. The expansion allows for greater coating of the aggregate at lower temperatures compared to Hot Mix.

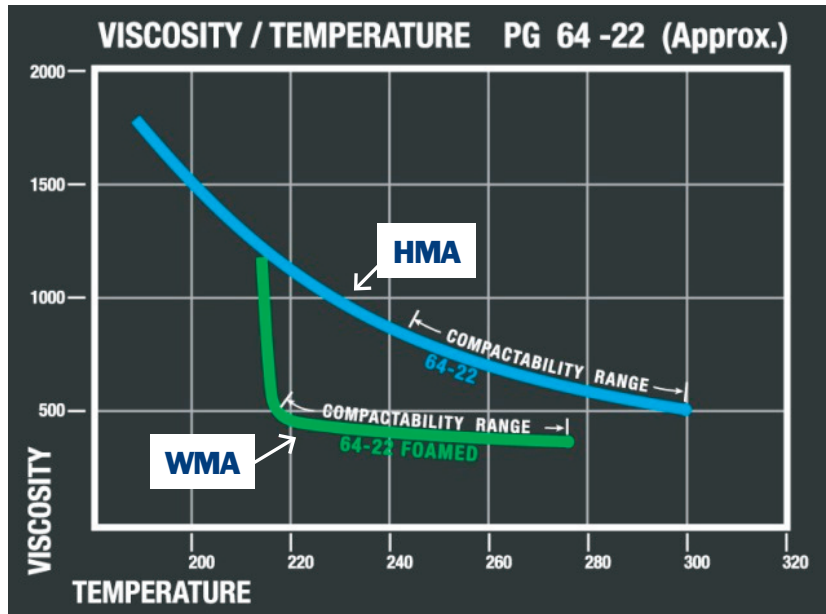
Reducing the viscosity also makes the mixture easier to manipulate and compact at the lower temperature while still providing a durable driving surface.

## WHAT ARE THE BENEFITS OF WARM-MIX ASPHALT?

**Better Compaction = Better Performance** - Proper compaction is critical to well-performing pavements. One indication to proper compaction is density. Warm-Mix Asphalt is a compaction tool that can help to achieve proper density and improve pavement performance goals. During paving with Warm-Mix Asphalt, infrared thermography tests have shown that mat temperature is uniformly consistent. These images have shown that it is the key to achieving uniform density.

**Warm-Mix Asphalt Cools Slower** - When paving with Hot-Mix Asphalt, we have determined that the greater the differential between the asphalt mixture and the ambient air temperature, the faster the mix cools. Since Warm-Mix Asphalt is produced at lower temperatures, the rate of heat loss is lower. The longer cooling period allows additional time in the workable zone for longer hauls from the production plant to the job site and/or placement and compaction time.

**Good for Workers & Good for the Environment** - Working conditions are much healthier with Warm-Mix



This shows the viscosity-temperature relationship for PG 64-22 Hot-Mix Asphalt compared to Foamed PG 64-22 Warm-Mix Asphalt. Notice the greater temperature range for workability and compactability with the Warm-Mix Asphalt mix.



Warm-Mix Asphalt has no steam, thus improving working conditions at the paving site. The crew's first reaction was to say, "There's no smoke!"

Asphalt at the production facility and on the construction site where workers are inhaling far less smoke and dust. By producing asphalt mixtures at lower temperatures, producers are able to cut fuel consumption at the plant (30 to 35 percent) and decrease the production of greenhouse gases. Studies have shown that the reduced emissions result in 45 percent reduction in carbon dioxide (CO<sub>2</sub>), 40 percent reduction in sulfur dioxide (SO<sub>2</sub>), 50 percent reduction in volatile organic compounds (VOCs), 35 percent reduction in carbon monoxide (CO), 75 percent reduction in nitrogen oxide (NO<sub>x</sub>), and 30

## Warm-Mix Asphalt Use in Pennsylvania



Warm-Mix Asphalt being applied on Route 2012 near Spring Mills, Centre County.



Warm-Mix Asphalt being applied in Patton Township, Centre County, as part of LTAP training in May 2013.



Road crews that use Warm-Mix Asphalt like how the mixture is produced and placed at lower temperatures.

percent reduction in dust. By cutting the emissions, Warm-Mix Asphalt improves the conditions for workers and neighbors living near the asphalt plants.

**Other Benefits in the Field** - Since Warm-Mix Asphalt produces asphalt mixtures at temperatures lower than 285 degrees F, asphalt binder ageing is not increased. Pavements stay blacker longer since the light oils are not cooked out of the asphalt binder. Some agencies have also found that Warm-Mix Asphalt paving eliminates or reduces the bumps caused by expansion of underlying crack sealant when placing thin overlays.

### WHAT IS HAPPENING WITH WARM-MIX ASPHALT IN PENNSYLVANIA?

The current approved Warm-Mix Asphalt technologies in Pennsylvania are identified in PennDOT Publication 35, Bulletin 15. The PennDOT-approved technologies are broken down into four categories: chemical, foaming additive/process, mechanical foaming equipment/process, and organic additives. Of the 14 companies throughout the United States that have met the PennDOT Warm-Mix Asphalt technology requirements, half are approved for mechanical foaming equipment/process.

## Municipalities should specify in their bids that they are bidding both Hot-Mix and Warm-Mix Asphalt.

As a consumer, a municipality will not have a specific choice in which Warm-Mix Asphalt technology is used at its local asphalt plant. All four processes have worked in Europe for nearly 20 years, and each asphalt producer will decide if, when, and which technology that it will install and upgrade at its own facility. Regardless of the Warm-Mix Asphalt technology chosen, the municipality will ultimately receive a better SUPERPAVE mixture.

**Warm-Mix Asphalt Specification in Pennsylvania.** The recent changes (Oct. 4, 2013) in PennDOT Publication 408, Section 311, cover 25 mm and 37.5 mm Warm-Mix Asphalt base course while the addition of Section 411 covers 9.5 mm, 12.5 mm, 19 mm, and 25 mm Warm-Mix Asphalt wearing and binder course.





### **HOW WILL SUPERPAVE MATERIALS BE BID IN THE NEAR FUTURE?**

Since Warm-Mix Asphalt technology is new and costly for asphalt paving producers, not all facility owners have installed Warm-Mix Asphalt additive systems at their plants. Because it will take time to convert all the plants from Hot-Mix Asphalt to Warm-Mix Asphalt production facilities, it is recommended that municipalities specify in their bids that they are bidding both Hot Mix and Warm Mix. Previous bid results from PennDOT indicated that Warm-Mix Asphalt was less expensive in most cases.

Concerning previously awarded contracts that have not been constructed, if a contractor proposes to substitute Warm-

Mix Asphalt for Hot-Mix Asphalt, a municipality could agree to such a proposal if the contractor agrees to substitute the material at cost neutral (i.e., results in a zero net change to the project) or a cost reduction.

PennDOT's Bureau of Municipal Services has taken the position that substituting Warm-Mix Asphalt for Hot Mix is acceptable based on PennDOT Publication 408, Section 104.02. Municipal Services encourages municipalities to bid both Warm-Mix Asphalt and Hot-Mix Asphalt and if both products are available to make the choice of which product to use on their projects. Bidding questions should be directed to your Municipal Services representative prior to advertising for bids.

### **Additional Information on Warm-Mix Asphalt**

- FHWA Every Day Counts  
[www.fhwa.dot.gov/everydaycounts/technology/asphalt/intro.cfm](http://www.fhwa.dot.gov/everydaycounts/technology/asphalt/intro.cfm)
- PennDOT Municipal Services  
[www.dot.state.pa.us/Internet/Bureaus/pdBMS.nsf/infoContacts?readform](http://www.dot.state.pa.us/Internet/Bureaus/pdBMS.nsf/infoContacts?readform)
- Warm-Mix Asphalt  
[www.warmmixasphalt.com/Default.aspx](http://www.warmmixasphalt.com/Default.aspx)
- Pennsylvania Asphalt Pavement Association  
[www.pahotmix.org/Warm\\_Mix\\_Aspphalt.asp](http://www.pahotmix.org/Warm_Mix_Aspphalt.asp)
- National Asphalt Pavement Association  
[www.asphaltpavement.org/index.php?option=com\\_content&view=article&id=148&Itemid=329](http://www.asphaltpavement.org/index.php?option=com_content&view=article&id=148&Itemid=329)