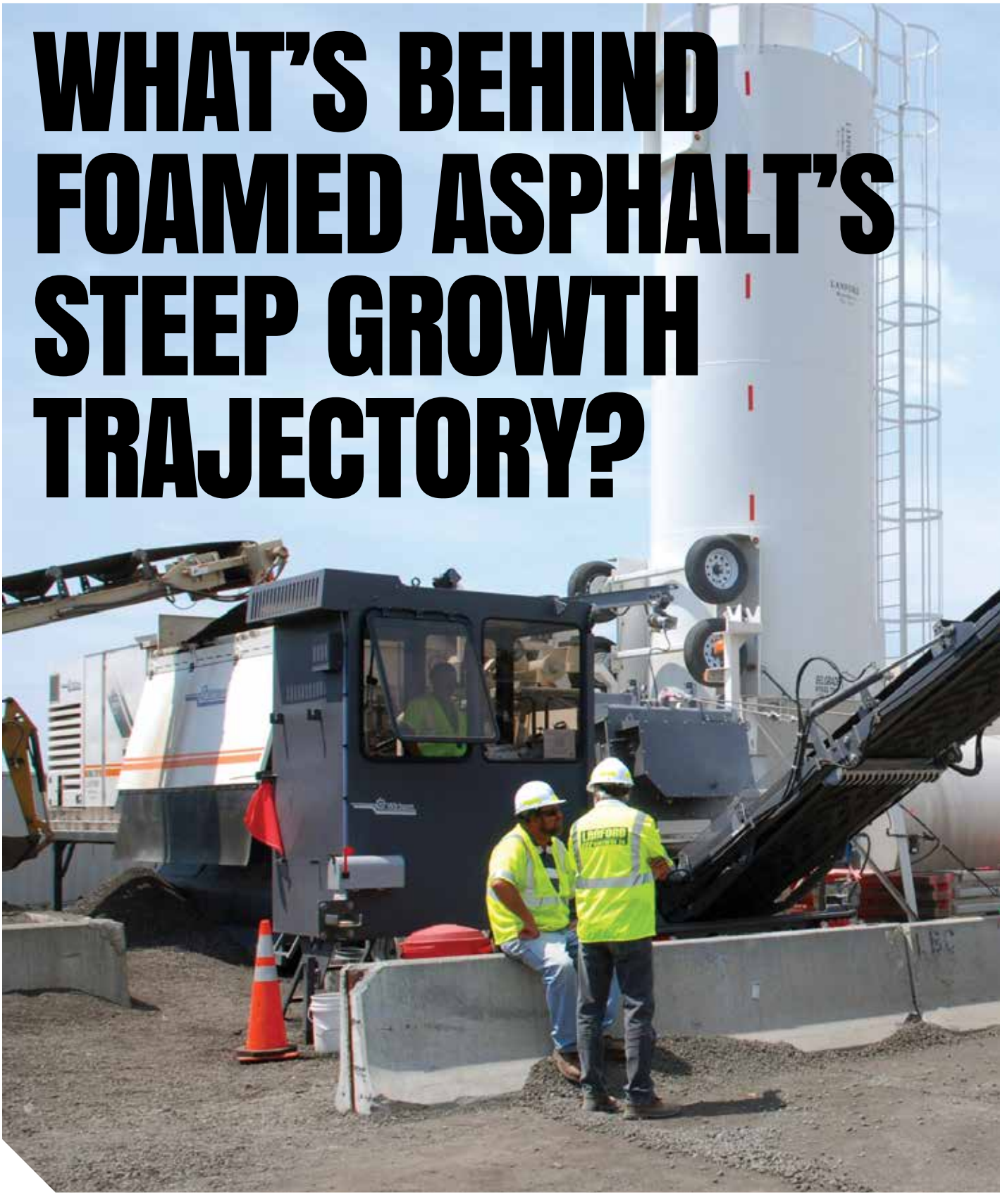
WHAT'S BEHIND FOAMED ASPHALT'S STEEP GROWTH TRAJECTORY?



Just like the swelling froth of expanded liquid asphalt in a foamed asphalt application, use of foamed asphalt in warm mixes is growing exponentially, and its use for full-depth recycling and base stabilization of roads is increasing as well.

Warm mix asphalt (WMA) production in the United States has exploded in recent years, from 19.2 million tons in 2009 to 86.7 million tons in 2012, an increase of more than 400 percent in only three years, according to the National Asphalt Pavement Association. Since mechanical foaming units were used in 88 percent of all WMA produced in 2012, it's clear the use of foamed asphalt is following the same steep growth trajectory.

To help everyone understand the new WMA environment of foamed asphalt, the National Cooperative Highway Research Program released a new report earlier this year on test methods, performance measurements and mix designs. (A copy of the report can be downloaded by doing an Internet search for "NCHRP 807.")

Foam stabilization is not just for mobile recyclers; adjacent to Virginia's I-81, Wirtgen KMA 220 portable cold mix plant foam-recycles cold millings from the Interstate for immediate placement as a flexible base course.

Photo: Wirtgen America

The foamed asphalt mix on this Champaign County, Illinois, road was 2.5 percent liquid asphalt, performance graded PG 64-22 at 320 degrees, 1.0 percent dry cement as mineral filler and 2.2 percent water, as a percent of total.

Photo: Dunn Company

Why WMA use is growing

In general, warm mix asphalt processes reduce the viscosity of the liquid asphalt through a variety of means, and enable the complete coating of aggregates at temperatures 35 to 100 degrees lower than conventional hot mix asphalt. It's manufactured by mixing one of a variety of solid or liquid chemical modifiers like Sasobit or Evotherm with asphalt mix in the plant, but it also can be made by foaming the liquid asphalt with water in the plant just as it's mixed with aggregate.

In North America, WMA began growing in popularity in the 1990s following the popularization of European technologies by the Federal Highway Administration and NAPA. Before then, another type of foamed asphalt – a cold mix created in a portable plant (or *in situ* in the field using a recycler/reclaimer) and using as much as 100 percent reclaimed asphalt pavement – gained popularity for base stabilization and full-depth reclamation of roads.

Fueling the growth in lower-cost, plant-foamed asphalt warm mixes is the fact that it's a sustainable technology that reduces plant emissions, lowers fuel consumption at the plant, and creates a better environment for workers in the field.

In contrast, heat is the essence of conventional asphalt mix production, which takes place at temperatures from 275 to more than 330 degrees. Before mixing with hot liquid asphalt, fine and coarse aggregates are heated to high temperatures to drive off moisture, ease coating of the mineral aggregates with the liquid asphalt, and to keep the complete mix fluid enough to be workable during placement.

In addition to consuming huge amounts of fuel, heating liquid asphalt and aggregate to these temperatures produces volatile organic compound (VOC) fumes.

Today's warm mixes have the potential to all but eliminate these emissions, giving a plant owner a powerful tool to use in the permitting process. They also can use up to 50 percent less burner fuel.

With plant-mounted foaming equipment (green) in advance of drum, water is injected into liquid AC through a series of all-stainless steel injectors located above corresponding foaming chambers.

Photo: Astec Industries

Other warm mix advantages include faster construction of deep-lift pavements (since less time is required to cool the lift), the ability to transport loads of asphalt over greater distances without fear of temperature loss, and in some instances, construction of pavements in colder weather. Also, pavement durability may be enhanced since the burner heat doesn't drive off the lightest hydrocarbon fractions from liquid asphalt in the mix.

In addition, in cold recycled mixes, foamed asphalt uses significantly less costly liquid asphalt for an equivalent performance than conventional asphalt emulsion, cement or lime stabilizing agent. In the case of an in-place recycling train, the foamed process will be much shorter – usually done with tankers carrying liquid asphalt and water flanking a specially equipped recycler – instead of lengthy recycling train. But this process also requires sophisticated equipment and additional personnel training.

In-plant foaming systems

Water-based, in-plant foamed systems for low energy mixes use nozzles that precisely meter water into mixing chambers adjacent to the drum of a drum mix plant. Injection of water, along with the liquid asphalt cement, causes the liquid asphalt to foam and expand in volume. The foaming action helps the liquid asphalt coat the aggregate at a temperature that normally is in the range of 230 to 270 degrees.

These systems provide a foamed asphalt binder without reliance on additives, special binder, special techniques or asphalt cement delivery systems, says Astec Industries, a manufacturer of in-plant foamed asphalt systems.

"The additives are expensive and add significant cost per ton of mix," Astec says. "Astec warm mix systems eliminate the need for expensive additives and special asphalt cement by mixing a small amount of water into the AC to create microscopic bubbles. These small bubbles act to reduce the viscosity of the AC coating on the rock allowing the mix to be handled and worked at lower temperatures."

With Astec's system, water is delivered using a positive displacement piston pump capable of accurately metering water into the system. Using feedback controls, the pump speed is modulated to maintain the appropriate flow of water based upon the flow of AC. Programmable logic controls provide for smooth and consistent water flow as production rates increase or decrease.

Then, the water is injected into the liquid AC through a series of all stainless steel injectors located above corresponding foaming chambers. AC flows through the

Close-up of compacted, foam-asphalt stabilized mat in Champaign County, Illinois, which eventually will receive a 3.25-inch asphalt overlay over 4-inch-deep foamed base.

Photo: Dunn Company

foaming chambers where water and AC are thoroughly mixed to produce mechanically foamed AC.

A skid-mounted corrosion-free water reservoir is provided with an automatic filling valve. If supply water is lost, a low-water alarm alerts plant personnel so the problem may be resolved quickly without wasting mix.

Though the system is compact, it has been designed with the plant crew in mind, Astec says. The self-cleaning water injectors require only periodic inspection and may be removed and replaced from the top of the unit without removing the front cover. The foaming chambers have no moving parts.

Significantly, Astec can retrofit warm mix systems to continuous mix and batch plants from any manufacturer, bringing the benefits of warm mix asphalt to all asphalt pavement plant configurations.

Cold foamed mixes

A different kind of foamed asphalt incorporates liquid "foamed" asphalt as a stabilizing agent for bases or FDR, in which hot liquid asphalt is foamed with water and air, and is then injected into RAP or aggregate in a mixing chamber in a portable plant, or a self-propelled recycler/reclaimer.

In this cold mix foamed asphalt process, the recycled aggregate is not completely coated, as is the process with in-plant foamed injection using mostly virgin aggregate. Instead, as 100 percent reclaimed materials are introduced to the pug mill or mixing chamber, foamed asphalt is injected into the material stream, and acts as a binding agent to "glue" the reclaimed aggregates together.

This permits use of less liquid asphalt and much lower mixing temperatures. Depending on the degree of presence of fines in the existing materials to be recycled, up to 1 percent cement or hydrated lime may be required to act as a carrier or "dispersing agent" for the liquid asphalt to assist its spread throughout the pulverized material; this will add to the cost of the project.

Last summer, foamed asphalt was incorporated into an in-place cold recycling project. Using a Wirtgen 3800 CR cold recycling machine, recycling subcontractor Dunn Company, Decatur, Illinois, cold-milled 96,200 square yards on Champaign County Highways 11 and 20, a total of approximately 7.2 lane miles.

Then, following a quick conversion of the same machine, using it to feed a paver instead of a recycler-mounted screed, the crews recycled the lower lift using foamed asphalt. Two tandem

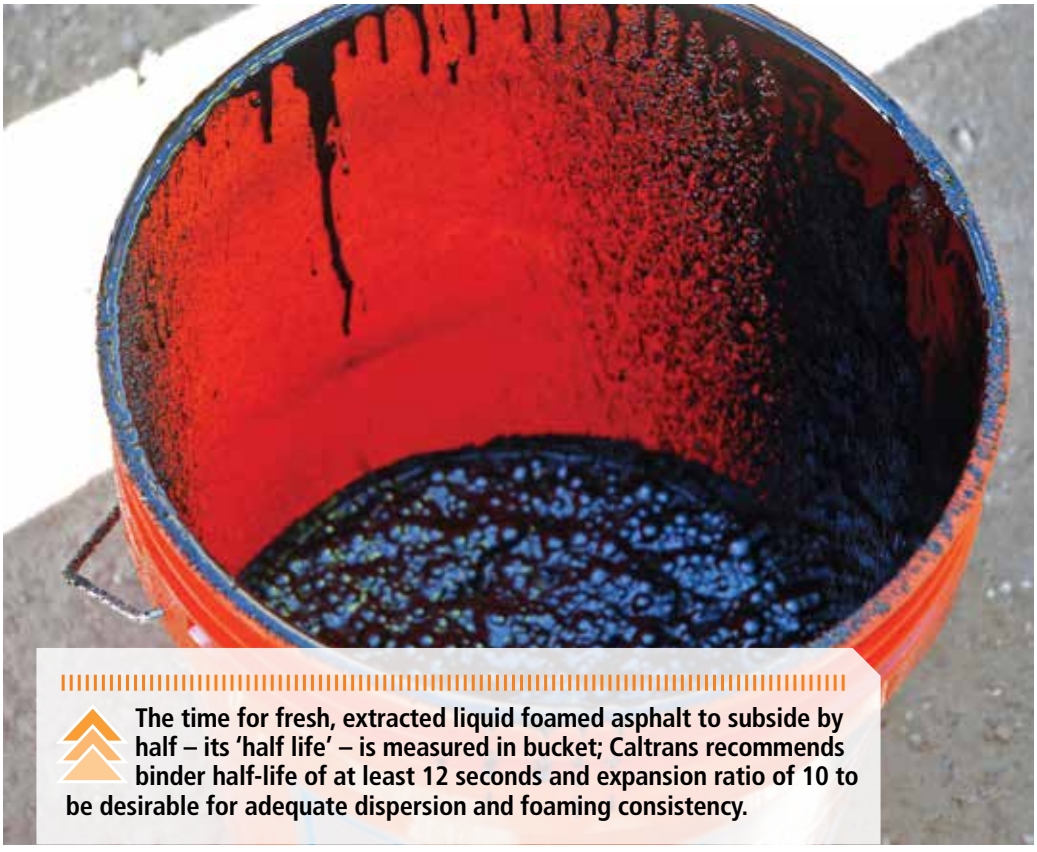
vibratory compactors executed breakdown compaction of the recycled foamed base.

Dunn pre-milled with the 3800 CR recycler to allow room for surface courses as well as correct elevation and slope issues. Ultimately, prime contractor Open Road Paving, Urbana, Illinois, placed an asphalt overlay on the 4-inch foamed base. A 1.5 inch-lift of binder or leveling course was topped with 1.75 inches of surface or "friction" course, in two 11-foot-wide lanes.

"Cold in-place recycling (CIR) via foamed asphalt is a

In Champaign County, Illinois, in-place foamed asphalt recycling moves from right to left, with conveyor feeding paver; contractor also had option of using recycler-mounted compacting screed at rear of machine.

Photo: Dunn Company



The time for fresh, extracted liquid foamed asphalt to subside by half – its 'half life' – is measured in bucket; Caltrans recommends binder half-life of at least 12 seconds and expansion ratio of 10 to be desirable for adequate dispersion and foaming consistency.

Photo: Tom Kuennen

good complement to traditional construction methods," says Mark Stahl, Dunn Company vice president of operations. "As an intermediate layer, CIR provides the structural strength and flexibility that make the wearing courses more durable and make the pavement last longer. And by re-using materials in-place for the intermediate layer, we help the wearing courses perform better while reducing the time, cost and environmental impact of projects. That benefits agencies as well as the taxpaying public." EW