Scan Tour Examines Warm-Mix in Europe

By Brian Prowell, P.E.

Five years after bringing warm-mix asphalt (WMA) to the U.S. from Europe, a scan tour returned to Europe to examine the technologies there. The 2007 scan tour had as its objective to identify and evaluate foreign technologies and practices that could significantly benefit highway transportation systems in the U.S.

During a two-week scan tour, representatives from NAPA, American Association of State Highway and Transportation Officials (AASHTO), Federal Highway Administration (FHWA), Asphalt Institute (AI), contractors, and consultants met with the people who first developed the warm-mix technologies. The tour also allowed the team to examine the performance of some of the oldest warm-mix projects in Europe. The scan tour took the participants to projects, laboratories, and plants in Norway, Germany, Belgium, and France.

Performance

The scan team was especially interested in the long-term performance of WMA. During the tour, participants were able to view WMA sections constructed as long ago as 1999. The general consensus in the countries visited on the scan tour was that WMA should provide equal

Warm-mix asphalt pavements in Norway have held up to truck traffic.

or better performance than HMA. Case studies were reported in France and Germany where WMA has been used on interstate-like highways and bus lanes.

In Norway, the scan team viewed six WAM-Foam pavements and was provided with data on 28 sections. Some of the sections had been in use as long as eight years. Although the performance was mixed, where poor performance did occur, the failures were not attributed to the WAM-Foam process. In Germany, data was presented on seven test sections being monitored by BASt, the German equivalent of the FHWA. All of the sections were performing as well as or better than HMA control sections placed at the sites. Based on performance to date, guidelines for WMA have

been developed in Germany which allows the use of Fischer-Tropsch wax (Sasobit), Monatan wax, fatty acid amides (Licomont BS 100), and zeolite. In France, new technologies are approved as part of a public-private partnership by an agency known as SETRA. Approval typically requires three trial sections to be monitored for a minimum of three years. To date, Aspha-min zeolite has received a certificate of approval and several other processes are still being monitored.

Diversity of WMA

A large number of WMA technologies are being used in Europe. In 2002, the scan tour identified four technologies: Aspha-min zeolite, Asphaltan-B (Montan Wax), Sasobit, and WAM-Foam. The 2007 scan team identified at least 12 technologies, some with production temperatures as low as 194 °F. Additional processes include warmed cold-mix and mixtures produced with vegetable based synthetic binders which also allow reduced production temperatures.

Foam-expansion chamber for WAM-foam at Kolo-Veidekke plant in Norway.

The technologies can still be classified into two major categories: wax-like additives and processes that use water to produce a foaming action. The wax-like additives reduce the viscosity of the binder above the melting point of the wax. Asphaltan-B, Ecoflex, Licomont BS 100, and Sasobit are examples of wax-like additives. Unlike paraffinic bitumen waxes, the waxes used in WMA are long-chain waxes which do not form large crystals at cold temperatures. Typical paraffin waxes crystallize at low temperatures and are known to cause cracking in pavements.

The processes that use water rely on the fact that when water turns to steam, its volume increases approximately 1,600 times. If the steam bubbles are encapsulated in asphalt binder, the steam expands the binder as well, reducing its viscosity and improving workability. Water is introduced into the mix using either a hydrophilic carrier, such as Aspha-min zeolite or even wet sand, or by a direct foaming process using a nozzle through an emulsion, or through in-line injection of a diluted additive. The WAM-Foam process was the first direct foaming process introduced to produce WMA.

Lowering temperatures

Warm-mix asphalt can be produced at a wide variety of temperatures from approximately a 40° F reduction, with production temperatures of 270º F, all the way down to 194° F. Significant fuel savings are also possible if a portion or even all of the aggregate can be heated to temperatures below the boiling point of water. These technologies have been called half-warm asphalt.

The Low Energy Asphalt (LEA) used in France dries the coarse aggregate at normal HMA temperatures. The dry, coarse aggregate is coated with all of the asphalt needed for the mixture and then is mixed with cold, wet, fine aggregate. The water in the fine aggregate foams the asphalt, allowing the fine aggregate to be coated. Approximately 100,000 tons of LEA are scheduled to be placed in New York state this summer.

The LEAB process used in the Netherlands heats all of the aggregate to 194 °F and then foams in the asphalt using a series of nozzles. This process has been successful, in part, due to the low water absorption of the aggregates used in the Netherlands. This process is also routinely used with mixes containing 50 percent RAP. The Nynas low-temperature asphalt

process combines a special foaming process with added hydrophilic filler. Most foaming processes use some kind of additive to improve coating and adhesion.

The development of WMA technologies is not limited to Europe. New technologies are also being developed in the U.S. The first was MeadWestvaco's Evotherm™, an emulsion-based process that has

Scan tour group visits LCPC facilities in Nantes, France.

now been used in more than 40 trials around the world, including Europe. This summer, Astec Industries debuted a new foaming process for their double barrel drum plants. In June, over 4,000 tons of WMA were placed using the Astec process in Chattanooga, Tenn. Production temperatures were about 275° F. Like the LEA process, mixtures have been produced with 50 percent RAP. Mathy Construction, Onalaska, Wis., has also developed a foaming process and is conducting trials.

Two concerns about WMA have been identified in U.S. trials: moisture trapped in the aggregate and burner issues when producing at lower temperatures and lower production rates.

Contractors in the countries visited addressed the moisture issue by emphasizing that the aggregate used to produce WMA must be dry. The scan team learned that aggregates with high water absorption rates are rarely used in the countries visited. In France, it was reported that none of the aggregate sources used to produce HMA or WMA had water absorption in excess of 1 percent. The scan team also observed that a number of best management practices were routinely used to help keep aggregate dry. For example, Kolo Veidekke in Norway used a portable enclosure system to cover their RAP stockpile. Belts in Norway and France were covered to cut down on dust. In urban areas, many HMA plants have enclosed aggregate storage.

Regarding burner issues, HMA plants in Europe tend to be smaller and production rates lower. Although larger drum plants are sometimes used, particularly in France, batch plants tend to be more common. Batch plants allow the aggregate more dwell time at an elevated temperature before it is coated with asphalt. This should help the aggregate to dry at lower temperatures. The drum plant used by Kolo Veidekke to produce WAM-Foam was rated at 250 tons per hour. Since the burner for the plant was smaller it was able to operate at lower temperatures more efficiently. In no case was unburned fuel reported when producing WMA as has been suspected in some U.S. trials. To remedy the problem that has been encountered in the U.S., contractors should pay careful attention to fuel viscosity and consider having a burner technician on-site when first running WMA to help with burner adjustments. In some trials, U.S. contractors have also made changes to the flights to improve heat penetration in the drum.

Testing

European practice for designing and contracting HMA, as well as WMA, differs in many respects from U.S. practice. European Standards are being developed to standardize test methods and provide broad definitions of mix types. Individual countries develop national application documents to specify exactly what they want within the framework of the European Standards. Performance tests play a more dominant role in the European mix design process.

Norway and Germany are using a dry Hamburg-type wheel-tracking test with a hard rubber wheel, and France uses the French wheel-tracking test with a pneumatic tire to assess rutting potential. Other tests may be used during design to assess cracking potential and fatigue life.

The European Union, like the U.S., is still searching for a reliable moisture damage test. In Norway, contractors routinely blend hard and soft binder components in both HMA and WMA to produce the desired binder grade. In Germany, contractors frequently modify binders in-line to produce the desired grade. Most contracts include some kind of materials and workmanship guarantee, which lasts up to five years.

The expanding number of technologies being used in Europe is a function of the relationship between the industry and government agencies in Europe. Contractors in Europe tended to be larger and fewer than in the U.S. and some, like Eurovia, Colas, and Effiage, have impressive research capabilities that allow them to lead innovation. Throughout Europe the development of WMA technologies has been led by large contractors. The agencies concentrate their efforts in evaluation of the technologies.

In France, the agencies are interested in sustainable development and "green" construction practices. Some French agencies even recognize technological aspects within the bidding process. Finally, both France and Germany have in-place methodologies for evaluating and approving new technologies.

Paving practices

Placement of WMA in Europe

Workers place Low-energy Asphalt on a freeway ramp in France.

could best be described as business as usual. Heavy, tamping bar screed pavers are generally used to place both HMA and WMA. Compaction is done with steel wheel rollers in both vibratory and static modes. Pneumatic rollers are rarely used. With most of the technologies observed, workability appeared to be good. On several occasions it was reported that equipment stays cleaner, e.g. there is less build up of asphalt, when placing WMA.

The benefits of WMA discussed in Europe are the same as those observed in the U.S.: reduced emissions, reduced fuel usage, and more comfortable conditions for workers. The ability to haul WMA longer distances or pave in cooler weather and still obtain compaction was also discussed. Less aging of the virgin binder may allow for the use of higher RAP percentages without the need to alter the virgin binder grade.

Although WMA first emerged in Europe almost 10 years ago, the total tonnage that has been produced there is still very small. Economic factors and uncertainty over long-term performance have prevented widespread use to date. European contractors are striving to have technologies available and to gain experience by staging WMA paving demonstrations. The U.S. is not as far behind Europe with WMA as many had thought, thanks in part to industry-agency partnerships like the WMA Technical Working Group.

The scan team agreed that WMA is a viable technology and that U.S. agencies and the HMA industry need to continue to cooperatively pursue the current path. One of the team's implementation goals is that WMA should be an acceptable alternative to HMA at the contractor's discretion. *HMAT*

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