WARM MIX ASPHALT

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),

Warm Mix Asphalt (WMA) is applied at a temperature around 20 - 40 °C lower than an equivalent Hot Mix Asphalt. Less energy is consumed in the manufacture of WMA and due to the lower mix temperature there are significant benefits for the paving operations and improved working conditions for the crew.

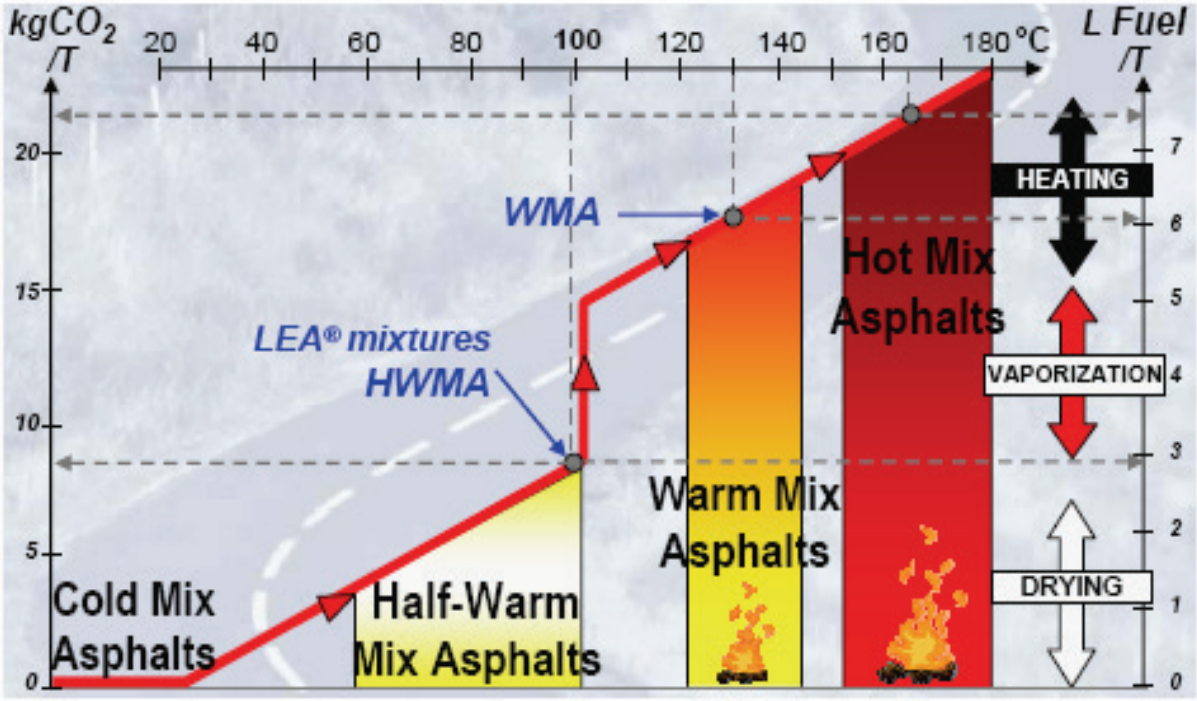

Figure 1: Classification by temperature range (Temperatures and fuel usage are approximations)

Figure 1 shows how WMA fits into the full range of techniques from cold mix through to hot mix

WMA PRODUCTION

Warm-Mix Asphalt (WMA) technologies operate above 120^{o}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 aggregate coating and adequate compaction at lower temperatures.

The most common techniques are:

- Organic additives
- Chemical additives
- Foaming techniques

Organic additives to the mix or to the bitumen

Different organic additives can be used to lower the viscosity of the binder at temperatures above about 90°C. The type of additive must be selected carefully so that its melting point is higher than the expected in-service temperatures (otherwise permanent deformation may occur) and to minimize embrittlement of the asphalt at low temperatures. The organic additives, usually waxes or fatty amides, can be added either to the mixture or to the binder.

A commonly used additive is a special paraffin wax produced by conversion of natural gas. Additives may reduce the mix and compaction temperatures by about 20 - 30°C whilst also improving the deformation resistance of the asphalt.

Chemical additives

Chemical additives do not change the binder viscosity. As surfactants they work at the microscopic interface of the aggregates and the bitumen. They regulate and reduce the frictional forces at that interface at a range of temperatures, typically between 140 and 85°C. It is therefore possible to mix the bitumen and aggregates and to compact the mixture at a lower temperatures.

Foaming techniques

A range of foaming techniques can be applied to reduce the viscosity of the binder. Various means are employed to introduce small amounts of water into the hot binder. The water turns to steam, increases the volume of the binder and reduces its viscosity for a short period until the material has cooled. The foam then collapses and the binder behaves as a normal binder.

The amount of expansion depends on a number of factors, including the amount of water added and the temperature of the binder.

Two techniques are commonly used for foaming:

• Injection foaming
• Hydrophilic minerals

The direct method of foaming is to inject a small controlled amount of water to hot bitumen via a foaming nozzle. This results in a large but temporary increase in the effective volume of the binder which facilitates coating at lower temperatures. Some vapour remains in the binder during compaction reducing effective viscosity and facilitating compaction. On cooling the binder reverts to normal, as the amount of water is insignificant.

The “Two phase process” is a method where a soft grade of bitumen is used to initially coat the aggregate, then the filler is added. After this, foamed hard bitumen is added and mixed resulting in a warm mixture of an intermediate binder grade.

An indirect foaming technique uses a mineral as the source of foaming water. Hydrophilic minerals from the zeolite family are commonly used. Zeolite is a crystalline hydrated aluminium silicate that contains about 20 percent of crystalline water, which is released above 100 deg C. This release of water creates a controlled foaming effect, which can provide an improved workability for a 6 to 7 hour period, or until the temperature drops below 100 °C.

In this instance the foaming results in an improved workability of the mix which can subsequently allow a decrease in the mix temperature by approximately 30°C with equivalent compaction performance.

BENEFITS OF WMA

The use of Warm Mix Asphalt at lower mixing and laying temperatures will result in reduced emissions. There are also positive effects on the working environment during production and paving.

Environmental benefits

Because of the lower production temperature of WMA less fuel is needed to heat the aggregate. This results in lower emissions. The actual reductions vary based on a number of factors.

• The reduction of the production temperature in the WMA processes does lead to significant reductions of stack emissions;
• The reduced fuel and energy usage gives a reduction in the production of green house gases and reduces the CO2 / Carbon footprint;
• The lower mixing and paving temperatures help to minimise fumes, emissions, and odours and a subsequent reduction of workers' potential for exposure to emissions from the plant.

Manufacturing and paving benefits

The use of Warm Mix Asphalt has the following advantages -

• Lower asphalt temperatures results in less hardening of the bitumen/binder during manufacture
• The WMA process will lower the amount of dust extraction because the aggregate is heated to a lower temperature
• WMA is fully compatible with the use of RAP.
• 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 lower mixing and paving temperatures minimises fume and odour emissions and creates cooler working conditions for the asphalt workers. As a rule of thumb, the release of fume is reduced by around 50% for each 10degC reduction in temperature.
• This reduction in emissions of fume and odour also minimises inconvenience to the public near work sites.

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.

AUSTROADS / AAPA WARM MIX VALIDATION PROJECT

As an industry we recognise the importance of always seeking new ways to make even better roads. AAPA industry and government members have undertaken a major project to validate warm mix asphalt for Australia.

The site selected for the Validation Project was a highly trafficked three-lane section of the Hume Highway in northern Melbourne, with traffic volumes between 6500 and 8500 vehicles per day on each lane.

The decision to use a wearing course on a multiple lane urban highway with heavy traffic was made to ensure the project would demonstrate the field performance of WMA in a very difficult environment.

The validation project was a collaborative effort involving AAPA, VicRoads, ARRB and three major asphalt producers, Boral Asphalt, Downer EDI Works and Fulton Hogan. Initial and ongoing testing for the project was undertaken in the asphalt producers' laboratories and monitored by VicRoads and ARRB personnel.

The Project required placing 21 different WMA and hot mix wearing course sections of asphalt in a grid pattern on the section of the roadway. The work was undertaken in April 2010. To ensure consistency in placement one company undertook all the placement

Two foamed WMA processes and two additive WMA processes were used to produce the WMA materials. Some WMA materials were made with new aggregates and others with differing proportions of reclaimed asphalt pavement (RAP), up to 50% RAP.

The structural (strength) and function (roughness, rutting, texture) performance of the validation sites after almost two years of trafficking was excellent, with no discernible difference between the WMA and HMA 'control' sections and no discernible difference between the various WMA mixes, including mixes containing additives, those incorporating various percentages of RAP and those manufactured using a foaming process.

The results of the Validation Project will be published as part of Austroads Project TT1454: The Performance of Warm Mix Asphalt Pavements.

Each State Road Authority has now included the option to use WMA. It is recommended that reference should be made to the standard specifications of the relevant jurisdiction for the use of WMA.

REFERENCES

Austroads (2012) Field Validation of Warm Mix Asphalt Pavements. Austroads, Sydney

EAPA (2010) Use of Warm Mix Asphalt Position Paper. European Asphalt Pavement Association. Brussels, January 2010.