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MOTORWAY NOISE REDUCTION BY COVERING GROOVED CONCRETE WITH OPEN GRADED RUBBERISED ASPHALT

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INTRODUCTION

Noisy road surfaces can be improved at relatively low costs by an open graded covering, using rubberised asphalt as binder.

This has been carried out in 1982 on the Ring motorway at the East of Brussels which was originally realized in grooved cement concrete. Although this road surface already offered several advantages, the tyre/road noise was indeed excessive and especially annoying by a pitch in the frequency spectrum at about 1000 Hz corresponding to the distances between the transverse grooves at the high speeds used by most vehicles on this road.

The new open graded layer has been laid on a stress absorbing membrane interlayer (S.A.M.I.) with 7-10 mm stone chips resulting in 20 % voids. The binder contains 20 % rubber recycled from worn tyres and ensures very good mechanical properties even at temperatures far under 0°C.

As shown on figure 1 this surface is characterized by an excellent water draining so that it stays practically dry in rainy weather, with all the benefits resulting from this, including the suppression of the usual tyre/road noise increase on wet roads.

The acoustical properties of this new surface have been measured by several experts in Belgium and it is the object of the present paper to give a synthesis of their findings.

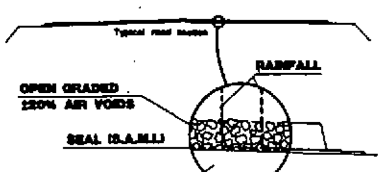

Figure 1

ACOUSTICAL ABSORPTION

The acoustical absorption factor for normal incidence has been measured by the Acoustics and Heat Conduction Laboratory of the University Leuven on two samples of the new surface, on one sample of grooved cement concrete and on one of dense graded asphalt. The results are shown on figure 2.

Unlike concrete and dense graded asphalt, for which the absorption factors are low over the whole frequency range, the open graded asphalt presents a value of about 0,7 at about 1000 Hz and still relatively high values above this frequency.

TYRE/ROAD NOISE COMPARISONS

Tyre/road noise has been measured by a microphone placed close behind the rear wheel at the right side of an Opel Rekord type Caravan of the Study Fund (the engine being in front and the exhaust at the left). The tyres were Vredestein Radial Steel ones. Other measurements were taken at the standard lateral distance of 7,5 m from the axis of the vehicle at 1,20 m above the ground.

The results shown on figure 3 indicate, with reference to dense graded asphalts, a reduction of about 2,5 dB(A) on the open graded and an increase on the grooved concrete ranging from 4 dB(A) at 70 km/h to 5,5 dB(A) at 120 km/h. The rolling noise has also been measured at 7,5 m by the Belgian Road Research Centre with the same vehicle type but with Michelin XZX tyres. The results were slightly different.

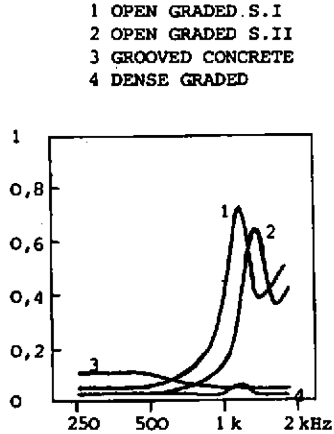

Figure 2

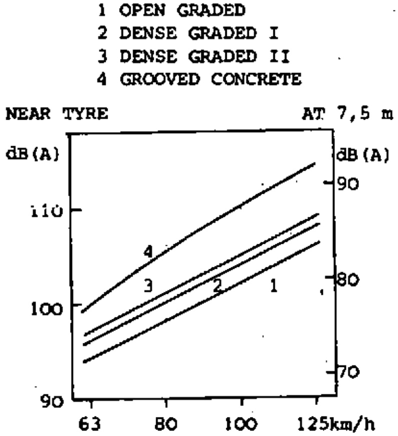

Figure 3

VEHICLE TOTAL NOISE COMPARISONS

Test procedure
The noise of vehicles in real traffic conditions has been measured on late friday nights in order to ensure the presence of isolated cars and trucks. This was performed with the help of Mr J.M.Junger and our both families. Two sound level meters were installed as indicated by figure 4 on both sides of the separation between the grooved cement concrete and the open graded rubberised asphalt at the moment that only a first section of the new layer was completed.

Vehicle speeds
The statistical distribution of the vehicle speeds was

	10th percentile	median	90th percentile
for cars :	80 km/h	115 km/h	140 km/h
for trucks :	70 km/h	85 km/h	105 km/h

Results
On figure 5 the maximum sound pressure levels on the open graded asphalt, L_a, and on the grooved concrete, L_b, are indicated for 60 cars and 10 trucks. They are corrected for a distance of 7,5 m by reducing the levels for the vehicles in the right lane by 4,5 dB(A) (no isolated vehicles passed in the left lane). As shown on this figure a series of measurements have also been executed with a test car, calibrated in speed, indicating that the differences increase with the speeds.

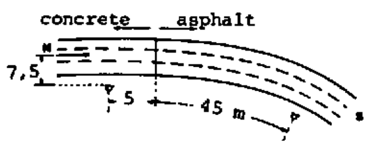

Figure 4

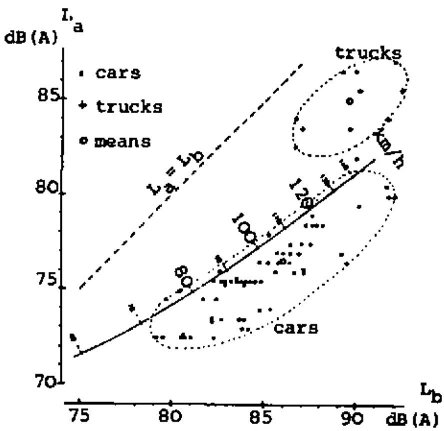

Figure 5

The energetic mean values calculated by : $\bar{L} = 10 \log\left[\frac{1}{n}\Sigma 10^{\frac{L}{10}}\right]$
are also indicated on the figure.

It is interesting to notice that on the open graded asphalt the noise levels are of the same order of magnitude as those obtained during the type-approval tests according to ISO 362, while on the grooved concrete the levels are much higher due to the excessive tyre/road noise.

IMPACT ON THE ENVIRONMENT

Based on the energetic mean values for cars and trucks on the two road surfaces the difference of the equivalent continuous sound levels can be calculated in terms of the percentage trucks in the traffic. This is represented on figure 6.

As a consequence, during the week-ends, when no trucks are present, the covering of the concrete by an open graded layer has resulted in a L_{eq} reduction of nearly 10 dB(A) in the environment. On weekdays, during the working hours, when about 20 % of the traffic is composed by trucks, the L_{eq} reduction is 7 dB(A). This last figure has been confirmed by several measurements executed by the Infrastructure Department of the Belgian Road Administration as well as by the Acoustics and Heat Conduction Laboratory of the University Leuven that even registered the third octave frequency analysis over 20 minute periods as shown on figure 7.

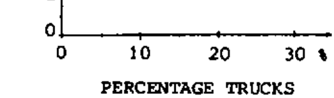

Figure 6

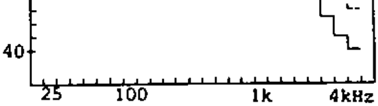

Figure 7