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[N1003] Results from the Dutch Noise Innovation Program Road traffic (IPG) and Roads to the Future Program (WnT)

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ABSTRACT

In the Netherlands within the frame of both the Noise innovation program (IPG) and the Roads to the future program (WnT) recently test sections with very silent pavements have been constructed. IPG focuses on the short term and on the most silent roads currently available. No new technique or materials will be used. WnT focuses on the long term and on very silent roads preferably laid with innovative fast construction techniques.

The state-of-the art IPG-two layered porous tests sections should have a reduction of 6 dB(A) after construction and an average of 4 dB(A) noise reduction during the aimed entire life time of eight years. The futuristic 3rd generation silent pavements of WnT claim noise reduction of 6-10 dB(A) directly after construction. The acoustic (CPX, SPB and absorption spectra) and constructive properties (e.g. rutting and raveling resistance) of all the pavements are measured thoroughly directly after construction and during lifetime. In this presentation results of the described measurements will be shown.

KEYWORDS: Silent Roads, Acoustic Performance

INTRODUCTION

In the Netherlands a small dense populated country road traffic noise is an important issue. This resulted in regulations and policy wishes of both the Ministry of Environmental Affairs and the Ministry of Transportation. In response to this documents noise barriers and silent pavements were developed. This resulted in a main motorway network with 500 km noise barriers (7 % of the network), and about 4000 km (60% of the network) of silent porous asphalt. However, as traffic intensity is still increasing, more roads and extra lanes are necessary to fulfil the mobility demands of the Dutch citizens. Consequently, more noise reducing measures are needed. When only the current technology is used an investment of about 2 billion euros during the next years in noise reducing measures is necessary. This dilemma, increased mobility accompanied with huge investments in noise reducing measures, was for the Ministry of Environmental affairs and the Ministry of Transport the reason to initiate the Noise Innovation Program (IPG: innovatie programma geluid). The goal of this program is to implement new cost effective noise measures as soon as possible. Regarding the noise reduction a short term target of 8 dB(A) to be obtained in 2006 is set and a long term target of 12 dB(A) in 2010, both with respect to the Dutch reference Dense Asphalt Concrete. The total investment in noise reducing measures should be about 50%. To achieve the goals of IPG, a high number of project proposals were drawn. These projects can be allocated to five clusters that focus on the use of Silent Roads, Improvement of Tires and Vehicles, Optimisation of Barriers, Knowledge Management and Facilities and Assessment Methods. In total the budget for the noise abatement for road traffic is about 50 million euro. This research budget should lead to reduction of 50% of the investments in noise reducing measures, i.e. 1 billion euro.

The current paper deals with research in the field of advanced silent pavement types within the frame of IPG. For the pavement cluster the short term target is an initial reduction of 6 dB(A) of construction and a lifetime averaged reduction of 4 dB(A). For this short term target mainly two layer porous asphalt is studied. The long term goal for the silent road cluster is a lifetime averaged reduction of 6 dB(A). The research for the long term goals will focus on third generation silent pavements, i.e. new innovative ideas like the Road to the Future (WnT) test sections. WnT is the innovation program of the Ministry of transport to challenge the market to propose innovative ideas for the problems in 30 years. During the last three years within the WnT much effort was spent in innovative concepts for noise reduction.

DUTCH SILENT PAVEMENT TYPES

Two layer porous asphalt

Since 1994 test sections of two layer porous asphalt are laid, both on the national main network and on the local network. The top layer consists of an about 15-25 mm thick porous layer with a maximum aggregate size of 6 or 8 mm, a porosity of about 20% and polymer modified bitumen is used. The lower of the two porous layers is 45 mm thick with a maximum aggregate size of 16 mm, a porosity of about 25%. In the test sections a large scatter in data is found and the durability is often found to be low. From the first sections much is learnt, e.g. construction should only be performed under good climatic conditions. This means that in Netherlands construction is only possible from May until October.

Traditionally two layer porous asphalt is laid in two passes, i.e. one pass per porous layer. Within the IPG-project on five different locations eight contractors will lay their best mixture to obtain a better overview of the performance of state of the art two layer porous asphalt (Zebra test sections). In another project innovative equipment tested to construct two layer porous asphalt in one pass, i.e. both layers are laid at the same moment. This technique, which in Germany is already used for construction with thin top layers, in potential will lead to better performing two layer porous asphalt.

Experimental Road to the Future test sections

The very silent sound module

The design concerns a functionally and physically modular system. The sound-reducing functional modules contain Helmholtz resonators. The road surface on top of these is made of a thin porous top layer. This single layer of asphalt has optimised surface properties, such as a low sound generation and a high skid resistance direct after construction.

The way of no resound

The design consists of three layers. The two top layers, with a joint thickness of approximately 30 mm, are assembled in the factory as one roll-up layer. The bottom layer or supporting layer consists of concrete elements with a high supporting power, in which cavities are included that function as Helmholtz resonators. Thanks to the prefabrication, a road

surface without any irregularities in the macro-texture is obtained, with as a result that vibrations of the car tyres are kept to a minimum

The Bonding Road

The design consists of a prefab asphalt mat on a roll, which can be bonded to and removed from the substrate fast by means of an innovative on/off-switching bonding system. Prefabrication ensures a constant, high quality of the end product and offers the possibility to produce several variants, according to the performance requirements (sound reduction, life, roughness, etc.). After application on site, the bonding between the asphalt mat and the substrate can be switched 'on and off' by electromagnetic waves, without any physical contact.

Modieslab

Modieslab has been developed as an extremely durable design, resulting in a settling-free road. The relatively high construction costs are offset by an estimated life of 25 years. The top layer consists of an open concrete layer of 15 mm thick on another open concrete layer of 35 to 55 mm thick, in which coarsely broken gravel is used as granular material. The thickness of the lower layer decreases from the right-hand to the left-hand lane. Therefore, sound absorption will match the type of the main traffic in those lanes: at 55 mm the absorption will peak at 600 Hz (heavy goods vehicles), and at 35 mm at 1000 Hz (private cars).

Quiet Transport

The road surface is based on porous asphalt with a very silent top layer. In the construction a special layer is present to absorb engine noise. Hence, this pavement is a combination of reduction of both truck engine noise and reduction of tyre road noise. This make it is suitable for lanes with a high number of heavy vehicles, i.e. right lanes and special lanes for heavy vehicles.

Tapis tolerance

This a construction with a number of integrated new ideas, i.e. a soft top layer, a perforated compression layer, an absorption layer of honeycomb profiles in mineral wool. This is a

complete new road concept and due to the high number of noise reducing elements the expected noise reducing potential is very high. After optimisation a reduction of more than 10 dB(A) could be possible.

MONITORING

The two layer porous asphalt, both laid in the IPG-program and those laid outside the IPG-project, and the Road to the Future sections are tested on their acoustical and structural behaviour (see table 1).

Table 1 Measured road surface properties within the IPG-monitoring scheme

property	method
noise reduction	SPB-method (at a height 5 meters), CPX-method
acoustic absorption	alfa in-situ method
skid resistance	braking deceleration, wet skid resistance, dry skid resistance
ravelling resistance	visual inspection
transverse evenness (rutting)	Automatic Road Analyzer (ARAN)
longitudinal evenness	Automatic Road Analyzer (ARAN)
texture	Laser profilometer
water permeability	falling head method (Becker apparatus)
air permeability	air drainometer

FIRST RESULTS

Pre-IPG sections

Acoustic performance of two layer porous asphalt was determined at several sections as a function of life time. At this moment only regular sections, which were constructed before the IPG-program started, have sufficient long life to determine the acoustic performance as a function of lifetime. Consequently for some sections only a limited number of data is available. From the measured SPB-values for light vehicles at 80 km/h (figure 1) it can be concluded that initial noise reductions of 4 to 6 dB(A) can be obtained. It should be noted that the test sections with relative poor noise reduction, i.e. less than about 4.7 dB(A), were constructed under unfavourable climatic conditions. For most sections an extra of about 0.5

dB(A) is obtained at a half year after construction. After four years the noise reduction is less than the initial value. Now the reduction varies between 1.8 and 5.3 dB(A). The decrease of reduction is mainly due to ravelling and clogging of the pores. Although much less results available, the CPX-method give similar results.

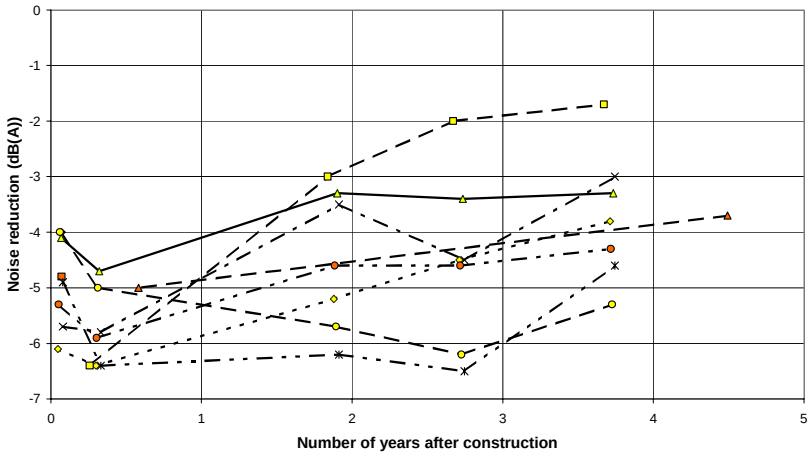

Figure 1: *Noise reduction levels for light vehicles at 80 km/h on regular pre-IPG two-layer porous asphalt sections Noise reduction levels for light vehicles at 100 km/h on. As reference a fresh Dutch dense asphalt concrete is chosen (74.8dB(A)at 100 km/h)[3].*

Unfortunately, the best noise reducing two-layer porous asphalt types have a poor structural performance. For instance two sections, with a good noise reduction and a good ravelling resistance, after four years suffer of a poor skid resistance [4]. This indicates that until now no two-layer porous asphalt section exists with both sufficient acoustic and sufficient structural performance. IPG should make clear whether the state-of-the-art test sections laid at the Zebra test sections have both good acoustic and good structural performance.

IPG test sections

The first SPB-measurements performed at the Zebra and the warm-in-warm sections (figure 2) indicate that for light vehicles at 100 km/h initial noise reduction levels vary between about 4.5 and 7 dB(A).

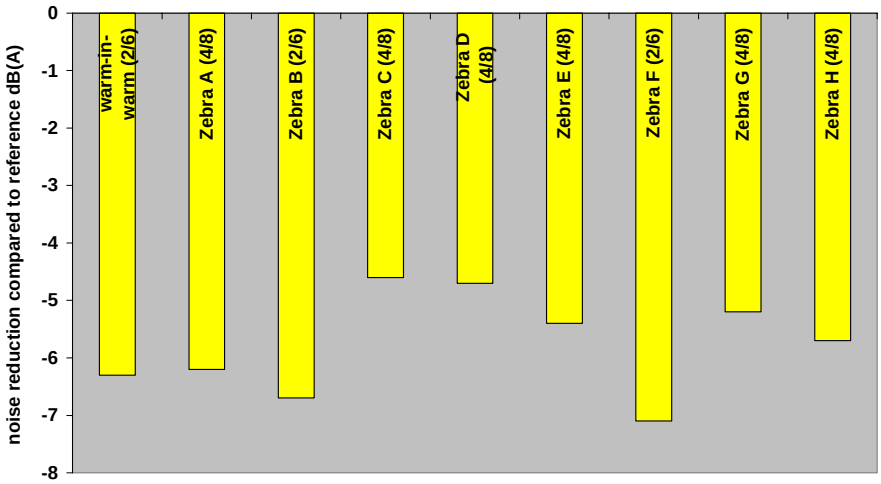

Figure 2: *Noise reduction levels for light vehicles at 100 km/h on both Zebra and warm-in-warm two layer porous asphalt sections as measured by the SPB-method (numbers between brackets indicate the used aggregate grade). As reference a fresh Dutch dense asphalt concrete is chosen (78.0 dB(A at 100 km/h)) [3].*

Roads to the Future test sections

The first SPB-measurements of the Roads to the Future sections (table 2) indicate that for light vehicles at 100 km/h initial noise reduction levels vary between 5 and 7 dB(A). This is lower than the claimed reductions that in some cases even exceeded 10 dB(A). However, as it concerns prototypes of new pavements, after optimisation much higher reduction levels could be possible.

Table 2: *Noise reduction levels for light vehicles at 100 km/h on Roads to the future section as measure by the SPB-method. As reference a fresh Dutch dense asphalt concrete is chosen (78.0 dB(A)at 100 km/h)[3].*

Name	Noise reduction (dB(A))
Very Silent Noise Module	5
The rollable Road	6
ModieSlab	6-7
The adhesive road	6
Quiet transport	6-7*
Tapis Tolerance	7-8*

*. CPB-measurements.

2003 AND BEYOND

In this paper only the first measurements within the IPG program are reported. The measured initial noise reduction levels are in the range of the aimed level. However, only limited information is present about both acoustic and structural lifetime. Construction of four more Zebra test sections and determination of acoustic and structural performance during the next four years is absolutely necessary to draw reliable conclusions. Next to this some specific properties of two-layer porous asphalt, like clogging, winter maintenance and skid resistance direct after construction, will be studied in more detail.

Finally, research towards improvement of non-porous asphalt and third generation noise reducing silent roads will be initiated. For the non-porous layers much knowledge is available outside the Netherlands. The IPG is eager to use this knowledge and cooperate with international partners who have experience in this field. The available results of the tests on third generation road surfaces within the Roads to the Future program will be evaluated thoroughly. Useful concepts will be selected for further investigation. This should lead to at least one test section on the Dutch main road network.

REFERENCES

1. R. Smaak, policy dilemma's of a central government about noise abatement, in proceedings of Euronoise 2003, paper ss05-2144, to be published.
2. E. Vos, Noise Innovation Program – Road Traffic, DWW report number 2002-073, Road and Hydraulic Engineering Institute, Ministry of Transport, Public Works and Water Management, 2002.
3. Pavement corrected on acoustic properties, CROW-publication 133, Ede (Netherlands), 1999 (in Dutch).
4. J. Fafié, Two layer porous asphalt test sections in Nistelrode, part 3 measurements 1998-2002, DWW report number IR-N-02.014, Road and Hydraulic Engineering Institute, Ministry of Transport, Public Works and Water Management, (2002) (in Dutch).

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