EAPA
European Asphalt Pavement Association

The use of Warm Mix Asphalt

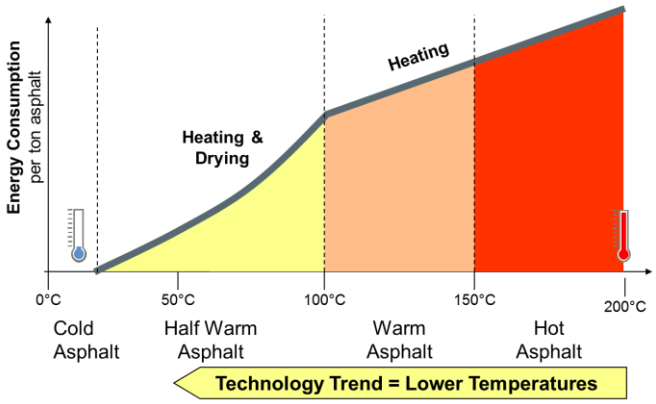
EAPA – Position Paper - 2015

Introduction

Since the mid-1990s a range of techniques has been developed to reduce the mixing and laying temperatures and energy of manufacture of Hot Mix Asphalt (HMA).

This paper focuses on Warm Mix Asphalt (WMA) technologies for producing asphalt at temperatures slightly above 100 °C with properties or performance equivalent to that of conventional HMA.

A typical WMA is applied at a temperature around 20 - 40 °C lower than an equivalent Hot Mix Asphalt. Less energy is involved and, during the paving operations, the temperature in the mix is lower, resulting in lower emissions, lower exposure and improved working conditions for the crew.
This lower exposure supports the goal of the European asphalt industry to reduce bitumen fumes during paving operations.



Techniques available

Warm-Mix Asphalt (WMA) technologies operate above 100 °C, so the amount of water remaining in the mix is very small. Various techniques are used to reduce the effective viscosity of the binder enabling full coating and subsequent compactability at lower temperatures.

The most common techniques are:

- Organic additives, usually waxes or fatty amides; can be added either to the mixture or to the bitumen giving a temperature reduction of between 20 – 40°C.
- Chemical additives, working as surfactants, may reduce the mix and compaction temperatures by about 20 - 40°C.
- Foaming techniques; the two techniques that are commonly used for foaming are the use of injection foaming nozzles and the use minerals containing water. With the injection foaming nozzles small amounts of water are introduced into the hot bitumen. The water turns to steam, increases the volume of the bitumen and reduces its viscosity for a short period. The use of a mineral as the source of foaming water can be seen as an indirect foaming technique. A second indirect foaming technique uses the moisture on the sand (or RAP) to generate naturally created foam. These techniques can enable a temperature reduction of the asphalt mix of about 20 to 40°C.

Next to the above mentioned techniques there are also combined products that can be used to produce Warm Mix Asphalt, like pallets with fibres and zeolite or fibres with organic additives.

As one can see the gain in temperature reduction is between 20 to 40°C (more or less) independent from the technique used. One has to keep in mind that this gain also depends on the paving grade of the bitumen used.

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Performance of WMA mixes

There is a history of use of WMA going back over more than fifteen years, from the early sites in Germany and Norway. Several test sections have been built in Europe afterwards.

In 2007 laboratory and short-term field performance data from some of the oldest WMA pavements in Europe were collected by the U.S. WMA Scan Team. Based on the data collected by the scan team, performance of WMA mixes appears to be the same as or better than the performance of conventional HMA [1.].

Also in the USA many test sections with WMA have been built. Based on the performance of these various test sections built in the USA it can be concluded that the rutting performance of WMA has been observed to be good [2.].

In the USA also a variety of WMA technologies have been tested under heavy loading conditions in Accelerated Pavement Testing (APT) facilities primarily to evaluate rutting performance. Most of the WMA test sections performed similarly to companion HMA sections. Each of the facilities has reported that compaction of the test sections was aided by the WMA technologies considering the much lower placement temperatures used in the construction of the WMA sections. The NCAT Test Track experiments also demonstrated that WMA mixes provide similar structural response to HMA under traffic and seasonal climate changes. The University of California's Pavement Research Center's Heavy Vehicle Simulator (UCPRS HVS) testing also demonstrated that the WMA mixes were not susceptible to moisture damage under saturated conditions [3.].

There are believed to be several reasons for this good performance. In particular, as a result of improved workability, a higher compacted density can be achieved. This higher density reduces the long-term in-service hardening of the bitumen and also prevents ingress of water.

Lower production temperatures can also decrease the ageing of the bitumen during the production stage which can additionally improve the thermal and fatigue cracking resistance of the asphalt.

Workability improvements also have the potential to extend the construction season and the time available for placement of the asphalt mixture during any given day.

In [4.] a review of field trials of WMA technologies conducted in various countries in the world is presented, with the emphasis on performance differences between WMA and conventional HMA.

Numerous studies have been carried out in Europe and show that the same mechanical performance / the same mechanical properties can be obtained compared with the traditional hot mixes whatever the process used is.

France: All techniques to decrease the mixing temperature are used in France and the different studies performed show that the technical specifications (mechanical performances of the asphalt concrete) are achieved whatever the process used [5.].

Norway: in 2010 the Asphalt Producer Association in Norway (FAV) initiated a new project called Low Temperature Asphalt "LTA-2011" to study the consequence for the asphalt workers' health and the asphalt quality, by doing 11 trial sections with 6 different technics. The production temperature was decreased by 30 °C. On each site also a reference section with ordinary HMA was established. The conclusions of that study [6. and 7.] were:

- No significantly differences in the work load for the workers
- A reduction of 50 % of the fumes
- No differences in quality for WMA versus HMA pavement regarding air voids, evenness and rutting.

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Benefits of WMA

Asphalt workers benefits

The lower mixing and paving temperatures minimise fume and odour emissions and create cooler working conditions for the asphalt workers.

Environmental benefits

Because of the lower production temperature of WMA less fuel is needed to heat the aggregate. This results in lower emissions of the asphalt plant. The actual reductions depend on the temperature reduction itself and a number of other factors.

In recent study in the USA [3.] where they monitored fuel usage for six projects consisting of the production of six HMA control mixtures and eleven WMA mixtures, they measured that decreasing the mix production temperature by an average of 27°C resulted in an average burner fuel savings of 22 percent.
The reductions in carbon dioxide emissions measured at asphalt plant stacks were directly proportional to reductions in fuel usage. These data were consistent with results reported in other studies. However, other emissions, such as carbon monoxide and volatile organic compounds depended more on fuel type and burner tuning than the use of WMA.

Manufacturing and paving benefits

The use of Warm Mix Asphalt has several advantages, not only for the asphalt mix itself but also for the paving operations:

- Lower asphalt temperatures results in less hardening of the bitumen/binder during manufacture
- Lower production temperatures reduce the thermal stress on the plant components.
- WMA is fully compatible with the use of Reclaimed Asphalt.

Paving operations benefits

The use of Warm Mix Asphalt improves the handling characteristics of asphalt and creates a more comfortable (working) environment for the asphalt workers and the public near work sites:

- For some technologies like foam, WMA can be compacted at a lower temperature than conventional HMA for an equivalent degree of compaction.
- Alternatively, producing WMA at HMA temperatures will permit an extended time for haulage and compaction. Therefore more distant sites can be served from each plant with the same degree of workability, or the period of workability to achieve the same degree of compaction is extended. Or, a higher degree of compaction can be achieved at the same (HMA) temperature. This can additionally extend the laying season into colder months and/or night working.
- WMA can be used in deep patches where the site is restricted. As the lower temperature WMA starts with less heat it will therefore cool faster to ambient temperatures. Therefore, the site can be opened for traffic at an earlier stage.

The way European asphalt standards allow the use of WMA

The European Standards for “Bituminous mixtures” (EN 13108-1 to -7) do not preclude the use of Warm Mix Asphalt. They include maximum temperatures for particular mixtures, but there are no minimum temperatures. The minimum temperature of the asphalt mix at delivery is declared by the manufacturer. The standards also contain provisions for dealing with mixtures containing additives, subject to demonstration of equivalent performance.

Thus, European Standards should not be seen as a barrier to the introduction of WMA.

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Consequences for the asphalt plants when producing WMA

Mixing asphalt at lower temperatures affects the whole production process. The consequences for the asphalt plants when producing WMA are described in [5.].

Summary and recommendations

Studies have showed that the performance characteristics of WMA mixes can be at least equivalent to conventional mixes. This can be achieved because of the often better workability and hence better compaction which can be achieved.
The lower production temperature also reduces the ageing of the bitumen during the production stage, which results in an improved thermal and fatigue cracking resistance.

WMA techniques can be used for most types of asphalt mixtures, including mixtures traditionally produced at elevated temperatures such as EME2 and Mastic Asphalt as well as asphalt mixtures with polymer modified bitumen.

In the future the Carbon Footprint / environmental aspects will become more important and the use of WMA may prove to be one of the ways to achieve a lower Carbon Footprint. A good and easy to use LCA-tool to calculate environmental effects will be beneficial during the tendering process.

Last but not least, including WMA technologies in local and national specifications will stimulate the industry to provide society with state-of-the-art solutions regarding ecological issues.

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