Low Emission\(^2\) Asphalt Pavement, LE2AP

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Introduction

BAM, the largest contractor of the Netherlands, aspires to play a leading role in product innovation and sustainability. On basis of her visions on the Dutch asphalt paving industry R&D efforts focus on three pillars, noise reduction, sustainability and maintaining undisrupted traffic flow. In addition BAM analysed the development of the Dutch road network. The network development started in the mid 1950’s. Asphalt production grew to a maximum in the mid 1970’s, see Figure 1. Hereafter network development progressed at declining rate and asphalt production figures reached a minimum in the mid 1980’s. Hereafter asphalt production increased again. This increase resulted from network maintenance and was coupled with an increase in the availability of reclaimed asphalt pavement, RAP.

Figure 1. Asphalt production in The Netherlands and the availability of reclaimed asphalt, RAP.

LE2AP is an acronym for Low Emission Asphalt Pavement, with the 2 indicating that both the emission of noise and of pollutants are considered. The end goal of the LE2AP is to produce and install a surface layer produced at 80°C, comprising 30% reclaimed material and having an initial noise reduction of ≥ 7 dB. LE2AP thus aims at a new, more sustainable recycling process which combines higher recycling rates, reduced production temperatures and emissions and increased quality. Because of the latter this process allows for recycling of surface layers such as noise reducing porous asphalt. PA. With this LE2AP meets with the vision of BAM and the stage of life of the Dutch network. The feasibility of LE2AP is proven by the installation of 600 m\(^2\) of LE2AP PA comprising 93% reclaimed material and produced at 100°C.

The LE2AP recycling process in a nut-shell

1. RAP (Reclaimed asphalt Pavement) is decomposed into its components: a bitumen rich mortar sand <2 mm and various stone fractions containing ≤15% of bitumen.
2. The reclaimed mortar sand is heated, brought to specification and homogenized.
3. The reclaimed mortar is foamed and mixed with warm reclaimed stone to obtain a mixture with an extremely high percentage of recyclying, high quality due to full control over mixture composition and quality of ingredients and produced at reduced temperature.
4. The obtained mixture is used in standard road building equipment.

Decomposition of RAP

RAP is subjected to impact generating mechanical stresses at high frequencies. At such conditions mortar behaves brittle so that the mortar film is shattered of the stones. By sawing, the shattered mortar is separated from the stone so obtaining mortar sand <2 mm and reclaimed stone in various fractions. The installation to decompose RAP is fully operational and uses electricity as a power source. The process does not require heat or chemicals, is purely mechanical and thus energy efficient.

Figure 2. Decomposed RAP. Mortar sand (left) and stone in various fractions (right).

Heating and treating the reclaimed mortar

Reclaimed mortar sand is heated to approximately 170°C. While heating the mortar it is brought to specification by adding soft bitumen and/or rejuvenator. The rates of application of rejuvenator and soft bitumen are determined by use of a mortar design method. This method controls both the content and the quality of bitumen in the obtained LE2AP mortar. During the whole process the mortar is stirred and homogenised. The mortar is never in contact with a flame. Also contact with air is limited. This guarantees that aging, or worse, burning of bitumen is prevented resulting in increased quality and reduced emissions.

Mortar and mixture quality

The quality of an asphalt mixture is determined by the quality of used ingredients, the mix composition and may be affected by the method of production. Elaborate testing was done to ensure that LE2AP mixtures at least equal their hot produced equivalents comprising only fresh commodities in terms of quality. These tests indicate that the response behaviour of LE2AP mortar equals that of fresh mortar. However, LE2AP mortar has better aging resistance and better after aging fatigue properties.

Figure 3. Elaborate mortar testing by use of a Dynamic shear Rheometer, DSR, indicated that recycled LE2AP mortar (coloured lines) out performs its equivalent produced using fresh commodities (black lines).

Tests done on a LE2AP Porous Asphal containing 93% reclaimed material, i.e. a combination of LE2AP mortar and reclaimed stone, indicate that the LE2AP mixture at least equals its hot produced equivalent containing no recycling in terms of consistency (ITS), water susceptibility (ITSB) and ravelling performance (AIR).

Mortar Foaming

BAM developed a method for the production of asphalt at reduced temperatures (<100°C) without alteration of the mixture recipe. Bitumen foaming plays a key role in this process called LEAP. Using the experience with bitumen foaming a mortar production and foaming laboratory unit was designed and build. After some start up problems the machine performed flawlessly and proved that LE2AP mortar can well be foamed. At optimum machine settings an expansion ratio of >50 was reached. The foamed mortar has a half life of 250 sec and a temperature of 135°C.

Figure 4. Laboratory mortar production and foaming unit placed over laboratory asphalt mixer (left). LE2AP mortar fed into an asphalt plant via a makeshift side entrance (right).

LE2AP PA mixtures comprising 93% reclaimed material were produced. For these mixtures the foamed LE2AP mortar was mixed with reclaimed stone having a temperature of 120, 100 and 80°C. The tests indicated that the workability of the 80°C mixture was too low leading to compaction problems and thus reduction of mix performance. It was concluded that without alteration of mix recipe it is not feasible to produce a LE2AP mixture at 80°C. As mixture recipe alterations are outside the scope of LE2AP and the philosophy of BAM, it was accepted that LE2AP mixtures cannot be produced at 80°C as anticipated at the start of the project. The mixtures produced at 120 and 100°C were perfectly workable.

600 m\(^2\)

In a full scale 600 m\(^2\) test section the previous work was combined on industrial scale. The LE2AP mortar was produced by makeshift equipment and fed into an asphalt plant via a side entrance. Figure 4. The mortar was fed to the mixer of the plant and foamed just before entering the mixer. Here it was mixed with warm reclaimed stone so obtaining a mixture of 100-110°C comprising 93% reclaimed material. The mixture was installed using normal equipment without difficulty and complied with all thinkable demands. Later this year LE2AP PA will be installed on a 1000 m road section as the final step in the LE2AP project.

Conclusions

It is feasible to decompose RAP into its components: mortar sand and stone in various fractions. The reclaimed mortar can separately be heated, treated and homogenized. This implies that it no longer passes through a dryer drum which reduces bitumen aging, or worse, burning of bitumen. This reduces emissions and increases mixture quality. The hot (170°C) mortar can be foamed and mixed with warm (100-105°C) reclaimed stone according to recipe. The obtained mixture may be installed by use of standard equipment. The described production process provides full control over the quality of used ingredients and mixture composition. This allows for the application of reclaimed material at high rates (>95%) without loss of quality and thus for the recycling of surface layers such as noise reducing Porous Asphal. By use of mortar foaming these mixtures can be produced at reduced temperaturas (100-110°C).

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The ability to effectively identify and address environmental challenges in the construction industry is critical for continued growth and sustainability. Our company, LE2AP, is dedicated to advancing this field through innovative solutions and technology. We are committed to reducing the environmental impact of our operations and promoting sustainable practices throughout the construction process. By focusing on efficient material use, lower emissions, and optimized production methods, we are able to create a more environmentally friendly and sustainable future. Through our innovative solutions, we strive to create a positive impact on the industry and the planet, ensuring the well-being of future generations.

Our team of experts is dedicated to pushing the boundaries of what is possible in the field of construction. We believe that by working together, we can achieve incredible results that benefit both the environment and our communities. We are proud to be a leader in the industry, and we look forward to continuing our work in the years to come.