inter.noise 2000
The 29th International Congress and Exhibition on Noise Control Engineering
27-30 August 2000, Nice, FRANCE

I-INCE Classification: 3.5

CONTRIBUTION OF DOUBLE LAYER ASPHALT IN REDUCTION OF URBAN TRAFFIC NOISE

A. Poggi*, D. Casini*, C. Fagotti, S. Secchi***

* A.R.P.A.T. - Regional Agency of the Environmental Protection of Tuscany, Via San Salvi 12, 50135, Florence, Italy

** A.R.P.A.T. - Regional Agency of the Environmental Protection of Tuscany, Via Bastianini 18, 53100, Siena, Italy

Tel.: ++39 055 678309 / Fax: ++39 055 678314 / Email: a.poggi@arpat.toscana.it

Keywords:
NOISE REDUCTION, DOUBLE LAYER, POROUS ASPHALT

ABSTRACT
This paper concerns the use of two double layer asphalts employed in Florence to reduce traffic noise in two different urban streets. In this case, tyre/road interaction is negligible because of the low speed of vehicles. For this reason, it was expected that porous pavements couldn't give a great contribution in the reduction of traffic noise. Measurements have been carried out during two years after the laying down of the new asphalts, taking sound pressure level at the border of the road, together with fluxes of vehicles. A statistical analysis has been implemented on the base of a model that permits to evaluate the actual contribution of the asphalts. Results point out a quite significant reduction of sound levels and long-term durability, even in urban streets with low vehicle speed.

1 - INTRODUCTION
Porous asphalts have been used mainly to improve the security of the streets, by means of their drainage properties. Moreover, the benefit achievable with such products in terms of acoustic gain is well known, but until now tests and controls on their acoustical properties have been carried out for high velocity of the vehicles, as highways or extra-urban roads.
Such studies have underlined that the excitement of tire vibrations by the road roughness and aerodynamic noise, caused by air-pumping, dominate the overall noise.
Otherwise, it seems difficult to extend these results to urban area; in fact, the mechanism of noise generation may be different in this case, as here the speed is generally lower than 50 km/h and queues of vehicles are possible.
The first experiments on the efficacy of porous asphalts laid down in urban area, have been carried out in France, starting from the second half of the eighties. Acoustical gains comparable with those obtained in highways or extra-urban roads, have been measured [1].
These results have been confirmed by more recent experiments carried out in Italy, in an urban street of Modena [2].
Nevertheless, such previous studies, involving single layer porous asphalts, have shown that the acoustical performances decrease in the course of the first year of lifetime. Such short-term durability depends on the clogging of porosity, due to many factors, as dust, oil, materials from tyre deterioration, etc...
Acoustical duration of surfaces is by far the most important problem to optimize costs and benefits, as well as to find real alternative solutions to traditional asphalts.
Short-term durability in terms of drainage and acoustical properties, has led to develop a new generation of pavements, made by two porous layers with different granulometry, that are superimposed. The fine grain of the higher layer works as a filter for dust and deposits which are removed by means of the cleaning effect due to vehicles passages. On the other hand, the coarse grain of the lower layer is projected to drain away rainwater.

Two porous double layer asphalts were laid in Florence, within an experimental project to reduce traffic noise in dense urban areas. Measurements have been aimed to analyse several aspects: 1) the reduction of sound pressure levels in relation to the amount of traffic in the streets, which is the object of the present work; 2) the changing in the propagation of sound [3]; 3) the absorption coefficient of the asphalts [4, 5].

2 - THE STREETS AND THE ASPHALTS UNDER TEST

Both streets present typical features of a city with ancient plant. One of these (A) is located in the centre of Florence. It is approximately 12 m wide and it has buildings on both sides, 18-20 m high. The other street (B) is in a small centre nearby Florence. It is very narrow (6 m in width) and it has low buildings only on one side (Fig. 1).

Figure 1: Street A, on the left; street B, in the two photos, on the right.

The two streets present markedly urban features, as they are characterised by low speeds of vehicles and intense traffic, with different composition of vehicles. One street (A) presents a high percentage of scooters (60%) and an appreciable portion of buses (10%). In the other case (B) cars are predominant in the total traffic flow, while scooters and heavy vehicles are almost negligible. Here speeds are quite low (about 30 km/h) as the street is very narrow and queues are possible.
Both pavements are composed of two draining layers with different granulometry, as shown in Fig. 2.

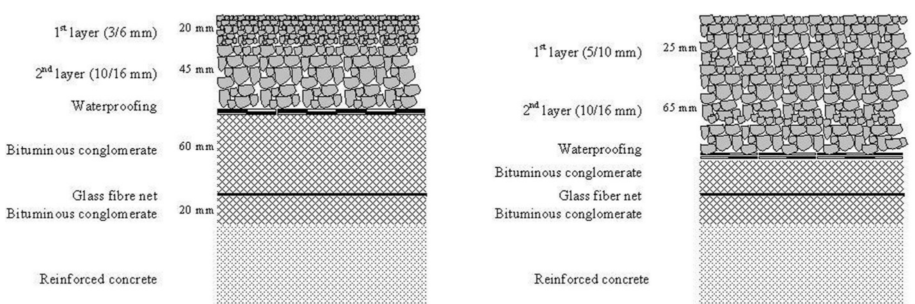

Figure 2: Thickness and granulometry of the two asphalts (A, on the left, and B on the right).

3 - RESULTS

Noise level in urban streets typically shows a large variability, induced by changes in traffic flow. Such fluctuation has almost the same magnitude of the quantities to be evaluated. It means that fluctuations on measurements of a few dBA, do not allow to estimate the variation due to the asphalts, as it is valuable of the same magnitude. To appreciate the contribution of the pavements, it is necessary to evaluate noise

levels in standard conditions of traffic, that it means fixed volume and proportion of vehicles. Therefore, fluxes for each type of vehicle have been measured and correlated with corresponding sound levels, by means of a mathematical model.
A non-linear law has been used, whose unknown parameters have been adjusted to fit measured data. The shape of the chosen function derives from simple physical considerations:

$$L_{Aeq} = A + 10 \cdot \log_{10} (\text{car} + B \cdot \text{scooter} + C \cdot \text{heavy}) \quad (1)$$

Car, scooter and heavy represent fluxes of the corresponding type of vehicles. Heavy is rather a generic class, but, in the two studied streets, it is mainly composed of buses. The other terms, A, B and C are the regression variables. A set of values for them has been computed in each measurement campaign. Fixing the same conditions of noise emission (i.e., the logarithmic argument in Eq. 1) it has been possible to compare homogeneous data, even if relative to different measurement campaigns.
Fig. 3 shows sound levels obtained using this procedure, at each measurement campaign (months are counted from the date in which the asphalts were laid down; such point is marked with 0 in the x-axis).

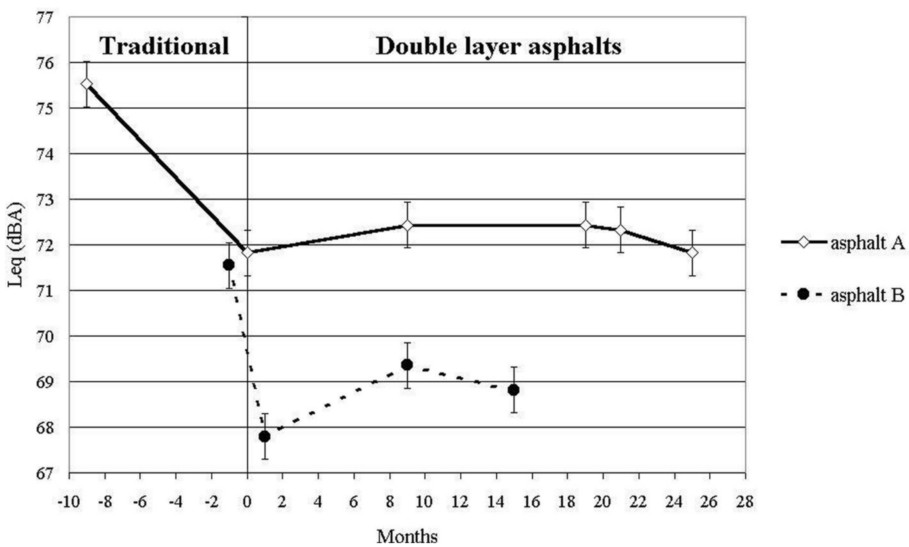

Figure 3: Calculated sound pressure levels vs. months, by means of the correlation procedure.

The error bar that appears in Fig. 3, has been estimated comparing the standard error of the regression with the uncertainty coming from the phonometric measurements of the sound levels. In the latter case, it has been assumed an indicative error of 0.5 dBA, as the same technical devices conforming to the specifications of class 1, have been used all the times. Moreover, the calibration of the instruments has been checked sometimes, by means of a pistonphone of class 0. As the statistic error has resulted less or equal to the uncertainty of the measurements, the error of 0.5 dBA has been attributed also to the noise level computed by the fitted function.
Initially, both asphalts present an acoustic gain of about 3.5 dBA. In the case of A, such value is substantially unchanged after two years. On the other hand, the asphalt B shows a worse trend, during a shorter lifetime. Different performances of the two pavements may be due not only to the granulometry, but also to many factors, such as volume and composition of traffic, as well as other environmental factors.

4 - CONCLUSION

Noise reduction due to a double layer asphalt amounts to approximately 3.5 dBA.
It is generally emphasized the role of porous surfaces in relation to the so called "rolling noise" which is predominant in high velocity context. Nevertheless, our results show that double layer asphalts can reduce traffic noise also when employed in urban streets. Here, speeds of vehicles are generally not so high and the tyre/road interaction is not always the dominant component of the global noise emitted by vehicles.
In one of the streets under test, the large portion of scooters in the total traffic flow, enforces the idea that rolling noise is negligible. As a consequence of these evaluations a different action mechanism must be hypothesised.

Until now long-term durability of porous surfaces has been considered crucial, and not yet proved to be sufficient. Our results point out that double layer porous asphalts maintain acoustic properties for a longer time than a single layer in the same operative conditions. Acoustic duration seems to be comparable with their lifetime.

REFERENCES

1. **Several authors**, Bruit de contact pneumatiques/chaussées, In *Déplacements CETUR*, 1992

2. **D. Bertoni and al.**, *Studio sul comportamento acustico di asfalti particolari in ambiente urbano*, 1996

3. **P. Battini and al.**, Contributo di un asfalto fonoassorbente a doppio strato nella riduzione di rumorosità da traffico: confronto tra dati teorici e sperimentali, In *XXVI Convegno Nazionale AIA*, pp. 543-546, 1998

4. **P. Battini and al.**, Misure del coefficiente di assorbimento di un asfalto fonoassorbente a doppio strato, In *XXVI Convegno Nazionale AIA*, pp. 539-542, 1998

5. **D. Casini and al.**, Measurements of the acoustic absorption coefficient of double layer asphalt; analysis of variability, In *Forum acusticum*, pp. 448, 1999