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THREE YEARS OF EXPERIENCE WITH THE BELGIAN TEST SECTION OF TWO-LAYER POROUS ASPHALT

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Abstract

In 2000 a 500 m test section of two-layer porous asphalt has been constructed on a secondary road in the village of Bambois, Belgium, which is the only section of this road type constructed in this country so far. The top layer has been replaced in 2002, due to excessive ravelling. There have been carried out a number of “initial” tests since the renewal of the top layer in 2002, like the resistance to ravelling, the composition of the asphalt mix and the evenness. Moreover, an intensive follow up program has since then been carried out, and some tests have been repeated periodically after the initial test. The development of the visual damage, skidding resistance, texture, noise, sound absorption, density and drainability has been determined. The behaviour of the section under winter conditions has also been observed, as well as the effect of a cleaning of the surface. In the present contribution, an overview of the behavior during these 3 years of experience of the acoustic and - in brief - also of some relevant non acoustic parameters will be given. One found an evolution of the noisiness of the experimental section, which will be explained by means of the results of the texture and the absorption measurement data.

INTRODUCTION

Porous asphalt has numerous advantages: it is on average more silent than dense asphalt, it prevents splash and spray and glare under rainy conditions, and it is quite resistant to rutting due to its stony skeleton and so on. Unfortunately, the classic single layer porous asphalt shows also some disadvantages: the pores tend to clog as it becomes older, it is sensitive to ravelling reducing its lifetime and it is more difficult to keep ice- and or snowfree under winter conditions. These disadvantages made Belgian regional authorities – which are responsible for the major roads – abandon more or less the option of the porous asphalt. This policy is deplored by

some specialists, who think that porous asphalt does have interesting perspectives and that disadvantages may be overcome.
Two-layer porous asphalt (TLPA), developed in the beginning of the 1990ties in the Netherlands [1], was in the first place meant to further optimize the acoustic properties of the porous asphalt, but it is also believed to reduce the negative aspects of single layer porous asphalt. It is believed to clog less quickly than the single layer version.
As there has been no experience at all with this type of road surface in Belgium so far, the Walloon road administration decided to construct a test track with a length of 500 m on a secondary road (N988, between km 19,257 and 19,755) in the rural community Bambois between Fosses-la-Ville and Saint-Gérard (Figure 1) [2].

Figure 1 – Location of and view on Belgian test section for two-layer porous asphalt in Bambois

The ADT is quite low, with about 2100 vehicles/day with 3 % of heavy vehicles. The first version was constructed in 2000, but was already severely ravelled by the spring of 2002. The Walloon road administration decided to restart the project in collaboration with the Belgian Road Research Centre and the ravelled top layer of the TLPA was ground away. The under layer was subsequently cleaned and a new top layer was applied. The evolution of the test section during the following three years was monitored by means of an extensive measurement campaign. This paper reports about the evolution of the acoustic properties TLPA and also briefly about some other aspects that have been studied: ravelling (visual inspection), skidding resistance and winter behaviour. The influence of a single cleaning of the surface has also been studied.

CONSTRUCTION SPECIFICATIONS

The new top layer constructed in 2002 has a 4/7 grading and was placed on the "old" 0/14 sub layer, which was cleaned after the grinding as aforesaid. The mixture for the new top layer was slightly modified in order to achieve a better resistance to ravelling: the binder and filler contents were slightly higher and a softer binder type was used. Immediately after the construction of the new top layer, 10 cores were taken, from which the void contents and the layer thicknesses have been determined. The thickness of the layers was on average 29,8 mm for the top layer and 37,6 mm for the sub layer, the total thickness of the two layers is hence on average 67,4 mm. The average void content of the porous layers was determined to be 27 %.

ACOUSTIC PROPERTIES

Global Noisiness

The development of the noisiness of the TLPA section has been followed up by means of six SPB measurements complying with ISO 11819-1 each time on exactly the same location between August 2002 and November 2005. The track in the direction to Fosses-la-Ville was monitored at km 19,327 and the microphone location was on the other side of the road. As the number of heavy vehicles was by far lower than the number prescribed by the standard within a reasonable time interval, only cars were taken into account.
The development of noise level L_{veh} for cars at 80 km/h is shown in Figure 1.

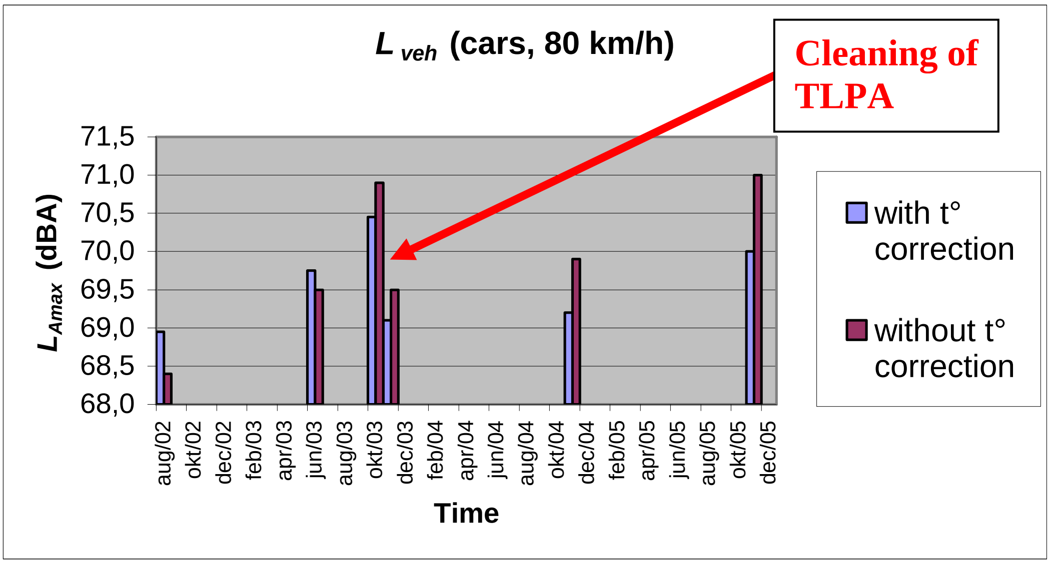

Figure 2 – Development of noisiness of TLPA section between August 2002 and November 2005

At every noise measurement also the air temperature was measured. The L_{veh} values, corrected for the temperature influence according to -0,05 dB(A)/°C is also indicated. One sees a gradual increase of the noisiness with about 1 dB(A)/year.
The drop of the noisiness between the two consecutive measurements in November 2003 is noticeable. The improvement of about 1,5 dB(A) is due to a cleaning of the surface which took place between the two measurements.

Some reference measurements were carried out on adjacent sections in dense asphalt concrete (DAC) in a worn condition and on a gap-graded thin layer in fairly new condition. The results of these measurements were respectively 78 dB(A) and between 74,5 and 76 dB(A). The initial noisiness of the TLPA is hence about 6 dB(A) quieter than the gap-graded thin layer. In order to explain the gradual decline of the acoustic performance, also texture and sound absorption measurements were carried out.

Sound Absorption

Three times cores of 100 cm² each have been taken from the TLPA road surface: in September 2002, in September 2003 and in October 2004. The second and the third time, the core locations were chosen at 1 m longitudinally from the previous location. The second and the third time, only six cores have been taken: four in the wheel tracks and one in the middle of the driving lane in the direction of Fosses-la-Ville and one in the other lane. Absorption measurements have been carried out by the Catholic University of Leuven on the cores with a Kundt's tube complying with the procedure prescribed in ISO 10534-2. The most relevant features are the height, width and location of the first absorption peak. Ideally, this peak should be as high and wide as possible and should reach its maximum between 500 and 1000 Hz.
Figure 3 shows the development of the absorption curves at one core location (n° 1, which is in the wheel track on the lane in the direction of Fosses-la-Ville). Within this two years time period, one sees only a slight decrease of the height of the first absorption peak. The fact that the absorption characteristics are quite well preserved at this core location, is most probably due to the cleaning effect by the wheels of the cars during rainy weather.

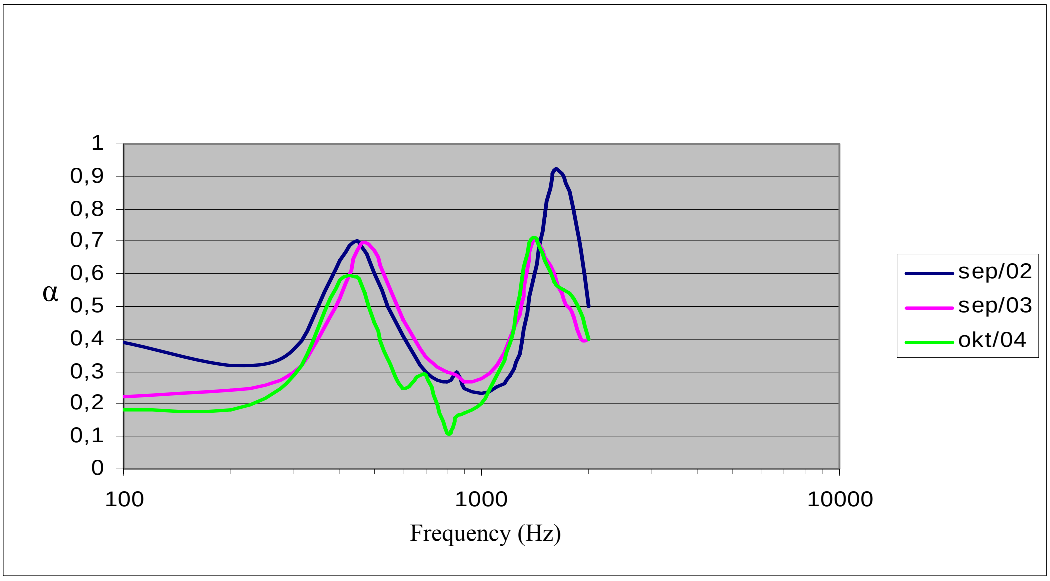

Figure 3 – Absorption curves at core location 1 between September 2002 and October 2004

When one looks at the development of the absorption curve at the core location between the wheel tracks, one gets a different picture (Figure 4).

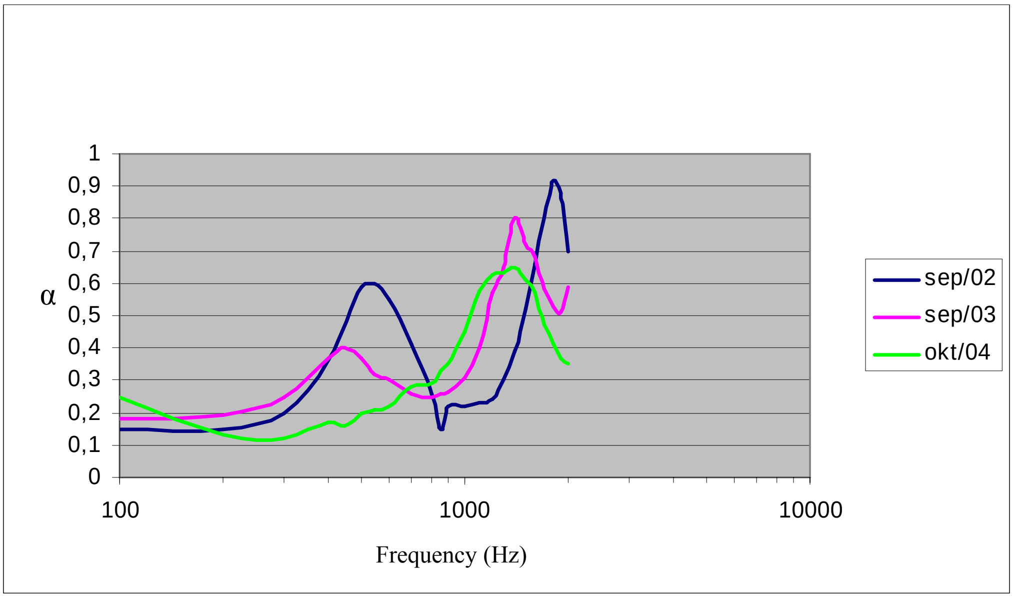

Figure 4 – Absorption curves measured at core location 5 between September 2002 and October 2004

The first absorption peak, which is clearly present in September 2005, is one year later reduced in height by about 30 %. One more year later, it has completely disappeared. This quick clogging of the pores is most probably due to the lack of cleaning effect by the traffic between the wheel tracks.

Texture

Changes in texture may dramatically change the acoustic properties of a road surface (e.g. by the appearance of megatexture due to ravelling). Therefore, texture measurements have been carried out three times between September 2002 and May 2005 by means of the BRRC laser profilometer.
At each measurement campaign, fifty 502mm-long profiles have been measured in the right wheel track with a sampling interval of 0,5 mm.
From each profile, the texture spectrum has been calculated. The average texture spectra for the three measurement campaigns are shown in Figure 5. The measurements and the processing of the profile comply with the ISO 13473 standards.

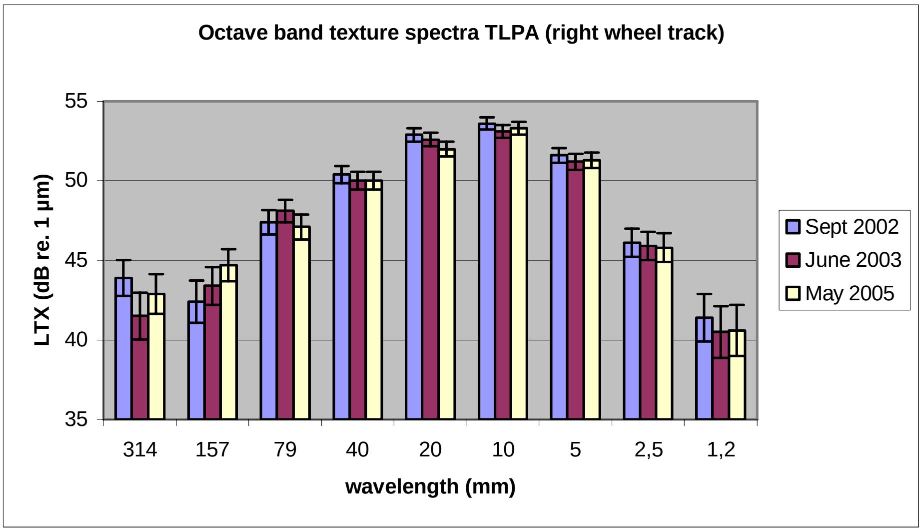

Figure 5 – Average texture profile spectra wiht uncertainty ranges.

The figure shows that there is no significant development of the texture, which is in agreement with the observation that there is no important ravelling (see below). the increase in noise can hence not be due to texture effects.

SOME OTHER MONITORED ASPECTS

Visual Inspections

Between October 2002 and May 2005, seven visual inspections were conducted along both lanes of the test track, i.e. twice a year: once just before and once immediately after winter period. Each ravelling spot was noted. These ravelling spots were typically round (between 2 and 10 cm in diameter) or elongated (between 10 or 20 cm long). A steep increase of the number of ravelling spots in November 2003 was observed. This is due to the cleaning, which has obviously caused some damage. Only one lane (towards Fosses-la-Ville) was cleaned. To avoid further deterioration, it was decided not to repeat the cleaning procedure. Other causes of ravelling were reported namely horse shoe marks and the chemical action of smashed animal bodies. However, one should keep in mind that the ravelling is still very limited and affects less than 0,02 % of the total area after 3 years.

Draining capacity

Between June 2002 and May 2005, nine campaigns were conducted to measure the draining capacity of the TLPA by means of an “outflowmeter” (see Figure 6).

Figure 6 – Outflowmeter consisting of a transparent tube filled with water. The time for the water level in the tube to drop by a given height is a measure for the draining capacity

The initial value was 11 s, which gradually increased up to 32 – 36 s in May 2005, which is still below the limit value of 40 s. It is remarkable that the cleaning action had no significant influence on the draining capacity: the outflow time was 19 s before cleaning and 18 s after.

Skidding Resistance

Skidding resistance was measured several times with the ODOLIOGRAPH and the SCRIM of the Walloon Road Administration. A gradual decrease of the skidding resistance was observed as the section became older (Figure 8), although the values stayed well above of 0,45, which is the minimum required for new road surfaces.

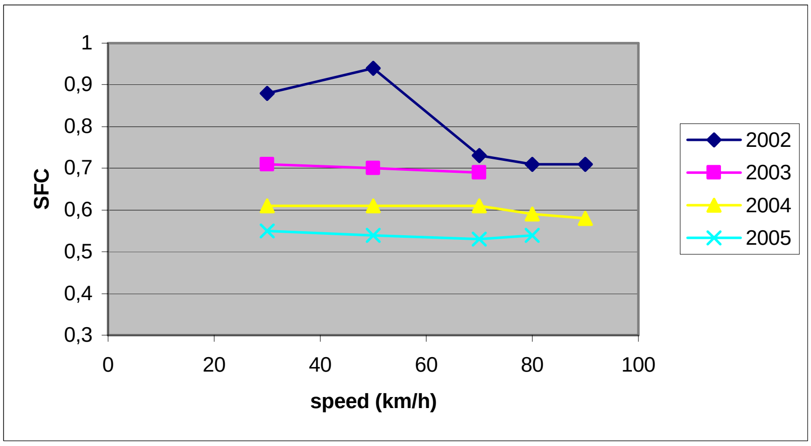

Figure 8 – Sideways Force Coefficient (SFC) measured with the ODOLIOGRAPH as a function of speed and time

Winter behaviour

The section was monitored during three successive winters. Because of its porosity, the TLPA exhibits some differences in behaviour regarding temperature and humidity under some winter conditions. However, one never found a more slippery condition on the TLPA than on the conventional DAC. On the contrary, in certain situations with wet or melting snow, the macrotexture of the TLPA provides a better grip to the car tyres than on the DAC.

CONCLUSIONS

The study of the acoustic properties revealed a gradual decrease of the initially excellent noise reduction (-6 dB(A)) with roughly 1 dB(A)/year, which is due to a decline of the noise absorption, more particularly between the wheel tracks. Cleaning of the surface restores the acoustic properties, but at the expense of some ravelling However, ravelling remained quite limited. No particular safety problems have been observed on the test track. Wet skidding resistance decreases gradually, but is still well above safety limit. Winter behaviour of the TLPA is slightly different, but not worse than of ordinary DAC.

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