HYDRATED LIME
A proven additive for durable asphalt pavements

European Lime Association
Association européenne de la Chaux
Europäischer Kalkverband

More than ever, transportation authorities are challenged to :
• get better financial return from their pavement investments,
• minimize the public inconvenience that results from the repair and maintenance of pavements that fail prematurely.
To maximize, or to extend the life of their pavement investments these authorities are looking at reliable and proven solutions.

MAJOR ROAD DISTRESSES

Moisture-induced damage

Moisture-induced damage of pavements occurs when the physical bond strength between the bitumen and the aggregates is weakened by the infiltration of moisture. This results in a wide variety of pavement failure symptoms such as stripping, ravelling, pothole, etc.

Moisture-induced damage

Rutting

Rutting is often defined as the permanent deformation of the asphalt, caused when stresses on the pavement exceed the material's elasticity or ability to recover. High-energy pavement loading situations, such as truck traffic and busy intersections can exacerbate rutting damage.

Rutting

Oxidation and Aging

Asphalt oxidation and aging occurs over time to generate less elastic and even brittle pavements. In particular, polar molecules in the bitumen react with the environment, causing the mix to stiffen and to be less able to recover from loading energy. Cracking and rough riding pavements are only two symptoms seen in aged pavements. As imagined, high-energy pavement loading, which comes from high traffic levels and from truck traffic loading, increases the threat of pavement damage in these weakened, inelastic pavements.

Oxidation cracking

Cracking

As described above, cracking can result from traffic-induced fatigue as the pavement weakens and becomes less elastic over time. However, cracking can also occur from environmental conditioning, such as in low temperatures, or in locations where there are large diurnal temperature swings. These conditions can contribute to cracking because of inelastic pavements, as well as from temperature induced (expansion / contraction) stresses.

Cracking

For more than 50 years, hydrated lime has been proven to be the worldwide reference among asphalt modifiers to mitigate moisture damage.
However, as lime's use has grown, other benefits have been identified and quantified, both in the laboratory and by transportation authorities. As a result, lime is now regarded as a multi-functional asphalt modifier.

LIME ACTS AS A MULTI-FUNCTIONAL ASPHALT MODIFIER TO EXTEND PAVEMENT LIFE

When hydrated lime is added to asphalt, it reacts with the aggregate, strengthening the bond between the bitumen and the stone. Additionally, hydrated lime reacts with highly polar molecules in the bitumen, blocking the formation of water-soluble soaps. These soaps result in weaker bond strength, and thus contribute to moisture damage. Instead, lime promotes the formation of insoluble calcium-based salts that do not attract water into the system.

Indirect Tensile Strength (©BRRC)

Unlike most mineral fillers, hydrated lime is chemically active rather than inert. When lime is dispersed throughout the mix, it reacts with the bitumen, removing undesirable components while making the asphalt mix stiffer and tougher at higher temperatures. This results in an asphalt mix that is more resistant to rutting and fatigue cracking. The addition of hydrated lime, however, will not cause the mix to become more brittle at lower temperatures. At low temperatures the hydrated lime becomes less chemically active and behaves as an inert mineral filler.

Wheel Tracking Test (©BRRC)

Hydrated lime reduces the rate of asphalt pavement aging by slowing the oxidation of many types of bitumen. This is because lime reacts with the highly polar molecules in the bitumen, slowing the rate of change of bitumen chemistry. Consequently, the pavement remains more flexible over time, and is protected from brittle cracking for years longer than it would without the contribution of lime.

Rotating Cylinder Ageing Test (©BRRC)

As pavements age, cracking often begins with the formation of micro-cracks, which in turn, coalesce to form pavement-damaging macro-cracks. Hydrated lime particles are able to intercept and deflect these micro-cracks as they begin to form. Additionally, as a chemically active filler, lime reduces cracking more than inactive fillers are able. This is explained because lime reacts with elements within the bitumen, forming larger particles that are better able to intercept and deflect micro-cracks, preventing them from growing together into larger cracks, which contribute to pavement failure.

Thermal Stress Restrained Specimen Test (©BRRC)

METHODS OF ADDING HYDRATED LIME TO ASPHALT

Hydrated lime can be added to hot mix asphalt by several methods. The most commonly used methods of addition are as follows:

Drum addition method

Worldwide, hydrated lime is primarily added in its pure dry form, but can also be mixed with fine limestone to produce an active filler (mixed filler). Depending on the HMA production technology used, lime is either added to the drum along with mineral fillers, or is blended with other fines in batch processing.

Dry lime on damp aggregate method

This method involves metering lime onto a cold feed belt. Typically, the lime adheres to slightly surface-wetted aggregate.

Lime Slurry method

This method utilizes a lime slurry, a mixture of lime and water, that is applied to the aggregate at a metered rate. This method insures a superior coverage of lime on the stone surface. After the slurry is applied, the aggregate can either be fed directly into the plant or can be marinated in stockpile for a period of time, which allows the lime to react with impurities (such as clay) on the surface of the aggregate.

SPECIFYING HYDRATED LIME IN ASPHALT

Hydrated lime has been used for many decades in the USA where lime is currently added to approximately 50 million tons of asphalt pavement per year. In some regions, lime addition is compulsory. In the USA, researchers and transportation authorities have concluded that lime extends pavement life by up to 38%. [1]

In Europe, hydrated lime has also been used for many years. New research is establishing that lime creates multiple benefits for both hot, warm and cold asphalt mixtures, as well as for cold in-situ recycling. The addition of hydrated lime prevents premature failures and enhances pavement life. [2],[3],[4],[5],[6]

Hydrated lime is **defined** according to:
***EN 459**: Building lime*

Hydrated lime can be **specified**:
- As an additive according to:
***EN 13108**: Bituminous mixtures – Material specifications*

- As a mixed filler according to:
***EN 13043**: Aggregates for bituminous mixtures and surface treatments for roads, airfields and other trafficked areas*

Following years of research, some European countries have made the use of hydrated lime in asphalt mixtures compulsory in their national regulations for their local and national roads and highways.

[1] *Sebaaly, P.E., Hitti, E., and Weitzel, D. "Effectiveness of lime in Hot-Mix Asphalt Pavements," Journal of the Transportation Research Board, N° 1832, TRB, National Research Council, Washington, D.C., 2003, pp. 34-41.*

[2] *Schneider, M.; Schellenber, K.; Ritter, H.-J.; Schiffner, H.-M."Improvement of asphalt properties by addition of Hydrated Lime" – field test/mixing (AiF-No. 12542N), Report-No. 2/02, Research Foundation for Lime and Mortar, Cologne*

[3] *P.C. Hopman, A. Vanelstraete, A. Verhasselt "Active filler as asphalt modifier", AIPCR/PIARC, Use of modified bituminous binders, special bitumens and bitumen with additives in road pavements, March 1999, P. 199*

[4] *S.Vansteenkiste, J.De Visscher, F.Vervaecke, A.Vanelstraete and R.Reynaert,'Validation of the indirect tensile strength ratio (ITSR) as a performance indicator for water sensitivity of asphalt pavements', Proceedings of the 4th Eurasphalt & Eurobitume Congress, Copenhagen, 21-23 May 2008.*

[5] *Dallas N. Little, Didier Lesueur and Jon Epps. " Effect of hydrated lime on the rheology, fracture and aging of bitumes and on the performance of asphalt mixtures", AIPCR/PIARC, Use of modified bituminous binders, special bitumens and bitumen with additives in road pavements, March 1999, P. 200*

[6] *Jaskula P., Judycki J., " Evaluation of effectiveness of hydrated lime additive in protecting asphalt concrete against water and frost", The 6th International Conference, Environmental Engineering, Vilnius, May 26-27,2005, s.5.*

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EuLA aisbl (European Lime Association)
Rue des Deux Eglises 26 - B-1000 Brussels
Tel. +32 2 210 44 10 - Fax +32 2 210 44 29
info@eula.be - www.eula.be