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EuLA Position paper on the use of hydrated lime in warm-mix asphalt

ABSTRACT

Hydrated lime is a known additive for Hot Mix Asphalt (HMA) but its use in the context of Warm Mix Asphalts (WMA) is not so well described in the technical literature.

In this paper, the use of hydrated lime in WMA has been reviewed. Most WMA technologies have already been shown to be improved thanks to hydrated lime addition. WMA technologies making use of surfactants need to be checked in a mix design study in order to assess their compatibility with hydrated lime. If the surfactant acts as an adhesion promoter, then substitution by hydrated lime would probably be equally efficient. If the surfactant acts as a lubricant, then there is a risk of surfactant overconsumption due to adsorption on the lime particles.

1 INTRODUCTION

Hydrated lime has been known as an additive for asphalt mixtures since their inception [1,2,3].The use of hydrated lime became very popular in the USA in the1970s, partly as a consequence of a general decrease in bitumen quality due to the petroleum crisis of 1973, when moisture and frost damage became some of the most frequent pavement failure modes of the time. Hydrated lime was observed to be the most effective additive [4] to prevent those failures and as a consequence, it is now specified in many States and it is estimated that 10% of the asphalt mixtures produced in the USA now contain hydrated lime [5].

Given its extensive use in the past 40 years in the USA, hydrated lime has been proven to be more than a moisture damage additive [3,6,7,8,9]. Hydrated lime is known to reduce chemical ageing of the bitumen [3,6,7,8]. Furthermore, it stiffens the mastic more than normal mineral filler [3,6,7,8], an effect only observed above room temperature [3], that has an impact on the mechanical properties of the asphalt mixture.

Given that all of the above mixture properties impact the durability of asphalt mixtures, the use of hydrated lime has a strong influence on the durability of asphalt mixtures:

- North American State Agencies estimate that hydrated lime at 1-1.5% in the mixture increases the durability of asphalt mixtures by 2 to 10 years, that is by 20 to 50% [5],
- The French Northern motorway company, Sanef, currently specifies hydrated lime in the wearing courses of its network because they observed that hydrated lime modified asphalt mixtures have a 20-25% longer durability [10].
- Similar observations led the Netherlands to specify hydrated lime in porous asphalt [11], a type of mix that now covers 70% of the highways in the country.

As a result, hydrated lime is being increasingly used in asphalt mixtures in most European countries, in particular Austria, France, the Netherlands, the United Kingdom and Switzerland.

2 HYDRATED LIME AND WARM MIX ASPHALT

Still, the experience with hydrated lime is mostly limited to Hot Mix Asphalt (HMA). Now, with the growing use of Warm Mixes (WMA) [12,13,14], it is interesting to review the use of hydrated lime in combination with warm mix additives and/or processes. In this paper, WMA is used as a generic name for all technologies allowing the manufacturing of asphalt mixtures at temperatures 30°C to 60°C below the usual temperature. In other words, what some people call “semi-warm mixes” or “half-warm mixes” are also included in this definition of WMA.

As a general comment, the effect of hydrated lime on WMA should be similar to that found on HMA. In fact, hydrated lime is known to modify asphalt mixtures essentially through the following mechanisms [15]:

- Bringing calcium ions to the aggregate surface, from which bitumen/aggregate adhesion is improved,
- Neutralizing the acids of the bitumen, from which (i) bitumen/aggregate adhesion is also improved and (ii) bitumen chemical ageing is slowed down,
- Stiffening the binder, due to a higher porosity than that of “normal” mineral fillers.

In principle, all of these mechanisms are also beneficial to WMA and it is therefore not surprising that most WMA technologies, such as foamed bitumen, zeolites or waxes, have already been shown to be improved when hydrated lime is added (Table 1).

Still, hydrated lime has a large surface area (typically 15m^2/g [16]), that is 2 to 10 times larger than the mineral filler already present in the mix [3]. As a consequence, when surfactant is used in a WMA technology, there is a risk of surfactant adsorption on the hydrated lime particles. Depending on the role of the surfactant, two options are then available to the designer:

- If the surfactant is only used as an adhesion promoter, then hydrated lime could be successfully substituted for the surfactant [17]. In addition, hydrated lime would bring additional benefits such as reduced aged-hardening and improved mechanical properties.
- If the surfactant is used as a lubricant, then an additional amount would probably be needed in order to compensate for the adsorption on the hydrated lime particles. Here, it would be wise for the designer to validate at the lab scale whether the surfactant dosage has to be adapted in the presence of hydrated lime (Table 1).

As a result, a summary of the compatibility of existing WMA technologies with hydrated lime is proposed (Table 1). As can be seen, most WMA technologies have already shown to be compatible with hydrated lime.

Type of WMA Technology	Name of WMA Process (Supplier)	Typical Temperature Reduction	Compatibility with Hydrated Lime	Comments
Foamed bitumen	Double Barrel® Green (Astec), Ultrafoam® (Gencor), Aquablack® (Maxam), LEAB® (BAM)	30°C	Yes	HL recommended – Already used in combination with HL on a daily basis in the USA – [18,19,20]
Double coating incl. foamed bitumen	WAM-Foam® (Kolo Veidekke / Shell), Enrobé 3E DM (Colas)	60°C	Yes	HL recommended
Wet aggregate	LEA, EBT, EBE (LEA-CO / Eiffage TP / Fairco)	60°C	Yes	HL recommended – adhesion promoter not necessary if HL is used
Emulsion	Evotherm® ET, Evotherm® DAT (MeadWestVaco / Eurovia)	60°C	To be checked	Risk of surfactant overdosing due to adsorption on the lime particles – Compatibility with HL must be checked in the mix design
Waxes	Sasobit® (Sasol), Asphaltan-B (Remonta),	30°C	Yes	HL recommended - see [14,21]

	Licomont® BS 100 (Clariant), SonneWarmix® (Sonneborn), Enrobé 3E LT (Colas)			
Zeolites	Aspha-Min® (Aspha-Min), Advera® WMA (PQ), Asfalite (Ankerpoort)	30°C	Yes	HL recommended - see [14,21,22,23,24]
Surfactants	Evotherm® 3G (MeadWestVaco), Cecabase® RT (Ceca), CWM (Colas), Rediset® WMX (AkzoNobel)	30°C	To be checked	Risk of surfactant overdosing due to adsorption on the lime particles – Compatibility with HL must be checked in the mix design

Table 1: Compatibility of hydrated lime (HL) with existing WMA technologies.

3 CONCLUSIONS

The use of hydrated lime in WMA has been reviewed. Most WMA technologies have already been shown to be improved thanks to hydrated lime addition.

In principle, all of the functionalities of hydrated lime that have been shown to be beneficial for HMA, should also be beneficial to WMA. It is therefore not surprising that most WMA technologies, such as foamed bitumen, zeolites or waxes, have already been shown to be improved when hydrated lime is added.

Still, WMA technologies making use of surfactants need to be checked in a mix design study in order to assess their compatibility with hydrated lime. If the surfactant acts as an adhesion promoter, then substitution by hydrated lime would probably be equally efficient. If the surfactant acts as a lubricant, then there is a risk of surfactant overconsumption due to adsorption on the lime particles.

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