



WARM MIX

Keeps Asphalt Workable After Long Drive to

CALIFORNIA COAST

by Tom Kuennen

California's State Route 1 – known alternatively as the Pacific Coast Highway, Cabrillo Highway, and Shoreline Highway – runs some 655 twisting miles along California's scenic and rugged coast. It encompasses extraordinary, unspoiled views of the Pacific Ocean, shore and mountains.

But because Calif. 1 runs through remote terrain on the west side of the coastal ranges that separate the wild Pacific Coast from California's more-populated interior, much of the roadway lies far from the hot mix asphalt plants needed for overlays and repairs from storms off the Pacific that lash the coast during winter.

Calif. 1 paving projects can be a three-to-four-hour drive from the hot mix asphalt plants typically used to produce mix in the region. After a lengthy, slow drive over switch-back mountain roads, mixes would arrive barely warm, to be further cooled in the chilly, foggy

ocean air along the coast.

If mix temperatures were ramped-up at the plant to arrive with enough residual heat to provide workability, the producer risked binder degradation. But if they were shipped at conventional temps, then attainment of onsite density would be threatened.

Warm mix asphalt offers Caltrans an alternative that has received rapt attention in 2008.

In May 2008, a warm mix workshop and demonstration project on Calif. 1 in Morro Bay, Calif. – between Monterey and Santa Barbara – generated excitement in the California engineering community. The demonstration included MeadWestvaco's Evotherm product and two other warm mix additives.

Then, in September 2008, Evotherm was chosen for a long-haul Caltrans demonstration project, in which both dense-graded and open-graded asphalt mixes were produced at conventional hot mix temperatures at the

Syar Industries, Inc., plant at Santa Rosa. The mix was hauled to Calif. 1 at Point Arena on the coast north of San Francisco, a four-hour drive through the mountains.

What is Warm Mix Asphalt?

Warm mix asphalt is not a single product, but a variety of technologies that reduce the temperatures at which asphalt mixes are produced and placed. WMA processes generally reduce the viscosity of the asphalt through a variety of means, and enable the complete coating of aggregates at temperatures 35 to 100 deg F lower than conventional hot mix asphalt (HMA).

In North America, the vast majority of pavements are made in hot mix asphalt plants. The liquid asphalt is a

Above: Loading the hauling trucks at the asphalt plant, the warm mix asphalt was produced at higher than normal temperatures in anticipation of the three-hour haul to the chilly California coast paving site.

relatively small part of the mix (typically 5 to 7 percent) and performs as a visco-elastic binder between the fine and coarse mineral aggregate.

Because WMA technologies generally reduce viscosity, they reduce compaction challenges associated with cooled mixes or cold weather, possibly lower the number of rollers required at a job site, and reduce the risk of failed compaction with stiff mixtures.

Conventional HMA production takes place above 280 deg F, not to exceed 325 deg F. Ideal placement and compaction temperatures are between 260 and 300 deg F. Before mixing with hot liquid asphalt, fine and coarse aggregates are heated to high temperatures to drive off moisture, to 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 consumption of prodigious amounts of natural gas, fuel oil or powdered coal, heating of liquid asphalt to these temperatures produces volatile organic compound (VOC) fumes which may either be vented to the exterior, or collected with fume enclosures and revented back into the process.

Like any other industrial facility, fumes from asphalt plants are an issue for regional air quality in areas that are not in compliance with federal air quality standards. However, plentiful research indicates there is no evidence that these fumes are harmful to either workers or nearby residents.

Nonetheless, use of today's warm mixes has the potential to all but eliminate such emissions, giving a plant owner a powerful tool to use in the permitting process. Warm asphalt mixes produce emissions at a greatly reduced level from conventional HMA plants, thus potentially enabling the permitting of asphalt plants in air pollution nonattainment areas, or where there is local opposition.

While they come at a cost premium, warm asphalt mixes can save money in the plant through reduced energy costs.

While this historically has been less of an issue in the U.S. than it is in Europe, with its higher-cost energy sources, in 2007 and 2008, skyrocketing energy costs in the United States have made this aspect even more of a benefit.

Similarly, and of interest to Caltrans, warm mixes may allow construction of pavements in cooler environments and following long hauls, because contractors need no longer fear critical loss of temperature in the cold. The result may be a longer construction season extending into the winter in some regions of the country.

Warm mixes can allow faster construction of pavements made up of deep lifts of asphalt, for example intersections, which need to be opened as soon as possible. Because the mix is not so hot to begin with, less time is required to cool the mix before the next lift is placed.

These benefits have been noted overseas. In its February 2008 report, FHWA's WMA European Scanning Tour reported WMA enabling paving

in cooler temperatures and still obtaining density, hauling the mix longer distances and still have workability to place and compact, enabling the ability to compact mixture with less effort, and the ability to incorporate higher percentages of reclaimed asphalt paving (RAP) at reduced temperatures.

MeadWestvaco Evotherm WMA Technology

One such lower-temperature technology is Evotherm, produced by MeadWestvaco Specialty Chemical Division, a water-soluble surfactant which adds lubricity to individual microscopic asphalt particles. The particles develop "slip planes" which let the asphalt particles move more easily, requiring lower levels of energy. Because the energy is lowered, Evotherm warm mix has the same viscosity properties at lower temperatures as conventional hot mix asphalt.

"By lowering the temperature of production we are avoiding some of



Haul truck dumps warm mix into material transfer vehicle after three-hour trip through coastal mountain range.

the potential degradation to binder that can occur at higher production temperatures,” said Everett Crews, Ph.D., technical manager for MeadWestvaco.

Evotherm is different from other warm mix technologies in its ability to produce mixes around 200 deg F, Crews said. “Other warm mix technologies produce material at temperatures up to 260 deg F,” he said. “Evotherm is unique in that we can push the limit lower. We have made mixes at below 200 deg F that have performed very well.

“In the United States the bulk of our applications have been dense-graded surface mixes,” said MWV’s Crews. “These typically have 19mm (3/4-in.) or 12.5mm (1/2-in.) nominal maximum aggregate size, sometimes down to 9.5mm (1/3-in.) NMA. In other countries we are seeing WMA being used in project-scale quantities, as opposed to demo-scale, and the U.S. market is moving in that direction.”

Evotherm was developed in the United States and is completely compatible with SHRP Superpave pavement designs. The aggregates and asphalts used with Evotherm warm mix chemistry are the same as those used for traditional mixes. Producing Evotherm requires little to no plant modifications, and the product is paved using conventional paving equipment.

Evotherm was first developed in 2003. Since that time it’s been used on over 50 projects globally. Working in the U.S., Canada, Mexico, China, Europe, and South Africa, Evotherm warm mix chemistry is generating a lot of interest around the world.

Caltrans and WMA

Caltrans has been evaluating Evotherm and other warm mix asphalt technologies since 2006. The 2008 study of warm mix asphalt at Point Arena and Morro Bay results from Caltrans’ need for confidence in specification of any new technology.

“Warm Mix Asphalt (WMA) is a set of technologies that reduces the temperature needed to heat hot mix as-



Material transfer vehicle feeds warm mix asphalt into paver hopper.

phalt during the compaction process,” said Caltrans’ Division of Research and Innovation in its Annual Accomplishment Report 2008. “It offers the potential to reduce energy use, reduce air emissions, reduce cost, and improve the quality of construction.”

Use of WMA in California is especially attractive due to its intrinsic lower emissions, thus smaller carbon footprint, compared to conventional HMA. As such it fits into California Governor Arnold Schwarzenegger’s green initiatives for state building and procurement.

However, the Division of Research and Innovation identified several questions regarding the risks of increased rutting and moisture damage when WMA is used. As a result Caltrans funded laboratory and Heavy Vehicle Simulator (HVS) testing to address those issues for warm mixes.

HVS test sections were built in Watsonville, Calif., in August 2007 in cooperation with the Graniterock Co., and three WMA technology providers, including MWV.

As a result of the tests, Caltrans determined that warm mix asphalt pavements were not intrinsically prone to rutting. “Results of [the] HVS testing have been completed and indicate that there is no increased risk of rutting in WMA sections compared to the conventional hot mix asphalt (HMA) pavement,” Caltrans Division of Research and Innovation reported in early 2008. “HVS testing for moisture sensitivity is currently underway. Plans

for repeating this testing using HMA with rubberized asphalt binders are under development.”

Following this research, Caltrans’ District 5 held the Morro Bay warm mix open house in May 2008, where three types of WMA – including Evotherm – were placed on Calif. 1. Morro Bay was followed by the Point Arena project in September.

Asphalt Mix at Point Arena

The Calif. 1 project at Point Arena involved thin-lift asphalt resurfacing of the two-lane highway to a depth of 1 1/4 inch.

“Caltrans has been actively studying warm mix,” said Brandon Milar, pavement technology engineer, Telfer Oil Co., Martinez, Calif., and supplier of Evotherm for this project. “For the last year they have been looking for candidate projects, and for us they’ve picked the toughest project. District 1 has been very interested in utilizing warm mix technology because they have a lot of projects along the coast, with long hauls associated with the mix. They wanted to find a better way of paving and so they were interested in Evotherm chemistry.”

Due to local conditions on Calif. 1 near Point Arena, both dense-graded and open-graded warm asphalt mixes were used. For the dense-graded portion – to be placed in a portion of the road subject to local flooding – the grade of asphalt binder was specified at PG 64-16, with aggregate

complying with Caltrans' 1/2-inch top-size grading.

And on the open-graded friction course (OGFC) section, which constituted the largest part of the project, the grade of asphalt binder mixed with aggregate was specified at PG 58-34, polymer modified. The aggregate for OGFC had to comply with the 1/2-inch grading, and the binder for OGFC aggregate had to be treated with liquid antistripping. The mix consisted of anywhere from 15 to 24 percent air voids to permit drainage of water through the thin lift.

Both dense and OGFC courses were being placed at 1 1/2-in. and compacted to 1 1/4-in. depth, from downtown Point Arena north about five miles. A total of 4,000 tons of Evotherm chemistry warm mix asphalt were placed.

For both mixes, a material transfer vehicle (MTV) was specified to receive mix from haul trucks and feed to the paver. The MTV was required in order to remix the WMA before loading the paver, be self-propelled and independent of the paver, and have sufficient capacity to prevent stopping the paver, according to Caltrans' contract addendum.

"We were using a dosage of Evotherm H5 DAT at 5 percent by weight of the asphalt binder content," said Hans Ho, technical and environmental director, Telfer Oil Co. "For this open graded friction course, the mix design calls for 5.8 percent asphalt binder, so the Evotherm H5 DAT will be 5 percent of that, or 0.29 percent of the total mix."

At the plant, the Evotherm additive was introduced to the drum mixer via an injection system. Because of the long haul, the mix was being made at temperatures higher than would be normal for warm mix. "Warm mix would normally be made at 230 to 275 deg F," Ho said. "For this particular project we are making it at 300 to 305 deg F so that we can haul it for three hours and still have a workable mix."

Typically the mix was leaving the

hot mix plant at Santa Rosa at just above 300 deg F, and was arriving at the job site at about 260 deg F, where it was placed by contractor North Bay Construction, Inc., of Petaluma, Calif. After transition in the MTV, the mix was being placed on the roadway at temperatures from 220 to 240 deg F. But with Evotherm, the temps can go lower. "We've placed WMA as low as 180 deg F without any workability issues," Plouff said.

"Evotherm makes the mix more workable at those lower temperatures," Telfer's Milar said. "We have seen the mix laid down, placed and rolled at those temperatures and still be very workable. Without the additive we have seen it set up quicker, and be a lot harder to roll and fix imperfections. And that makes it harder to provide a really high quality final surface."

Lowering Mix Temp in Stockton, Calif.

Use of Evotherm in California is not confined to Caltrans. In September 2007, the City of Stockton, Calif., sponsored a demonstration of warm mix asphalt paving using Evotherm on city streets, in which mix production temperatures were lowered by 100 deg F.

"The immediate benefit to producing warm mix asphalt is the reduction in energy consumption required by burning fuels to heat traditional hot mix asphalt to temperatures over 300 degrees," said Christine Tien, deputy city manager, City of Stockton. "European countries have already been using this technology for some time

as a method to reduce greenhouse gas emissions. Continued use of this technology could have a significant impact on transportation construction projects in the San Joaquin Valley where air quality is very poor."

"We are very pleased with the successful results of this project," said Gordon McKay, Stockton deputy public works director for operations and maintenance, in a press release. "This is the first time we have tried warm-mix asphalt in Stockton. It is a next-generation technology that produces durable roads while significantly reducing the environmental impact of construction on our community, something that we are striving to do as part of Mayor Chavez's commitment to the U.S. Mayors Climate Protection Agreement of 2005."

"With the sensitivity to greenhouse gases and other harmful emissions," said Telfer's Ho, "one can argue that working with hydrocarbon material at reduced temperatures makes a positive change to environment impact. With the reduction of fuel consumption and the subsequent reduction of harmful emissions, warm mix technology is a giant step forward for the future. I envision the day in the future when all asphalt pavements will be constructed using warm mix technology." ■

**Specialty
MWV Chemicals**

Asphalt Innovations
Phone: 800.458.4034 or 843.740.2236
Email: evotherm@meadwestvaco.com
www.evotherm.com



Chilly temperatures and fog localized along the Pacific Coast saps warmth from asphalt mix.