RAP TAKES CENTRE STAGE

Virgin asphalt could become a rare commodity if research into recycled asphalt by Dutch global infrastructure group BAM is any indication. Rien Huurman* explains

Intensive road network development in the Netherlands started during the years following the Second World War. The rate of network expansion was at its peak in the 1970's and so was asphalt production.

Today the network is expanding but at a lower rate. Growth this time is accompanied by an increase in the availability of reclaimed asphalt pavement – RAP. Also, the Dutch road network is in more of a phase of maintenance now than network expansion.

Asphalt must be produced in a more environmentally friendly way. BAM concludes:

- emission of the greenhouse gas CO_2 accompanied with the production of asphalt should be reduced dramatically;
- asphalt roads should be as quiet as possible to limit noise pollution;
- as the Dutch network is in a maintenance phase, asphalt should be produced in a circular manner, especially surface layers which have a service life two to four times shorter than that of binder and base layers;
- emissions of pollutants such as CxHy (Hydrocarbons) and CO (Carbon Monoxide) should be decreased radically.

MAKE THE LE2AP

LE2AP is acronym for Low Emission Asphalt Pavement, the '2' indicating that both the emission of noise and pollutants are considered.

LE2AP is an entirely new approach towards asphalt recycling. The first step is to decompose - separate - milled asphalt into its components, such as bitumen (filler) dust and sand and aggregates of various sizes.

The second step is to heat, treat, enrich and homogenise the reclaimed mortar so that the obtained LE2AP mortar has the same composition and performance as its equivalent produced using virgin commodities.

The third step is to combine the reclaimed ingredients into a new mixture. By foaming the LE2AP mortar this new mixture may be produced at a lower temperature.

Finally, the mixture should be installed using standard road building equipment.

The advantages of this approach are many. Decomposition of asphalt allows full control over the composition of new asphalt produced with reclaimed material, even at extremely high rates of recycling.

Decomposition separates the mortar in milled asphalt. By adding fresh bitumen and rejuvenator the reclaimed mortar may form the basis of a new mortar. The quality of this new mortar is controlled and can be checked by laboratory testing. It may be homogenised through constant agitation which also prevents development of a layered system in which fresh bitumen sits on top of old bitumen.

Reclaimed mortar is heated in a separate process and no longer in contact with flame and air as in the case of conventional recycling. This limits emissions and reduces loss of bitumen quality due to overheating – short-term ageing or even bitumen burning.

Because the mortar is separately available, the use of foaming techniques becomes feasible. As a result, asphalt production temperature can be lowered from around 170°C to between 100-110°C. This significantly reduces both energy use and the amount of emissions.

The suggested procedure provides control over both mixture composition and ingredient quality. It allows the possibility of recycling even higher quality mixtures such as noise reducing porous asphalt at high rates and at lower temperature.

The above suggestions were acknowledged by the European Commission in the form of a €1.3 million grant under the LIFE+ programme, a funding instrument for the environment and climate action. The general objective of LIFE is to co-finance projects that help implement, update and develop European Union environmental and climate policy and legislation. BAM invested an equal amount in the LE2AP project which should end in the production and installation of 1km of dual-lane noise-reducing asphalt.

TOP: *Surface layer paving of the N279 in Noord-Brabant province*
BELOW: *N279 compacting first-pass surface layer*

PERFORMANCE DATA

	Target set in LIFE+ grant application	Reached value
Noise reduction relative to AC16 surf	≥7 dB(A)	8.4 dB(a)
Percentage of reuse	≥80%	82-92%
Production temperature	≤80°C	100-110°C
CO emissions relative to standard production method	-35%	-72%
CO_2 emissions relative to standard prod uction method	-35%	-51%
NO_x emissions relative to standard production method	-50%	-85%
SO_2 emissions relative to standard production method	-30%	-64%
Odour/CxHy emissions relative to standard production method	-80%	-77%
Energy use relative to standard production method	-35%	-51%

Paving the surface layer of the N338 in the province of Gelderland

SHATTERING EXPERIENCE

Milled asphalt is decomposed by first literally throwing it against a steel wall. This generates conditions - high frequency loading - at which the mortar shows brittle, glass-like behaviour. Because of this, it shatters off the stones. The turmoil of stones hitting each other results in abrasive action that acts to further separate mortar from aggregates.

A second step takes the resulting mix it of mortar and aggregates and separates is further by means of sieving. The obtained mortar sand is heated, homogenised and enriched with soft bitumen and/or rejuvenator. A dynamic shear rheometer, DRS, tested the mechanical properties, including response, fatigue and ageing susceptibility, of the obtained LE2AP mortar. On the basis of these results, a system for mortar production was developed.

MIXING IT UP

Laboratory scale production of mortar, mortar foaming and mixture production was evaluated. The quality of obtained mixture comprising up to 93% reclaimed material was evaluated on basis of various tests. The ITSR test (NEN-EN 12697-12) was used to determine water sensitivity, an indication of mixture durability.

Ravelling resistance was evaluated by means of the ARTe (Aachener Raveling Tester, CEN/TS 12697-50). Skid resistance of surface layers, after polishing by the ARTe test, was determined by means of the Skid Resistance Tester T (NEN-EN 1436+A1). Results obtained for the mixture comprising 93% of reclaimed material were compared to results obtained for similar types of porous asphalt produced with fresh commodities. It was found that the mixture comprising 93% reclaimed material was at least equivalent to mixtures produced on the basis of fresh commodities at 165-170°C. It was also shown that mortar may be successfully foamed.

In the autumn of 2015, a 600m² trial section of PA16 comprising 93% reclaimed material was produced and installed at the yard of the asphalt plant of Brabantse Asfalt Centrale in the Dutch town of Helmond.

High-quality mortar was produced from reclaimed mortar sand inside Guss-Asphalt kettles with built-in agitation devices. Using a heated dump cart and a crane, the mortar was fed into the plant via a makeshift side entrance. The mortar was brought to the plant mixer through a heated temporary makeshift heated pipe. Just before entering the mixer it was foamed by a manually controlled high-pressure water injection using makeshift equipment. Within the mixer, the foamed mortar was mixed with reclaimed stone at between 100-110°C.

Production and installation of the 600m² trial section went flawlessly. Elaborate testing during production and on the installed product indicated that quality of the industrially produced mixture was equal to the mixtures produced in the laboratory. It was, therefore, decided to proceed with production and installation of a test section within the public road network.

After consulting acoustic bureau M+P - and taking into account limitations following civil engineering considerations - it was decided to install 2-layer PA consisting of 25mm PA 5/8 top-layer on a 55mm bottom layer of PA 8/16. Two provinces showed an interest in having test sections: Noord-Brabant along its N279 route and Gelderland along its N338.

Both layers of the top layer PA consisted of reclaimed stone. Automated industrial facilities for the production and application of mortar on the basis of reclaimed mortar sand are not yet available.

This implies that the production of asphalt with reclaimed mortar can be done using only makeshift equipment and at a low production rate as was done for the 600m² trial section. For this reason, it was decided to apply reclaimed mortar in only the bottom-layer over a 250m stretch of Gelderland's N338.

In October/November 2016 a total of 2.3km dual-lane noise-reducing 2-layer PA was produced and installed on both the N279 and the N338. The recycling rate in the test sections varied from 82% for the top and bottom layers produced with fresh mortar to 92% for the bottom layer produced with reclaimed mortar. The asphalt was produced at 100+°C. On both test sections the temperature behind the screed was around 105°C.

RESULTS

Results are relative to the production of PA with 80% RAP at 165-170°C (see performance data). Such PA is not produced in practise because its quality is far too low for application on the network.

BAM is further pushing the envelope with respect to circular asphalt production at lowered temperatures. Stone that is reclaimed from milled PA is certified as a building material and thus not considered as RAP. This opens the way to apply these stones in various mixtures.

Investments in a fully automated mortar production system are not yet feasible. Such investment can be done only when an increase in market share would follow. Because purchasing departments in public road authorities are always searching for multiple suppliers, this means that an increase in market share will, in the Dutch system, never follow innovation.

Fortunately, BAM's LEAB system allows for production of asphalt at between 100-110°C by means of (fresh) bitumen foaming. The combination of BAM's low-energy asphalt (LEAB) and LE2AP thus makes it possible to produce mixtures with elevated levels of recycling at lower temperature. In a controlled and gradual manner BAM is installing various surface layers produced at lowered temperature and comprising high levels of reclaimed material.

These surfaces are being monitored to collect performance data that the Netherlands will require in the near future as the country moves towards a more circular and energy-neutral way of asphalt production. ■

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