INFLUENCE OF HYDRATED LIME ON THE FIELD PERFORMANCE OF SMA10 MIXTURES CONTAINING POLYMER MODIFIED BINDER

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Introduction

The application of hydrated lime in order to improve the overall durability of asphalt mixtures is well known for already a long time, especially in the USA. In Europe, its use is at present less common practice, although the benefits of hydrated lime as an active filler material have been reported in several countries such as France or the Netherlands. It is generally accepted that the positive effects of hydrated lime on the performance of asphalt mixtures are mainly related to an improvement of water sensitivity, rutting resistance and reduction of the negative impact of ageing of bitumen.

A large amount of data as discussed in the literature demonstrating the positive effect of hydrated lime is based on studies carried out in the laboratory. In only few reports experience with hydrated lime in the field has been described, especially over a long period. Moreover, experimental evidence of the impact of hydrated lime in combination with the use of a PmB on the field performance of an asphalt pavement is rather scarce. Therefore, a comparative study was initiated which focused on demonstrating the impact of the addition of hydrated lime on the durability of a number of SMA10 variants in the field.

In order to access the performance in the field of the SMA10 variants and their evolution with time, the construction of test sections on a public road was set up. In a first step of the study, prior to the construction of the test sections, a limited number of laboratory tests were conducted to ensure a sufficient workability of the SMA10 variants including the use of hydrated lime. In a second phase, a series of tests were conducted during and shortly after the construction of the field test sections. Latter testing involved both the follow up of the compaction in situ as well as a series of performance tests carried out in the laboratory including the assessment of the workability, the water sensitivity, the resistance to rutting and finally the resistance to ravelling or scuffing.

Test sections in Heppignies

In particular, the test sections were integrated in the construction of a new road of about 2 km long at Heppignies (N568a) in order to facilitate the access to the local airport of Charleroi (Brussels South). The construction of this new road was during the spring of 2013 in a final phase. The two base courses of AC20 were already realized before the winter 2012-2013. In 2013 only the construction of the SMA10 surface layer was planned before the summer holidays.

The test program was conducted on four variants of a SMA10 mixture as summarized. Overview of the SMA10 test sections :

- Section 1: SMA10 : PmB 45/80-50 - 152.5 m
- Section 2 : SMA10 : PmB 45/80-50 + 1.5% $Ca(OH)_2$ - 145.0 m
- Section 3 : SMA10 : B50/70 + 1.5% $Ca(OH)_2$ - 127.5 m
- Section 4 : SMA10 : B50/70 (reference) – approx. 1,500 m

Tab 1. Characteristics of bituminous binders

Bitumen	Pen (0.1 mm) according to EN 1426	R&B (°C) according to EN1427
Paving grade B50/70	61	48.4
PmB 45/80-50	77	58.4

Laboratory tests prior to field trials

No significant effect of the addition of hydrated lime on the compactibility of the SMA10 variants could be demonstrated. All air voids percentages at 120 gyrations are in line with the initial type testing results of the reference mixture (SMA10 while using a paving grade B50/70 bitumen) and comply to the tender specifications in the Walloon Region (Qualiroutes, 2011).

Tab 2. Test results on the gyratory specimens (compacted to 120 gyrations)

SMA10 variant	Air voids (geometric) %	Bulk density (hydrostatic) g/cm³	Maximum density g/cm³	Air voids (hydrostatic) %
Section 1	8.9 ± 0.4	2.333 ± 0.011	2.437	4.3 ± 0.5
Section 2	8.5 ± 0.3	2.334 ± 0.006	2.430	4.0 ± 0.2
Section 3	8.4 ± 0.5	2.342 ± 0.005	2.430	3.6 ± 0.2

Laboratory tests during the construction

The field compaction was monitored by using a γ-nuclear density gauge (Troxler Model 3450). As all relative densities in the field exceed 97%, the field compaction can be considered as very good for all sections. In order to maximize the risk in terms of water sensitivity, cores were always taken at the location characterized by the lowest relative compaction degree (= highest air voids content) for each section.

Laboratory tests shortly after the construction

COMPATIBILITY : The compactibility of the SMA10 mixtures was determined while using NBN EN 12697-31. In order to obtain additional information (the gyratory compactor only provides the evolution of the geometrical bulk density) with respect to the void content both the bulk and the maximum density were measured by hydrostatic weighing according to NBN EN 12697-6 procedure B and NBN EN 12697-5. The test was carried out while making use of the bulk mixtures sampled at the asphalt plant from the trucks departing to the corresponding test sections. Bulk samples were reheated to the appropriate temperature prior to carrying out the gyratory compaction tests: SMA10 variants containing PmB's were compacted at 160 ± 5°C while the SMA10 variants containing a paving grade bitumen were compacted at 150 ± 5°C.

RUTTING RESISTANCE : The resistance to rutting was assessed by the wheel tracking test according to NBN EN 12697-22 while using the large size device. The tests were performed at a temperature of 50°C and up to 30,000 cycles (standard test conditions in Belgium). Test specimens were obtained from the road by coring specimens of 400 cm2 (∅ 220 mm) the day following construction.

WATER SENSITIVITY : The water sensitivity of SMA10 asphalt mixtures was evaluated by indirect tensile strength (ITS) measurements carried out before and after conditioning in water, using the test method NBN EN 12697-12 in combination with NBN EN 12697-23. The indirect tensile tests were performed at 15°C as required in NBN EN 13108-20 (type testing of bituminous mixtures). Routinely, the air void content of the test specimens was calculated according to NBN EN 12697-8 following the determination of the maximum density according to NBN EN 12697-5. The test was conducted on cylindrical test specimens (∅ 100 mm) obtained by coring in the field (carried out by the contractor) the day following the construction.

RESISTANCE TO RAVELLING : Field experience shows that aggregate loss at the surface or ravelling is a frequently observed damage phenomenon of asphalt mixtures with a stony skeleton. Porous Asphalt is highly sensitive, but SMA may also be sensitive in case of high void contents or poor adhesion between the bitumen and aggregate. The ravelling due to traffic induced shear forces (also called "scuffing" forces) was probed for while using a procedure based on a new European draft Test Specification (TS) prCEN/TS 12697-50 'Resistance to Scuffing' as developed recently by the task group CEN TC227 WG1/TG2 "Test methods for bituminous mixtures". The fabrication of the slabs was carried out by roller compaction according to NBN EN 12697-33. Therefore, bulk samples were reheated to the appropriate temperature prior to carrying out the roller compaction: SMA10 variants containing PmB's were compacted at 160 ± 5°C while the SMA10 variants containing a paving grade binder were compacted at 150 ± 5°C.

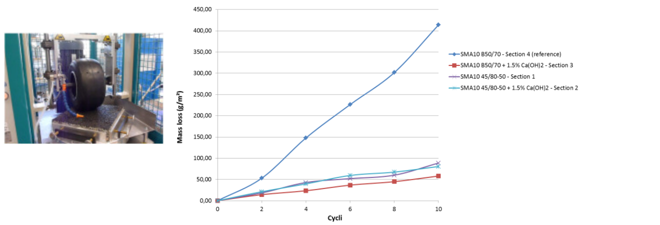

Figure 1. Experimental set-up of the 'Darmstadt Scuffing Device' (DSD) equipment at BRRC, and comparative results of the scuffing tests conducted at 40°C

Conclusions

The objective of the test program was to gain as much as possible experience from the field. Based on the results acquired, the following conclusions can be drawn:

- The compactibility of SMA10 variants as probed by gyratory compaction test in the laboratory prior to the construction indicated a good workability of all mixtures. No negative effect of the use of hydrated lime was demonstrated also in combination with the application of a PmB binder. A similar observation was made while using bulk materials sampled at the asphalt production plant during the construction of the test sections.
- The in situ measurement of the compaction by use of the γ-nuclear gauge confirmed the very good compaction in the field for sections. Generally, the uniformity of the compaction within each test section can be considered as high. Surprisingly, the reference section which did not include a polymer modified binder nor hydrated lime was characterized by the largest variability
- Performance testing following the construction of the test sections showed that all SMA10 variants were characterized by a very low water sensitivity and a good resistance to rutting.
- The results of scuffing tests showed a positive effect of the use of hydrated lime on the resistance to ravelling in case of the B50/70 binder, especially when the test was conducted at higher temperature (e.g. 40°C).

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