EUROPEAN CONCRETE PAVING ASSOCIATION

Concrete pavements, for low-noise performance that lasts

Low-noise concrete pavements are the standard today. They contribute to addressing the general issue of environmental noise, as required by the Environmental Noise Directive (END) of the European Union.

Traffic noise has become an important criterion in the design and construction of transport infrastructure. Modern concrete road surfaces are competitive with dense asphalt surfaces in terms of rolling noise. The durability of this low-noise performance is an extra advantage of concrete pavements.

In addition, high skid resistance, which is important for road safety, is guaranteed over the lifetime of the pavement. Concrete is the clear choice for a sustainable pavement when all aspects are considered, including durability, life cycle cost and surface characteristics.

Durably quieter is the goal

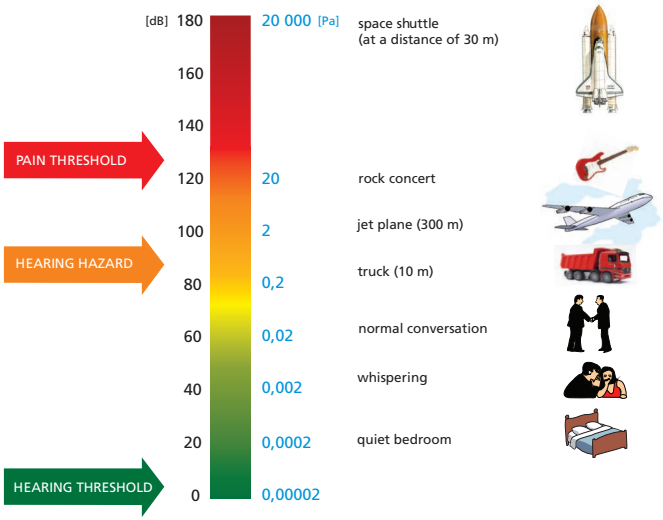
Photo: E. Schelstraete

■ About sound and noise

Sound consists of small, rapid, cyclical changes in air pressure. Our hearing system picks up these changes in pressure and converts them into the sound that we hear. However, this is a non-linear process which works according to a logarithmic scale. This is why sound level is expressed in decibels according to the following formula:

Sound level (dB) = 20 log (pressure/ 0.00002)

Figure 1 also shows this conversion, along with pictures to give an idea of what kinds of sounds produce the various levels.



Comparison of sound pressure, sound levels, and common examples.

Moreover, we hear sound in different frequencies, in a range from 20 to 20,000 Hz (Hertz). Since we are not able to perceive all pitches in the same way, when we talk about "noise level values", these are generally filtered for certain frequencies. For traffic noise, the A-filter is used, which focuses on the frequencies between 1000 and 4000 Hz, which are the frequencies for which humans have greatest sensitivity. These are then referred to as "A-weighted decibels" or dB(A).

Noise is sound that we experience as objectionable. This is subjective and will therefore differ from individual to individual. The sound that is generated by traffic is usually referred to as "traffic noise". The total traffic noise consists of three components: the engine noise, the aerodynamic noise and the rolling noise.

The rolling noise, generated by the tyre-pavement interaction, becomes dominant for speeds above 30 km/h for passenger cars and 75 km/h for heavy vehicles. In urban environments, where the driving speed is low and where city buses operate, the engine noise is the most important. Pavements for bus lanes should therefore be designed primarily with durability in mind.

Traffic noise can be abated by the construction of noise barriers and/or low-noise surfaces, the latter being the most efficient solution.

It is the challenge for road authorities to build quieter pavements that will sustain their noise-reduction benefits over time while not compromising on safety, ride quality and durability.

Project Tzen (Photo: Laurent Descloux - EPA Sénart Communication)

Photo: A.Nullens

■ Low noise concrete pavements

Quiet pavements are characterised by a smooth surface with no bumps or irregularities. They can either have a porous or a dense structure with small aggregates on the surface. In terms of surface finishing and texture, concrete surfaces have undergone a significant evolution in the past 50 years. Noisy surfaces are no longer used on motorways or trunk roads and those still in service are there thanks to the extraordinary longevity of concrete pavements. Transversely brushed finishing is still a good solution to attain a low-noise surface for low speed roads (≤ 50 km/h) but the present standard surface finishing in Europe is fine-grained exposed-aggregate concrete, either in a single layer or a double layer concept. Double-layered concrete motorways have been built in several countries, mainly in Austria, Germany, the Czech Republic, Poland, Belgium and the Netherlands.

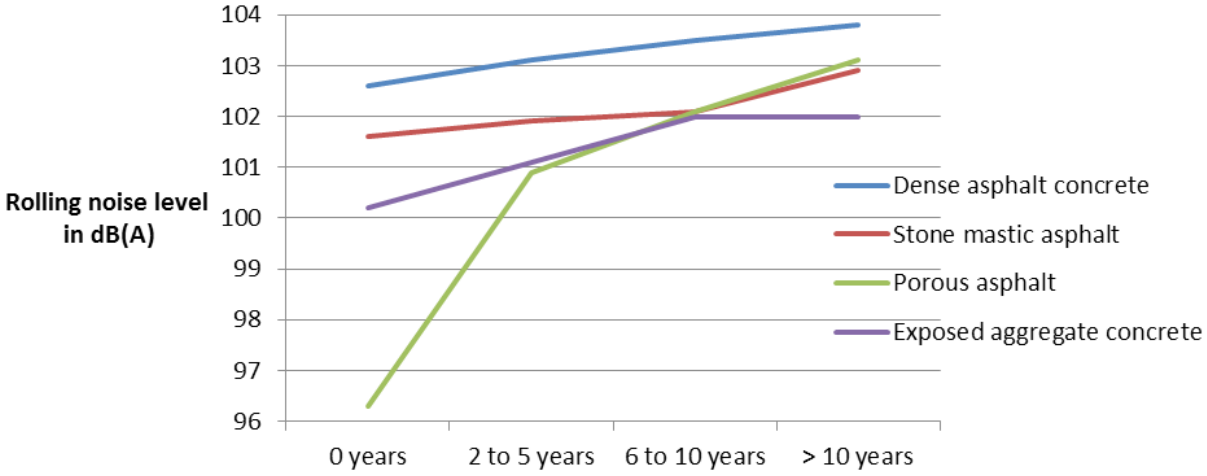
Alternative finishing techniques for concrete pavements are longitudinal tining, micro-milling, diamond grinding and the "Next Generation Concrete Surface", which is an optimised combination of grooving and grinding with very promising results for the future.

Fine-grained exposed aggregate concrete

Today, the technique of aggregate exposure is the most frequently used surface finishing method on concrete motorways in Europe. It offers a comfortable surface combining good skid resistance with low rolling noise.

In Austria, fine exposed-aggregate concrete was optimised as the surface layer of a double-layer jointed concrete pavement. The first applications on Austrian highways date back to 1990. Since then, a significant part of the highway network has been constructed in this way. An Austrian study revealed that all types of surfaces – asphalt and concrete, all with a same maximum aggregate size of 11 mm - show an increase in rolling noise level over time. The exposed aggregate concrete surface was the best performing solution over the long term.

Evolution of rolling noise level over time for different pavement surfaces



Diamond grinding

The technique of longitudinal tining of the hardened concrete, known as "diamond grinding" is also often used. This technique has already been used frequently in several countries for the restoration of existing concrete surfaces. This can result in tyre-pavement noise levels that are even lower than for exposed aggregate concrete.

Next Generation Concrete Surface

In the U.S., the International Grooving and Grinding Association (IGGA) has developed a smoother and even quieter surface, known as "Next Generation Concrete Surface" (NGCS). It combines the technique of diamond grinding with longitudinal grooves. It is described as the quietest non-porous concrete surface. In Europe there are also plans for trial sections in order to be able to assess the performance of this technique on an existing concrete surface.

The porous surface of "Modieslab"

"Modieslab" is a modular pavement system, developed in the Netherlands as part of the Dutch "Roads to the Future" programme. It consists of precast concrete slabs with a base layer in conventional concrete and a surface in double-layered porous concrete. This structure results in extremely low noise levels: 6 dB(A) less than the Dutch reference surface (densely graded asphalt). In addition, the durability of the noise characteristics is very good: only a 0.6 dB(A) increase in noise level after 5 years, which is far superior to the performance of other comparable surfaces. This makes it the best performing concrete surface in terms of noise abatement.

In a selection process for the type of pavement or surface, it is important to make a holistic evaluation of the possible options, taking into account not only the noise criterion but also the overall whole-life performance in terms of safety and durability. In terms of obtained noise levels, modern concrete pavements are very competitive with stone mastic asphalt surfaces, and outperform them over time.

FOR MORE INFO AND REFERENCES, *see the full EUPAVE Brochure "Durable Low-Noise Concrete Pavements" available on EUPAVE website and on request.*

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