Cooling Down the Mix

NAPA Explores New "Warm Mix Asphalt" Technologies Developed in Europe

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Imagine producing and placing Hot Mix Asphalt pavement material at temperatures up to 100°F lower than currently considered feasible. Perhaps the most obvious benefit would be the reduction in fuel consumption, which would conserve precious natural resources.

In addition, production of asphalt fume would decline. The relationship of temperature to asphalt fume production has been confirmed by research at the National Center for Asphalt Technology and elsewhere. Experts say that, as the temperature of asphalt cement is raised, the amount of fume increases and the chemical makeup of the fume changes. With lower temperatures, both emissions and odors sometimes associated with asphalt are reduced or practically eliminated. Total emissions from asphalt plants, including greenhouse gases, would also be reduced.

The leaders of the National Asphalt Pavement Association learned of cutting-edge technologies in Europe for bringing down temperatures and, during the summer of 2002, conducted a European study tour to research and evaluate three of these processes. Peter Wilson, NAPA's 2003 Chairman; Dave Carlson, NAPA's 2002 Chairman; Michael Mangum, NAPA's Co-chair of the Asphalt Paving Environmental Council; Mike Acott, NAPA's President; Gary Sauer, Commercial Asphalt Co.; Dr. Mary Stroup-Gardiner, NCAT; and Bob Thompson, Thompson-McCully Co., visited asphalt plants, paving sites, and completed roads in Germany and Norway.

"NAPA has a long history of reaching out to craft innovative approaches to issues that may affect the future of the industry," Wilson commented. "One example is the 1990 study tour that brought Stone Matrix Asphalt to this country, and another is the initiative that placed engineering controls on asphalt pavers. We put together the 2002 study tour because we felt the timing was right for exploring whether Warm Mix Asphalt will work in the United States.

"The impact of Warm Mix technologies on the industry may be as significant as the introduction of SMA and engineering controls," Wilson concluded.

While the Warm Mix Asphalt technologies seem very promising, it will be necessary to study them thoroughly to determine their applicability to the U.S., according to Acott. "We need laboratory and field research to evaluate the material characteristics and performance," he commented.

"There are questions about whether the processes and products are compatible with the mix designs, equipment, climate conditions, and work practices in the United States, which are quite different from those in Europe. We need to find out whether the products perform up to U.S. expectations. We must not lose any of the significant performance benefits of Stone Matrix Asphalt, Superpave, or mixtures containing reclaimed asphalt pavement.

"And we have to look at plant operations, control of the mixing process, workability at the paving site, and the ability to turn pavements over to traffic quickly. In other words, it's going to take us some time and some work to see how these European developments may be applied in our country," he observed.

NAPA plans to initiate a research program at NCAT, in cooperation with the Federal Highway Administration and European technology sponsors, to begin to answer some of these questions. Demonstration projects to evaluate performance in the field are a logical next step. Validating and implementing these technologies will be a years-long process.

The three technologies are quite different from each other and are marketed in Europe as proprietary technologies. They include:

- A synthetic form of zeolite called aspha-min® is added during mixing at the HMA plant. The zeolite slowly releases a small quantity of moisture to create a foaming effect in the binder. This reduces the viscosity and permits a reduction in temperature.
- WAM-Foam is a two-component system which uses both a soft asphalt and a hard asphalt, introduced sequentially during the mixing process. First, the aggregate is coated with the softer binder; then, the introduction of a foamed hard binder enables lower mixing temperatures.
- A third method is the use of organic additives with the asphalt cement to reduce the viscosity of the binder at mixing and compaction temperatures.

NAPA invited experts from Europe to San Diego to share the European experience with low-temperature asphalt mixes in a special workshop at NAPA's Annual Convention in January.

German Bitumen Forum promotes Warm Mix Asphalt

Dr. Reinhold Rühl of the Bitumen Forum, Frankfort, Germany, set the stage for the presentations. The Bitumen Forum, a partnership which represents all sectors (government, industry, and labor unions) of the asphalt industry in Germany, was founded in 1996 to provide a focused and objective scientific approach to research on asphalt fume. Research results are published regularly. The effectiveness of the partnership is acknowledged by the Ministry for Labour and Social Affairs, said Dr. Rühl.

The Bitumen Forum's highest priority is the development of low-temperature asphalt, with "low-temperature" defined as close to 100°C, or 212°F. The benefits of reducing the temperature of asphalt production and placement include:

- Less or no fumes,
- Less emissions at the plant,

- Less energy consumption,
- Less wear and tear on the plant, and
- Less aging of the binder.

Going forward, the Bitumen Forum's goals include further development and promotion of low-temperature asphalt to minimize emissions, energy consumption, and carbon dioxide (greenhouse gas) production.

Organic additives

Dr. Heinrich Els of DAV (German Asphalt Pavement Association) in Bonn, Germany gave an overview of the German experience with low-temperature mixes, with an emphasis on the use of organic additives.

Several methods for lowering mix temperatures are being developed in Germany. These include a method for adding aggregates in sequence, a two-phase bitumen mixing method (see WAM-Foam below for an example), and both organic and mineral additives.

The two types of organic additives are synthetic paraffin waxes and low-molecular-weight ester compounds. The paraffins are long-chained aliphatic hydrocarbons derived from coal gasification using the Fischer-Tropsch process. The ester additives consist mainly of esters from fat acids and wax alcohols and are produced by toluene extraction of brown coal. These additives increase viscosity and penetration of the bitumen at low temperatures.

These additives have been researched in the lab and in the field for about five years. The performance goals for low-temperature mixes include having the same (or better) resistance to fatigue and deformation, and comparable workability at the paving site, said Els. Field experience with Stone Matrix Asphalt has shown that compaction can begin at 215°F to 250°F.

Els cautioned that over-compaction should be avoided. For example, pneumatic rollers can sometimes "pump up" the binder. Prompt delivery of paving material to the paving site is important, and he added pointedly, "Do not lose time in transporting, laying, and compacting the material!"

WAM-Foam process

Burgard Koenders of Shell Global Solutions in Petit Couronne, France, and Olle Larsen of Kolo-Veidekke ASA in Oslo, Norway teamed up for a presentation on WAM-Foam. WAM-Foam is the product of a joint venture between Shell and Kolo-Veidekke which began in 1995.

Koenders and Larsen explained that European companies are required to keep "accounts" of their CO2 emissions. In addition, "green purchases" are required – that is, at an equal price, the most environmentally friendly solution must be chosen.

The developers of WAM-Foam set goals that include being able to produce low-temperature mixes in existing HMA plants to current HMA specifications. They focused their efforts on dense-graded mixes for wearing courses. WAM-Foam is a process that uses a blend of hard and soft asphalts. It is produced in a conventional HMA plant (batch or drum) that has been modified with the addition of foaming equipment.

A typical WAM-Foam mix described by Koenders and Larsen is produced with 90 percent aggregate, 4 percent filler, and 6 percent asphalt binder. The aggregate is heated to about 260°F in the dryer, then mixed at about 225°F. In their example, 1.8 percent soft binder and 4.2 percent hard foamed binder were used. After mixing, the material is stored in a silo and ultimately is placed at 175°F to 200°F.

Several demonstration projects using WAM-Foam pavements were put into service in Norway from 1999 to 2002. The pavements are performing well in Norway, where the climate is extreme and studded tires are common, said Koenders and Larsen.

Synthetic zeolite added

Max von Devivere of Eurovia Services GmbH in Bottrop, Germany discussed using a synthetic zeolite that Eurovia has trade-named aspha-min®. He said that in Germany, asphalt mixes are typically produced at 302°F to 482°F. With aspha-min®, production and placement temperatures can be reduced dramatically, to 266°F to 293°F.

Zeolites – crystalline hydrated aluminum silicates – release water at different rates. Eurovia's synthetic crystal offers more uniformity and predictability.

In the aspha-min® process, 0.3 percent of the additive is added to the mix at the same time the asphalt binder is introduced. All known bitumens can be used in this process, said von Devivere, and all aggregates and fillers can be used. There is no need to change mix designs. He added that aspha-min® has been observed to improve the workability of the paving material at low temperatures.

In tests conducted by Eurovia, lowering the mix production temperature by 55°F reduced energy consumption by about 30 percent. It also reduced the production of asphalt fume by 75 percent. Measurements at the paving site, where the material had cooled even further, showed a 90 percent reduction in fume. Significant reductions in odor were also documented, said von Devivere.

At least eight test sections have been constructed, and no difference in performance has been seen. Eurovia expects to build a 50,000-ton test section on the German motorway this spring. HMAT

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