Warm Mix: The Wave of the Future?

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Imagine if hot mix could be produced at 50 to 75 °F lower than is now done, then trucked to the site, paved, and compacted, and with the needed density, smoothness, and rut resistance! Some of the advantages would include lower plant emissions, lower energy consumption, and less plant wear. Neighbors and employees might notice the reduction in fumes, odors, and emissions. In the long run, there might be less cracking because the binder did not age as much during construction.

This highway in Europe was constructed using warm mix technology.

Workers compacted the warm mix at the demonstration and were able to achieve the same density as with traditional mixes.

Warm mix demonstration: At the 2004 World of Asphalt, the warm mix demonstration lowered paving temperatures approximately 80 degrees.

You're thinking, "Right . . . when Captain Kirk opens a Hot Mix plant and hires Scotty to run the lab!" Well, the 21st Century is here and you can set your infrared gun to stun because warm mix is on the way.

The Europeans have already begun using technologies to lower mix temperatures, and the results have been very promising so far. Much of the incentive in Europe comes from the goals to reduce emissions in mastic and gussasphalt mixes (mastic and gussasphalt are high-temperature mixes that are not used in the U.S.) and the reduction of greenhouse gases in response to European Union mandates. In the U.S., we are beginning to look at warm mix technologies with an eye to the future, and the hope that the promising benefits they bring can be realized.

Currently, at least four different processes are being actively marketed:

- A process that uses foamed asphalt
- One that relies on a mineral additive
- One that involves the use of an organic additive
- A chemically based method.

Some of these proprietary approaches are being examined at the National Center for Asphalt Technology at Auburn University to see what impact they may have on the performance of asphalt mixtures in a U.S. setting. This research will be important to the ultimate acceptance of warm mix technology by owner agencies.

The WAM (Warm Asphalt Mix) foam process was a joint development between Shell and Kolo Veidekke a.s. In this technique, aggregate is initially coated with a soft asphalt binder and mixed. Then, a harder asphalt is foamed by injecting a small amount of cold water into the hot binder under controlled conditions. The resulting steam causes the hard asphalt to increase in volume. The foamed asphalt is then added to the pre-coated aggregate and mixed. The foaming reduces the stiffness of the mix, which increases its workability, thus allowing the lower production temperature. This type of mix has been successfully produced in both batch and drum plants. Reductions in mix temperatures from 310 to 230 °F have been reported.

The process was first used in Norway in 1996 on a rural road. The WAM foam material was placed side-by-side with regular HMA. In this project, and at least three others, the WAM foam material has performed as well as, or better than, conventional HMA. All this with a 30 percent reduction in energy and CO_2 emissions, a 50 to 60 percent reduction in dust, and fumes that are below the detection limit, while the production rate is maintained. The only issue noted in the plant is the presence of some humidity in the batch plant stack.

Aspha-min® is a process marketed by Eurovia that uses a mineral additive called zeolite. Zeolite is a fine crystalline hydrated aluminum silicate that is added at a concentration of about 0.3 percent to the mix in the temperature range of 250 to 295 °F at the same time as the asphalt binder. The zeolite releases a small amount of water into the mix to create a mousse that reduces stiffness of the mix and increases the workability. Again, the result is the ability to reduce the mix temperature.

The Aspha-min® process can be done in either a batch or drum plant, and the mineral can be fed in either bag form or from a mineral filler silo. No change is required in the mix design of the HMA. A reduction in energy consumption of about 30 percent was reported by Eurovia, with a commensurate reduction in CO_2 emissions and a reduction in fumes of about 90 percent. The mix handles the same as a conventional HMA, and the resulting field densities were about the same. It has been used in Europe and in two U.S. paving projects as well as a paving demonstration at the 2004 World of Asphalt.

Organic additives modify the behavior of the asphalt binder by lowering the viscosity at construction temperatures while maintaining the required stiffness at service temperatures. Currently, there are two organic additives that are used including Fischer-Tropsch paraffins and low molecular weight ester compounds. These products were originally developed to enhance the compaction of HMA, but are now being used to lower the required temperature of the mix. These materials must be used judiciously since too much additive will create an overly stiff mix at service temperature that might cause the HMA to be susceptible to cracking.

The organic additives can be blended with the hot binder prior to introduction to the mix. Experience thus far suggests that the material be delivered at 300 °F or lower and that over-compaction needs to be avoided. Compaction of SMA can begin at about 250 °F. Static rollers are preferred and vibratory rollers should be used with care. Pneumatic rollers are not recommended. One of these products, Sasobit, from the Sasol company, has been used in Germany. After five years, the field performance of the material has remained good. It was recently used to pave the main runway at the Frankfurt Airport in Germany, so that the facility could be rapidly opened and turned over to heavy aircraft traffic.

The last product, Evotherm, relies on a chemically modified binder produced by MeadWestvaco. It can be used with or without a wide range of polymer modifiers. A Superpave Level I mix design approach can be used in determining proportions, and RAP can be included. In South African field trials, no problems were noted in mixing and placing the material, and production and paving temperatures were on the order of 140 °F. Compaction was started as soon as the placement was done, and the road was returned to traffic immediately after compaction. A range of lift thicknesses was employed in these field trials, from about 0.35 to 2.5 inches.

In summary, while there are definite reductions in fumes, emissions, and energy consumption, questions still remain to be answered. Will success in Europe translate to success in the U.S.? How will we handle issues with binder grading when we are changing the way the mix behaves in construction? Although less cracking might result from a binder that is aged less in construction, will rutting be more of a problem? Will we be able to turn pavements over to traffic as fast as we do now? How much will the new technologies cost and will the benefits justify additional spending?

None of the above issues are insurmountable. It is in our interest to look at these approaches to see if they can be implemented in the long term in the U.S. The study at NCAT will go a long way to provide a beginning in answering some of the questions that are raised. Further work involving the construction of demonstration projects is also planned for the future. Maybe next we can find a way to beam the mix from the plant to the paver. HMAT

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